A MORGAN-GRAMPIAN PUBLICATION

Digital Design

- Peripheral Controller Advances
- Dumb Terminals
- Embedded μP Applications
- Midwest's Silicon Valley

Industry Spotlight.
Dr. Walter Bolter on
DATA COMMUNICATIONS

COMPUTERS/SYSTEMS · PERIPHERALS · COMPONENTS ·

1/83
VOL. 13
NO. 1

Four reasons why you should look at our Winchesters

1. **100% SMD format and interface compatible.**
   Just plug it in and it is ready to accept data.
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   Kennedy can save you an average of $2000.00 per unit over comparable disk equipment.
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DCA'S SYSTEM 355 master network processor solves your data communications problems... and saves you time, money, and valuable space.

THE SYSTEM 355 maximizes data communications and minimizes headaches.

COMPLETE NETWORK TRANSPARENCY allows the interconnection of varied hosts and terminals.

VIRTUAL-CIRCUIT SWITCHING gives every network user a dedicated-line feeling.

ERROR-CONTROLLED DATA TRANSMISSION eliminates the probability of undetected errors and allows the use of low-cost hardware and less CPU memory.

COMPATIBLE MODULAR HARDWARE keeps repairs and upgrading quick and easy.

X.25 LEVEL 3 GATEWAY INTERFACE allows your network to access public data networks. And ASCII terminals in your network may communicate with any host supporting X.25.

44 TRUNK-LINK CAPABILITY offers centralized network management control with no geographic limitations.

DCA delivers what others are still promising. If you're stuck in traffic call DCA toll-free at (800) 241-5793. Digital Communications Associates, Inc., 303 Research Drive, Norcross, Georgia 30092.

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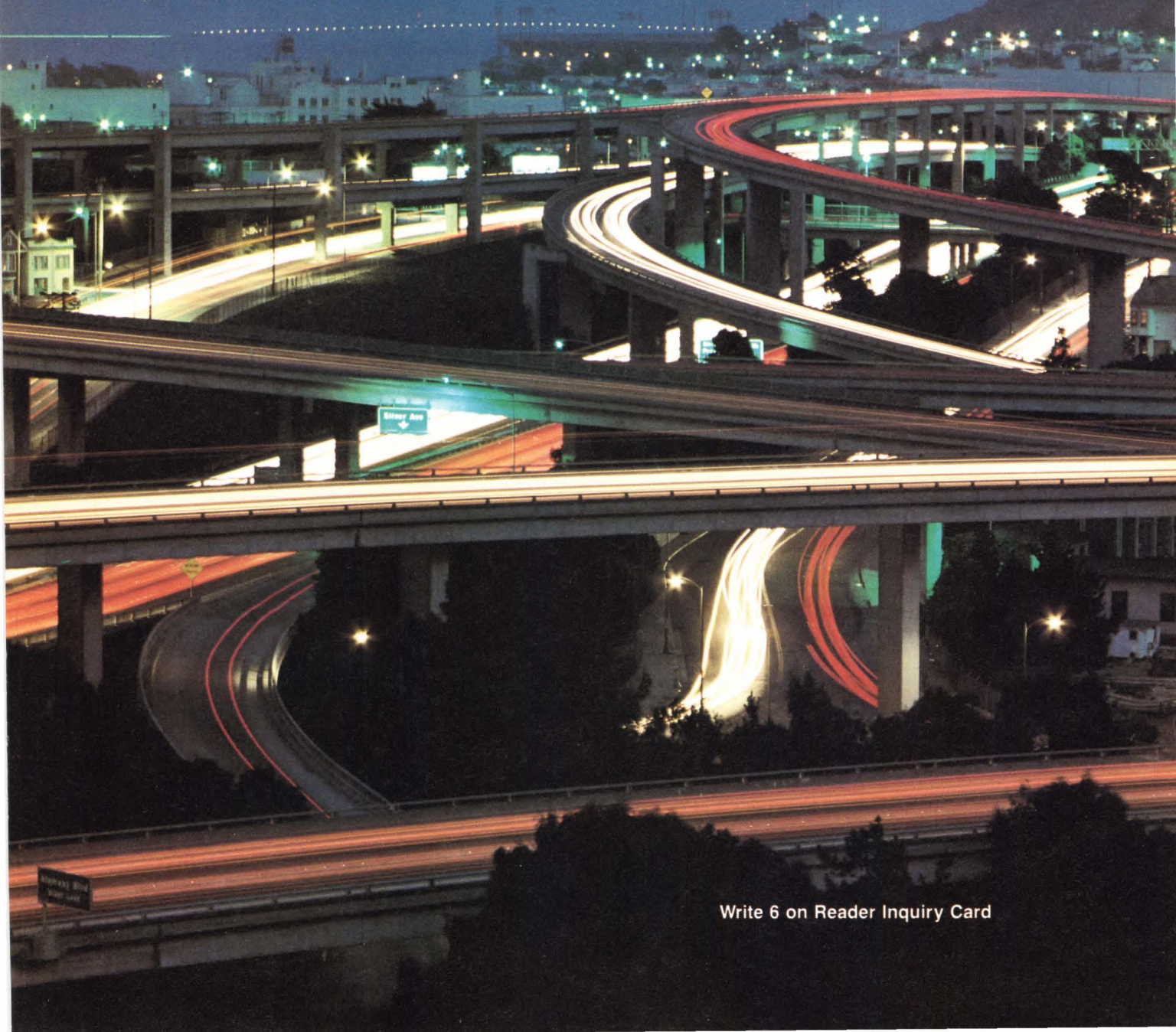
DCA Products Are Available Worldwide.

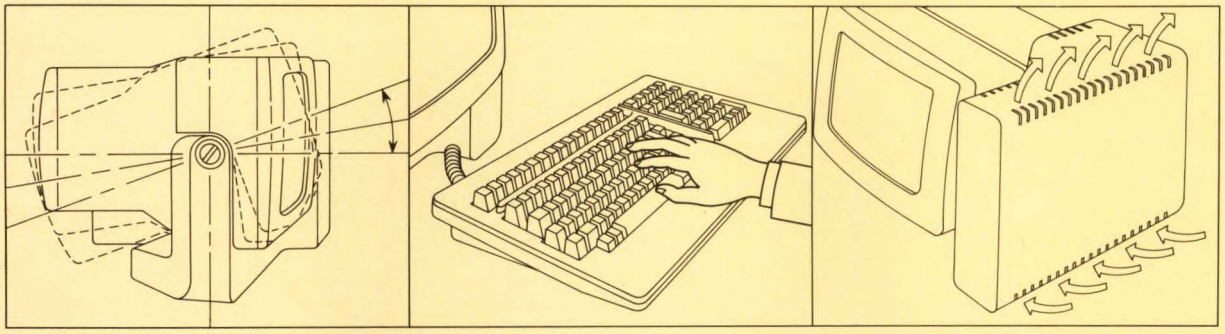
SIMPLE SOLUTION FOR NETWORK TRAFFIC SNARLS



Write 6 on Reader Inquiry Card


TELEVIDEO SYSTEMS INC PRESENTS THE 970
ANSI 3.64
256 DOWNLOADABLE FONT
14" SCREEN
VT-100 COMPATIBLE
32 NON-VOL. FUNCT. KEYS
ACCOUNTING KEYPAD
24 X 132 COLUMN
NO SPACE ATTRIBUTES
LOGICAL ATTRIBS.
TELEVIDEO 970
TeleVideo
MODEL 970

The new 970 from TeleVideo. Nothing else looks like it. Nothing else performs like it.



Productive office work depends on people and their equipment working efficiently together.

That's why we have engineered the exciting, new TeleVideo 970 to perform better than any other terminal.

For instance, only our "natural balance" tilting mechanism lets you easily adjust the screen at a touch, so you avoid neck-craning, straining and glare.

Our unique keyboard is designed to avoid user fatigue. We've created a natural palmrest, sculpted keys and the best ten-key accounting pad in the industry. Our non-volatile function keys save time and energy.

Like every feature of the new 970, the screen is designed for ease of use. Our non-glare 14-inch green screen is restful on the eyes, and its 132 column display can format more information. All in highly legible double-high, double-wide characters.

Our communications protocol is the industry standard ANSI 3.64.

As you probably know, most terminal downtime is caused by overheating that results from extended use. There's no such problem with our unique vertical convection cooling tower.

And because we wanted to extend the life of your CRT, we've installed a screen saving feature that automatically turns it off after fifteen minutes of idle time.

Naturally, like all TeleVideo terminals, service is available nationwide from General Electric's Instrumentation and Communication Equipment Centers.

The new 970 from TeleVideo. Nothing else looks like it and nothing else can perform like it.

For more information about TeleVideo's new 970, call 800-538-8725; in California 408-745-7760.

TeleVideo Systems, Inc.
Dept. # **220C**
1170 Morse Avenue
Sunnyvale, CA 94086

Yes, I'd like to know more about the unique 970 from TeleVideo:

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ADDRESS_____

CITY_____

STATE_____ ZIP_____

TELEPHONE (_____)_____

California/Santa Ana 714-557-6095; Sunnyvale 408-745-7760; Georgia/Atlanta 404-255-9338; Texas/Dallas 214-980-9978; Illinois/Chicago Area 312-351-9350; Boston/Massachusetts 617-668-6891; New York/New Jersey 201-267-8805; United Kingdom/Woking, Surrey 44-9905-6464.

TeleVideo Systems, Inc.

Write 11 on Reader Inquiry Card

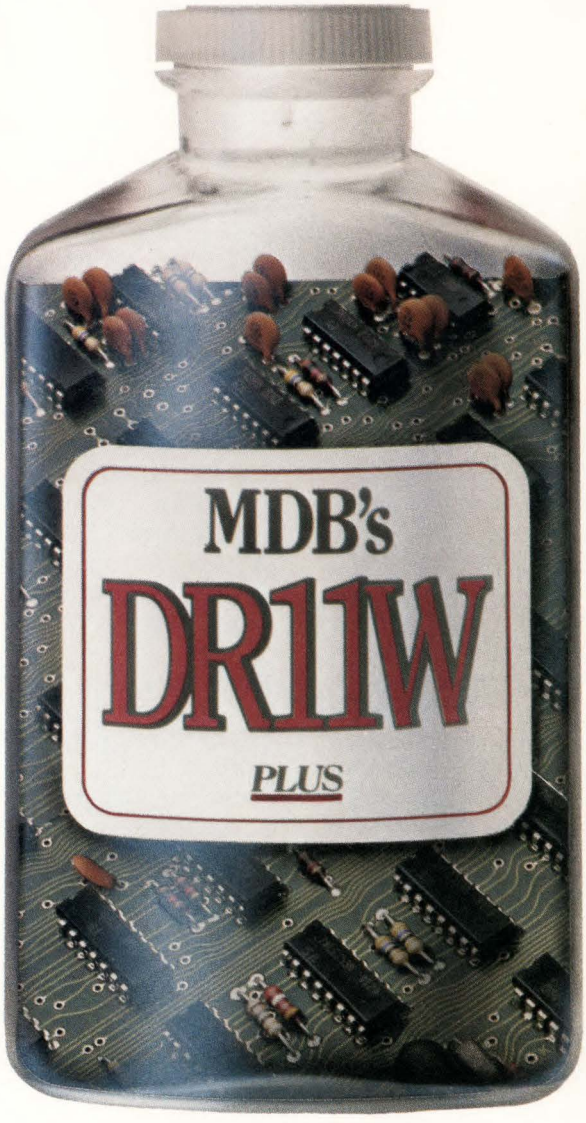
How do Unibus* users spell peak I/O rate relief?

High speed data acquisition can be a real headache. Especially during peak I/O rates when transfer can exceed the CPU's capacity and key bits of information go off in thin air.

So we developed a DR11-W module. First for the Unibus. Now for the Q-Bus. Both feature our exclusive DMA Throttle that efficiently regulates data flow down to average rates to maximize overall CPU performance. But that's not all.

Additional design features make it a cure for many other troublesome Unibus or Q-Bus system ills. For example, it offers:

- Edge mounted LED's to illuminate performance status
- Micro-sequencer driven, self-test diagnostics
- Long lines capability
- Switch selectable 22-bit addressing (Q-Bus)



- Bus Address Extension for memory transfer throughout the 4 megabyte range (Q-Bus)
- Switch selectable, level or single level interrupt arbitration (Q-Bus)
- Compatibility with 16, 18 and 22-bit backplanes (Q-Bus)

This high speed, digital input/output device is prescribed for such typical applications as:

- High speed graphics
- Digital data acquisition
- Parallel information processing
- Interprocessor linking between a Unibus and Q-Bus

There's more. And we're anxious to spell out all that the DR11-W and our complete line of computer interfaces can do for you. Call or write today and ask about full year warranty. Available under GSA contract #GS-00C-03330.

Now for Q-Bus* users too.

*TM Digital Equipment Corp.

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714-998-6900 TWX: 910-593-1339

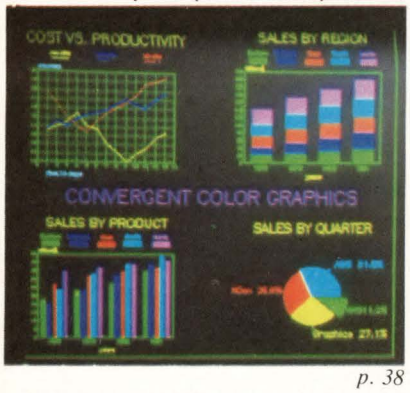
Write 8 for LSI-11, 49 for PDP-11.

See us at Southcon, Booths 651-653.

JANUARY 1983/VOL. 13, NO. 1

Digital Design

p. 30 (photo courtesy AT&T)



p. 38

(photo courtesy Convergent Technology)

p. 44 (photo courtesy Xylogics)

Cover

New technologies and rapidly changing federal regulations have placed data communications uppermost in the minds of system designers, as illustrated by this month's front cover (courtesy Racal-Vadic). Our January spotlight, beginning on p. 30, takes a thoughtful look at this dynamic industry.

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COMPUTERS/SYSTEMS

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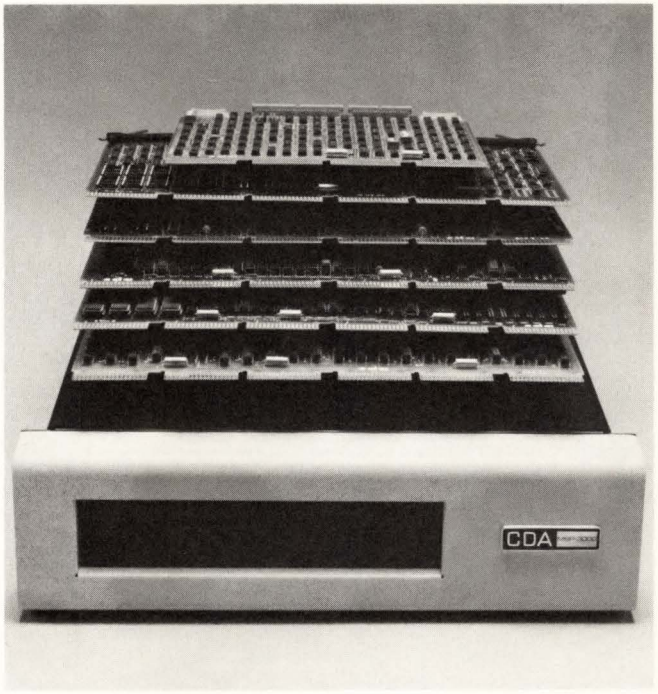
THE VERY PROGRAMMABLE
ARRAY PROCESSOR
FROM
CDA
COMPUTER DESIGN & APPLICATIONS, INC.



The MSP-3000 32-bit floating point array processor provides a level of programmability that other array processors don't. It includes a large Fortran callable library containing vector, matrix and signal processing functions. Additional mini-programming and microcoding levels simplify and speed easy development of special algorithms. Available programming tools include a symbolic assembly language, cross assembler, loaders and debuggers.

Complete systems, including 256 kilobytes of memory, array library and support software for the LSI-11,* PDP-11* or VAX* are under $25,000 in ten-unit quantities.

The DPG raster display controller attaches directly to the MSP-3000 internal bus. A high resolution display of up to 1024 x 1024 pixels is refreshed from the MSP-3000 data memory. The host bus need not be tied up to transfer processed data to the display.

Specifications

Speed: . . Five million floating point operations per second
Memory: 256KB, 512KB, 1MB, 1.5MB, 2MB
Display Format: . . . . . 128^2 256^2 512^2 1024^2
x 1, 2, 4, 8, 16, 32, 48 bits/pixel
Options: . . . . . Parallel I/O; joystick; color or b/w monitor

CDA
COMPUTER DESIGN & APPLICATIONS INC.
411 WAVERLY OAKS ROAD
WALTHAM, MA 02154
617/647-1900

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Tell us your thoughts

Digital Design is your forum — your inputs help keep the magazine interesting and vital to the design community. So let us know how we're doing and how we can serve you better in the future. We want to know what you like or dislike about *Digital Design,* the subjects you'd like to see us address, how you feel about the problems you face every day as design professionals.

If you have thoughts your peers should know about, put them in a letter in *Digital Design.* Have your say in *your* magazine! Send letters and comments to: Editor, *Digital Design,* 1050 Commonwealth Ave., Boston, MA 02215.

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BEACON™ PUTS MORE GRAPHICS AT YOUR FINGERTIPS.

It's a rare graphics system that can produce business graphics and also operate as an engineering work station for under $20,000. The Beacon™ System from Florida Computer Graphics puts it all right at your fingertips.

Using Multi-Processor Architecture (MPA) and 48-bit microcoded firmware, the Beacon System produces virtually instantaneous generation of vectors, arcs, circles, rectangles, and polygon fills. And BeaconBRIGHT™ makes those images far more visible even in brightly lit areas.

With the addition of 640KB of optional graphics memory, Beacon's 640 X 480 resolution can create a 1280 X 960 addressable image, typical of many CAD/CAM applications. This higher resolution, combined with the standard BeaconROAM™ and Zoom features, makes Beacon ideal for many engineering and scientific applications.

Check these unique Beacon features, standard on all models.

- A wide range of true graphics and character graphics including dot addressability, 1X zoom increments (up to 16X), horizontal and vertical scrolling in variable speed, and more.
- A palette of 256 colors; 32 usable at one time (16 in the graphics planes, 16 in the alphanumeric plane).
- Superior ergonomic design. From a display that's *twice as steady* as those advertised as "flicker free" to the monitor that tilts, swivels, and adjusts in height. Beacon leads the way in human-factors engineering.

Beacon works with joysticks, light pens, digitizer tablets, printers or plotters. It also interfaces with slide cameras, color copiers and even large screen video projectors.

For generating either business or engineering graphics, the Beacon System (stand alone or host dependent), offers a spectrum of capabilities unmatched in its price category. To find out more write for our full color literature:
Marketing Communications Manager
Florida Computer Graphics, Inc.
1000 Sand Pond Road, Lake Mary, FL 32746.
Or call (305) 321-3000. In the Continental U.S. outside Florida, dial 1-800-327-3170.

FCG

FLORIDA COMPUTER GRAPHICS
VISION IN COMPUTERS

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Calendar

February 1–3

EMTAS '83. Electronics Manufacturing Technologies and Systems '83 Conference. Phoenix Hilton Hotel, Phoenix, AZ. Contact: SME, One SME Dr., PO Box 930, Dearborn, MI 48128. (313) 271-1500.

February 1–5

Kuwait Info '83. 2nd Int'l Information Management Exposition and Conference. Kuwait Int'l Exhibition Center, Safat, Kuwait. Contact: Clapp & Poliak Int'l, 7315 Wisconsin Ave., PO Box 70007, Washington, DC 20088. (301) 657-3090.

February 2–4

Peripherals '83. Peripherals Suppliers Exhibition. Contact: IPC Exhibitions Ltd., Surrey House, One Throwley Way, Sutton, Surrey SM1 4QQ, England. Tel. 01-643-8040.

February 7–9

Electronic Display Technology Course. Contact: The Center for Professional Advancement, Dept. NR, PO Box H, East Brunswick, NJ 08816. (201) 249-1400.

February 22–24

Industrial Productivity Conference and Exposition. The San Jose Convention and Cultural Center, San Jose, CA. Contact: SME, One SME Dr., PO Box 930, Dearborn, MI 48128. (313) 271-1500.

February 23–25

Int'l Microelectronics and Teleinformatics Conference. Milan, Italy. Covers VLSI as a tool and application in teleinformatics. Contact: Bias-Microelectronics Conference, Fast, Pile R. Morandiz, 20121, Milano, Italy. Tel. (02) 78-3051.

February 23–25

ISSCC '83. 30th Int'l Solid-State Circuits Conference. New York, NY. Contact: IEEE, 345 East 47th St., New York, NY 10017.

February 23-25

Microsystems '83. Buyers and specifiers of all types of microcomputers, microprocessors and associated services. Contact: IPC Exhibitions Ltd., Surrey House, One Throwley Way, Sutton, Surrey, England, SM1 4QQ. Tel. 01-643 8040.

February 28–March 2

Optical Fiber Communication. Topical Meeting and Exhibit. Hyatt Regency, New Orleans, LA. Contact: Meetings Dept., Optical Society of America, 1816 Jefferson Place, NW, Washington, DC 20036. (202) 223-8130.

March 1–3

NEPCON West '83. Anaheim Convention Center, Anaheim, CA. Contact: Cahners Exposition Group, 222 W. Adams St., Chicago, IL 60606. (312) 263-4866.

March 3, 9, 15

Invitational Computer Conference. 4th International ICC Series. Frankfurt, Germany. March 9, Paris, France. March 15, London, England. Contact: Susan Fitzgerald, B. J. Johnson & Associates, 3151 Airway Avenue, #C-2, Costa Mesa, CA 92626. (714) 957-0171.

March 8–9

SIGCOMM '83. Symposium On Communications Architectures And Protocols. University of Texas, Austin, TX. Contact: Rebecca Hutchings, Honeywell/FSD, 7900 Westpark Dr., McLean, VA 22102. (703) 827-3982.

March 10–12

International Computer Color Graphics Conference. Tallahassee-Leon County Civic Center, Tallahassee, FL. Contact: Computer Graphics Applications, 314 Wescott, Florida State University, Tallahassee, FL 32306.

March 14–16

Electronic Display Technology Course. Contact: The Center For Professional Advancement, Dept. NR, PO Box H, East Brunswick, NJ 08816. (201) 249-1400.

March 14–16

Phoenix Conference On Computers And Communications. Phoenix, AZ. Sponsored by IEEE in conjunction with The Computer And Communications Societies. Contact: Gerald Fetterer, GTE Automatic Electric Lab, 2500 W. Utopia, Phoenix, AZ 85027.

March 16–18

Ink Jet Printing Conference. Novotel, Amsterdam, Holland. Contact: Richard D. Murray, Director of Conferences, Institute for Graphic Communication, 375 Commonwealth Ave., Boston, MA 02115. (617) 267-9425.

March 20–22

Electronic Imaging Conference. Andover Inn, Andover, MA. Contact: Richard D. Murray, Institute for Graphic Communication, 375 Commonwealth Ave., Boston, MA 02115. (617) 267-9425.

March 21–24

Interface '83. 11th Annual Conference. Miami Beach Convention Center, Miami, FL. Contact: The Interface Group, 160 Speen St., PO Box 927, Framingham, MA 01701. (617) 879-4502 or (800) 225-4620.

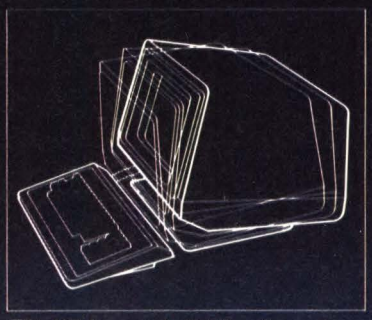
March 22–24

Engineering Workstations Conference. Andover Inn, Andover, MA. Contact: Richard D. Murray, Institute for Graphic Communication, 375 Commonwealth Ave., Boston, MA 02115. (617) 267-9425.

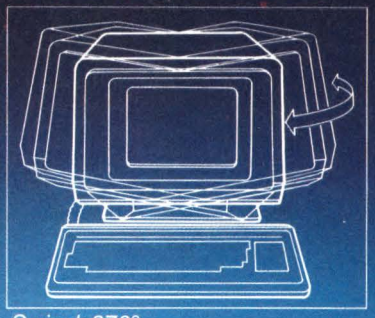
March 24–27

Computer Showcase Expo. Atlanta, GA. Contact: The Interface Group, 160 Speen St., PO Box 927, Framingham, MA 01701. (617) 879-4502 or (800) 225-4620.

VISUAL presents ergonomic elegance and high performance in a low-cost terminal.



Tilt: 10° forward, 15° backward



Swivel: 270°

$695 list

The VISUAL 50 represents a new approach in low cost terminals. Although it costs drastically less, it offers the features you expect from the high priced units.

For example, the VISUAL 50 enclosure is ergonomically designed in light weight plastic and can easily be swiveled and tilted for maximum operator comfort. A detached keyboard, smooth scroll, large 7 × 9 dot matrix characters and non-glare screen are a few of the many human engineering features normally offered only on much higher priced terminals.

Another distinctive feature of the VISUAL 50 is its emulation capability. VISUAL 50 is code-for-code compatible with the Hazeltine Esprit,™ ADDS Viewpoint,™ Lear Siegler ADM-3A™ and DEC VT-52.® Menu driven set-up modes in non-volatile memory allow easy selection of terminal parameters.

And you're not limited to mere emulation. As the chart shows, the VISUAL 50 has features and versatility the older, less powerful low cost terminals simply cannot match.

FEATURE COMPARISON CHART

FEATURE	VISUAL 50	Hazeltine Esprit	ADDS Viewpoint	Lear Siegler ADM-5	TeleVideo® 910
Tilt and Swivel	YES	NO	NO	NO	NO
Detached Keyboard	YES	NO	YES	NO	NO
N-Key Rollover	YES	NO	YES	NO	NO
Audible Key Click	YES	YES	NO	NO	NO
Menu Set-Up Mode	YES	NO	NO	NO	NO
Status Line	YES	NO	NO	NO	NO
Full 5 Attribute Selection	YES	NO	NO	NO	YES
Smooth Scroll	YES	NO	NO	NO	NO
Line Drawing Character Set	YES	NO	NO	NO	NO
Block Mode	YES	YES	NO	NO	YES
Insert/Delete Line	YES	YES	NO	NO	YES
Bi-Directional Aux Port	YES	YES	NO	YES	NO
Columnar Tabbing	YES	YES	NO	NO	YES
Independent RCV/TX Rates	YES	NO	NO	NO	NO
Answerback User Programmable	YES	NO	NO	OPT.	NO

VISUAL **See for yourself**

Visual Technology Incorporated
540 Main Street, Tewksbury, MA 01876
Telephone (617) 851-5000. Telex 951-539

Write 5 on Reader Inquiry Card

News Update

Am29116 Price Reduction

Advanced Micro Devices, a manufacturer of bipolar integrated circuit devices, has announced a 15% price reduction for its proprietary Am29116 16-Bit Bipolar Microprocessor. Over the next three years, the Am29116's price is projected to decline at a rate of 30% per year, making the 1000-piece price under $70 in 1985.

National Sells Transducer Operation

National Semiconductor Corp., Santa Clara, CA, sold its transducer business to a new firm called Sensym, Sunnyvale, CA. Sensym has been formed by a group of former National employees and will use the same sales representative and distribution channels used by National.

Televideo Signs Licensing Agreement

Televideo Systems has signed the first software licensing contract for extending the CP/M-86 operating system with GSX Graphics Software. Televideo will offer GSX along with CP/M-86 on TeleVideo's 1602G and 1602GH 16-bit small business computers with high resolution graphics.

Ada Solution For Military Computers

ROLM Corp., Santa Clara, CA, announced that it is the first company to release a fully implemented DoD-Spec, ANSI 1982 Standard Ada Compiler and Ada Development Environment (ADE) coupled with a powerful multi-terminal, 32-bit computer system. Named the ROLM Ada Work Center, the system allows from eight to 128 simultaneous users to become immediately productive in the development of Ada language applications.

Semi-Custom Group Formed

American Microsystems, Inc. (AMI), Santa Clara, CA, announced the formation of a new Customer-Product Group. The semi-custom group will join together AMI's gate array, standard cell and alterable microcomputer programs to provide an increased integrated emphasis on the design, fabrication and marketing of these semi-custom integrated circuit solutions.

New Pricing For DSD Controller Boards

Multibus-compatible controller boards that can simultaneously interface to Winchester, tape and floppy drives are now available for $950 in quantities of 100 from Data Systems Design, Inc., San Jose, CA. These single-board controllers were previously priced from $1,200 to $1,300 in quantities of 100.

Second-Sourcing Agreement

Mitel Corp. and AMI announced the signing of a mutual second-sourcing agreement for the u-Law and A-Law single-chip codecs. As part of the exchange Mitel will furnish AMI with tooling for the MT8960 thru MT8963 families, and AMI will provide tooling for Mitel's synchronous and asynchronous codecs.

ARTIS Available For License

Color Terminals International, Troy, MI, developer of ARTIS, has negotiated two licensing agreements with Via Video, Cupertino, CA, and Computer Graphics, Inc., Lake Mary, FL. Graphics software which currently runs on the ARTIS Color Graphics Service System is now available for license to end users, OEM's and systems integrators.

California Devices Licenses CorinTech

California Devices, Inc., manufacturer of semicustom gate arrays, has completed an agreement with CorinTech Microcircuits, Ltd., Hampshire, England, to manufacture and sell CDI's products in the UK and Europe. This agreement gives CorinTech exclusive license to CDI's metal and silicon gate technologies in the UK and non-exclusive license for the rest of Europe.

Toward Higher Productivity

Interdesign, Inc., Scotts Valley, CA, has converted to a ten hour day, four day work week with a thirty-six hour weekend shift. The company expects the new schedule to result in both higher productivity and more efficient equipment utilization, and will provide greater accessability to customers on the East Coast and in Europe.

1K Complex FFT in 0.5 msec and faster...

MARS-232 Array Processors Support the User
who needs:

Signal Processing
with programmable high-speed arithmetic, logical, and decision-oriented operations for real-time applications.

Data Acquisition
directly into the processor at sample rates up to 20 MHz via a prioritized multi-port bus structure.

Standard I/O Interfaces
using 32-bit digital I/O, A/D and D/A modules with speeds up to 5 MHz, all with software support for ease of integration.

Architectural Modularity
to configure ultra-high performance multi-processor systems reaching to 300 million arithmetic operations per second and beyond.

OEM Capabilities
where, as a development system, the MARS-232 supports low-cost ROM-based MARS-132's or customized user-defined VLSI implementations.

MARS-232 Array Processor Features Include:

- 1K Complex FFT Performance
  1.05-msec Single Data Processor
  0.5-msec Dual Data Processor
- 100-ns Clock
- DMA Transfers at I/O Bus Rates of 20 Mbytes/second
- Modularized 16- or 32-bit Arithmetic Units
- Multiple Processor Configurations for Application Flexibility
- Low-cost OEM Configurations
- Full Software Support at Systems/Utilities/Applications Levels

MARS-232 Array Processor Software
In today's world it is not enough to have outstanding hardware. Our interactive software system, GSP, allows hands-on assembly/disassembly, loading, debugging, and diagnostic services – with multiple processor support built-in. For the real-time environment, we use ESP, a host-resident executive. It provides intelligent supervision for host programs that call applications library or user-defined subroutines, without compromising the speed of MARS.

MARS-232 Applications
With its high computational capacity and low cost, the MARS family provides solutions for a broad range of application areas – on-line video inspection and image analysis; front-end data acquisition, compression, and formatting; spectral analysis, filtering and thresholding.

MARS- a new world of performance for medical, seismic, radar, sonar, and communications systems.

NUMERIX

For additional information on the MARS Family of High Speed Array Processors, write or call:
Numerix Corp., 320 Needham Street, Newton, MA 02161 Tel. 617-964-2500

Write 50 on Reader Inquiry Card

News Update

Software Conversion

Floating Point Systems, Beaverton, OR, and MacNeal-Schwendler Corp., (MSC) announced plans under which the MSC/NASTRAN engineering analysis software will be converted to operate on the FPS-164 Attached Processor. The FPS-164 high-speed 64-bit arithmetic processor attaches to systems from DEC, IBM and Sperry Univac, to process computationally-intensive engineering and scientific jobs.

Joint Specification For 16K PROMs

Raytheon's Semiconductor Div., and Advanced Micro Devices have agreed upon a joint specification for their power-switched 16K PROMs. This agreement allows users alternate-sourced plug-in replacements with common functionality.

Natel Enters Custom Hybrid Market

Natel Engineering, Chatsworth, CA, is planning to enter the custom high performance hybrid microcircuit business. Custom work will be accepted from those looking primarily for high performance, high reliability military and industrial hybrid circuits; all produced in accordance with military specifications.

ERG Offers VME Bus With NS16032

Empirical Research Group, Kent, WA, is offering their VME Bus with National Semiconductor's 16032, 16/32 bit microprocessor. The multiprocessing 16/32 bit VME bus is part of a package that includes National Semiconductor's 10 MHz, 16/32 bit, NS16032 microprocessor, along with the internationally accepted Eurocard format.

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General Electric Enters The Gate Array Market

General Electric announced in November, 1981, that its wholly owned subsidiary, Intersil, would formally enter the gate array market, which is estimated to be worth $800 million in 1986. The

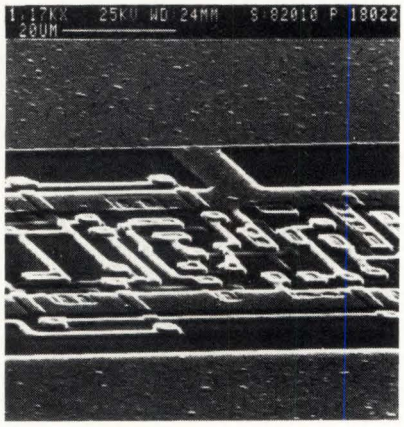

Figure 1: Photo taken by scanning-electron microscope shows divider circuit's features as small as 1.25 microns.

announcement reflects the efforts of GE's Technical Systems Group who purchased both Calma and Intersil in 1981. The Calma acquisition seemed a natural extension of the company's design and engineering interests, but the Intersil purchase raised questions about the company's possible desire to compete in the semiconductor marketplace. James A. Baker, Executive Vice President for the Technical Systems Group stated that GE has no intention of competing with the memory chip segment of the market. The company has recently signed a joint agreement with Intel to provide one of its microprocessors as a second source (in combination with some of its analog logic) while providing a return of GE licenses to Intel.

Baker outlined a four-fold approach to GE strategy to capture a large segment of the gate array market: use of CAD systems from CALMA, the acquisition of Intersil with its strength in CMOS manufacture, use of the scientific resources of GE's Corporate Research and Development Center, and a new Microelectronics Center—which has recently begun production and research for Intersil in Research Triangle Park in North Carolina.

The new production facility cost $55 million; only part of the $100 million that GE has infused into Intersil to allow it to compete effectively in the IC logic (TTL and CMOS) and custom IC markets. This investment indicates several aspects of GE's interest: the belief that CMOS will be the dominant silicon market in the near future, that GE's other internal divisions must have access to custom IC products, and, in addition, of the recognition of the need to implement analog functions on silicon

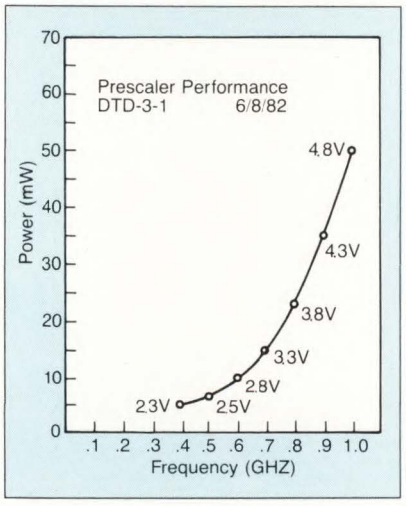

Figure 2: Clock rates for circuits with lengths of 1.1 and 0.9 microns such as those shown on Figure 1.

chips (signal processors, and power supply chips for A/D or D/A). Current production is for 3μ levels of VLSI, but 1.25 μ distances are going to be implemented under the company's advanced VLSI program.

The market internally is so large that Intersil already has an order backlog of 22 custom chips from GE divisions. The attractiveness of the gate array approach to semi-custom IC development is shown in the reduction of production time for a chip from approximately 14 months to as little as 10 weeks.

Part of the marketing effort will include a new approach made possible by the companies CAD, CMOS, and research expertise. GE claims that one of the important advantages of the program will be to allow the small and medium sized manufacturer to develop their own semicustom chip. The Gate Array program will provide a five day training in their design system, and then the customer and a GE team will work together to customize the chip. Such training has already begun at the new facility in Raleigh for GE companies wishing to make use of the system.

Intersil, and Datel-Intersil the sister company also wholly owned by General Electric are among the top ten semiconductor producers in the US with over 3,000 employees in their facilities in California, North Carolina, Massachusetts, India, and Ireland. The current strength of the company is in the production of HMOS ROMS, with some production for RAMS. The thrust of the development of the new facility in North Carolina, however is to strengthen the companies work in CMOS. Sales however, are the reverse with 80% of the volume being in CMOS and 20 for other products. The HMOS products relate to the data acquisition mar-

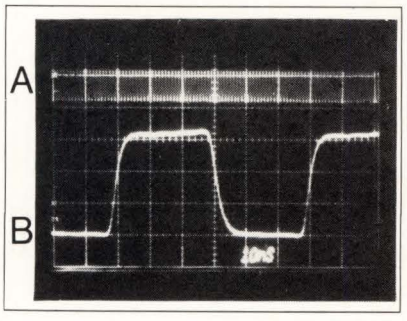

Figure 3: Output waveform (trace B) for the prescaler circuit shown in Figure 2. Input frequency (trace A) is 1 GHz.

ketplace, while the CMOS work is for custom applications.

The initial offering in gate array chips will be of three sizes: 408, 766, and 1500 gates respectively, and in the near future the company will offer 1,000 to 6,000 gate chips. The company predicted that the cost will be in the $5 to $15 range in quantities of 25,000. The first chips have the equivalent of several thousand device circuits, while the latter offerings will offer up to 500,000 devices per chip. One current application for the existing gate array chip is for a microprocessor-based heart pacemaker with incorporates all analog sensing on-board. Successive devices will find use in light bulbs, roots, fan motors, and jet engines—roughly approximating the GE product line.

—Borrell

New Offerings From Data General And Harris

With particular emphasis on industrial automation, Data General announced the Eclipse MV/4000, the newest member of its 32-bit MV family. (See **Table 1**). DG claims that revenues for this marketplace, which today account for less than two billion dollars, should reach eight billion by 1985, $27 billion by 1990 and $90 billion by 1995, a growth rate of 34% per year.

The Eclipse MV/4000 computer features a microprogrammed architecture on a two-board CPU, and can be used either as a standalone system or as a part of a distributed network. The design uses Fujitsu's gate array logic and PAL technology. Faults are isolated by ROM-based powerup diagnostics built onto the processor boards. A microcoded soft console controls the processor microdiagnostics and system error logging to allow determination of system status. The instruction set is fully upward compatible with other members of Data General's Eclipse MV Family computers.

In addition, the Eclipse MV/4000 provides a 16KB user writeable control store, implemented as 4K X 32 bits, to define additional instructions, and further enhance the instruction set.

Application development languages include: ANSI standard implementations of Cobol, Fortran, PL/I, and Basic; a Pascal implementation, which conforms to the proposed ANSI standard; industry-standard APL, RPG II and "C" Compiler; and DG/L development language. The major development languages feature a common code generator, optimizer, and runtime libraries to enhance development efficiency and programmer productivity. Other programming utilities include the PROXI COBOL program generator, SWAT high-level language debugger, SGU screen generator, TCS Text Control System, and MPL macroprocessor for procedural languages.

Characteristics	MV/4000	MV/6000	MV/8000
Data General Relative Performance	.4	.8	1.0
Mips	.6	1.2	1.2
Memory Size (MB) (Min-Max)	1–8	1–4	1–12
Machine Cycle Time (ns)	200	220	220
I/O Bandwidth (MB/Sec)	5.0	18.2	18.2
Cache (Buffer) Size	None	16KB	16KB
Bus Architecture	Yes	Yes	Yes
Price/MB Main Memory	$9,000	$9,000	$9,000
Intelligent Asynchronous Controller (IAC)	Optional	Optional	Optional
Whetstones (KWIPS)			
Single	600*	1240	1260*
Double	400*	415	995*
Writeable Control Store	Optional	---	---
Online Storage (Max) (GB)	4.7	6.0	9.6
Number of Terminals	Up to 64	Up to 96	Up to 128
Logical Address Space (GB)	4.0	4.0	4.0

* With optional hardware Floating Point Unit.

Table 1: Data General Corporation's 32-bit Eclipse systems.

Programs developed on 16-bit Eclipse systems can also run under AOS/VS on the new computer. Because AOS/RT32 is a runtime subset of AOS/VS, programs can be developed and debugged under AOS/VS for transport to the AOS/RT32 runtime environment. In addition, programs targeted for microNOVA, NOVA, and 16-bit Eclipse systems can be developed, debugged, and tested on the new system by using Data General's cross Development Software.

One application of the MV/4000 is supervisory control. Here, the MV/4000 controls and acquires data from a circuit board manufacturing line. The circuit boards are first drilled with a laser that is controlled by an Eclipse S/20 computer. At the next station, component insertion is controlled by an Eclipse S/120 computer.

At the last station, automatic testing is done under the control of an Eclipse S/140 computer.

Figure 1 illustates where Harris are positioning their new 700 superminicomputer in relation to DEC. The 700 competes with a range of superminis including the VAX. Its modular performance enables users to add appropriate enhancements as needed without exchanging the CPU.

A cache memory performance enhancement option, extended

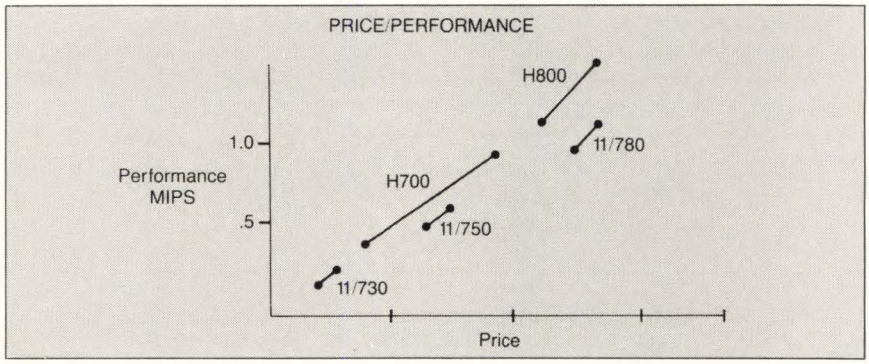

Figure 1: Price/performance of Harris machines versus DEC (courtesy Harris). Note: Prices may vary depending on peripherals used.

addressing features, an optional floating point processor and a new memory are key elements of the Harris 700. For example, the cache memory enables the H700 to support as many as 128 terminals.

Features of the H700 (**Figure 2**) include Harris' new Integrated Memory Subsystem (IMS), which combines a memory controller and memory arrays on a single board. With IMS sizes of 384KB, 768KB or 1.5MB, the Harris 700 supports up to 12MB of physical memory. It also offers up to 48MB of hardware implemented virtual memory, a program size of up to 6MB and up to six ports of shared memory. Under VOS, Harris' virtual operating system, there is no limit to the number of tasks which can run concurrently in the 48MB virtual space.

Harris' claim both that hardware-implemented virtual memory gives users the best of both the virtual memory flexibility and real-time response time, and that competitive machines either do not have virtual memory or provide software-implemented virtual memory which is not as fast. Performance on a virtual memory machine can be enhanced by adding more physical memory, as a general rule.

Other Harris products available with the Harris 700 are the new integrated Disk Controller (IDC) and the Communications Network Processor (CNP). The IDC combines the I/O channel and disk controller functions on one board and supports up to four disks. The single board CNP simultaneously supports up to 16 individually programmable communications lines for local or remote device connection via synchronous, asynchronous, isosynchronous and × .25 protocols. The operator's console port is also on the CNP.

The Harris 700 is fully compatible with Harris' entire line of virtual memory systems—the Harris 80, 100, 300, 500, and 800.

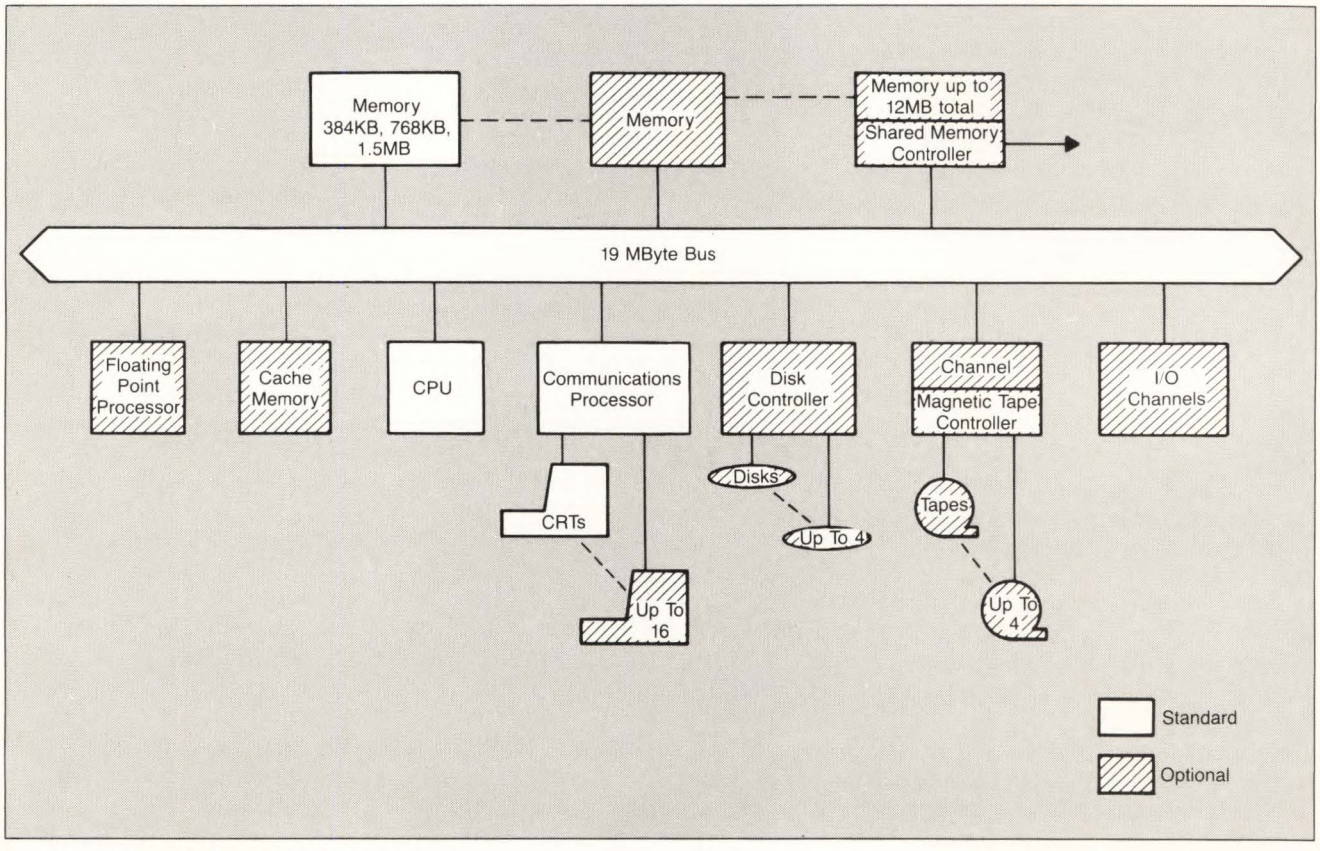

Figure 2: Harris 700 system block diagram.

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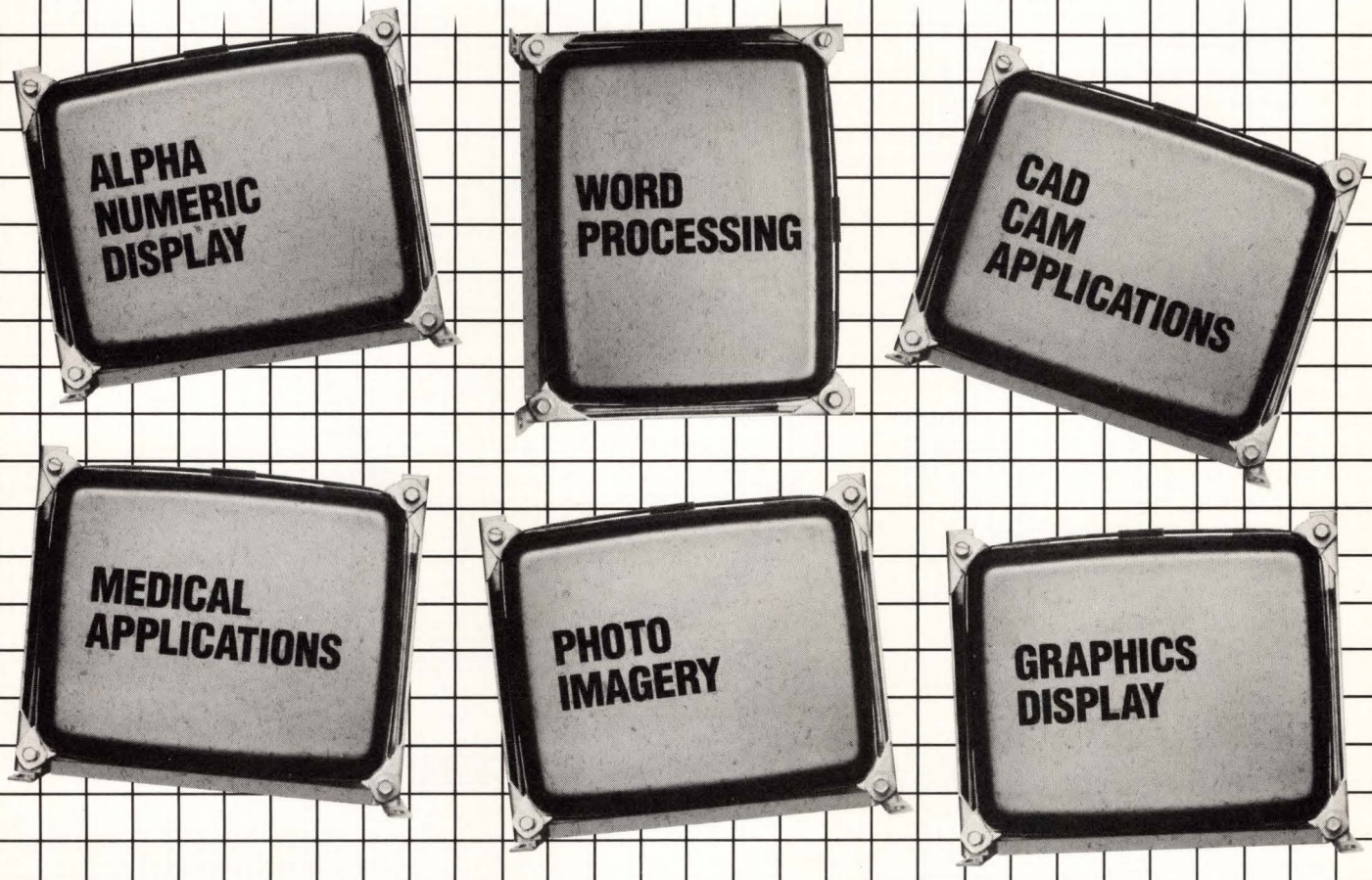

Yesterday's ideas might not be good enough for today or tomorrow, and selecting the proper data display has never been more significant. Recent studies in the computer marketplace indicate the CRT display has become the single-most important element in today's computer systems. An easy-to-read, jitter-free display is of course a dynamic part of this critical man/machine interface.

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Color Impacts Alphanumeric CRT Market

The ever expanding alphanumeric CRT terminal market will be heavily impacted by color terminals in the near future. Although color is usually associated with graphics terminals, it is quickly becoming more popular in alphanumeric terminals. In 1981, over 30% of the US manufacturers were offering color alphanumeric terminals. These manufacturers include Data General, Datamedia, IBM, and most of the 3270 plug-compatible manufacturers who are now making 3279 plug-compatible terminals. The 3279 is IBM's color version of the 3270 terminal.

According to a recent study by VDC, 65.4% of the US alphanumeric CRT manufacturers will offer color terminals by 1986. Only 7.7% of the manufacturers have no intention of getting into the color market segment, with the remainder undecided.

Color alphanumeric terminals will be used for new applications such as computer-aided education, home information systems and color highlighted word processing. The Data General color alphanumeric terminal is currently being used in applications such as process control, financial, scientific and data base information systems where color highlighting is desirable. In addition, many of the new color alphanumeric terminals will also offer limited graphics capabilities.

The VDC study indicates that over 50% of the alphanumeric terminals shipped in 1981 are being used for data entry and inquiry/response applications. This will change in the future as more color terminals are introduced into the market.

For further information contact: *Venture Development Corporation, One Washington Street, Wellesley, MA 02181. Tel: (617) 237-5080.*

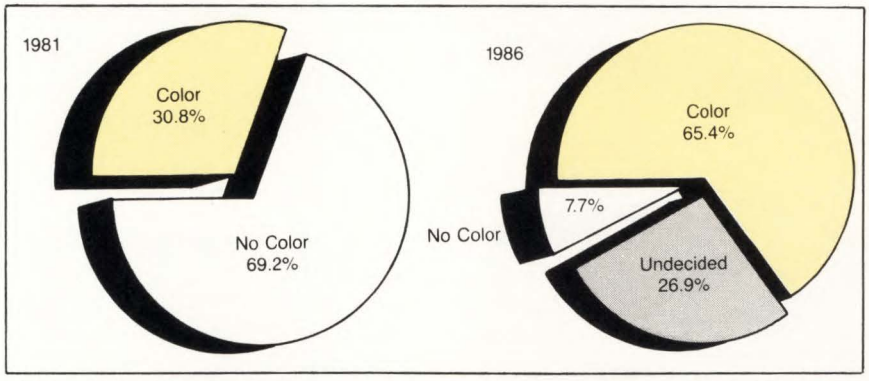

Figure 1: Number of alphanumeric CRT terminal manufacturers offering color capabilities (percent of respondents).

ADA And Motorola 68000 Combined In First Nonmilitary Use

Intellimac, a Rockville, MD based firm, recently announced the availability of a new series of multiuser 68000 based computers. Softech Inc, contracted by the Department of Defense to develop ADA as a standard language, has plans to implement ADA on the new Intellimac system. The development is a coup for the Rockville firm which has been working with ADA over the past five years, developing one of the only commercial software packages and the first installations of ADA for NASA and Naval Operations in that language. The development may also prove to be of great importance to the growth and application of ADA which is still held by many to be "too large" to implement on small computer systems.

The company has three areas of strength: hardware development based on its 68000/Multibus/single board computer, Software Development for multi-user systems, and Turnkey systems some of which are based upon AI programming.

The marketplace for ADA over the near future holds the promise for enormous development. Despite early criticism of ADA, a recent DOD estimate places the market for the software at about 7 billion by 1985. It has gained strength recently as a result of the recognition that the non-transferability of languages, programs, and applications software are preventing effective evaluation of price versus performance by DOD agencies.

Proponents of the language see its standardization as necessary to bring what some consider chaotic conditions in the military computer environment into order and to speed the process of program development. The latter is true because ADA was developed with modules in discrete easily documented packages—such packages are more easily modified than is possible with other languages. The language's detractors note that because there are no extensions of the language it will be more difficult to tailor it to fit new applications. Another point is that all ADA compilers will require the approval of the DOD before they may be sold because the language has been trademarked by the DOD. The rebuttal to both of these is that the designers hope to maintain its transportability. Supporters also point out the major firms such as IBM and DEC have yet to release compilers in ADA, and this may form part of the resistance to the language.

The base of the company's rap-

id development is its two series of Motorola 68000 computers: the 7000K and 7000M systems. The K and M series make use of single board 68000 computers with 256K of onboard RAM. Designed for a multiuser environment the systems have 8 RS232 ports, Multibus slots for expansion (9 or 21 slots), floppy disks and internal hard disks (in 160 or 80 MB configurations). The company's ability to provide software such as the UNIX operating system and its own multitasking operating system, screen editors, diagnostics, and both Telesoft-ADA compiler and a PASCAL compiler are a distinct advantage for the system. One other aspect, not normally considered in selection of a powerful computer system is its design for extremely high reliability and ruggedness.

The company's founder and Vice-President have military backgrounds. Not surprisingly their work with the military is reflected in features such as high strength packaging, voltage fluctuation protectors, powerful cooling systems, security locking of the system cabinet and component selection based upon reliability; combine to give the system an above normal MTTF.

The multiboard design of the M series allows multiple 68000 boards to be connected to the same bus; however, individual tasking can be done on each of the boards. For a performance benchmark, the company cites a test for a K configuration of the Intellimac system in which a triple-nested loop written in "C" under UNIX Version 7 performed at 50% of the speed of the VAX 11/780 (with both machines in a single user mode). The same system however, is available in over 7 different configurations of storage and memory access.

Recent selection and purchases of the company's systems by GTE and Singer Librascope over DEC products indicates to its management that both its hardware approach with the 68000 and its continued work with ADA are going to pay off. A recent RFP from WMMCCS Command at the Pentagon declaring that "ADA will be the only applications programming language" on its computers further strengthens the near term outlook for firms using ADA.

—Borrell

The IBM Personal Computer Market And Beyond

During 1981, Columbia Data Products (Columbia, MD) was working to develop a 16-bit μC product to expand its line of computers. The product was to be based on the Intel 8086/7 but before the design could be completed IBM announced the release of its Personal Computer. The designers of the New Columbia Data Products (CDP) system realized the importance of the IBM release and decided to modify their design to be compatible with the IBM product. IBM had not only anticipated this sort of emulation, but actually encouraged it (as had Apple Computer) to insure that their product would become embedded in the microcomputer market. The cottage industry phenomenon is encouraged by allowing third party manufacturers to supply peripherals or additional boards for the main system. This allows the smaller and faster manufacturers to address specialized markets that the main manufacturer may not profitably build for—and in the long run raises sales for the primary system.

During their initial examination of the system, the CDP designers noticed what they felt were shortcomings in the IBM design. The biggest problem had to do with the motherboard configuration for additional PC cards; While IBM allowed for 5 slots, all of these were used in basic system requirements such as the disk controller card, additional memory, and serial port card. In order to run many of the popular software programs, such as the Peachtree or Visicorp programs, the slots would be filled by memory requirements. The approach at CDP was developed with a twofold intent: to provide all of the basic functions of the IBM with additional functions on the motherboard, thus allowing the user more flexibility in adding on capability, and to construct the system so that it would be practical to add the capabilities of second generation devices as 32-bit processors become available. To date the efforts at CDP seem to have paid off; revenues for 1982 were at 12 million annually, while anticipated revenues for 1983 are over 36 million. Another feature not found with the IBM design is the internal capability to support a video display tube. The Multi-Personal does not require a separate card for a CRT and the system will support any ASCII terminal with an RS-232 interface for alphanumeric displays.

The installed board for the Personal Computer has an Intel 8087 CoProcessor, 2 serial ports, parallel port, Winchester disk controller, 123K of RAM, floppy disk controller, DMA controller, and a tone generator.

The Winchester controller which has been built onto the motherboard has cache memory and a Z-80 processor. One advantage in the CDP design is that the controller can access either 5½″ or 8″ disks. The internally accessible storage is either 5 or 10 Mbytes (Tandon) whereas IBM interfaces with an external 8″ drive. An additional 8 slots are provided for the board. The real value of the system, however, is found in the range of supplementary boards that the manufacturer is providing, such as a graphics board. The

CDP graphics card is based on the 6845 chip as is the IBM board, but the company provides only one board (IBM makes two) which may be used with either monochrome or color monitors at 512x760 resolution. A light pen interface is also provided.

Both a single and double serial port cards are also manufactured. The former is designed for support of modems, plotters, or other peripherals, while the double board is provided for those users wanting to implement up to the maximum of 8 terminals in increments of two. Memory cards come either in 128 or 256K increments to enable the multi-tasking systems to operate with Xenix, Oasis, or MPM. An asynchronous direct dial modem for telephone jack connection is available. Currently the card will only accept 300 baud, but a 300/1200 card is to be released. A floppy disk control card is provided to allow the user to daisy chain disk drives together, and in order to provide a backup for the hard disk, the manufacturer also supports a tape drive. A soon to be released card will have an onboard Motorola 68000 which will run UNIX & ADA, and to access Digital Engineering's new 68000 version of CPM. When this card is implemented the 8088 becomes an intelligent controller of the I/O data.

The Market For The Multi-Personal Computer

The CDP system is one of three reported in a recent issue of the PC journal which are seeking to emulate the IBM product. CDP has already benefited from its product and recently announced a 12 million dollar international sales of the system for 1983. The company anticipates to more than triple total sales over 1982 due to its MPC. Given that the product was first shown at the NCC resulting in the sale of 2000 systems by the end of 1982, the projection is realizable. Having established distributors in Australia (President), Venezuela (Mega), Columbia (Byte), and the United Kingdom (Icarus) the company is now seeking to establish a dealership in Japan. CDP is also establishing a national sales network throughout the US. The two basic systems configurations have either the 5 or 10 Mbyte hard disk, and cost $4500 or $5000 respectively. To date 70% of systems sold have had the 10 Mbyte disk.

The company could not have expected such quick recognition of its product, and as a result has a tremendous order backlog for the MPC. This will be improved upon in 1983's production by a tripling of staff size.

The success of the MPC after several already prosperous years in the field of μC manufacture has instilled an atmosphere at the headquarters that some would like to say is the beginning of its drive to become the new IBM of the μC world. The firm seems to be in one of those enviable positions in which everything is right. When IBM announced its 3270 emulator package an even larger market for the MPC appeared that of computer aided design, where its enhanced capabilities give it a distinct advantage over the IBM system. Addition of the 68000 promises to allow the current packaging to be retained over the forseeable future—something which is already being considered at CDP where the next two generations of systems are on the drawing boards.

—Borrell

Turnkey Workstation Systems For Business Graphics

ISC, Norcross, GA, has recently announced the release of a new turnkey graphics workstation called the Executive Presentation System. The move comes as no surprise, as the company has been actively involved in graphics for almost a decade, but some marketplace observers may wonder if the market is sufficiently lucrative at the present to support large sales of such a system. Recent trends for graphics systems have been for smaller systems that are either extremely low cost or provide remote access to remote data or services. The marketplace for business graphics has, it seems become so competitive that the number of firms entering the market may almost equal those that are abandoning efforts in the area.

Notable recent departures from the field include, ABT Graphics of Cambridge, Comshare's much reduced effort to market its Executive workstation, Ramtek's deemphasis on business graphics in its marketing, and what some perceive as a general softening of the market for business graphics, caused by fierce competition, and by the growing implementation of small business computers into the field.

The ISC system incorporates the company's 8000 color graphics terminal, an ink jet printer, image resource camera system used to produce slides of Polaroid pictures, an interface to either of two models of Hewlett-Packard's plotters, disk drives with over 2 Mbytes of data storage, and software developed at ISC. The software is based upon a command language, and so may not be as quickly used as some other systems available in the market, but once learned such systems provide ready access. There is an interface available for a graphics tablet, but the tablet may only be used at this point for digitizing artwork. Because the system is priced from about $25,000 to nearly $35,000 it does offer an alternative to much higher priced systems oriented towards presentation graphics. It should also fare well in Europe, where the company does over 25% of its business.

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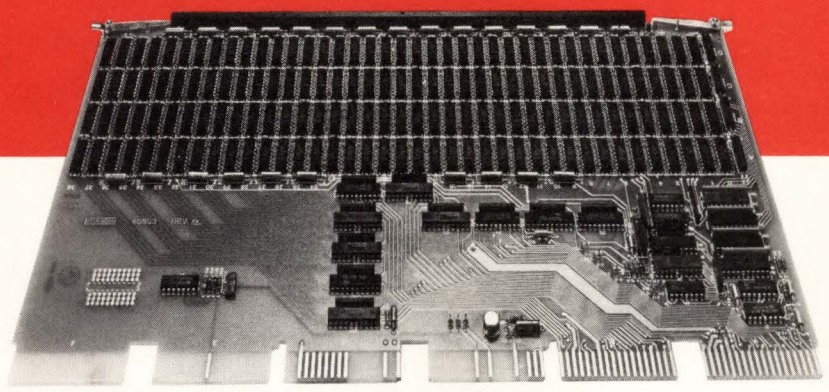

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LSI-11	DR-215	dual	256 KB
LSI-11	DR-213	quad	1.0 MB
PDP®-11	DR-114S	hex	256 KB
PDP-11	DR-114SP	hex	256 KB
PDP-11	DR-214	hex	1.0 MB
PDP-11	DR-144	hex	256 KB
PDP-11	DR-244	hex	1.0 MB
VAX®-11/750 PDP-11/70	DR-175	hex	256 KB
VAX-11/750 VAX-11/730	DR-275	hex	1.0 MB
VAX-11/780	DR-178	extended hex	512 KB
VAX-11/780	DR-278	extended hex	2.0 MB
DECSYSTEM 2020®	DR-120	extended hex	256 KB

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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.

DATARAM CORPORATION

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Building A Composite Video Generator

Presenting video text and graphics from computer equipment to large viewing audiences has long been inconvenient and costly. In the education industry these preparations have become more and more practical, and often necessary. The following circuit should allow any video source, whether a home computer or terminal connected to a large mainframe, to drive any NTSC standard television monitor equipment. The output is a 1.5V. p–p composite video, negative sync driving 75Ω. It has the bandwidth to display 80 character lines and the capability to record on standard Beta and VHS video tape recorders. Large screen projection systems are an especially useful output because the size of the characters allows a large group to read the text comfortably. Compatibility is probably this design's nicest feature: inputs are TTL; output is single coaxial NTSC standard; and power is +5V at 90 ma.

Theory of operation

Horizontal synchronization is accomplished using the inverted Horizontal Drive signal found in most CRT displays. This is generally a symmetrical square wave TTL signal running at the horizontal scan rate. The drive signal is coupled to a monostable multivibrator via R1, C1, and D1. V101 produces a positive pulse from the negative input edge. Timing components RP1, R4, and C2 determine the pulse width and delay. The delay is the useful function here. This sets the horizontal centering of the video information to be displayed. The pulse is then coupled via C4 to a second monostable, which allows the pulse width to be established to a useful duration. Again the timing components, now RP2, R6, and C6, accomplish this. The pulse width is fully adjustable from 2 to 10 μsecs. The 2 to 4 μsec area is desirable in synchronizing to video recording equipment, whereas 5 to 10 μsecs allows better stability on some monitors. The horizontal sync signal is now inverted and combined with vertical drive, again a signal available from your CRT display equipment. Next, the positive pulse combination sync is inverted to meet NTSC standard negative sync requirements, and coupled to diodes D2, D3, D4, and impedance matching network R9, and R10. The TTL video information is applied to Q101 via R7 and is mixed with the negative sync pulses to achieve composite video at the output connector.

This design was originally made for use with Heath/Zenith terminals and computers, but has since achieved excellent results in Lear Siegler and Beehive Medical equipment as well. When used with dot addressable graphics, a high resolution monitor is necessary for optimum results. In completed pc board form, cost is $70 per board; $50 each for 10 or more. *Mike Sjulstad, Sjulstad Engineering, 503 E. Fremont, Northfield, MN 55057. (507) 663-3391.*

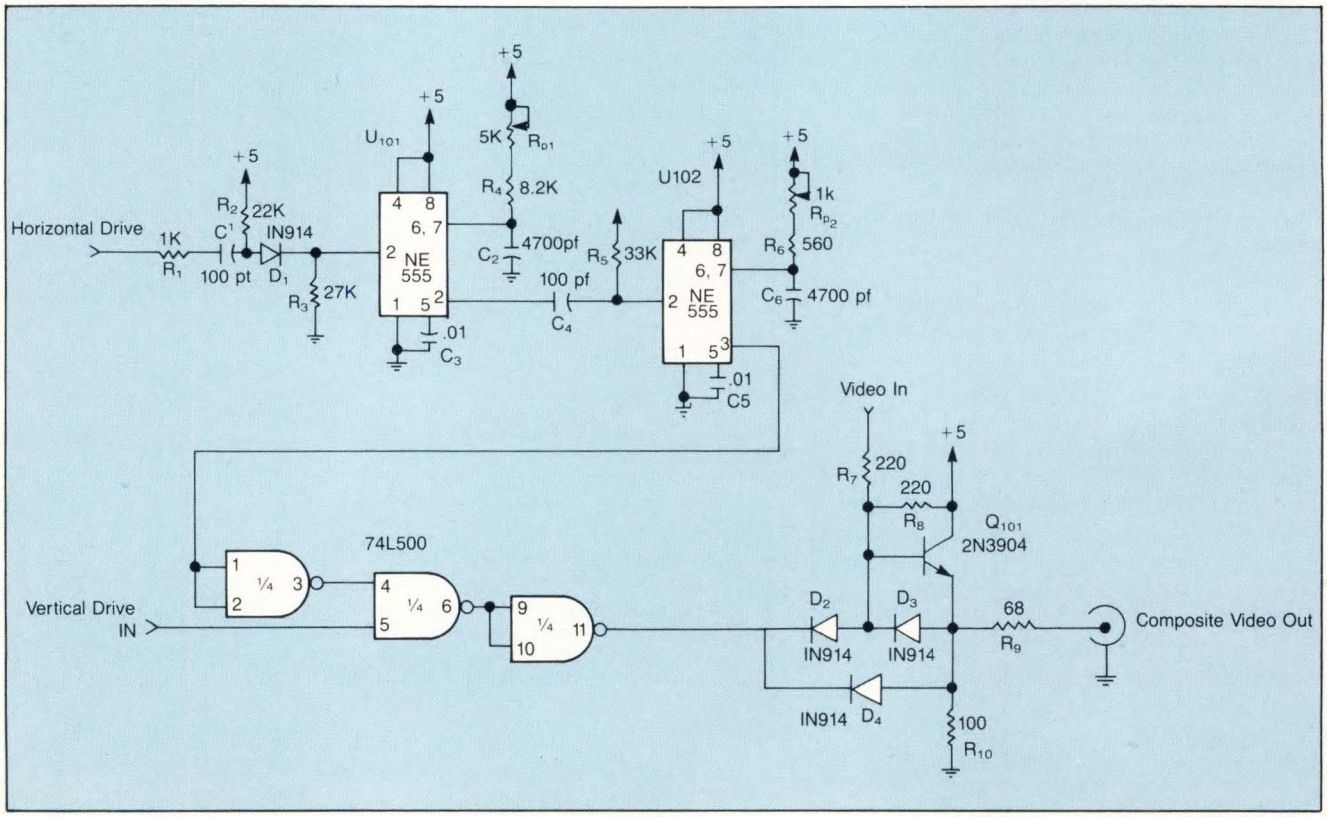

Figure 1: This composite video generator allows any video source to drive any NTSC standard television monitor equipment.

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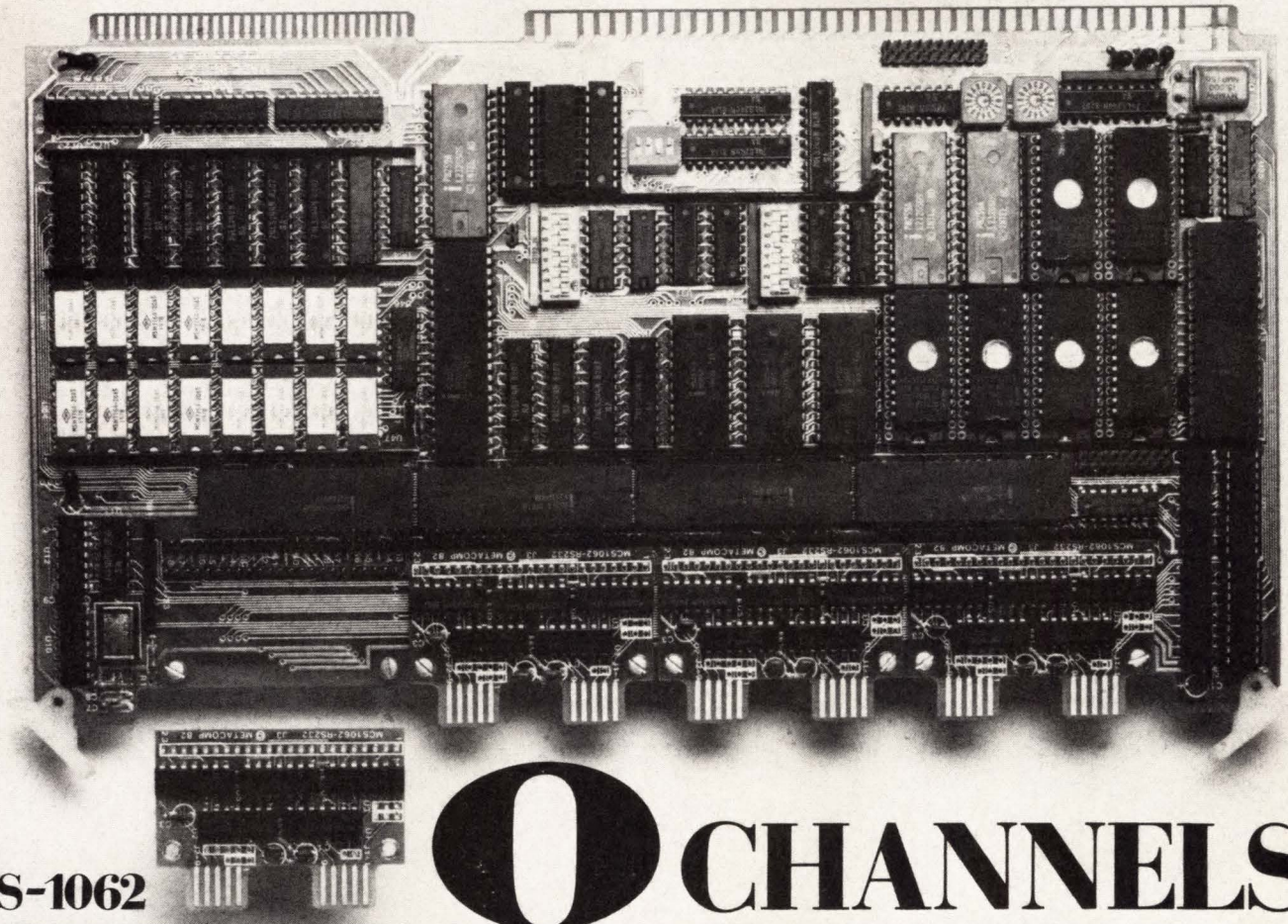

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Dumb Terminals: Workhorse Of The Computer Industry

by Daniel S. Raker

CRT terminals are alive and kicking with new buzzwords, new suppliers, a new look, and new price/performance. While CRT technology trends are clearly heading towards advanced intelligent features mimicking microcomputers, standard "dumb" ASCII terminals are still selling like hotcakes.

Dumb terminals are seeing a rejuvenation of applications in distributed processing and as communicators to local supermini computers.

By the end of 1982, close to 2 million non-intelligent computer terminals will be communicating to numerous hosts. International Data Corp. (Framingham, MA) estimates that by 1986 CRT terminal manufacturers will ship 583,000 "conversational CRTs"—IDC's polite name for "dumb" terminals. This 1986 number represents a 13% compounded growth rate from 1981's shipments of 333,000. While the calendar year figures for 1982 are not yet in, roughly double the 13% is expected. Through 1983, the dumb terminal market will almost certainly support 20% growth before tapering off in the mid '80s.

Why discuss dumb terminals when μPs are revolutionizing the terminal market? Dumb terminals are seeing a rejuvenation of applications in distributed processing and as communicators to local supermini computers. In the late 1960s and early 1970s CRT and printing terminals acted as mere I/O devices to central hosts. The late 1970s saw much offloading of terminal control to CRT-based μPs—as hosts became communications and applications bound in a time sharing environment, only smarter terminals could alleviate some of the CPU burden.

Distributed processing and μP or microcomputer based workstations began to eliminate the demand for dumb terminals in the early 1980s, but the advent of small business computers, 32-bit superminis, and independent intelligent terminal cluster controllers are pushing the demand back up. Dumb terminals are here to stay and will play an increasing role in bottom line profits of many independent CRT manufacturers.

But with half a million units shipped annually, the dumb terminal has become a commodity product, selling practically like bushels of wheat. To take a look at where the dumb terminal is going lets divide the unit into three functionally distinct areas: the computer/terminal communication link, the internal core (DAC, CRT, bit plane), and the human interface (screen, cabinet, keypads).

Computer/Terminal Link

The communications port of a dumb CRT is its link to the computer world. Here EIA RS232 links are standard—what is not standard are the buffering capabilities of ASCII character streams either into or out of the terminal. Older ASCII terminals operated at speeds of up to 1200 bps, requiring buffering of data at the host. Today's terminals devote a front end chip to handling

Dumb terminals, such as this one from Visual Technology, are experiencing increased demand.

Daniel S. Raker is President, Design & Systems Research, Inc., 55 Upland Rd., Cambridge, MA 02140. (617) 497-5300 (Daniel L. Geiger, Research Associate).

Manufacturer		1981 Shipments
DEC VT52/VT100	**Write 201**	66,000
ADDS	**Write 202**	54,000
Televideo	**Write 203**	27,000
IBM (3101)	**Write 204**	28,000
Lear Siegler	**Write 205**	24,875
Data General	**Write 206**	18,000
Hazeltine	**Write 207**	13,200
Visual	**Write 208**	12,000
Datamedia	**Write 209**	12,560
Soroc	**Write 210**	8,000
Beehive	**Write 211**	7,080
C Itoh	**Write 212**	6,000
Perkin Elmer	**Write 213**	3,300
General Terminal	**Write 214**	no 1981 shipments
Wyle	**Write 215**	no 1981 shipments
Four Phase	**Write 216**	OEM 1981 shipments

* data courtesy of IDC.

Table 1: 1981 "Dumb" Terminal shipments. Write in appropriate numbers on the Digital Design *reader inquiry card (p. 65).*

communications up to 9600 bps, many with several thousand character memories to match host communications and internal terminal working speeds.

Communications advances in the dumb market are centering on interfaces to local area network (LAN) and local supermini host communications cards. While their more intelligent cousins are learning to handle file and token passing network commands, the dumb units are simply being given a quick lesson in protocols. Since new communications chips for dumb terminals cost under $10, no major advances are expected to drive down either the technology or cost of the computer/terminal link.

But be on the lookout for such communications links as Advanced Micro Systems' Am7910 modem on a chip and Intel's coming Ethernet chip. These two high performance additions to a simple dumb environment (along with soon to follow mimics from other vendors) will be invaluable for terminal designers.

Internal Core

Within the CRT, non-communications electronics and power supply account for well over half of a dumb terminal's cost (up to 70% in some automated manufacturing facilities). In this area, much room is available for reduction of cost and enhancement of price/performance.

The power supply market is essentially stable, with most power supplies doing their important, but simple tasks for $40–$50.

The CRT and electronics components, however, show room for improvement. Nippon Electric's (NEC) new line of display controller chips are impressing terminal manufacturers with their speed and ease of handling raster bit maps and DAC guns. While most standard terminal CRTs (12", 2000 characters) are stable at $40–$50, reduction of unit cost via mass production is on the way. Basic CRT demand is on the rise for emerging videotex, dumb and intelligent terminals, and newer "executive workstations." Even though CRT designers may not develop better DACs or find cheaper phosphors, the shear magnitude of automated manufacturing volume will drive the CRT price into the $25 range by 1985.

Human Interface

Ergonomics—cool clean lines of interaction between human and machine—is the buzzword for 1983. The keyboard and housing of a dumb terminal account for roughly 40% of the remaining manufacturing costs. While design engineers pour research dollars into sleek profiles for executive workstations, dumb terminals generally sport basic plastic injection molded skins. As soon as the higher priced intelligent terminal and executive workstations begin to net manufacturers a profit yield on new housing designs, these pretty bonuses will be passed along to the commodity terminal market.

Keyboard technology, like the power supply, is becoming stable. At $40–$50 per key set, this terminal component is not headed for any revolutionary changes soon.

Ergonomic terminal design is lining up with Europe's DIN standard for human engineering. Televideo, with projected sales of "over 100,000 units" next year has refined the DEC VT100 sculpted keyboard de facto standard with new palm rests, swivel, and tilt. Watch for Beehive's new low profile DM5 series and IBM's PC style sculpted keysets.

With engineering and manufacturing costs declining on a gentle slope, the key to the ASCII terminal market is marketing. As in most commodity markets, those products with high recognition or a stable order base survive and flourish; fly-by-night vendors contain the shape of the market by forcing price and simple enhancement changes from the periphery.

. . . the key to the ASCII terminal market is marketing.

Color and Graphics

Demand for color and graphics capabilities in the dumb market is low. As these functional features demand more processor support, buyers are opting for higher priced, intelligent 'workstations' to offload the graphics burden from the CPU.

But this doesn't mean color and graphics aren't selling in the dumb terminal market. Digital Engineering's Retrographics and Selanar's SG100 and SG200 line of black and white graphics retrofit kits sell in the $700 to $1200 price range and come in models for nearly all the makes of terminals listed (see **Table 1**). In addition, Datamedia is

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Canoga Park, CA 91304
Write 218

Aydin Controls
414 Commerce Dr.
Fort Washington, PA 19034
Write 219

Falco
1286 Lawrence Station Rd.
Sunnyvale, CA 94086
Write 220

Lexidata
755 Middlesex Tpke.
Billerica, MA 01865
Write 221

OCLI
2789 Northpoint Pkwy.
Santa Rosa, CA 95401
Write 222

Spectragraphics
10260 Sorrento Valley Rd.
San Diego, CA 92121
Write 223

TEC
2727 N. Fairview Ave.
Tucson, AZ
Write 224

shipping a large volume of its Colorscan models 10 through 70 color retrofits. In 1983 watch for new color retrofits planes and tubes from Digital Engineering and others.

How The Market Shapes Up

Approximately 140 companies are now selling what could be called "dumb" terminals. Not for long. During the next two years buyers will have a choice of from less than 100 vendors and by 1985 the market should settle down to about 60 suppliers. The remaining companies (and those that will start up, briefly flourish, and then fail) will see the market for the commodity CRT go to highly automated, volume producers.

Vendors selling terminals to match minicomputer demand will flourish, as will those selling on an OEM basis through new office automation processor vendors. For instance, young Wyle Terminals Inc., (San Jose, CA) OEMs a large portion of its units through Altos Computers; Altos is currently not manufacturing CRT terminals and apparently has no plans to do so in the near future. OEM arrangements for smaller terminal suppliers are lucrative and coveted and they protect the system integrator from obsolescence and product/cost erosion.

"The market for dumb terminals is niching—splitting between the DEC VT100 'high function' machines and the ADDS Viewpoint dumb units," claims Aaron Goldberg, Research Manager at International Data. "Opportunities abound," but the window for new classes of products is closing.

While the 1981 roster of major terminal suppliers (**Table 1**) boasts old friends to readers of the computer trade press, the top of the list in 1982 and 1983 will include names not even around in 1981. What happened to the once king of the terminal trade, DEC? Changing priorities at home and market opportunities for the other vendors have opened DEC's one-time hold on the marketplace. ADDS, Televideo, Lear Siegler have all scooped market share with innovative product design, marketing, and advanced manufacturing capabilities. Watch for big shipments in 1982 from C. Itoh and Visual Technology, as well as newer sellers like Soroc, Datamedia, Wyle, and General Terminal. □

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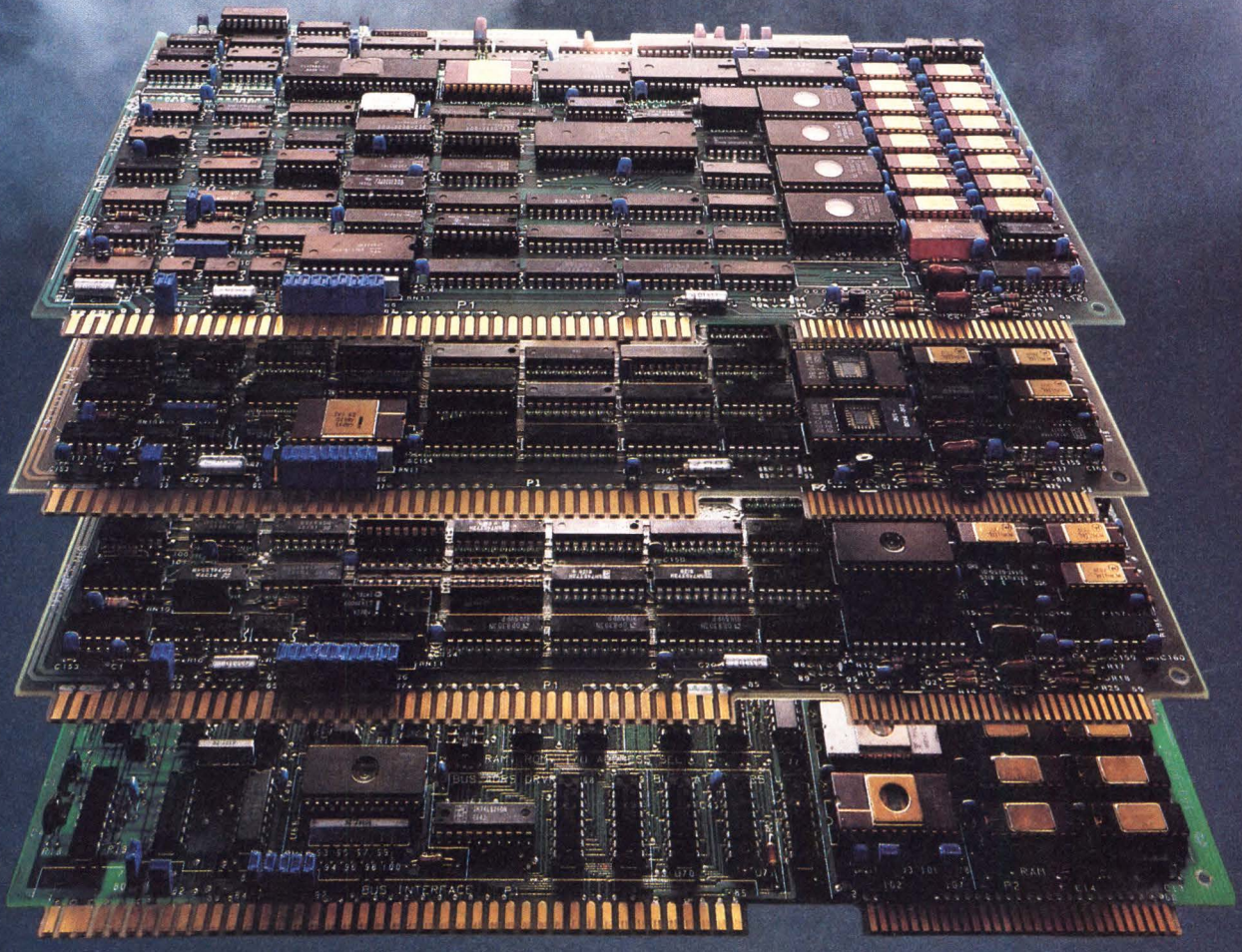

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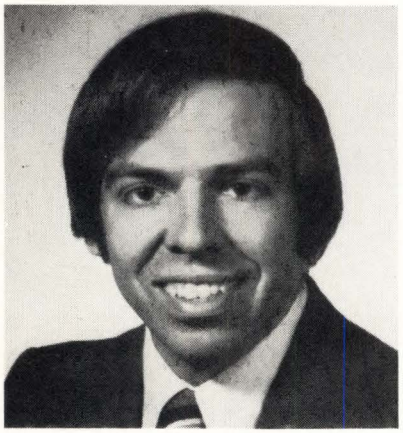
Trends In Communication: A Market And Policy Perspective

Technology advances have fueled an explosion in communications.

by Walter G. Bolter, Ph.D.

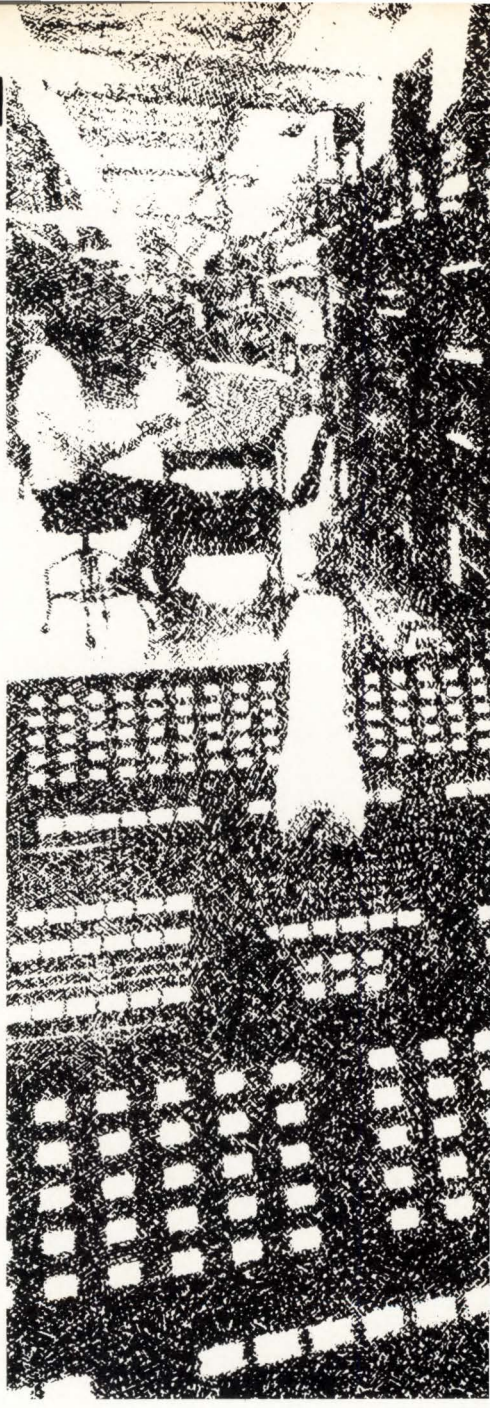


Dr. Walter G. Bolter holds a Ph.D. in economics from the University of Maryland, a Master of Arts from the University of Maryland in economics, a Master of Science in Industrial Management from the Georgia Institute of Technology, and a Bachelors Degree in Mechanical Engineering from Georgia Tech.

Dr. Bolter was formerly Chief Economist of the U.S. House of Representatives Subcommittee on Telecommunications where over the past two years he has worked intensively in the efforts to rewrite portions of the Telecommunications Act of 1934. Previously he served as the Chief of the Economics Division at the FCC, where he served for 7 years. Prior to his work at the FCC, he spent two years in the Office of Telecommunications Policy of the U.S. Department of Commerce.

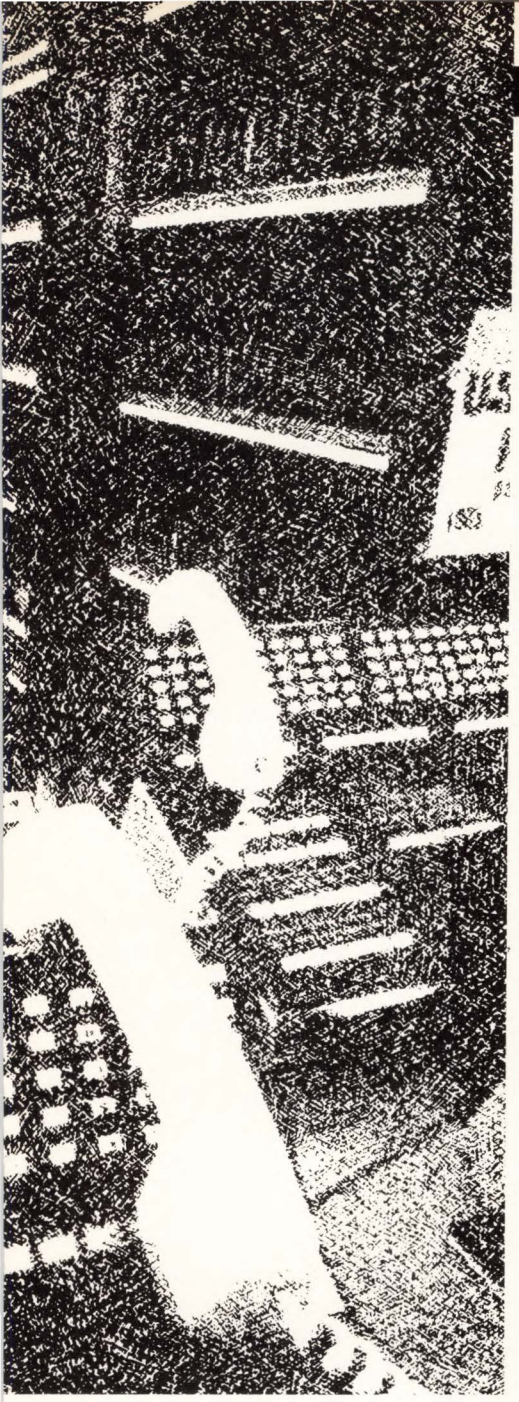
Before work with the Federal Government and the Legislature he worked as a financial analyst for the Dupont Corporation, and as a mechanical engineer for Lockheed and Westinghouse Corporations.

He is now a private consultant and partner in the firm of Bolter and Nilsson in Bethesda, Maryland. The firm works in a wide area of financial, technical, engineering, and policy applications of Data and Telecommunications.



In recent years, it has become apparent that communications can no longer be considered merely an efficient but largely static and transparent industry. Today, communications serves as the nervous system for the rest of the American economy, and is also a major factor itself as a source of final production and trade.

These changes in communications are consistent with the latest in a series of major transformations of this country's economic base. Of course, first there was the movement from agriculture to manufacturing. Then, particularly since World War II, manufacturing has given way to information



products and services. It is estimated that information now accounts for over one-half of Gross National Product (GNP) and two-thirds of the change in GNP over the last 20 years.

Driven by the development of new technologies, advances in communications and electronics have been at the heart of the information sector's fantastic growth. Over the last two decades, nine out of ten jobs created in the United States can be traced to such markets as satellites, fiber optics, communications network services, computers, and data base management activities. In 1970, communications or media services were a $70 billion industry. Only ten years later, these approached $200 billion, and should double in size before the end of this decade.

But evolution of communications is responding not only to the unrelenting march of technology. Actions of the Courts, Federal Communications Commission (FCC), Congress, and antitrust authorities are also having profound institutional effects. As a result, traditional analyses concerning the nature of this industry must be completely re-evaluated. For instance, traditional boundaries between telephony, telegraphy, broadcasting, cable television, and other sectors may not hold fast. Moreover, joint ventures and new entry, both from outside the industry and between its sectors, are altering long standing relationships among particular markets and suppliers.

The objective here is to describe this volatile landscape and the factors, especially FCC policies, which have led to its rapid development. Major markets and prominent firms will be identified, as well as related technological and institutional parameters. Finally, past trends and expected industry development will be explored along with the issues that will face suppliers, users, and public officials in the years ahead.

Communications Evolution

The Communications Act of 1934 was designed to govern an industry divided by then existing technology into two basic compartments: broadcasting or "content" services, and telephone/telegraph common carriage or "conduit." The broadcast networks, AT&T, and Western Union Telegraph company were the major players at that time, although a multitude of primarily small, fringe suppliers vied for existence in each of these sectors. In contrast to today, the initial policy focus of the FCC was not on competition. Instead, the Commission concerned itself with creation of universal service in common carrier markets, and maintenance of diverse information sources in broadcasting.

The application of microwave radio, cable television, and other new technologies after World War II, and later development of satellites, dramatically lowered communications service costs and permitted entry by many new suppliers. At first, new entry was not supported by the FCC. Instead, the Commission favored protection of traditional markets and supply sources. But by the 1960s in common carriage, and the 1970s in mass media, the FCC actively began to promote open entry.

The results of these policies in common carriage are already in evidence. During the 1970s, a host of new terrestrial carriers entered this field. These firms included MCI, Southern Pacific Communications, Datran, and United States Transmission Systems (a subsidiary of ITT). Satellite, value added, and resale service suppliers also initiated new competitive services. Among these firms were American Satellite (jointly owned by Fairchild Industries and Continental Telephone), Satellite Business Systems (a joint venture of IBM, Comsat, and Aetna Insurance), Tymnet and Telenet (which employed new packet data delivery systems), and U.S. Telephone Communications (the major resale carrier).

Status of Common Carrier Transmission Markets

Despite entry that occurred during the 1970s, long distance and local transmission services remained monopolistic. This is like-

ly to persist in the future, despite the impact of the AT&T/Department of Justice settlement. For example, by the end of the 1970s, AT&T (and its Independent telephone company partners) still accounted for 96.3% of all long distance revenues. Also, Bell served about 82% of all local service subscribers. In the aggregate, AT&T accounted for about 80% of total common carrier revenues, employees, and plants.

While huge in relative terms, Bell's absolute size was truly staggering: it accounted for 9 cents of each dollar invested in new equipment in the U.S. and was responsible for about 2 cents of each dollar of output. AT&T also employed 1 out of every 100 U.S. workers.

As part of the 1982 settlement of the Department of Justice's antitrust case, AT&T agreed to divest its 22 Bell operating companies (BOCs). These will be reorganized into regional firms, adding seven new entities to the list of telecommunications players.

The BOCs will only provide local services after divestiture. Yet, each of these firms' revenues will still be of a magnitude that would rank among the current top one hundred industrial firms. On the other hand, despite loss of the BOCs, AT&T's remaining revenues will still be over 150 times those of MCI, its most important long distance competitor.

In addition to the new regional companies, local service will be provided by 1459 Independent telephone companies. Four of these firms, General Telephone & Electronics (GTE), United Telephone System, Continental Telephone, and Central Telephone & Utilities, account for about 80% of all Independent companies' revenues, with GTE alone accounting for about one-half.

GTE and the seven regional Bell companies will be about equal in size. Thus, the bulk of local distribution services will be in the hands of eight firms, which will reach about 90% of all telephones in service.

New firms may service local markets using the many alternative technological means of providing local distribution that are now in evidence. These technologies include two-way cable television, mobile radio systems, cellular radio, local microwave, digital termination systems, and fiber optics.

Many of these hold promise of providing improved service quality and capacity, and even entirely new offerings. For instance, Bell Telephone Company of Pennsylvania is installing a fiber optic cable in Pittsburgh which can be used for videophones and security systems, in addition to regular telephone service. The new cable will have about five times the capacity of existing copper cable.

Many new technologies hold promise of providing improved service quality and capacity.

But these alternatives are all still in early stages. While these may ultimately substitute for local telephone carrier facilities, their impact to date is minimal.

For instance, today total served telephones number about 190 million. However, only 150 cable television systems offer two-way capabilities. Even by 1990, it is expected that no more than 50 million subscribers will be served by such systems. Mobile radio systems have a long history. But existing paging units still total only about 1.3 million. Commercial cellular radio systems, which promise to provide huge additions to the availability of mobile services, are still only at the regulatory application and licensing stage. Finally, fiber optic cable has only recently reached a stage where installation as a system for growth or replacement is economically feasible.

Telephone Equipment Markets

Provision of new customer premises telephone equipment for all telephone companies must be separated from local service offerings and detariffed by January 1, 1983 as a result of the FCC's *Computer Inquiry II* decision. Separately, AT&T has decided that the BOCs, which now provide both new and embedded equipment, will only furnish embedded gear during 1983. Another firm, American Bell, is being organized to provide new (unregulated) equipment.

The BOCs will be divested by January 1, 1984. At that point, these firms may again provide (but cannot manufacture) new customer premises equipment (CPE). However, the BOCs must transfer embedded CPE or the installed base of equipment (which these firms provided in 1983) to AT&T.

Western Electric, which is wholly owned by AT&T, is not directly affected by the divestiture. Western will continue to manufacture customer premises, network and other equipment for sale to the entire Bell System, apart from restrictions on BOCs' procurement of new CPE during 1983. After divestiture, the BOCs status vis-a-vis Western Electric will essentially become analogous to that of a non-Bell purchaser of equipment in today's environment.

In the past, the Bell System's share of total telephone industry purchases of equipment was very significant. This held true for most, but not all, individual equipment categories. For example, Bell's 1980 purchases of telephone sets represented 62% of the industry total. For other categories, Bell's shares were PBXs (61%), microwave (73%), wire and cable (84%), switching (76%), and fiber (68%).

Western Electric supplied the

bulk of Bell System equipment needs. For example, in the network equipment area, Western's share of total Bell purchases was 88%. The company's share of the U.S. market was 67.1%. Last year's Western Electric revenues were $13,008 million, which ranked the firm 22nd among the largest industrial corporations.

Other major firms furnishing telephone equipment directly or through affiliated manufacturing operations included GTE-Automatic Electric, Continental Telephone-Executone, Harris Corp., ITT, M/A-Com, Motorola, Northern Telecom, ROLM, Scientific-Atlanta, Plantronics, and General Dynamics. Future prospects for these firms for network equipment and other sales to the BOCs should be considerably improved as a result of divestiture.

In the customer premises equipment area, Bell's past share of installed equipment varied from about 80% to 90%, depending on the product line. Markets for new CPE appear to be less monopolistic, and the company's share seems to be in decline. However, competition for new CPE is not uniformly developed in all areas of the country. For example, in cities such as New York, Los Angeles, and St. Louis, competitors' shares of new PBX sales total about 30%. But in comparable markets, such as Philadelphia, San Francisco, and Detroit, these shares total about 14%.

The Bell System's strong position in embedded equipment may have important competitive implications. For instance, during the course of last year's hearings before the House of Representatives Subcommittee on Telecommunications, Consumer Protection, and Finance, many witnesses testified that AT&T employed a "migration strategy" in CPE markets. This was designed to straddle new and embedded CPE markets and permit transfer of Bell's power in embedded equipment into the market for new products.

Under migration, old equipment prices are increased to lessen price differentials with new CPE and make changeover to new Bell "flagship" products more attractive. Then, AT&T allegedly attempts to lock-in customers to its equipment through the use of long term contracts. These would expire at points where the company will have competitive next-generation equipment available.

Interestingly, the pending divestiture of the BOCs and deregulation of CPE would increase AT&T's incentives to employ migration tactics. Under *Computer Inquiry II,* offerings of new and old CPE must be separated. Thus, cross subsidization among joint activities, such as maintenance and administration, may be more difficult. Moreover, the installed base will be clearly distinguished as a "target" for competitors.

The Bell System's strong position in embedded equipment may have important competitive implications.

In 1984, when the BOCs lose the installed base to AT&T, these companies can join other firms in taking dead aim at embedded CPE. Thus, only 1983 remains as a period during which AT&T can control these major market forces. In consequence, 1983 appears to be a likely apex for application of migration.

Common Carrier Mergers and Integration

Joint ventures and integration, along with technological change, are blurring what remains of traditional common carrier market divisions and the relationships of these markets to suppliers and users. For instance, important local telephone companies have been positioning themselves to serve long distance and enhanced services markets. Prominent examples include GTE's movement into long distance satellite transmission and its acquisitions of Telenet and Southern Pacific Communications. Other illustrations are Continental Telephone's interests in American Satellite, and United Telephone's acquisition of ISA Communications Systems.

Long distance carriers are following suit. For instance, MCI appears to be integrating backward into local transmission, through use of new digital termination and cellular radio technology. On the other hand, SBS is employing existing cable television facilities for end links to complete coast-to-coast high speed data transmission service.

Major communications users are in the process of providing for their own local or long distance transmission needs. For instance, Westinghouse, using digital microwave radio transmission, has set up its WESDIN network of PABX switching systems in the Pittsburgh area to connect the company's many locations. In long distance, large users have contracted to purchase satellite capacity in order to provide some of these needs "in house." Many others are employing long distance private microwave facilities (PMW). PMW plant alone compares to about 4% of the transmission capacity of AT&T's long distance network.

Traditional supply distinctions are also changing at the "extreme ends" of common carrier transmission, namely inside wiring and international carriage. Inside wiring has long been the exclusive domain of wireline carriers. However, this plant may soon be deregulated, and is likely to be provided by a host of new specialized companies. Indeed, some sophisticated inside wiring applications, such as those involving very high speed data, could accelerate use of cable television plant for local transmission. These might also

hasten development of entirely new local networks (e.g., the Xerox/DEC/Intel Ethernet project), or employment of new technologies (e.g., fiber optics).

International common carriage has traditionally operated apart from domestic markets. In addition, international has been further subdivided by a "voice/record dichotomy" under which AT&T has provided most voice services, while the international record carriers have furnished nonvoice or record offerings. Finally, market lines have been drawn to restrict Comsat to wholesale offering of satellite services.

Recent acquisitions, FCC proceedings, and Congressional actions are removing many of these international market divisions. For instance, MCI has purchased Western Union International, an international record carrier, and thus gained direct access to overseas markets. Similarly, the FCC is providing SBS with authorization to extend its domestic base of operations to offer service to Europe. In addition, the Commission is in the midst of modifying restrictions on Comsat to permit it to offer retail services, and is seeking to change traditional voice/record market distinctions. Finally, legislation passed during the 97th Congress has removed prohibitions against international carriage by the (domestic) Western Union company. By way of balance, international record carriers have been granted similar status in domestic markets.

Despite these changes, international transmission is still highly concentrated. For instance, AT&T's overseas revenues are about twice those of all of the international record carriers combined. AT&T has over a 70% share of total international revenues, and is about 7 times the size of the second largest carrier. Even if there is full retail service participation by a major new entrant such as Comsat, this would only add facilities comparable in magnitude to those of the second largest firm.

Common Carriage Spillover Into Content

Differences between common carrier entities and those in content or programming services markets are no longer distinct, as is the case for the market lines between these areas. For instance, RCA, which is a domestic satellite and international record carrier, controls NBC, one of the three major television networks. RCA is also a television set, video cassette, and video disc manufacturer.

AT&T and CBS, another major television network, have recently combined forces to initiate a videotext service venture. This follows on the heels of a similar venture between AT&T and Knight-Ridder, the largest newspaper concern. A commercial test of the AT&T/Knight-Ridder service is scheduled for next year.

Differences between common carrier entities and those in content or programming services markets are no longer distinct.

Integration and cross ownership abound within content markets, and these markets are highly concentrated. For example, in television broadcasting, the three networks (ABC, CBS, and NBC) account for about 52% of advertising revenues. And broadcasters own about 30% of cable television systems, while about 18% are owned by publishers and 20% by program production companies. Even telephone companies, such as Continental and Centel, have entered the cable television industry.

Some illustrations of cross ownership transcend the provision of electronic and non-electronic communications. For example, Home Box Office, which controls about 66% of the pay cable programming market, is itself owned by Time, Inc., which is the largest book publisher. Many leading newspapers own broadcasting and other media properties. And, these entities are increasingly engaged in teletext, viewdata, and other ventures with conduit companies, such as AT&T.

Common Carrier Policy Trends

As noted earlier, since the 1960s FCC common carrier policies have increasingly favored open entry and competition. But recently the Commission has begun deregulating portions of common carriage, and seems to be taking a "laissez faire" view of the intermixing and concentration evidenced in these markets.

As an outgrowth of the FCC's *Computer Inquiry II* decision, all new CPE sales and enhanced service offerings will soon be deregulated. And, other decisions, such as the competitive carrier findings in Docket No. 79-252, resulted in elimination of requirements for cost support materials for specialized carrier tariffs. These and resale carrier tariffs are now generally not scrutinized. Finally, even international common carriage seems to have been directed toward the path of "unregulation."

Yet, these policies do not seem to have been based on strong statistical evidence that substantial competition is present. Nor have the many mergers, acquisitions, and joint ventures in these areas had a perceptible effect on the FCC's overall policy thrust.

Content Services Policy Trends

In television and radio broadcasting and cable television areas, Commission policies have been less consistent over the years than in common carriage. For example, in video markets, at several points in the past the FCC has attempted to check the power of the three dominant television net-

works. Thus, in program procurement and production, the Commission adopted requirements involving prime time access, and financial interest and syndication rules. These rules were primarily intended to prevent the networks from controlling program supply. But these might also induce new networks to favor cable television and other nondominant distribution outlets.

For similar reasons, the FCC has imposed structural regulations on the ownership of audio and video outlets. These included one-to-a-market rules for radio and television stations, and concentration of control regulations to bar entities from ownership of more than five VHF stations. Other examples include rules barring cross ownership of cable systems and television broadcast stations or translators in the same service area, and newspaper-broadcast station combinations in the same market.

From a public policy perspective, the goal of these rules seems to have been promotion of a diversity of programs and service viewpoints and prevention of excessive market concentration. In the context of Congressional investigations, evidence has been advanced to show that a need for such rules still exists in the video area. However, the FCC currently seems intent on seeking repeal of many of these safeguards.

In radio markets, the FCC also seems to be pursuing repeal of safeguard rules. But control of radio program supply and station outlets appears to be much more diffuse than in video. Thus, most agree that the FCC's recent deregulation of radio broadcasting is more consistent with actual market conditions. As yet, no entities appear to be exerting pervasive influence over content in this sector.

Trends in the cable industry appear to be biased toward greater concentration. Many multiple systems operators exist, such as Cox, Warner, Storer and Times Mirror. In the top 50 markets, the seven largest system operators pass by well over 50% of all households. And merger activity has been substantial. Of the 25 largest cable operators in 1976, 11 have been bought or subject to mergers, including five of the 10 largest cable companies.

Trends toward cable industry concentration may have far reaching consequences. Recent industry growth has been explosive. Concurrently, the Commission substantially deregulated cable and facilitated its access to programming. The overall objective seemed to be the encouragement of the industry to compete fully with traditional broadcasters for viewers. But, increased cable concentration may not be consistent with this goal.

Many maintain that if deregulation is effected prematurely, there is danger that it will permit aggregations of economic power.

FCC Proceedings and Social Policy

The FCC's pursuit of deregulation may result in the competitive environment that the Commission is seeking. But many maintain that if deregulation is effected prematurely, there is danger that it will permit aggregations of economic power which portend precisely opposite results. Possible adverse effects of these policies on the social goal of diversity have been discussed. However, "side effects" are also likely for the universal service objectives of the Communications Act of 1934.

Indeed, Commission decisions favoring deregulation and open entry have already affected the price and affordability of local service. For example, these decisions have resulted in greater risk for telephone companies, and, this, in turn, has been used to justify faster capital recovery rates and higher depreciation charges. Similarly, such decisions have been used to support arguments favoring full recovery of telephone equipment installation charges from the local subscriber or "cost causer." In the past, these charges were averaged among all customers and capitalized or recovered over many years.

On the basis of FCC estimates, these related accounting and depreciation decisions will account for about one-half of the overall 76% increase expected in local rates over the next five years. Increases in rates for rural areas are expected to be even larger.

There are other Commission proceedings which may increase local rates. Most involve charges that long distance services pay for use of local plants. For instance, the Commission's decision to detariff customer premises equipment will significantly reduce these interstate payments. In addition, the FCC may alter methods used to recover long distance charges for use of local facilities. Many believe that the Commission will mandate use of a method which recovers *all* of these charges directly from local customers. Of itself, this would result in a massive increase in local rates.

Some predict that the combined effect of these expected changes, coupled with those already underway, will increase local rates to a level that is two or three times that existing at present. The impact on universal service could be devastating. Indeed, analyses employed by AT&T in the context of the Department of Justice's antitrust case show that if local rates were to increase by 200%, for instance, about 60% of the rural poor would be unable to afford basic telephone services. For certain other customer groups, such as low income blacks, the impact would be even more severe.

Summary and Conclusions

Communications is clearly one of this nation's industry "winners," and stands out among a much less appealing overall economic picture. Change has become the industry's watchword. New firms are entering, existing concerns are expanding, and new technologies are being applied rapidly. Soon even the industry's basic structure will undergo a dramatic transformation in the wake of settlement of the most momentous antitrust case in history.

Many factors are at work simultaneously. Prominent among these are the industry's dramatic rate of technological innovation since World War II; ongoing regulatory, Congressional, and other institutional pressures; major strategic decisions of larger firms; and the exogenous influence of national and international economic forces. Precise cause and effect relationships are difficult to determine, but several trends are clear:

- The FCC is increasingly seeking to deregulate all communications markets to the maximum degree.
- Large communications users and suppliers are attempting to reduce expected greater risks of future communications supply. Users are striving to provide a larger proportion of their communications needs internally; suppliers are attempting to increase the level of vertical integration of their operations.
- Traditional market segmentations and engineering distinctions within conduit and content markets are blurring. Horizontal integration between these markets is also increasing.
- Higher costs of basic telephone communications, particularly in rural areas, is underway in the wake of lessened regulation on pricing. But new services, such as in the data communications and video areas, are becoming increasingly feasible as new technology is applied.
- Recurrent cycles of entry and exit have begun in both conduit and content markets. Major existing players will be affected, some adversely, as industry rationalization proceeds.

It is not yet certain who the ultimate "winners and losers" will be in communications. Many industry structures could result from unleashing these markets. These include re-establishment of monopoly, without concomitant regulation, movement toward truly competitive conditions, or evolution toward some "in-between" form of oligopoly. What is clear is the central role that the industry will play across the breadth of future American society. Indeed, by the end of this decade, communications is very likely to be the nation's most important basic industry. □

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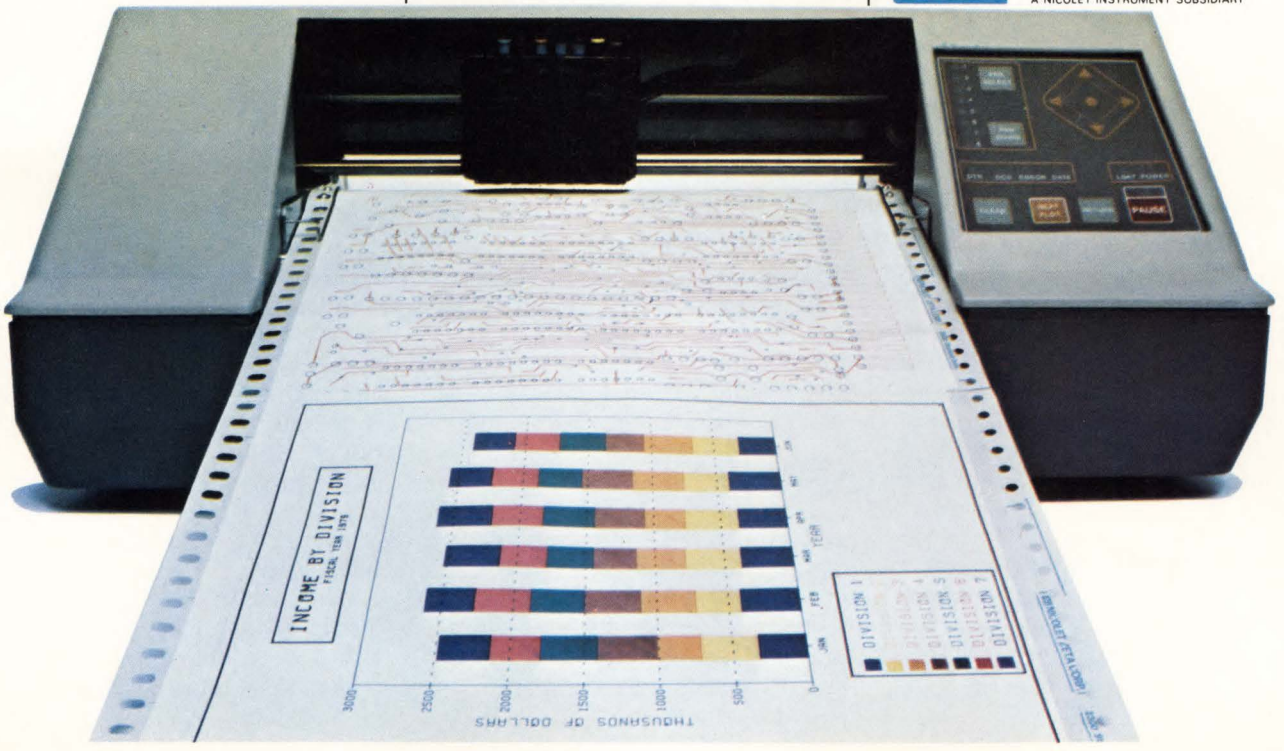

Designing A High Quality Color Graphics Workstation

by Larke E. Reeber and Gunter Musolf

The desire to convert data into graphical forms that can be readily manipulated is making color graphics capability a requirement of many computer customers. This article discusses common methods of adding graphics to a desktop workstation and then discusses why Convergent Technologies chose to use a specialized LSI processor dedicated to graphics display control, coupled with a general-purpose MOS μP, to implement the AWS Color Graphics Workstation.

Larke E. Reeber and Gunter Musolf are hardware engineers with Convergent Technologies, 2500 Augustine Dr., Santa Clara, CA 95051. (408) 727-8830.

Character Set

An inexpensive and easy way to add graphics-like functions to an existing design is to enhance the character set by adding one or more ROMs or PROMs. Line drawing sets are created this way, as are some of the "graphics" on personal computers.

For simple forms generation or very simple bar charts this approach may be adequate. It requires little or no redesign of the alphanumeric display structure and is therefore quick to implement. But it is also inflexible since only predesignated graphic symbols are available. Typically no combining or overlaying of the symbols is possible either.

To increase flexibility this approach is often extended by using a RAM-based character set with an option to reload the character set or add more RAM for "user-de-

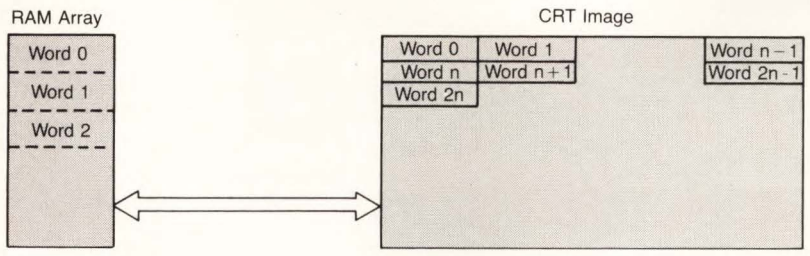

Figure 1: Correspondence between bit-mapped RAM array and image on CRT. There is a one-to-one correspondence between the words in a linear RAM array and the picture on the screen.

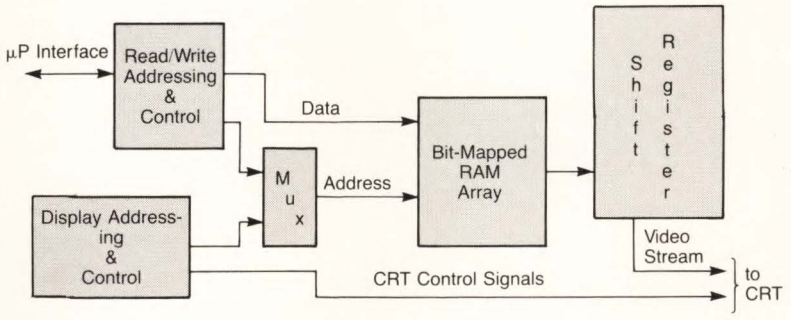

Figure 2: Bit mapped graphics video control. A typical bit-mapped graphics system shares a single address port into the RAM array.

fined" characters. This allows users the flexibility to design character cells that fit specific applications. For simple bar charts and pictures, where the necessary character cells are repetitive, this is usually sufficient. For more complex pictures, where the frequency of repetition of character cells is lower, the user may not have enough unique characters to complete the picture or graph. If there are not enough unique characters, the user must simplify the chart leaving out potentially valuable detail. To guarantee a sufficiently large number of unique characters requires a large RAM array with a short access time, thus eliminating the cost advantage of this structure.

Because of the problems associated with making enhanced character mode displays work for even moderately complex pictures and graphs, most raster-scan graphic implementations are bit-mapped. With a bit-mapped graphics system, complex pictures and graphs with a lot of information to be displayed are no more difficult to show than simple ones with little information.

In a bit-mapped graphics system a RAM array that has a one-to-one correspondence with the visible image on the display is used to store the graphic image (**Figure 1**). This array must be controllable in two ways. First, the data in the RAM array must be read and sent to the CRT or other raster display. Second, the array must be modifiable so that storing the picture or graph into it is not difficult. Some bit-mapped graphics systems are organized as dual-port memories with one address port for the display addressing and the other port for image generation. Most systems share a single address port with one function having priority (**Figure 2**).

This approach to color graphics combines the 8086 with the power of the 7220.

Controlling A Bit-Map Display

The design of a controller for a graphics bit map system requires understanding the overall system function. Graphics systems must be able to take objects and modify them and their characteristics on a display. Objects may be structured, that is, contain other objects, or be simple collections of vectors, arcs, and other primitive elements. These primitives must be manipulated to do translating (moving horizontally and vertically), rotating, scaling (changing the relative size on the screen), and clipping (deletion of invisible portions) of

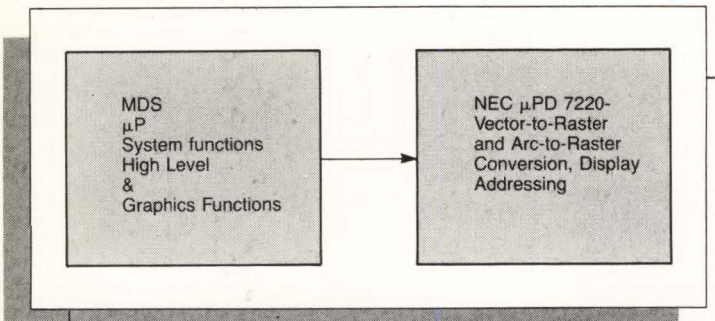

Figure 3: Partitioning of graphics functions with a 7220 adds a level of pipelining that increases throughput.

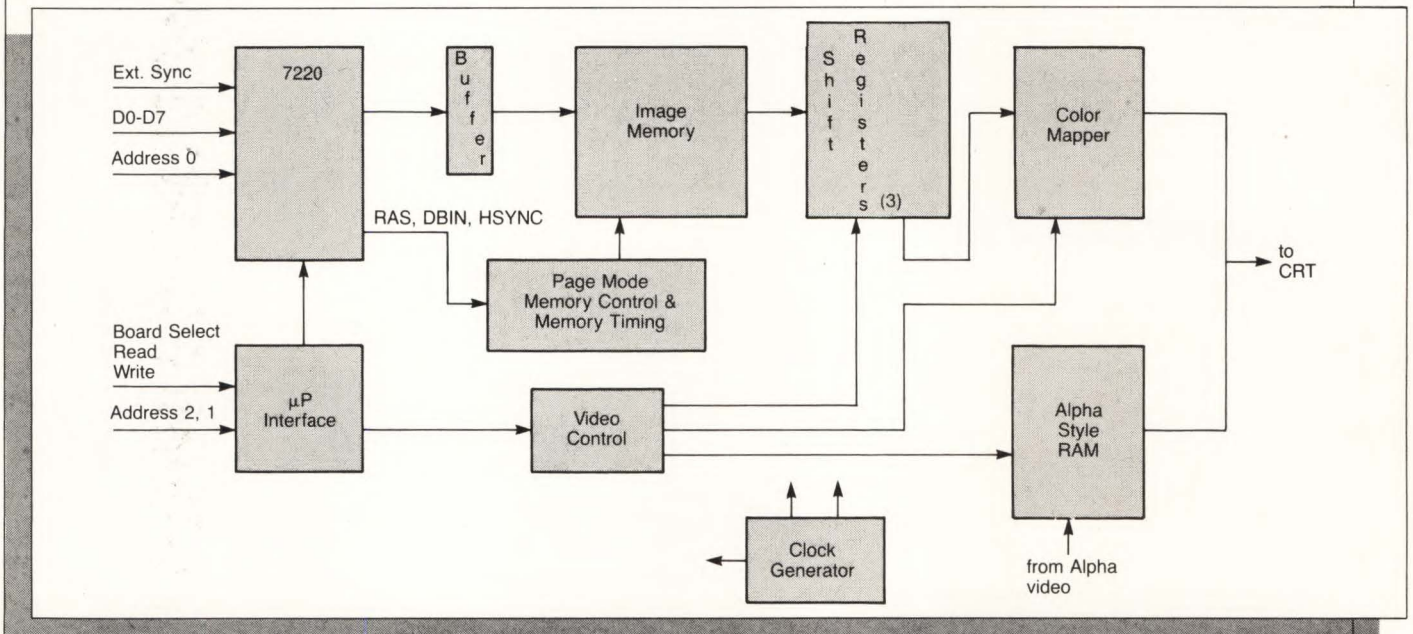

Figure 4: Block diagram of Convergent AWS graphics hardware architecture shows how the 7220 interfaces to the rest of the system.

the objects as the image is moved about on the screen. Once the vectors or arcs that need to be displayed are determined, then this information is converted into locations and data to be written. The process of converting vector information to raster RAM addresses is known as "vector-to-raster" conversion.

There are numerous ways to partition the sequence of tasks associated with converting data to pictures or charts. The most common way has all computations done by one processor. For large mainframe systems the host computer does all the computations and a "dumb terminal" holds the display. Personal computers take a similar approach on the opposite end of the scale. All system functions including all levels of graphic functions are done with one MOS μP.

Other partitionings include having a general-purpose MOS μP handling system functions with a specialized finite state machine controlling a set of registers, counters, and adders which handle the vector-to-raster conversion. This adds a level of pipelining which increases throughput, but it also increases the amount of hardware needed. Substituting a MOS μP to handle the low level graphics manipulations in addition to the vector-to-raster conversion increases the flexibility and potential capabilities with little sacrifice in speed. Substituting a bipolar bit-slice processor for either processor increases throughput proportional to the increased processing speed, but bit-slice processor systems typically require excessive space and power. Having three levels of pipelining by separating the vector-to-raster conversions from the vector transformations from other system functions has a similar effect: an increase in speed for additional board and power penalty.

In general, all these approaches suffer beause they use general purpose ICs and processors, which are optimized for functions other than graphics. An LSI chip designed to handle graphics functions, the way USARTS handle data communications and CRT controller chips handle alphanumeric displays, is needed. NEC's μPD-7220 Graphics Display Controller is especially designed to handle graphics display address generation, vector-to-raster conversion, and arc-to-raster conversion. It does these functions at a fraction of the cost of the specially designed TTL versions. Although it does not perform vector transformations or associated matrix manipulations, it can simplify a design by combining many functions in one IC. It can also enhance performance by adding a layer of pipelining to the processor at a very reasonable cost (**Figure 3**).

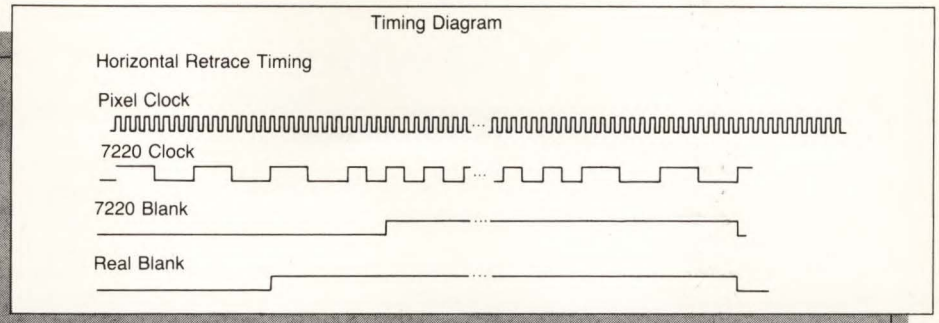

Figure 6: Adjusting the 7220 clock timing to increase vector drawing speed.

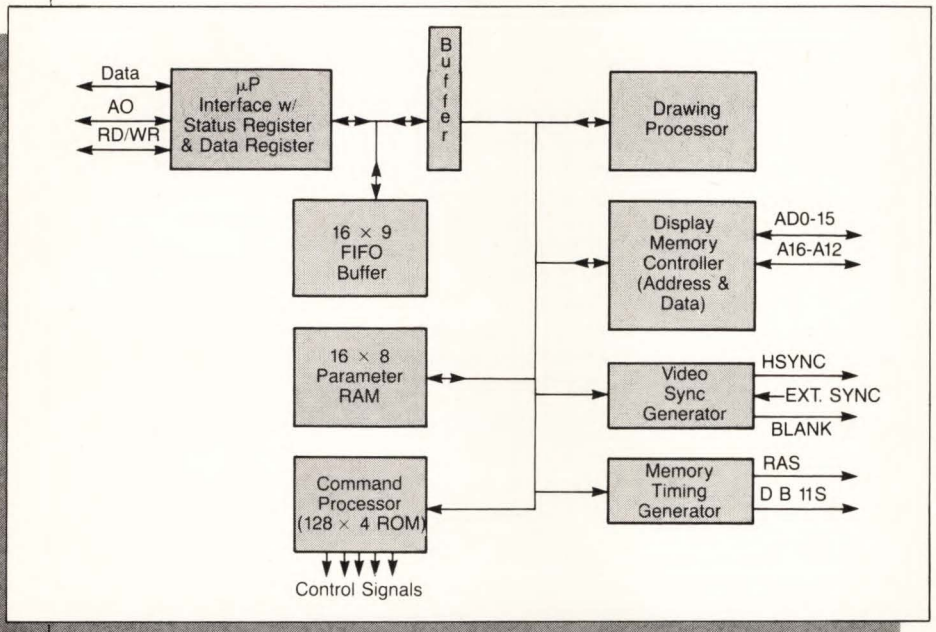

Figure 5: The 7220 internal architecture provides a FIFO to store commands and data, RAM to store parameters, and address and data generation for controlling the image memory.

7220 Based Graphics Design

The AWS Color Graphics Workstation consists of an 8 MHz 8086 running the CTOS Operating System as well as high level graphics software and a 7220 graphics controller handling low level graphics functions. The AWS Workstation also has a detachable keyboard, CRT display, communications ports, and optional mass storage. The video display is 319 lines by 432 pixels per line. An Intel 8275 CRT controller handles the alphanumeric display and supplies the CRT control signals.

In addition to the 7220, the AWS graphics board uses a page mode memory controller to get three bits/pixel using sixteen 64K dynamic RAMS. The three bits/pixel go through a color lookup table to provide a choice of 8 or of 64 colors. This information is then combined with the alphanumeric video stream and sent to the display (**Figure 4**).

The 7220 (**Figure 5**) interfaces directly to a microcomputer bus and controls the bit-mapped image memory. By programming the designer can specify memory organization and screen timing. Drawing a vector or arc requires sending a series of commands and parameters which describe the item to be drawn. The 7220 then draws the vector during available memory cycles indicating data and address to be written.

Interfacing to a μC bus

One address bit indicates command or parameter when writing and indicates data or status when reading. An 8 bit bidirectional data bus contains the command, parameter, or data information. A simple board select, address, and read/write decoding provides the read and write signals for the 7220.

Interfacing to the display memory can be more complex. In the AWS Graphics Workstation implementation, the 7220 is operated in slave mode in order to synchronize it to the 8275 CRT Controller which generates the alphanumeric display. In slave mode the 7220 expects a minimum of eleven memory cycles during horizontal retrace, where a memory cycle is sixteen pixels long. Because the existing timing only has 6¼ memory cycles, the clock speed is doubled during horizontal retrace except for the first half of the first cycle which is left unchanged (**Figure 6**). This gives twelve memory cycles during horizontal retrace and doubles the number of RMW cycles possible during blanking which increases the drawing speed. The 7220 also expects an even number of memory cycles during the visible portion of the horizontal scan. Because the system has 432 pixels/scanline

A Low-Cost Color Monitor

Unlike other color systems which use external color monitors the AWS color monitor was developed to match the styling, software, and hardware of existing Convergent Workstations. This meant adherence to a relatively small packaging size, certain deflection speeds, and other electronic specifications.

The development started with the selection of a high resolution color picture tube. To reduce the circuitry requirements an in-line CRT was chosen. Use of the in-line CRT eliminates the need for convergence circuits, but requires a larger DC bias range for the three cathodes. Simplified circuits satisfy the DC bias range requirements and also provide RGB equalization of the tube characteristics.

Special modulation circuits are employed to provide electronic vertical and horizontal pin-cushion correction for the picture tube. A flyback transformer provides all voltages used in the color monitor except for one unregulated DC input voltage, which is supplied by an outside power supply.

The monitor is built to operate without a fan in a 60°C environment. A special outside heat sink is part of the integrated monitor.

Degaussing of the picture tube occurs automatically at AC power turn-on time and can also be manually activated by a push button switch, without interruption of input power. The degaussing function operates on 110 VAC or 220 VAC at 50/60 Hz. The only other external control is an overall brightness adjustment.

The video amplifier input stage is designed to make the signal amplitudes controlling the CRT independent of input TTL levels. Gamma correction is inserted into each color channel to compensate for tube brightness nonlinearity and amplitude adjustment of the individual color channels is included in the video design.

High voltage and picture size regulation is provided by a number of feedback circuits encompassing the anode voltage and the DC input voltage to the flyback. Feedback circuits in the vertical amplifier make a short flyback time possible.

Fast rise and fall times in the video output stage with low overshoot at high voltage swings are accomplished by using shunt series inductor and emitter capacitor peaking. Arc protection for the circuitry is incorporated in the CRT socket for highest effectiveness.

Ease of adjustment in the video and deflection amplifiers is achieved by locating all controls at the edge of the PC boards. The circuit and PC board designs are adapted to accommodate the longer traces required without deterioration of performance. A special filter on the CRT screen reduces reflection from room light sources.

which, at 16 bits/word translates to 27 words/scanline, a special blanking circuit to blank the display one word early during each horizontal scan was added.

A method for accessing all three planes is needed, as the 7220 cannot manipulate more than one bit/pixel. The display memory is organized as a linear array of pixels with each plane contiguous. Page mode reads access the three planes for video display cycles using a counter for the two highest order address bits. For creating the picture, vectors are drawn three times, once at each plane.

When the video cycle is complete, the data is loaded into three parallel-to-serial shift registers where each pixel is shifted out to the color lookup table, an 8 × 6-bit RAM. The output of the lookup table is resynchronized on a pixel basis (**Figure 7**).

The alphanumeric display normally has three character attribute bits per character (halfbright, reverse, and underline in a monochrome system). An 8 × 8-bit color lookup table, separate from the graphics lookup table, uses the attributes to both select the color of the character and specify whether the character is reversed or underlined. This information is resynchronized for each character (**Figure 7**). The character video stream then selects between the character information and the graphics information. If the character video stream is selected, then the character information is enabled and displayed. If it is not selected, then the graphics pixels are displayed.

In addition, the alphanumeric displays and graphics displays can be selectively disabled. This allows the user the flexibility to display only text or only graphics or to combine the two with the text taking precedence. □

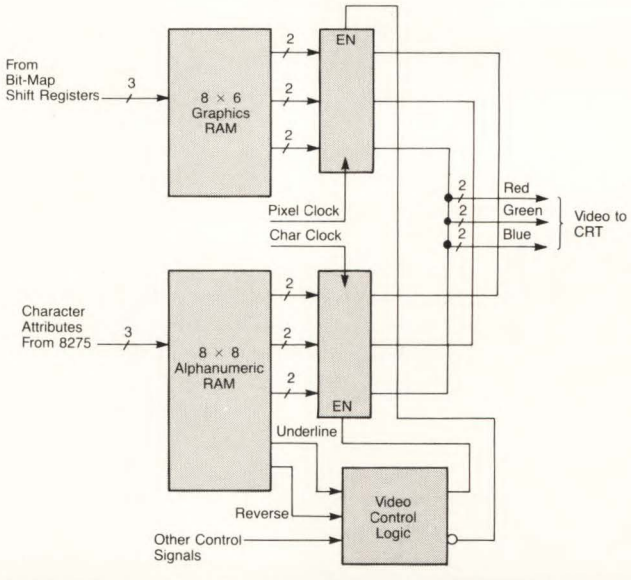

Figure 7: A dual set of look-up tables allow alphanumerics and graphics to have independent color mapping.

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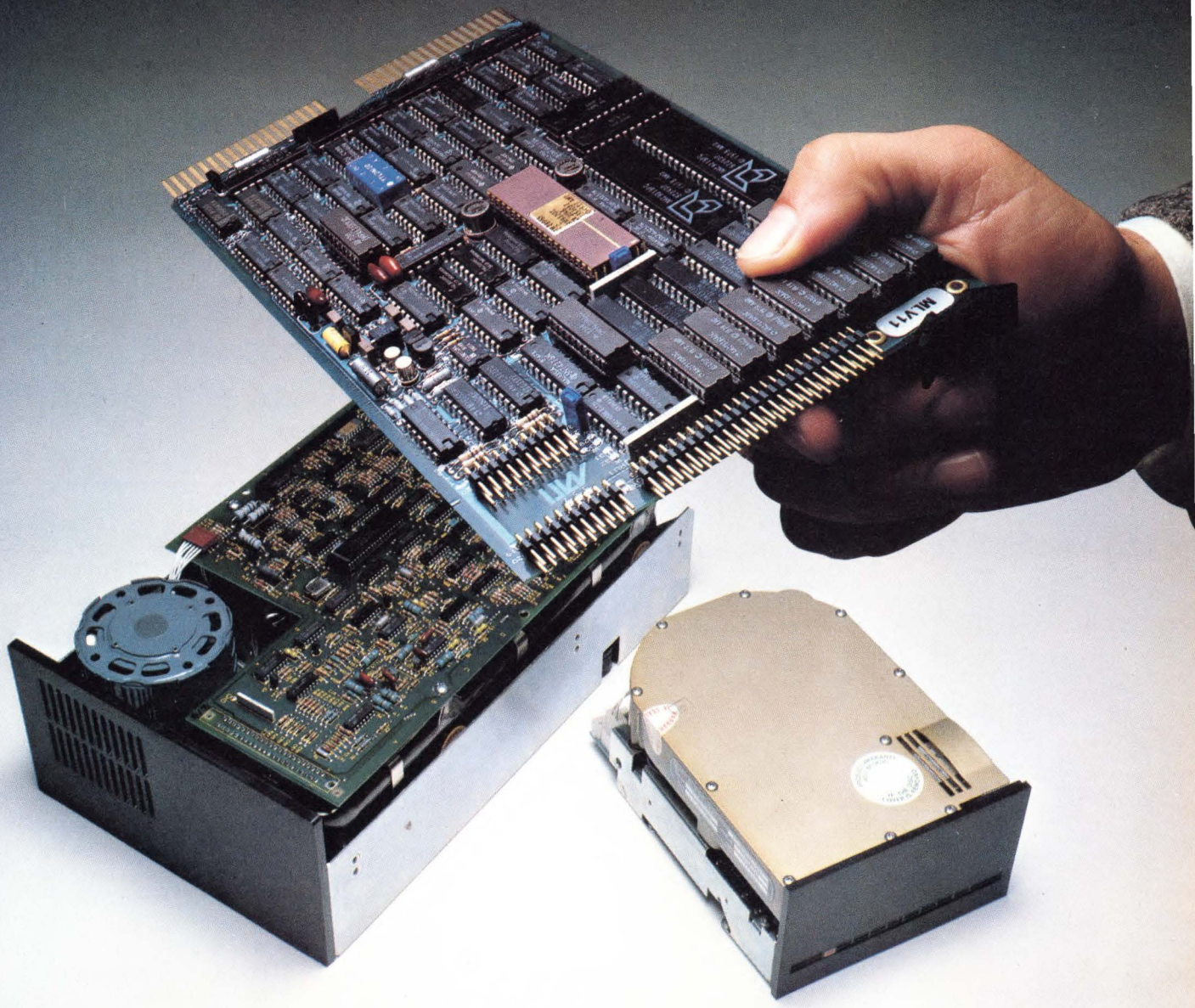

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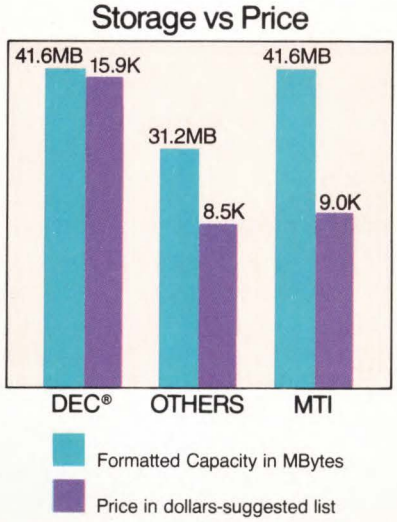

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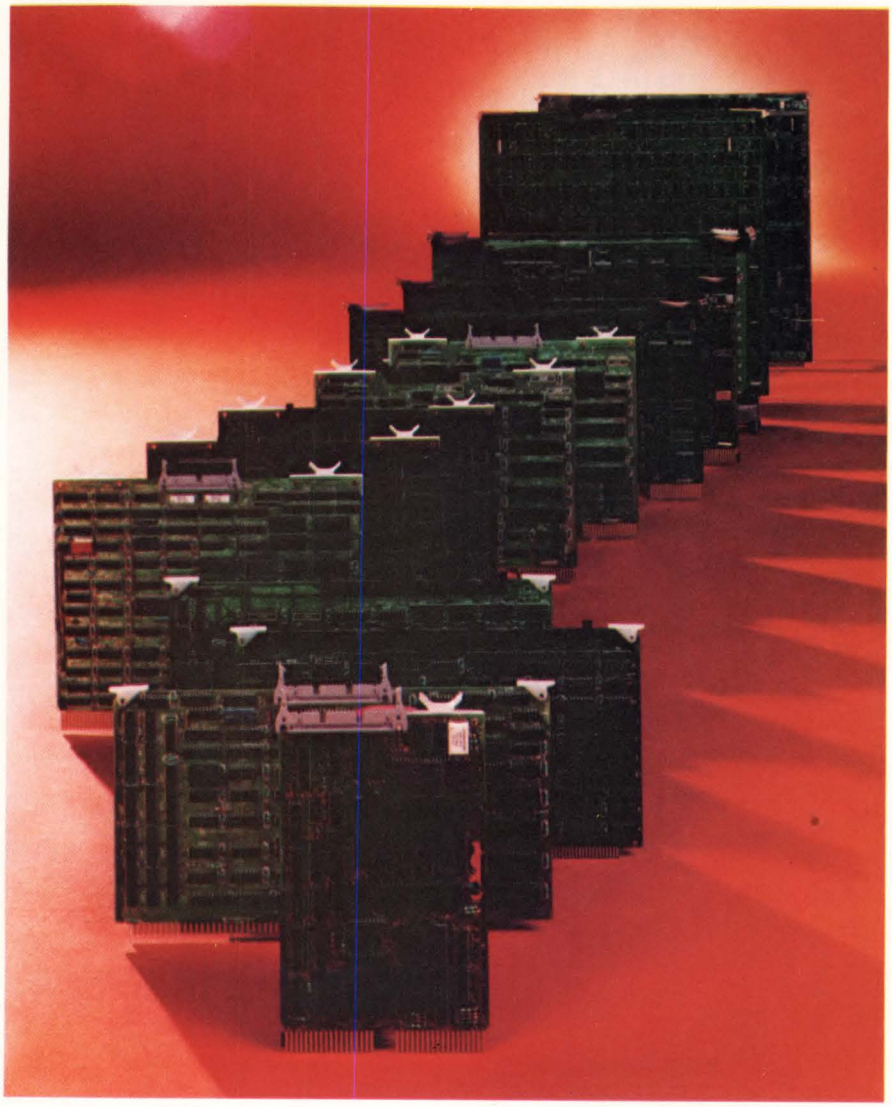
Peripheral Memory Controllers: Change And Growth In The '80s



Several forces are converging to force major changes in the peripheral controller market over the next few years.

by Richard Barrett

Pressures from emerging standardization, higher performance requirements, and increased price competition over much greater unit volumes are not unusual to the electronics and computer industry. But the convergence of so many forces simultaneously in one area promises major upheavals in the peripheral controller industry in the near future.

Richard Barrett is President of Adaptive Data & Energy Systems, 2627 Pomona Blvd., Pomona, CA 91768.

Interface Standardization

Controllers must handle at least three different interfaces—the peripheral interface, the host hardware interface, and the host software interface. Standardization has been lacking historically at each of these levels, which partially accounts for the intense fragmentation of the market currently. However, pressures from systems integrators and from peripheral vendors themselves are forcing standards at all three levels.

Standardization At The Peripheral Interface

Within the last five years, interface standards have emerged for almost all types of peripheral devices. The largest market, Winchester disks, has seen the expansion of the 14″ and 8″ markets, and the creation of the 5¼″ and sub 4″ markets. Interestingly, the level for standardization for each size reflects in microcosm the overall trend in electronics toward increased standardization.

The 14″ Winchester disk market, with its established OEM's and large installed base, may never standardize beyond the existing SMD and MMD interfaces, although the ANSI disk interface seems to be gaining some popularity. The 8″ disk market, which developed next, has made a strong effort toward commonality, with the SA1000 interface dominating the field for drives which do not provide on-board data separation. But the 8″ disk market shows a split here, with many vendors offering other interfaces which provide separated clock and data (NRZ), similar to the 14″ disk interfaces. The 8″ disk market shows more standardization than the older, more estab-

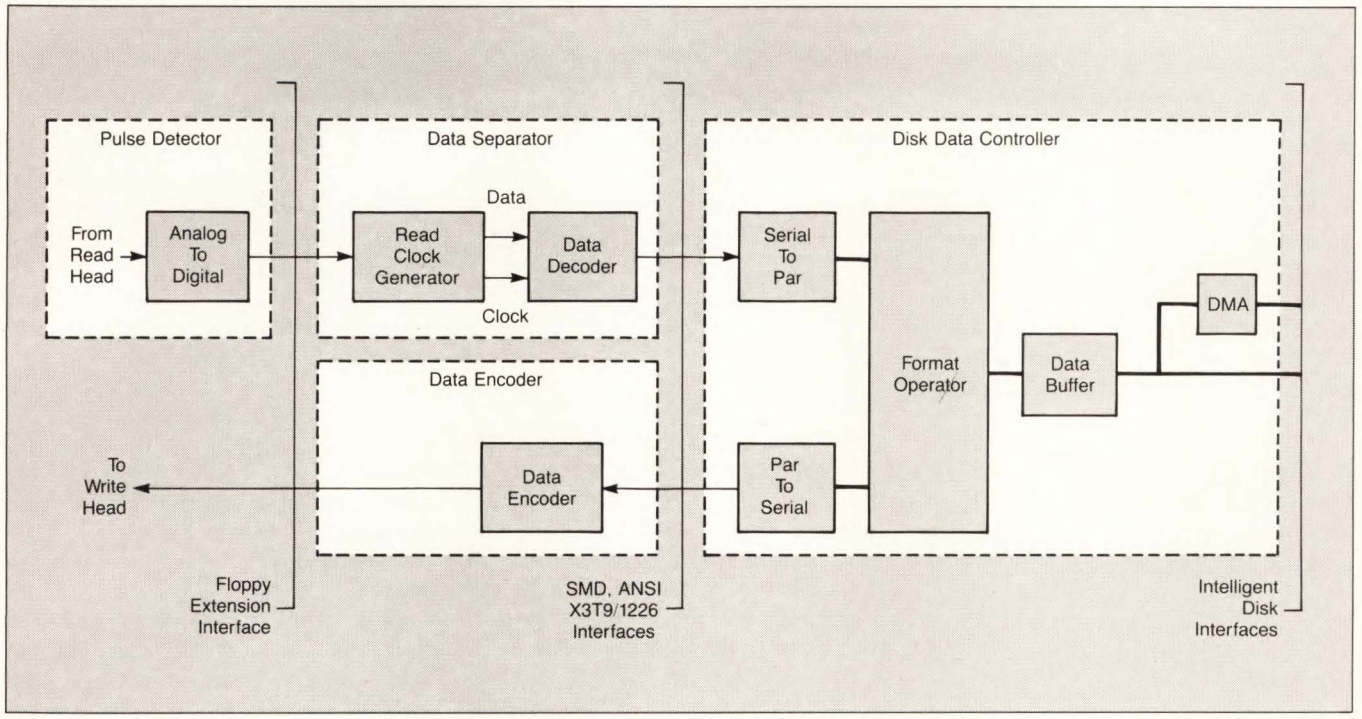


Figure 1: The four chip set from National Semiconductor are the Disk Pulse Detector, MFM Data Separator, MFM Data Encoder, and Disk Data Controller. (From a paper presented at the Mini-Micro convention, 1982.)

lished 14″ disk market, but it still has significant variety in the choices of interfaces available.

Virtually complete de facto standardization arrived with the 5¼″ and smaller (microWinchester) disks. Seagate, one of the first companies with a 5¼″ product, promoted the ST506 interface so well that every significant microWinchester manufacturer offers the ST506 interface on its products.

The latest standardization effort has come in the tape area, with several major ¼″ cartridge tape drive vendors recently agreeing on a common intelligent interface, the QIC interface, for the streaming tape drive.

Standardization At The Host Interface

The host interface at present is in chaos. If possible, it suffers from too many standards. Each computer bus, from DEC's Unibus to the S100 bus, is a target for a controller host interface. However, the ANSI committee on Intelligent Peripheral Interfaces is proposing the Small Computer Systems Interface (SCSI), which has significant industry support. Many controller vendors and peripheral OEM's already support a subset of the SCSI peripheral bus interface.

As a single peripheral interface point, the SCSI bus offers major advantages. It improves system performance by removing the system CPU from the details of the bulk data transfers. Rather than handling each byte within the file, the CPU simply specifies the source device, the destination device, and the logical blocks to transfer. The specified devices do the actual transfer, and notify the CPU when the transaction is complete.

The SCSI bus also simplifies system peripheral expansion. It allows all data transfers to occur at the high rate of 1.5 Mbytes per second. As intelligent SCSI controllers become available for a wide range of peripheral devices, SCSI bus ports will become a common feature in host computers.

The SCSI peripheral bus helps reduce the purchase price of computers. The systems designer can select the necessary peripherals from all those available on the market, rather than just those few which have already been interfaced to a particular computer system. The best example is the costliness of specialized peripheral interfaces in DEC systems. Because interfacing peripheral equipment to DEC systems is so difficult, "DEC compatible" devices often cost three to five times as much as the same equipment without the special interface. With the commonality of SCSI peripheral bus, the systems designer not only gets to select exactly the right peripherals, but also gets to shop between vendors for price, warranty, and maintenance contracts.

In a similar fashion, the SCSI bus reduces the expansion costs of adding peripheral devices. For many families of business computers, each model in the line can accommodate a specific, limited number of peripherals. Once the user reaches the limit, the only alternative is to replace the entire system, or at least make major modifications to it. But with SCSI, adding a new peripheral requires only plugging it into the SCSI bus and informing the operating system of its presence, and the type of device it is.

Standardization In Operating Systems

The remaining area of host diversity is in the operating system, which impacts the controller through the software drivers which the OS uses to access disk and tape memory. Historically, OS's have not been standardized across vendors, and the separation between driver software and interface hardware has not always been clear. As a result, controller vendors had to design controllers for a specific OS and host interface.

Current development directions in operating systems may very well alleviate the OS interface problems within the next few years. First, some OS's are emerging as standards. These include CP/M, CP/M86, MSDOS, Unix, and TurboDOS, among others. Further, OS's are starting to develop good software/hardware isolation in the peripheral interface area, so that "customizing" the driver for a particular controller will probably reduce to describing the interface to the OS at initialization via a look up table.

Higher Performance Requirements

Entirely new approaches will be necessary to handle peripherals of the future effectively. The controllers must become more intelligent to offload data preprocessing tasks from the host. Some tasks are already beginning to move into the controller domain, including: masking out all permanent media defects, correcting all random data errors, and assembling data blocks for burst transfer.

Permanent Media Defect Correction

The purpose of masking out permanent media defects is to present a "logically perfect" disk to the host. In the minicomputer and mainframe arena this is a common controller function. But there is no standardization in the method of defective media identification and replacement. Normally, during a format operation, the controller will identify defective sectors or the ID field, and assign replacement sectors for them. However, the controller identifies only obviously bad sectors, not marginal sectors. Some newer disks have a defect map written on the disk at the factory, which flags all marginal sectors as well as totally defective ones. The controller should read the factory defect map and map out all sectors listed in it as well as any additional bad sectors found during the format operation.

Random Error Correction

Only recently have controllers began to take over the error correction task, which has three distinct phases. First the unit calculates the error code, typically from 16 to 64 bits, then it writes the data to the disk. Second, the unit recomputes the error code when it reads data, and compares the computed code to the written code. If they match, the data is error free, within the limits of the code. Otherwise, either the controller or the host must use the code to generate the correction pattern and correct the data. Although most controllers handle the error code generation and checking, the actual correction task has not promulgated down to many controllers in the low end yet.

Block Data Transfers

One area in which controllers can offer immediate improvements in system performance is in assembling blocks of data for burst transfers. Many controllers already perform "deblocking" on disk data, combining data from several sectors into one, large packet before transmitting the entire packet to the host in a single burst. Another technique currently in use is to "interleave" logical sectors around each disk cylinder, which roughly matches the average data rate from the disk to the average host data input capacity. But even these simple approaches need close integration with the host operating system. To expand the controller file handling functions further, while relatively straightforward on the controller side, will require more development in operating systems to utilize file handling controllers.

Increase In Unit Volume

The third fundamental change in the controller market will be dramatic increases in unit volumes over the next five years. The drivers for this change are the development of Winchester disks and the evolution of the personal computer. As a gross generality, the most common computer configuration, in terms of unit volume, for the next several years will be a personal computer with a small Winchester disk, floppy disk, and possibly a ¼" cartridge tape. Therefore, as a rough rule of thumb, the controller market will maintain approximately the same unit volume as the small Winchester market.

The dollar volume of the controller market can be similarly extrapolated from the small Winchester market. With OEM target prices for small Winchesters at $700 apiece or less, a reasonable upperbound for the controller cost is somewhat less than 50% of the drive cost, or below $350. The real question involves the lowerbound for the controller cost. In OEM quantities, the lowerbound is dictated by the minimum gross profit margin necessary for company survival, typically 35% — 45% in the electronics industry.

For a "dumb" controller such as is available today, $350 cannot be justified in volume. However, by increasing the controller capabilities, controller vendors can expect volume prices to stabilize at around 40% of the disk cost. Thus, a reasonable dollar volume for the controller market is somewhere from 35% to 75% of the small Winchester dollar volume, depending on activity in other peripheral markets, such as 8" and 14" Winchester drives, tape drives, local area networks, and printers.

Future Growth Directions

Future growth directions for controllers vividly demonstrate the electronic trend of increased performance at lower price. Controllers must increase their performance, both in terms of speed and functions. The drivers for lower price will be the increased unit volumes, discussed earlier, and tech-

nological innovation, primarily in specialized VLSI integrated circuits.

Increased Functionality

Many functions which now come under the purview of the host are natural targets for inclusion in the expanded capability of the next generation of controllers. This set of functions includes: decoupling electro-mechanical constraints from host data access time, providing data search capability, maintaining physical directories for peripherals, and assembling entire files for transfer.

Decoupling Electro-mechanical Constraints

One area in which the controller can offer immediate improvements in system performance is in masking all disk electro-mechanical constraints on the data rate from the host. The most noticeable are the rotational latency and the seek time, because controllers mask the high serial data rate from the host. Current techniques of interleaving sectors and deblocking data do not mask the electro-mechanical constraints from the host. Rather, they force the host to match the electro-mechanical data rates. With decreasing memory costs, controllers can include large buffers to match the high burst rate, low duty cycle host data transfers to the constant data rates of peripherals.

A tape peripheral may impose even more severe constraints on data transfer rates. Tape drives may take a long time to search the tape prior to reading any data from it; but, once the drive locates the file, it reads unremittingly at the selected speed, from 25 Kbytes/s up to 125 Kbytes/s. If the host falls behind, the penalty is a tape reposition cycle, which can take from 25 ms to over a second.

Printers, on the other hand, do not have repositioning time, but typically require data either too slow, or much too fast for a host. User response can suffer during a print operation because the host spends an inordinate amount of time bouncing back and forth from a printer service routine, or because a high-speed printer takes data so fast that the host literally may never get back to service the user.

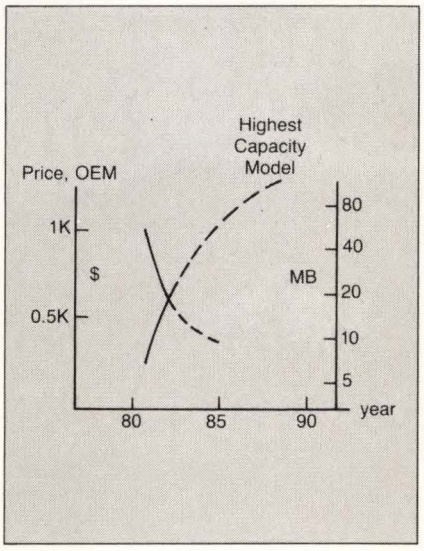


Figure 2: As the 5¼" market grows, price will continue to decrease. (Courtesy Seagate Technology; from a paper presented at the Mini-Micro convention.)

Data Search Capability

As data bases inevitably expand to fill the available memory, the time required for data searches will expand even more rapidly. Data search activity is presently a host CPU task, except for some expensive, dedicated relational data base processors. Future controllers can easily include a data search function. More importantly, controllers can search key words or fields at disk speed, off line from the host. Thus a data search at the controller level yields two advantages—faster search, and one less burden for the host.

Physical File Management

The directory is simply a logical to physical mapping which shows where each file is stored on the disk. Most current-day OS's manage the directory themselves. They assign free physical sectors to files as needed and reclassify them as available when no longer in use. But physical file management is a time consuming and mechanical task. The controller can easily take over the task of physical file management as soon as OS's develop the capacity to utilize "file oriented" controllers.

Complete File Transfer

As soon as the physical file directory management task migrates across the interface to the controller, then logical file transfer, by file name rather than physical location, becomes a possibility. Logical file transfers have several advantages. First, the source device can block the data to maximize transfer speed. Second, the host need only specify the file name, source device, and destination device to initiate a transfer. Third, other devices or networked computers can request the file by name directly from the source device.

Other Capabilities

Selective file backup, transaction backup, file protection and controlled file access can also all be done at the controller level. Data security, with passwords and/or encryption can be handled within the peripheral network. Time and date stamps, which some operating systems now put on files, can be off loaded to the controller.

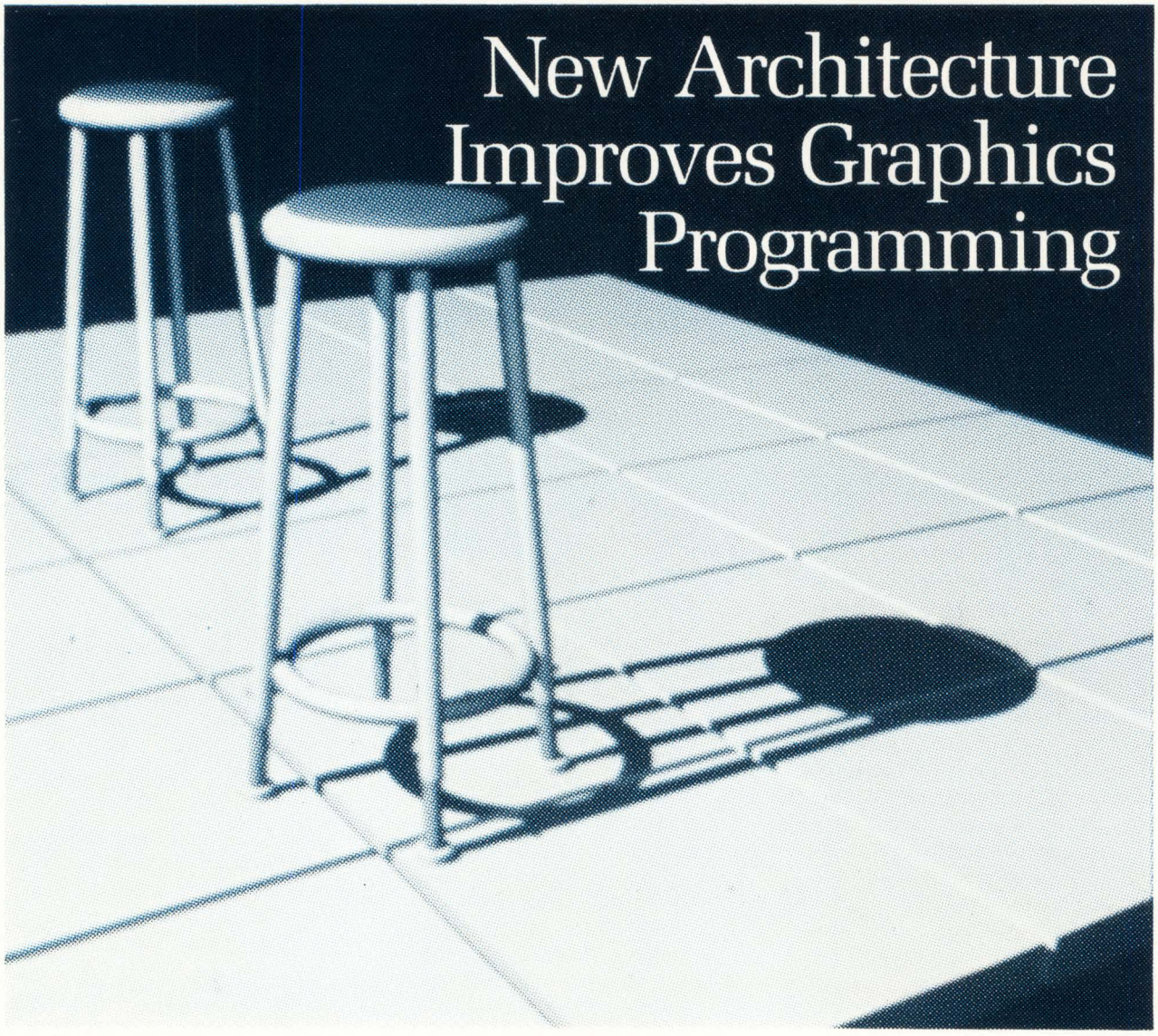
Lower Cost

One major key to lower cost will be the availability of specialized VLSI ICs which perform dedicated controller functions. Several companies, including NEC, Adaptec, and Western Digital, either have available or are developing commercial chip sets for controllers. Others are working on proprietary designs for use exclusively in internal products. The custom controller chip, or chip set, will lower costs in several ways. The obvious cost reductions will be in total IC cost and PC board size and cost.

The VLSI approach to controllers will reduce controller cost in the long term as well, by changing the industry philosophy toward controllers. Rather than being sources for integration problems, controllers can become standard elements for system design. From

Continued on p. 70

New Architecture Improves Graphics Programming



by Louis Doctor

Previous generations of graphics workstations have been based either on a single general-purpose μP or a single custom-microcoded μC.

Workstations based on single 16-bit general-purpose μPs offer the advantage of being potentially "user-friendly." The μP can offer a "rich" command set, which provides a wide range of graphics functions. These commands can be accessed and altered at the host software level. However, μP-based graphics workstations are comparatively slow in terms of raw performances (measured in picture-drawing capability).

"Bit-slice" processor based workstations use a single custom-microcoded 12 or 16-bit μC. By contrast to the previous approach, these systems have high performance—typically ten times that of general-purpose μP-based systems, when performing the simple iterative operation of generating graphics primitives such as lines and circles.

However, access to these resources in high-performance systems is very narrow. The command set is usually quite minimal in scope, and very low-level in function. To perform most useful graphics functions therefore requires long sequences of commands, and intensive host computer resources. To alter the actual command set requires extensive direct horizontal microcoding of the graphics controller—an expertise relatively rare and expensive, particularly when a given company's need for such skills is unpredictable.

"Bit-slice"-based workstations are therefore not true workstations, but high-performance rasterizers, requiring most of the program and control activity to reside in the host. Effective graphics program development and use calls for real-time, locally interactive, intelligent graphics workstations. Real-time, because many dynamic graphics processes cannot be viewed adequately in a slower time frame; locally interactive, because host involvement precludes real-time

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response, and poses other programming limitations; intelligent, to provide a certain level of stand-alone capability.

Neither the custom nor general single-processor architecture is capable of providing this level of workstation functionality essential to effective graphics development.

Raster's solution was a multi-processor architecture, to provide both performance and intelligent/friendly degrees of functionality. The Z8000 was selected for a general-purpose 16-bit μP, and hardware accelerators chosen for high-speed generation of graphics primitives.

We opted for custom processors (hardware accelerators) to provide the performance of a "bit-slice" system. We were able to do this because graphics problems can be decomposed into fairly simple algorithms, which such custom hardware can handle very efficiently. These algorithms include vector generation, pixel processing, and pixel moving for windows. These three functions alone provide over 90% of the functionality needed to do graphics; Raster's implementation using custom processors yields speeds exceeding those of bit-slice processors.

The general-purpose Z8000 16-bit μP provides a front-end capable of offering a compact command set for access by development programmers and by applications programs. It handles translation of simply-stated high-level commands into the strings of low-level commands accepted by the hardware accelerators.

Benefits of this approach include functional partitioning, some degree of local capabilities for the workstation, and reduced demands on the host computer and device-driver software.

Functional Partitioning

The multi-processor architecture of the Raster workstation (Model One Series) provides both high- and low-level functionality to applications programs and to graphics programmers. Because functions are handled by specific dedicated processors, various activities are "partitioned" off from each other, and thus isolated from changes to internals in other areas.

The front-end μP insulates users from the technology and internals of the display-driving hardware. Changes can be made by Raster to the back end—changes as substantial as complete reimplementation of the entire hardware unit—without impact to the software which drives the Model One's front end. This allows new technologies to be integrated into Model One units without obsoleting the entire device, and without the need to modify existing graphics programs. Similarly, the Model One's microcode can be altered, by Raster, without effect on front-end activity.

One bottleneck preventing the increased use of graphics is the cost and complexity of graphics applications programming.

The front-end processor also frees all users from the need to know Model One internals, and from the need to do step-by-step control specifications for graphics functions. Instead, high-level commands can be used. Programmers need to know what they want to happen, but not how to make the workstation perform it.

Local Capabilities

Local capabilities, made possible by workstation intelligence, are important both for graphics developers and for end users.

In the Raster Model One series, high-level graphics subroutines can be entered, stored, initiated and executed locally. This is accomplished by using command sequences, which can be grouped together to "macros." These macros can be stored locally during workstation sessions, uploaded to or downloaded from host systems, and are always executed locally in response to interactive devices.

The Model One's architecture also includes read/write registers for coordinates and pixel values (colors). These registers can be accessed both by the Model One and by a connected host system. The consequences of these capabilities include:

Real-time interactivity. Local storage and execution of commands and macros avoid I/O and time-sharing load delays with the host. Initiation of procedures such as moving rubber band lines and crosshairs can be automatically performed using downloaded macros pre-requested from the host.

Local program development. The graphics programmer can enter, store and execute commands (usually in the form of macros) at the workstation. Completed macros can be uploaded directly into the host-based application program (or host subroutine library).

Real-time processes. The local registers can be used to store and manipulate values in the same manner that general-purpose processors use general registers. Iterative processes can be performed without processing assistance from the host; updating host data is done by reading register values for newly-generated data.

Reduced Host And Driver Demands

As a high-level intelligent workstation, the Raster Model One architecture can execute most high-level commands directly and completely. Consequences include:

Reduced load on host and software driver interface. Whenever a display device does not have a function called for by a graphics application program, the device-driving software must either emulate the function (on the host) or default (if possible). Emulation places a heavy process load on the host. The volume of command output from the host, when emulation has been performed, is also far greater than the size of a single

Continued on p. 71

Embedded μP Applications Require a Real-Time Operating System

by Patricia Yelvington

An *embedded* μP is a μP buried inside some larger system; for example, inside an intelligent terminal, a communications system, an analytical instrument, an industrial robot, navigation and guidance systems, stored program controlled telephone exchanges, or a peripheral controller. The key feature is that the main role of the μP is that of an information processing component within a larger system. Embedded μPs are to be distinguished from *stand-alone* microcomputers, such as small business systems, personal computers, and word processors.

Embedded environments have a unique set of requirements that conventional operating systems are ill suited to meet.

Embedded μP Hardware

One typical example of an embedded μP might be a 68000 that is part of a system for controlling some continuous process in a chemical plant. The system consists of analog to digital converters (A/Ds), digital to analog converters (D/As), parallel input and output lines, serial communication ports, a real-time clock, and other hardware specialized to the chemical plant environment (see **Figure 1** for a diagram of such a system).

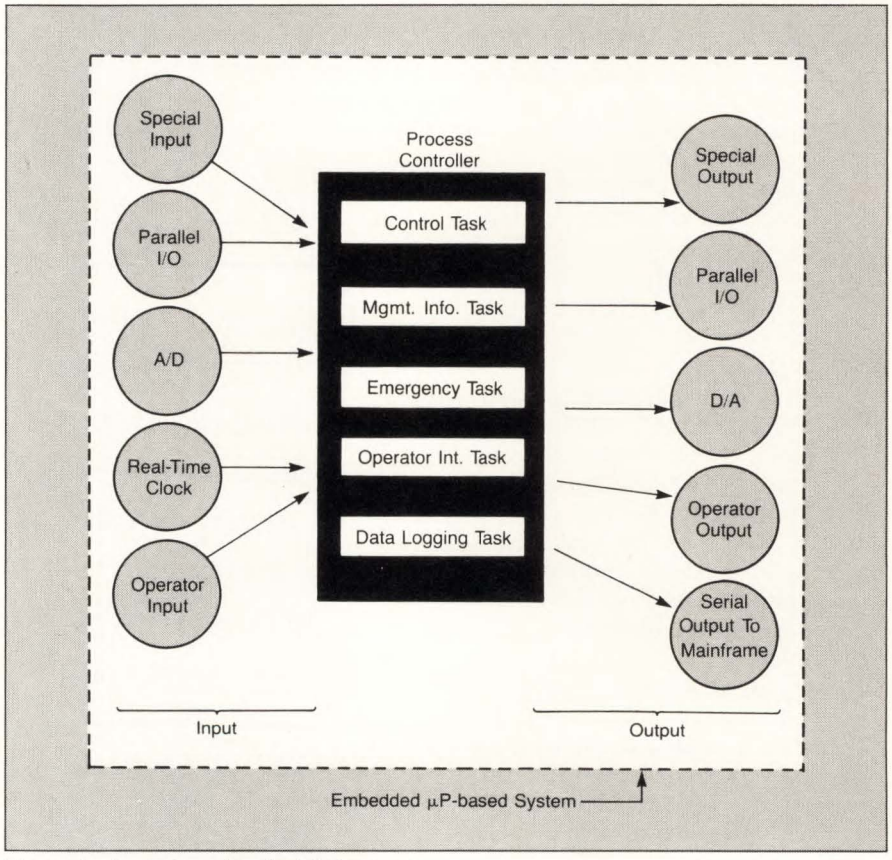

Figure 1: A μP-based embedded system.

The μP is dedicated to controlling the operation of process equipment in the chemical plant. It is interfaced directly to this equipment via the A/Ds and D/As, which enable it to measure the state of the equipment and to impose some control over the equipment operation. For example, the temperature, material flow rate, and pressure of the system could all be measured by A/D converters. Similarly, the D/A converters adjust the temperature, flow rate and pressure to correspond to the desired control parameters.

The parallel I/O lines are used to sense the position of valves in the equipment (either open or closed) as well as set the position of the valves as appropriate. As the control algorithms used will require the state of the equipment to be sampled at regular intervals, a real time clock is provided to interrupt the computer after each sample period has elapsed.

As well as interfacing to the plant, the computer must interface

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with human operators, so that the start-up and shut-down sequence operations can be activated and so that the overall behavior of the process can be varied. The serial communication ports are used for this interface.

In addition, control engineers and managers must be able to monitor the operation of the equipment. This can be done by relaying information about the equipment's operation via another serial communication port to a central computer elsewhere in the plant.

Embedded μP Software

The software that runs on embedded μPs must meet a different set of requirements than software that runs on stand-alone systems. The most important of these is *real-time* responsiveness. The system must be able to respond to unexpected events in the outside world rapidly enough to control some ongoing process. By real-time we mean that the system has to respond to externally generated inputs within some finite and specifiable delay. For embedded systems the failure to respond within a specified time may be just as bad as computing an incorrect result. Such a failure of an embedded system may be very catastrophic, as in the case of a medical instrument or a flight navigation system.

The software for embedded systems usually divides into distinct modules whose importance at any given instant in time can vary widely. It is desirable for each module to be able to execute when it is most needed. In the example described above, five modules can be identified. One for direct control of the process, one for data logging, one for providing management information, one for handling emergency conditions, and one for providing an operator interface. Other systems often have even more modules than this. For example, modules may be needed for long term optimization and supervisory control.

It would be desirable if these modules could actually execute concurrently. In reality, on a single-processor system, the modules must execute in an interleaved fashion, with control of the CPU

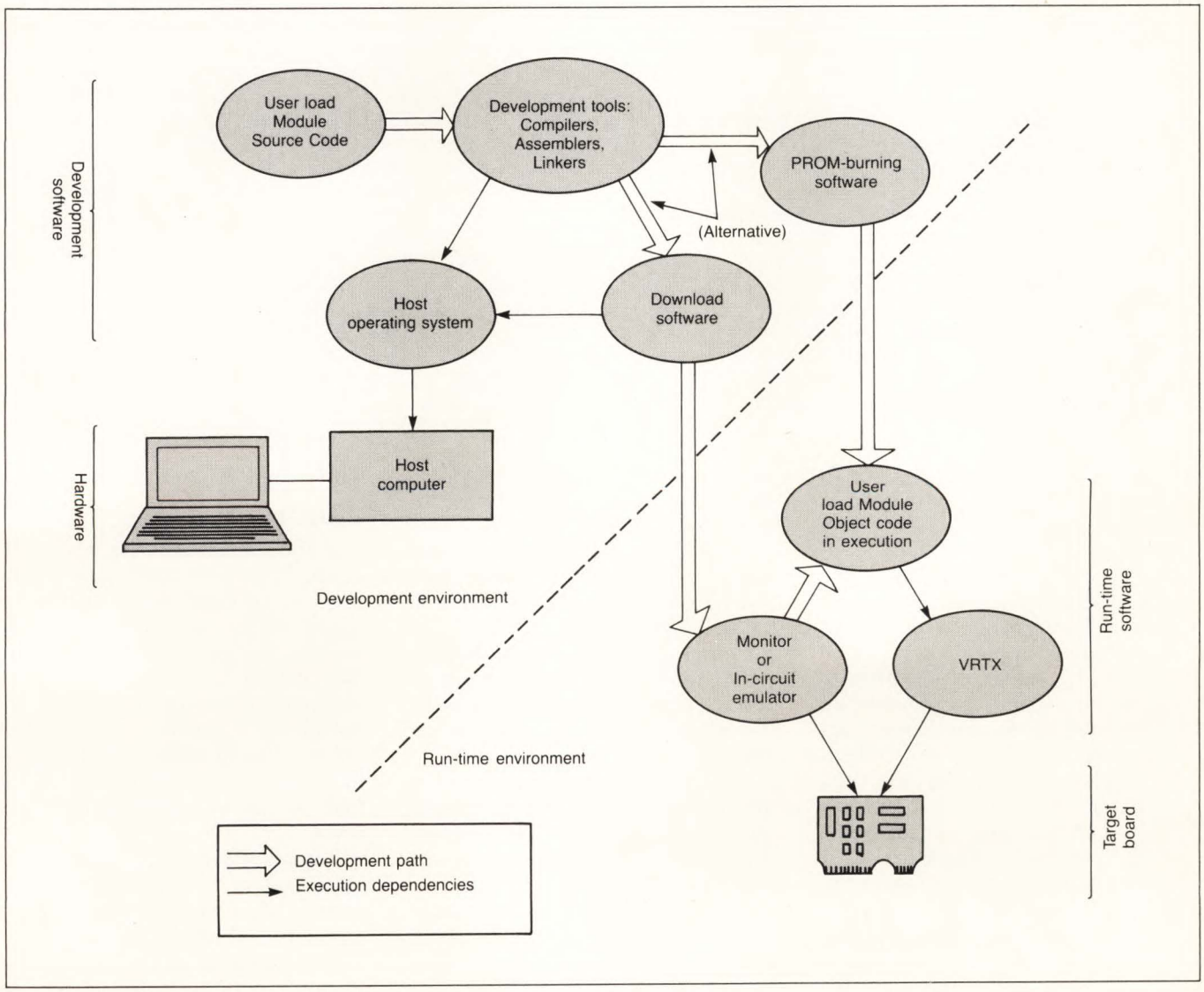

Figure 2: Host and target environments.

Intel's Approach to Firmware: The iAPX 86/30, 88/30 Operating System Processors

The increased performance and memory space of iAPX 86/10 and 88/10 have proven sufficient to handle most of today's single-task or single-device control applications with performance to spare, and have led to the increased use of these to control multiple tasks or devices in real-time. This trend has created a new challenge to designers—development of real-time, multitasking application systems and software. Examples of such systems include control systems that monitor and react to external events in real-time, multifunction desktop and personal computers, PABX equipment which constantly controls the telephone traffic in a multiphone office, file servers/disk subsystems controlling and coordinating multiple disks and multiple disk users, and transaction processing systems such as electronics funds transfer.

The Intel iAPX 86/30, 88/30 Operating System Processors (OSPs) were developed to help solve this problem. Their goal is to simplify the design of multitasking application systems by providing a well-defined, fully debugged set of operating system primitives implemented directly in the hardware, thereby removing the burden of designing multitasking operating system primitives from the application programmer.

Both the 86/30 and the 88/30 OSPs are two-chip sets consisting of a main processor, an 8086 or 8088 CPU, and the Intel 80130, Operating System Firmware component (OSF) (see **Figure 1**). The 80130 provides a set of multitasking kernel primitives, kernel control storage, and the additional support hardware, including system timers and interrupt control, required by these primitives. From the application programmer's viewpoint, the OSF extends the base iAPX 86,88 architecture by providing 35 operating system primitive instructions, and supporting five new system data types, making the OSF a logical and easy-to-use architectural extension to iAPX 86, 88 system designs.

The OSP Approach

The OSP system data types (SDTs) and primitive instructions allocate, manage and share low-level processor resources in an efficient manner. For example, the OSP implements task context management (managing a task state image consisting of both hardware register set and software control information) for either the basic 86/10 context or the extended 86/20 (8086+8087) numerics context. The OSP manages the entire task state image both while the task is actively executing and while it is inactive. Tasks can be created, put to sleep for specified periods, suspended, executed to perform their functions, and dynamically deleted when their functions are complete.

The Operating System Processors support event-oriented systems designs. Each event may be processed by an individual responding task or along with other closely related events in a common task. External events and interrupts are processed by the OSP interrupt handler primitives using its built-in interrupt controller subsystem as they occur in real-time. The multiple tasks and the multiple events are coordinated by the OSP integral scheduler whose preemptive, priority-based scheduling algorithm and system timers organize and monitor the processing of every task to guarantee that events are processed as they occur in order of relative importance. The 86/30 also provides primitives for intertask communication (by mailboxes) and for mutual exclusion (by regions), essential functions for multitasking applications.

switching rapidly back and forth between modules. In many systems these modules are called *tasks*. Modularization of the software into tasks simplifies design and development just as functions and procedures do for standard programs. Tasks execute in parallel and interact when necessary to synchronize on certain events to communicate information. Thus, another key requirement of software for embedded systems is *multitasking*, the ability of the software to handle a large number of tasks concurrently.

The concept of tasks also makes it easier for the system to meet the often tight response time needed to respond to interrupts. For example, when a real-time clock interrupt is received, a task monitoring the state of the equipment must run immediately and measure the state of the equipment and also compute an appropriate control output. This high priority task must not be delayed by processing being performed by less critical tasks. If the whole software package were designed as one large sequential program, the dynamic partitioning of control among different sections of the program would be much more difficult to achieve.

Other major requirements for embedded system software include handling complex input output. Embedded systems have a wide variety of input/output devices to which they are interfaced—chemical sensors, telecommunications controllers, missile guidance controllers, graphics interfaces, and carburetors. In fact the only standard is that there is no standard.

Real-Time Operating Systems

The basic function of the *operating system* in an embedded system is to provide the facilities for executing multi-task programs. Such a multitasking operating system provides mechanisms for defining a task, for assigning a priority to a task, for scheduling control of the CPU among several tasks, for allocating memory among competing tasks, and for communicating between tasks.

These applications need an operating system that provides a uniform mechanism for responding to external and internal interrupts, an easy method for incorporating special I/O into the system, and an overall means for structuring a

Programming Language Support

Programs for the OSP can be written in ASM 86/88 or PL/M 86/88, Intel's standard system languages for iAPX 86,88 systems.

The Operating System Processor Support Package (iOSP 86) provides an interface library for application programs written in any model of PL/M-86.—*Wilson*

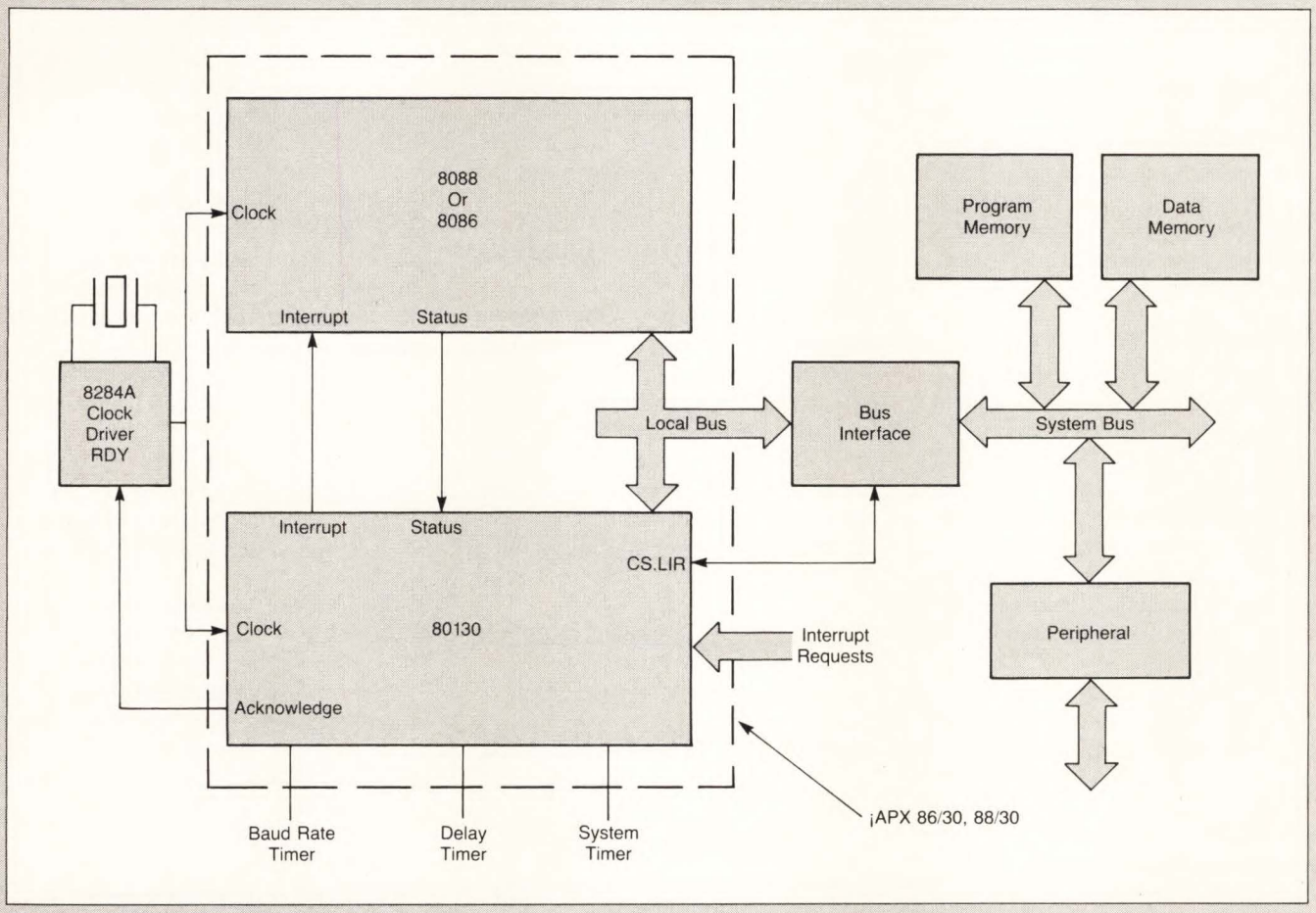

Figure 1: iAPX 86/30, 88/30 block diagram.

complex, multi-function application program. Usually, a real time operating system is used to provide the multitasking services required by embedded systems.

Traditional operating systems for stand-alone systems (e.g. CP/M or UNIX) are rarely suitable for embedded applications, because stand-alone systems do not usually provide multitasking in this sense, although they often support multiple *users*. It must be emphasized that a task is not a user; a task is a component of a program. In addition, stand-alone operating systems are usually designed to support several standard peripherals (e.g. disks, terminals, printers), whereas embedded applications have no standard peripherals—every application is different.

VRTX—A Real-Time Operating System For μPs

VRTX, the Versatile Real-Time Executive, is a multitasking operating system for 16-bit μPs in embedded applications. Versions exist for the 8086, the 68000, and the Z8002, the three most widely used 16-bit μPs.

VRTX is a compact (4 Kbytes) highly efficient (it takes approximately 100 μs for the system to switch between tasks) real-time multitasking executive that responds to the needs of embedded applications. It offers interrupt-driven task scheduling, intertask communication and synchronization including message queuing, dynamic memory allocation, real-time clock support and character I/O.

VRTX is also a silicon software component designed to be a general purpose software building block out of which larger systems can be constructed. It makes no assumptions about the hardware environment in which it will run, thus it can be used in many different custom applications, without any need to modify the component itself.

The operating system must be multitasking. By their very nature, embedded systems are responding to events, possibly unrelated, occuring asynchronously in time. Multitasking is a methodology that allows designers to structure the application as a set of cooperative, communicating tasks that control and process the events that have occurred.

In fact, tasks are the time domain equivalent to functions and

procedures in programming languages like C and Pascal. Therefore it is important that tasks be "cheap" to use, that is, that they take up as little system overhead in time and space as possible. For example, a system which required 1 Kbyte of memory for each task, took milliseconds to switch between tasks, and which was limited to a maximum of 6 tasks would not be very useful in a telecommunications system. A Pascal that had similar restrictions on procedures would not be considered a very useful implementation of Pascal.

Deterministic Behavior

The operating system must have deterministic behavior. It is critical that an embedded system have predictable behavior irrespective of unpredictable events occurring asynchronously in time. These systems are used in environments where failure could be life-threatening, such as medical instruments, process control equipment, and military systems.

Determinancy, which allows us to predict the behavior of the system from knowing the current state of the machine and the current inputs, is not found in some operating systems. For example, some standalone operating systems do an implicit round-robin scheduling which results in a task being suspended even though it otherwise would continue to run. Thus a task might be suspended from execution during certain critical conditions when it needs to run, with no way for a programmer to alter the scheduling.

Another kind of indeterminancy is found in systems like UNIX, which store parts of the system code (overlays) on disk. Consequently a particular system overlay may or may not be in memory when it is needed; if it isn't, it will have to be brought in from disk resulting in a randomly occurring delay in processing critical tasks.

Adding new interrupts and new I/O devices to the operating system must be easy. Unlike standard program development systems, which have a small set of possible peripheral devices, embedded systems are characterized by a wide range of I/O devices, as is illustrated in **Figure 1.** Programming these devices, such as A/D converters, specialized communications interfaces, and custom I/O hardware, is a large part of the software development process. The operating system should not contribute to the expense of the software by requiring complex, system-dependent I/O device interface software, which takes costly system programmers to implement.

Efficient Interrupt Handling And Coordination

Interrupts and multitasking must be coordinated in an efficient manner. Since the processing of interrupts is partitioned between interrupt code and task level code, the system must provide an efficient mechanism for changing the multitasking environment from the interrupt level. The purpose of a multitasking system is to always allocate processor time to the highest priority task that is ready to run. Therefore, interrupt code, which is outside of the task environment, should be kept to a minimum. A system that forces excessive processing at the interrupt level because of inefficient synchronization with the task level defeats the whole purpose of a multitasking system.

The operating system must be fast and compact relative to the machine to which it's targeted.

Real-time Responsiveness

The operating system must be fast and compact relative to the machine to which it's targeted. Real-time systems are often called upon to interact with the outside world within rigorous time constraints. They must minimize the processor time and memory space required to support multitasking and leave more for the application software.

A complete specification of the time that is required for each system call should be available, as well as the maximum time that interrupts are turned off by the operating system. Designers must have this kind of information to successfully build reliable real-systems.

The system must interface easily to high level languages. Different high level languages lend themselves to different applications. For example, Fortran might be suitable for numerical control applications where complex mathematical functons need to be computed in real time. C is better suited to the multilevel analysis of a communication protocol. But it is important that the operating system not limit the languages it supports by demanding all compilers meet a fixed interface specification.

For μP-based systems, the operating system must be inexpensive and easy to use. When embedded systems were built from expensive minicomputers, the operating system could be complex and require sophisticated programmers because the systems could be priced to cover the expense. Now, with low priced μP-based systems, the cost of software is a limiting factor. Furthermore there is a shortage of system programmers capable of doing all the complex programming required with traditional operating systems (e.g., adding device drivers). Any operating system targeted to embedded systems should be as easy to use as the target itself.

A fundamental distinction must be made between the computer system under which programs are developed (i.e., written, compiled, assembled, and linked) and the system under which these programs are executed. The former is called the development system or "host," while the latter is called the runtime system or "target." The term *environment* is used to refer to the combination of the hardware configuration and its operating system. For example, VRTX is an operat-

Continued on p. 71

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Buffer:	3000 characters
Data Rate:	110-2400 baud
Paper Capacity:	300 pages
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Write 17 on Reader Inquiry Card

New Advances In Modem Technology

by Racal-Vadic Staff

Major improvements in modem designs have taken place in the last few years using semi-custom and custom LSI circuits in conjunction with μPs. A typical OEM modem circuit board might take up about 50 to 60 sq. inches. A conventional 103 type modem using discrete components would come close to filling this space. But if the basic 103 functions are included in a single IC chip, the same modem would fit on 10 sq. inches, leaving enough room to introduce a μP to handle advanced functions.

Until recently, LSI designs for modems centered around individual elements of a modem. These are:

- Modulator
- Demodulator
- Transmit Filters
- Receive Filters
- Carrier Detector

IC technology, combined with the μP, is changing and improving the traditional role of modems in data communications networks.

- AGC
- Answer Tone Generator
- Answer Tone Detector

But not all of these elements were combined in a single package or even multiple packages. Chip sets of this type were developed by such companies as Motorola, Rockwell, Cermatek and even licensed from Western Electric. These chip sets resulted in reduction in size and cost and allowed the addition of some features. The first complete single modem LSI package to contain all of the major analog operating elements was a complete 103 modem on a 16 pin dual in line IC package. The size reduction is startling. The equivalent circuits, a receiver and transmitter module designed in 1969, occupied 27 sq. inches. The 16 pin IC is a direct replacement.

The design is centered around the use of switched capacitor filter techniques on a monolithic LSI package and provides full originate/answer capability. Complex as the design is, the performance of the chip is comparable to the 103J modem.

Custom Modem Market

While modem manufacturers are utilizing the latest advances to streamline the production of discrete devices used in stand-alone units, the most dramatic changes have occurred in customized modems that are designed as an integral part of other communication devices. These modems are usually incorporated into larger units such as terminals and mini-computers by system integrators and original equipment manufacturers (OEMs).

Such OEM modems are often built to specifications with fast turn around to meet demanding production schedules. The new design processes allow an OEM modem supplier to turn out a modem in less time even though the unit may contain more than the usual complement of advanced features.

The latest developments in OEM production are centered on the units that range from 300 to 9600 bps (**Table 1**).

A good example of the dramatic size and price change is the 9600 bps market. Several years ago a 9600 bps modem cost $10,000. Today you can buy that modem, with improved performance and added features, for less than $3,000. In 1975 a modem manufacturer required 575 MSI/SSI packages to build a 9600 bps modem. Today that same modem can be built using 7 LSI packages and 6 MSI packages (**Table 2**).

Speed	U.S. Type	CCITT Type
300	Bell 103	V.21
1,200 hdx	Bell 202	V.23
1,200 fdx	Bell 212	V.22
		Vadic 3400
2,400 hdx	Bell 201	V.26
4,800 hdx	Bell 208	V.27
9,600 hdx	Bell 209	V.29

Table 1: Modems affected by technological change.

The advent of μPs and the significant growth of distributed data processing has opened the market for data communications. LSI devices now make it feasible to design the modem into the device and treat it as a component rather than a standalone device. An auto-dial capability is one of the more desirable of the new features. When a serial character interface is added to a modem card within a terminal, it makes it possible for the terminal operator to initiate an auto-dial procedure from the keyboard.

When the modem has the ability to communicate with the terminal

Racal-Vadic (a subsidiary of Racal Electronics Ltd.), 222 Caspian Dr., Sunnyvale, CA 94086.

in character-serial format it can accept commands from the terminal and it can send information from the dialer. If the auto-dial capability were added to the terminal as a stand-alone device, the interface would be more complex and the cost would range between $300 and $1000 depending on the modem type.

Building the dialer into the modem, by adding a μP, adds the serial interface and simplifies the design; the total cost for the built-in device is less than $100.

The μP-controlled modem could be used to store a menu of numbers that could be selected through the use of control keys from the keyboard. Instructions on how to call up the auto-dial sequence could be stored in the intelligent modem and could be called up when the terminal operator required assistance.

	EQUIVALENT PACKAGES		
YEAR	MSI/SSI	LSI	MODEM COST
1975	575	—	$7,000
1977	40	18	2,000
1980	6	7	250

Table 2: This chart shows the evolution of the 9600 BPS modem from 1975 to 1980.

In addition to providing advanced functions to terminal manufacturers for inclusion in new devices, the intelligent modem on a board makes it possible to provide upgrade capabilities to terminals and other devices already installed at user sites. This type of upgrade can provide significant added flexiblity to the user at minimal cost.

Today, OEM modem suppliers can supply customized intelligent modems of the type in **Table 1** on less than 60 sq. inches. Using computer-aided-design techniques, it is possible to provide a prototype within 90 days and production units within 90 days after approval of the prototype.

The intelligent modem typically combines an LSI modem on a chip with μP-controlled advanced functions. The processor functions are programmed in ROM and tailored to the specific needs of a customer. Using the manufacturing experience of earlier modem models, standardized circuit blocks are stored in the CAD system. These

Continued on p. 70, column 2.

Completing The Modem Design

The LSI chip needs to be combined with a line interface, user interface and control circuits to produce a usable modem. The following are some of the modem modules which provide these designs:

- Bell 103 module and/or 212A modules
- Line Hybrid and Control Module (LCM)
- Automatic Tone Origination Module (ATM)
- Line Status Module (LSM)
- Audio Call Monitoring Module (ACM)
- Handset (telephone) Module (HSM)
- Control INTERFACE (Customer defined interface; usually a microprocessor)

Line Hybrid and Control Module (LCM). This module provides the necessary circuitry to interface to the telephone line, and also provides the required data access arrangement function and the HSM module interface functions. The module provides direct connect capabilities to the switched network telephone lines according to F.C.C. recommendation CSP2. (This configuration is only used in Canada.)

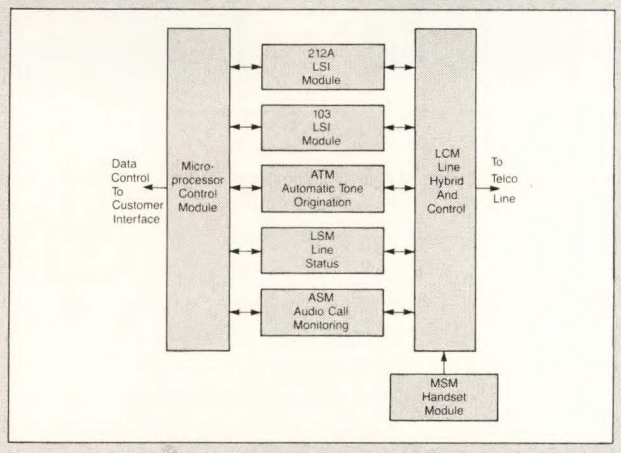


Figure 1: This block diagram contains all of the basic elements which make up a complete Bell 212A/103 equivalent modem.

Automatic Tone Origination Module (ATM). The ATM module contains all the necessary circuitry required to perform tone dialing functions. It will interface directly to the LCM module and the control interface. Automatic pulse dialing can be performed directly via LCM/control interface and it is always provided with the LCM module.

Line Status Module (LSM). The LSM module provides all of the necessary signals required to properly monitor the progress of an automatic dialing sequence. Sub-blocks for this module include low-pass filters and line integrators, and it is able to properly identify the following tones: • Ring Tone • Busy Tone • Dial Tone

Audio Call Monitoring Module (ACM). The ACM module provides an audio monitor or an audio monitor driver for the dialing process.

Control Interface. This interface provides all the necessary control circuitry needed to connect the different modem modules with a customer's *data terminal equipment* (DTE).

The control interface is also responsible for controlling hand-shaking procedures, call origination and answering procedures and other general control functions for the modem.

Additionally, the modem, if it is to be used on the switched network, must be tested and the results submitted to the FCC for registration. Other tests must be performed to receive UL approval and if the modem is to be used in Canada, the modem has to be certified in accordance with the Terminal Attachment Program (TAP) and CSA (the CSA is the Canadian equivalent of UL).

Kokomo's Silicon Valley: Integrating Cars and Computers

by Jerry Borrell

General Motors Corporation exemplifies the new focus of *Digital Design* in examining the computer-related OEM. With several major facilities producing electronic components worldwide, GM is one of the largest computer builder/purchaser/integrators in the US. Despite its production levels, very little is known outside the automotive engineering world about how computers are being used in automobiles.

Despite its production levels, very little is known outside the automotive engineering world about how computers are being used in automobiles.

As a company, the work of General Motors in electronics is much broader than automobiles. Each of the manufacturing facilities of GM has a different but complementary role in electronics. In Milwaukee, WI, for instance, the firm manufactures inertial navigation systems for commercial and military aircraft, as well as parts for electronic engine controls. In Santa Barbara, guidance and control systems for space vehicles, oceanographic, ship navigation, and electronic engine control devices are manufactured. Singapore facilities are used for the manufacturing of sub-assemblies for its electronic parts. The main location for work with electronics, however, is in Kokomo, IN, where several functions are carried out including: design and manufacture of ICs, R&D, manufacture of engine controls, and other automotive electronic systems such as radios.

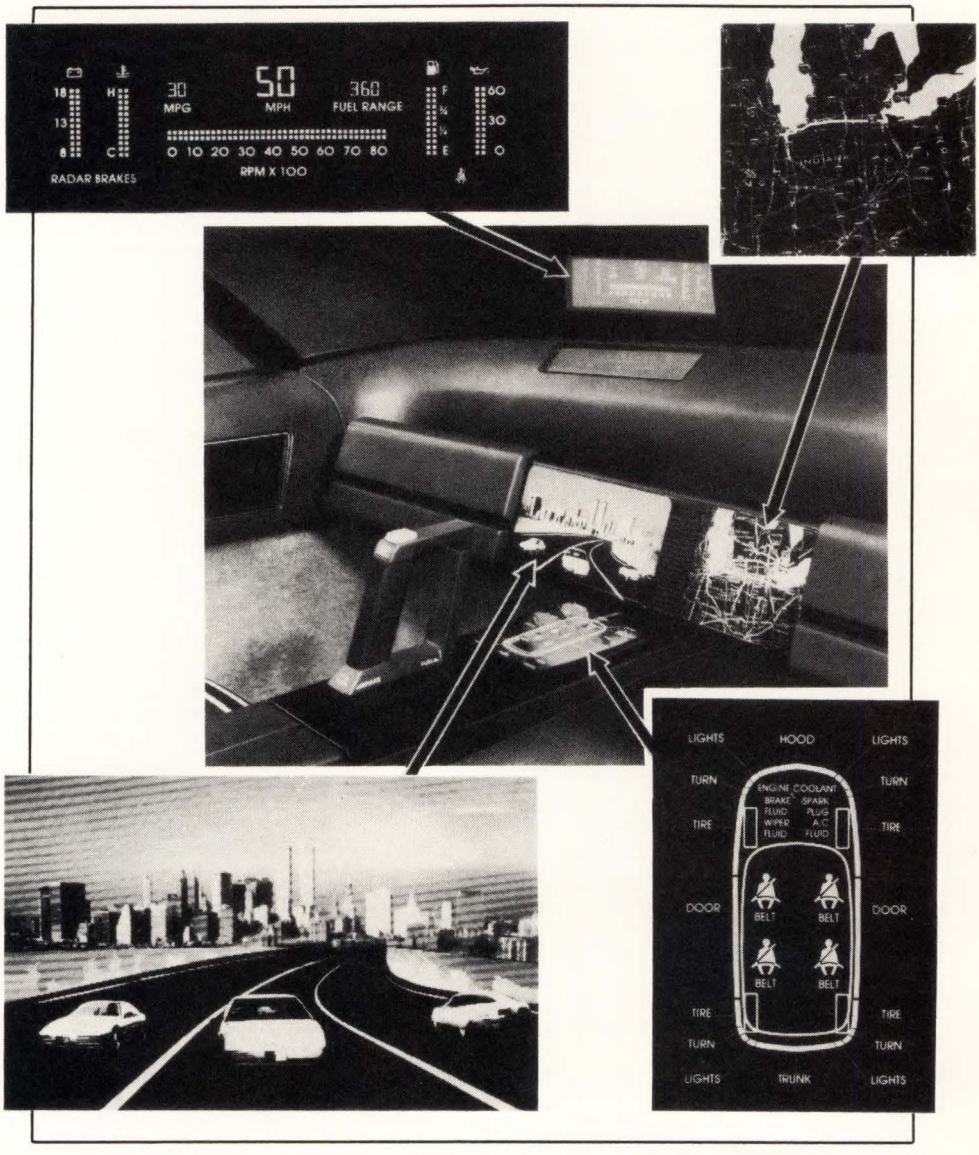


Figure 1: GM's advanced instrument panel incorporates an electroluminescent panel and a touch sensitive CRT display.

The division of General Motors that performs the company's work with electronics and systems is Delco Electronics. Formerly, AC Electronics Division did a great deal of the work, but in 1970 the AC Division (including the Milwaukee and Santa Barbara groups) was consolidated to form the Delco Group. The origins of General Motors interests in electronics have had three key influences: its work

to develop more reliable radio systems for automobiles, its work with the Apollo space mission, and its need to develop pollution control/fuel economy techniques for automobiles. The current culmination of these forces is the onboard computer in 1982 General Motors automobiles. The future, however, is already under consideration and open to public scrutiny. The General Motors pavilion at the new Epcot Center near DisneyWorld in Florida features GM's turbine car (see **Figure 1**) which has an instrument display based on an electroluminescent panel, advanced music system from Bose, a touch sensitive CRT display (which provides climate control, navigation and map access, telephone, and other car system information) and a large color CRT which displays a rear mirror projection of the highway. The automotive uses of computers for such applications are probably the most variable applications found in computer use: they must be mobile, able to withstand extremes of environment, low cost, of minimal size, and provide the sort of access/usability that fixed systems will be providing to consumer and industrial users over the next decade. GM is building towards this future today by implementing advanced engine and emission controls, radio and entertainment devices, and automobile control systems such as trip computers, level controls, and anti-theft devices.

Entertainment Systems

GM was the first automobile manufacturer to implement transistor radios in 1954–57, and has since introduced features such as stereo, tape players, and modular radios for CBs. Its current work with the Bose Company will result in very high quality sound systems that will regain part of the market lost to third party service companies that currently install stereo equipment into finished automobiles. The current production rate for radios is over 20,000 per day and over its history the company has installed 200 million radios. 1982 radio receivers make use of Nationals COP (4 bit) microprocessor and an ADI

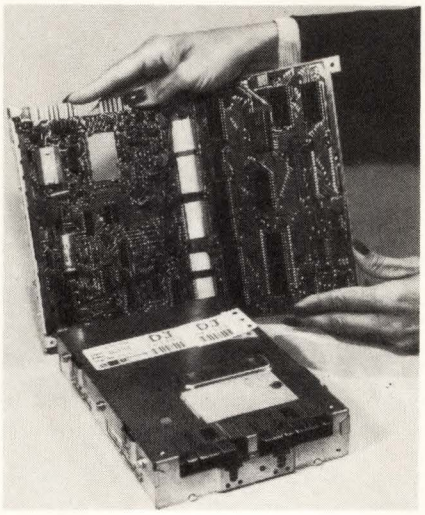


Figure 2: The "brain" of GM's computer command control (CCC) emission system is this electronic control module.

synthesizer chip. The effort to build higher quality systems, and the eventual integration of climate control (heat-air conditioning) into a central processor with the radio and entertainment indicate the direction that future systems will take. At present Delco provides only the electronics while A.C. Spark Plug Division provides the readouts. Current use of vacuum florescents may be enhanced in the future through further integration of electronics and display logic.

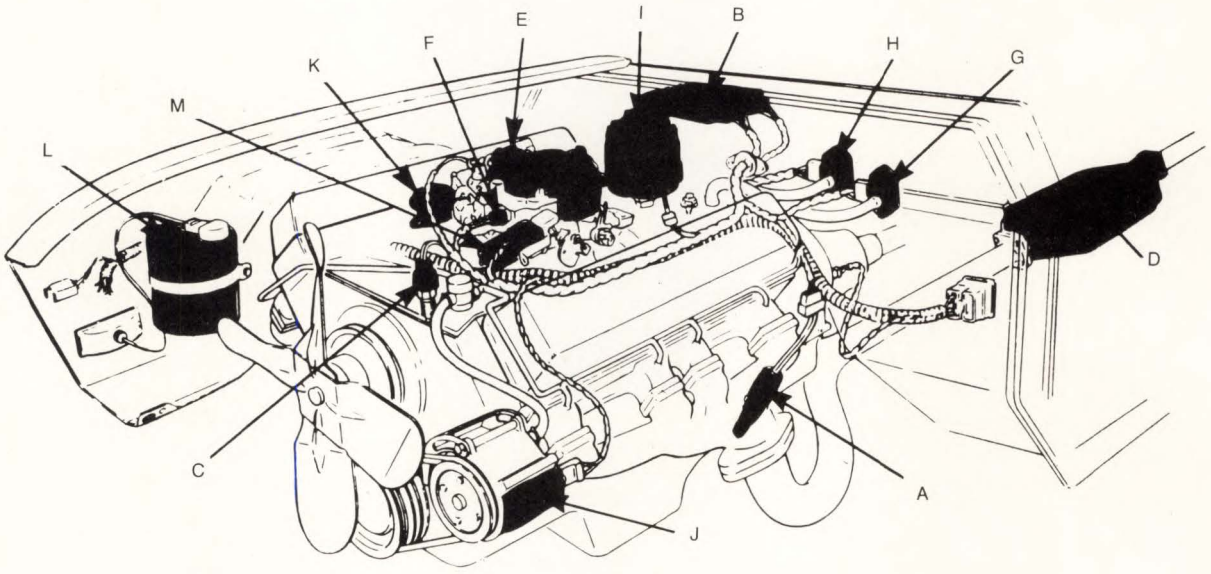
Onboard Computer—The Electronic Control Module

In the early 1960s, GM became involved with the guidance and navigation systems for the Apollo Space System. One area of manufacture resulting from this work was the development of airplane navigation systems. In 1968 Boeing replaced its plane navigator with a Delco "Carousel" Automatic Navigation system. Today 65 airlines make use of GM systems for this purpose. Part of the expertise gained from directing the vehicles engine firing sequences has helped in the development of a system for controlling exhaust emissions, and to meet fuel economy requirements. The 1982 corporate average fuel economy, for instance, must be 24 miles per gallon, increasing to 27.5 by 1985. For the company to meet the fuel economy and emission level standards a system had to be designed to meet both standards—and therefore to regulate the air/fuel mixture while controlling gaseous emissions. In 1978 the first approach was to use electronics fuel control. In 1980 and 1981 GM introduced its computer command control (CCC) system which had the capability to control spark timing, idle speed, torque conversion, air management, and the throttle body, which injects fuel into the carburetor. The heart of the CCC is the electronic control module (**Figure 2**). The ECM plays a role not only in the fuel and emission control but also to provide diagnostics. The diagnostics are of two types: if there is a malfunction in any of the systems noted in the figure an amber "check light" signal is lit; at the service department the mechanic is able to plug into the ECM and read a code that locates the problem within one of the systems.

Delco produces not only the majority of the silicon products used in the ECM, but also products for the sensor applications within the engine. The manifold pressure sensor, for instance, is a 3mm square silicon chip which is recessed to form a pressure sensitive diaphragm approximately 0.025mm thick. The diaphragm reacts to pressure resulting from engine load and speed, and sends a related voltage signal to the ECM. Sensors are used in several systems: oxygen, throttle, coolant, vehicle speed, and others.

The divisions requirements are so large that it is one of the largest purchasers of several manufacturers: National, Signetics, TI, Motorola, and Hitachi. The company also produces its own silicon, growing over 20 metric tons in 1981 alone. The level of the technology is at the leading edge of circuit production design (see box), testing, and packaging—with some of the company's products being manufactured at the three micron level. The company's work with semiconductors is complicated by two needs: the requirement to produce hybrid boards that will combine both the IC chip and the analog sensor function, and the

Computer Command Control System



(CCC) Components And Their Manufacturers

A Oxygen Sensor (O_2-Sensor)
Manufacturer: AC Spark Plug Division, GMC

B Electronic Control Module (ECM)
Manufacturer: Delco Electronics Division, GMC

C Coolant Sensor
Manufacturer: AC Spark Plug Division, GMC

D Catalytic Converter (Three-Way or Dual Bed)
Manufacturer: AC Spark Plug Division, GMC

E Electro-Mechanical Carburetor
Manufacturer: Rochester Products Division, GMC

F Throttle Position Sensor
Manufacturer: Rochester Products Division, GMC

G Manifold Pressure (Map Sensor) Or Differential Sensor
Manufacturer: Bendix Corporation (no Differential Sensors)
Delco Electronics, GMC

H Barometric (BARO) Sensor
Manufacturer: Bendix Corporation or
Delco Electronics, GMC

I EST Distributor and HEI Module
Manufacturer: Distributor—Delco-Remy, GMC
HEI Module—Delco Electronics, GMC

J Air Management System
Manufacturer of Air Management Valves:
Rochester Products Division, GMC

K EGR (Exhaust Gas Recirculation) Valve
Manufacturer: Delco Products Division, GMC

L Purge Canister
Manufacturer: Rochester Products Division, GMC

M Idle Speed Motor
Manufacturer: Delco Products Division, GMC

requirement for environmental protection or ruggedization. "Flip-Chip" techniques are frequently used in which the IC is mounted backwards on a ceramic substrate incorporating other sensor components. Further protection may be offered by silicon sealant coverings on the chip, and air filtering, and impact resistant packaging. The on-board computer is mounted within the passenger cabin and so is subject to less stringent conditions than engine components.

Automobile Control Systems

There are several new functions on automobiles being carried out by μPs which are not linked to the ECM. While combining functions is possible with newer logic chips available, GM's designers must reckon with additional factors such as the 50,000 mile warranty on the emission control system, and the more practical limitations of current memory technology (4K RAMs) which slow the use of memory when used in multiple applications. Another limitation on the amount of integration of automotive computing has been caused by regulation and legislation. GM developed in the mid-1970s a system of ignition identification to be used on cars, but the outcry from dealers and drivers was so great that the project was shelved. The most common criticisms related to elderly or tired drivers who would be forced to leave the automobile unused for periods of time because

Continued on p. 70, col. 3

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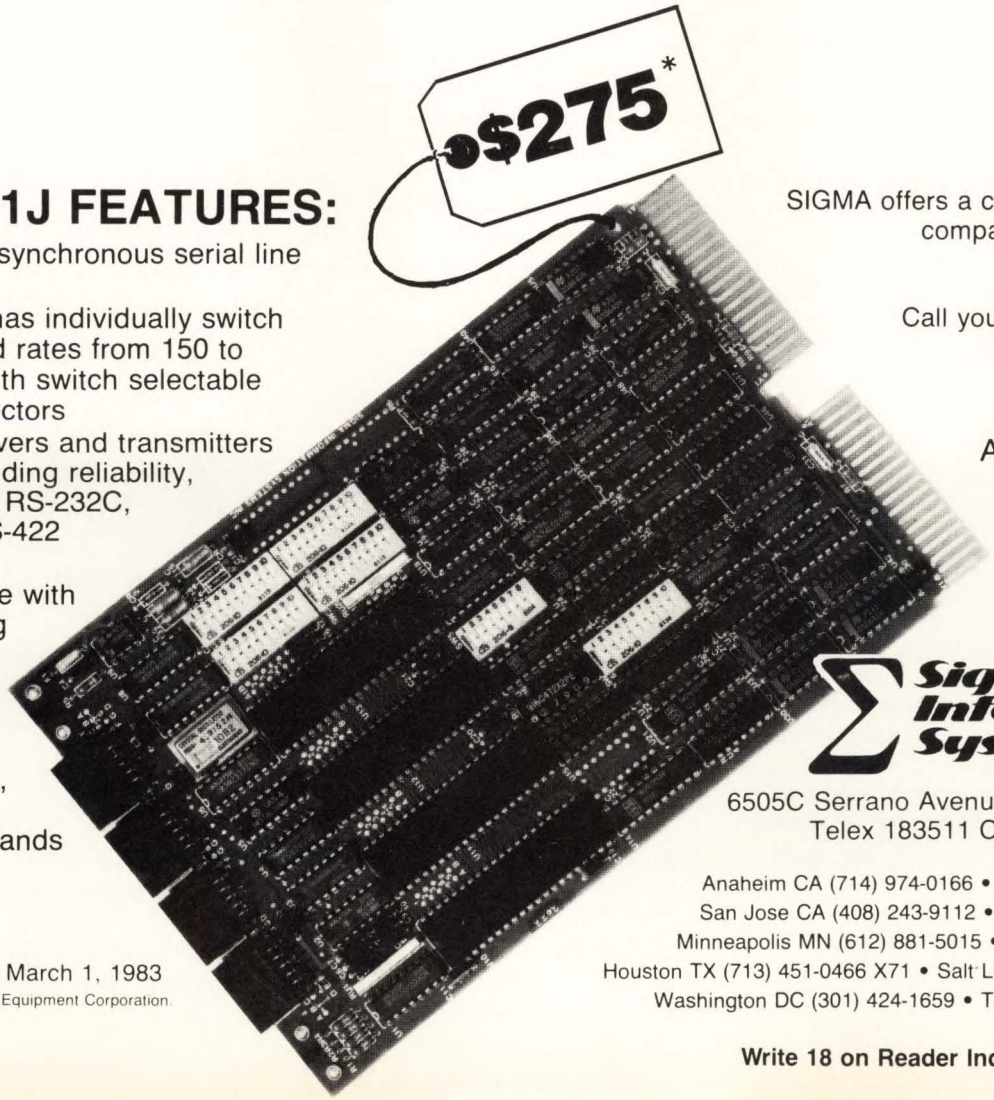

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Write 18 on Reader Inquiry Card

Distributed Intelligent Architecture Improves System Performance

by Michael F. Wells

Recent advances in μP technology, coupled with a flood of new and sophisticated VLSI peripheral components, have created the building blocks necessary to develop a new generation of μC systems. This new generation, by employing the concept of a distributed intelligent architecture, will address such high performance requirements as communications concentrators, multiplexors, emulators, database processors, transaction processors and multi-user data processing systems. Consequently, system designers are witnessing explosive growth in both quantity and function of processors and intelligent peripheral controllers of all varieties.

A new architecture to service high throughput demands using a hardware and firmware message passing facility.

With an increasing number of intelligent controllers becoming available, μC systems are enjoying a newfound performance improvement rivaling superminicomputers at a fraction of the cost. By incorporating distributed processing techniques, true plug-in performance improvement is possible as each device performs its share of the processing load in the most efficient manner possible. Intelligent devices are tailored to solve a specific set of problems without the tradeoffs that are apparent in dedicated processor designs.

Enter The Multibus

Distributed intelligence in any system requires two fundamental ingredients: a bus arbitration technique to allow multiple intelligent devices to share a common bus and a method of inter-device communication for the passing of parameters, commands and data. Various system busses address these requirements, including the Intel Multibus. However, as can be seen in the following discussion, the performance improvements and architectural flexibility offered by distributed processing are not achieved without corresponding tradeoffs.

Current distributed intelligent Multibus systems utilize the traditional methods of shared memory, programmed message transfer and single contiguous message blocks for inter-processor communication. This technique relies upon RAM memory resident on the Multibus. Devices participating in inter-processor message transfers require either dual-ported RAM resident onboard, or the capability to operate as a bus master. Regardless of the actual implementation techniques used, message management must be provided. This is invariably done with software requiring pro-

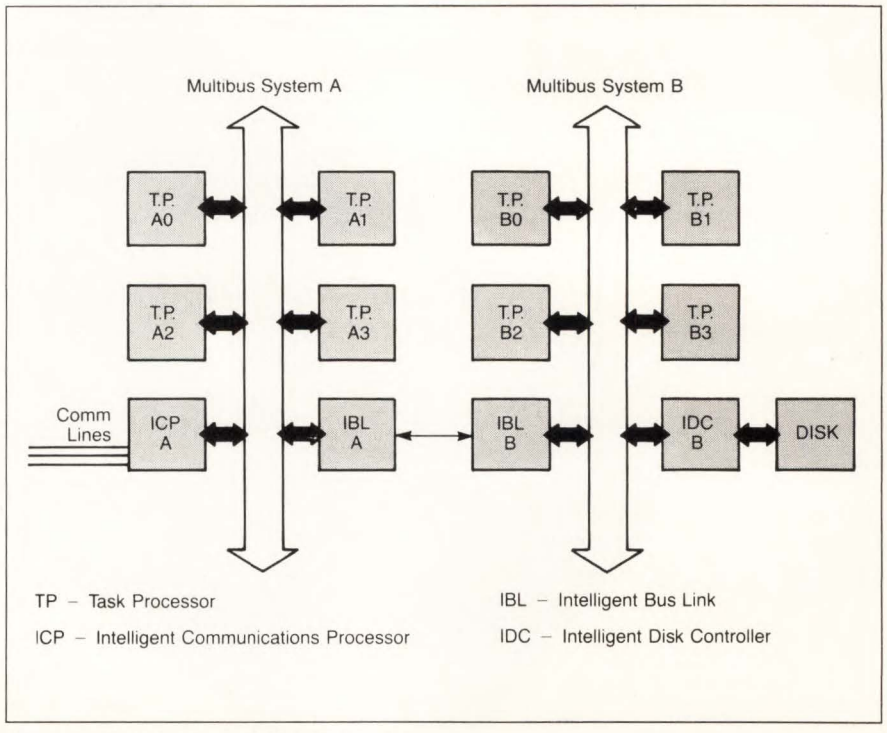

Figure 1: Interconnected MetaPaket Systems.

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cessor execution cycles.

The transition to distributed Multibus systems has shed light upon many of the inherent weaknesses of existing implementations. These manifest themselves as poor system performance brought about by a multitude of related issues; the most important of these being bus bandwidth saturation. Bus saturation becomes evident when additional processing resources fail to increase overall system performance. Various causes can be attributed to this, most notably the utilization of Multibus cycles for program execution, message movement requiring multiple processor (and Multibus) cycles and Multibus and dual-ported RAM arbitration delays.

Other issues, while not contributing as directly to performance limitations, create related problems more evident in the definition phase of a system design. Memory fragmentation is a natural by-product of the differing hardware techniques used to provide dual-port address decoding and size control. This has an effect of partitioning and aliasing blocks of memory into groupings too small or randomly distributed to be efficiently utilized. While this may be acceptable in some system configurations, the ability to service large message transfers is severely inhibited.

Existing message passing techniques utilize several approaches for handling large messages. But, because they rely on shared (and sometimes fragmented) memory, tradeoffs exist between fixed region memory allocation, memory management and message size. Large message transfers require either contiguous memory space, or multiple transfers occurring sequentially; both restrictions being costly in space and processor overhead. Since chaining of message data (which allows variable length messages to exist, and would tend to minimize message size limitations) is rarely supported, user application software must often perform this task, further restricting performance. Ultimately, each approach is a compromise between processor cycles and efficient use of memory resources.

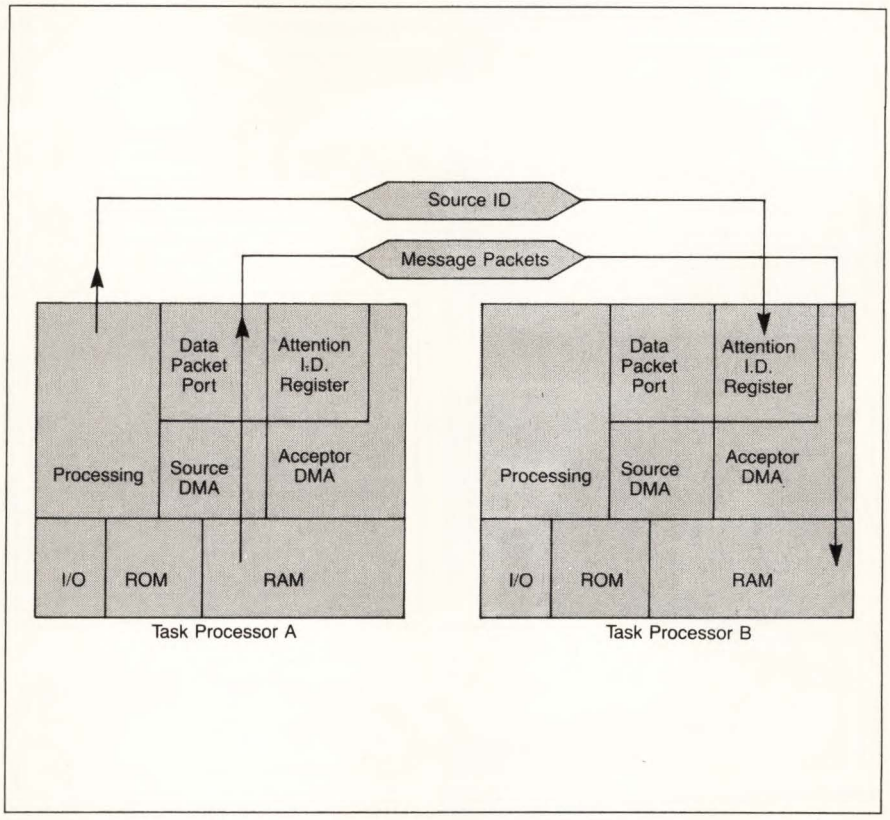


Figure 2: Message packet transfer example.

A more serious concern exists for providing message security and data integrity. With any number of intelligent devices having access to the memory, the need to protect regions from unauthorized use or corruption is vital. Clearly, in a shared memory environment this is difficult and expensive to provide.

Software Friendly Devices

As software and systems become more complex, techniques to simplify peripheral interfacing have taken on new importance. Existing methods, while presenting a "layered" software interface, have not measurably influenced hardware and firmware designs. The concept of making an intelligent device "software friendly" by imbedding the message facility into the basic design, could greatly improve user understanding of the overall system architecture. Current inter-processor message passing facilities fall short of this goal.

The MetaPaket Architecture (MPA) features a high performance hardware and firmware message passing facility resident on a new generation of Multibus processor and intelligent peripheral controller devices. The MetaPaket design philosophy allows a Multibus-based system to be used in applications typically reserved for other more costly solutions. Thus, the OEM system designer can benefit from the flexibility allowed by multi-processor, multi-tasking concurrent processor solutions. Systems incorporating MPA, alone or in combination with existing Multibus products, can economically service the high throughput demands of applications requiring rapid data movement, concurrent processing, extensive data manipulation or multiple users.

The MPA utilizes the Multibus as a high speed parallel data path for message packet transfers between intelligent Multibus devices. Message packet transfer is accomplished by on-board firmware and custom high speed Direct Memory

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.

Access resources. The MetaPaket facility operates concurrently with the on-board processor. Access to the channel is achieved by granting of Multibus master status through typical Multibus arbitration mechanisms. MPA message ports are accessed as Multibus I/O addresses and do not rely on any resident Multibus memory. The MPA can be accessed by easy-to-use operating system extensions to support interprocessor communication. Since the MPA supports chained buffer operations, message packets may be variable in length and number.

Figure 1 shows a typical multiprocessor environment in which two MPA systems are interconnected by Intelligent Bus Link devices. Message communication takes place between independent devices within System A or System B. Communication between System A and B is also possible through the IBL devices. System A, through ICPA, controls serial communications. Devices in System B may transfer messages to ICPA through IBLB and IBLA as if ICPA resided in System B. System B, through IDCB, controls data transfers to and from disk memory. Devices in System A may communicate data packets to disk memory as if the disk physically resided in System A. Each MPA device in **Figure 1** processes data independent of the Multibus until MPA message traffic is required. This allows the multiprocessor configuration in **Figure 1** to operate with maximum processing throughput.

Each message transfer involves a source and an acceptor device. **Figure 2** illustrates an MPA message transfer with Task Processor A acting as the source device and Task Processor B as the acceptor device. TPA requests the message transfer by sending TPA's ID to TPB's Attention ID Register. Sixteen message requests (one for each possible device) can be simultaneously queued in an Attention ID Register. Receipt of an entry into the Attention ID Register interrupts TPB, providing notification of a message request. The message transfer is accomplished by simultaneous DMA transfers by the source and acceptor. TPA's source facility transfers the message between local memory and TPA's Data Packet Port. TPB's acceptor facility reads the message from TPA's Data Packet Port to TPB's local memory. In using dual DMA facilities operating concurrently, the message is passed in the most efficient manner providing transfers approaching 2 Mbytes/s. Message transfer protocol and password protection is provided by hardware security mechanisms.

New architectural techniques can greatly reduce some of the inherent weaknesses in existing design philosophies.

MPA systems self configure upon system reset. At that time each MPA device requests message traffic to each of sixteen possible devices. Those devices resident in the system return an identification message, thus informing the requesting device of its presence. Intelligent Bus Link devices return the identification block of all connected Multibus systems.

Conclusion

Distributed intelligence, when employed in μC systems, can provide high performance solutions to a variety of requirements. New architectural techniques can greatly reduce some of the inherent weaknesses in existing design philosophies while retaining all of the advantages. The MPA provides this, while also contributing to a simplified system concept of common software/hardware interfaces for all devices in a system. □

Controllers

Continued from p. 47

that perspective, customers will give even more impetus to the standardization trends already underway. As more controller houses adopt the VLSI chips as the core elements in the controller, the designs will begin to merge also, further eroding the barriers between different fragments of the controller market.

VLSI controller chips will also become increasingly flexible and programmable. Most of the customization for particular applications will be in firmware, rather than hardware. Firmware, while expensive to develop and debug, is extremely inexpensive in production, compared with hardware alternatives.

Other Alternatives

The above scenario for future growth directions in the controller industry is by no means the only one. If the VLSI controller chip develops as predicted, the silicon giants such as Intel, Motorola, AMD, and others may well choose to develop the controller chips and boards for sale, thus crowding out the many smaller companies now in competition. Intel has already taken this approach with the use of specialized chips in the popular Multibus product family.

A second group which can dominate the controller industry is the peripheral manufacturers themselves. If the industry does achieve interface standardization, and the controller reduces to a small number of custom chips, the peripheral manufacturers may simply move the entire controller onto the peripheral.

Will the controller market of tomorrow reach the potential it shows today? The only certainty is the fact of rapid change, and exciting growth. Technological developments have created a unique opportunity for the birth of a major OEM market in peripheral formatters. If formatter vendors can meet the market challenge and establish real barriers to entry in cost, technology and marketing, the rewards will be significant, both for the vendors and for the computer industry as a whole. □

Modem Advances

Continued from p. 57

circuit blocks are then manipulated and interconnected on circuit boards to meet special customer requirements.

Switched capacitor filter (SCF) technology helped solve the real estate problem. SCF technology allows you to simulate high value resistors with small capacitors. Miniature MOS capacitors and transistors are easy to fabricate, thus a switched capacitor filter can be very small—witness a complete 103 modem in a 16-pin LSI package.

The applications, design testing, registration experience and the fast turn-around time provided by modem companies are the reasons why most manufacturers still prefer to buy modems rather than attempt to design and build them in-house.

The Future For Modems

As terminals, workstations, personal computers, and similar devices proliferate among users with limited technical expertise, the intelligent modem will play a key role in helping to make these devices more user-friendly. The intelligent OEM modem provides the supplier with a cost effective method of installing prompting sequences without the need to make major design changes.

The modem market, particularly low and medium speed, will eventually become a chip or component market. More and more manufacturers will design these components into their systems as they gain the necessary application, design, testing and usage experience.

To maintain presence in data communications market, modem manufacturers will have to continue to add more capability and value to their products. A few of these for consideration are:

- Encryption
- Error Control
- Improved Diagnostics
- Network Control
- Protocol Conversion

Assuming they do all of these things, the user and the supplier will continue to benefit with the continued introduction of better data communications devices. □

Cars & Computers

Continued from p. 60

they were unable to complete an ignition coding sequence within a required period of time. A similar situation developed with the air bag restraint for collisions. A logical implementation of the controls for such systems might be in a central location, but their placement would have made the ECM unnecessarily expensive in light of their lack of use. GM subsequently cancelled the system.

For these reasons several of the current projects have remained independent of the ECM, and newer projects are likely to remain so. Such projects include the theft prevention system which is controlled by input from sensors in the doors, windows, and trunk. If an unusual entry is made into the car the ignition is disabled and lights are turned on. This system is controlled through another of GM's custom chips. Another of the projects is the introduction of automatic or continuously variable transmissions—gear systems controlled by a chip which would vary ratios according to fuel consumption, torque, and grade of the truck. There are several more exotic applications such as anti-personnel radar braking systems, and voice synthesis undergoing evaluation.

> There are several new functions on automobiles being carried out by μPs which are not linked to the ECM.

There are other applications, however, which are likely to be introduced as a result of the changing shape of automobile production. Dynamic Ride Control, for instance, will have the spring tension adjusted in response to cornering and braking. This advance is considered necessary for new, smaller cars—the philosophy being that Americans still want a "big car" feel from their autos. □

Continued from p. 49

compact command which the Model One is able to execute locally.

If every single command has to be expanded by the host into a great number of lower-level commands for the workstation, what seems to be a simple task results in a large, tedious number of commands generated and downloaded by the host; display updates proceed with corresponding slowness.

Where a greater degree of the graphics processing is assured to take place within the workstation, smaller hosts can be used, or less resources allocated.

Debugging at the workstation level. If display activity has already been broken down into low-level components by the host and driver (i.e., for a non-intelligent terminal), it becomes difficult to track the intent of functions requested by applications programs, i.e., the forest gets lost among the trees.

The ability to accept and run compact code with macros and powerful commands allows Model One users to work at the level of these commands, and view changes as macro sequences. Commands can be displayed in readable form. Special trace and stepping debugging tools made possible by the presence of a general-purpose 16-bit μP allow developers to "step through" execution. Thus, debugging can be performed locally, and can be done with greater precision and care.

Rich command set. The multiprocessor architecture of the Raster approach means that a rich workstation command set can be implemented. The "richness" lies not only in having a wide range of graphics functions, but also in having multiple implementations of functions, such as several ways to have polygon filling or circle drawing performed.

A rich command set makes it easier to use the workstation with a variety of graphics software, and with new graphics applications. Macro facilities allow new "commands" to be created by graphics programmers. In addition, the workstation command set can be extended by Raster, and these versions installed on existing workstations.

Cooperation

One of the most gratifying developments in the graphics industry in recent years has been active cooperation among vendors for standards and common interfaces, to facilitate backwards integration of graphics systems by users. The effort towards optimum interfacing between the Raster Model One and PVI's DI-3000 is but one example; the recent slew of announcements of vendor support for various graphics standards is another. This reflects a real commitment to the end user's needs above short-term benefits to individual vendors. □

Embedded μP

Continued from p. 54

ing system for the run-time environment of embedded μP applications. It is not a development operating system like UNIX.

The development environment of μP applications is usually quite different from the run-time environment (for example, programs can be developed on a VAX computer running UNIX and targeted to a 68000-based μP board running VRTX). It is certainly not important for an embedded system to "self-host" itself (i.e. for the host system to be the same as the target system and to run the same operating system). In fact, a trend towards specialized systems for software development, like the UNIX and the Ada program development environments, is rapidly gaining acceptance. Most real-time operating systems would, at best, provide a poor development environment compared with the UNIX programmer's Workbench, for example.

Figure 2 shows the development and run-time environments of a program designed to run with VRTX. The thick arrows indicate the development path for VRTX-targeted application software. The source code of the user program is first compiled and/or assembled, then linked together with other routines into a *user load module* and downloaded to the execution environment.

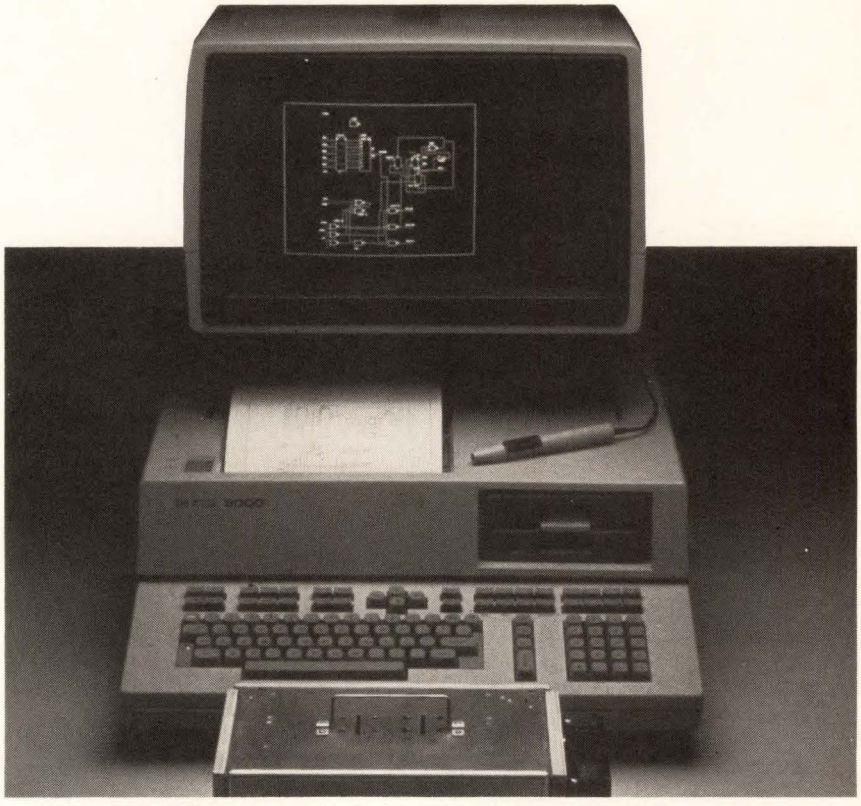
A trend towards specialized systems for software development, such as UNIX and Ada, is rapidly gaining acceptance.

VRTX is permanently resident on the target system and need not be linked; it is accessed by means of software traps or interrupts. The thin arrows indicate the execution dependencies of each program. After the application program has been thoroughly debugged, the monitor can be removed and the application program itself burned into PROM with VRTX.

Summary

The embedded environment has a unique set of requirements that conventional stand-alone operating systems are ill suited to meet. This occurs not because those systems are deficient in any way for their own environment, but rather because they are designed for non-embedded applications. Just as some programming jobs are best accomplished in Fortran and others in Lisp, some applications require a stand-alone operating system and others require a real-time, multitasking system. □

HP's Desktop Mainframe— Personal Power For CAE



Based on the HP chip set described at the 1982 ISSCC conference (*Digital Design*, March p. 81), the HP9000 represents a fourth major product family to HP's current line of computers. Intended primarily for computer-aided engineering applications, the HP9000 family features models with up to three CPUs, Ethernet-compatible and HP networking and a choice of UNIX or BASIC operating systems. Individual 32-bit workstation prices range from $28,250 to $64,565.

The 9000 can include a monochromatic or color graphics CRT display, keyboard, built-in printer, a built in 10 Mbyte Winchester disk drive, 256 Kbyte flexible disk drive and up to 2.5 Mbytes of error-correcting and self-healing main memory.

The heart of each HP9000 is a lunchpail-sized, enclosed card cage called the memory processor module. This module houses boards containing the HP9000's CPU, I/O processor for 8 separate DMA channels, 128K RAM memory, memory controller and 18 MHz clock. The CPU, I/O processor and memory communicate over a memory-processor bus, or backplane, with an exceptionally fast 36 Mbyte per second bandwidth.

Other HP9000 features include 55ns CPU microcycle time for one million instructions per second performance, and a 6 Mbytes/sec. I/O rate. Memory cycle time is 110ns.

The 32-bit virtual memory addressing capability enables technical users to deal easily with programs and data structures as large as 500 Mbytes.

Two Operating Systems

HP9000 users have a choice of two operating systems: HP-UX, a fully supported, extended function HP version of UNIX, and a high performance version of HP's enhanced BASIC.

HP-UX adds such enhancements as virtual memory for both programs and data, greatly improved file reliability, full HP documentation, Image/9000 database-management software, and 2D and 3D graphics with Graphics/9000 software. HP-UX also supports Pascal, Fortran and C languages, a terminal emulator for asynchronous data communications. Ethernet networking and HPs Shared Resource Manager for linking clusters of HP9000s with each other and with HP9800 series desktop computers.

The HP9000 is the first HP computer to utilize Ethernet concepts. It will also support the industry standard IEEE-802 LAN when it becomes available in 1983.

HP's Shared Resource Manager (SRM) provides a networking capability for linking HP9000's with all models of HP's family of 16-bit desktop computers. In addition, the SRM permits HP 32-bit and 16-bit workstations to share common databases and peripheral equipment such as high capacity disks, large plotters and high-speed printers. **Write 197**

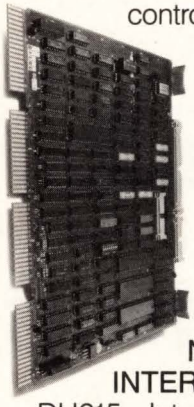
Component	9030A	Base System 9040A	9040S
Packaging	System II Rack Mount Enclosure	Stand-alone Cabinet	Stand-alone Cabinet
Memory (std.)	512 Kbyte	512 Kbyte	1 Mbyte
Memory (opt.)	Up to 2.5 Mbytes in 256 Kbyte increments		
Service/Diag. Panel	Standard	Standard	Standard
System Software	HP-UX	HP-UX	HP-UX plus add'l software options and compilers

Table 1: Some configurations of the 9000 system.

DILOG INTERFACES WINCHESTER/BACK-UP PDP-11*

You can't find a better, high-performance line of low-cost, single board, disc and tape controllers for your PDP-11 data storage system. All Winchester disc and ½" tape controllers are based on uP architecture and automated design common to the thousands of DILOG controllers in use. So they consistently offer you best price/performance.

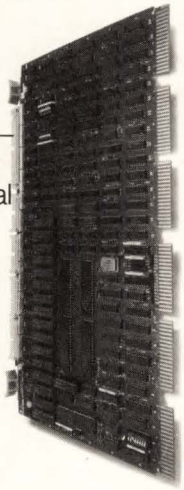
The vital time-saving and data base protecting features you want, including diagnostic test/self-test/error correction/etc., are all built into each intelligent controller. You'll also find RT-11, RSX-11, RSTS, IAS, MUMPS, DSM or VMS software compatibility, plus I/O compatibility with all popular drives.



WINCHESTER/SMD/CMD CONTROLLERS

These controllers mate with larger capacity hard disc drives employing RK, RM and RP emulations. The following is a partial listing of models:

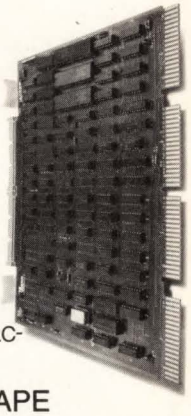
NEW—UNIVERSAL SMD INTERFACE COMPATIBLE—Model DU215—Interfaces UNIBUS to SMD I/O drives—switch selectable RK06/RK07—two 8" or 14" Winchester SMD/CMD drives to 300 MB capacity (mix or match without any component change)—56-bit ECC—88% utilization of unformatted storage capacity—exclusive universal formatting.



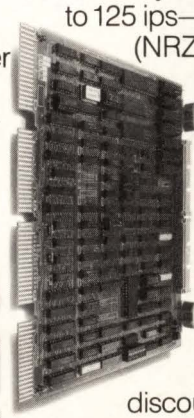
NEW—SMD INTERFACE COMPATIBLE—Model DU218—Full RM02/RM05/RP06 media compatibility—interfaces PDP-11/04 through 11/60 computers with up to four Winchester, or CDC9762/9766 equivalent disc drives employing industry standard SMD interface, as well as Memorex 677/RP06 type drives—includes three sector buffering, 32-bit ECC and dual port capability.

MAGNETIC TAPE CONTROLLERS

These ½" mag tape controllers/couplers handle standard start-stop and streaming drives with TM-11 or TS-11 emulations.



½" STREAMING/START-STOP COMPATIBLE—Model DU130—Handles up to eight 9-track, 800/1600 BPI industry standard drives at 12.5 ips to 125 ips—interfaces dual density (NRZI/PE) drives from all manufacturers. TM-11 emulation.



NEW—½" MAGNETIC TAPE COMPATIBLE—Model DU132—Emulates TS-11—interfaces up to four start-stop or streamer drives, including "Cache Streamer"—**12.5 ips to 125 ips speeds—exclusive 800/1600 BPI dual density—also interfaces GCR transports.

Contact your local DILOG sales office for complete details and O.E.M. quantity discount pricing/delivery of specific models providing Winchester/Backup for PDP-11.

Corporate Headquarters
12800 Garden Grove Blvd. • Garden Grove, Calif. 92643
• Phone: (714) 534-8950 • Telex: 681 399 DILOG GGVE

Eastern Regional Sales Office
64-A White Street • Red Bank, New Jersey 07701
• Phone: (201) 530-0044

European Sales/Service Office
12 Temple Square • Aylesbury, Buckinghamshire • England
• Phone: 44-296-34319 or 34310 • Telex: 837 038 DILOGI G

DISTRIBUTED LOGIC CORP.
DILOG

NUMBER 1 FOR DEC-11

*DEC, PDP, RSX, RSTS, IAS, VMS, UNIBUS Trademarks Digital Equipment Corp.
**Trademark Cipher Data Products

Stand-Alone Four Color Graph Plotter

A new stand-alone four color graph plotter has been introduced by the Yokogawa Corporation of America—the Graphmate II. It takes only minutes to be able to program it to perform a variety of complex data plots, in circular, bar, and line forms.

It has its own built-in keyboard and display unit that allows the user to input simple data entries that the machine will manipulate into high-quality visual charts and graphs of crisp, clear origin.

Ed Pevovar, Contributing Editor for *Digital Design*, had the chance to evaluate the capabilities of the machine.

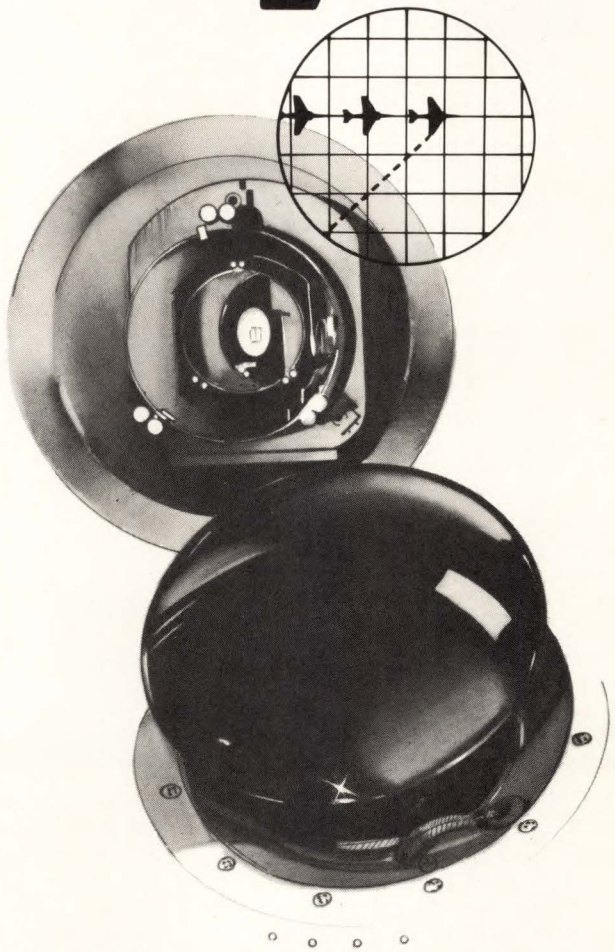
"In just fifteen minutes, I was able to figure out the keyboard, input some data, and get a four color pie-chart printed out—all without the instruction manual," he reports. The plotting is performed by 4 ceramic-tipped pens. Standard 8½″ × 11″ paper may be used; however, you can produce transparencies for overhead projection.

There is also a micro-disk available to serve as a facility for stored programs and/or modified plots. This allows the user to reload the Graphmate II at any time for use by the 4Kbytes memory designed into the instrument.

"This entire system is a single stand alone utility, in that you can operate it without a computer terminal or any type of computer system interface," Pevovar concludes. Total cost at time of announcement is $2800 and it should be available from stock this month. **Write 200**

The Hughes story continues...

Missile Story.



Our story begins with you. Your talent. Your skills. Your career and Hughes Missile Systems Group.

Some of the world's most sophisticated missile technology can be traced to decades of Hughes exploration and development.

In 1947 Hughes began work on the United States' first air-to-air Radar Guided missile, Falcon.

The advances in missile technology continued. Hughes employed the use of infrared detection. Wire and TV guided systems. And a revolutionary programmable missile technology that allows the missile to seek its target after the pilot's withdrawal.

Missiles like Phoenix, Wasp, Maverick, and AMRAAM employ some of the latest technological advancements in electronics in the world today.

Hughes Missile Systems is where future engineering discoveries will be made. With over 1500 projects company-wide, Hughes offers challenge and technological growth.

If you'd like to be part of a story that's still unfolding, write yourself in.

Current openings:

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Circuit Design Engineers
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Missile System Analysts
RF Engineers
Software Designers

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Fallbrook at Roscoe
Canoga Park, CA 91304

Proof of U.S. Citizenship Required/Equal Opportunity Employer

Creating a new world with electronics

HUGHES

HUGHES AIRCRAFT COMPANY

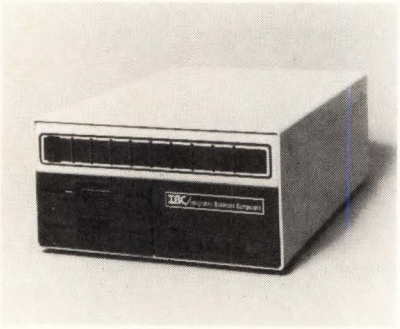
Missile Systems

Write yourself in.

Z80 COMPUTER

Bank Switchable Memory

The Middi-Cadet is a Z-80 based computer system housed in a 12″ wide × 6″ high × 17″ deep cabinet and includes a 256 Kbyte RAM memory, a 20 Mbyte 5¼″ hard disk, a 1 Mbyte 5¼″ floppy disk, 10 serial ports, and

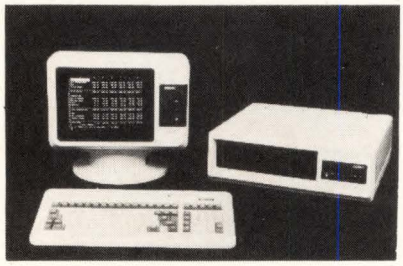


one Centronics port. Optionally available are cache memory, a cartridge tape controller, and a bisynchronous port for communications capability. The Middi memory can bank switch within any 4K block and the bank sizes can be varied at the flick of a switch. Therefore IBC offers the only systems that can easily jump from MP/M to OASIS to FAMOS, etc. The system is completely vectored interrupt driven. All serial ports and disk controllers have interrupts available. The system uses an intelligent disk buffer rather than a DMA interface; this disk buffer allows CPU processing during disk operations. $7500, qty discounts available. **IBC,** 21592 Marilla St, Chatsworth, CA 91311. **Write 175**

COMPUTER SYSTEM

Multiuser Operating Systems

The Series 8600 desktop multiuser small business system is a 16-bit, 5 MHz 8086-based unit offering up to 512 Kbytes of RAM with parity, two 5¼″, 640 Kbyte diskette drives or one diskette, and an integrated 5¼″ 10 Mbyte hard disk drive, four EIA half or full duplex RS-232C serial ports offering speeds from 50 to 19.2K baud,

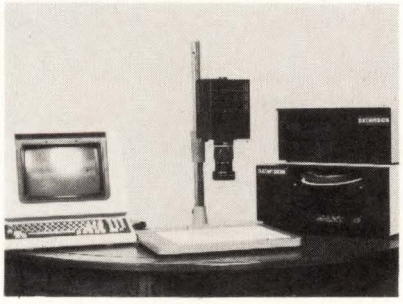


one Centronics-compatible 8-bit parallel I/O port, an optional CCITT-X.21 standard HDLC communications interface, and from one to four intelligent CRTs. It is supported by operating system and applications program software. In all, six operating systems, six basic as well as numerous special applications functions, and six languages are supported by Series 8600. **Sci-Com,** 981 Route 22, PO Box 6050, Bridgewater, NJ 08807. **Write 176**

IMAGE CAPTURE AND PROCESSING SYSTEM

For Entry Level Processing

The turnkey system consists of a high resolution CCD based camera with up to 1720 × 2660 × 8 bit resolution, a high speed data interface, a Z80A based processor with a minimum of 128K bytes of main and buffer memory, 2 double density diskettes with 1.1 Mbytes of storage, a CRT operator console and several optional storage devices including a Winchester disk drive, a 9 track 1600 bpi tape drive with interface, a streaming cartridge drive, a systems printer interface and a graphics printer or plotter interface. Communications options on the Datavision system allow RS232 transmission in either sync or async

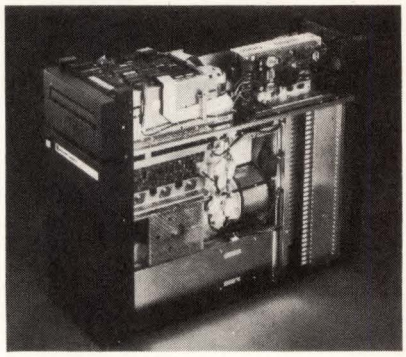


modes at speeds up to 19.2k baud. Software for the system is CP/M based allowing the operator to control the camera, manage the high speed interface, move blocks of data into the processor region, manipulate grey scale data planes, make bit mapped threshold decisions, and move a resolved image into either graphics memory or to external storage. **Datavision Corp,** 10 Cider Mill Lane, Upton, MA 01568. **Write 177**

SUPERMICRO

64-User, 120MB Multiprocessor

The Supermicro 64 features a multiprocessor architecture which can support up to 64 simultaneous users.

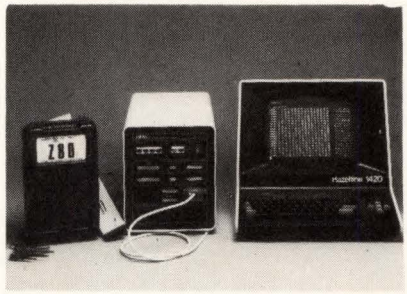


Each user has a dedicated 64K Z80A 8-bit Application Processor, a 4″ × 9″ card which is internally mounted and directly connected to the system bus. A separate Z80A-based File Processor with 64K of RAM controls disk management and other shared peripherals. A 16-bit processing capability is provided by an optional "AP/86 Performance Accelerator". Based on the Intel 8086, the Performance Accelerator features expandable memory from 256K to 1MB and can be accessed by any user. It can be used for more complex functions requiring very large arrays or complex calculations. Parity for error detection and 8MHz clock are standard on the Performance Accelerator. Options include an Intel 8087 math processor with floating point, and error correction circuitry (ECC). The 60MB Supermicro 64 lists for $17,995. Basic configurations of the Supermicro 8 and the Supermicro 32 list for $7,995 and $14,995, respectively. Application processors list for $995 each and the AP/86 Performance Accelerator with 256K of RAM lists for $2,795. **Molecular Computer,** 1841 Zanker Road, San Jose, CA 95112. **Write 178**

CMOS IN-CIRCUIT EMULATORS

For Intel Intellec Development Systems

RELMS Inc. is expanding its support for CMOS applications to include the OKI 80C85 SPICE™ and the ZILOG

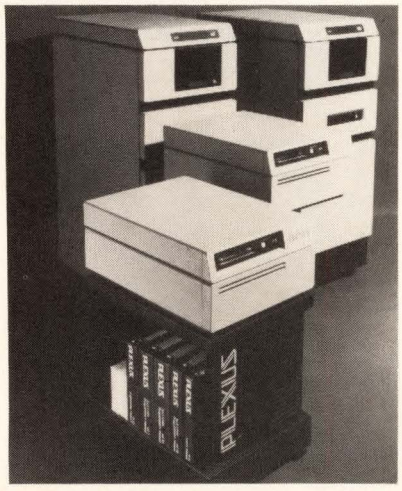


Z80L SPICE™, increasing the number of processors support by the Intel Intellec® development station to five; including the Z80A, Z80B, Z80L, NSC 800, and 80C85. SPICE units are designed to operate in conjunction with any Intel development system, including the new iPDS. Relocatable macro assemblers with link, locate utilities provide software development capability. These assemblers are fully compatible with PL/M FORTRAN, PASCAL, and basic compilers which run on the Intellec. **RELMS,** 1180 Miraloma Way, Sunnyvale, CA 94086. **Write 184**

SUPERMICROCOMPUTERS

Featuring VAX 11/780 Performance Capabilities

These 16/32-bit MC68000-based systems, the P/35 and P/60, incorporate the multiprocessor architecture used by Plexus in the company's P/40 and P/25 systems. Both utilize additional cache memory, on-board static RAM, memory management hardware, a 32-



bit dedicated memory bus, and DMA throughout. The P/35 is a tabletop system that supports up to 16 users and includes an 8″ Winchester disk drive, a streaming cartridge tape drive for backup, main memory of up to 2 MB, and is priced at $13,500 in OEM quantities. An 8-user version lists for $15,000 in OEM quantities. The P/60 supports up to 40 users, is based on 14″ Winchester disk drives, offers a 9-track streaming tape drive for backup, and has up to 4MB main memory. An 8-user P/60 system, with 512 Kbytes of main memory, 72 Mbytes of on-line disk storage, and streaming 9-track tape drive, is priced at $32,250. **Plexus Computers,** 2230 Martin Ave., Santa Clara, CA 95050 **Write 179**

UNIVERSAL EMULATION

For HP 64000 Logic Development System

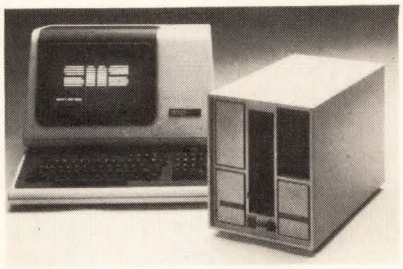
The two products are a user-definable emulator subsystem and a ROM emulator subsystem. The user-definable emulator (Model 64274S) consists of a general-purpose emulator control

card that is installed in an HP 64000 development station. The emulator supports address buses up to 24 bits wide and data buses up to 16 bits wide. Full software development and real-time emulation support can be developed for new microprocessors and proprietary processors as well as those not supported by off-the-shelf emulators. The ROM emulator system (Model 64272S) is suitable for target systems with 8- or 16-bit processors. It consists of a general-purpose emulator control card and a ROM emulator pod for interfacing with popular ROM sockets in target systems. Both new emulators, as subsystems of the HP 64000 logic development system, can be used in multiple emulator applications or in an integrated HP 64000 measurement system. Additionally, the HP 64851A user-definable assembler and HP 64856A user-definable inverse assembler are available to generate companion software tools for the emulators. The HP 64274S user-definable emulator is $4,000. The HP 64272S ROM emulator is $4,250. **Hewlett-Packard Co**, 1820 Embarcadero Road, Palo Alto, CA 94303. **Write 182**

DEC COMPATIBLE COMPUTER

Complete LSI-11 16 Bit μC

The MDX-11 contains a DEC compatible Q-bus backplane which can be configured with the LSI-11/2 or LSI-11/23 CPU. The quad size backplane can accommodate up to 8 dual height Q-bus cards and can be configured with 22-bit memory for a total of 1 MB of memory. A 5¼″ Winchester disk, an integral part of the system, is formatted with 512 bytes per sector with no sector interleave for contiguous high speed DMA transfers. The MDX-11 can be configured with 10.6 or 15.9 MB of formatted data. It also contains a double sided/double density slim line floppy—RX02 compatible. The controller allows automatic recognition of DEC floppy formats (RX01, RX02, RX03) and IBM floppy formats (3740 and 2/2D). The system is supplied with extensive self-test capabilities which allow isolation of problems down to the module level. The MDX-11 is switch selectable for 110 VAC or 220 VAC input voltage. This 35 pound table top microcom-



puter measures 11.2″H x 9.5″W x 17″D. Price for the 10.6 MB version without DEC CPU and memory is $5,700 at quantity 15. **Scientific Micro Systems, Inc.,** 777 East Middlefield Rd., Mountain View, CA 94043. **183** **Write 183**

ETHERNET SOFTWARE

Supports Variety of CPUs

FUSION supports file transfer, remote program execution, and electronic mail between VAX, PDP-11, 68000, 8086, and other CPU's across a 10 Mbit Ethernet local area network. Performance varies with host system disk and CPU speeds, but process-to-process data transfer rates in excess of 100 kB/sec are easily achieved. Multiple communications protocols are handled by FUSION, including datagram and virtual circuit support for Xerox's XNS and DARPA's TCP/IP. Protocol support for the ISO Open Systems Interconnect is currently under development. Available with binary licenses from $500. **Network Research Corp**, 1964 Westwood Blvd., Suite 200, Los Angeles, CA 90025. **Write 188**

VISION DEVELOPMENT SYSTEM

Simplifies In-House Automation Tasks

The Model 20/20 VDS allows engineers to prototype, debug, install and enhance task-oriented applications that require machine vision for accuracy and high speed. System includes: intelligent image processor, CRT ter-

minal, hard-copy printer, display monitor, camera, lenses, 7.8MB Winchester disk with 8″ floppy drive, and light table all integrated around the DEC LSI-11. Flexible, interactive instructional software guides users in vision development. Once a process has been fully automated using VDS, the application program is downloaded to a dedicated Target Application System, or TASK, for execution of machine vision applications. Developers can create as many customized TASKs using one VDS as needed to fully automate a variety of manufacturing processes. $49,800. Each TASK is $19,000. **Octek**, 7 Corporate Place, Burlington, MA 01803. **Write 186**

COLOR GRAPHICS TERMINAL

Can Display And Manipulate 16 Windows

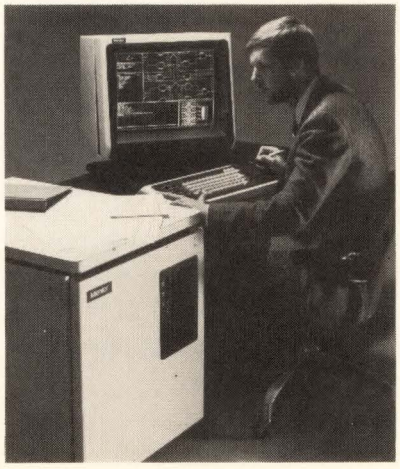
Designed primarily for business use, Graphos' features include: resolution 640 × 480; individual scroll, pan and zoom for each of the 16 windows, with graphics overlay for each window; segment retention without retransmission from host; 2D segment transformations; full "2½ Dimensional" polygon rendering with shading, cross-hatching, and textures; device independent graphics subsystem; multiple fonts, including any language, typeface, graphic art; and selection from 32,768 colors, with independent color menu for each window. The heart of the design is the "Shiftable Cell" concept that combines alphanumeric and bit mapping architecture. Cells are dynamically assigned to the 16 windows on the screen. Text and

graphics can be smoothly scrolled, vertically, horizontally and diagonally, under any fixed window; the windows can be manipulated independently of one another without the need to rewrite the display memory. Under $8000. **Ithaca Intersystems, Inc.**, 1650 Hanshaw Rd, PO Box 91, Ithaca, NY 14850. **Write 187**

CAE WORKSTATION

Logic Creation And Capture System

The IDEA 1100 CAE system is the integration of a series of interrelated design application programs and high-performance, 32-bit hardware. It provides full hierarchical design capabilities through Mentor's Structured Logic/Circuit Design Package, interfaces to popular design automation tools (e.g., Tegas, SPICE, ILOGS, Logcap, SCI-cards, Applicon, Calma, etc.), and a Programmable Netlister which allows users to develop other interfaces if necessary. In addition, the IDEA 1100 includes Mentor's Document Preparation System with integrated graphics and Electronic Mail Package for engineering project management. Each node consists of an Apollo Domain Computer with 32-bit architecture (two 68000 processors), a high-resolution graphics display with an optional electrostatic hard-copy printer, up to 3.5 MB of



program memory and up to 158 MB of Winchester disk storage. $61,900 per station in qty 2 and $54,900 each in qty 10 or more. Lease terms are available. **Mentor Graphics Corp.**, 10200 SW Nimbus, G–7, Portland, OR 97223. **Write 191**

68000/UNIX–BASED μC

Multi-User System

The standard 8-user 3300 comes with an integral 5¼″ (33MB) Winchester drive ($9600). A lower priced 2-user version—configured with a 12MB Winchester—is priced at $7,800. For more demanding multi-user/multitasking applications, it may be ordered with an 8″ (84MB) Winchester, priced at $13,500.

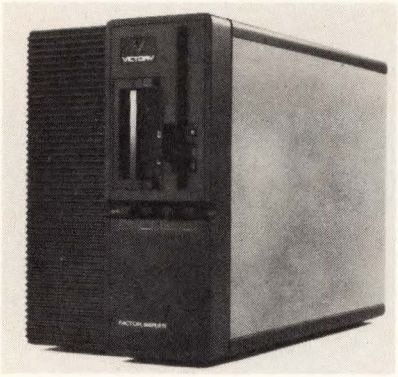
The new system comes with 320 KB

of parity-protected RAM (expandable to 1.5MB with memory management), and its Multibus architecture supports several different storage configurations. Backup can be accommodated through quad-density floppy disk, cartridge tape or 9-track tape drives. Applications support and online updates directly from the factory are available. **Codata Systems Corp**, 285 N. Wolfe Rd., Sunnyvale, CA 94086. **Write 190**

16–BIT SUPERMICROS

Multi-User Systems

The SPIRIT series, designed for the EDP/office environment, is an Intel iAPX186 (80186)-based system supporting CP/M–86, MP/M–86, and CP/M–80 operating systems for up to 16 fully supported users. The FACTOR series, for industrial control and robotics applications, is based on the Motorola 68000, supporting the UNIX and CP/M–80 operating systems. The UNIX implementation includes a real-time executive operating system (VRTX) in PROM to add speed and real time capability. Both product lines combine functionally dense SBC architecture in conjunction with the new VME bus. The high speed VME bus makes possible the combination of multiple 8, 16, and 32-bit μCs with



high performance peripherals in a modular, desktop multi-user system. Expansion from 8 to 32 users is possible. From $16,000 to $26,000 depending on configuration. **Victory Computer Systems,** 201 E. Hamilton Ave., Campbell, CA 95008. **Write 192**

AUTONOMOUS SOFTWARE TOOL

For Logic Array Design

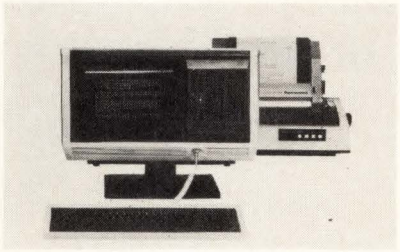
TDU (Transportable Design Utility) gives designers the ability to completely prove their designs, logically and functionally, in their own office and using their own computer facility. TDU guides the designer through four essential steps: defining the structure of the design by a Hardware Description Langauge (HDL); defining the tests for the design using a Test Description Language (TDL); checking that the basic design rules are met for the process technology being used; and simulating the design by exercising the TI Hardware Description Language with the TDL and/or SIMCL. The initial year lease of TDU is $65,000, including the license, on-site installation and first year software, updates and user support. **Texas Instruments**, Literature Response Center (SC–395), PO Box 202129, Dallas, TX 75220. **Write 195**

WORD PROCESSOR

Standalone System Combines Word And Data Processing Capabilities

The Series 3000 word processing system features compact, ergonomic design, and a complete package of advanced text processing capabilities. Featuring Data Pro and Advanced Office Concepts software, the 3004 offers a range of capabilities for word processing, records processing, arithmetic, and communications. Flexible software architecture and expanded memory allow users to combine several software functions at once for simultaneous, multifunction operations.

Hardware accessories include standard and wide-carriage printers, numeric keypad, dual and single tray pa-



per processors, continuous forms tractor, sound covers, and paper holders. Additional timesaving, no-extra-cost features include: keystroke memory, which stores repetitively used keystrokes or functions; a glossary function for building subject indices; and a new "HELP" function for assisting the new or casual user. Series 3004, with operator console and detachable keyboard, dual 5¼″ diskette drives, and letter-quality 40 cps printer is $9900. **Philips Information Systems,** 4040 McEwen, Dallas, TX 75234. **Write 193**

CAD SOFTWARE

Gate Array Physical Design Package

A key element of this batch processing system and interactive environment is its flexibility. Designed to handle a wide variety of technologies, CADISYS operates on DEC VAX, IBM, Prime and Apollo. Programs are written in Pascal and Fortran to ensure portability. In addition, easy interfaces complement a variety of engineering work stations, simulators, and turnkey graphics. The layout system was specifically designed to achieve 100% automatic completion for a variety of technologies. CADISYS can successfully lay out circuits with over 10,000 logic elements. It consists of three subsystems: automatic placement (CADIPLACE), automatic routing (CADIROUTE), and interactive graphics (CADIGRAPH). **California Automated Design Inc.,** 2620 Augustine Dr., Suite 280, Santa Clara, CA 95051. **Write 196**

16-BIT μCs

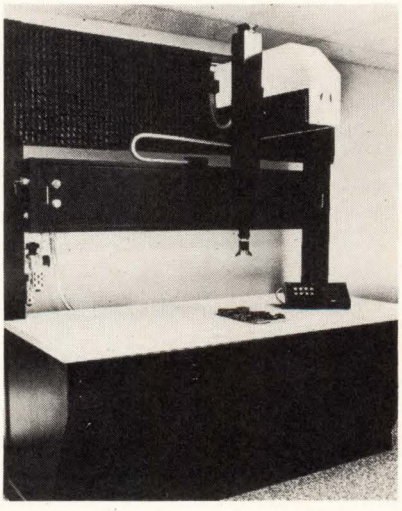
CP/M Based Small Business Computers

One system, the TS1603, features two 500 kB floppy disks and expansion capability that allows an inexpensive upgrade to business-quality graphics with resolution of 640 × 240 pixels. Can either stand alone or integrate into a data-sharing, 16-user network of 8- and 16-bit TeleVideo computers. The second entry is the TS1600, an intelligent workstation connecting into TeleVideo's MmmOST network (Multiuser, multitasking, multiprocessing Operating Systems Technology). Both computers are based on Intel's 8088 μP and have 128kB of user RAM, expandable to 256K. Each has two RS-232 ports for modem and serial printer, plus an RS-422 port for 800 Kbit/sec communications to either of the TeleVideo multiuser service processors, TS806 or TS816. The TS1603 has an additional parallel printer port built in. The fully configured TS 1603 is $3495. Graphics and memory upgrades are available. Fully configured, the TS1600 satellite user station is $1795. OEM discounts are available. **TeleVideo Systems, Inc.,** 1170 Morse Ave., Sunnyvale, CA 94086. **Write 189**

CARTESIAN ROBOT

Speeds Assembly of PCBs

This μP controlled robot is capable of high speed, automatic placement of non-standard parts. The "Sembler"

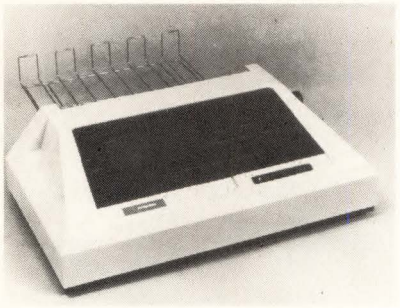


Model CAR–1000 is an all electric, all digital robot that utilizes cartesian geometry and advanced servo control. Available with either one, two or three arms and provides precision to ±.001″. Each arm is capable of coordinated motion in X, Y and Z axes, plus wrist rotation (theta). The work envelope is 56″ long, 20″ deep and 20″ high. The robot wrist is capable of rotation of up to ±180°. **Control Automation Inc.,** PO Box 2304, Princeton, NJ 08540. **Write 194**

MULTI-MODE PRINTER

DP and Letter Quality Modes

The DP-9625A employs a dot-matrix printhead and print mechanism. Maximum speed is 200 cps in DP mode and 50 cps in near letter quality mode. Intermediate speeds of 150, 120, and 100 cps provide correspondence quality. Other features are an acoustic noise level of 55 dBA, and high speed graphics with either 72 or 144 dots/in. in both the horizontal and vertical dimensions. **Anadex, Inc.,** 9825 De Soto Ave, Chatsworth, CA 91311. **Write 150**



¼″ TAPE CARTRIDGE DRIVES

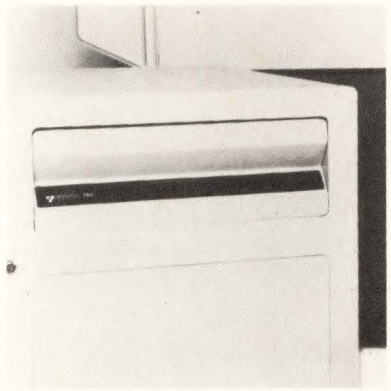
From 20MB to 40MB

The 4-track TDC 3204 and the 8-track TDC 3214 allow expanded storage capacity from 20MB to 40MB by simply changing heads. No mechanical adjustments are necessary. The drives feature a 3-point cartridge locking mechanism for solid tape cartridge positioning, and a floating head design that accurately locates edge of tape without relying on mechanical references. Requiring only two circuit boards, the drives have a 2K to 16K circular buffer, and internal self-test diagnostics. $1600 for the 20MB model TDC 3204; $1950 for the 40MB TDC 3214; qty discounts avail. **Tandberg Data**, Data Storage Div., 571 N. Poplar, Suite H, Orange, CA 92668. **Write 152**

PLOTTING CONTROLLERS

Support Electrostatic Printing And Plotting For IBM Computers

These controllers support electrostatic printer/plotters in media widths from 11 to 72 inches for 360/370, 4300, and 30xx IBM computers and compatible mainframes. The 780-11 accepts unordered graphic data in the new Versatec Random Format and ordered vectors. The 780-13 accepts Versatec compressed raster, blocked raster, and



EBCDIC print formats. Processing files for most plots is less than six seconds. Random Element controllers are from $20,000 (780-11). Compressed raster models are from $12,000 (780-13). Two controllers, integrated in a single cabinet, can drive two Versatec printer/plotters. **Versatec,** a Xerox Co, 2710 Walsh Ave, Santa Clara, CA 95051. **Write 154**

MEMORY SYSTEM

Expands Power Of The Apple III

The RAMDISK 320K Memory System is physically the same size as an Apple III disk drive yet contains 320 kB RAM (200NS). It functions like one 80 track or two 40 track floppy disk drives. It interacts with the Apple SOS operating system and leaves 32K of RAM for the user to utilize in advanced programming techniques.

Includes software for diagnostics, fast load and copy routines, as well as business applications. All firmware is contained in static RAM on the interface board. $1395. **Axlon Inc.,** 170 N. Wolfe Rd, Sunnyvale, CA 94086. **Write 156**

HALF-HIGH WINCHESTER

Uses Thin-Film Disks

The ST206 half-high 5¼″ micro-Winchester disk drive incorporates thin-film plated media for improved durability and advanced technology ferrite R/W heads for higher performance. It stores a total of 6.38 MB of unformatted data (5 MB formatted) on two

surfaces of a single thin-film plated rigid disk, and is fully compatible with the industry-standard Seagate ST506 interface. The drive operates at a transfer rate of 5 Mbits/sec. Average access time is 85 ms (including settling) using a split-band positioner and stepper-motor driven actuator. $745 in qty 500. **Seagate Technology,** 360 El Pueblo Rd, Scotts Valley, CA 95066. **Write 157**

5¼″ DISK DRIVE TESTER

Portable, μP Based System

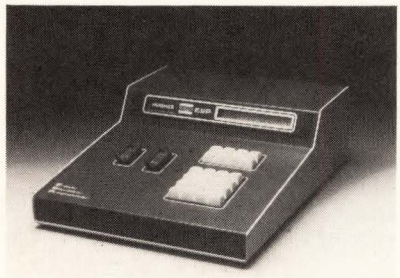
This system automatically exercises ST506-type disk drives (5¼″ Winchesters) through a series of programmed test and evaluation functions. DX525 prompts the operator through up to 16 programmed test functions and supplies a flaw map of bad tracks and overall error-rate statistics. It exercises and evaluates all major functions of the attached disk drive, including the ST 506 compatible interface, device selection, positioning electronics and R/W circuits. It also provides for user-requested functions. Can operate in single cycle or continuous modes, will configure for a variety of manufacturer model types, and permit specification of a

selectable error threshold. $2225, qty discounts avail. **Applied Memory Technology,** 2822 Walnut Ave., Tustin, CA 92680. **Write 158**

ERASER/SIMULATOR PROGRAMMER

Now Supports 128K EPROMs

The μP-controlled unit, H3000 ESP, provides the necessary modes to erase, program, read, copy, simulate, modify and compare the various Hughes EEPROMs and industry standard MOS UV-PROMs that are now available from 4K up to 128K. It requires no personality boards, hardware changes or switch settings for PROM type and date transfer parameter selections. The 16-character dot-matrix liquid crystal display and menu-oriented software guide the operator through each mode of operation without the need to refer to the manual. Special command and avail-



able software routines enable users to write and execute their own application programs. $2950. **Hughes Solid State Products**, 500 Superior Ave, Newport Beach, CA 92663. **Write 159**

¼" DATA CARTRIDGE

Certified For 6400 bpi Recording

This type of cartridge has a capacity of over 17 MB. With 450' of tape and the capability of operation, in either the start/stop or streaming mode, at

tape speeds of up to 90 ips, the Model 300671 Certified High Density Data Cartridge has a data reliability of one error or less in a 64 block write then read, erase then read and write then read test. $39. **Data Electronics, Inc.**, Media Div., 10150 Sorrento Valley Rd, San Diego, CA 92121. **Write 160**

5¼" WINCHESTERS

Fast Average Access Time

The V130, V150 and V170, offer 30 MB, 50MB and 70MB capacities. Average access time (including settling) is 30 ms, with a 5 Mbit/sec data transfer rate. They help reduce the problems of temperature induced R/W and off-track errors; and, reduce damage to heads, media and data incurred when drives are shipped or moved around. From $1100 to $1500 in OEM qty. **Vertex Peripherals Corp.**, 2150 Bering Dr., San Jose, CA 95131. **Write 155**

132-COL VIDEO TERMINALS

ANSI ×3.64 Functionality, DEC Software Compatibility

The concept VT108 terminal includes 4 pages of memory standard (expandable to 8 pages), 43 programmable functions, windowing, and multiple computer capabilities. The concept VT-APL8 has the same capabilities

and supports APL with full, true overstrike. Features: switchable 80/132-column format; 128-character U/L case ASCII (concept VT108) and APL/ASCII, with full, true overstrike (concept VT-APL8); non-volatile memory; setup mode; up to 4 user-selectable character sets (total of 512 characters), including, as standard, VT-100 graphics, continuous curve approximation, forms drawing, and math symbols, and communications control symbols; monitor with etched faceplate for glare reduction; self-test; detached keyboard; and advanced text editing, data entry/retrieval, and business graphics functionality. The concept VT108, with 8 pages of memory is $1440 (qty 75); $1230 with 4 pages memory. Concept VT-APL8 terminals are $1575 and $1365, respectively. **Human Designed Systems, Inc,** 3440 Market St, Philadelphia, PA 19104. **Write 162**

BAND PRINTER

Heavy Duty Cycle

Using an interchangeable steel band, the BT-1500 prints 1500 lpm using a 48 character set and 1200 lpm with a 64 character set. An easy-to-use design allows rapid band paper and ribbon changes for minimum off-line

time. Diagnostic and status indicators minimize downtime. Selfcontained Electronic Character Alignment is standard. Under $20,000. **Data Printer Corp,** 99 Middlesex St, Malden, MA 02148. **Write 151**

PRINTERS/TERMINALS

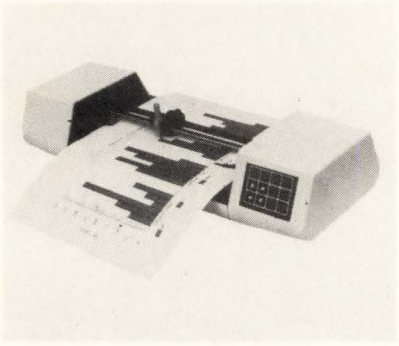
Wide Range of Types/Specs

Introduced at COMDEX were the following: The A10 Daisy Wheel Printer with printing speed of 18-20 cps and 100-character wheel. The 8600 Serial Impact Printer, 180/90 cps, features an 18-wire head, a 9 x 9 matrix, and an 80 cpl format. The ET 1000/3000/5000 Electronic Typewriters, offered in three models for general office use, with built-in display and full-page storage, and with built-in floppy. The CI-300 Variable Speed Printer, prints at 80-300 lpm for near letter quality printout and graphics. The CI-600 Variable Speed Printer, 100 to 600 lpm. The CIG-261 Graphics Card Option brings color graphics and Tektronix compatibility to C. Itoh's DEC-emulating CIT-161 terminal. And the High Speed/Resolution Printer with a 200 dots per inch resolution, variable printing speeds up to 10 seconds per page, and a built-in sheet feeder. **C. Itoh Electronics, Inc.**, 5301 Beethoven St, Los Angeles, CA 90066. **Write 153**

SMALL PLOTTER

Portable Single-Pen Drum Plotter

DMP-40 features pen speeds of up to 4.2 ips, and a format size of up to 11″ × 17″. It automatically generates circles, arcs, ellipses and general curves on command. Five different character sets are resident in ROM, which may be presented normally, or as italics.

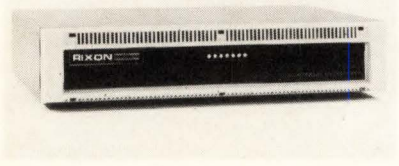


and at 255 possible sizes and 360 different degrees of rotation. Eleven different line types are available, ranging from solid lines, to variations on dotted and dashed lines. The DMP-40 will also clip, window, viewport and scale to size. RS-232-C interfacing is built in, as is the ability to autobaud. $995. **Bausch & Lomb,** 8500 Cameron Rd, Austin, TX 78753. **Write 161**

SYNC MULTIPLEXER

μP Controlled, 4 Channel Unit

The DCX725 permits an intermix of input speeds from 1200 to 9600 bps. The 4 ports accept sync data and are transparent to the protocol. Although primarily intended for use with other DCX family members to supplement async data transmission over the same composite link, the DCX725 may be used exclusively in sync point-to-point applications. It eliminates idle time found in conventional time-division multiplexing by dynamically allocating the capacity of the composite link

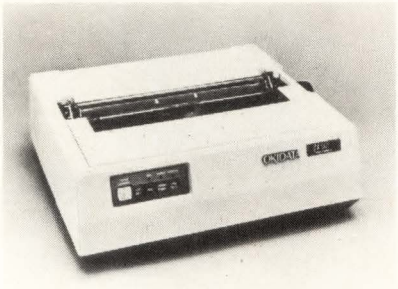


to the 4 channels, at 3 user-selectable priorities. Available in a standalone enclosure with integral power supply or may be used as the Synchronous Module in DCX825 Statistical Multiplexer systems and mounted in the RM80 Rack Mountable Card Cage. **Rixon Inc.,** 2120 Industrial Pkwy, Silver Spring, MD 20904. **Write 164**

MULTI-FUNCTION SERIAL PRINTERS

Correspondence Quality

The Microline models 92 and 93 provide two high speed printing modes: bidirectional data processing with short line seeking logic at 160 cps and high resolution correspondence quality at 40 cps. The Microline 92, with a maximum column width of 136, at 17 cpi and the Microline 93, with a maximum width of 233 columns at 17 cpi both offer, as standard features, enhanced and emphasized printing, and dot addressable graphics. Downline loadable character sets allow the user to create custom characters and sym-



bols. Both models are offered with either Centronics-compatible parallel or a high performance RS 232C serial interface. The Microline 92 is $695; the Microline 93 is $1249. **Okidata Corp,** 111 Gaither Dr, Mt. Laurel, NJ 08054. **Write 165**

FULL DUPLEX MODEM

For TeleVideo Displays

An integral originate-and-answer modem for use in TeleVideo Systems models 910, 920, 925, and 950 video display terminals is now available. The single-board model MB80505 has been designed for direct mounting in the TeleVideo terminals without modifications. The 0-to-1200-baud modem provides full-duplex, two-wire operation at 300 or 1,200 baud over a switch telephone network. Signalling and timing characteristics are compatible with the Bell 103 series,

Bell 212A and VA3467 data sets. The modem allows TeleVideo's terminals to automatically dial from the keyboard, redial up to 15 times busy numbers until a connection is made, answer incoming calls, and perform self-tests when it is idle. The modem permits the terminals to be programmed for recognition of special characters. Under $700. **MicroBaud Systems, Inc,** 3393 De La Cruz Blvd., Santa Clara, CA 95050. **Write 166**

Z80-BASED TERMINAL

For VAX Environments

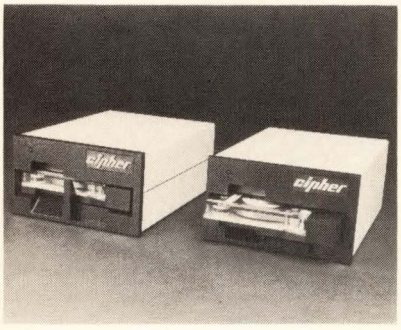
Model 831 is a VT100-family-compatible block mode terminal for VAX system environments. It features a 16 kB display memory, local editing capabilities, field definition and data entry checking routines, user programmability, downloading and debugging, and switch- and program-selectable 80- or 132-column display in one or two phosphor colors. Options

include an additional 16 kB of display memory, an integral modem, and Plot 10-compatible business graphics. Can be field-upgraded to a CP/M-based 8-bit μC while retaining all of its terminal attributes. $1395; qty OEM discounts avail. **Direct Inc.,** 4201 Burton Dr, Santa Clara, CA 95050. **Write 171**

TAPE DRIVES

¼" Streaming Cartridge Units

Two new products introduced by Cipher are an expansion of the company's current line of Quarterback ¼" streaming cartridge tape drives. Model 540-CT, a 45-Mbyte 5-¼" streaming cartridge tape drive, features an innovative front load design, allowing front loading of a standard size tape cartridge by turning the cartridge sideways for insertion. The Model 440-CT provides 45 Mbytes of capacity and QIC-02 interface compatibility, in an 8" form factor. Available for volume delivery in July 1983, with evaluation units available in February 1983. Approximately $850 in OEM quantities. **Cipher Data Products,** 10225 Willow Creek Rd, PO Box 85170, San Diego, CA 92138.



Write 167

DATA COMMUNICATIONS DEVICE

Send and Receive Electronic Mail Independent of Host

The Visionary 100 stores messages for sending at a later time and automatically answers the phone and stores incoming messages that you can later load into host machine. It includes an integrated real-time clock and calendar that allows you to send messages at a later time, and automatically answer the phone and take messages during specific preset times only. In addition to storing outgoing and incoming messages, the unit stores lists of phone numbers and user-defined custom commands. $595 for 2K unit, each additional 2K of memory storage is $15. **Visionary Electronics Inc.,** 141 Parker Ave., San Francisco, CA 94118.

Write 168

SLIDE CAMERA

Converts Computer Graphics Display Images To 35mm Slides

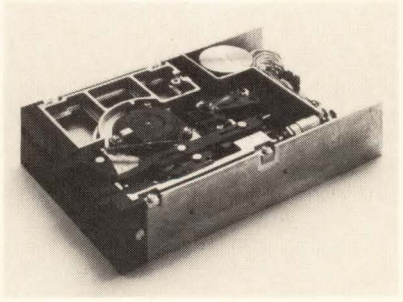
The Model 4500 Video Film Recorder (VFR) photographs computer graphics displays from Ramteks 6211 Colorgraphic Terminal via an RS-170 interface on Kodak Ektachrome ASA 64 (daylight) color slide film. Slide resolution is 640 × 480/512 pixels. Special features of the camera include a preview display port, front panel controls, film frame counter and automatic film rewind. $2495. **Ramtek Corp,** 2211 Lawson Lane, Santa Clara, CA 95050.

Write 169

3.33 MB SUPERMINIFLOPPY

3 ms Access Time, Half-Height Minifloppy Size

The DRIVETEC 320 SuperMinifloppy is targeted at both 8" and 5¼" floppy-based systems as a cost-effective system upgrade; and at small-



Winchester-based systems as a backup device. Its track following embedded servo system allows a recording density of 192 tpi. It ensures diskette interchange between drives in different systems or environments. The drive utilizes a unique two-stepper system which is more accurate than conventional single-stepper head positioning systems. Other key features include an absolute-vertical clamping mechanism for accurate, repeatable diskette registration; an on-board μP and brushless DC drive motor; an activity light and door lock; buffered track seek; and downward compatibility with existing 48 tpi minidiskettes. Under $325 in OEM qty 1000. **DRIVETEC Inc.,** 2140 Bering Dr., San Jose, CA 95131.

Write 170

ADVANCED MODEM SERIES

Offer Front Panel Network Control Features

Omnimode 48 offers a combination of standard and optional features to allow users to select the level of control for their particular network arrangement. It operates at 4800 bps and can

be selected to operate either with CCITT standards for international applications, or in domestic data networks with Racal-Milgo modems. The front panel gives the user complete information and full control of operating parameters. It also displays all data on the modem, line and interface status in easily understood language. Built-in test features for local and remote modems including CCITT V.54 loops can be used worldwide. The operator also selects and adjusts all modem operating parameters and speed selection (for 4800 or 2400 bps) from the front panel. **Racal-Milgo,** 8600 NW 41st St, PO Box 520399, Miami, FL 33152.

Write 174

MULTIOUTPUT SWITCHERS

Open-Frame Switching Power Supplies

First in this series is the CP1000-101 providing 165 W of continuous DC power from 6 regulated outputs. A typical application would be a small system consisting of TTL logic, memory, a CRT monitor, a mini-Winchester Drive, plus a 5¼" or 8" floppy drive. Features include: meets VDE safety, 3750 VRMS isolation; all regulated outputs; 65% minimum efficiency; 115/230 VAC input; and provides popular system outputs. $195. **Power-One, Inc.,** Power-One Dr, Camarillo, CA 93010.

Write 163

RIGID DISK DRIVES

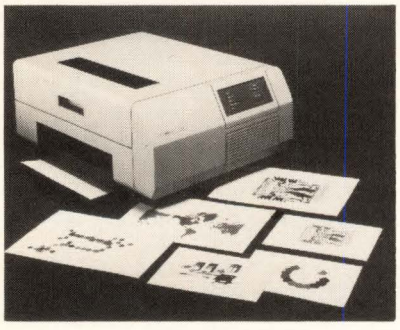
25.5 MB And 38.25 MB Models

The AEGIS family of rigid 5¼" disk drives feature a 25.5 MB model 10/10, which includes a fixed disk plus a removable disk cartridge for integral disk-to-disk backup. Each of the two 5¼" disks of the 10/10 has a storage capacity of 12.75 MB. One of the disks is contained in a removable cartridge. Access time is 35 ms and its data transfer rate is 5 Mbits/sec. The AEGIS 30 features 38.25 MB of storage capacity on three two-sided nonremovable platters. Compatible with the ST 506/412 hardware interface. Model 10/10 is $1300. **Athenaeum Technology, Inc.,** 105 Bay State Dr, Braintree, MA 02184. **Write 172**

COLOR GRAPHICS COPIER

Ink Jet Technology Produces 8-Color Copies

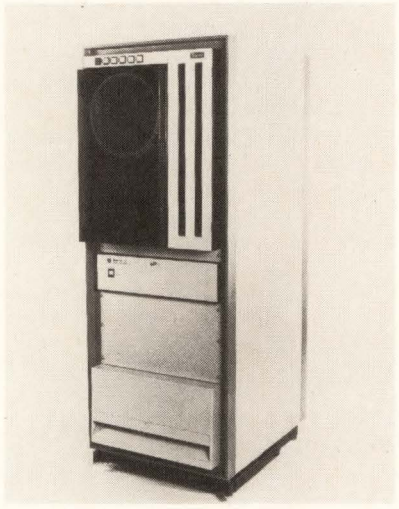
The 4691 produces B-size (279 × 432mm) as well as A-size (216 × 279mm) output. Images can be produced in a horizontal or vertical format for A or B sizes, and multiple copies may be produced under program control. Ink is supplied from separate ink cartridges containing yellow, cyan and magenta. Black comes from a fourth ink cartridge resulting in a dense, solid black. It produces additional colors through a shading technique called dithering. 4113 Local Easy Graphing software, for example, will include routines which produce 125 callable shades for use on the 4691 color copier. High resolution is the result of the combined capabilities of addressability, dot size and placement accuracy. It can place 150 dots/inch in both horizontal and vertical directions. Another feature of this ink on demand technology involves an automatic mini-cleanse of the printing heads after each copy. The 4691 forces a tiny amount of water through the head before recapping, eliminating clogging from dried ink. In local applications, up to 4 terminals can be interfaced to a single 4691 color copier. **Tektronix, Inc.,** PO Box 500, Beaverton, OR 97077. **Write 173**



9 TRACK TAPE SYSTEM

1600 cpi PE/6250 cpi GCR

The Series Six is a 9 track system capable of reading or writing in either 1600 PE or 6250 GCR formats. It is compatible with existing HP software, and up to 180 MB of data may be stored on a single 10-½" reel of tape,



with data transfer rates of 468 kB/sec with GCR or 120 kB/sec PE. May be used with all HP 1000 series and most HP 3000 series computer systems. Features include: full autoload capability; a standard HP-IB interface, allowing compatibility with existing hardware and software; extensive self testing and diagnostics. Optional features include expanded buffer memory, 9 channel triple density 800/1600/6250 operation, and tape speed to 125 ips. **Dylon,** 9561 Ridgehaven Ct, San Diego, CA 92123. **Write 233**

DATA MODEM

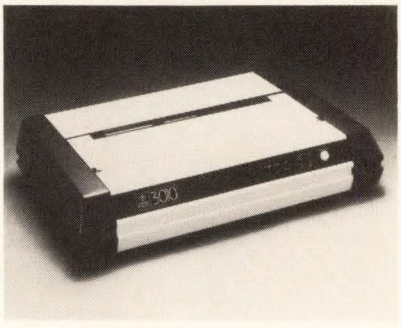
Meets 48, 56 or 64 Kbps Requirements

The 3082 is designed for wide-ranging applications in data communications including transmission of high-speed data on leased lines, transmission of multiplex aggregate bit streams on public data nets and extension of PCM channels at 64 Kbps over analog facilities. Also applicable in common channel signalling systems in both telephony and public data networks. In addition, it can be used in extended single-channel-per-carrier satellite earth stations. Complying with CCITT recommendation V.36 for sync data transmission over 60 to 80 kHz group band channels, the 3082 also operates over balanced two-wire lines. Can be installed in a two-unit configuration in a standard 19" rack or ordered as a free-standing desktop model. **ITT,** Data Equipment and Systems Div., Suite 8927, One World Trade Center, New York, NY 10048. **Write 234**

MATRIX PRINTERS

Dot-Addressable Graphics Capability

Both μP-based printers offer plug-to-plug compatibility with many desktop μCs, including Televideo, Apple, and IBM units. The GE 3010 and 3014 models print up to 4 copies bidirectionally at 160 cps. For word processing applications, the GE 3014 features both a high-resolution print mode that produces overlapping dots for near-letter quality printing at 40 cps and a horizontally enhanced



memo mode at 80 cps. Each model employs a 2K-character print buffer. From $850 to $1150, depending upon model and qty. **General Electric Co,** Data Communication Products Dept, Waynesboro, VA 22980. **Write 235**

5-¼" WINCHESTERS

Seagate ST 400 Compatible

The 5006 drives come in 3 different capacities. The single platter 5006/1 offers 6.38 MB (5.0 formatted), the two platter 5006/2 contains 12.76 MB (10.0 formatted), and the three platter 5006/3 raises capacity to 19.14 MB (15.0 formatted). The drives will have an MTBF of 11,000 hours. Component life is estimated at 6 years. Average access time is 70 ms. There is a μP-controlled buffered seek, and power consumption is 25W. In OEM qty 1,000, the 5006 series is $585 for the 6MB 5006/1, $695 for the 12MB 5006/2, and $850 for the 19MB 5006/3. **Irwin Olivetti Inc.,** 2000 Green Rd., Ann Arbor, MI 48105. **Write 236**

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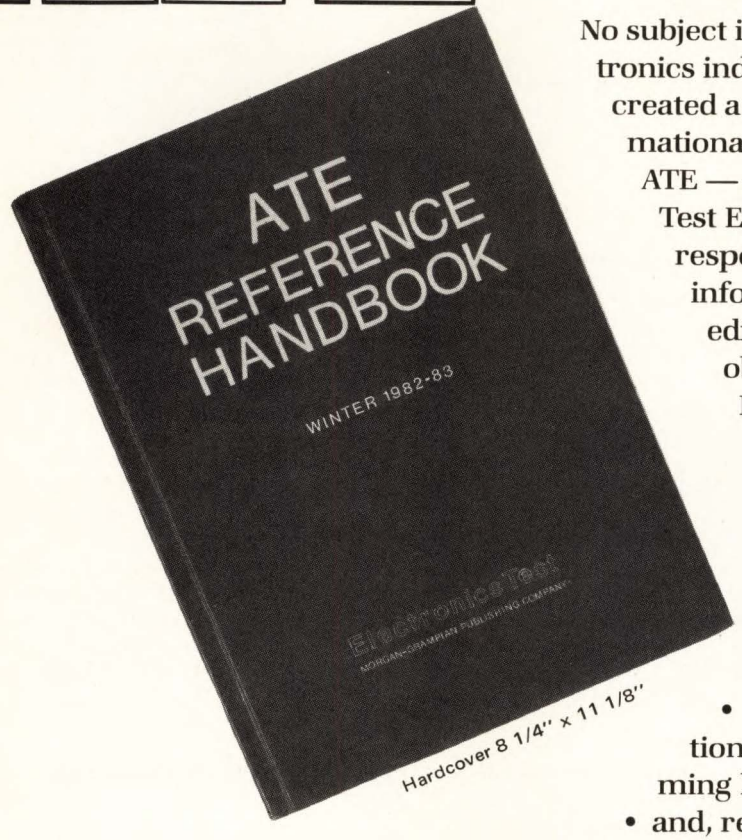

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DD183

WORD ALTERABLE DEVICE

Addition To Line Of 16K EEPROMs

The Microelectronics Group of General Instrument Corporation, is introducing a new word alterable device to its line of 16K EEPROMs. Designated ER5816, this device features remote programability and is electrically erasable in-system, thus eliminating the need for circuit removal for UV exposure such as in the popular 2716 UV PROM. Further features include 300nsec access time and 10msec erase and write time. With applications in point-of-sale terminals and program storage in microcomputers, the ER5816 will be available as samples in December at under $20. Bulk production is scheduled to begin shortly after sample introduction. **General Instrument,** Microelectronics Div., 600 W. John St., Hicksville, NY 11820. **Write 135**

CP/M COMPATIBLE μC

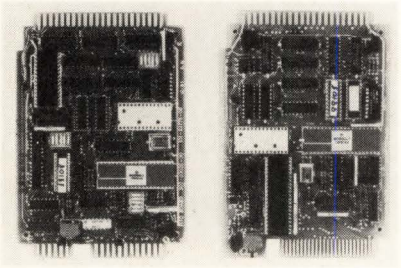
Constructed On A Standard Eurocard PCB

Based on the 6 MHz Zilog Z-80B 8-bit μP, the QUARK/100 includes a dual-mode Alphanumeric/Graphic Video Display interface with a programmable character set, a floppy disk interface for up to 4 double-sided, single- or double-density 8″ or 5¼″ floppy disk drives, a full duplex serial interface port as well as a simplex serial port, a parallel printer interface, and 22 general purpose I/O lines for keyboard input and other I/O functions. $1195. **Megatel Computer Corp Inc.,** 150 Turbine Dr, Toronto, Ontario M9L 2S2. **Write 143**

REMOTE I/O COMMUNICATIONS LINK

Control Remote Machinery And Processes

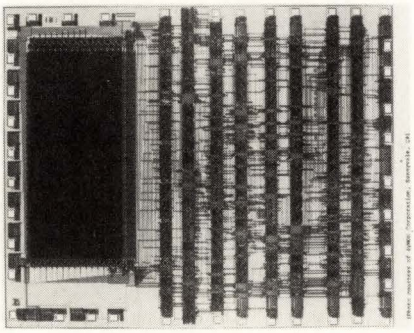
Four remote stations, each with its own processor capable of handling up to 256 I/O devices, can be interfaced to the PC 400 (Master Station) providing for a total of 1,024 I/O devices as far as 4,000′ from the Master Station. A single twisted pair is used as the communications link from the master to the remote stations, minimizing wiring costs. The link is serial with RS422 balanced line drivers and receivers. Expansion beyond four remote stations is possible as multiple "First In First Out" Communications boards can be added to the master station. **Giddings & Lewis Electronics,** 555 S. Military Road, Fond du Lac, WI 54935. **Write 132**



64K CMOS ROM

Features Fast Access Time

This mask-programmable 64K CMOS read-only memory utilizes a proprietary 3-micron silicon gate process that speeds up access time. The new

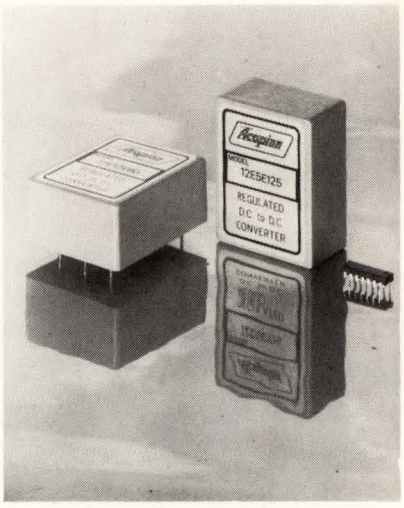


ROM chip, designated H23C64, is a direct replacement for the industry standard Type 2364. Typical access time is 300 ns and operation power is 5 ma. The unit features a single 5-V power supply with supply voltages of 4–6.5V available. The H23C64 is available in Jedec standard ceramic and plastic dual-inline packages, as well as a ceramic leadless chip carrier. A standard 28-pin version will be available in the near future. Unit price for the new ROM is $8.90 in quantities of 10,000. ROM codes are being accepted now by factory, and programmed ROMs will be available within six weeks of customer code approval. **Hughes Solid State Products,** 500 Superior Ave., Newport Beach, CA 92663. **Write 134**

DC-DC CONVERTERS

Board Mounting

Single output models provide 5, 12, and 15 V at 400 mA to 1.25A. Duals offer ±12 VDC at 300 mA and ±15 VDC at 250 mA. Input voltage ratings are 5, 12, 24, and 28 VDC. All outputs are regulated to ±0.02% line, ±0.05% load. Ripple is less than 1 mV RMS, 50 mV pk-to-pk.



Designed for mounting on printed circuit boards or in a socket, each measures 1.8″ × 2.3″ × 1.0″. Input reflected ripple is reduced to less than 1% by means of a standard built-in pi filter, and electrostatic shielding on all six sides minimizes radiated energy. Provision for trimming the single output models permits setting the output to an accuracy of better than 1%, when required. Price: Single output models, $98; duals, $105. **Acopian Corp,** Easton, PA 18042. **Write 138**

LOGIC ARRAY EVALUATION CHIP

Analyzes Array Performance

LSI Logic Corp has introduced an evaluation chip for its LSI 5000 series of logic arrays that allows potential users to analyze the performance of the arrays in specific applications. The chip (the LSI 5220Q) is the first evaluation unit for HCMOS logic arrays. Using it, potential users can gauge the functions of LSI's high-density, high-performance 5000 series over a variety of environmental conditions and system requirements. The LSI 5000 series is based on 3 micron, double-layer metal HCMOS technology and offers gate complexities of 880 to 6000 gates. It is competitive in speed with ISL, TTL and LSTTL, and can replace these families in most applications. The evaluation kit contains the LSI 5220Q, a detailed logic description of the device and a technology description. The cost is $125. An optional Fairchild Sentry Series 20 test tape formatted for master or M3 operating systems is available at an additional cost. **LSI Logic Corp,** 1601 McCarthy Blvd, Milpitas, CA 95035. **Write 136**

ECL GATE ARRAYS

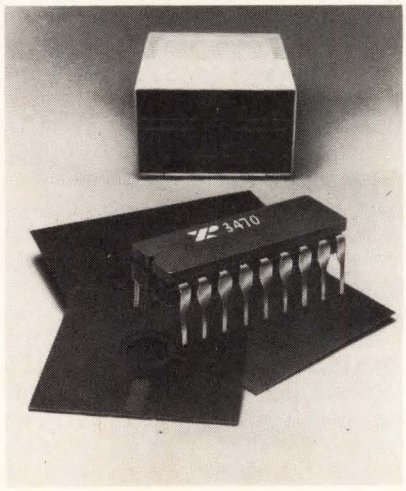
600 And 1200-Gate

National Semiconductor has introduced the first members of its MCA series of ECL gate-array devices. These devices are available as part of a recently-announced multi-year alternate-source agreement with Motorola on families of silicon-gate CMOS, bipolar TTL and ECL gate arrays. The two new ECL gate-array devices are designated the MCA600 and the MCA1200. These devices are 600-gate and 1200-gate equivalents of an ECL macro-cell array. Both devices feature a typical gate speed of 1ns and are 10k ECL compatible. The MCA1200 includes 48 major internal macrocells while the MCA600 includes 24. Both arrays feature an extensive functional library. Both the MCA600 and MCA1200 are housed in a 68 I/O ceramic JEDEC standard leadless chip carrier package, with the MCA600 additionally available in a 40-pin ceramic dual-in-line package. Development costs range $16k–$29k; manufacturing costs are $27 for the MCA600 (1000/options/year) and $45 for the MCA1200. **National Semiconductor**, 2900 Semiconductor Dr., Santa Clara, CA 95051. **Write 133**

FLOPPY DISK READ AMPLIFIER

For Single/Double Density Floppies

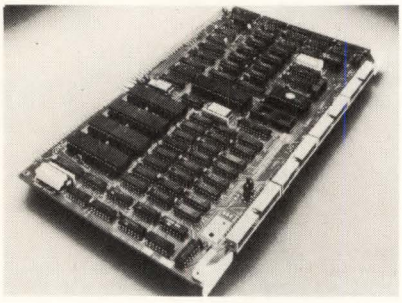
The XR-3470 is a floppy disk read amplifier circuit for single and double density floppy disk systems. It contains all circuitry required to perform the transformation of the magnetic head signal to a digital data stream. To insure compatibility with major 8″ and 5¼″ floppy disk systems, the XR-3470 features a maximum transfer rate of 3 Mbaud. A nulling network at digital output minimizes peak shift to less than 5%. And pin-for-pin, the XR-3470 is a lower priced, second source for Motorola's MC-3470 circuit. Exar's read amplifier accepts read back signals from a magnetic head and converts the peaks of this signal to digital pulses. The XR-3470 contains a high frequency amplifier, active differentiator, zero crossing detector, and a time domain filter. In plastic packaging, XR-3470CP, the read amplifier circuit is $3.12 in quantities of one hundred; delivery is six weeks ARO. **Exar Integrated Systems,** 750 Palomar Ave, PO Box 62229, Sunnyvale, CA 94088. **Write 141**



8-CHANNEL I/O BOARD

High Performance For Multibus

Now available is an intelligent, 8-channel serial I/O board for Multibus systems. The board may be purchased separately or as part of the CTW-300, Codata's 68000/UNIX-based microcomputer system. The new board offers eight serial input/output channels, configured for use with a variety of data communciations equipment. The on-board Serial Communications Controller (SCC) has a built-in baud generator which permits the board to handle several different communications protocols, including sync, async, monosync, bisync, SDLC and HDLC. Moreover, all communications lines are buffered to be compatible with RS-232 and RS-423 specifications. I/O operation is handled by a 4MHz Z80A μP supported by 64 Kbytes of parity-protected RAM (accessible from P796 bus structure), 16 Kbytes



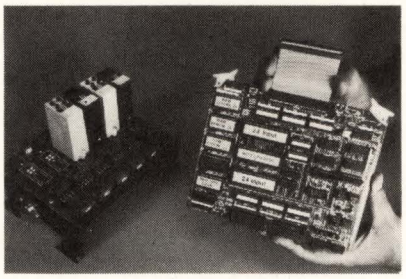
of EPROM, and P796 bus interface standards. The board can operate in one of three modes: as a simple I/O channel device; as a simple I/O channel device with 64 Kbytes of RAM; or as an intelligent I/O controller. The serial I/O board has an OEM price of $1350 and delivery is 30 days ARO. **Codata Systems Corp,** 285 North Wolfe Rd, Sunnyvale, CA 94086.

Write 139

PROGRAMMABLE CONTROLLER

Dual Language

The CP73P programmable controller is a dual language microcomputer controller for industrial automation. It executes a control program written in both Tiny BASIC, and PSM (Process State Monitor), a new high level interpretive language designed to efficiently handle the sequential aspects of the application program. PSM can make calls to BASIC subroutines so that arithmetic, terminal I/O, and other Tiny BASIC functions can be easily accommodated. The unique



feature of PSM is that it permits the programmer to define the process using a set of state diagrams. The PSM program will run 5 to 30 times faster than BASIC alone and only uses about 25% of the memory space for similar applications. The CP73P, with PSM and Tiny BASIC, mounts in the small, modular POWR-TRAK industrial frame and is compatible with other POWR-TRAK industrial function cards. The CP73P is available from stock at $625 in singles. **Adaptive Automation Technology,** PO Box 1339, Sandpoint, ID 83864. **Write 140**

256KB DYNAMIC RAM

For The Z80-STD Bus

The DRAM-256 Dynamic Memory Card provides 256kB of memory that is easily configurable in 8K segments over a possible 4MB memory array. Multiple cards may be used to fully populate the 4MB array. Designed for use in a variety of memory mapped applications such as multi-tasking, simulating a high speed disk or simply as a 64K system memory card. Memory requirements greater than 64K are accomplished by bank switching through a single user selectable I/O write port. $445. **Computer Dynamics, Inc.**, 105 S. Main St, Greer, SC 29651. **Write 228**

68000 BASED SBC

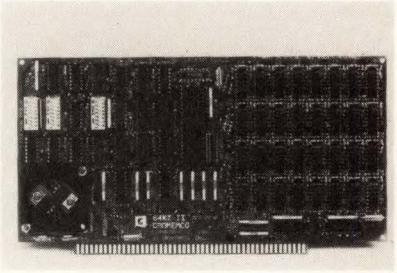
Multibus Compatible SBC With DMA

The latest member of the Gateway family, the FT-68X, is a single, Multibus compatible board containing: the 10 mHz 68000, 256kB RAM with parity, memory management and protection, two serial ports, one parallel input port, 5 counter/timers, and DMA capability. The DMA capability allows off-board devices to access the local RAM without intervention by the processor. Additionally, the 68000 runs with no wait-states while accessing the local RAM. $3995, qty discounts avail. **Forward Technology, Inc.**, 2175 Martin Ave., Santa Clara, CA 95050. **Write 229**

64K RAM CARDS

For S-100 Bus Compatible Computers

Model 64KZ-11, a 250 ns R/W memory board, is designed to draw less power and generate less heat than previously available 64K RAM cards. Power requirements are +8 A and +18 V at 0.1 A. Capable of operating in a 4 MHz Z80A-based systems with absolutely no wait states, the 64KZ-II is organized as two 32K blocks of memory. Each block can be placed in any of 8 different memory banks. Address and bank assignment of each



32K block is switch selectable. With this bank select feature, memory space can be expanded from 64K to 512K in 8 banks. **Cromemco Inc.,** 280 Bernardo Ave., Mountain View, CA 94043. **Write 142**

SINGLE-CHIP IPC DEVICES

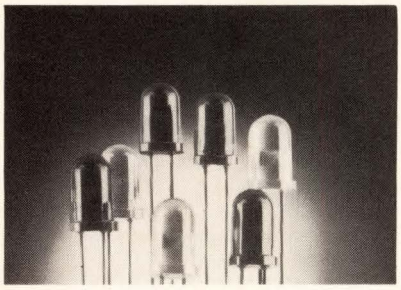
Reduce Parts Count

Four new single-chip, 8-bit intelligent peripheral controllers, designated R6500 IPC devices, were introduced by the Electronic Devices Division of Rockwell International Corp. The IPC devices reduce parts counts as well as design costs in distributed control systems using them as programmable slave controllers. They also have cost reduction potential in standalone applications. The devices feature a parallel host data bus compatible with 6500/6800 and 8080/Z80 μP families. Additionally, the devices have on-chip input, output status and control registers for data transfer functions. Codes are now being accepted for the ROM-based R6500/41 which in 40-pin DIP is priced at $5.60 and for the R6500/42 and R6500/43 which in 64-pin QUIPs are priced at $8.60 and $6.40, respectively. All prices are for volume production quantities. The R6541Q in 64-pin QUIP is available now and is priced at $15.90 in single unit and $11.45 in 100 unit quantity. **Rockwell International**, Electronic Devices Div, 4311 Jamboree Rd, PO Box C, Newport Beach, CA 92660. **Write 137**

LED LAMPS

Feature 7 Distinct Colors

The SLH/SLR Series precision-color LED lamps are available in 2 shades of red, true orange, yellow, and 3 shades of green. Industry-standard T-



1 and T-1-¾ configurations are offered in two different intensity groups: High Efficiency and 250 mcd Super Bright. Three lens types are available: Diffused, for wide angle viewing applications; Colored Transparent, for off-state color recognition; and Clear for applications requiring the brightest possible illumination such as outdoor sunlight viewing. $0.65 each at 1000 units for Super Bright LEDs, all colors; $0.14 each at 1000 units (typical price for red LEDs). **Rohm Corp.**, 8 Whatney, Irvine, CA 92714. **Write 149**

5V 16K EEROM

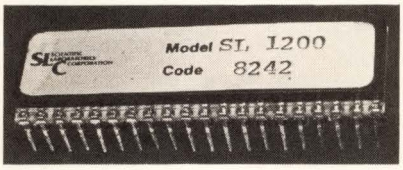
Can Be Written Using A Single 5V TTL Level Or 21V Signal

The 5213 is organized 2K by 8 bits in a JEDEC approved, 24-pin dual in-line package and is used wherever user reconfiguration of nonvolatile program store is needed. Applications for the nonvolatile-memory include robotics, programmable character generators, industrial controllers, military avionics, and self-calibrating instrumentation. Using the 21V write capability, the 5213 is plug-compatible with Intel 2816 EEROM. $31 in 100 qty. Also available is the 8001 EDLC monolithic Ethernet data-link controller that completely supports Layer 2 of the Ethernet protocol. The chip is the first device to have silicon structures generated by a logical function description (i.e., silicon compiler). $135 100 qty. **SEEQ Technology, Inc.**, 1849 Fortune Dr, San Jose, CA 95131. **Write 227**

MODEM IC

0 To 1200 Baud

The SL 1200 operates as an FSK modem for data rates to 1200 baud and is available in models to serve Bell System or CCITT applications. Containing a continuous phase sinusoidal FSK modulator and balanced demodulator, the unit is suitable for use in

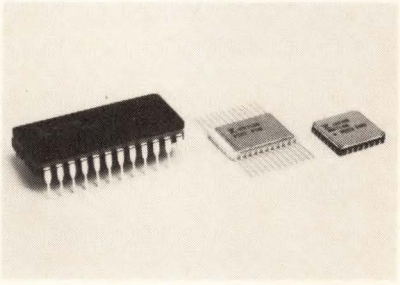


low power applications as the device draws only 7 milliamps from its 5.0 VDC source. $95 (1–99). **SLC Marketing**, 7871 Ring St, Long Beach, CA 90808. **Write 230**

64K TTL PROM

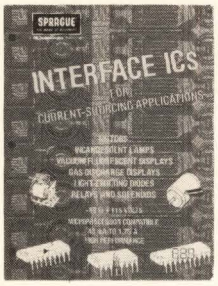
Access Time Of 40ns

The MB7143/44 is available with two output options: the open collector (MB7143) and the three state output, (7144). The 7143 combines high den-

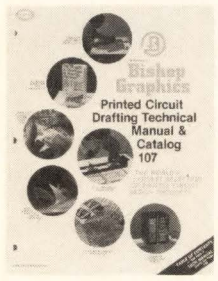


sity with extremely fast speeds, with minimal power consumption. The 7143/44 offers a memory cell size of 168 um^2 by using Fujitsu's patented isolation technology, in conjunction with advanced SVG (Shallow V-Groove) and stepper process technology. Available in either the industry standard 24pin DIP package, a 24pin flat package or a 28 pad LCC (leadless Chip Carrier) configuration. Can replace existing 32K PROMs such as Fujitsu's MB7141/42 by switching CE input to the address pin. Such an arrangement offers double memory density on the memory board. Can also be used to upgrade memory size and performance in ROM memory systems used in control memory, program memory and control logic circuits. **Fujitsu Microelectronics**, 2985 Kifer Rd, Santa Clara, CA 95051. **Write 232**

New Literature

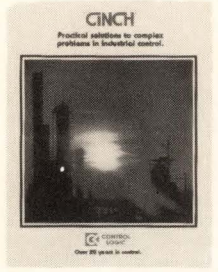


Interface ICs Brochure. A new short form catalog describes integrated circuits specially designed for current-sourcing applications. Uses include: motors, incandescent lamps, vacuum-fluorescent displays, gas-discharge displays, light-emitting diodes, relays and solenoids.
Sprague Electric Co. **Write 266**



Printed Circuit Drafting. A revised and expanded 200-pp. P.C. drafting aids technical manual and catalog, "Bishop Graphics Printed Circuit Drafting Technical Manual & Catalog 107," is designed to help the P.C. drafter utilize the most recent innovations in printed circuit design to create precision P.C. master artworks. Among the innovative methods illustrated are complete instructions on overlay drafting to achieve the accuracy of CAD.
Bishop Graphics **Write 267**

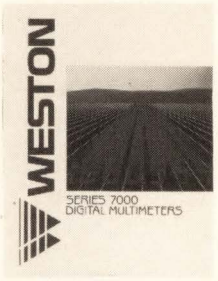
Computer Accessory Catalog. This 27th edition features numerous price reductions, new products, and helpful editorials. Among the new products offered in the catalog are two advanced T-Switches, the Auto-T-Switch, and the Mini-I-Switch. Other new products include a 1200-baud modem, Inmac's high-quality print bands, three types of Inmac disk packs, and a new EIA Line Driver.
Inmac **Write 268**



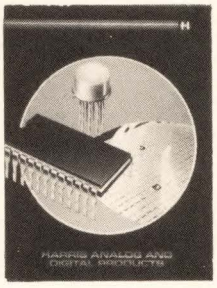
Literature On CINCH. The Cinch Digest, 16 pages in color, contains descriptions of real life applications and detailed hardware information including specifications as well as programming examples demonstrating the easy-to-use CINCH BASIC language. The CINCH microcomputer is the practical alternative to programmable controllers, minicomputers and data loggers for data acquisition and control of industrial processes.
Iconix Corp. **Write 269**

Line Printer Controller. A 12-pp. line printer controller product brochure gives information on controllers for all major line printers interfaced to DEC's PDP-11, VAX, LSI-11/2 or 11/23, PDP-8, DG Nova and Eclipse, H-P 1000, Perkin-Elmer and IBM Series/1 computers. Also included is a description of MDB long-line interface products, an informative tutorial on a line printer controllers, and technical data.
MDB Systems **Write 270**

Semicustom Engineering Guide. An engineering guide to semicustom integrated circuits provides design engineers with the necessary information for planning and determining design feasibility of semicustom integrated circuits for their applications. Included is a description of CDI's CMOS gate array families and their characteristic data; development flow of design; and how to get started with a semicustom gate array circuit.
California Devices, Inc. **Write 253**

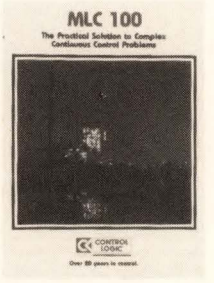


Multimeter Literature. A 20-pp., full color brochure describes a new line of distributor-stocked Series 7000 Digital Multimeters. Handheld models with 3½ digit resolution, 4½ digit bench instruments, 5½ digit ATE units, and a full line of accessories are presented with complete specifications.
Weston Instruments **Write 271**



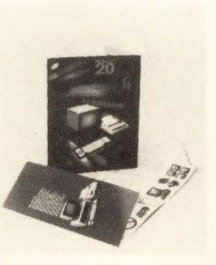
Analog and Digital Products. A 44-pp. shortform data book describes analog and digital integrated circuit line. Each section of the book provides an individual product description including applicable technical specifications and pinout. Standard products highlighted in the book include: bipolar digital logic, CMOS digital products (RAMs, PROMs, communications ICs, bus drivers and microprocessors), and analog products.
Harris Semiconductor **Write 258**

IBM Interface Products. Line Printer Controllers, Asynchronous Serial Interfaces, Wire Wrap boards and Long Line products for IBM Series/1 computers are described in an 8-pp. brochure, available from MDB Systems, Inc. In addition to product descriptions, interface schematics and application information is also included.
MDB Systems **Write 259**



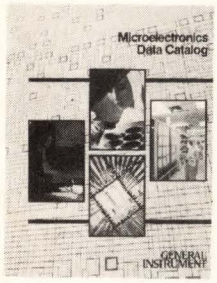
Multiloop Controller. This 8-pp. color brochure describes the MLC 100 multiloop controller, which provides up to 16 loops of continuous control without the need for programming. The brochure details how the operator selects control parameters from a prompted menu and enters the appropriate values to implement full cascaded PID control and six types of alarms for extremely tight process control.
Control Logic **Write 260**

Computer Accessories. This 16-pp. catalog introduces a line of computer accessory products consisting of: DataGard—spike, transient and noise protection power conditioners to filter out unwanted electrical disturbances on all types of mini, micro, and word-processing equipment; electrical outlet strips—allows users to multiply and relocate electrical outlets without the high cost of fixed wiring; and CordGard.
SGL Waber Electric **Write 261**

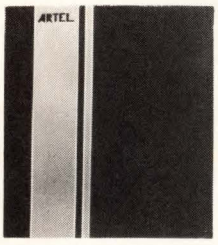


Telecommunications Terminal Brochures. This full color brochure describes the two high performance, low cost, desk top terminals which are the latest additions to Sidereal's line of multiport telecommunications terminals. Based on the state-of-the-art 6809 CPU, the new "Micronet 20" has two ports. Each port can be configured from the keyboard for TWX, Telex, DDD (110-1200 baud) or IRC telex.
Sidereal Corp. **Write 254**

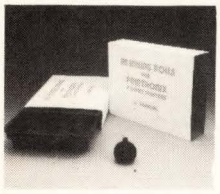
New Literature



Digital Microcircuits Catalog. A new 559 page catalog provides detailed technical and design data on nine families of digital microcircuits dedicated to the computer and communications industries. Product catagories include ROM, Electrically Alterable Non-Volatile Memories, Microcomputer, Audio, Telephony, Data Communications, ULA, Video, and Tuning.
General Instrument **Write 263**

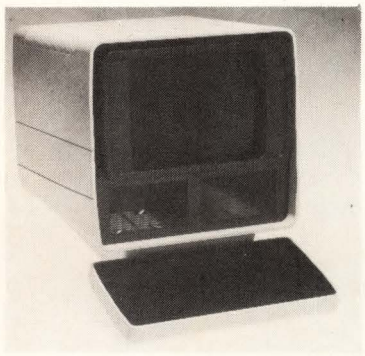


Fiber Optic System Brochure. This full color, 4 pp. brochure describes the SL-2000 Fiber Optic Transmission System for video, audio and data communications. Artel's SL-2000 brochure explains how fiber optics solve transmission problems faced in computer graphics, television broadcasting, teleconferencing, military C^3 and local area networks.
Artel **Write 256**



Printer Re-Inking Info. This brochure describes Porelon's printer ribbon re-inking system, which significantly increases the life of printer ribbons. Since some companies wear out several ribbons per shift, per printer, re-inking can result in considerable savings. Designed to work with Printronix printers, the barrel-shaped devices install quickly and easily.
Porelon, Inc. **Write 251**

BUY DIRECT AND SAVE A BUNDLE!



NEW!
Model 770
12" Monitor Housing
with 5½" dual
floppy disc drives

$95.54

Yearly orders of 5000 or more reduce the unit price to $49.48! Choose from two keyboard sizes, $19.29 and $22.50

This handsome enclosure is molded by Hettinga's advanced stress-free TCM process that vastly improves on traditional structural foam molding. Combining beauty, function and durability, this housing has the most competitive price on the market.

Easy to build into, its exceptional sturdiness permits the monitor to be mounted directly to the bezel bosses and eliminates the cost of the wire frame. Standard inserts are molded in.

- Meets all foreign and domestic standards
- EMI/RFI shielding available
- Made from UL VO 94-95 approved rating molding materials
- Any size order welcome
- 24-hour shipment on stock items
- We do molding, shielding and painting in our plant
- Other sizes available, ask for our brochure

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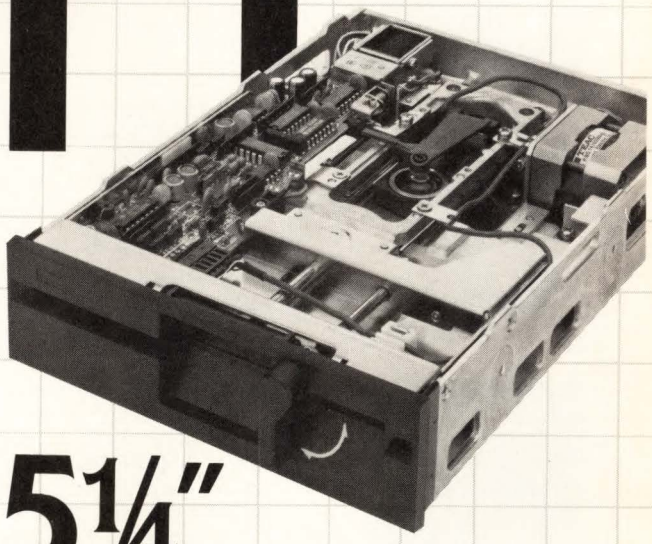

5¼" Floppy Disk Drives

TEAC FD-55 Series

AT 1⅝" HIGH, TEAC FD-55 SERIES 5¼" FLOPPY DISK drives use half the space and run cool at half the power of conventional drives. High-reliability, low-noise brushless DC motors provide an MTBF of over 10,000 hours, backed by a one-year parts and labor warranty.

FD-55A	FD-55B	FD-55E	FD-55F
• 48tpi	• 48tpi	• 96tpi	• 96tpi
• 40 track	• 40 track	• 80 track	• 80 track
• 250KB	• 500KB	• 500KB	• 1MB
• single side	• double side	• single side	• double side

Power Requirements:
DC +12V ±5% 0.3A typical, 0.7A max.
DC + 5V ±5% 0.5A typical, 0.7A max.

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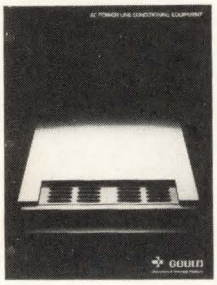
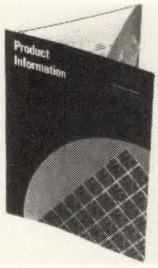
New Literature



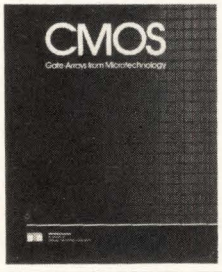
AC Power Line Conditioning. Gould Inc., Electronic Power Conversion Division, has just published a new 16-pp. catalog detailing its line of Super Isolation Transformers and AC Line Conditioners in ratings from 100VA to 60KVA. The free catalog discusses AC Power Problems and the appropriate line conditioning device necessary to solve them, and provides detailed technical specifications on five different series of products.

Gould **Write 255**



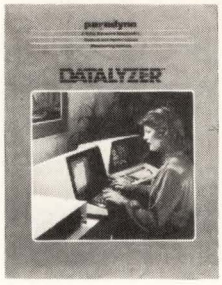
High Performance DSP Components. High performance digital signal processing components are described in a new 6-pp., 4-color product information brochure. Contains six major categories: Multipliers; Multiplier-Accumulators; A/D Converters; D/A Converters; Special Functions, and Storage Products. The catalog also provides a listing of all North American and International sales offices.

TRW, LSI Products Div. **Write 250**



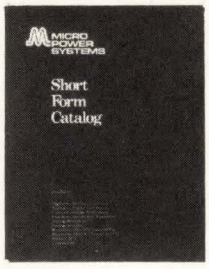
MOS Gate-Arrays. A full-color, 9-pp. brochure introduces semi-custom CMOS LSI/VLSI gate-array design and fabrication services. The "technology center" approach can overcome the design-support, cost, turnaround-time and second-source problems often associated with converting discrete or MSI-logic TTL circuits to custom or semi-custom ICs.

Storage Technology **Write 265**



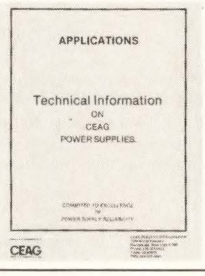
Datalyzer Brochure. A 12-pp. color brochure describes Datalyzer, an option to the Paradyne ANALYSIS automated network management system. It analyzes host computer traffic, reports response time and provides inservice parameters with color graphic and statistical displays. Datalyzer allows the network management operator to observe the performance of the communication/data processing system.

Paradyne **Write 264**



Converters, ICs And Custom LSI. Micro Power Systems has updated and printed its Short Form Catalog for standard products. The B/W, 12-pp. catalog lists all of the current and new products. Four product areas have been expanded: military ICs, dual transistors, op amps and DACs. MPS now provides a complete line of DACs ranging from a 6-Bit DAC up to an 18-Bit DAC, and op amps from OP-01 to OP-37.

Micro Power Systems **Write 257**



Switching Power Supplies. New literature has just been released by CEAG Electric Corp. providing an overview on state-of-the-art design relative to switching power supplies. Additional topics covered in the booklet are application, measurement techniques, paralleling, load sharing and specifications. Also featured is a section with definitions of common terms.

CEAG Electric Corp **Write 252**

Advertiser Index

IT'S SUPERCONTROLLER!

It's a 6250 BPI (GCR) controller that can handle dual and tri-density drives from STC and Telex.

It's a software compatible streamer controller for today's streaming 1/2" drives.

It's a TS11* emulator.

It's a 6250 BPI streamer controller for tomorrow's new technology GCR streaming drives.

It's a single board imbedded controller with a 64K byte onboard memory that acts like a large buffer in start-stop mode and as a multiblock staging buffer while streaming.

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The Model 701 μPackage is a general purpose, RETMA standard enclosure containing STD BUS card rack, 3-voltage power supply and fan. It simplifies STD BUS system implementation.

The Model 702 STD Disk Package is a well-engineered, flexible package to support data collection, ATE and process control applications. Designed for mass storage applications, the 702 contains two thin-line 8-inch floppies, a 13-slot STD BUS card cage, a 4-voltage switching power supply and fan.

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