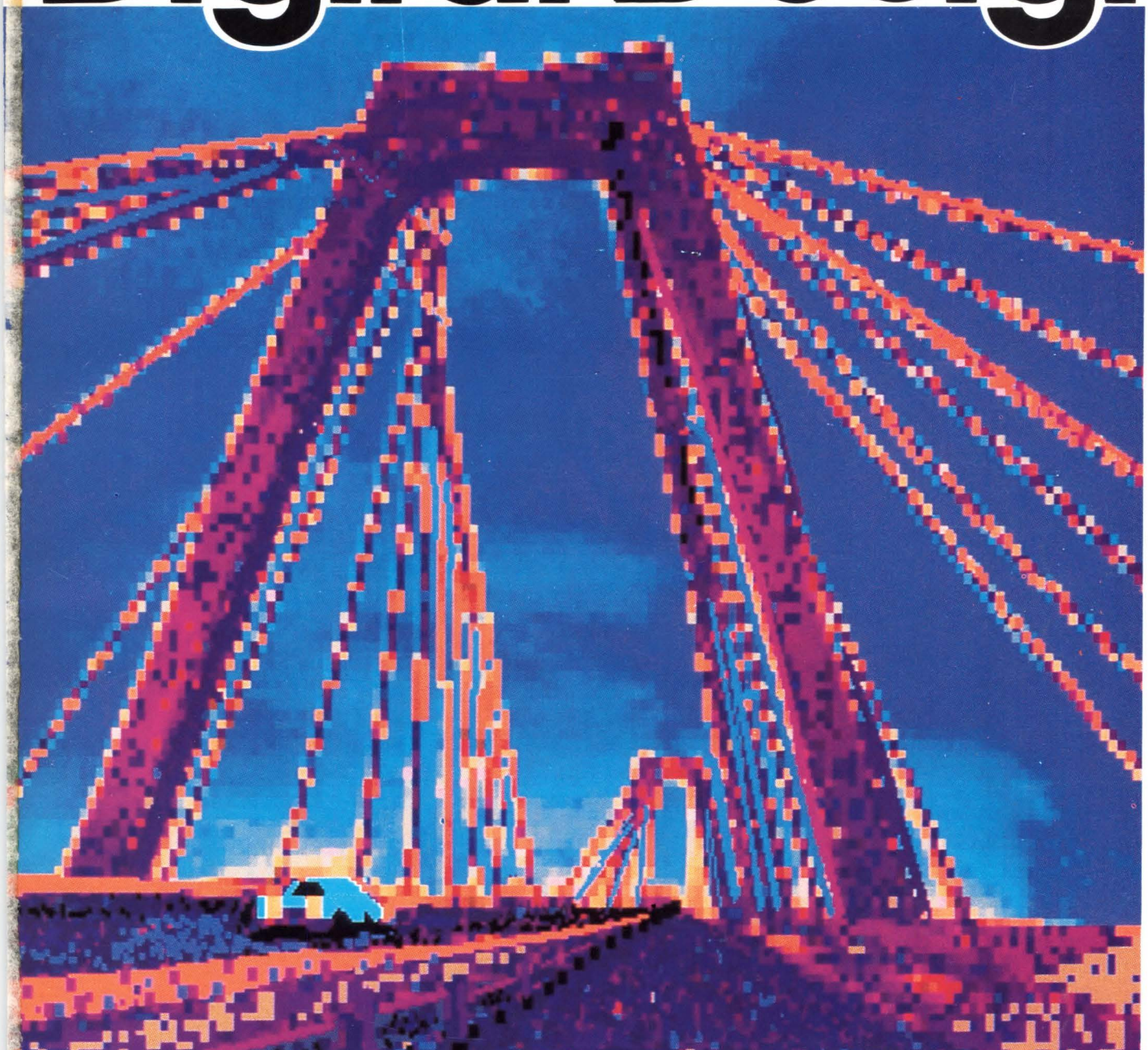
A MORGAN-GRAMPIAN PUBLICATION

Digital Design

COMPUTERS/SYSTEMS • PERIPHERALS • COMPONENTS • 2/83



Color Graphics Terminals To Bridge The CAD/CAM Gap

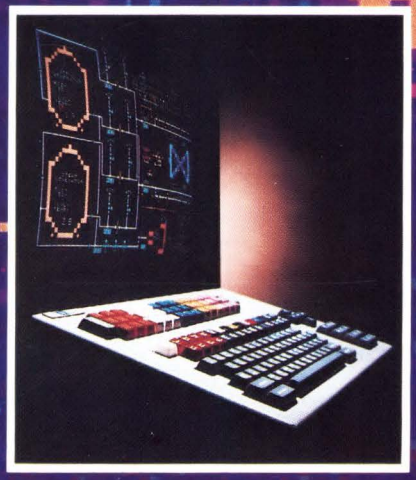
- Designers' Guide To The Multibus
- Upgrading Your Printer
- Winchesters To Go
- Micro Floppies Complement Small Systems

Plus

Industry Spotlight

Dr. Karl H.E. Kroemer and Dr. Harry L. Snyder on

ERGONOMICS



VOL. 13
NO. 2

THE LEADING EDGE IN PRINTERS

ONE GREAT LINE. ONE GREAT WARRANTY.

Finally, there's one full family of printers that covers every business or word processing application—all from C. Itoh, a company known for packing more product into less price; and all distributed exclusively by Leading Edge, a company known for searching out and providing that very thing. Which means that one call to one source can get you any printer, any time you need it, for any purpose. All backed by a full years' warranty from Leading Edge. (Try *that* on any other line of printers.)

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The Starwriter F-10. In short (or more precisely, in a sleek 6" high, 30-pound unit), it gives you more of just about everything—except bulk and noise—than any other printer in its price range. It's a 40 cps letter-quality daisy-wheel with a bunch of built-in functions to simplify and speed up word processing. It plugs into almost any micro on the market, serial or parallel.

THE MASTER.

The Printmaster F-10. Does all the same good stuff as the Starwriter except, at 55 cps, the Master does it faster.

Distributed Exclusively by Leading Edge Products, Inc., 225 Turnpike Street, Canton, Massachusetts 02021.
Call: toll-free 1-800-343-6833; or in Massachusetts call collect (617) 828-8150. Telex 951-624.

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The Incredible Shrinking 212A!

For High- and Medium-Volume Users — Intelligent Custom 212A Modems on a Card with Incredible Features at Incredible Prices

FOR HIGH-VOLUME USERS — AN INTELLIGENT CUSTOM 212A

The "Make or Buy" decision becomes incredibly easy for high-volume 212A modem users. The answer is "Buy" Racal-Vadic intelligent modems, custom designed to your specifications.

These intelligent custom modems, designed around a new breed of 212A and 103 LSI chips are incredibly small and flexible, incredibly low in cost, and Racal-Vadic takes an incredibly short time from prototype to high-volume production.

Tiny 18- and 24-pin dual in-line chips contain a modulator and demodulator, transmit and receive filters, a carrier detector, automatic gain control, and answer tone generator/detector. Racal-Vadic has added telephone line, user, and control interfaces to these dual in-line chips. And our custom 212A modems are delivered to you FCC Registered and TAP Certified.

And that's just the beginning! A built-in microprocessor gives you all the options you've dreamed of: automatic dialing with stored numbers, interactive conversation with the data terminal operator, sophisticated diagnostics... and more.

If you need a lot of 212As, each packaged in less than 50 square inches, come to Racal-Vadic. We'll build them to your size, shape and specifications — and deliver them in a minimum of time.

FOR MEDIUM-VOLUME USERS — A STANDARD INTELLIGENT 212A

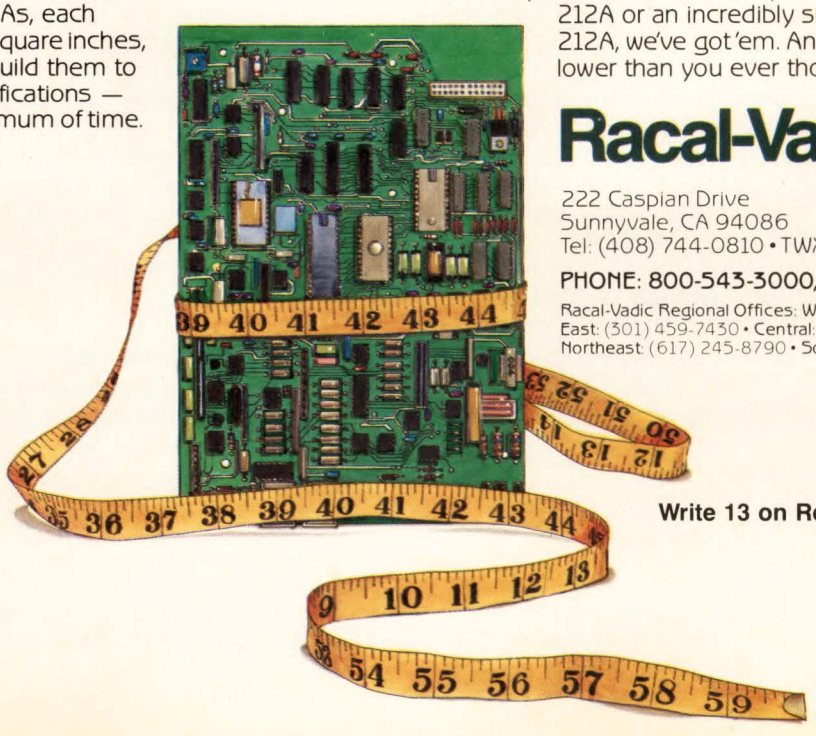
For medium-volume 212A users, the perfect solution is our VS212P — a standard intelligent modem packaged on an 8.85- by 5.50-inch PC Board. The VS212P fits comfortably inside most terminals and computers, because each modem occupies less than 50 square inches.

The VS212P, which uses the same chips, microprocessor and functional modules that make up a custom 212A, provides 1200 and 0 to 300 bps full-duplex operation with manual and automatic originate/answer. It's FCC Registered and TAP Certified for direct connection to the switched network and has built-in RS232C and TTL interfaces to simplify integration into new or existing systems.

A sophisticated automatic dialer, which allows up to 32 digits to be stored in memory and instantly retrieved by the terminal operator, is included in the VS212P. The modem provides a unique digital or analog input/output capability and can be used in systems where voice and data transmissions are required.

The price is right. Just $420 in lots of 100.

Whether you need an incredibly small custom 212A or an incredibly small standard 212A, we've got 'em. And at prices much lower than you ever thought possible.



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Guaranteed Fast Turn Around – Most likely, turn around is important to you. Universal guarantees an eight week turn around for arrays of 720 gates or less. For larger arrays, add one week per 150 gates. That means we'll turn a 1500 gate array around in 13 weeks.

The Latest CAD Support – The advanced Applicon 4575 system linked to a VAX 750 and supported by versatile software programs for routing, automatic checking, logic and circuit simulation, and test program generation. That's your assurance that your logic will be translated to silicon efficiently and accurately at Universal.

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Highly Competitive Prices – The Universal ISO 3/5 arrays are the densest in the Industry. High density means smaller chips and smaller chips mean lower prices. Check with us for a production quotation. You'll be surprised how much you can save with a Universal fast CMOS array.

Need More Information? – Call or write us today! We'll send you a fully descriptive product brochure, plus, as a bonus, **a poster of Miss Universal** - suitable for framing.

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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, 4-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.

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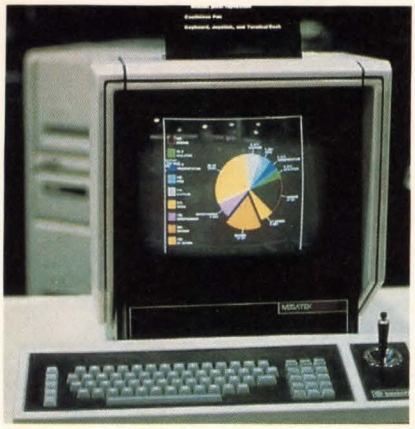
Write 8 for LSI-11, 49 for PDP-11

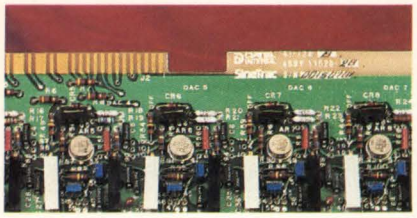
FEBRUARY 1983/VOL. 13, NO. 2

Digital Design



p. 46 *(photo courtesy Megatek)*

p.68 *(photo courtesy DMA)*



p. 75 *(photo courtesy Datel-Intersil)*

Cover

This month's cover illustrates two examples of advanced graphics with one picture. The Willemsbrug Bridge, spanning Rotterdam harbor, was completely designed, simulated, and tested on a Harris 800 superminicomputer with advanced graphics capability and software (courtesy Harris Computer Systems Div., 2101 West Cypress Creek Rd., Fort Lauderdale, FL 33309). The actual cover illustration of the bridge was created on a Digital Effects video palette by Jeffrey Kleiser (Digital Effects Inc.), directed by John Garr (Doremus Advertising). Inset color graphics terminal, courtesy of Aydin Controls. For more on color graphics terminals, see p. 46.

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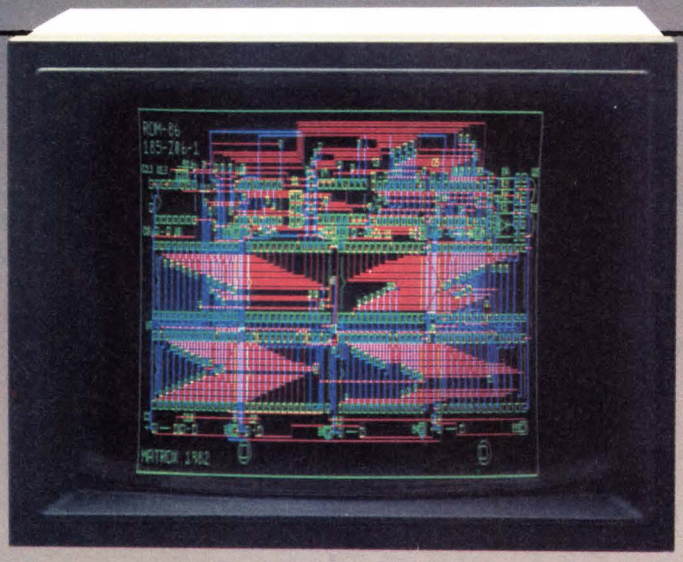

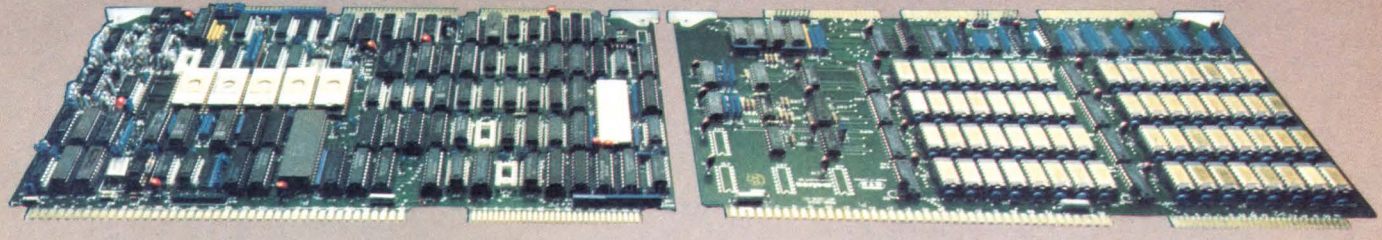

MATROX GXB-1000 - The complete color graphics solution.

DISPLAY RESOLUTION: 1024 x 768 pixels non-interlaced at 60Hz or up to 1600 x 1200 pixels interlaced at 30Hz

READ/WRITE AREA: 1024 x 1024 x 4 bits/pixel expandable to 1024 x 1024 x 16 or 2048 x 2048 x 4

SPEED: Four pipelined on-board processors draw graphics primitives at speeds of 50 to 800 nsec/pixel

COLOR: 16 display colors can be selected from a palette of 256 different shades

SOFTWARE: On-board 16 bit CPU with resident graphics software interprets over 256 commands and supports local segments, 2D primitives, tablet tracking, rubber banding, etc.

MODULARITY: GXB-1000 is fully Multibus compatible (IEEE-796), and operates from a single + 5V supply

Multibus - TM Intel *QTY 100

The GXB-1000 is a complete color graphics display system implemented on two Multibus boards. The system executes a display file containing high level graphics commands, generated by the user's host CPU. The GXB-1000 includes all the necessary hardware and software to draw lines, polygons, circles, characters, etc.

The GXB-1000 represents true state of the art performance. The boards generate the highest display resolution available from a raster scan device. The multi-processor pipelined architecture provides the highest possible drawing speeds.

Over six man years of Matrox programming effort have gone into the development of the on-board graphics software. An extensive command set allows the user to construct complex images with a minimal number of host CPU instructions and time.

The unmatched performance and low cost of GXB-1000 make it the perfect solution for OEM color graphic displays. Additionally, Matrox can provide RGB monitors, CPU boards, memory boards, cardcages and keyboards for complete display system requirements.

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Lundy graphics terminals are setting standards because we set high standards for Lundy.

Standards: no other 3D graphics vector work-station delivers more speed or a higher IQ than the UltraGraf,™ only our color raster scan display products offer resolution as high as 1,536 × 1,024 pixels. But there's still another standard you should investigate—the one we set for our company.

Be careful. The fast-paced world of high tech breeds a lot of companies that don't survive; five years from now, many graphic terminal manufacturers won't be around anymore. Which means you could be left without service, support or enhancements.

Lundy: a company as good as its products.

That's why we think it's important you know as much about our company as our products. We're a high tech company that's been able to balance standard-setting technology with solid business sense—no small achievement.

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T5680 color raster, 3D UltraGraf™ and T5470.

Lundy maintains the largest service infrastructure—52 locations.

Our graphics terminals feature the best price/performance ratios available today.

We have developed a new software subroutine package with exceptional compatibility. Its 300 functions deliver a new high in high powered productivity.

Lundy continues to invest in expanded R&D each and every year. Because R&D is the name of this highly competitive game—and we intend to *keep* setting standards.

We'll help you see more in graphics.

When you take a close look at our graphics terminals, service, support, software, systems capability, enhancements—and our company—you'll understand why Lundy can help you see more in graphics now and in the long term.

For more information, write: Lundy Electronics & Systems, Inc., Glen Head, New York 11545, or call: (516) 671-9000.

LUNDY®

Mt. Everest, symbolic of aiming high, was generated on the Lundy T5680 raster. It offers 16 colors and 136 shades from a palette of 4,096 colors.

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Calendar

February 28–March 2

OFC '83. Topical Meeting On Optical Fiber Communication. Hyatt Regency, New Orleans, LA. Contact: OFC '83, Optical Society of America, 1816 Jefferson Place, NW, Washington, DC 20036.

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. March 3, 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

Micro-Delcon 83. Sixth Annual Conference on Computer Technology. Newark, DE. Contact: John S. DeGood, Research and Development, Hewlett-Packard Co., Route 41 and Starr Road, Avondale, PA 19311. (215) 268-2281.

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

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

16th Annual Simulation Symposium. Tampa, Florida. Contact: V.P. Boyd, US Postal Service, 475 L'Enfant Plaza, Washington, DC 20260.

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 20–23

ACM Sigsoft/Sigplan Software Engineering Symposium on High Level Debugging. Pacific Grove, CA. Contact: Professor Richard E. Fairley, Department of Computer Science, Colorado State University, Fort Collins, CO 80523.

March 21–23

Second ACM Sigact-Sigmond Symposium on Principles of Database Systems. Atlanta, GA. Contact Dr. Ronald Fagin, IBM Research, 5600 Cottle Rd., San Jose, CA 95193.

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 22–23

Office Automation Conference and Exposition. Zurich Switzerland. Contact: Foreign Commercial Service, American Embassy, P.O. Box 1065, CH-3001 Bern, Switzerland, 031/437001. Telex 32128.

March 22–24

Compec Wales. Exhibition for users and suppliers of computers. University of Cardiff. Contact: The Exhibition Manager, Compec Wales '83, IPC Exhibitions LTD, Surrey House, 1 Throwley Way, Sutton, Surrey SM1 4QQ. 01-643 8040. Telex 946564 BISPRS G.

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.

March 29–31

Industrial Productivity. Conference And Exposition. Shreveport Exposition Hall, Shreveport, LA. Contact: SME, One SME Dr., PO Box 930, Dearborn, MI 48128. (313) 271-1500

March 29–31

Symposium on Computer Systems Organization. New Orleans, LA. Contact: Dr. Bruce D. Shriver, USL Box 4330, Lafayette, LA 70504. (318) 231-6284.

March 31–April 1

VLSI Technology, Systems and Applications. International Symposium Taipei, Taiwan, Republic of China. Contact: Dr. H.N. Yu, IBM T.J. Watson Research Center, P.O. Box 218, Yorktown Hghts., NY 10598.

April 4–8

Computers/Graphics in The Building Process '83. The Second Annual International Congress, Convention Center, Washington, D.C. Contact: National Computer Graphics Association, Inc., 2033 M Street, N.W., Suite 333, Washington DC 20036. (202) 775-9556. Telex NATL. GRAPHICS 248301 RCAW UR.

April 5–6

Symposium on Automated Integrated Manufacturing. San Diego, California. Contact: Symposium General Chairman, Leonard B. Gardner, P.E., 2406 Buttetop Pl., Spring Valley, CA 92078. (714) 464-2446.

April 5–8

Communications Tokyo. Tokyo Ryutsu Ctr, Tokyo, Japan. Contact: Clapp & Poliak International, P.O. Box 70007, Washington, DC 20088. (301) 657-3090

April 5–8

Intermag Conference. Philadelphia, PA. Contact: C.D. Graham, Jr., Department Materials Science, University of Pennsylvania, 3231 Walnut St., Philadelphia, PA 19104.

April 6–8

International Optical Computing Conference. Cambridge, MA. Contact: S. Horvitz, P.O. Box 276, Waterford, CT 06385. (203) 447-4270.

April 11–13

Engineering Software. Third International Conference and Exhibition. Imperial College, London, England. Contact: Conference Secretary, 125 High Street, Southampton SOI 0AA, England. Tel. (0703) 21397. Telex. 47388 Attn COMPMECH.

April 11–14

Southeastcon '83. Conference and Exhibit, Orlando, FL. Contact: Russell E. Theisen, Southeastcon '83 Chairman, Martin Marietta Aerospace, P.O. Box 5837 MP-3, 2667 Fitzhugh Road, Winter Park, FL 32792. (305) 671-4139.

April 11–15

Intergraphics '83. Tokyo, Japan. Contact: World Computer Graphics Association, 2033 M St. NW, Suite 250, Washington, DC 20036. (202) 775-9556.

April 12–14

Federal DP Expo. 9th Annual Conference and Exposition for the Federal ADP Community, Washington, DC Convention Center, Washington, DC. Contact: The Interface Group, 160 Speen Street, P.O. Box 927, Framingham, MA 01701. (617) 879-4502 or Toll Free (800) 225-4620.

Smart Graphics™ GX-100

The Modgraph **GX-100** is the first low cost graphics terminal to offer multi-page high resolution graphics and alphanumerics. Designed to be compatible with Plot-10® (4010/4014) and DEC's VT-100 and VT-52. We call it **Smart Graphics™** and with good reason — powerful graphics, multi-page alphanumerics and more.

GRAPHICS

As a graphics tool the **GX-100** is the smart choice; TWO pages of 768 x 585 viewable resolution on a 15" screen. Information from one graphics screen can be added and subtracted to the other with the push of a key. Circle, Rectangle, Vectors, Points, Patterns, Complex Area Fill and of course Plot-10® (4010/4014) compatibility.

ALPHANUMERICS

The independent alphanumeric plane allows alphanumeric overlay without overwriting graphics. Two independent pages store a total of 6 scrollable screens in 80 x 24 format with selectable scrolling methods including window scroll. This and VT-100, VT-52 compatibility, all designed to help you work smarter not harder.

- Direct access of microprocessor via host allows downloading of code for stand alone use.
- Optional Floppy Disc Drive with CP/M O/S.

To fully appreciate the Modgraph **GX-100** you have to see it in action. Drop us a line, or give us a call. We'll arrange for a demonstration and show you how powerful graphics can be yours with **Smart Graphics™**

® Plot-10 Trademark Tektronix
VT-100 Trademark Digital Equip. Corp.

Modgraph

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News Update

North America and CEPT Agree in Principal on Videotex Standard

An agreement was signed on November 23 of 1982 between representatives of the Council of European Postal and Telecommunications Ministries and North American representatives at the meeting of CCITT. The agreement signifies a willingness to establish a World Wide Unified Videotex Standard (WWUVS), and embodies language to the effect that there should be an unambiguous definition of the standard, that it will not inhibit new technology, and that it will prevent economic harm affecting existing standards. The structure of any such standard will be discussed at a series of international meetings during 1983. The document is a respectable effort towards reconciling and/or at least insuring the compatibility of videotex systems already under development in the United States, Japan, and Europe.

Battelle To Emphasize Electronics

A new Electronics Department has been established at Battelle's Columbus Laboratories to consolidate research and development in electronics, optics, lasers, digital systems, and related technologies.

Studies include artificial intelligence, image processing, time-domain electronics, inspection techniques, millimeter wave systems, electro-magnetic materials characterization, laser materials processing and machining, sensors and signal processing, systems reliability, and quality assurance.

AMD Reduces Prices

Advanced Micro Devices has announced price reductions for members of the Am2960 Memory Support family of integrated circuits. Decreases as much as 20% follow the recent 15% price reduction of the Am29116 16-Bit Microprocessor.

Prices were also cut 15% on the Am2961 and the Am2962 Bus Buffers.

Additionally, AMD and Motorola recently signed an agreement for joint development of next-generation memory support products to support 256K dynamic RAMs. Parts under the agreement include the Am2968 Dynamic Memory Controller and the Am2969/ Am2970 Timing Controllers.

SyQuest Signs Distributor

SyQuest Technology has appointed Hamilton/Avnet, the industrial distribution arm of Avnet, Inc, as the exclusive North American distributor for SyQuest 3.9-inch Winchester removable and fixed disk drives.

The contract will give SyQuest customers access to the drives at 45 locations throughout the United States and Canada.

Atari vs. Coleco In $350 Million Suit

Atari is seeking a preliminary and permanent injunction against the manufacture and sale of Coleco's Expansion Module which is intended to allow Atari VCS™ compatible cartridges to be played on the Colecovision™ home video game unit.

In the lawsuit, Atari claims that the Coleco cartridge adapter infringes two basic video game patents held by Atari.

Attorneys representing Atari stated that the Coleco adapter contains circuitry that is substantially identical to the motion object and sound circuitry of the Atari VCS. The only difference is that Coleco made certain superficial changes in one proprietary Atari chip.

CP/M For Z8000

Zilog, Inc., and Digital Research Inc. have agreed to modify CP/M operating system to run on Zilog's Z8000 family of 16-bit microprocessors.

Digital Research will market and support the Z8000 version of CP/M; Zilog will be licensed by Digital Research to use the product in its own board- and system-level products.

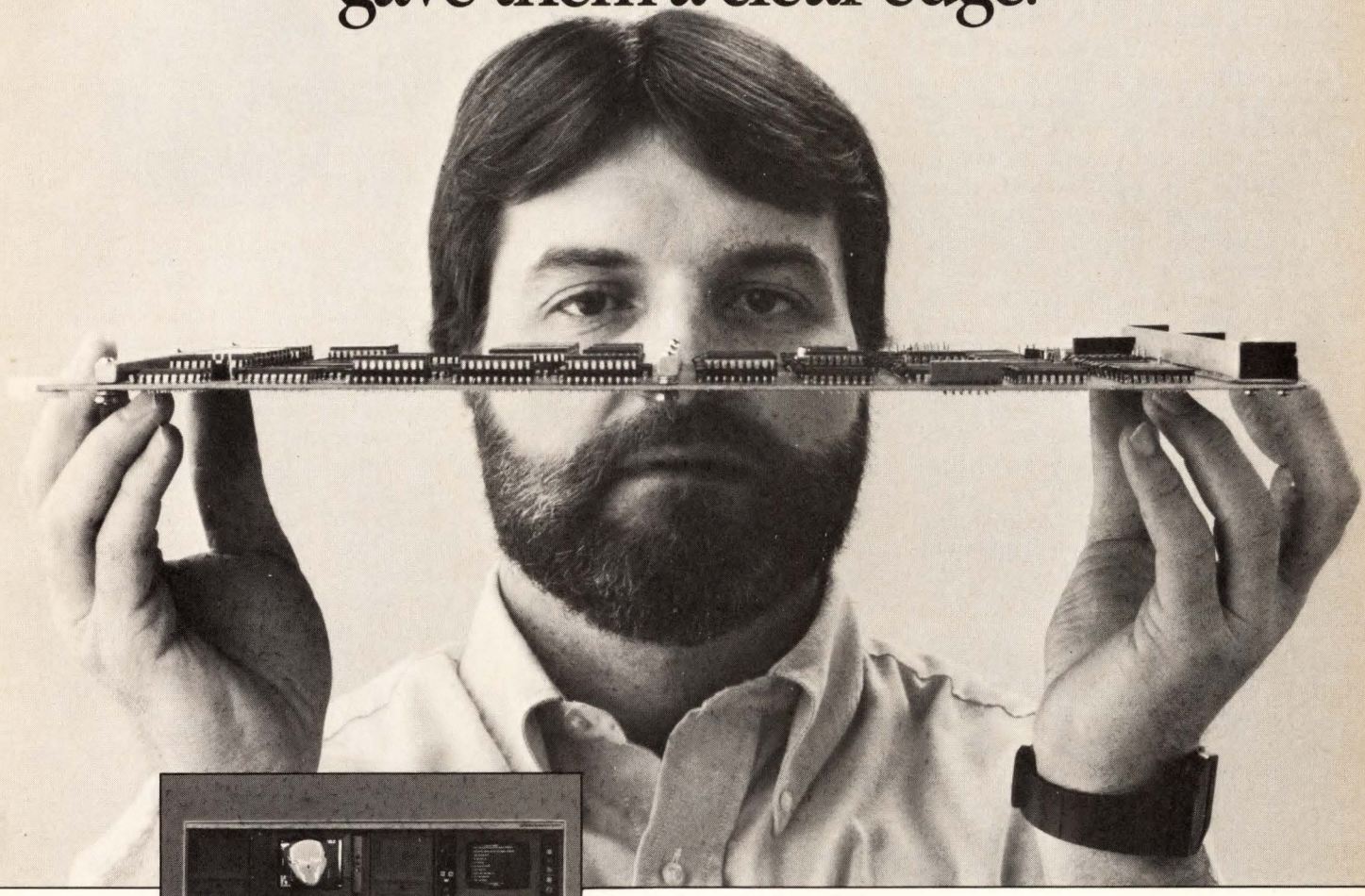
The Z8000 version of CP/M will be implemented on the original Z8001 and Z8002 CPUs, as well as on the new Z8003 and Z8004 virtual-memory CPUs.

TeleVideo Enters Unix Systems Business

TeleVideo Systems has introduced a Motorola 68000-based computer that runs the Unix III operating system. This is the firm's initial entry into the Unix systems market. TeleVideo is expanding into the Unix system marketplace estimated to grow from a currently installed base of about $160 million to over $800 million by 1985.

Picker International had a clear picture of their CT imaging needs.

The MSP-5 ARRAY PROCESSOR from CDA gave them a clear edge.



When Picker International was selecting an array processor for their new line of CT imaging systems, they looked for three things.

Ease of integration. Flexibility. And cost effectiveness.

Computer Design and Applications' MSP-5 array processor met all three qualifications.

As Jim Pexa, Engineering Manager, says, "CDA's MSP-5 array processor gives us a full range of performance for our new systems. Our highest performance unit uses 5 MSP-5s, our lowest, 1. So we purchase only as much processing power as we need. We really didn't need the more costly array processor, when it was so easy to implement our very specific algorithm on the MSP-5. And all we have to do is plug it into the computer chassis, and it's ready to go."

The MSP-5 can give you a clear edge, too. Write for more information.

CDA array processors are available for Digital Equipment Corporation, Data General and Perkin-Elmer computers. Priced at $5850 in OEM quantities. If you need full floating point 32-bit performance, the very programmable MSP-3000 will meet your most demanding requirements.

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Personal Computers Drive Floppy Disk Industry

The floppy disk drive industry will grow from $1.3 billion in 1981 to $4.6 billion in 1986, with all disk drives valued at OEM prices. This represents a compounded annual growth rate of 28.7% per year.

An increasing percentage of floppy disk drive users, particularly in the word processing and industrial computer system areas, are turning away to competing technologies such as hard disks. However, the sheer growth rate of systems utilizing floppies connote a healthy growth of floppy disk drives through 1986. Analyzing the marketplace according to minicomputers, industrial μP systems, small business computers, intelligent terminal systems, word processors and personal computers, the critical user group of floppy disk drives are personal computer owners. This market segment accounted for approximately 41% of all units shipped in 1981.

In 1981 5 ¼" singled-sided floppy disk drives constituted the largest percentage of unit sales, outselling its nearest competitor by almost a 2 to 1 ratio. In 1983, it will lose its dominance in sales to its double-sided counterpart. However, single-sided 5 ¼" drives will hold on to second place in unit sales through 1986.

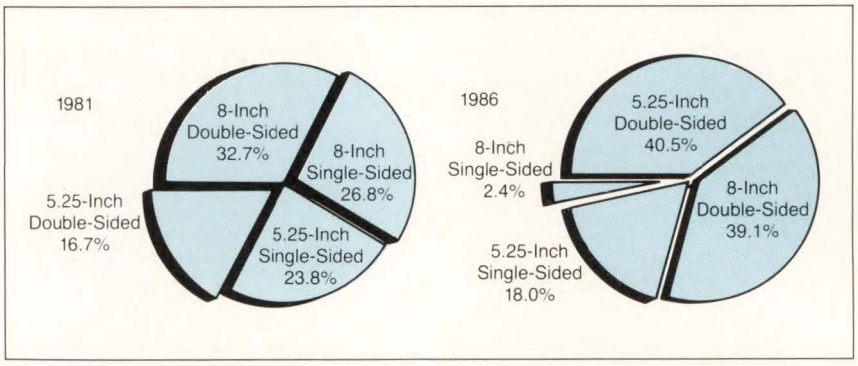

Figure 1: Floppy disk drive market share by type of drive: 1981 vs 1986 (dollars).

What will determine the floppy disk industry's development is the success of both half-height drives and micro floppy drives. The latter product is in a state of turmoil due to several different versions being promoted in the marketplace.

Many manufacturers, in an effort to keep up with users' demands for more competitive technology and to increase revenues, have added hard disk drive technology to their product lines. At the other end, important customers such as Tandy and Datapoint have started producing their own floppies rather than seeking products from disk drive manufacturers.

The report "The Floppy Disk Industry—A Strategic Analysis" can be obtained from: *Venture Development Corp., One Washington Street, Wellesley, MA 02181; Tel: (617) 237-5080.*

Micro Aftermarkets To Overtake Micro Sales

Microcomputer aftermarkets will overtake sales of microcomputers themselves by 1986 or 1987. Aftermarket sales, which include items or services purchased for microcomputers after the initial purchase, are expected to reach close to $22 billion a year by 1986 and over $70 billion a year by 1991. Comparatively, annual sales of microcomputers will be about $20 billion in 1986 and over $37 billion by 1991. The gap between the two industries widens considerably during the second half of the decade—while growth of microcomputers will begin to tail off, aftermarket growth will be fueled by the still rapidly expanding installed microcomputer base.

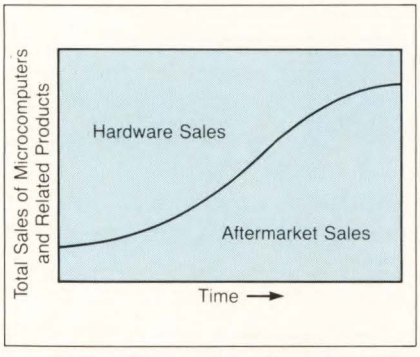

Figure 1: Relationship between hardware and aftermarket sales volumes.

The huge micro aftermarket will be led by office consumables, which include magnetic media, paper and forms, and other miscellaneous supplies. Consumables are expected to reach over $36 billion in sales by 1991.

The second largest aftermarket will be software, including systems level as well as applications software for businesses, homes and education. While business software aftermarket sales currently exceed home sales by about two to one, home sales will be slightly larger by the end of the decade, reaching about $6.5 billion by 1991. Most of these sales will take place in retail establishments and by mail order.

The third peripherals aftermarket segment consists of terminals, printers, storage and data communication hook-ups. These after-

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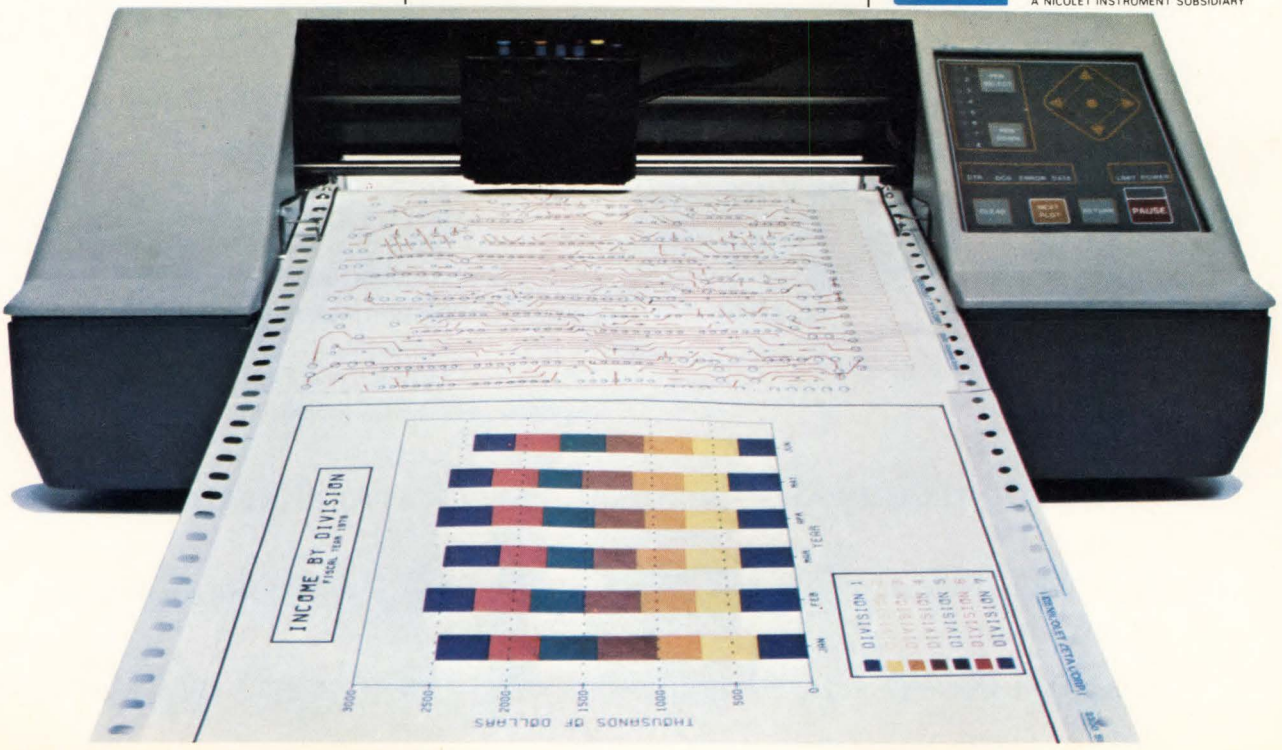

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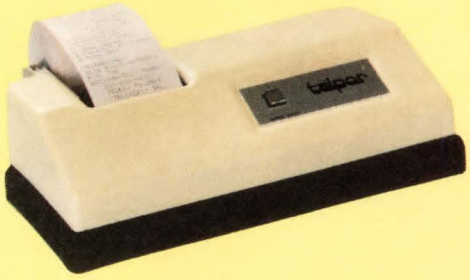
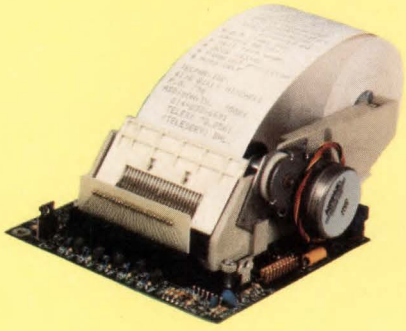


TABLE TOP MODEL PL20C



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market sales will reach over $11 billion by 1991. At that time data communication equipment will comprise almost half of this aftermarket, as a result of the surge in local area networks expected by the end of the decade. Micros will be a valuable link in these networks since they can inexpensively serve both as personal workstations and as links to larger data bases elsewhere.

While the maintenance aftermarket is the smallest of the four major segments, it is nonetheless expected to have annual sales of over $10 billion by the end of the decade. These revenues will be derived primarily from businesses, who cannot afford downtime on their micros and are therefore willing to pay anywhere from 7% to 30% of the hardware's cost on maintenance per year (usually on service contracts). Home and educational users are much more likely to put up with longer downtime in order to save on the service charges.

For more information on the report "Microcomputer Aftermarkets" contact: *IRD, 30 High Street, Norwalk, CT 06851; Tel: (toll-free) 800-243-5008 (from CT or outside the US call 203-866-6914).*

$1 Billion Market For Optical Communications In Europe

A rapid spurt in the market for optical communications devices in Europe is forecast for the 1980 decade.

From $44 million in 1981, the market will nearly double to $80 million this year, and proceed on to hit $346 million in 1985 and $1.4 billion at decade end. As to market demand, the proportions 70 to 80% civilian vs. 20 to 30% military are expected to continue throughout the decade. Sales of subsystems and components, accounting for half of the market now, will pull ahead of sales of complete systems, growing to account for 65% by 1990.

The reason for this is that communications end-users are expected to learn how to assemble their own systems, which will induce companies to manufacture more components.

Because most optical communications now is systems oriented, hardware imports play a minor role, accounting for only about 10% of the current business total. However, component and subsystems imports will become more significant as users do turn to the building block approach. Accordingly, imports will mount, meaning new business opportunities for overseas suppliers.

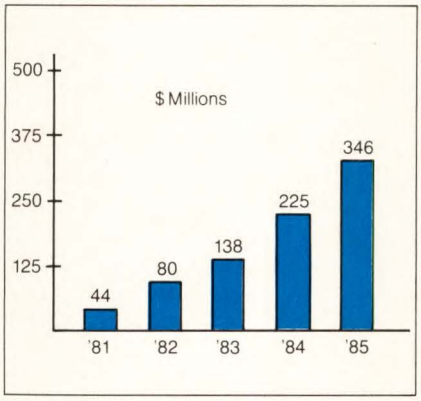

Figure 1: Optical Communications Market in Europe.

The European market is now being supplied by 66 indigenous companies, with the majority of them located in the UK and in France. Most of the European companies are still struggling to become profitable; they are not expected to show a positive cash flow until 1983. Twenty-six US companies, seven Japanese, and two Canadian firms make up the foreign contingent in the European market.

End-users are also installing specialized communications systems to meet current needs, another short term trend likely to be reversed. Subscribers are expected to merge their video, audio and data communication requirements into single broadband networks. By 1990, broadband systems could account for about 40% of systems sales; up from 19% in 1981. A significant proportion of the value of an optical communications system is represented by installation costs. In 1981, for example, the $44 million in sales of such equipment served to generate $20 million worth of installation services.

For further information contact: *Frost & Sullivan, 106 Fulton Street, New York, NY 10038; Tel: (212) 233-1080.*

Non-Impact Printers Make Major Gains

The worldwide market for computer printers will increase from $5.7 billion in 1981 to more than $13 billion by the close of 1986, reflecting a compound annual growth rate of 18.8%. During this period, nonimpact technologies based on matrix character formations will see the fastest growth.

With the application of new and upgraded technologies, as well as declining prices in some segments, the forecast for computer printers promises rapid growth far into the 1980s. Unit shipments in 1986 will be triple the shipment level of 1981, growing at a compound annual rate of nearly 25% to reach 4.2 million units.

Serial solid-character printers will show the fastest growth of the impact printer segments, with a compound annual growth rate of nearly 25% through 1986. Be-

cause end users continue to seek the advantages particular to impact printers (i.e., superior print quality and multiple copy output), impact printing is expected to remain the trend in serial dot matrix, serial solid-character, and line printers. In these segments, nonimpact printers—although gaining wider acceptance—are still not as cost-effective as impact printers, and will have to come down in price if they are to increase their share of the market.

The greatest surge in growth, however, will occur in the market for nonimpact printers, due to improving print quality and new applications. Electrophotographic printers will exhibit the most dramatic growth, with unit shipments through 1986 increasing at a compound annual rate of well over 50%. Although sales are expected to decline in the market for nonimpact printers which require expensive, chemically-treated paper, technological innovations—as well as the upgrading of current methods—will force nonimpact printers into the high-growth impact printer marketplace.

Computer printers account for well over half the revenues generated by all computer output equipment. Printer manufacturers in the US produce a large portion of the printers used worldwide, and the US market consumes more than half of all printers produced. The industry has become fairly stabilized, as proven by the lowering of prices in line printers by major manufacturers. However, a fierce price competition is gradually moving up through the low end, which could mean a market share shakeup in that segment.

Competition will become more accute as manufacturers scramble to improve print quality and speed, as well as to respond to the demand for color printers brought about by computer graphics. Current techniques, such as the serial impact matrix and daisywheel printers, meet customer demands now, but it is only a matter of time before the inkjet and laser technologies are refined enough to be potent contenders.

IBM is recognized as the dominant participant in the industry, offering a complete printer product line manufactured in-house and marketed as system components. Okidata recently began concentrating on low-speed, low-cost serial matrix printers, and is making sizable gains in those segments. NCR, Epson, and Datapoint, with their increasingly sophisticated and varied product lines, will also present a challenge to IBM. Some other smaller companies have dropped out of manufacturing altogether, or have reduced their product lines. For the report "Computer Printers" contact: *Creative Strategies International, 4340 Stevens Creek Blvd., Suite 275, San Jose, CA 95129; (408) 249-7550.*

Increasing Need For Larger PC Boards?

CAD Systems Inc. of Townsend, Mass., recently split off from its neighboring service bureau firm of CAD Services Inc., is taking aim at the top end marketplace for the development of printed circuit boards with over 300 integrated circuits. Gene Dancause, President of CAD Systems Inc. has noted that there have been over 300 clients over the past two years at CAD Services Inc.—for all sizes of PC boards, but his observations of market trends over this period lead him to believe that there is a significant market for the much larger boards, 16″ × 20″. He estimates that 25% of all custom designs made contain 300 or more IC's, and the problem is that few systems for CAD are able to support the design of such complex board systems. Dancause feels that there are 5 to 7 vendors who can provide systems which can support up to 300 IC's at a cost of over $200,000 for a system. The hope at CAD Systems Inc. is to develop a system that can support a much greater number of IC's to provide more systems integrators with very powerful development tools.

The philosophy of the program being written at CAD Systems Inc., comes from Dancause's knowledge of the PC development industry—acquired during a ten year period at DEC. He notes that while firms such as Hewlett-Packard can afford to spend seven years and a great deal of money to develop a VLSI chip, such as the 32-bit device in its new minicomputer, the smaller producer has to move quickly to take advantage of lower capitalization of his operation. He must also meet a market niche that may disappear after a short period of time. The new generation of surface mount chips that do not require the soldering of most of today's boards may be supporting this market. Currently the most effective way for the small manufacturer to do this is to develop a large board. There is the potential for systems that could integrate up to 2,000 IC's on a single board.

Because these large boards are so complex they may need extensive revision in the engineering process. To alleviate some of the problems caused by the successive engineering change orders the company has produced two software packages: "CADS" and "CAD-IDS" software. CAD-IDS allows the designer to make a check of his photoplot before it reaches the film laboratory, where changes can only be made at great cost—and very slowly. CADS is designed to allow the user to verify the logic of the board's design.

—Borrell

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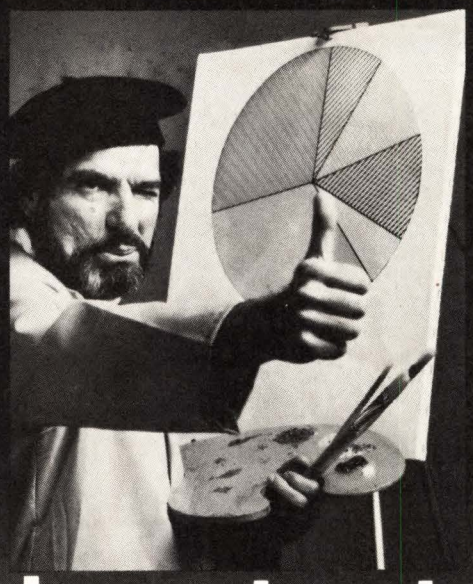

The deluxe 16-pin KX-P1160 operates at 196 cps Elite, 165 cps Pica (for correspondence-quality, speed is only reduced by half). It can print an impressive 272 characters per line. And has an optional single-sheet front feed.

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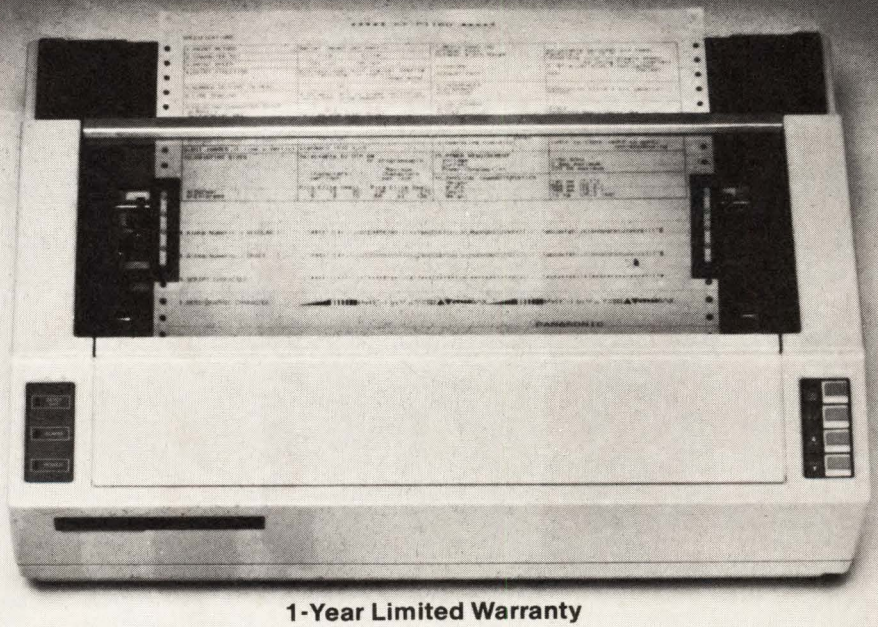

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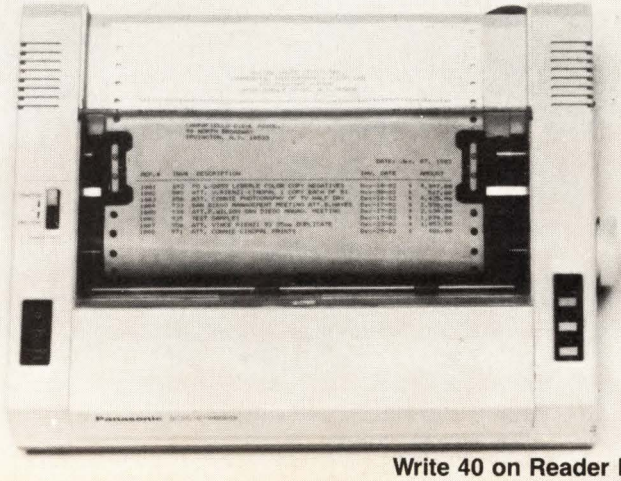

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Milling Machine Company Integrates CAD/CAM To CIM

Computer Integrated Manufacturing has already become a reality at the Ingersoll Milling Machine Company in Rockford, IL. Many users today settle for CAD, or worse, a small segment of CAD such as computer graphics, according to George Hess at Ingersoll. Others see CAM as dealing with numerical control tools or manufacturing resource planning.

Ingersoll has successfully integrated computer aided engineering with a business information and data base management system, picking up a recent LEAD award from the Computer and Automated Systems Association for its efforts.

The heart of the system is a large IBM-3033 central processor that serves both CAD and CAM, including direct numerical control systems. It also supports business information systems such as marketing reports, engineering bills of material, shop scheduling, purchasing, accounting, and word processing.

A National Semiconductor AS/5 serves as emergency backup. It is used for direct numerical control (DNC) in case of interruptions on the 3033. 115 alphanumeric video display terminals operate on the main-line production management functions, such as inventory control and word processing, with another 30 vector graphics terminals in the CAD/CAM area for engineering design and numerical control (NC) programming.

Because Ingersoll builds only special machinery seldom duplicating efforts, they do not have time for models, prototypes or test units. They have heavily invested in NC machines and developed a computer graphics NC programming system with special micro commands, families of parts and internal collision checks. They are programming for 126 machine shifts/day with 36 shifts for 3, 4, 5, and 6-axis machining centers.

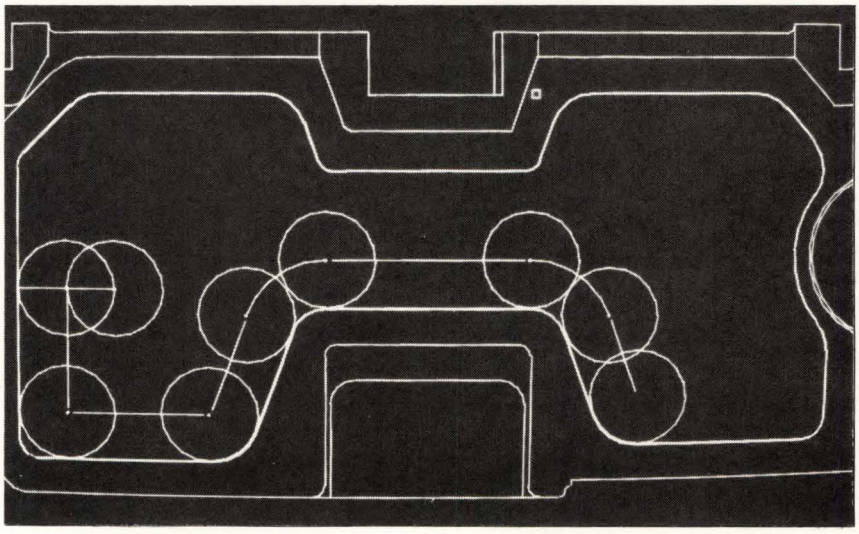

Figure 1: In programming NC machines, the entire path of a tool can be seen on a computer graphics terminal screen. This example shows a tool moving around the top perimeter of a workpiece from right to left, starting from a position at the right middle. Only a part of the path is shown here. Such CADAM software has enabled Ingersoll to increase programming productivity by 300%.

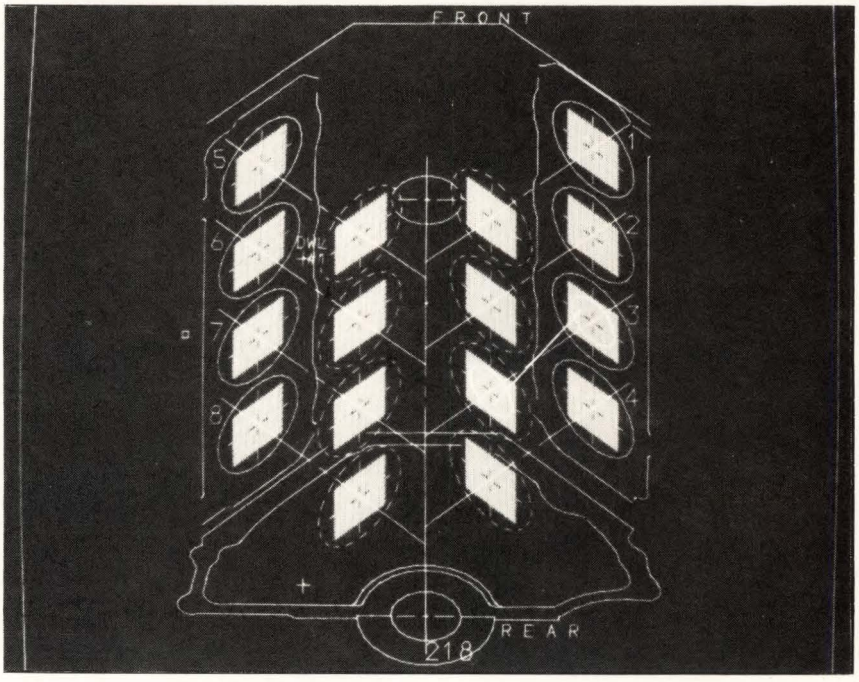

Figure 2: This view of an 8-cylinder "V" automobile engine block shows how the Ingersoll Milling Machine Company's computer graphics system can be used to measure accurately the location of bore centerlines. A further development of computer power has permitted Ingersoll to slash transfer line prove-out time and customer launch time on the plant floor. Tradenamed "I-Check" the computerized method rapidly and accurately measures the centerline location of holes machined in test parts on a transfer line, and then calculates the "best fit" adjustment of multi-spindle stations to bring the line into final alignment.

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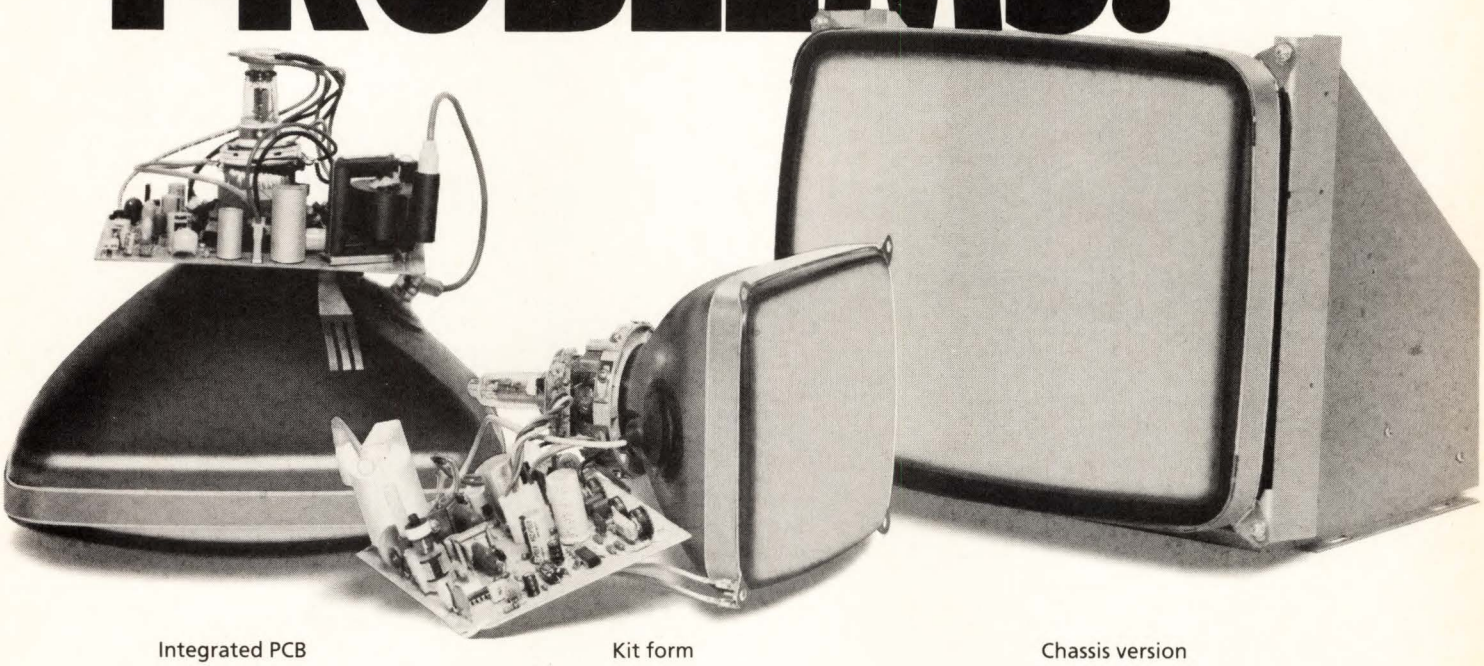

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High Capacitance Power Distribution Component For 64K DRAM

All dynamic RAMs draw substantial transient currents during refresh and read/write operations, but 64K DRAMs are the most demanding. They typically draw about 150mA, over twice that of 16K DRAMs. Such high transient currents with fast rise times require power distribution systems on printed circuit boards to have low inductance and adequate capacitance. Inductance in the power distribution system causes voltage spikes on both the voltage and ground lines which can disturb normal operation of the memory board. Adequate decoupling capacitance provides current to the RAM without allowing V_{cc} to fall to an unacceptable level.

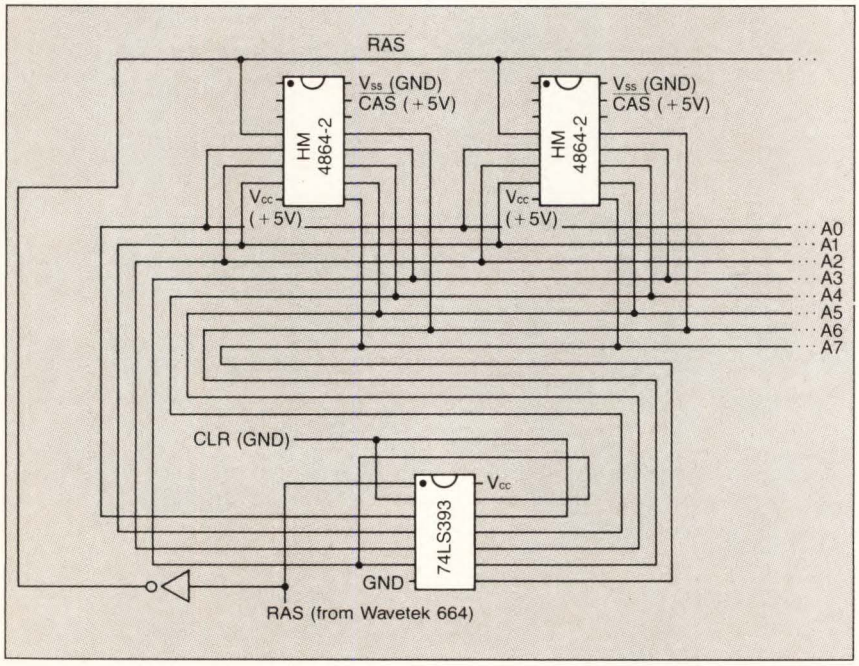

Figure 1: This RAM test board simultaneously refreshes sixteen Hitachi HM4864-2 dynamic RAMs (only two are shown in the diagram). A Wavetek 664 pulse generator was used to generate the RAS waveform, as recommended by Hitachi.

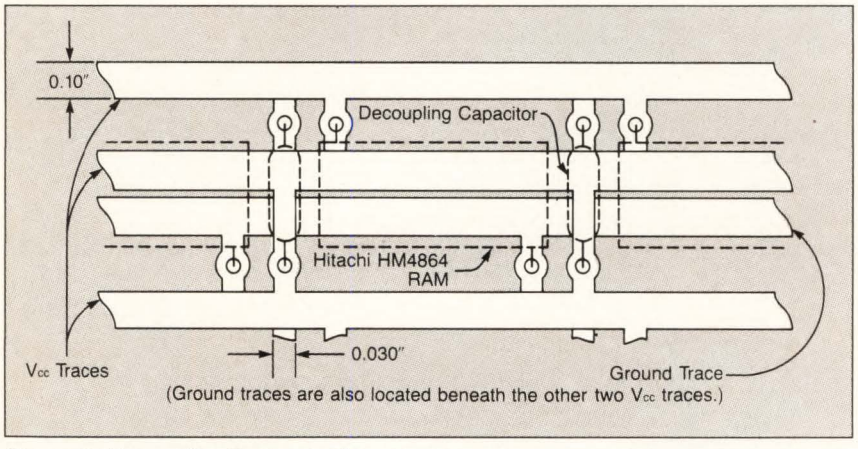

Figure 2: Power distribution in the memory array.

Testing

A memory array made up of sixteen Hitachi HM4864-2 64K DRAMs (150ns access time) was assembled on a Robinson-Nugent VQC PC board. The RAMs were connected to a 79LS393 counter which provided row address sequencing for refresh. Refresh waveforms followed Hitachi's recommendations (270ns cycle, 128 cycles in 2ms) and were generated by a Wavetek 664. All sixteen RAMs were refreshed simultaneously. (The circuit diagram is shown in **Figure 1** and the power distribution scheme in **Figure 2**.)

Several power distribution systems were tested to determine the operating noise levels. In all cases, a 22 mfd. tantalum bulk capacitor was used as a board decoupler (located at the card edge). First, photos of V_{cc} with respect to a "hard" ground were taken. Second, photos of the ground level at the RAM with respect to a "hard" ground were taken. Thirdly, photos were taken of the voltage across the V_{cc} and ground pins of a RAM.

Results

Noise spikes of nearly 1V were measured across the RAM, even with very wide power and ground traces and high quality decoupling capacitors. This did not vary with capacitance level because it is a function of inductance only—inductance of traces, and also of leads and internal structure of decoupling capacitors. Q/PAC components with low inductance construction, reduces noise spikes by a factor of ten to an acceptable level in memory systems. Note also that spikes on the ground line, a particularly troublesome type of noise for RAMs, are reduced by a factor of seven to 45mV. Since voltage sag is a function of capacitance (**Figure 3**), both Q/PAC and conventional decoupling techniques can satisfy

maximum sag specifications. Using the common noise limit value of 300mV, Q/PAC can distribute power on two-layer PC boards and maintain reliably functioning memory. In fact, Q/PAC results in an operating noise level of only 160mV, which until now could be only achieved using a well-designed multilayer PC board.

Memory Board Design

The preferred design method uses QH-type Q/PAC with power bussed in at the top with a wide trace (greater than 0.070-inches to handle the current levels). No other power distribution traces are required though gridding is advised. To properly grid the board, 0.010-inch to 0.030-inch traces connect ground pins of each Q/PAC together and the V_{cc} pins together (**Figure 4**). Though gridding at each RAM is best, gridding at every second or third RAM is also acceptable. This assures that ground and V_{cc} potentials remain uniform at all locations on the PC board.

Memory boards can also be designed around the QV-type Q/PAC by using short jumper traces. This adds some inductance, but not enough to cause voltage spikes exceeding 300mV.

Q/PAC is available in capacitance levels of less than 0.01 mfd/RAM up to about 0.04 mfd/RAM. Lower capacitance Q/PAC components cost less so it is important to choose the lowest capacitance Q/PAC that will give an acceptable V_{cc} sag level. Use **Figure 3** to determine required capacitance levels and multiply it by the number of RAMs serviced by the Q/PAC to give the total capacitance level required for each Q/PAC.

Joseph E. Johnston, Rogers Corp **Write 233**

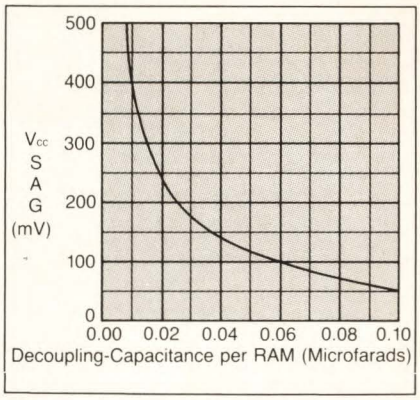

Figure 3: V_{cc} sag (maximum) as a function of decoupling capacitance per HM4864-2 RAM.

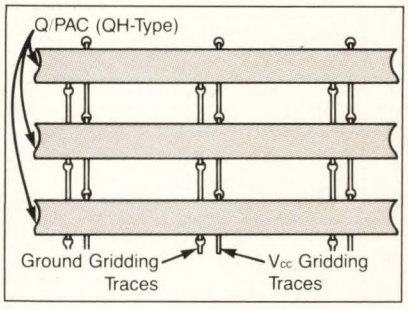

Figure 4: Typical gridding scheme for a 64K memory board.

Visual Ergonomics And VDT Standards

Emerging standards for VDTs are attempting to combat reduced operator performance caused by poor design.

by Harry L. Snyder, Ph.D.

Dr. Harry L. Snyder is Professor of Industrial Engineering and Operations Research, Virginia Polytechnic Institute and State University, Blacksburg, VA 24061. His research has emphasized visual performance and visual display evaluation. He has served on the Committee on Vision, NRC/NAS Panel on Video Viewing, and has conducted a number of evaluations of VDT installations.

From the early days of commercial television the scientific community has continuously researched the display design requirements for acceptable presentation. Early research emphasized transmission bandwidth requirements, the number of raster lines per frame, the acceptability of and requirement for interlace to avoid flicker, and later, standards for color compatibility. This research led to acceptable criteria for the viewer of entertainment programming in the relaxed living room environment.

More recently, the advent of the inexpensive digital computer has made possible the widespread use of CRT-based terminals, generically called video display terminals (VDTs), as the most flexible choice for an I/O device. Not unpredictably, the very large volume production CRT has been modified to provide a flexible and inexpensive VDT. The CRT-based VDT has remained inexpensive because the large home television volume has driven the VDT cost, in the commercial quality form, to a cost comparable to that of the home quality computer, which is in the low hundreds of dollars.

While commercial television developments are compatible with

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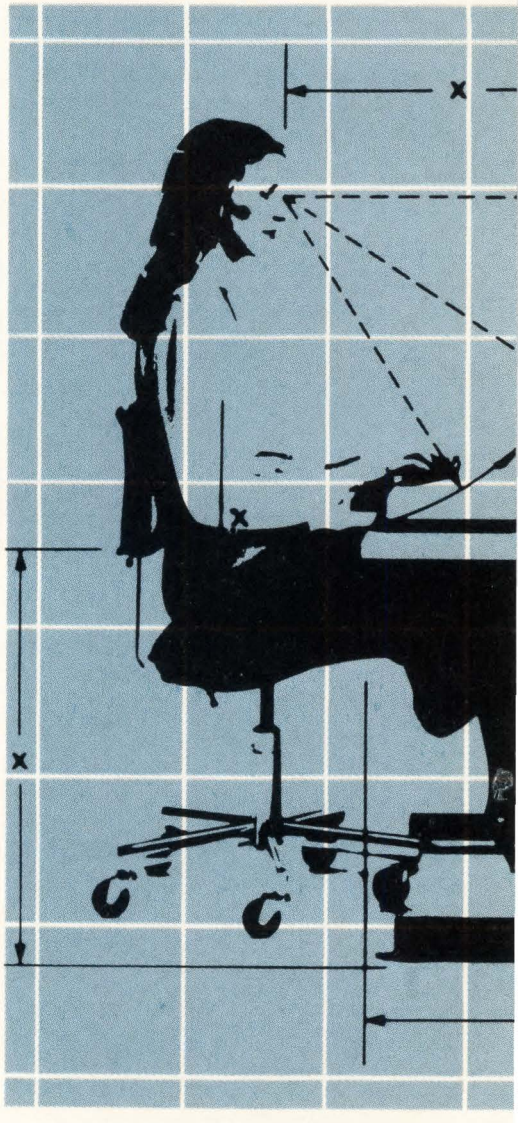
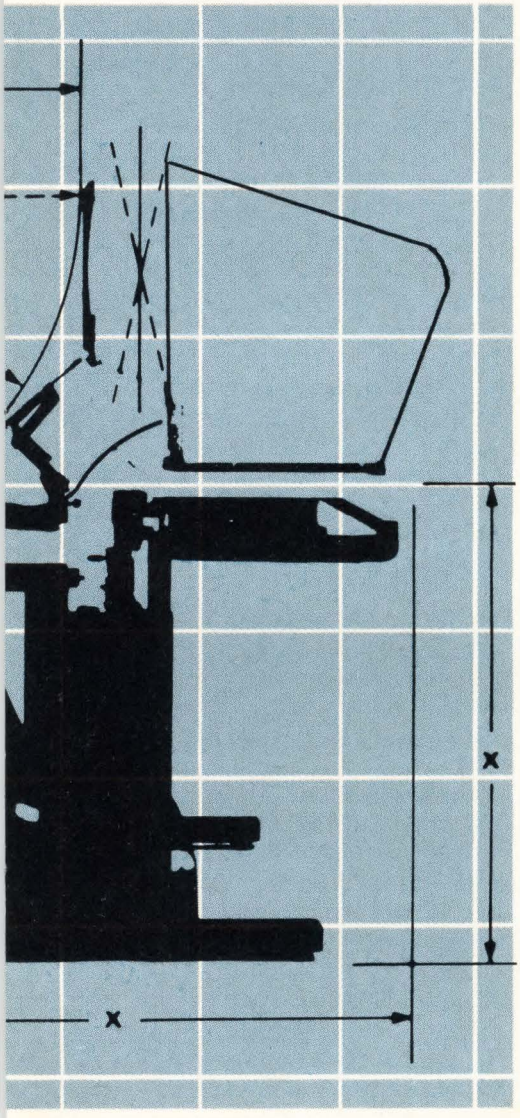


Ergonomics Of VDU Workplaces

Since a VDU is completely dependent on human interface, office systems must be designed to fit the capabilities of operators.

by Karl H.E. Kroemer, Dr. Ing.



VDUs (Video Display Units), also called VDTs (Visual Display Terminals), are about to become the dominant interfaces between person and equipment in the office, second only to the telephone. Estimates are that the number of people working with VDUs may double every two years. With such a growth rate, there may be 25 to 50 million VDUs in offices in about ten years.

Without an operator, the output of a VDU is zero. Since it is so completely dependent upon the human, this office system must be designed to fit the capabilities, preferences and physical limitations of its operator. The advent of the VDU has focused general attention on the need for office ergonomics.

People are the limiting factors in office work. Operators have limitations regarding information processing, viewing of objects, operating keys, maintaining hand and arm posture, keeping head and neck in a given position and retaining healthy trunk postures while sitting for prolonged periods with minimal space for positioning of legs and feet. All of these place limits on the output that can be expected from a person working in an office.

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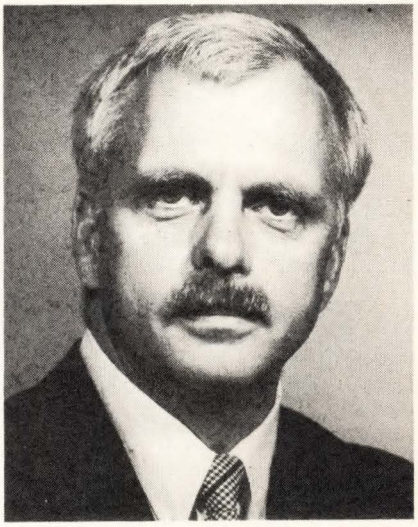

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the home computer cost market and with the visual requirements for home-entertainment television, they are not compatible with the visual requirements for demanding data entry, text entry, and other office-type VDT tasks. For these occupational applications, where intensive interaction with the display takes place many hours per day, at a close distance and often under time-limited circumstances, a different quality of VDT is required.

This article summarizes some of the areas of incompatability, indicates the effects of poor design selection upon visual performance, and shows how emerging standards for VDTs are attempting to combat this mismatch.

VDT Resolution

The term "resolution" has come to mean different things, ranging from the number of line pairs resolvable in an optical test pattern, to the number of active (or total) raster lines in a TV image, to the number of elements per unit distance in a flat panel display. Without begging the question, it is most meaningful to characterize the "resolution" of a VDT in some form compatible with the capabilities of the viewer. Currently, the most useful approach is the modulation transfer function (MTF), which relates the amount of contrast the VDT can produce as a function of the closeness of information presented on the VDT. Typically, the testing is done by imposing a vertical sine-wave grating on the display and measuring the modulation or contrast as the number of sine-wave cycles per picture width is increased. **Figure 1** illustrates one measurement setup using a scanning microphotometer to determine the modulation at a single pattern size, or spatial frequency.

Modulation is defined as:

$$\text{Modulation, } M = \frac{L_{max} - L_{min}}{L_{max} + L_{min}}$$

The plot of modulation as a function of spatial frequency, known as the MTF, is shown in **Figure 2.** For most displays, the achievable modulation decreases with increasing spatial frequency; that is, as the lines in the grating are placed closer together and become narrower, the capability of the VDT to maintain contrast is diminished. Knowledge of the electron optics, the electron gun structure and the phosphor, permit the designer to make a fairly accurate estimate of the MTF of a CRT prior to device fabrication.

As the CRT has an MTF, so does the visual system. The MTF of the eye, plotted in **Figure 3** as the inverse, is characterized as a bandpass filter with maximum sensitivity at about 3–5 cycles per degree of visual arc. Cross-plotting the visual contrast threshold function from **Figure 3** with a typical MTF results in the direct determination of the limiting resolution of the display, that is, the crossover spatial frequency at which the contrast demand of the visual system equals the contrast generating capability of the CRT. Spatial frequencies above this value are not seen because the visual system requires more contrast than the CRT can produce.

A well designed graphics display will have a video bandwidth and spot size compatible with visual system requirements—typically a limiting resolution on the order of 25 cycles/degree (or 50 display dots per degree). This translates into a center-to-center dot distance of .007″. With this spacing between adjacent dots or addressing locations, the dot size should be chosen to give about 20% to 30% modulation between adjacent dots (The measurement of dot size is not standardized, but a useful definition assumes dot size as the width at half amplitude of the intensity distribution of the typically Gaussian dot.).

Alphanumeric displays need not have quite this much resolution. Using a fairly typical 12″ (diagonal) CRT as an example, the horizontal dimension of the usable display is about 9.6″ and the vertical dimension is about 7.2″. Research has shown that the upper case alphanumeric should subtend at least 18 arcminutes at the eye, or about .10″ in the vertical dimension. The width of the character should be between 65% and 100% of its height.

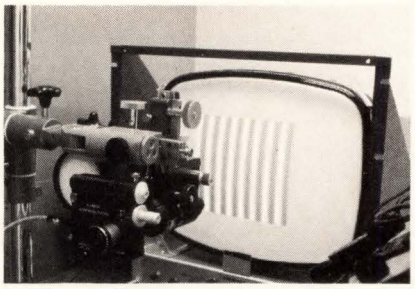

Figure 1: Illustration of microphotometer measurement of display modulation.

Because of the discrete addressing mode of most VDTs, it is most convenient to write the upper case character as a dot matrix such as 5 × 7 or 7 × 9 dots. Letting the 9-dot vertical dimension equal .10″, and allowing 2 dots for descenders and 1 additional dot for inter-line spacing, the character cell is defined as 12 dots high, occupying about .133″. Similarly, the horizontal character dimension is 7 dots plus at least 1 between characters, for a horizontal cell of 8 dots or .089″.

Placed into the available space of 7.2″ by 9.6″, one can theoretically write 107 characters per line and 54 lines in the vertical dimension. In practice, these numbers are reduced to avoid geometric distortion and lower resolution around the periphery of the CRT. The resulting useful display area is more typically about 8.5″ by 6.3″ which, when applying the same criteria, results in a maximum of 95 characters for each of 47 lines. Since most display formats require some number of lines dedicated to status and command information, the actual text information is again reduced. Over 40 useful lines of displayed information with up to 95 characters per line is compatible with visual requirements.

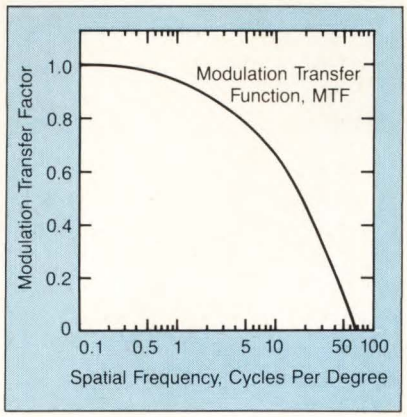

Figure 2: Modulation as a function of spatial frequency. For most displays, achievable modulation decreases with increasing spatial frequency.

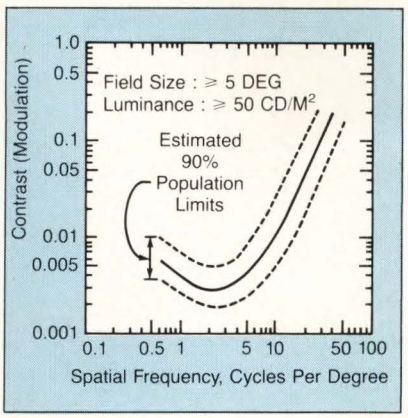

Figure 3: This graph shows the contrast threshold function of the human visual system.

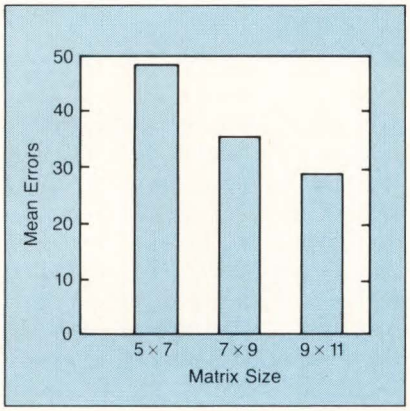

Figure 4: Numerous studies indicate a significant decrease in mean errors when character matrix size is increased.

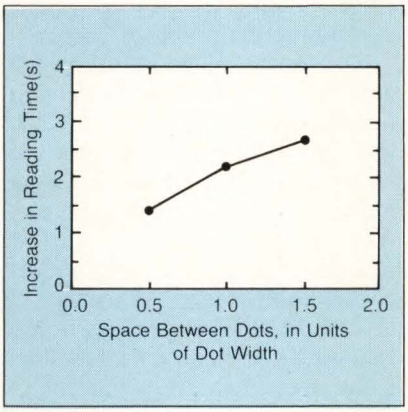

Figure 5: When space between individual dots in a character matrix increases, so too does the difficulty in reading the characters.

The question of economics enters the design activity at this point and causes a large incompatibility with the human visual system. To reduce cost, it is easiest to maintain the electronic characteristics of the commercial television receiver, that is, a video bandwidth of about 4 MHz and a line rate of 15,750 lines/sec, either interlaced 2:1 to give 480 active lines per frame or non-interlaced to give 240 lines per frame. If the designer chooses to minimize single dot flicker, he will use 240 lines per frame with no interlace. Since we have assumed, based on existing research, that each character requires 12 vertical lines (or dots) for visual compatibility, assuming the 7 × 9 dot matrix character structure, this display only achieves 20 lines of characters. The alternative is to use a 5 × 7 dot matrix character and 10 dots vertically, which then results in the conventional 24 character lines. The penalty is, of course, the difference in legibility between a 5 × 7 and 7 × 9 dot matrix character. Alternately, the 480 lines per frame permit up to 40 lines of 12-line characters, but with the penalty that some users will see flickering of individual dots with the 2:1 interlaced display.

The choices to be made are clearly cost-driven. To minimize cost by using commercial television electronics, one must choose between flicker with adequate information content and nonflicker with either inadequate legibility or minimal information content. Examples of both "solutions" can be found on the market, but the typical choice is to format the display as 240 active lines with 5 × 7 characters and sacrifice the legibility, particularly with lower case characters (of course, some displays in this cost category display only upper case characters). The preferred alternative found in the more expensive and ergonomically compatible displays is to alter the line rate and video bandwidth to make the display compatible with the user's visual system and accept the attendant cost increase in the pursuit of a quality display. Displays which have followed this approach have achieved good reviews in field and laboratory studies (Grandjean, 1981).

The above discussion has assumed that a 7 × 9 dot matrix is more legible than a 5 × 7 matrix. Numerous studies have demonstrated this result **(Figure 4),** and there seems to be little doubt about the acceptability of the data. Furthermore, displays using a 5 × 7 matrix have difficulty with lower case characters, usually writing them as smaller upper case characters or with a greatly constrained 5 × 5 submatrix. Descenders also present problems in the 5 × 7 format. Whether the 5 × 7 dot matrix causes greater visual complaints has yet to be proven, but it appears reasonable to relate these two issues.

Perhaps the largest visual problem caused by the 5 × 7 matrix is the resulting relationship between the size of the dot and the spacing between dots. Consider for the moment a display having an active area of 8.5″ by 6.3″ with 240 active lines and 24 lines of 80 characters. With a 5 × 7 dot matrix requiring an 8 × 10 dot "cell," the horizontal center-to-center dot spacing is .013″ and the vertical dot spacing is .026″. The spacing between dots is twice as large in the vertical dimension as in the horizontal. Selection of a spot size that permits the necessary horizontal resolution results in a per-

ceptible spacing between dots in the vertical dimension. Unfortunately, visible spacing between dots reduces both character legibility **(Figure 5)** and readability. It is quite possible that such spacing also contributes to complaints of visual fatigue.

Glare, Illumination, And Filters

The transition from the paper office to the electronic office has created the potential for significant improvements in productivity. It has also created a variety of problems related to job design, personnel skills, information flows, and the like. Other problems are created by the interaction between environmental characteristics and the VDTs themselves. Acoustic noise created by "clicking" keyboards and cooling fans has often presented sources of irritation and worker complaint. The installation of sound barriers and the selection of "quieter" keyboards often improve these conditions. A more critical interaction with the environment, however, exists in the change in illumination required for the electronic office.

The traditional paper office uses both natural (e.g., window) illumination as well as artificial illumination to bring the total illuminance typically to 90 to 130 foot-candles (965–1400 lux). When a VDT is introduced into this environment, a frequent result is a glare caused by direct reflections from the face of the CRT. In addition, even if glare sources are controlled by careful location and baffles, the high ambient level reduces the contrast of the displayed image through addition of the ambient energy to both the background and characters on the display. To combat these problems, various filters have been designed: circular polarizing filters with anti-reflective coatings, neutral density filters, notched or color filters, directional filters, etc. They achieve contrast improvement by differentially absorbing the ambient illumination, by doubly filtering the ambient as opposed to singly filtering the displayed energy, or by directionally controlling the reflected energy.

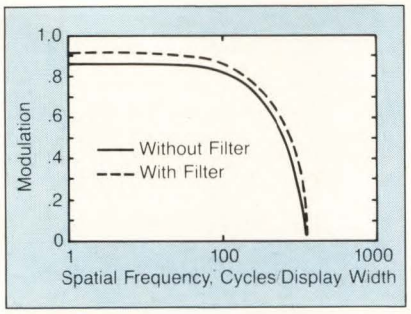

Figure 6: Use of a directional filter in a diffuse glare environment results in a modest gain in MTF.

The important corollary to the question of contrast enhancement, however, is the extent to which the image quality or luminance of the image is reduced. Unfortunately, some filters improve contrast to a lesser extent than they reduce image quality. That is, considerable edge sharpness is lost (the high frequency portion of the MTF is rolled off) while small gains in contrast are achieved.

Figure 6 illustrates the small gain in MTF from a directional filter when used in a diffuse glare environment. What is not indicated in this figure is the accompanying reduction of display luminance of 45% in order to obtain the indicated 5% increase in contrast or modulation. Such a tradeoff is typically not beneficial to legibility. Very recently, an informal study by Task (1982) concluded that "in general, filters are more effective against diffuse reflections than specular reflections. This is unfortunate, because it is the specular reflections that cause the greatest loss of contrast and probably the most problems with viewing VDTs."

The most recommended solution to the glare problem is to both reduce the ambient illumination and to control glare sources. For the most part, ambient illuminance of 25–35 foot-candles is quite adequate for both VDT us-

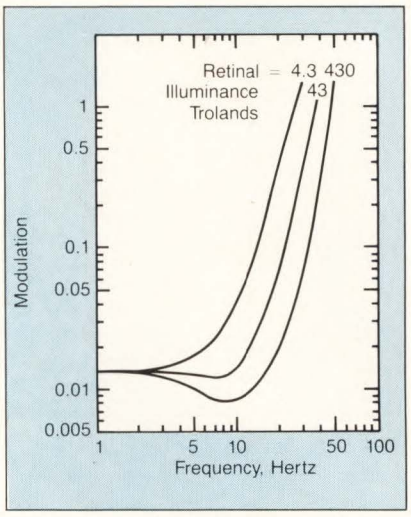

Figure 7: Higher average luminance levels require a greater refresh rate to avoid flicker.

age and reading of good quality reference or source material. For the visually handicapped or older worker whose illumination requirements are greater, localized light sources can be provided without impairing the visual performance of the typical user. In this fashion, it is usually necessary to drape windows and to orient the CRT surface perpendicular to windows and to the major axis of flourescent luminaires. By preventing glare sources in the environment, much can be done to reduce visual fatigue and avoid the reduction in image quality caused by the use of an inappropriate filter for a given problem.

Display Color

VDTs typically use white or green phosphors, although some orange and yellow CRTs are produced with the color created either by the emission spectrum or the color of the filter placed over the CRT. Personal preferences aside, the color of the phosphor or the filtered image will have no influence upon most visual attributes of the display. That is, given the same luminance, contrast, resolution, and persistence, the color of the display is immaterial so long as it is not at either wavelength extreme (red or blue).

The lens of the eye is not color corrected and therefore cannot focus perfectly upon all wavelengths simultaneously. For this reason, multicolor displays should not use extreme wavelengths at the same time. However, the luminance sensitivity of the eye is otherwise not affected by wavelength, and similar legibility will be obtained independent of wavelength if the other display properties are constant.

Refresh Rate And Persistence

As much as one can predict the limiting resolution of a display from knowledge of the display's MTF and the contrast threshold function of the eye **(Figure 3)**, so can one predict the perception of flicker of a display. The visual system is sensitive to flicker when the modulation of the fundamental temporal frequency of the repetitive waveform exceeds known threshold values. **Figure 7** illustrates the temporal threshold function for three different retinal illuminance levels expressed in trolands (A troland is the product of the display luminance in cd/m^2 and pupil area in mm.) One need only measure the temporal waveform, Fourier-analyze it to determine the modulation at the Fourier fundamental, and compare the value with the threshold function for the appropriate luminance level, as discussed by Snyder (1980).

Since it is usually the case that green phosphors have longer persistence than do white phosphors, the modulation of the green phosphor display is usually lower and therefore less likely to be seen as flickering for a given refresh rate. Conversely, a white phosphor typically requires a higher refresh rate than does a green phosphor to avoid flicker.

As illustrated in **Figure 7**, a greater refresh rate will be required at higher average luminance levels to avoid flicker. For this reason, a negative contrast display (dark characters on a light background, also called a positive image display) will require a typically higher refresh rate than will a more conventional light character (positive contrast or negative image) display, as demonstrated by Bauer and Cavonius (1981). On the other hand, these same researchers have also shown that the user's preference is greater and the text entry performance is better with the negative contrast display if the display is adequately compensated for refresh rate and stroke width. This latter requirement stems from the fact that a dark line on a white background is perceived as being thinner and therefore having less contrast than does a light line on a dark background, all other characteristics being the same. For this reason, a negative contrast display should have a stroke width about 20% larger than a positive contrast of the same character size and contrast. Better quality displays currently in design and production have this characteristic.

Display Standards

At present, the only country to promulgate VDT standards is West Germany, although other countries are close to doing so. As a practical matter, however, manufacturers are likely to design for the international market as a whole and will therefore attempt to meet the most rigid of existing or perceived standards in a universal design. For this reason, the German Standards (DIN 66234) have a large impact on current and future VDT design. The critical design variables and the required levels of each, as given by

Are VDT Standards Necessary or Desirable?

Considerable controversy has risen over the desirability of VDT standards. West Germany and Sweden have been at the forefront of creating and opting for national standards to protect the "health and safety" of workers, with health and safety to include psychological as well as physical concerns. England has offered a recommendation from the British Health and Safety Executive, and Canada has issued a report from the Defense and Civil Institute for Environmental Medicine (DCIEM). As indicated in the attached article, no standard has been proposed for the US, and the National Research Council Panel on Video Viewing has not recommended a standard at the present time. On the other hand, several states (e.g., Illinois, Maine, Massachusetts) have introduced bills into their state legislatures that create minimum "standards" for VDT work areas. An evaluation of the contents of these bills indicates them to be the work of nontechnically oriented people; people not trained in the language, scientific content, and problems of VDT ergonomics. It is the opinion of this author that these bills would not significantly benefit the worker, and would be best replaced with provisions that better reflect our state of knowledge about the problems and solutions to VDT workplace design.

A critical step will occur in May 1983, when the International Standards Organization (ISO) meets to discuss and evaluate national standards that have been proposed for adoption as international standards. To date, the West German and Swedish recommendations have been received by ISO. Under sponsorship from the American National Standards Institute (ANSI), the Human Factors Society is attempting to draft an alternative standard for consideration by ISO if ANSI approval can be obtained in time. 1983 may be an interesting year for VDTs, standards, and the office worker. In the meantime, many US manufacturers are redesigning keyboards, introducing tilt/swivel displays, and advertising "ergonomically designed" VDTs. Unfortunately, few of them have made use of the long-existing data, scientific knowledge, and basic ergonomic principles described in the accompanying article.

Harry L. Snyder, Ph.D.

SELECTED STANDARDS FROM DIN 66234

Display Variable	Required Level
Character Format	5 × 7 or greater
Line Spacing	1 dot or 10% of character height
Column Spacing	1 dot or 10% of character height
Character Contrast	3:1 to 15:1, with 6:1 to 10:1 preferred
Character Size	at least 18 arcmin
Screen Color	green thru orange
Contrast Polarity	negative contrast preferred
Illumination	300–500 lux for positive contrast; at least 500 lux for negative cont.
Refresh Rate	flicker-free (not expressed quantitatively)
Image Distortion	‹2% of display width; ‹10% of character size
Display Tilt Angle	‹5 deg down; ‹20 deg up; 0 deg detent
Viewing Distance	50–70 cm

Table 1: Display variables and their required levels designated by West Germany's DIN 66234 document have a large impact on VDT design.

the DIN 66234 document and/or the West German Trade Cooperative Association, are shown in **Table 1.**

The emphasis is on display luminance, character size, contrast, and other aspects of image quality. For the most part, these requirements have been supported by adequate research on human performance. In some cases, however, there is a loose interpretation of the research, coupled with worker preferences, which has resulted in the current standards. Continuing discussion between the standards organizations and the research community should result in modifications to the standards as better numbers are obtained.

One example of such a needed change is in the maximum permitted contrast of 15:1 (Modulation = .875). Research has shown that visual performance is improved at least up to contrast ratios of 35:1 and that some existing flat panel displays which have contrast ratios of 40:1 present no visual problems. In fact, such "high" contrast ratios are helpful in increasing legibility for slightly smaller character sizes, thereby permitting an effective tradeoff between character size and contrast. It is believed that this particular requirement in the standards is being reviewed for possible change.

Are Standards Needed?

A critical issue is whether the United States needs a standard for VDTs at this time. There are, of course, two possible positions to be taken. The argument for the creation and enactment of a standard is taken from the large number of field studies which have shown worker complaints and illnesses to be directly related to poor VDT design, manufacture, or installation, coupled with generally poor environmental conditions and job design. Many experts feel that the application of existing ergonomic/human factors engineering to current situations can solve many of these problems, and that standards would only reflect what is already in the public domain on good engineering design.

On the other hand, scientists and engineers who are opposed to standard enactment point out correctly that our current knowledge is incomplete with regard to minimum requirements for adequate VDT design and that any standards will, in part, be only educated guesses and therefore unsupported in totality. They further point out that there are many tradeoffs among the numerous design variables and that no standard can express these tradeoffs quantitatively, although independent compliance with each requirement will cause excessive overdesign.

A recent study by the Committee on Vision, National Academy of Sciences, also addresses this issue. That study is due for public release in April 1983.

Conclusions

The last eight years have seen growing numbers of VDTs employed in the working world and a similar increase in the number of worker complaints from these VDTs. Field studies have uncovered many of the fundamental issues in design, have categorized worker complaints, and have unfortunately been heavily criticized for biases and methodological errors. Nonetheless, there is no question that poor VDT design has directly led to many worker physical complaints and absenteeism.

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Other major factors affecting work are environmental conditions, particularly climate (temperature, humidity, air movement, and radiating heat) and lighting (general and task illumination, luminance, contrast, colors, glare, etc.). Management control exercised both by the employer and by the employee regarding working hours, change in activities during the working day, control over the work itself, setting the work pace, etc., also affect the output.

None of these components can be engineered independently. Office work involves a complex interaction between persons, equipment and task. Task and equipment must be designed, selected and adjusted to fit the operator, since only limited adaptation can be expected from the human, while there are relatively few basic constraints on equipment technology or work management.

If ergonomic design to suit the operator is neglected, or inadequate, problems are likely to arise. People will complain about visual or postural pains in neck, shoulders, arms and fingers. They feel fatigued and voice dissatisfaction with the work place and the work itself (Smith, Cohen, Stammerjohn and Happ, 1981). They may have health complaints and be absent from work, and work output will be deficient in quality and quantity.

This article will focus on the ergonomics of the VDU workplace in the office. This workstation can serve as a typical and critical model for applying ergonomic information to most office work places.

Design For The "Worst" Case

Work with VDUs falls into a number of categories (**Table 1**). These may be primarily clerical in the traditional sense if they consist mostly of data entry via the keyboard and data acquisition from the display. Professional tasks include word processing, interactive communication, programming, computer-aided design and computer-aided manufacturing (CAD/CAM) activities.

Performance of these different tasks by people with diverse educational backgrounds and varying motivation over a few or many hours per day will result in many different physical and emotional stress situations.

	JOB REQUIREMENTS					CONTROL OVER OWN WORK
	VISUAL		MOTORIC	POSTURAL		
Task	Screen	Source Document	Keyboard	Wrist Rest	Chair, Footrest	
Data Entry	M	H	H	H	H	L
Data Acquisition	H	M	M	H	H	L
Word Processing	H	H	H	H	H	L/H
Programming	M/H	M/H	M	M	H	M/H
Interactive Communication	H	H/M	M	M	H	H
CAD/CAM	H	M	M	M	H	H

L = Low M = Medium H = High

Table 1: Job requirements and control over one's work associated with different VDU tasks.

	Percentiles			
	5th	50th	95th	Std. Dev.
Stature (Height)	149.5/161.8	160.5 /173.6	171.3 /184.4	6.6 / 6.9
Eye Height	138.3/151.1	148.9 /162.4	159.3 /172.7	6.4 / 6.6 **
Shoulder (acromion) Height	121.1/132.3	131.1 /142.8	141.9 /152.4	6.3 / 6.1 **
Elbow Height	93.6/100.0	101.2 /109.9	108.8 /119.0	4.6 / 5.8 **
Knuckle Height	64.3/ 69.8	70.2 / 75.4	75.9 / 80.4	3.5 / 3.2 **
Height, sitting	78.6/ 84.2	85.0 / 90.6	90.7 / 96.7	3.5 / 3.7
Eye Height, sitting	67.5/ 72.6	73.3 / 78.6	78.5 / 84.4	3.3 / 3.6 **
Shoulder Height, sitting	49.2/ 52.7	55.7 / 59.4	61.7 / 65.8	3.8 / 4.0 **
Elbow Rest Height, sitting	18.1/ 19.0	23.3 / 24.3	28.1 / 29.4	2.9 / 3.0
Knee Height, sitting	45.2/ 49.3	49.8 / 54.3	54.4 / 59.3	2.7 / 2.9
Popliteal Height, sitting	35.5/ 39.2	39.8 / 44.2	44.3 / 48.8	2.6 / 2.8
Thigh Clearance Height, sitting	10.6/ 11.4	13.7 / 14.4	17.5 / 17.7	1.8 / 1.7
Head Breadth	13.6/ 14.4	14.5 / 15.4	15.5 / 16.4	.57/ .59
Head Circumference	52.2/ 53.8	54.9 / 56.8	57.7 / 59.3	1.63/ 1.68
Interpupillary Distance	5.1/ 5.5	5.83/ 6.20	6.5 / 6.8	.44/ .39
Forward Reach, functional	64.0/ 76.3	71.0 / 82.5	79.0 / 88.3	4.5 / 3.6 **
Elbow-Fingertip Length	38.5/ 44.1	42.1 / 47.9	46.0 / 51.4	2.2 / 2.2 **
Hand Length	16.4/ 17.6	17.95/ 19.05	19.8 / 20.6	1.04/ .93
Hand Breadth, Metacarpale	7.0/ 8.2	7.66/ 8.88	8.4 / 9.8	.41/ .47
Hand Circumference, Metacarpale	16.9/ 19.9	18.36/ 21.55	19.9 / 23.5	.80/ 1.09
Chest Depth	21.4/ 21.4	24.2 / 24.2	29.7 / 27.6	2.5 / 1.9 **
Elbow-to-Elbow Breadth	31.5/ 35.0	38.4 / 41.7	49.1 / 50.6	5.4 / 4.6
Hip Breadth, sitting	31.2/ 30.8	36.4 / 35.4	43.7 / 40.6	3.7 / 2.8
Buttock-Knee Length, sitting	51.8/ 54.0	56.9 / 59.4	62.5 / 64.2	3.1 / 3.0
Foot Length	22.3/ 24.8	24.1 / 26.9	26.2 / 29.0	1.19/ 1.28
Foot Breadth	8.1/ 9.0	8.84/ 9.79	9.7 / 10.7	.50/ .53
Weight (in kg)	46.2/ 56.2	61.1 / 74.0	89.9 / 97.1	13.8 /12.6

**Std. Dev. estimated by Kroemer

Table 2: US civilian body dimensions, female/male in cm or kg, for ages 20 to 60 years. Courtesy of Dr. J.T. McConville, Anthropology Research Project, Yellow Springs, OH, and Dr. K.W. Kennedy, USAF-AMRL-HEG, WPAFB, OH.

Assume a "worst" condition: intensive and long interaction with the VDU without much variation in posture and task. An example would be a clerical job in which the operator is "glued" to keyboard and display. For this confined position, ergonomic design of the work place is of overriding importance. The premise is that a workstation designed for such a job will also be suitable for the person who has more freedom in selecting work postures, work task, working hours, and work habits.

Body Postures

Positions of body segments are largely determined by interaction of:

- Eyes with screen, source document and keyboard.
- Hands and arms with keyboard and possibly other controls (e.g., light pen) and with writing utensils.
- Back and buttocks with backrest and seat pan.
- Feet and legs with foot controls, with their positions often limited by available space.

If the operator had a free choice, he or she would probably move around, alternatively standing in different locations and sitting in various relaxed or upright positions (Many of the complaints voiced by VDT users are linked to sustained postures of the neck, shoulders, arms and hands, trunk, legs, and feet.) However, with current VDT technology, eyes must remain in a rather fixed location with respect to the display, hands must be kept over the keyboard and the body must remain on the seat. Hence, the person has only a limited choice among different postures and positions in the chair.

If the equipment (footrest, seat, writing surface, keyboard, screen) cannot be adjusted according to the individual user's preferences, this person's working posture is fixed by the prevalent equipment dimensions. Since people differ in size, habits and postural preferences, adjustability of the equipment is necessary. However, adjustments need to be easy to make. If the adjustment is difficult, if it requires tools, skills and strength, it will not be done.

EQUIPMENT	OPERATOR
VDT Display/Source Document	Eye Height Above Seat Preferred Direction/Declination of Line of Sight Preferred Viewing Distance Trunk and Neck Posture; Muscle Tension
Keyboard of VDT, Typewriter, Etc.	Hand and Finger Dimensions Elbow-Hand Length Elbow Angle Upper Arm Length Shoulder Height, Sitting Trunk, Shoulder, Arm, Wrist and Finger Posture; Muscle Tension
Writing and Working Surfaces	Declination of Line of Sight Preferred Viewing Distance Arm Dimensions Shoulder Height, Sitting Trunk, Shoulder, Arm, Wrist and Finger Posture; Muscle Tension
Backrest of the Chair	Shoulder Height, Sitting Back Curvature Height of 5th Lumbar Vertebra Required Mobility of Trunk/Shoulder Blades Muscle Tension Buttock-Popliteal Length
Seat Surface of the Chair	Buttock-Popliteal Length Hip Breadth Body Weight Popliteal Height
Leg Room	Thigh Height Buttock-Knee Length Hip Breadth Knee Height Leg Length Foot Length
Wrist Rest	See above under Keyboard
Arm Rests	Elbow Rest Height Above Seat
Foot Rest	Popliteal Height, and see above under Leg Room

Table 3: Equipment dimensions determined by human dimensions.

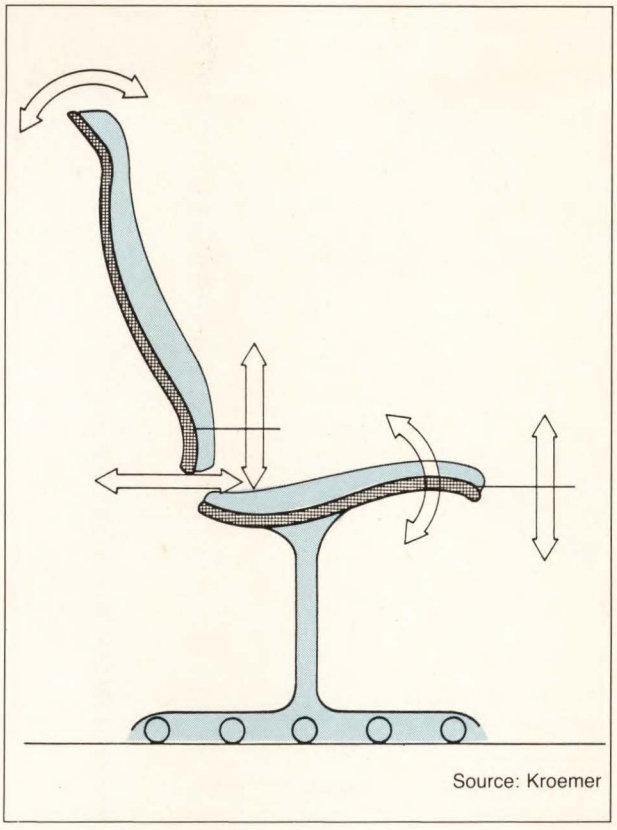
Body Dimensions

Body dimensions of the user obviously are primary inputs for the design of the VDT workstation. The composition of the working population in the US is changing dramatically. More women are entering occupations traditionally dominated by males. Conversely, more males seem to be doing work that, by traditional bias, would be expected to be in the female domain, such as office work with VDTs. This changing composition of the user population must be taken into account when furniture and equipment for VDT workstations are designed.

Until recently, relatively inaccurate and spotty information was available on US civilian body dimensions. Fortunately, one can use the amply available military data to draw inferences regarding the general civilian population. **Table 2** presents selected predicted body dimensions for US civilians. These data are the best available and most comprehensive compilation of current US civilian data. They supersede older data on the adult population which rely on surveys performed about two decades ago.

The simplest design model is

Figure 1: Adjustments of the work seat.



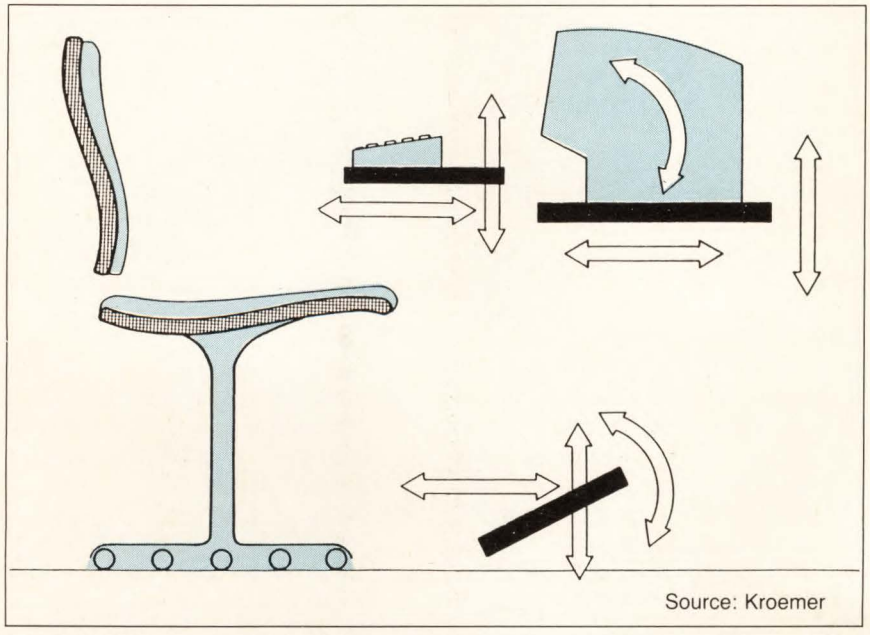


Figure 2: Adjustments of the VDU work station.

the "average person" who consists solely of mean values stacked and accumulated over several data categories. This mythical person of average body dimensions was proven to be nonexistent three decades ago (Kroemer 1983)—but some designers still believe in this ghostly figure.

Other faulty assumptions are that a large female can be represented by the body dimensions of an average man, or that the dimensions of a small man are similar to those of an average female (Small females and large men are not included in this scheme.) Obviously, this concept is false—there are differences other than size between men and women.

An appropriate technique for establishing body dimensions relies on the fact that given percentage values can be calculated from the mean by adding or subtracting multiples of the standard deviation. This percentile approach is correct and useful for *one* given dimension, provided this variable is distributed normally. (Of course, one cannot develop a complete human profile by adding percentile values, such as creating a phantom having only 5th percentile body dimensions. This is just as ghostly a figure as the "average person.") If the dimension is normally distributed, one can easily calculate percentiles using mean and standard deviation. In fact, one can do so for "mixed" populations, such as consisting of X% female and Y% males (Kroemer 1983).

This procedure can be put to good use if one wants to determine, for example, the adjustment range of the sitting height of a chair needed to fit a given user population. Knowing the statistics of the associated body dimensions, particularly popliteal height, one would decide on the smallest percentile to be accommodated (say, the 5th percentile female) and the largest percentile to be fitted (say, the 95th percentile male). The tradeoff between user accommodation (here: 95% of all) and adjustment range needed (here: 13cm or 5 in), i.e., fit versus expense, can be determined quickly using this information.

Ergonomic Equipment Design

As indicated earlier, designing a suitable VDU workplace is impossible if its components are treated as separate units. Rather,

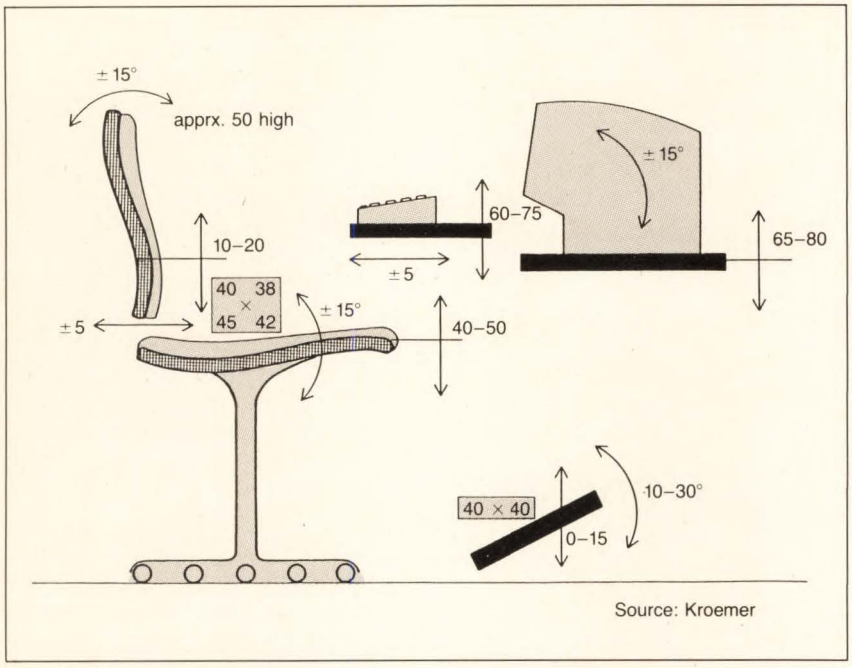


Figure 3: Dimensions (in cm) of an ergonomic work station.

one must consider the interactions between task and environment within and among the system elements, which include display, work surfaces and body supports.

The human is the limiting and determining component of the work system. Therefore, primary design recommendations for the workplace must be derived from human capabilities, limitations, dimensions and preferences (**Table 3**).

The following design recommendations are derived for a VDU workplace at which a person works many hours each day. If they are met, this workstation should be suitable also for occasional or short use. Disregarding the display, the recommendations are valid for practically all office workplaces.

Seat, keyboard, display and supports must be seen as an interacting workplace system. They are treated here separately only for the convenience of discussion.

Important design features of the chair are indicated in **Figure 1**. Supported securely on four legs (or five casters, as is required in most European countries for stability) it needs adjustability of seat pan height and height of the backrest. Furthermore, seat and backrest should be adjustable in their absolute and relative angles. The backrest should also be adjustable fore and aft with respect to the seat pan.

Figure 2 shows the adjustments needed for the other system components. The writing surface and the support surface for the keyboard (or the keyboard itself) need to be adjustable in height and distance fore and aft. The display unit, as well as the source document, should also be adjustable in height, angulation and distance independently from the keyboard. Finally, the footrest should also be adaptable in height, angulation and fore and aft distance.

Figure 3 presents suggested dimensions and adjustment ranges. These should be taken as approximate figures, indicating orders of magnitude. Given conditions such as special user population characteristics, fixed furniture measures or specific work conditions may warrant deviations from the values cited.

For example, if the work surface is non-adjustable, it needs to be on the high side to accommodate people with long legs; a high chair with a large adjustment range and a footrest for persons with short legs are also needed. If, in contrast, table height can be varied, less adjustability of the chair height is needed and footrests are probably not necessary.

Fore-aft adjustability of the keyboard support can be replaced, at least partially, by fore-aft adjustability of the display stand. Obviously, a loose footrest can be moved freely on the floor, which is not possible if it is incorporated in the table.

Prudent use of the ergonomic information available allows for provision of ergonomically correct office equipment. Its cost is minimal compared to the overall expenditures per workstation, and its benefits are obvious.

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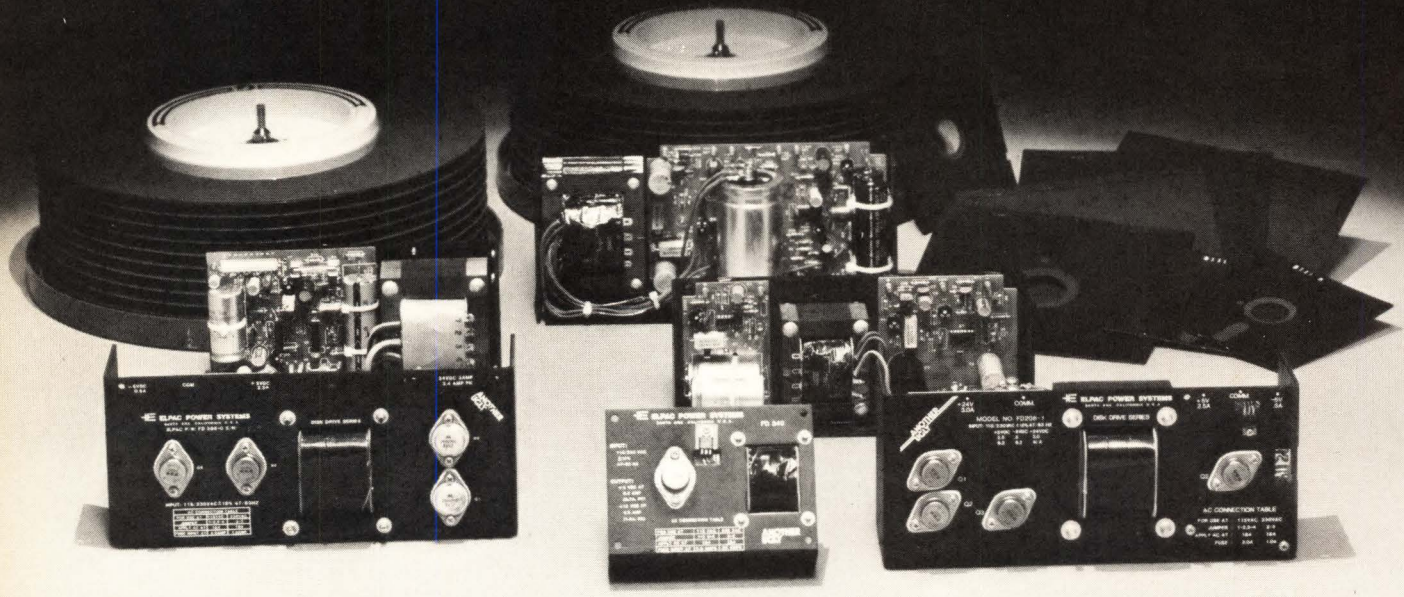

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FLOPPY DISK 8"	FD206	97.00	+5V, 2.5A	−5V, 0.5A	+24V, 3.0A/ 3.4A PK.	—	CP206	FCBB-90W	2PFD
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What's Ahead In Power Supplies

OEM companies specifying a power supply should be careful to confirm their market before committing to a given specification.

by Nywood Wu

Recognition of the power supply as a subsystem, rather than just another electronic component, is an important trend within the industry. This has developed because of the growing realization of the complexity and the overall importance of the multi-output switching regulated power supply in delivering more power in less space, at the least possible weight, for high density systems.

Emission And Safety Standards

One of the major side effects of industry attention to new noise and safety specifications (in the US the revised FCC, and internationally CSA, VDE, IEC, etc.) is the tendency among specifying engineers to overshoot their real specification requirements. At first glance it seems logical to call out the most stringent of these new specs as the minimum standard on a new product, when it often is not required. In the short term, this will in many cases increase costs unnecessarily because of overspecification.

The new specifications are broken into two basic categories: emissions (EMI/RFI) and safety. While many power supply manufacturers are boasting compliance with these new specs, in many instances they are only addressing the EMI portion, not the safety standards. Unfortunately, except in small stand-alone systems, the filtering of emissions at the subsystem level—as in the case of the power supply—will probably not satisfy the emissions spec at the systems level. Since the spec calls out limits for emission at the systems level, this means that it is simpler and more cost effective to filter the entire system, particularly in the face of limited space and high density encountered in most of today's systems.

Safety standards, on the other hand, impose definite physical constraints on power supply design. They impose major redesign requirements and stringent testing routines once R & D, engineering, and pre-production efforts are in place. OEMs specifying a power supply should be careful to confirm their markets before calling out a given specification, because of the wide difference in various performance limits imposed.

Companies who market their products exclusively in the US or third world countries would be wise to call out the UL specifications, which many major US manufacturers have already designed to meet. Adherence to US safety standards, as called out by the FCC and UL, assures systems specifiers a level of performance fully acceptable in the US as well as most third world countries.

Companies who are targeting on the European market will be calling out VDE, IEC or one of the other specs (probably the most stringent to satisfy all national requirements). In this case they should plan on longer lead times, increased costs, and significant testing because each component and subsystem, and the final system, must qualify under the international specs.

Parameters	Switcher	Linear	Ferroresonant
Efficiency	70%	40%	80%
Watts/in^3	3–4+	1/3	1/6
Watts/lb	50	5	3
Output Power	≥750W	≤500W	≤1KW
Primary Noise Frequency	>20KHz	>60Hz	>60Hz
Reliability	good to excellent	good to excellent	excellent
Regulation	0.4%	0.1%	10%
PARD	50mV	20mV	160mV
Transient Response	200μs	50μs	100ms
Level of Technology	developing	mature	mature
Input Voltage Range (brown out)	±20%	±10%	±15%
Input Frequency	47–440Hz	47–63Hz	59–61Hz
Hold Up Time	20ms	1ms	1ms

Figure 1: A comparison chart of Switcher, Linear and Ferroresonant power supplies.

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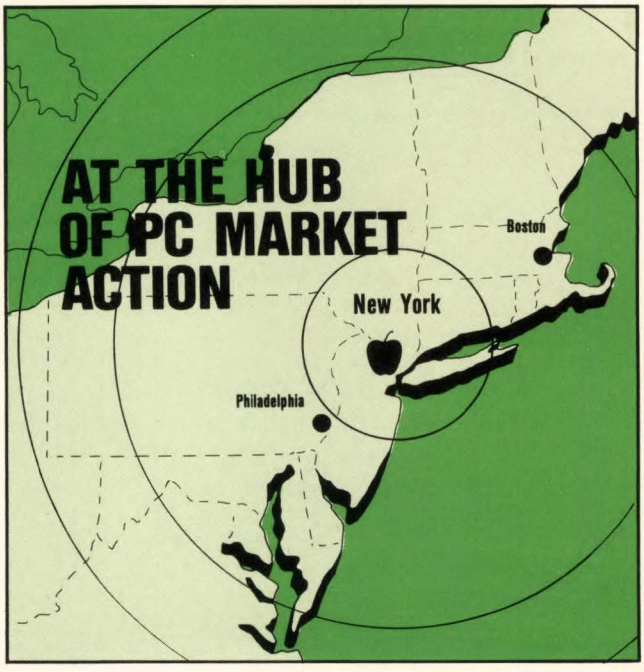

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In the long term, the tendency to overspecify among engineering and design teams will moderate with the realization that designing to actual requirements will bring down relative cost.

Design Stages

The best service to specifying engineers is providing both design assistance and assuring the flexibility to adjust to changes in a product design as needs become more defined. This process may be viewed in three basic steps:

Prototype Stage. At this point, a specifier would be wise to work with a standard power supply in developing his basic design.

Pre-Production Stage. Here the design is much tighter and the need for a modified standard power supply, due to both electrical and mechanical considerations, is the next logical step from a standpoint of price/performance and availability.

Production Stage. By now, a custom power supply may be provided to satisfy needs which have been mutually defined over the development life of the system.

Growth Potential

There is an opportunity for manufacturers to expand in the lower power ranges because this area offers the greatest potential for growth in terms of demand (number of units) through 1985. There will be a growing need for low power, multiple output units which address the marketplace's growth in personal electronics and other areas. Because of the required price/performance ratios needed to compete successfully, there will probably be an industry shake-out. Companies who display inflexibility and inefficiency in either manufacturing or product design will cease to be a force in this market segment. Because of the high entry fee (costs to develop switchers) only those companies with demonstrated technical expertise and financial resources will prevail.

Make/Buy Trends

Linear power supplies are relatively easy to design and manufacture. As a result they have been more often a "make" decision for manufacturers of systems equipment.

Unfortunately, the complexity of design inherent in a switching regulated power supply makes it a much less desirable product for internal manufacture for several reasons. First, a switcher is significantly more complex from both a design and manufacturing standpoint. It can take 12 to 18 months just in the design stage, and requires significant investment of capital in specialized manufacturing and testing equipment to assure achievement of performance and safety standards.

Second, the technical skills required for switcher design are much greater than for linears, and the availability of experienced design engineers is limited.

Finally, both linear and ferroresonant supplies employ a mature technology, whereas switcher technology is continuing to accelerate and change at a heady pace. Staying abreast of this, so that a company will be competitive in its marketplace, is a major effort.

More Power—Less Space

Switchers are the fastest growing segment in the power supply industry, directly addressing size, weight, efficiency, AC/DC requirements, low line conditions and cost. The industry at large is demanding more power in less space. This trend will continue, with more companies moving from the simpler single output switcher to the more complex, but cost efficient multi-output types. There will be large demands for units at both the low end and the higher end of the power spectrum (under 100W and over 1000W).

This continuing emphasis on obtaining more functions in less space, and the resulting density of electronics to deliver those mandates, will require clear thinking on the part of new systems designers if their products are to stay competitive for any length of time in a rapidly evolving price/performance product arena. There appears to be a mandate for safe, compact, efficient and reliable sources of power for these complex systems. □

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.

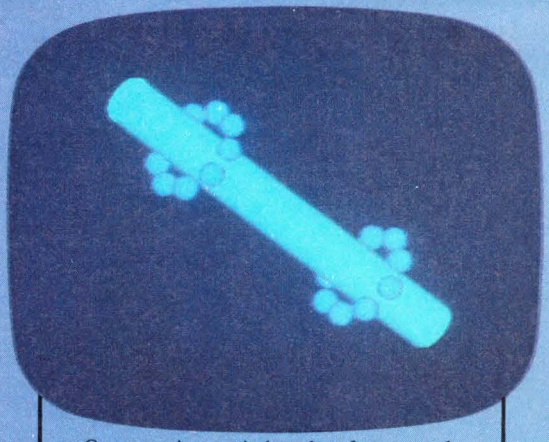
Now you can build in seconds what used to take forever.

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

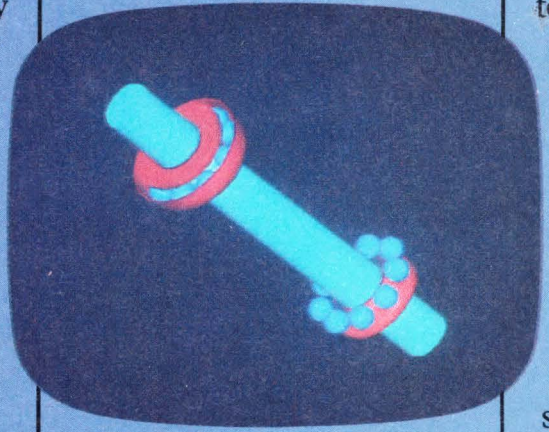
By processing tasks like hidden surface removal, visible surface shading, sectional views, contouring, and even piercing objects, SOLIDVIEW slashes image construction time from minutes to seconds. The host is then free to handle viewing transformations and clipping concurrently; system throughput is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

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

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

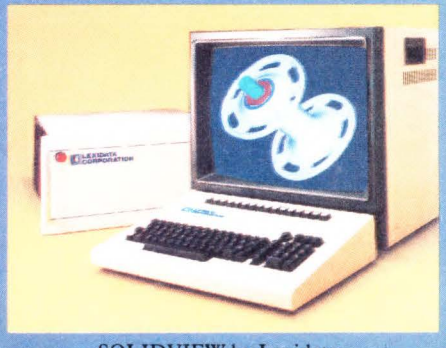


Construct images in less than four seconds.



Then build incrementally. In seconds.

Create complex solids just as fast.



SOLIDVIEW by Lexidata.

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

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Color Graphics Terminals: A Growth Market

The increasing availability of advanced semiconductor devices is allowing system developers to more easily enter the graphics terminal market.

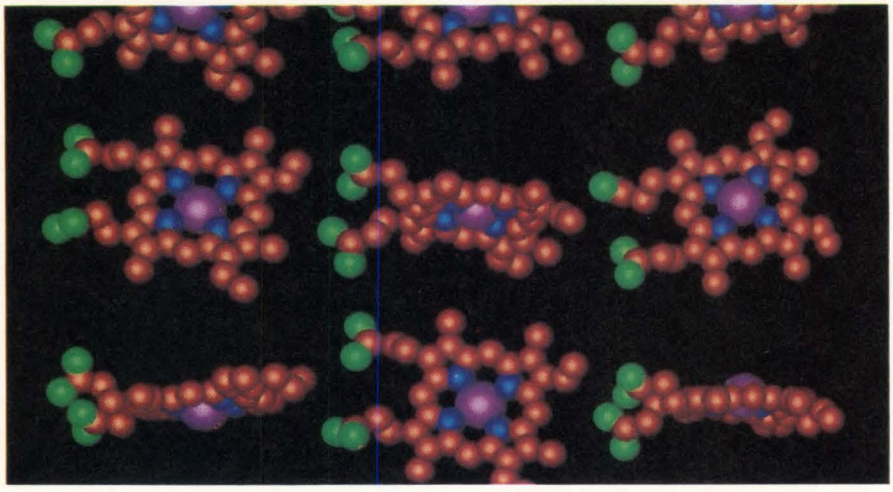


Figure 1: Molecular structure displayed on a Jupiter 7 graphics terminal. Each structure may be moved independently.

by Daniel S. Raker

A survey of the market place for graphics terminals shows that there are over 300 vendors supporting and selling color raster terminals. In under a year, 20% of the firms will have developed new designs, and the number of companies selling graphic terminals will have increased by another 20%. So many firms are working to develop graphics capabilities that the key to successful marketing is innovative design enhancement.

One of the most important elements in graphics terminal and systems design is the increasing availability of semiconductor devices which allow the system developer to enter the graphics market with greater ease. Devices such as the NEC and Intel graphic chips, and the myriad of graphics boards (see *Digital Design*, 5/82) are the primary impetus for the proliferation of systems. However, soon-to-be announced products which implement standards for graphics applications (business, CAD, etc.), or allow device independence, should temper the would-be designers' decision to release a product today.

From the observers' perspective, the existing market offerings of terminals is bewildering; at one end of the market lies the $1200 color display terminal, with eight or 16 colors and an approximate resolution of 256 × 256 pixels. At the high end of the market is the $140,000 color workstation, which is ostensibly standalone, but in practice requires a powerful host's support to make use of the full range of capabilities.

Enhanced terminal capability is also a more important factor than before because of decreasing DP budgets. Selections made in today's market lack the characteristics of five years ago. The would-be designer must not only plan for this increased competition, but utilize existing selections at different market levels.

At the lower end of pricing and capability are terminals from manufacturers such as Intelligent Systems Corporation (ISC), Envision, and Colorgraphic Communication Corporation.

In the middle ranges are the intelligent devices that offer more colors and are capable of supporting the software design with graphic features. Polygon fill, window operations, soft keys, color table operations, communications and local memory are typical enhancements. The primary vendors in this market are Tektronix (4110) series, Megatek (6200) series, and Megatek (9600) series. The latter two have made notable contributions in the lower price/capability category.

Daniel S. Raker is President of Design & Systems Research, Inc., a Cambridge, Massachusetts-based computer graphics market research and consulting firm.

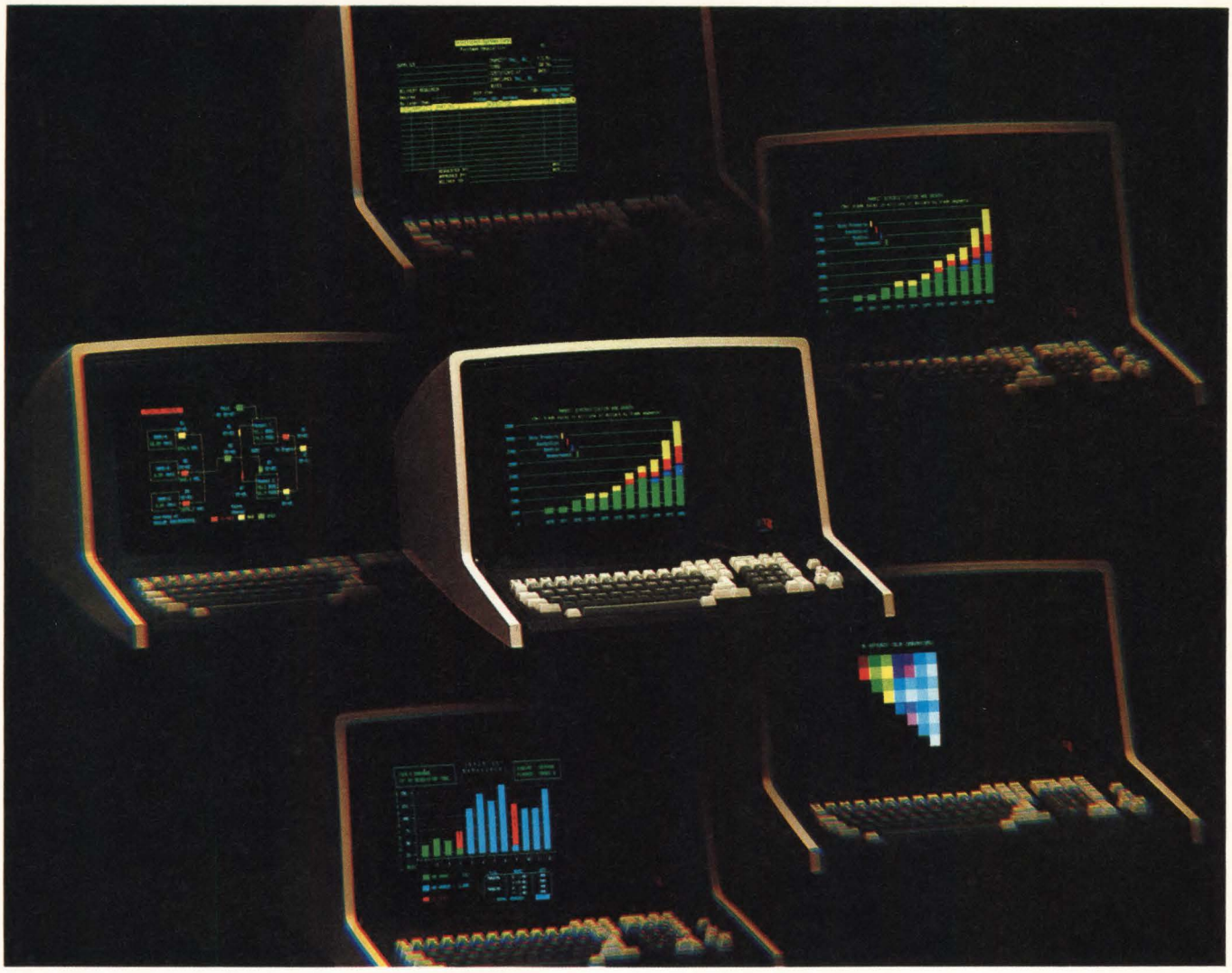


Figure 2: Intelligent Systems' Intecolor 2405 color terminal has ANSI X3.64, 80 × 24 screen format with added color vectorgraphics and almost all the capabilities of DEC's VT100. Photo courtesy Ted Rodgers Studio; The Marcus Group, Atlanta, GA.

The high end of the market offers an unlimited variety of sophisticated devices costing from $20,000 to $145,000. This category is characterized by OEM oriented products for customized systems or the most demanding users. Major players include Lexidata, ADAGE (with its recently acquired IKONAS), Megatek, Raster Technologies, Florida Computer Graphics, and Spectragraphics.

Design of Color Graphic Terminals

The majority of new colorgraphics terminals are being made for alphanumeric and business graphics. The existing desire is to tap these potential markets and strive toward manufacturing efficiency, rather than innovative design or cost saving price performance ratios. Terminal suppliers, therefore, who are building for the low end of the market, must produce a relatively inexpensive product, at low cost, and in high volume.

One of the causes of the recent increase in demand for colorgraphics was the IBM introduction of the 3279. Today after shipping thousands of 3279's, IBM faces competition from 3279 look-alikes that have more capability at equivalent prices. The Memorex 2079 Color Display Station, for example, is directed at business applications. Selling at a fraction of the 3279's cost, it offers 7 colors, as well as graphic capability in a plug compatible mode for the 3279 and associated controller configurations. In addition to supporting IBM 3270 protocols, the 2079 S2B model can support ASCII, APL and other character sets with up to 2560 characters on the screen at any one time. Along with graphics capabilities, the text processing local attributes include extended highlighting to accomodate IBM 3274 or 3276 control characteristics. By entering the IBM plug compatible graphics market, Memorex hopes for a market built on basic IBM features, but attracted by additional capabilities. Lee Data, ITT Courier, and Telex have adopted a similar approach with their basic color terminals for the IBM market. ISC model 8001 is available in a 3275 emulation mode

for just $4055 including a much larger (19") display than the IBM or its competitors.

Most graphics terminals have been developed for the PDP and VAX markets based on RS-232 communication. For under $4,000 there are approximately fifty vendors selling color terminals. ISC is one of the oldest color terminal manufacturers. It has entered the business marketplace based on its strong installed base in process control and engineering applications. ISC is improving its competitiveness by implementing mass production techniques for its new Intecolor 2405 Color Graphics Terminal, reducing the basic cost to $1195 (quantity one, 100 units OEM). The basic model has a single board design, centered about the 8085 processor, and offers 36 programmable function keys, 2K worth of CMOS RAM for menuing, 4K screen refresh RAM and an 8K EPROM for local operating system storage. Priced and packaged to sell in quantity, ISC includes RS232, 20mA host, and a serial port for peripherals. To make their basic color terminals compatible with the huge DEC VT52/VT100 market, ISC sells a model 8001C with VT100 emulation for just $2355.

Figure 3: The Megatek Wizard 6200 series terminal displays business graphics.

A newer entry into the market is Envision Corporation of San Jose, California. Models 210, 220 and 230 all have an Intel 8088 processor. The 220 and 230 make use of the NEC 2770 Graphic Display controller for scaling, rotating, and polygon fill. The two chips together in the 230 model allow local storage and manipulation of display lists. Envision prices range from $3400 to $7000.

One of the attractions of systems like ISC or Envision is that they provide the opportunity to use color for CRT communications tool, but also to cheaply and quickly capture the color image directly from the CRT. They offer this capability through dot matrix printers or color ink jet desktop devices respectively.

Another pioneer in graphics, Ramtek, is addressing the demand for the CRT/color printer combination by making their 41200 plain paper color impact copier available as a leased product and compatible with their color terminals. The 6000 series Ramtek products provide everything from basic (low end) display terminals to standalone, Pascal compiler-based systems. The basic 6211 offers 16 colors (from an available 64), 640 × 480 or 512 × 512 resolution and local support for the

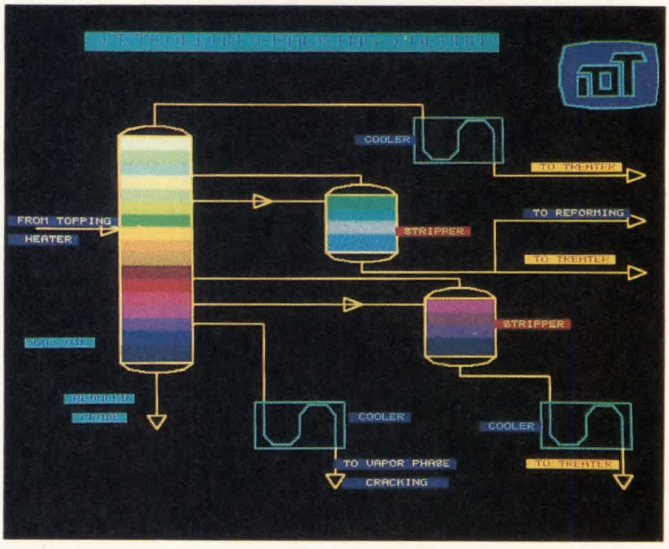


Figure 4: Process control application of a graphics terminal displayed on Industrial Data Terminals (IDT) system.

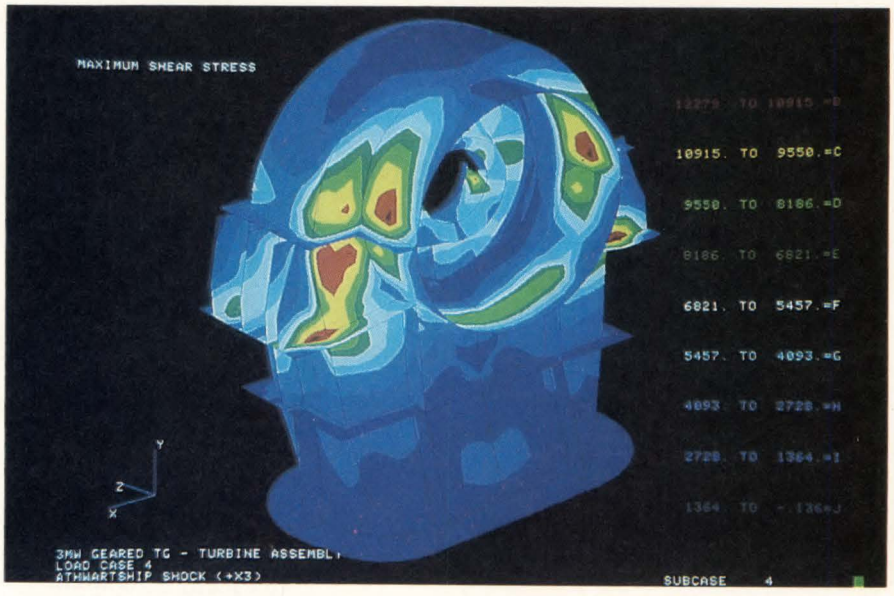
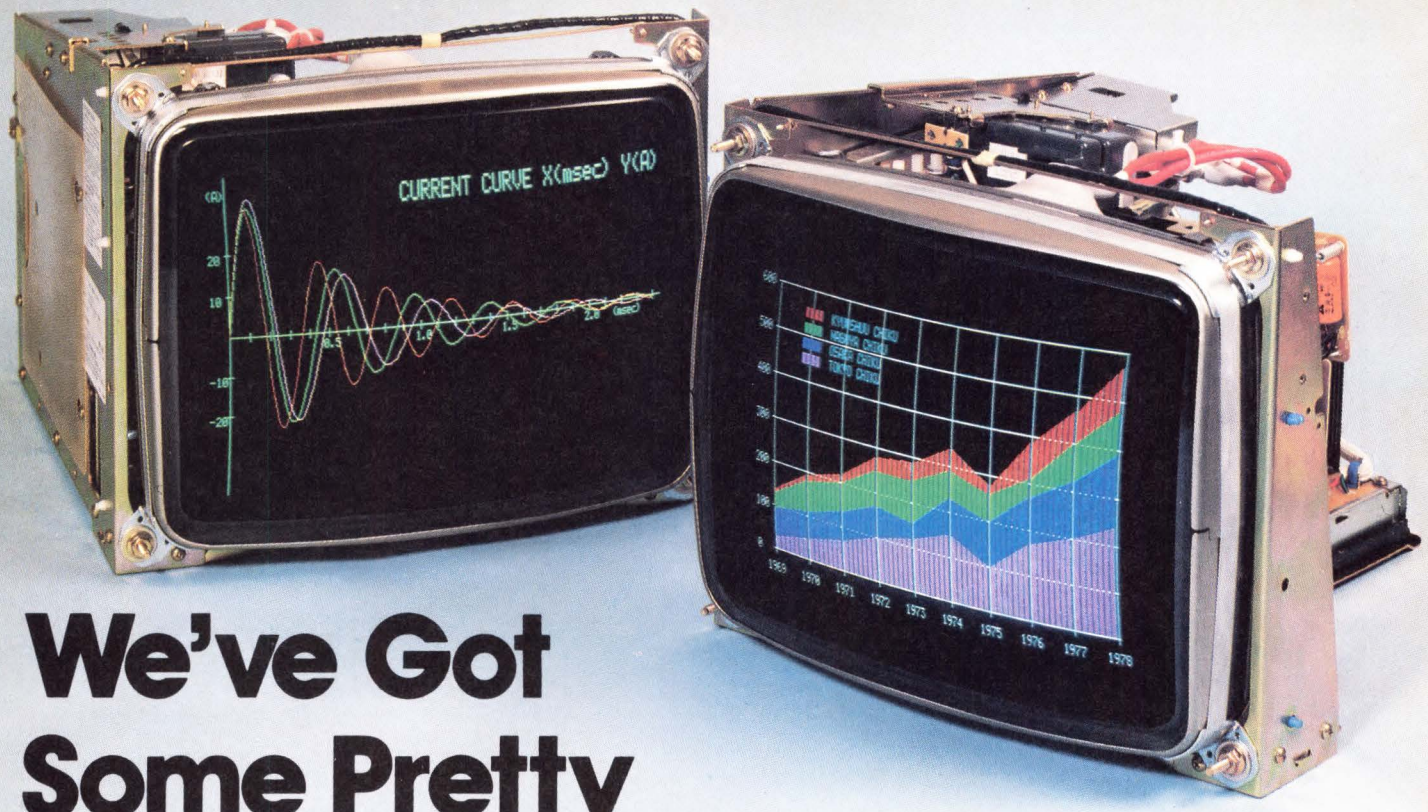


Figure 5: Engineering analysis application generated by Prototype Development Assc.'s (PDA) PATRAN-G.



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- IN-LINE ULTRA-HIGH RESOLUTION display tube (13 inch or 33 cm) incorporates a 0.31 mm dot pitch matrix that gives you sharp, clear characters and graphics.
- Compact chassis employs a SELF-CONVERGENCE SYSTEM, with enough space to encompass extra logic circuit boards.

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4100 color printer and film recording units. In addition the 6211 comes standard with pixel addressable fonts and offers additional RAM slots from local subroutine or downloadable font storage.

Other products in the basic midrange category include Tektronix's 4027, Aydin's line of 5200 color display processors, Chromatic's CG Series, Datamedias' DM8000 and Nippon Electronic Company's NJC-C1421. The common characteristics of this group include medium resolution (minimum 512 × 512 to 740 × 860), integral display processor chips (usually the 8086 or similar component) for controlling intelligent functions like polygon fill and graphic primitive generation, and 4K to 16K display refresh memory.

Without fanfare and sometimes without a reasonable amount of software to support them, the basic color terminal vendors are creating more powerful "big sisters" to their basic units. Faced with either entering the commodity terminal market or offering more intelligent (as well as profitable products), many of the early color terminal vendors have limited their low end markets by continuing to add features. This group includes the Tektronix 4100 line, Chromatics 7900 series, Aydin 16″ line and Megatek 1650 line.

The characteristics of this group include local intelligence for manipulation, storage, and processing of graphic commands based on high level graphic primitives. These devices do not usually operate in the pixel by pixel processing steps (as do the high end processors and image processors), but have relatively sophisticated, polygon fill, vector to raster conversion, scaling, zoom, rotation, and display list processing of such primitive elements as polygons, circles, hard and soft text fonts. Price range for this capability category is from $5000 to a high (on basic configuration) of about $15,000.

Thus the markets for middle ranges of price are dependent upon price-performance capability. In the lower cost market segments, the vendors seek ease of manufacture, reliability, and ease of repair. In the middle category, the vendor's products are characterized by serviceability and capability. Peripherals such as input/output devices are used to induce user buyers to demand more graphic solutions from the original supplier.

Many of the devices in the middle range are overbuilt in terms of capability—a feature that allows a progression of add-ons or enhanced systems through successive "versions." This pattern may have led to a stifling of design improvements. Megatek, Ramtek, Chromatics, Aydin, and others have added to their product lines while maintaining a static product design. Software capability additions, add-ons, (printer/plotter ports, camera units), and reduced product development costs have nevertheless increased profit margin.

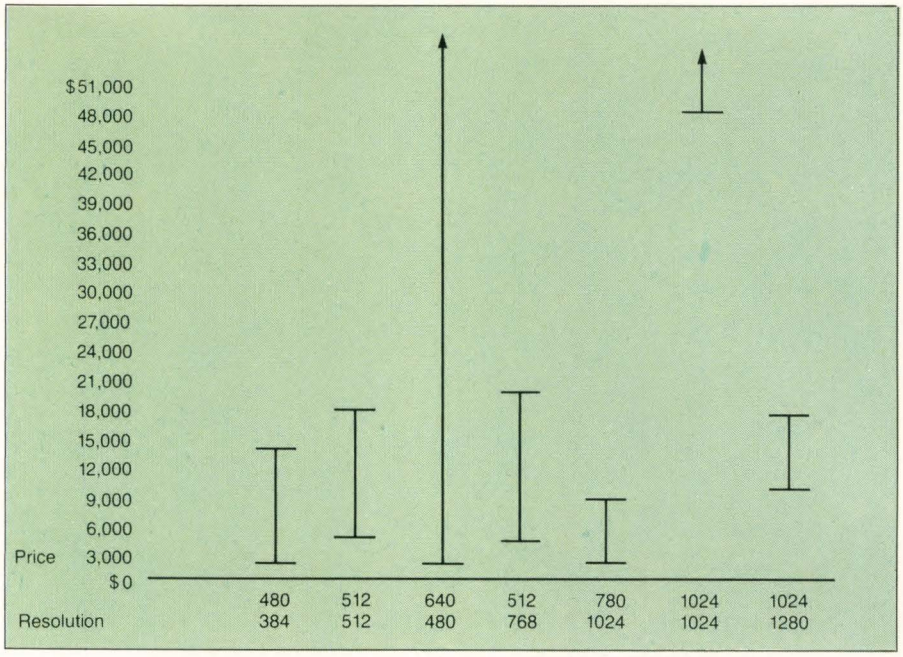

Figure 6: The relationship between cost and resolution.

PRICE/RESOLUTION

Company	Price	Resolution
Adage	$20,000-$130,000	1024 × 1024 (All Adage 3000 but different options)
CalComp	from $11,000	640 × 512 1024 × 1024
Colorgraphics Communications	$5,000-$20,000; $13,000-1,000	512^2 1024^2
Envision	$2750-6950	640 × 408; 640 × 480
Datamedia Corp	$4995	640 × 480
FL Comp Corp	$20,000	640 × 480 (expendable to 1280 × 960)
Ithaca Intercorp	$8,000	480 × 640
Jupiter	$15,560-$50,000	640 × 480, 1280 × 1024
Lundy	$5,500-20,000	512 × 768, 1024 × 1536
Nippon	$3,995-$9,950	1024 ×780
Spectragraphics	$80,000	1024 × 1024
DEC	$14,000	512 × 512
ISC	$2195-$4055	480 × 384
US Data	$6,400-14,500	384 × 480; 160 × 192 vector plotting
Megatek	$16,000-$75,000	640 × 480, 512 × 512 (deluxe has stroke writer)
Lexidata	$11,600-$15,485	1280 × 1024

Figure 7: The relationship between price and resolution for individual companies.

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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.

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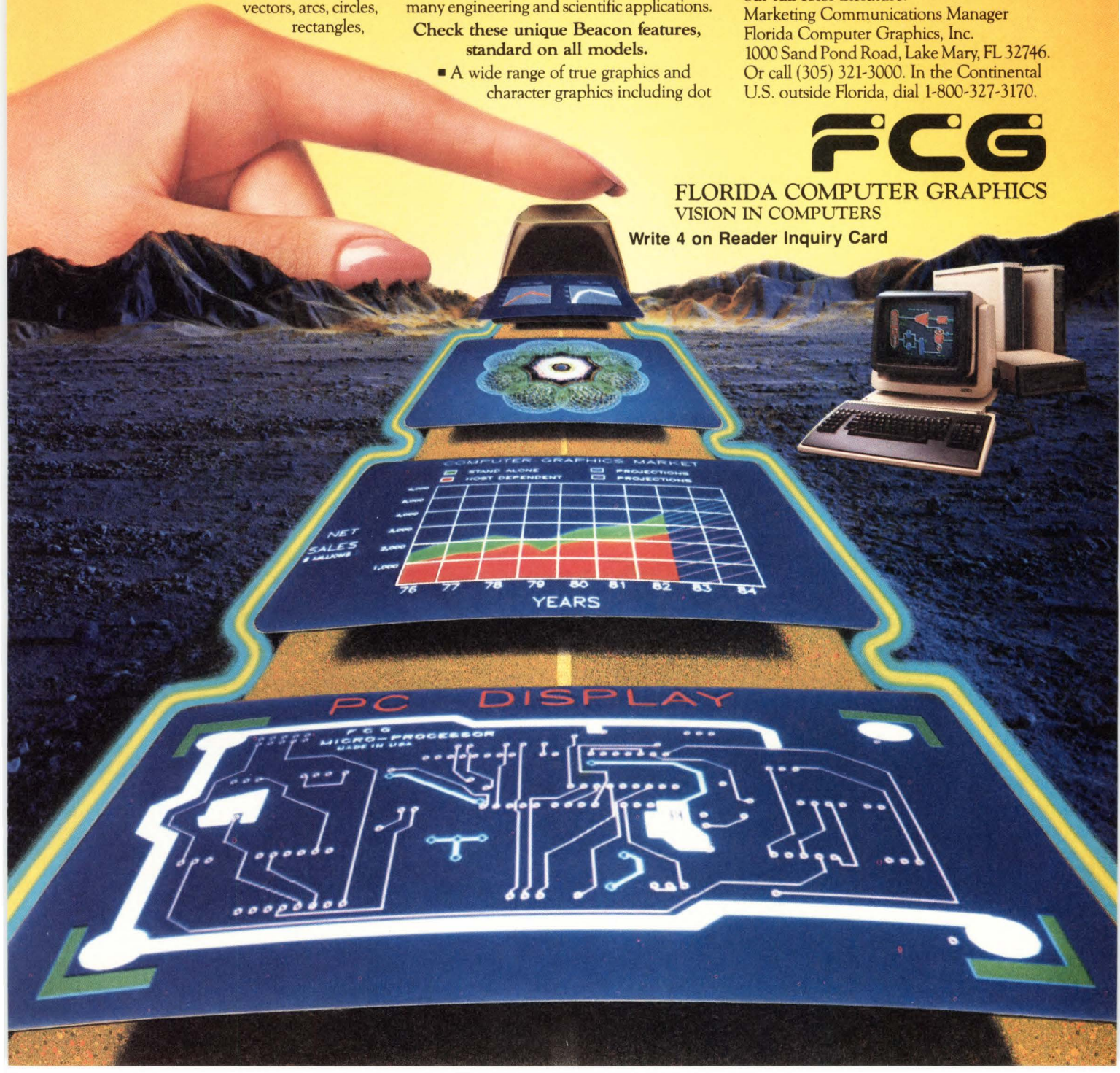

Insert: Image generated on custom color graphics terminal courtesy of Digital Effects.

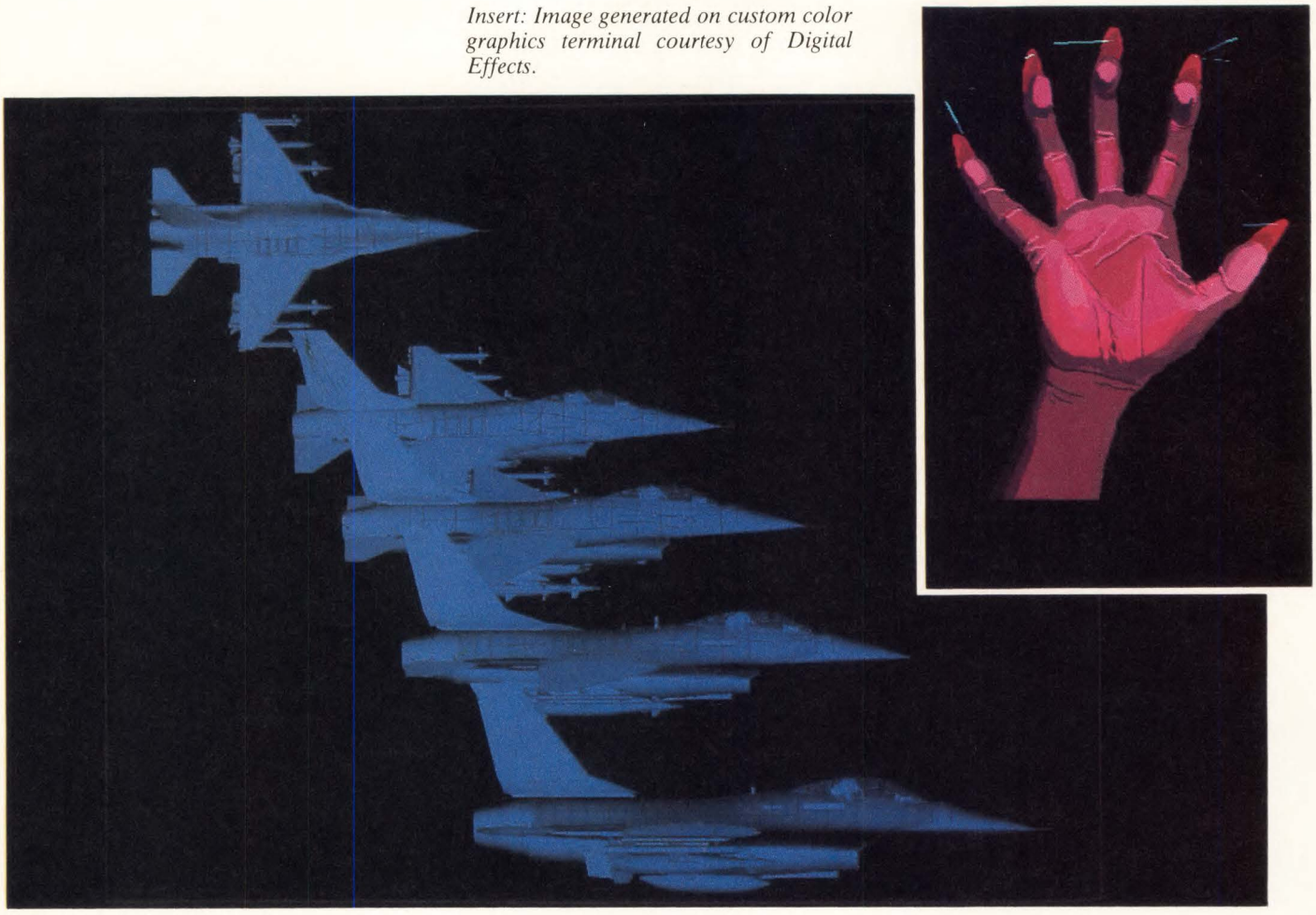

Figure 8: Solid model display on Chromatic's 7900 Series terminals.

While competition is affecting the mid-range terminal market, many vendors are maintaining profit and keeping product lines up-to-date. Tektronix, for instance, with its 4113 has influenced the graphic terminal marketplace by developing a device capable of displaying and quickly manipulating vectors. The 4113 is Tektronix's bid to propel itself out of the DVST market, while maintaining the software foundation of older Plot 10 compatible packages and in order to leap-frog the somewhat static capabilities of the 4028 "intelligent color terminal." The 4027 served a similar purpose for Tektronix but competitors are eroding its market in terms of resolution, capacity, and, most importantly, in price performance. The 4113 may face a similar end, but Tektronix is maintaining the 4113's position with add-ons such as display list processing software, extra storage, and a standalone processor enhancement that makes use of extra memory and intelligence for local processing.

To respond to the Tek 4027 type capabilities, Chromatics developed the CG series; Ramtek, the 6200 and 9000 series; Megatek, the Whizzard 7200 series, and Aydin the 5210 line.

New product lines from Chromatics like the 7900 terminals, border both mid-range and high capability machines. The 7900 includes a MC68000, ALU, and the capability to perform both 16- and 32-bit operations. While capable of supporting standalone operations (especially in a business/MIS application), the 7900 finds its most popular use in intelligent support of more engineering-oriented applications. The 7900 series rarely sells directly "off-the-shelf" and is instead configured with up to 16 backplanes for display and refresh memory mapping, pixel processing, and alleviation of host memory requirements.

Ramtek's middle range products center around the 9050 series—a group of user configurable products based on a Z80 micro and at least a 4K MOS dynamic RAM refresh memory. The 9050 line supports a 16-bit DMA interface for true pixel processing and throughput while at the same time supporting a high level programmer interface (callable graphic primitive instruction set). Comparable mid-range devices are produced by Lundy (the 5680), Aydin (the 5200 line), and others.

One step above the blurry line between mid-range capability and advanced color standalone workstations are those devices that have more computing power and faster memory than the most popular

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computers. They do, however, require a host computer. These devices direct a great deal of computational power behind a specific task: rapid, efficient, and almost complete control of graphic display functions.

The demand for the high end products is in applications where resolution, speed, and pixel throughput are critical. It might seem that DMA for pixel processing is critical here—but the mid-range products have a greater need for this facility due to their less sophisticated local processing capability. The high cost products end includes devices such as the Spectragraphics 3270 IBM compatible color CAD workstation ($20-30K), the Megatek WHIZZARD 7600 line ($50-90K), and the Adage/IKONAS RDS-3000 ($20-120K).

The high end of the market is characterized by application specific demands of resolution (usually 780 × 580 or 1024 × 1024), fast refresh (60Hz non-interlaced), pixel processing locally (hardware zoom, pan, scale, and origin addressing), and fast, local algorithms for color mapping (solid modelling support, hidden line removal, image processing, edge coloration calculation). With such a mix and match set of demands most of the devices sold in this range are custom tailored to OEM or sophisticated end-user specifications.

Lloyd Fugate, VP Marketing for Lexidata, describes the company's offering as "plug and play" for the company's 2000 series low end; and "pick and choose" for higher cost systems which give the OEM buyer and end user insight into just how the high end graphic system fits together. The workhorse of the Lexidata line is the 3400, a chassis or frame for holding and integrating a mix of processors (based on Lexidata's own 3400 12-bit slice micro), and an abundance of firmware (up to 30 different cards available) to fit in eight or 12 backplanes. The 3400 boasts widespread applications as a CAD monitor in PRIME, Summagraphics, Calma, and Gerger systems.

Advanced Electronic Design (AED) was one of the first companies to offer high-end raster processing systems. Their latest offering, the 767, boasts a 6502A architecture with up to 42 Kbytes of RAM/ROM. The important features of the 767 are DMA of up to eight back planes for multiple picture layer viewing (great for multiple layer PC CAD work), and downloadable microcode for specific "graphic subroutine" type operations.

Figure 9: Images generated on the Adage 3000 are used in animation and video-production application. Photo courtesy Loren C. Carpenter, Boeing Computer Services.

Jupiter Systems, the developers of the AED product line, now produce the Jupiter 12—a powerful enhancement on the AED 6502A architecture. By adding an M68000, the model 12 now handles 1280 × 1024 resolution and virtually unlimited (16 million) color palette capability.

The Megatek 7200 WHIZZARD series is another mix and match machine boasting a processor and refresh configuration limited only by the user application, imagination, and cost. The high end of the Chromatics 7900 can reach $100,000 as well. The most expensive off the shelf pricing is that of Adage/IKONAS. The RDS-3000 is a virtual store full of back planes, image processing capability, for about $140,000.

Future Market

The color raster market is maturing in capability as it is entering a mature stage of market penetration. The market will inevitably see a shakeout of both capability and price/performance as big vendors squeeze the small, as software is implemented as firmware, and as a result of Japanese competition. OEM and applications will drive "off-the-shelf" product design while application and capability specific users will continue to put together their own systems from a host of available (but possibly not well supported) components.

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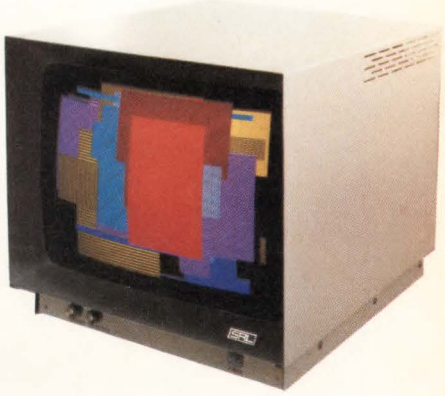

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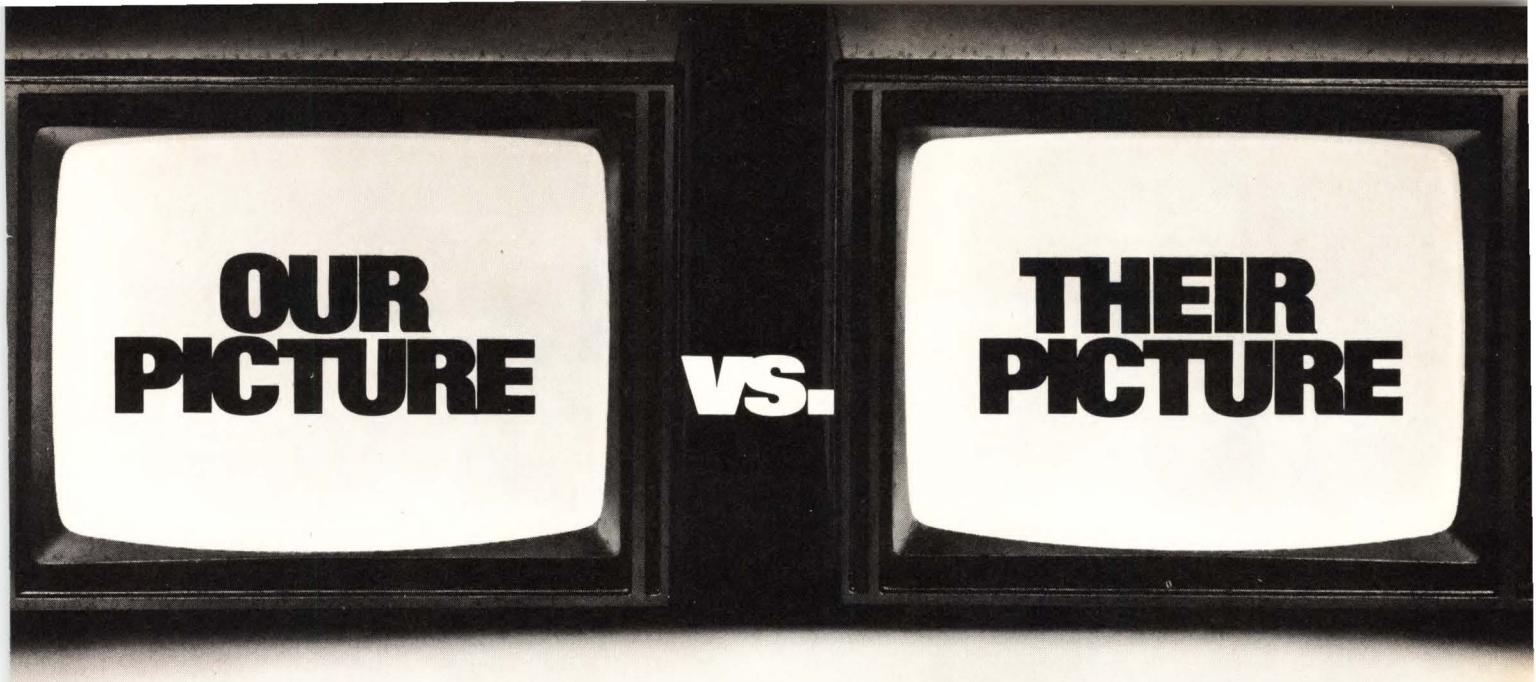

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Micro Floppy Drives Bring New Competition To The Market

by R. J. Pretko

The high density microfloppy struggle began with two Japanese participants, Hitachi and Sony. The initial U.S. response was a Verbatim/Shugart effort to catch up with the two leaders. Efforts primarily from Dysan supported a wider U.S. base and a "Micro Floppy Committee" was formed (This committee has no affiliation with ANSI.) Legal questions as to corporation liabilities along with differences of opinion as to size and soft or hard jacket initially thinned the ranks, but new interest and commendable leadership from Dr. Yoshiyasu Narahara of Shugart and Charlie Payne of Verbatim held the group together and later expanded its ranks.

Competition from Japan is forcing US media and drive manufacturers to address technical and economic challenges.

The committee's contribution has been to challenge the Japanese on their products as "standards". The Sony media was actually acceptable except for the following:

1. Sony had a manual shutter whereas the Hitachi auto-shutter concept was adopted by the committee.
2. Sony media was 80 microinches thick whereas the committee was very clear that 50 microinches was required.
3. Sony's drive used 600 RPM whereas the committee felt 300 RPM was required for 5 ¼" media compatibility.
4. The coercivity of the Sony media was less than 550 oersted while the committee insisted that particularly in light of the 300 RPM requirement, 650 oersted was more appropriate.

On the plus side, the Sony media was the only 3 ½" media (this size was considered ideal pocket size and did not overshoot the present head and positioning technology.) It also had a token media cleaning provision inside the cartridge

R. J. Pretko is Vice President-Engineering for Brown Disc Manufacturing, Inc.

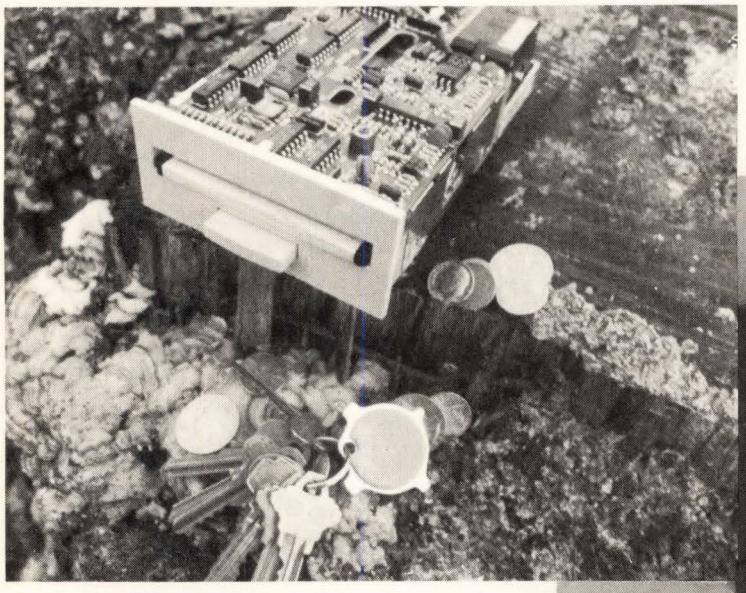
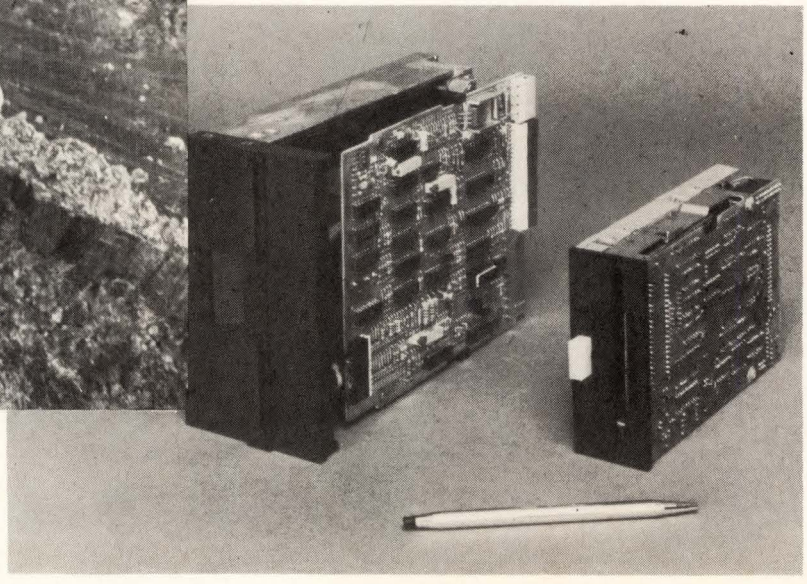


Figure 1: Hitachi's micro-floppy disk drive provides 250 Kbytes of capacity and is compatible with 5¼" flexible disk drives.

Figure 2: Shugart's 3.5" SA300 is a single-sided microfloppy drive offering 500 Kbytes of capacity and 6 msec track-to-track access time.



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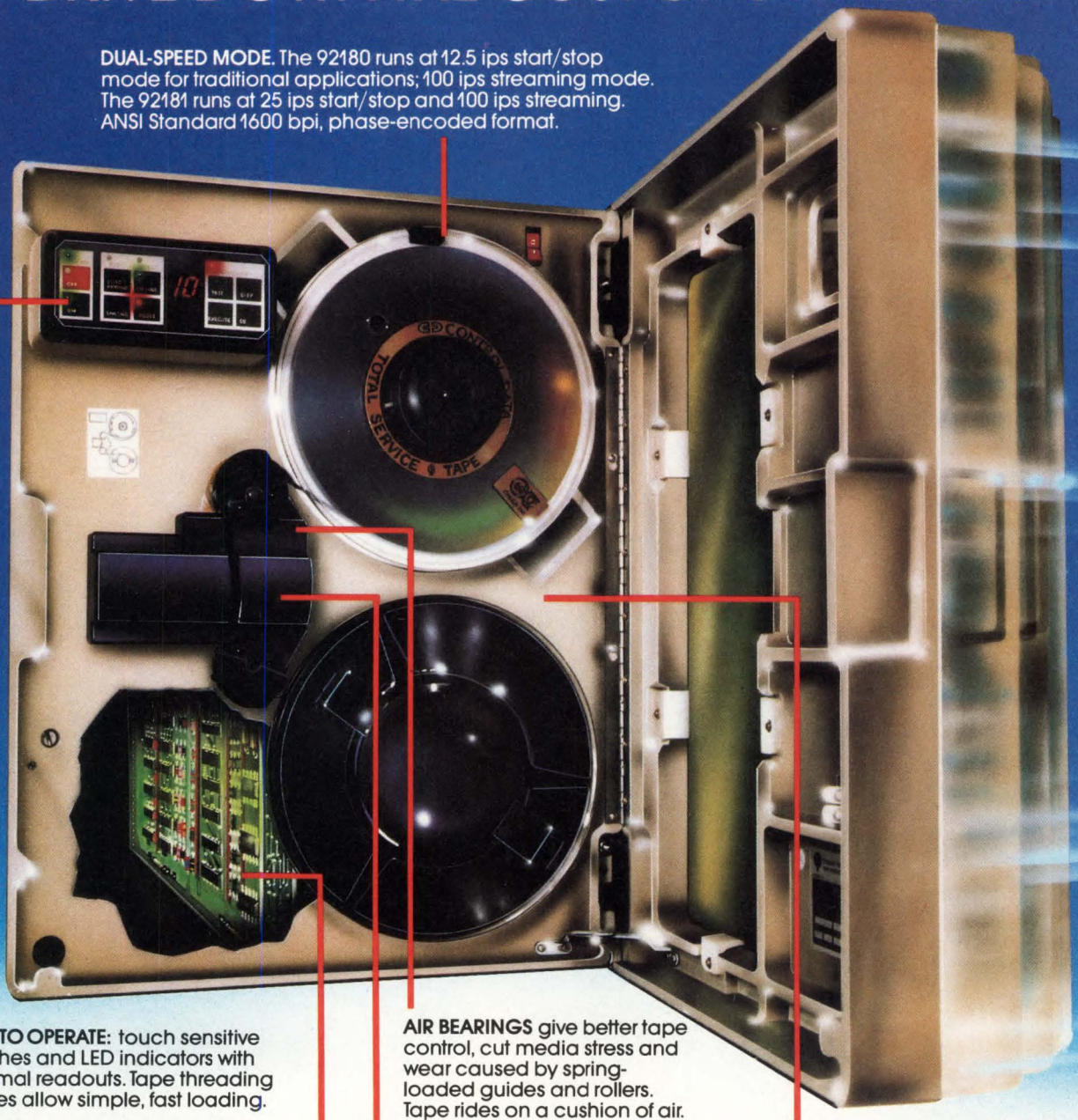

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whereas Hitachi was unnecessarily small at 3″, (hence less manufacturable since it sorely pushed the present head and positioning technology for the committee's 0.5 MB per side requirement) and had no media cleaning provisions. The committee could support neither Sony nor Hitachi. Both were willing to compromise in order to enlist the committee's support, but asking Hitachi to merely change their cartridge size to 3.5″ from 3.0″ was just too much since their drives were already announced and in production.

Sony was influenced by the committee in the interest of an industry standard to make the following changes:

1. They announced their autoshutter although they stated they would have announced one later even without the committee's urging.
2. Their thickness range is now recommended at 60 to 100 microinches bringing the low end reasonably close to the committee's requirement.
3. The coercivity has been changed to "around 625 oersteds."
4. With the committee's urging and influenced no doubt by Seagates' desertion from the Sony camp and license purchase for Tabor drives which use the soft 3 ¼″ media, Sony appointed a manager in their Corporate Planning Division, Mr. Saburo Kikuchi to actively process licensing agreements for media manufacturers at a "low flat fee."

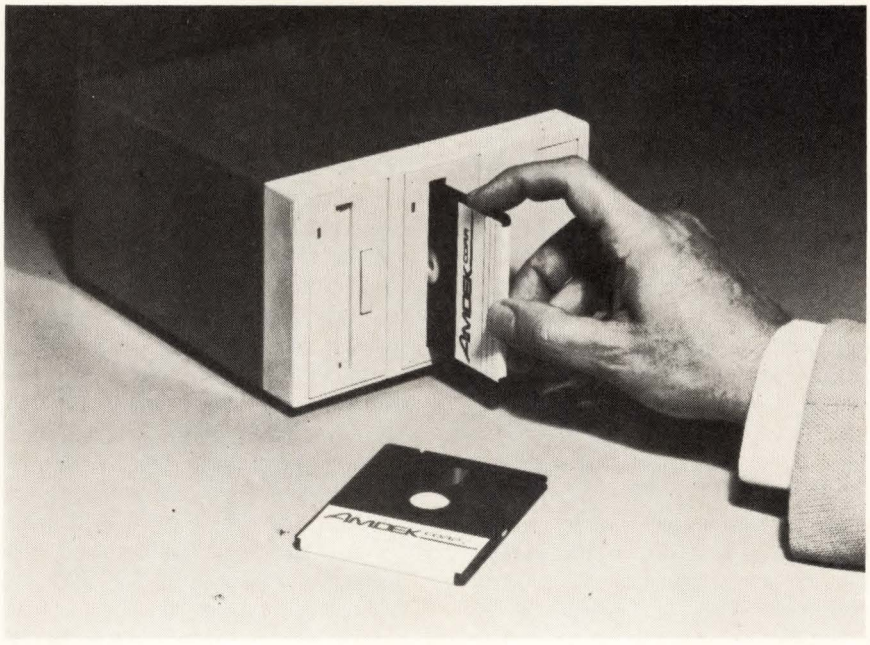
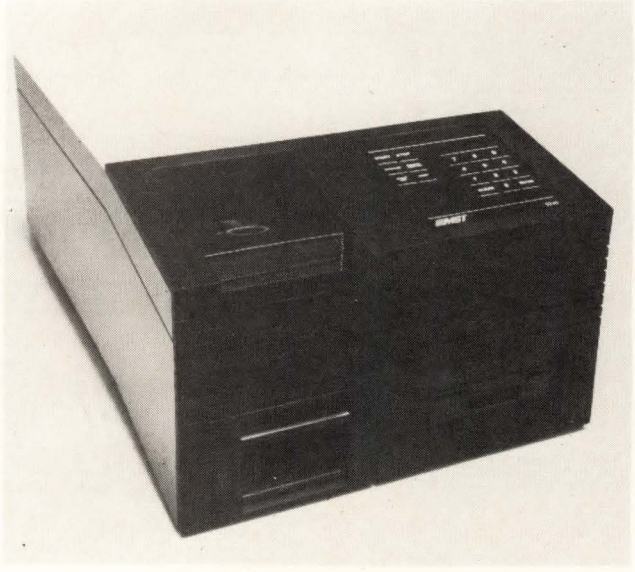


Figure 3: Amdek's 3″ microfloppy disk drive offers 1 Mbyte capacity and is compatible with standard 5¼″ floppy drives.

It would appear at this point that the committee's work is complete and ANSI could adopt the Sony cartridge as the "Microfloppy hard shell standard for 3.5″ media" and the remainder of the details would evolve with the product. Samples of the committee supported standard which is now compatible with the Sony media (except for media coercivity) were manufactured by Shugart, Verbatim, Memorex, Athana, and BASF and shown at the November/December Comdex Show. What had appeared to be a Single Standard based on Sony's

Media Systems Technology to Produce 3.5″ Disc Copier

MST Inc. of Irvine, California announced at Comdex last November that it would be manufacturing an automatic discette processing device for the 3.5 inch microfloppy. The company has entered into a joint agreement with Sony and Hewlett Packard to produce a system that will be able to make copies, format, and verify the discettes produced for use with their 3.5 inch disc drives. The company says that the use of the technology by HP, Computer Devices, Sony, Jones Computer, and RCA provides some assurity in the marketplace for the technology. The HP deal alone is said to be worth $30 million dollars for Sony. The new system will look much like the existing 5248 copier, will be available in the spring of 1983, and will cost $15,000.



3.5″ disc has therefore turned out to be a jointly inspired hard shell microfloppy psuedo-standard with minor, but clear U.S. influence. Drives (3 ½″) are purportedly being manufactured to utilize the "standard" by Sony, Shugart, Mitsubishi, and Tandon with others in the wings.

One then has to ask what happened to the soft jacketed 3 ¼″ high density entrant from Dysan/Tabor. Per Mike Hanley, President, "Tabor has orders for evaluation drives to 50–60 customers." It was also very obvious that Tabor's booth at Comdex was a beehive of activity. Mike stated that he is presently shipping product and further that he was requested to provide media drawings and specifications to the following media manufacturers: Verbatim, Xidex, Spin Physics, Graham Magnetics, Memorex, and Nashua.

Several names are conspicuously associated with the hard shell standard supporting committee. While at first glance this might suggest some question of a break of allegiance, it appears more feasible to assume that smart business dictates entertaining all potentials if your business is structured and sized to support the diversity of products. Contacts by the above companies with Tabor at this point in time indicate clearly that the soft jacket is a real market contender. While preliminary samples were less than impressive, the newly produced product is first class, viable, and also utilizes a metal hub for 200 microinch positioning accuracy.

Soft jacketed floppies for the Tabor drive were manufactured by and displayed at the recent Comdex Show by Brown Disc, Dysan, 3M, and BASF.

Bob Stetson of BASF Technical Marketing stated "BASF would hope to be able to continue to respond to needs of the marketplace." Brown Disc's posture is similar and Brown plans full scale production of the new product since there are some clear indications of demand quantities which would support capitalization in the form of automation and there are also no licensing questions or fees involved.

Automation is also vital to produce the hard case microfloppy economically. A 20% to 30% cost increase in the 3 ½″ hard case floppy over 3 ¼″ soft jacket appears feasible. Leaders in the 3 ½″ arena would have to be Verbatim and

MICRO-FLOPPY DISK DRIVES

	2 INCH	3 INCH		3¼ INCH	3½ INCH		
	Tec America †	Amdek	Hitachi, Matsushita, & MPI (2nd Source-Hitachi)	Tabor & Seagate (2nd Source of Tabor)	Tandon	Sony & Mitsubishi (2nd Source of Sony)	Shugart
Disk Diameter	66.	3.93	2.84	3.25	3.40	3.40	3.5
Cartridge Dimensions	Flexible Disk	.179 × 3.15 × 3.94	.197 × 3.15 × 3.94	3.27 × 3.43 × .065	.133 × 3.54 × 3.70	.133 × 3.54 × 3.70	3.54 × .13 × 3.70
Drive Dimensions	76 × 124.5 × 41	7.5 × 8.75 × 4.25	1.58 × 3.55 × 5.83	1.62 × 4 × 5.5	1.62 × 4.00 × 6.12	2.00 × 4.00 × 5.12	1.60 × 4.00 × 6.00
Tracks Per Side	1 Track Spiral Scan	80	40	80	40	70	80
Tracks Per Inch		100	100	140	135	135	135
Disk Speed (RPM)	405	300	300	300	600	600	300
Power Supply	5v/12v	5v/12v	5v/12v	5v/12v	5v/12v	5v/12v	5v/12v
Access Time Average Time/ Track to Track (in Milliseconds)		55/3	55/3	282/10	85/3	365/15	158/6
Settling Time (in Milliseconds)		15	15	15	15	15	15
Transfer Rate (Kbits per second) Single Density/Dual Density	50	250	125/250	250	250/500	250/500	125/250
Density (Bits per Inch) Single/Dual Density	1069/2138	3125/6250	4473/8946	4625/9250	3805/7610	3805/7610	4102/8204
Bytes Per Disk Total Bytes (in Thousands) Single Density/Dual Density	16	125/250	125/250	500	875	218.8/437.5	250/500
Number of Sides	1	2	2	1	2	1	1
5¼ Inch Drive Compatibility	No	Yes	Yes	Yes	2 Models; one is 5¼ compat., one is Sony comp.	No, 8 inch compat.	Yes
Covering	Flexible	Rigid	Rigid	Flexible	Rigid	Rigid	Rigid
Hub	None	Plastic	Plastic	Metal	Metal	Metal	Metal
Automatic Shutter	No	Yes	Yes	No	To Be Added	To Be Added	Yes
Media Producers		Maxell TDK		Brown Dysan 3M BASF	Verbatim Brown BASF Athana Memorex		

† Measurement in mm; all others in inches.

BASF with established molding and small assembly technology, while the soft jacketed 3 ¼″ media will have a much wider base from any media manufacturer capable of producing the established technology product of 5 ¼″ and/or 8″ floppies. Also, licensing is not a factor and cost is comparable to standard 5 ¼″ media with the same density. The coined metal hub, pressure sensitive adhesive hub label, and assembly are minimal in cost and should be transparent to the customer particularly in volume. Empirically, the soft jacket approach is also the only successfully demonstrated double sided approach of any of the micros with standard media.

With the proliferation of substandard low cost media in the end user market, it is apparent that customers are very price conscious and will make the soft jacketed 3 ¼″ media a booming success. But a segment of the marketplace will still prefer the hard case and the question now is not which will survive, but how large a segment of the marketplace will be captured by each.

The remaining entrants in the marketplace are the high density contender Hitachi, which does not have wide based U.S. support as a standard but will obviously not quickly vanish thanks to considerable Japanese support, Micro Peripheral Inc support (among others) in the U.S. and some support in Europe (with BASF in Europe positioned to produce the 3″ media). Canon at 3.8″ is a very low density product and IBM at 100mm is purported to be very conservative as well, and not competing in the density range of Tabor, Sony, and Hitachi.

"Standards", as Jim Porter, publisher of *Disk/Trend Report*, states, "are determined by deliveries to the marketplace." Jim feels that the Sony media is now the same as the aforementioned committee's proposal, and drive support from Sony, Mitsubishi, Shugart, and Tandon, along with Sony's new willingness to expedite licensing of media manufacturers, indicate considerable momentum. In fact, Shugart Marketing's Tom Jarrett indicated Shugart would be delivering next month. It is felt that a 3 ¼″ soft jacketed disk supported by Seagate and Tabor drives picked up considerable momentum at Comdex and will continue to escalate as deliveries increase. If deliveries are the key to standard adoption, it appears premature for ANSI to make a decision, and ANSI, conservative in nature, will not be manipulated into early endorsement of a product standard. The real battlefield will have to remain in the marketplace, not at ANSI nor in technical forums or publications.

Microfloppy Standards—Improving The Markets Or Freezing The State Of The Art?

The now splintered attempt to introduce standards into the marketplace for microfloppy media and drives has become a classic example of the problems that beset efforts to introduce standards into the microelectronics industry. On the one side are proponents who espouse the improvement of the marketplace through the promulgation of standards, while their opponents claim that the standards being promoted will simply freeze the technology prematurely or work to the benefit of the advocates of the standard. While simple truth seems to dictate that without standards of some sort all would be chaos, a quandry arises when someone attempts to assert that their idea is the best idea of the truth, or in this case of technological superiority.

When the idea of microfloppy technology was introduced there were several glowing advantages reported by the suppliers: the discs would fit in a shirt pocket, they could hold up to 500 kb per disc, the smaller size would allow higher track density and possibly better accuracy, the smaller physical size would enhance the design of the new generation of personal and business computers, the enclosed design of the discs would prevent dust contamination or friction damage to media, and finally the central hard hub would increase accuracy because it allowed for more accurate positioning of the disc. A great deal of impetus built up for the 3.5 inch design as the standard of popular choice—indeed it may be the only design being built into several major systems. At one point up to 21 companies appeared to be supporting the 3.5 inch drive and media as a standard. Today, however, there are three viable contenders for the marketplace with 3, 3.25, and 3.5 inch drives and media being supported. Several major companies shown in the accompanying chart have had second thoughts, however. One in particular, Seagate, is said to have become worried that supporting the most popular standard might result in a loss of market due to the advanced position of its potential competitors. As a result the support of Brown, Dysan, and Seagate (the three share part ownership) was shifted to another manufacturer that offered a competitive product—Tabor. Hitachi and Matsushita meanwhile were able to line up several powerful manufacturers in their camp and now we find Amdek and MPI working with the 3.0 inch standard supported by the aforementioned companies.

The point of all of the above was perhaps driven home at Comdex by TEC America, who announced a microfloppy disc drive that is 2.0 inches in size. Few of the existing systems have had interchangeable discettes until now, and the proliferation of systems is, if anything, increasing. Why should we come to expect that all manufacturers would conform to the physical rather than technical issues that are of real worth—issues such as compatibility with 5¼ inch drives, data transfer rates, common formats, and similar problems?

—Editor

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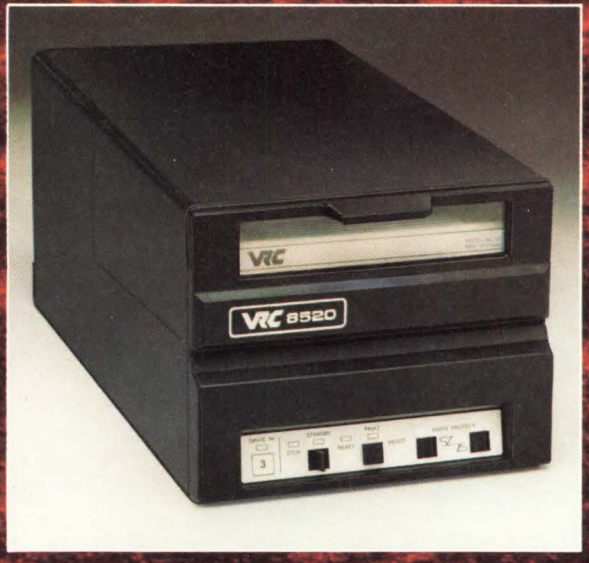

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Removable Winchesters Offer Simple Storage Solutions

by Bob Hirshon

There have always been a number of good reasons not to buy removable Winchester disk drives. They used expensive, non-standard media, they incorporated untried, exotic technologies and, most of all, their very existence seemed self-contradictory: Winchesters, by definition, have always used sealed, intact, non-removable media to provide high capacity and data integrity. Making the disks removable seemingly defeats this purpose.

On the other hand, there are a growing number of good reasons why users are demanding removable Winchesters. Chief among these is the lack of removable on-line mass storage for inexpensive, high-performance small computer systems. This rather specialized-sounding niche is one of the industry's fastest growing, and there are very few alternatives available. Flexible disk systems serve the low capacity niche, and large, removable disk packs handle larger, high-capacity systems. The fast-growing market between these two markets is currently served by small fixed-disk Winchesters combined with a second back-up drive. This second removable-media drive, usually a high-density flexible disk drive or a ¼" cartridge tape drive, provides file back-up (in case of a head crash or other malfunction) and

Figure 2: The Arapahoe 7110's low-mass mini-composite ferrite R/W heads are ramp-loaded onto the moving disk to decrease disk burnishing and increase data integrity.

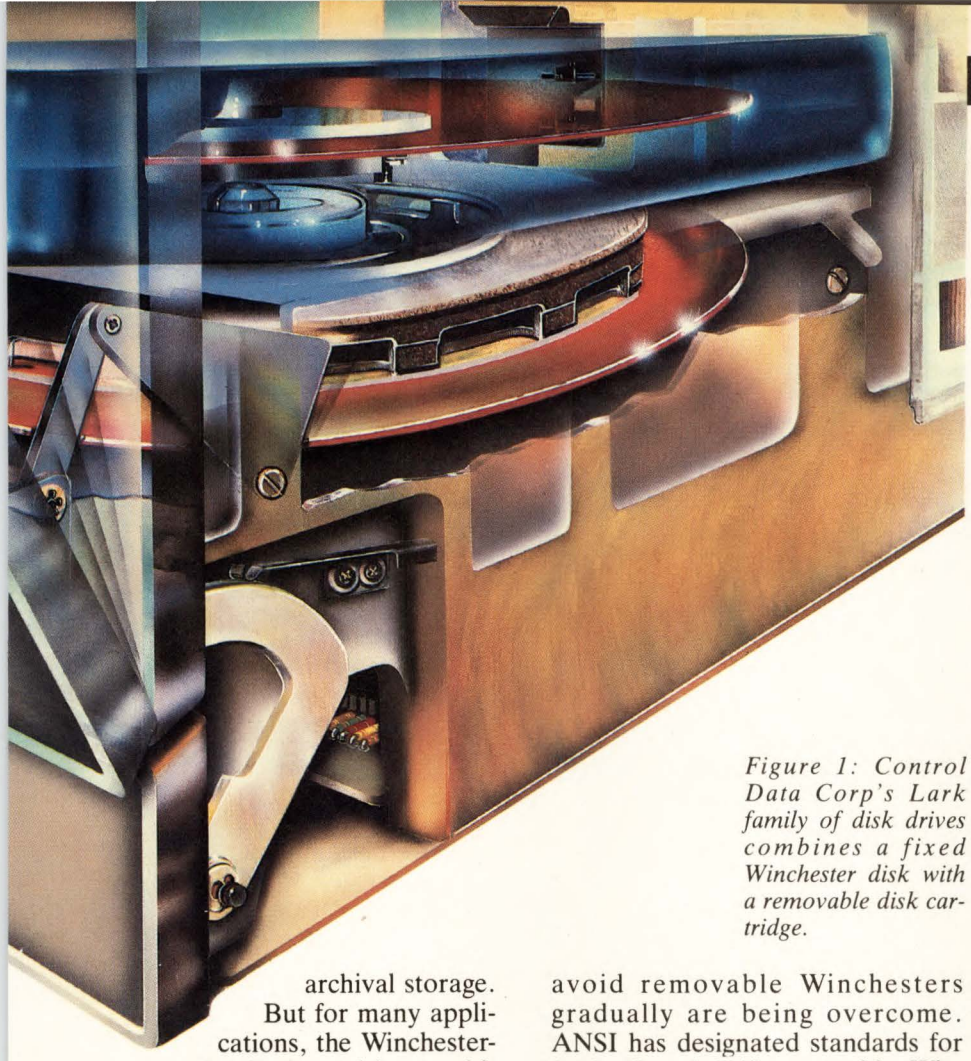

Figure 1: Control Data Corp's Lark family of disk drives combines a fixed Winchester disk with a removable disk cartridge.

archival storage. But for many applications, the Winchester-plus-back-up-drive combination is less than ideal. With few exceptions (the Irwin-Olivetti 510 being one), the back-up drive is not integral to the Winchester drive, and requires added space, power, and electronics. The addition of an extra drive also lowers system reliability. These drawbacks directly oppose a system designer's original purpose in specifying a Winchester—to have a compact, low power, reliable mass storage device.

Mini, micro and sub-micro removable Winchesters look forward to a healthy future, thanks to the boom in small computer systems.

Removable Winchesters appeal to a designer's sense of simplicity. They have one drive, one medium, one interface and a 1:1 data-to-back-up ratio. In addition, the good reasons designers have had to avoid removable Winchesters gradually are being overcome. ANSI has designated standards for both 8″ and 5¼″ removable Winchester cartridges. While this does not allow media interchangeability between different makes of drives (recording formats are not standard) it does allow media second-sourcing. Alternative suppliers of standardized media should lower the cost of removable disks, and thereby partly alleviate another major reason designers stay away from removable Winchesters.

Most importantly, designers are finally beginning to consider removable Winchesters trustworthy. Two years in the field has shown that they perform consistently and reliably, and specifying them has therefore become less of a risk. Also, the addition of a removable Winchester to the disk drive lines of several major manufacturers (most notably, Seagate Technology) gave the technology an air of respectability. Partly thanks to Seagate's blessing, what was once considered exotic has become acceptable.

Current Offerings

Seagate Technology's ST706 is a removable-only Winchester drive—that is, it doesn't have a fixed disk in addition to the removable one, as do some other drives. The ST706 can be combined with Seagate's 5¼″ fixed-disk drives to provide disk-to-disk back-up. It stores 6 Mbytes, unformatted, on an ANSI-standard 5¼″ disk cartridge. Seagate's acceptance of the 5¼″ ANSI cartridge effectively standardized the standard. However, this standardized only the mechanics of the cartridge. Seagate's stepper motor positioning system has a different recording format than servo positioned drives, and Seagate wants plated media for their cartridges. So although the cartridges have been physically standardized, they're not interchangeable between different manufacturers' drives.

Four other manufacturers use the 5¼″ ANSI standard cartridge, according to Bob Johnson, Manager of OEM Marketing and Sales for Dysan, who manufacture the cartridge. They are: Athenaeum Technology, CII Honeywell-Bull (Cynthia Peripherals in the US), DMA and Western Dynex. Athenaeum's Aegis 10/10 features a total of 25.5 Mbytes of storage, half fixed and half removable. Their high density results from the device's closed-loop, dedicated surface servo system and linear voice coil head positioner, which allow it to pack data at 690 tracks per inch, and 9074 bits per inch. Dedicating one disk surface for servo positioning information (rather than embedding ser-

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vo information on the same surface as the data) allows soft-sectoring on the Aegis 10/10. This is a convenient feature, especially for designers upgrading an existing system with a removable Winchester; soft-sectoring allows the Aegis 10/10 to operate with existing system software. A hard-sectored device might force the designer to alter existing software to meet the requirements of the disk drive.

Another soft-sectored 5¼" removable Winchester is the Western Dynex WD505. It uses neither embedded nor dedicated surface servo information for positioning; it has a mechanical, open-loop positioning system. This limits the drive to 5 Mbytes, but it also simplifies the electronics greatly. This, in turn, raises the unit's MTBF to 11,000 power-on hours (most removable Winchesters run at 7000 to 8000 POH) and reduces its cost—in large OEM quantities, the WD505 costs $495 ($975, quantity one). Like Seagate's ST706, it is a removable-only drive with a standard ST506 interface and uses the ANSI standard 5¼" cartridge.

The other two 5¼" drives using the ANSI standard cartridge are from CII Honeywell Bull (distributed by Cynthia Peripherals in the US) and DMA. Both companies manufacture fixed/removable drives employing embedded servo positioning systems. Since sector size is fixed by the embedded servo fields, they are necessarily hard sectored. However, both companies feel that embedded servo positioning offers advantages that outweigh the liability of hard sectoring and other disadvantages, such as the need for more complex electronics. Embedded servo positioning eliminates the need to dedicate an entire disk surface to positioning information, and thereby raises capacity. Because the servo and R/W heads are not physically separated, embedded servo positioning is less affected by temperature change and other environmental stress, and less dependent on precise head alignment.

A 5¼" removable drive using non-standard media is manufactured by New World Computer. Their Mikro-Disc family offers a number of different removable and fixed/removable drives up to a capacity of 8 Mbytes (4 Mbytes fixed, 4 Mbytes removable). The drives feature extremely low access times (as low as 8 msecs) made possible by using up to 32 R/W heads. Transfer rates range up to 6.25 Mbits/sec.

Four companies use ANSI's standard for 8" removable disk cartridges, according to Dysan's Bob Johnson. They are: Amcodyne, Century Data, Disctron (formerly Data Peripherals and Rotating Memory Systems), and Vermont Research. Amcodyne's Arapahoe 7110 provides 50 Mbytes total storage (25 Mbytes fixed, 25 Mbytes removable) in one drive. It uses a μP-controlled embedded servo positioning system and features an access time of 35 msecs. Rather than using Winchester technology, the Arapahoe 7110 uses IBM's Whitney technology, which Amcodyne claims provides better performance and higher data integrity.

Century's C2048 provides 48 Mbytes of storage (16 removable, 32 fixed) by using three fixed disks and one removable cartridge. It employs both a dedicated servo surface *and* embedded servo information. The dedicated servo provides fast access times and accurate timing information, while the embedded servo provides precise positioning for each head.

Disctron's Lynx is an 8" removable-only Winchester designed for use in tandem with the fixed-disk Puma drive. The Lynx has a capacity of 10.6 Mbytes, and uses a μP-controlled linear voice-coil, embedded servo-positioning system.

Vermont Research offers both removable-only and fixed/removable Winchesters. Their removable-only drive, the 8010, provides 11 Mbytes of unformatted capacity, and their fixed/removable 8520 provides 11 Mbytes fixed and 11 Mbytes removable.

Control Data's Lark family is a line of high performance 8" fixed/removable Winchester drives using non-standard media. The two drives that thus far comprise the family are the 9457, with 25 Mbytes fixed and 25 Mbytes removable, and the 9455, with 8 Mbytes fixed and 8 Mbytes removable. Both use embedded servo positioning information and a linear, voice coil actuator.

There is one sub-micro removable-only Winchester on the market, and that is SyQuest's SQ306 (see *Digital Design*, 7/82, "100mm 5-Mbyte Winchester Solves Back-Up Problems"). The SQ306 uses thin film disks 100mm in diameter in a "Q-Pak" cartridge. The SQ306 drive measures just 1.625" high, 4.8" wide and 8" deep and stores 5 Mbytes, formatted. It uses a closed-loop embedded servo positioning system and has an average

Removable Winchester Disk Pros And Cons

Pros

- Eliminates need for external backup device, along with its separate controller.
- Usually lower cost, when considering total sub-system with backup.
- Lower overall space and power requirements.
- Faster backup time than floppies or streaming tape.

Cons

- New technology supported by a small number of companies.
- Expensive media—too expensive for many archival applications.
- Interchangability of disk cartridges between drives from different companies won't be achieved in the foreseeable future.

REMOVABLE WINCHESTER DRIVES

Company	Model	Description	Capacity (Mbytes) fixed/removable	Avg. Access Time (msecs)	Price	For More Information, Write:
Amcodyne	Arapahoe 7110	8″ fixed/removable	25/25	35	$3175 (Qty 100)	Write 210
Ampex	DFR 932 DFR 964 DFR 996	14″ fixed/removable 14″ fixed/removable 14″ fixed/removable	16/16 48/16 80/16	30 30 30		Write 211
Athenaeum Technology	Model 10/10	5¼″ fixed/removable	12.75/12.75	35	$1300 (OEM Qty)	Write 212
Ball Computer	BDA 100 BDA 160 BDA 50 BDA 80	14″ removable 14″ removable 14″ removable 14″ removable	103.2 164.2 54.7 82.9	30 30 30 30		Write 213
Century Data	C2048	8″ fixed/removable	32/16	30	$3000 (OEM 100)	Write 214
Charles River Data Systems	RLX 3010	8″ fixed/removable	31.2/10.4		$9800 (Qty 10)	Write 215
Control Data Corp	CDC 9455 Lark CDC 9457 Lark CDC 9427 Hawk CDC 976X CDC 976X CDC 976X CDC 9710	8″ fixed/removable 8″ fixed/removable 14″ fixed/removable 14″ Storage Module Drive 14″ Storage Module Drive 14″ Storage Module Drive 14″ Storage Module Drive	8.35/8.35 25/25 6/6 40 80 300 82.9	42 35 35 30 30 30 30	$2930 (OEM Qty)	Write 216
Cynthia Peripherals (CII Honeywell Bull)	D520 D120 D140	5¼″ fixed/removable 10½″ removable 10½″ fixed/removable	13/13 12 12/12	40 50 50	$1500 (Qty 100) $1900 (Qty 100) $2675 (Qty 100)	Write 217
Disctron	Lynx	8″ removable	10.6			Write 218
DMA	5R 5/5 5/10 5/15	5¼″ removable 5¼″ fixed/removable 5¼″ fixed/removable 5¼″ fixed/removable	5 5/5 10/5 15/5	40 40 40 40	 $1390 (OEM Qty) $1450 (OEM Qty)	Write 219
IBM	3340A2 3340B1 3340B2	14″ removable 14″ removable 14″ removable	140 70 140	25 25 25		Write 220
Memorex	Jointly markets, manufactures, and develops DMA Systems Corp's line of removable Winchesters.					Write 221
New World Computer	2 2/2 4/2 4/4	5¼″ removable 5¼″ fixed/removable 5¼″ fixed/removable 5¼″ fixed/removable	2 2/2 4/2 4/4	19 19 19 19		Write 222
Santa Clara Systems	Mini-Mega Fixed Removable Subsystems	Subsystems with 5¼″ fixed and SyQuest 3.9″ removable drives	5/5 10/5 15/5	75 75 75	Qty. 1 prices range from $2,895 to $5,056	Write 223
Seagate Technology	ST706	5¼″ removable	6.4	85		Write 224
SyQuest	SQ 306	3.9″ removable	5	75		Write 225
Vermont Research	5017-4 8010 8520	14″ fixed removable 8″ removable 8″ fixed/removable	26.2/26.2 11 11/11	45 33 42		Write 226
Wang Labs	2260 2265 V-1 2265 V-2 2265 V-2B	14″ fixed/removable 14″ removable 14″ removable 14″ removable	6.25/6.25 80 300 300	35 30 30 30		Write 227
Western Dynex	WD 505 6000	5¼″ removable 5¼″ fixed/removable	6.4 6.3/6.3	35 35	$495 (Large OEM Quantities; $975, qty 1)	Write 228

seek time of 75 msecs.

Larger-than-8″ removable Winchesters are somewhat more common. 14″ removable drives are currently offered by Ampex, Ball Computer, Century Data, Control Data, IBM, Vermont Research, Wang, and Western Dynex.

As removable Winchesters have become more widely accepted, companies offering mass storage sub-systems have begun incorporating them into their designs. For example, Charles River Data Systems' RLX-3010 DEC-compatible sub-system includes a Disctron Lynx, Memorex markets the DMA 5¼″ drive, and Santa Clara Systems offers a subsystem based around the SyQuest sub-micro Winchester.

Removable Winchester Future

Market studies by research outfits put the market for mini, micro, and sub-micro Winchesters at about $3 billion to $5 billion dollars by 1986. One premise upon which these predictions are based is that flexible disk drives will remain in their low-capacity niche. This premise may not be a sound one. Three Phoenix Co. has introduced an embedded servo writer for flexible disk drives and is currently working on marketing the technology. Walt Price, Three Phoenix Product Marketing Engineer, claims that embedded servo positioning, like that currently used by Iomega, will enable mini floppies to store 8 Mbytes. Should embedded servo flexible disk technology catch on, it could displace lower capacity removable Winchesters in many small system applications. However, embedded servo floppies will face the same problems as embedded servo removable Winchesters—true media interchangeability will depend on cooperation between drive vendors.

High growth predictions for removable disk drives are based on other assumptions as well. They assume a certain high growth of small computer systems, which is probably reasonably accurate, and a lack of market-shaking technological innovation in mass storage in the next five years, which is probably inaccurate. It may be more meaningful to predict that several billion dollars will be spent in '86 on *some* form of on-line, removable-media mass memory devices—what percentage of this will be removable disks, high-density floppies, or some new, unexpected mass storage technology is impossible to predict. However, removable Winchesters should comprise a healthy chunk, if not all, of the multi-billion dollar market—and the few removable Winchester drive manufacturers now in existence are perfectly pleased at that prospect. □

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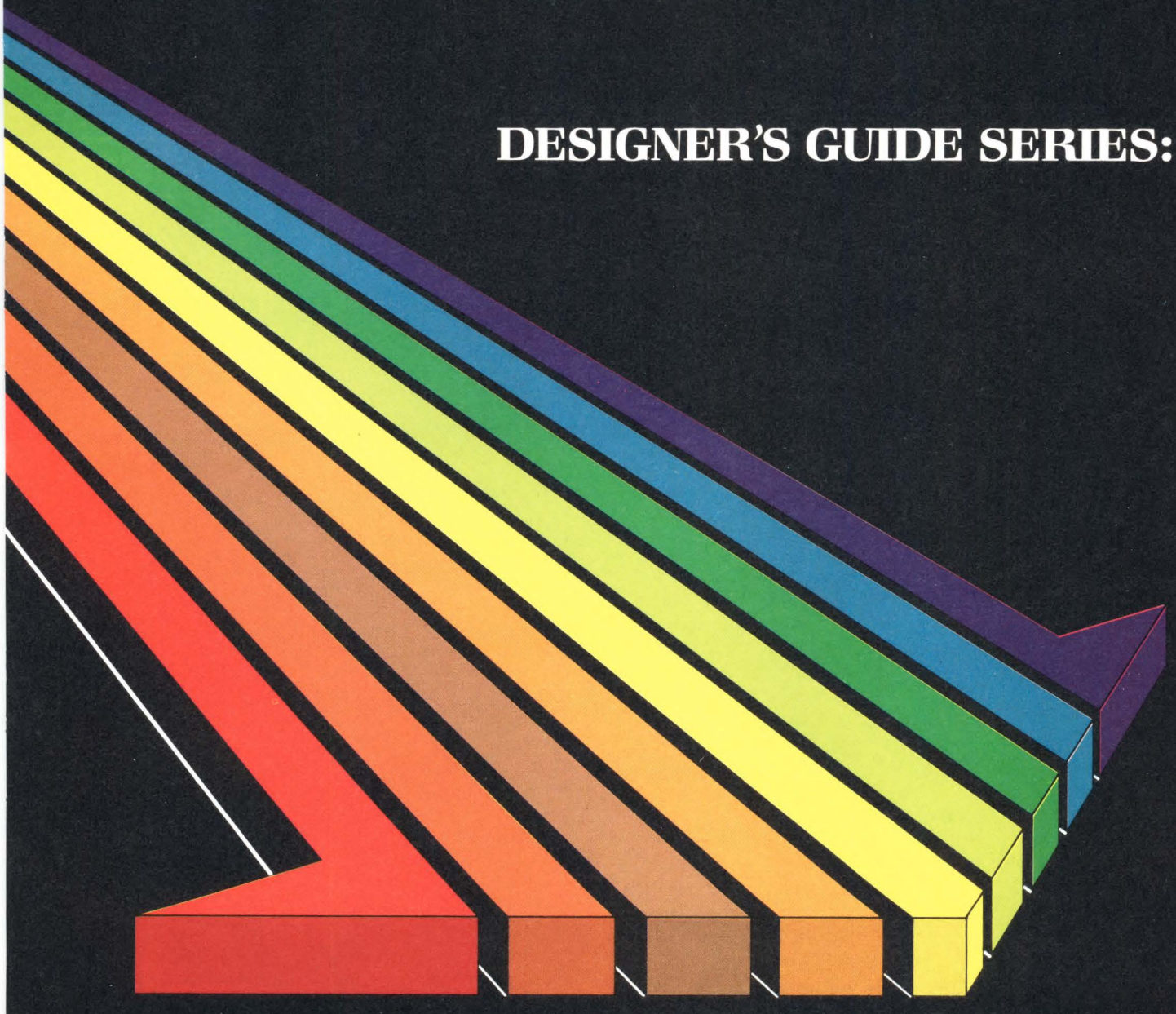

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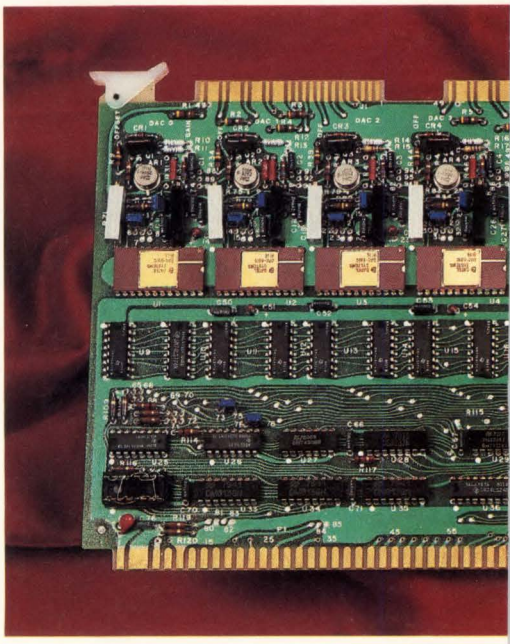

Multibus: Evolving To Meet New System Demands

by Dave Wilson, Senior Technical Editor

With over 800 board level products available from over 150 vendors, the Multibus has evolved to support three generations of VLSI technology—the 8080, 8086 and now the 286. As a testimony to its success as an industry standard, over half a million CPU boards for the Multibus have been shipped to date, according to Intel Corp.

Why has the Multibus been so successful? Rich Bader, Strategic Marketing Manager of Intel's Modules Operations, has some ideas.

"We think it takes four key ingredients to make a successful Standard. First, technical credibility—the proposed standard must be perceived as viably filling a technical need. Second, industry support by a number of market leaders. Third, a strong central point of control over the specification is needed to ensure compatibility with the Standard. With the approval of Multibus spec by the IEEE, they will now play that role. And fourth, the demonstration of the ability to evolve the standard to satisfy new requirements and do so in a compatible fashion."

Multibus History

The Multibus architecture has a long history of evolution. Previously, Intel incorporated the iSBX bus for on-board I/O expansion, dual port memory, established enhanced multiprocessing support with the intelligent slave interface, and a multiprocessing soft-

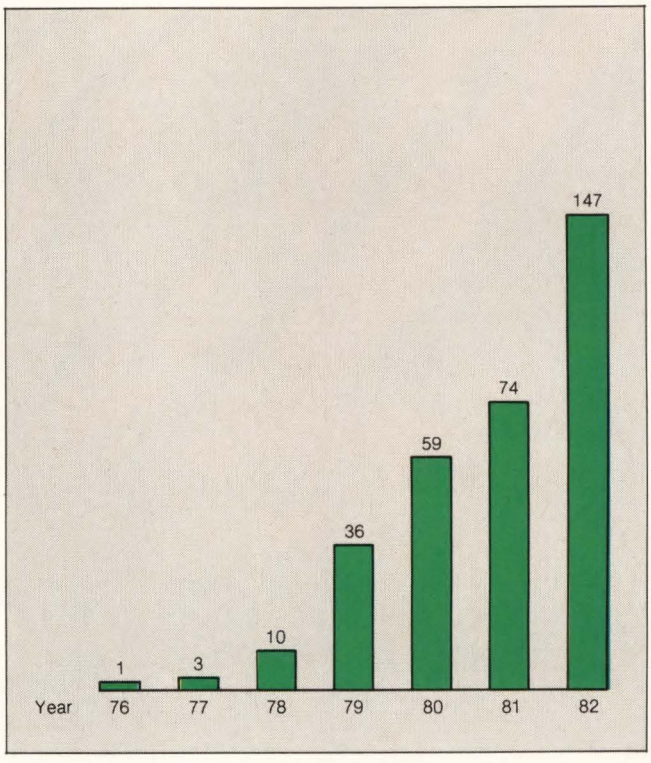

Figure 1: Multibus vendor growth.

Cover design courtesy Intel Corp.

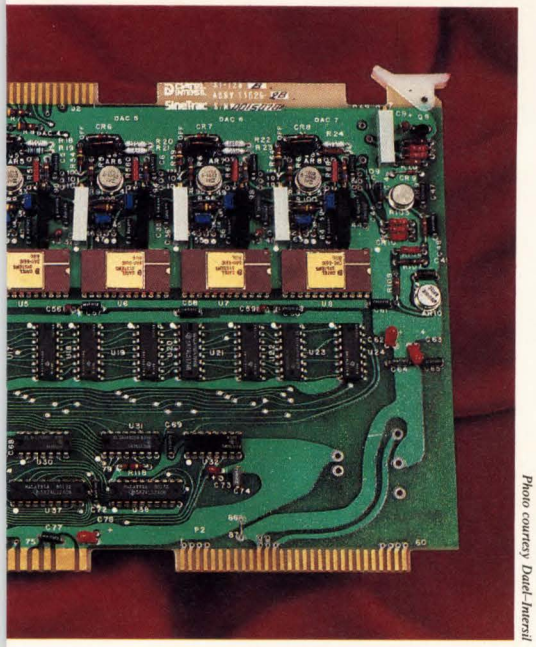

Photo courtesy Datel-Intersil

The Multibus supports three generations of VLSI technology—the 8080, 8086, and now the 286. The role of the Multibus architecture will evolve to meet the demand for 32- bit systems.

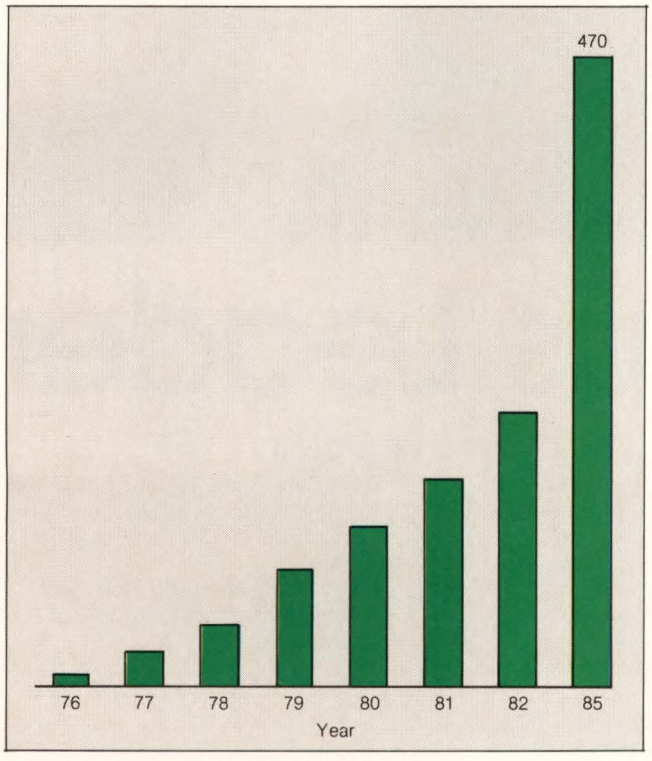

Figure 2: Multibus product revenue ($M).

ware package called MMX 800 (Multibus Message Exchange). All are part of what Intel claims is a consistent architecture for high performance, cost-effective microcomputer systems. Intel has been busy over the last year continuing this evolution, adding two additional bus structures: the iLBX Bus, a high speed execution bus; and the Multichannel I/O Bus, for very high-speed I/O. According to Rich Bader, these structures support a consistent architecture and are something unique to the Multibus system.

"Just a bus structure is no longer sufficient to take maximum advantage of the new VLSI technology. The Multibus represents an architectural concept with all of the features needed to implement it. Our customers have told us the architectural model is what they needed most, and we agree it's the key to long-term success." Multibus vendor growth is indicated in **Figure 1**; Multibus product revenue is illustrated in **Figure 2**.

RAM Requirements

As the designer builds high performance systems that include multiple SBCs, he finds that it is impossible to put all of his memory requirements onto the SBC; there is physically not enough space. RAM requirements are increasing at a rate faster than the RAM density of VLSI, due to processors such as the 286 and the 68000 that can address large memory spaces.

Intel has recognized that the architecture of a sys-

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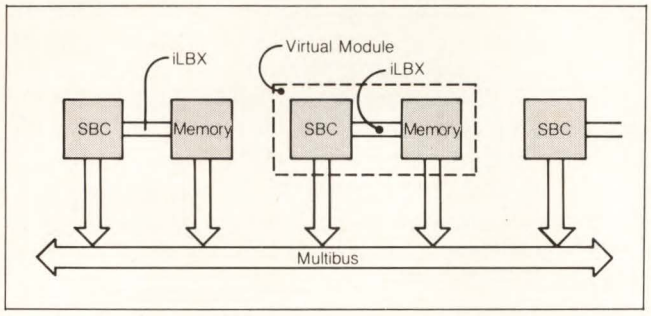

Figure 3: The iLBX bus.

tem must be able to support this and has introduced the iLBX, an add-on bus that allows the designer the ability to communicate between an SBC and memory card without tying up the Multibus. Typically, if the designer has been unable to put all the memory he requires on the SBC board, he has put the memory on the systems bus. This, however, causes the system to be used for execution. With the kind of processor performance that is available today, system buses cannot handle execution, DMA and interprocessor communication, and have sufficient bandwidth. For example, the Multibus bandwidth is not large enough to efficiently support multiple iAPX 286 or 68000 SBCs and memory boards. Bader claims, "VME bus users will find out very quickly they have the same problem." As a consequence, if the user intends to build big memory intensive systems, he needs a bus that can move the execution off the system bus and allow the system bus to focus on other things, such as DMA and interprocessor communication and have a separate high bandwidth bus to support the memory.

Enter The iLBX

With the iLBX bus the user can have as many virtual modules, consisting of SBC and memory as he requires **(Figure 3)**. From an architectural standpoint, having the SBC and the memory board all talking to the Multibus, the collection of boards looks like a collection of SBCs with all the memory physically on the card. A number of other companies have already introduced similar bus structures like this, e.g. Microbar. (Microbar call their aproach a dual bus.) Microbar will continue to support the dual bus, but they have announced their intention to support the iLBX bus in the future, as well. Microbar may perceive that with Intel backing the iLBX will become the next element in the industry standard architecture. Microbar's Dual Bus computer family features both the 8086 and 68000 μPs and utilizes a high speed dual bus architecture very

similar to Intel's recently announced bus extention. "Intel's iLBX validates our dual bus architecture" says Rich Boberg, President of Microbar systems, "and because of the design similarities, compatibility with the iLBX will be quick and easy." Microbar will offer the iLBX for both the 8086 and 68000 based CPU boards, as well as dual-ported memory for demanding high-performance applications. Interphase, Zendex, Central Data and Plessey have also announced their intent to support the iLBX bus.

Spec It

The 796 specification covers the P1 connector on the Multibus and includes 4 address lines on the P2 to allow for 20-bits of address. The remaining lines on the P2 connector were previously declared in the spec to be reserved. The iLBX will be physically on the P2 connector giving a standard definition of a function on that connector. The iLBX will be typically used for processors talking to memory.

However, if the designer has an application where he wants to use the P2 connector for other functions, there is no reason why this cannot be done. For example, if he has an A/D converter board he wishes to interface to the Multibus and does not need the iLBX bus, there is no reason to dedicate the pins for that function. The iLBX bus runs at 19 MB/sec when doing 16-bit transfers. If the user has 3 processors running, all talking to memory over their own iLBX bus, the total bus bandwidth in the system totals to 67MB/sec. (19 x 3) iLBXS plus the Multibus (10MB/sec.). The VME Bus is not significantly faster than the Multibus system bus structure and VME does not offer this type of iLBX bus—they do not offer a systems bus architecture, simply one bus structure.

In summary, bus bandwidth requirements are about doubling every 2 years, because of the increase in processor performance. With more multiprocessing systems, with faster processors and the inability to put all required memory onto an SBC, the iLBX bus is essential to build high performance systems.

Faster I/O

As processors are getting faster and faster, users require faster I/O as well. Just as execution can consume bandwidth on the systems bus, very high speed I/O can do the same. As the Multibus architecture continues to evolve, the system bus will be used for what can generically be called interprocessor communication; that may be a smart disk talking to a smart data processing unit, so it may have some resemblance of DMA I/O, but it will evolve more towards interprocessor communication as all of the boards become smart and they preprocess data that is being passed within the system.

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Multibus

With the architectural desire to devote the Multibus system bus to interprocessor communication, and in order to satisfy the need for higher performance I/O, Intel needed a very high speed bus for I/O transfers. Their customer base stated requirements for a fast bus that would allow them to run the bus outside the card cage (all system buses are card cage restricted), from box to box to a data acquisition system, for example. The customers also wanted a solution to the architectural problem. The Intel solution (**Figure 4**) was to create yet another bus structure called the Multichannel bus. In order to provide more buffer memory than implemented on the controller, the bus can also talk directly to the backside of additional memory boards. This allows the designer to move data into memory rapidly and move the data around at his leisure on the Multibus.

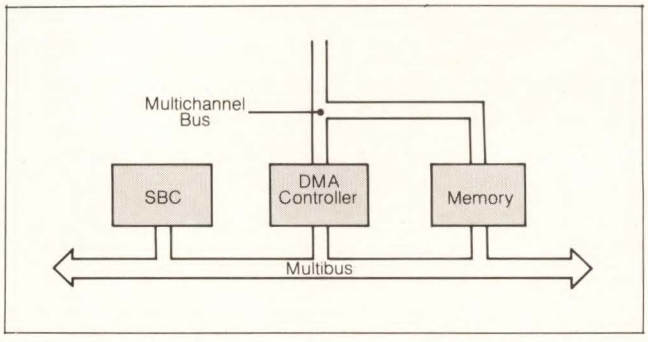
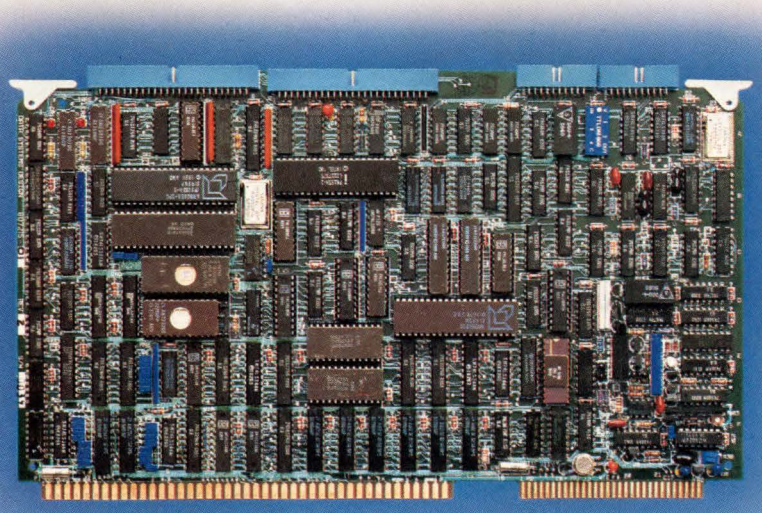


Figure 4: The Multichannel bus.

The DMA

The DMA controller, (**Figure 4**), dubbed the iSBC 589, can have control over the access of data, and according to the Multichannel specification, the user may also build on smart I/O devices to be able to do the transfer directly. **Figure 5** shows a system configuration using a Multichannel and iLBX interface for additional buffer memory. The SBC can access the system memory over the iLBX, and the Multichannel device can transfer information thru the 580 into the memory. It is

ONE SLOT SHOPPING.



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DATA SYSTEMS DESIGN

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Multibus

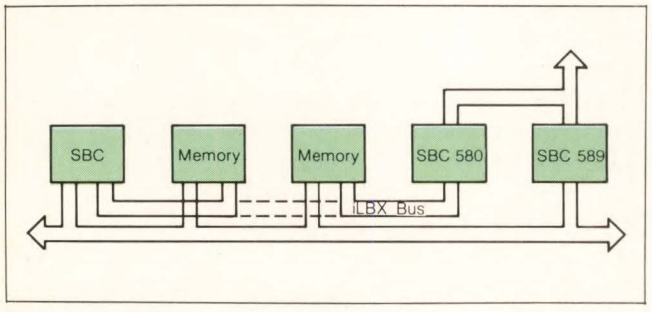

Figure 5: Multichannel iLBX interface.

left up to the designer to decide if he requires the 580 to transfer data over an iLBX bus that is common or separate from the SBC (see dotted lines), to establish the proper bus bandwidth balance. The 580 converts the protocol of the Multichannel bus to the protocol of the iLBX bus.

The multichannel bus is capable of tranferring data at 8 MB/sec. Using a block transfer protocol, it can transfer up to 15 meters (50 ft.) supporting up to 16 devices. The Multichannel protocol is similar to the IEEE 488 bus, in that it has talker/listener and controller functions—the difference is that it is significantly faster.

What About VME?

Many rumblings were heard at Comdex Fall '82 about the VME bus and its support of 32-bit machines. One manufacturer even said he wished Intel would get a move on and support it themselves. Intel's Rich Bader stated:

"Motorola has been trying to position the VME bus as a high performance bus. But if you look at the spec, it is only marginally faster than Multibus—we looked at system bus throughput—it's about 20% faster. However, because of the kind of technological change we're seeing, it's clearly insufficient. Major enhancements, like the execution bus are needed to keep up with the technology. My contention is that our systems bus architecture is a clear head and shoulders performance winner over the VME bus. Our architecture is abso-

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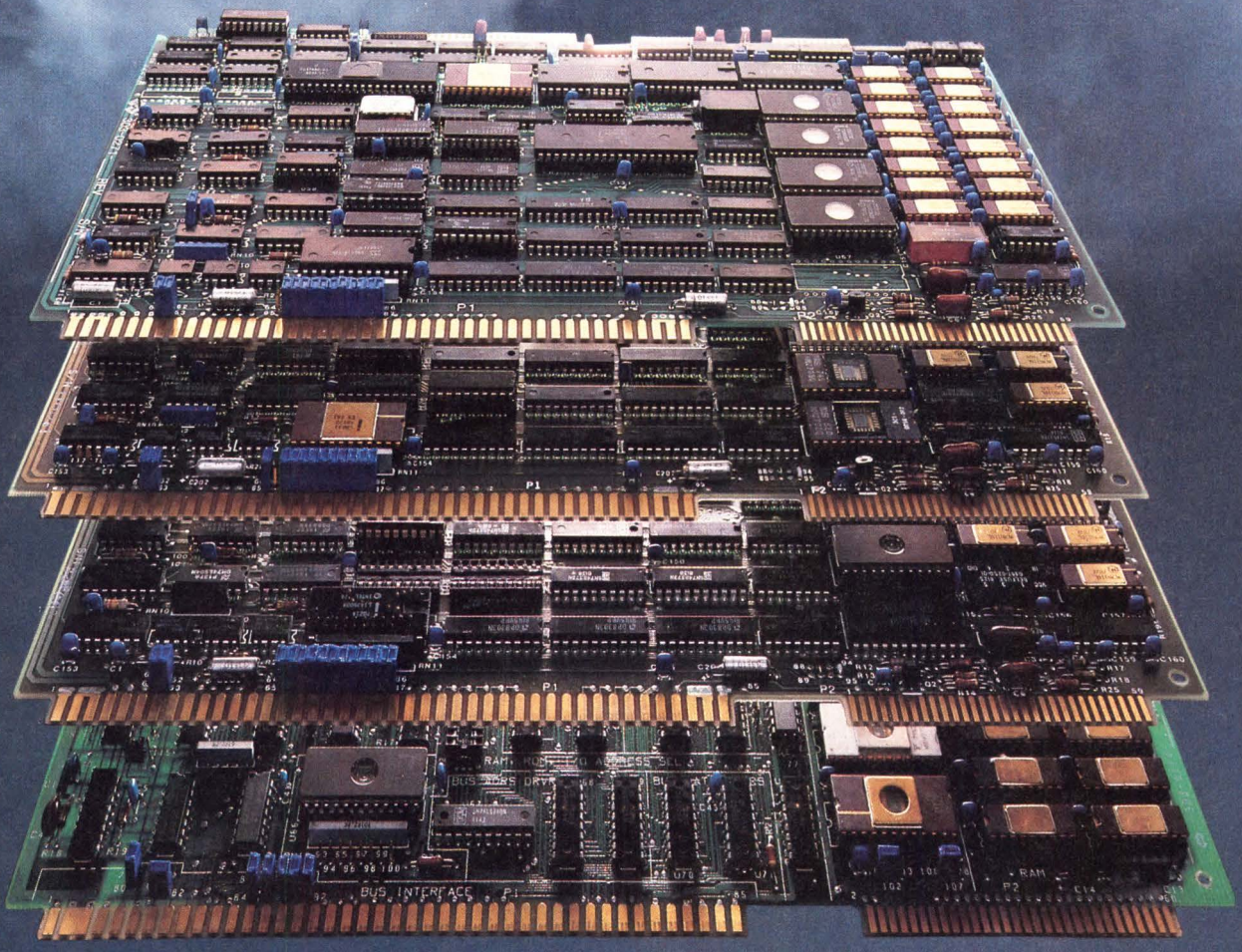

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lutely necessary to build future high performance systems."

There is a history of minicomputer companies that have gone through a similar evolution as they have been reaching for higher performance in their systems. The same kinds of problems they were faced with are similar to the ones that Intel is now finding in the μC area. "People that have been exposed to the Intel bus architecture and compare it with what they have with VME say the choice is clear," continues Bader. "If they want to build those high performance systems they're going to need this architecture and the VME bus appears to be just a bus structure without an architecture. With the proven track record and products available, the Multibus is the obvious business choice as well."

There is no execution bus within the VME spec or any of the products that exist on the VME bus, and there is no high performance I/O bus that is being offered. Nor does there seem to be room to add them on the connectors. However, an I/O channel does exist, a 2MHz, 8-bit only channel that does not support DMA. Bader feels that it is analogous to the iSBX multimodules that Intel put on their SBCs to enhance the features. "It's something we did 3 years ago," he added.

What about 32-bits? "Of course Intel is developing a 32-bit evolution to the Multibus architecture, called Multibus II. Now, with our architecture more fully established, that's the next step. It will offer significantly higher performance than existing structures, and incor-

Imaging Boards – Flexible Building Blocks Open

Imaging boards such as those manufactured by Datacube and Imaging Technology may be viewed simply as data acquisition and display systems. An analog signal from a video camera or other video source, such as a VTR, is converted to digital value by an A/D converter. The information is then stored in memory where it is available to the Multibus. Information from the memory also goes back to a D/A, where the digital data is converted to analog form for display on a video monitor.

"What makes us different is that we have intelligence on our board (an ALU) that can crunch pixels at 10^6/sec," says Bob Wang at Imaging Technology, "We're looking at the basic signal processing market with ALU capability—the fact is you can now take a camera input, store that, take another input, add it to what you've just started with, divide it by 2, and store it again."

This process of averaging data, called a running average, can reduce noise levels tremendously; a useful feature in low-light environments that use infra-red cameras.

"There are some things that ALUs are nice for," adds Dave Erikson at Datacube, "Such as subtraction of images in real time." (See *Digital Design,* October 1982). "But everything an ALU can do, a CPU/board can too—but not in real time. A complete screen may take several seconds as opposed to parts of a second. We've found that 99% of applications can be met by the CPU and they don't have to be done in real time."

"In some applications it makes no difference whether you acquire and process a frame in 16ms, if it has to be chewed up for 5s by the CPU," states Stan Karandanis, President of

Product	Resolution	Date Available
VG120	320 × 256 × 6 Bits	Now
VG121	320 × 242 × 6 Bits 320 × 484 × 6 Bits	Now
VG221	640 × 242 × 3 Bits 640 × 484 × 3 Bits	Now
VG123 2 Board Set	768 × 242 × 8 Bits 768 × 484 × 8 Bits 384 × 242 × 8 Bits 384 × 242 × 8 Bits	Now
VG124	640 × 242 × 6 Bits 640 × 484 × 6 Bits	2 months
VG131	$\binom{768}{384} \times \binom{242}{484} \times 8$ Bits With ALU	2–4 months
VG140	512 × 512 × 4 (8) Bits 3 Port memory with very high speed vector input port	2–4 months

Table 1: Datacube's product line: Past & Future

porates support for other requirements needed in the 1980's and 1990's; like enhanced multiprocessing support, reliability and serviceability, and so on. And perhaps most importantly, you will be able to utilize existing Multibus cards in a Multibus II environment. Preserving everyone's investment in existing hardware will give Multibus II an enormous headstart on industry-wide acceptance," Bader concluded.

Multibus Structural Features

The Multibus interface is an asynchronous, multiprocessing system bus designed to perform 8-bit and 16-bit transfers between single board computers, memory and I/O expansion boards. Its interface structure consists of 24 address lines, 16 data lines, 12 control lines, 9 interrupt lines and 6 bus exchange lines. These signal lines are implemented on SBCs and a mating backplane in the form of two edge connectors resident on 6.75″ × 12″ form factor PC boards. One of the big complaints about the Multibus is that the form factor is too big. The iLBX concept gets around that by defining a set of modular I/O cards, so that the user may tailor his system to his own requirements inexpensively. The primary 86-pin P1 connector contains all Multibus signal lines except the four address extension lines. The auxiliary 60-pin P2 connector contains the four Multibus address extension lines, and reserves the remaining 56 pins for implementing the iLBX Execution Bus into Multibus system architecture.

New Markets

Datacube, "If functions such as linear to polar co-ordinate conversions, matrix shift rotate/displace and non-integer zoom could be done by the ALU, you've got yourself some features. And it can be done! It's being done by Thomson CSF but it costs $50,000. It's possible to zoom in on a portion of an image—but that takes more than just a barrel shifter and an ALU to do."

"This month we will have a VG131 (**Table 1**) at least defined," he adds. "It will be the first of our products with an ALU for hardware image integration. We're going to be talking about a single Multibus board as well, not several."

End Users Want More

"The problem with an end user is that he always wants more," continues Bob Wang. "He sees the capability of image subtraction and now he wants to measure the size of the subtracted image. That's a completely different class of problem." If, for example, a user wants to take 2 images, and subtract them, he can use one of IT's driver packages, supplied on a floppy disk and written in μP code. "While most people are happy with that right now, we will definitely have to head towards a much better support as far as software is concerned, in order to make the product more effective," says Wang.

Applications

Although "These products aren't going into the world's most sophisticated image processing systems," according to Stan Karandanis, application areas for imaging boards are broad and diverse, and they range from teleconferencing to radar and supermarket check-out counters.

Today, Datacube is currently interfacing with a customer who wants to dispense with bar codes on products and the necessity for a laser scanner at check-out counters. "We can go back to just a label that the customer can read—it will be waved over a solid-state sensor that inputs the item and price into the cash registers regardless of rotation. Machine and human can have a common language and that's important," says Karandanis. "$1,000 at every station isn't unreasonable at all, and that's existing technology," adds Erikson.

Another customer is looking at archiving X-rays, on videotape. Instead of having 54,000 frames of continuous movement, the tape holds 54,000 individual X-rays. "We can record an ID code recorded on the audio track (or control track) depending on the tape recorder, identify a unique frame, grab that off the tape and freeze it for a doctor to examine. Conventional media like Winchesters have a data rate integrity of one part in ten, but the fact of the matter is, when you're dealing with the human eye, you can tolerate more data error," says Karandanis, "And when you think of the data available to you on a one hour videocassette, you have 2^{10} Bytes of data for under $1,000. And the tape costs ten bucks!"

"Right now you can hook a camera to some of our boards, but the camera costs as much as the boards—and the system requires three boards." Datacube's new VG123 Board is a 2 board solution that can hook up to low-cost cameras and be compatible with low cost monitors. "The 123 will have the ability to lock into the NTSC color subcarrier so you can digitize full color signals and freeze them as frames. We're going to attack the teleconferencing market with that product," states Erikson.

	(COMPONENT SIDE)			(CIRCUIT SIDE)		
	Pin	Mnemonic	Description	Pin	Mnemonic	Description
Power Supplies	1	GND	Signal GND	2	GND	Signal GND
	3	+5	+5 VDC	4	+5	+5 VDC
	5	+5	+5 VDC	6	+5	+5 VDC
	7	+12	+12 VDC	8	+12	+12 VDC
	9	−5	−5 VDC	10	−5	−5 VDC
	11	GND	Signal GND	12	GND	Signal GND
Bus Controls	13	BCLK/	Bus Clock	14	INIT	Initialize
	15	BPRN/	Bus Priority In	16	BPRO/	Bus Priority Out
	17	BUSY/	Bus Busy	18	BREQ/	Bus Request
	19	MRDC/	Memory Read Command	20	MWTC/	Memory Write Command
	21	IORC/	I/O Read Command	22	IOWC/	IO White Command
	23	XACK/	XFER Acknowledge	24	INH1/	Inhibit 1 Disable RAM
	25	AACK/	Advance Acknowledge	26	INH2/	Inhibit 2 Disable ROM
	27		Reserved	28		Reserved
	29		Reserved	30		Reserved
	31	CCLK/	Constant Clk	32		Reserved
	33		Reserved	34		Reserved
Interrupts	35	INT6/		36	INT7/	
	37	INT4/		38	INT5/	
	39	INT2/	Parallel Interrupt Requests	40	INT3/	Parallel Interrupt Requests
	41	INT0/		42	INT1/	
Address	43	ADRE/		44	ADRF/	
	45	ADRC/		46	ADRD/	
	47	ADRA/		48	ADRB/	
	49	ADR8/	Address Bus	50	ADR9/	Address Bus
	51	ADR6/		52	ADR7/	
	53	ADR4/		54	ADR5/	
	55	ADR2/		56	ADR3/	
	57	ADR0/		58	ADR1/	
Data	59	DATE/		60	DATF/	
	61	DATC/		62	DATD/	
	63	DATA/		64	DATB/	
	65	DAT8/		66	DAT9/	
	67	DAT6/	Data Bus	68	DAT7/	Data Bus
	69	DAT4/		70	DAT5/	
	71	DAT2/		72	DAT3/	
	73	DAT0/		74	DAT1/	
Power Supplies	75	GND	Signal GND	76	GND	Signal GND
	77	−10	−10 VDC	78	−10	−10 VDC
	79	−12	−12 VDC	80	−12	−12 VDC
	81	+5	+5 VDC	82	+5	+5 VDC
	83	+5	+5 VDC	84	+5	+5 VDC
	85	GND	Signal GND	86	GND	Signal GND

Table 1: Multibus groupings and pin assignments.

Multibus Elements

The Multibus system bus supports three device categories: Master, Slave and Intelligent Slave. A bus master is any module that has the ability to control the bus. This ability is not limited to only one master device. The Multibus interface is capable of supporting multiple masters on the same system through bus exchange logic. Once access has been acquired by a master device, it has a period of exclusive control to affect data transfers through a generation of command signals and memory or I/O addresses.

A bus slave device is a module that decodes the address lines on the Multibus and acts upon the command signals from the bus masters. Slave devices are not capable of controlling the Multibus interface. The intelligent slave has the same bus interface attributes as the slave but also incorporates an on-board μP, memory and I/O allow the intelligent slave to complete onboard operations without access.

Interface/Signal Line Descriptions

The Multibus systems bus signal lines are grouped into five classes based on the functions they perform: 1) control lines 2) address and inhibit lines, 3) data lines, 4) interrupt lines, 5) bus exchange lines. **Figure 6** illustrates the implementation of these signal lines. The Multibus control lines are broken down into five subgroups: clock signals (2), commands (4), acknowledge (1), initialize (1), and lock (1). The two clock signals provide for the generation of a master clock for the system and the synchronization of bus arbitration logic. The four command lines are the communications links between the bus masters and bus slaves, specifying types of operations to be performed such as reads or writes from memory or I/O. The transfer acknowledge line is the slave's acknowledgement that a requested action of the master is complete. The initialize signal is generated to reset the entire system to a known state. The lock signal is used by an active bus

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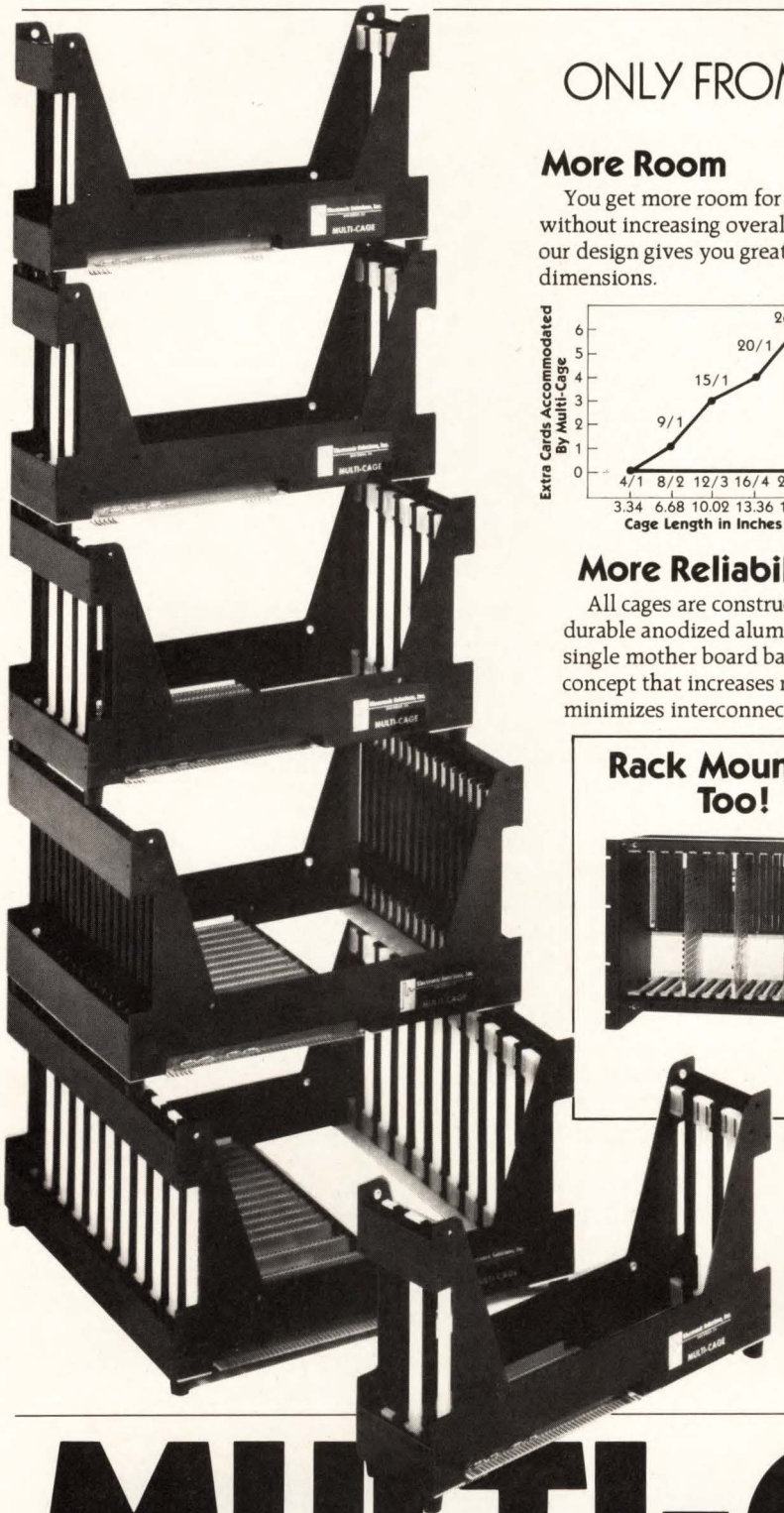

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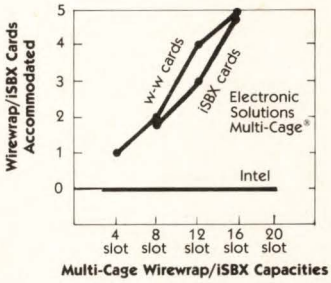

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COMPONENT SIDE				SOLDER SIDE		
16-Bit Pin	Mnemonic	Signal Name		16-Bit Pin	Mnemonic	Signal Name
1	DB0	DATA LINE 0		2	DB1	DATA LINE 1
3	DB2	DATA LINE 2		4	DB3	DATA LINE 3
5	DB4	DATA LINE 4		6	DB5	DATA LINE 5
7	DB6	DATA LINE 6		8	DB7	DATA LINE 7
9	GND	GROUND		10	DB8	DATA LINE 8
11	DB9	DATA LINE 9		12	DB10	DATA LINE 10
13	DB11	DATA LINE 11		14	DB12	DATA LINE 12
15	DB13	DATA LINE 13		16	DB14	DATA LINE 14
17	DB15	DATA LINE 15		18	GND	GROUND
19	AB0	ADDRESS LINE 0		20	AB1	ADDRESS LINE 1
21	AB2	ADDRESS LINE 2		22	AB3	ADDRESS LINE 3
23	AB4	ADDRESS LINE 4		24	AB5	ADDRESS LINE 5
25	AB6	ADDRESS LINE 6		26	AB7	ADDRESS LINE 7
27	GND	GROUND		28	AB8	ADDRESS LINE 8
29	AB9	ADDRESS LINE 9		30	AB10	ADDRESS LINE 10
31	AB11	ADDRESS LINE 11		32	AB12	ADDRESS LINE 12
33	AB13	ADDRESS LINE 13		34	AB14	ADDRESS LINE 14
35	AB15	ADDRESS LINE 15		36	GND	GROUND
37	AB16	ADDRESS LINE 16		38	AB17	ADDRESS LINE 17
39	AB18	ADDRESS LINE 18		40	AB19	ADDRESS LINE 19
41	AB20	ADDRESS LINE 20		42	AB21	ADDRESS LINE 21
43	AB22	ADDRESS LINE 22		44	AB23	ADDRESS LINE 23
45	GND	GROUND		46	ACK*	SLAVE ACKNOWLEDGE
47	BHEN	BYTE HIGH ENABLE		48	R/W	READ NOT WRITE
49	ASTB*	ADDRESS STROBE		50	DSTB*	DATA STROBE
51	SMRQ*	SECONDARY MASTER REQUEST		52	SMACK*	SECONDARY MASTER ACKNOWLEDGE
53	LOCK*	ACCESS LOCK		54	GND	GROUND
55	ADR22*	MULTIBUS® ADDRESS EXTENSION LINE 22		56	ADR23*	MULTIBUS ADDRESS EXTENSION LINE 23
57	ADR20*	MULTIBUS® ADDRESS EXTENSION LINE 20		58	ADR21*	MULTIBUS ADDRESS EXTENSION LINE 21
59	RES	RESERVED		60	TPAR*	TRANSFER PARITY

Table 2: Pinouts for the iLBX bus.

master to lock dual ported for mutual exclusion. The address and inhibit lines are made up of 24 address lines, two inhibit lines and one byte control line. The 24 address lines are signal to carry the address of the memory location or the I/O that is being referenced. These 24 lines allow a maximum of 16 Mbytes to be accessed.

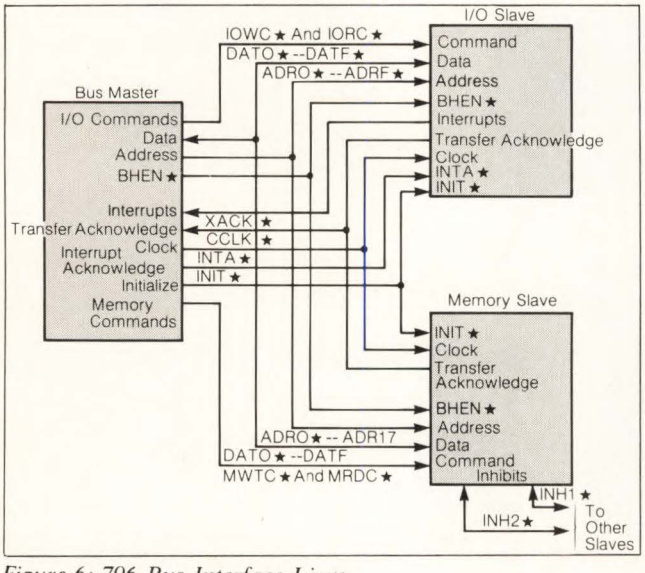

Figure 6: 796 Bus Interface Lines.

When addressing an I/O device, sixteen address lines are used to address a maximum of 64K devices. The two inhibit lines are used to allow different types of memory (RAM, ROM, etc.) having the same memory address to be accessed in a preferred priority arrangement. The byte control is used to select the upper byte of a 16-bit word in systems incorporating 16-bit memory and I/O modules. The Multibus interface supports sixteen bi-directional data lines to transmit information to or from a memory location or an I/O port.

The Multibus interrupt lines consist of eight interrupt request lines and one interrupt acknowledge line. Interrupts are requested by activating one of the eight interrupt request lines. The interrupt acknowledge signal is generated by the bus master when an interrupt request is received. It effectively freezes the interrupt status and requests the placement of the interrupt vector address onto the data lines. There are six bus exchange lines that support two bus arbitration schemes on the Multibus system bus. A bus master gains control of the bus through manipulation of these signals. The bus request, bus priority, bus busy and bus clock signals provide for a slot dependent priority scheme to resolve bus master contention on the Multibus interface. Up to eight bus masters can be supported on the Multibus. Use of the common bus request signal line can save arbitration time by providing for a higher priority path to gain control of the system bus.

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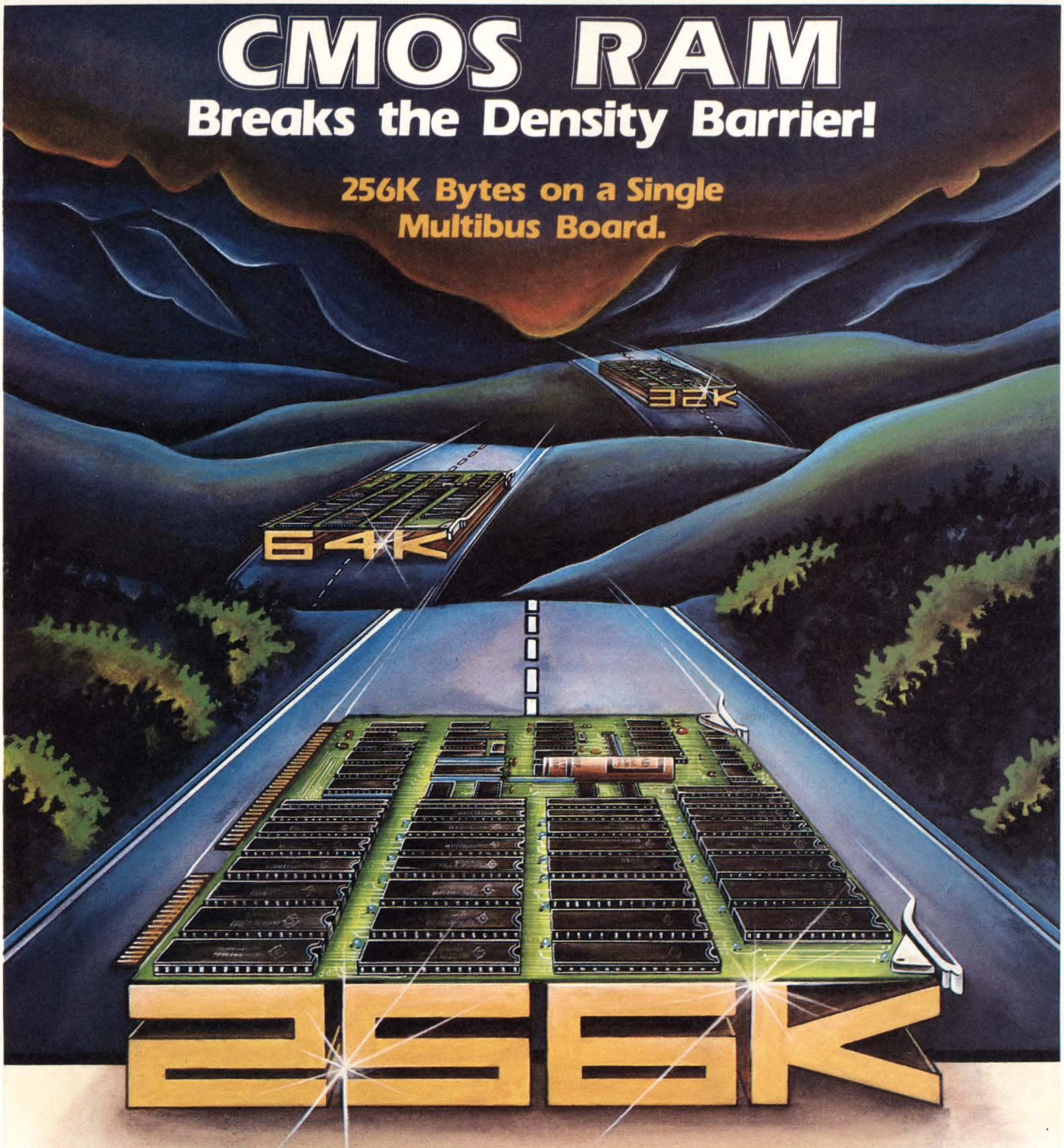

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iLBX Structural Features

The iLBX uses a non-multiplexed 16-bit configuration capable of 8 and 16-bit transfers. Used in conjunction with the Multibus interface, the iLBX bus resides on the Multibus form factor P2 connector and supercedes the Multibus interface definitions for the P2 signals. The iLBX bus uses the standard 60-pin Multibus P2 connector and occupies 56 of the P2 connector pins with 16 data lines, 24 address lines plus control, command access, and parity signals. The four Multibus address extension lines on the Multibus iLBX P2 connector retain the standard Multibus interface definition.

iLBX Bus Elements

The iLBX bus supports three distinct device categories: 1) Primary Master, 2) Secondary Master, 3) Slave. These three device types may be combined to create several iLBX local buses ranging in size from a minimum of two to a maximum of five devices per iLBX bus. There is only one Primary Master in any given implementation of iLBX bus, and its presence is required along with the attachment of at least one Slave device. To provide alternate access over an iLBX bus, one optional Secondary master may be incorporated to create a "two-master" local bus subsystem. By limiting the iLBX bus to two Masters (a Primary and a Secondary), bus arbitration is reduced to a simple request and acknowledge process, with privileged use of the bus maintained by the Primary Master, and limited access granted to the Secondary Master when needed.

LAN Boards For The Multibus

A recent draft of the IEEE 802 states that the applications environment for the local area network is intended to be commercial and light industrial. Use of the local network in home or heavy industrial environments, while not precluded, is not considered. Specifically, the use of the local network for process control and other real-time, high reliability applications is also not considered. Taking into account the kind of environments that both Interlan and Proteon are selling into at the moment the statement would appear to be wrong.

At present, most R & D groups are creating a prototype and testing the technology before applying it. Many people are also using networks in the CAD/CAM area to link together expensive graphics processors. A third market, the one not discussed in the IEEE document is in process control. Although there has been some debate about Ethernet in the PC industry, some are using it as a channel between front-end processors and back-end devices like the PDP-11.

Earlier networks were stars, such as airline reservation systems that access central processing systems where communications were from user to mainframe. "That's getting to be passé, when you look at what's happening now," says Howard Salwen at Proteon. "Over at the lab for computer science they are experimenting with one VAX per user—you don't have a star network anymore but diffuse computer power spread over the floor."

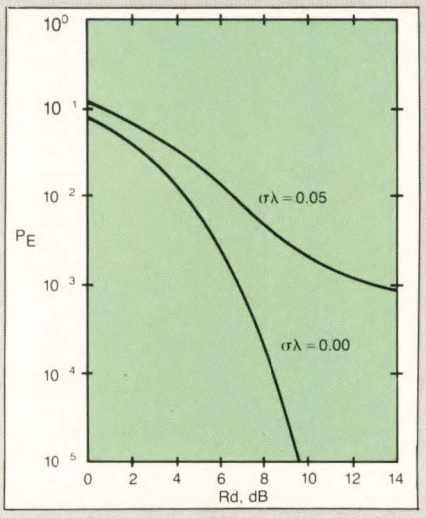

Figure 1: Average Probability of Error vs. Signal-to-Noise Ratio for Manchester Encoded Data.

Interlan and Proteon are offering different networking schemes to the marketplace both compatible with the Multibus. Interlan announced its first three major products, the NMIO Ethernet Protocol Module, NI 1010 Unibus and NI 2020 Q bus controllers in November 1981. The companies' fourth product was introduced in 1982. The NI310 Multibus Ethernet communications controller interfaces Multibus-based systems to the Ethernet local area network. It is specifically designed for OEMs implementing 68000, Z8000 and 8086-based systems. Interlan's second generation of Ethernet controllers, "the A-series," are claimed by the company to be the only group of products to support high station performances with DMA transfer to/from host memory.

In May, 1982 Interlan announced Etherway, an interconnection between DEC net and Ethernet. The NTIO Ethernet Transceiver featuring a non-intrusive cable top was introduced in September 1982. "Each transceiver top is a low capacitative load on the Ethernet—ours is 6pF at 250K, the lowest impedance on the marketplace," says Bob Olsen at Interlan. In a perfect world, one would like to pull as much energy as possible out of the cable, but one cannot because with Ethernet you have to share among the other users. This is why Interlan's transceiver aimed for such a low capacitive load.

Howard Salwen at Proteon was worried about the effects of transceiver reflections on the performance

The Primary Master executes the role of iLBX bus "supervisor" by controlling the general operation of the bus and managing Secondary Master accesses to the Slave memory resources.

The Secondary Master Device is an option providing alternate access to the Slave resources on the iLBX bus. Secondary Master Devices are typically DMA driven. This feature is provided for implementation flexibility when occasional DMA transfers in and out of iLBX memory resources can optimize the overall system performance. The Secondary Master essentially duplicates the Primary Master's data transfer capability, but must rely on the Primary Master to grant access. Once access is granted, the Secondary Master controls the bus, and drives all signal lines until the operation is complete and control is passed back to the Primary Master.

The Slave devices contain the memory resources used by the Primary Master and the optional Secondary Master. Each iLBX implementation can contain a maximum of four Slave devices. Using 64K RAM technology on four slave devices with ECC can provide for over 2 megabytes of "on board" high performance memory. With 256K RAM chips, each iLBX bus could contain slave devices with memory totalling 8 megabytes. As memory technology increases, the iLBX bus is designed to incorporate it in rapid fashion because it is capable of directly accessing a full 16 megabytes of memory on its high performance Slave devices.

of Manchester encoded systems, such as Ethernet, claiming that it was a cause of many missed Packets. He made his point in a recent article, and from that **Figure 1** shows the effect of synchronization error on probability of error performance in a Manchester encoded system. When the system is running at 10 MB/s, the estimate of bit synchronization must be less than 5ns RMS. Mr. Salwen states that such levels of performance are difficult to achieve in the burst mode. "I think it's important to know that there are problems with Ethernet—I think that software will bury these problems, and most people that use networks will not know that there are a lot of retransmissions going on," he says.

Out of the 500–1000 10 MB/s systems that are presently out in the field, Salwen claims to have greater than 50, 5/10% of the 10 Mbit/s market. His LAN, Pronet, is a token ring that operates at 10 MBit/sec. A maximum of 255 uses may be supported by each ring. **Figure 2** shows an extension of the star-shaped ring concept. Short runs from a wire center to various computers might be connected with twisted pairs. But long runs from wire center to wire center could be implemented with duplex fibre optic links. The attachment point for such fiber optic links at the wire centers includes a bypassing relay. If the fiber optic link connecting the two wire centers shown in **Figure 2** were to fail, the systems would automatically partition into two star-shaped rings with no interconnecting fiber optic link between them.

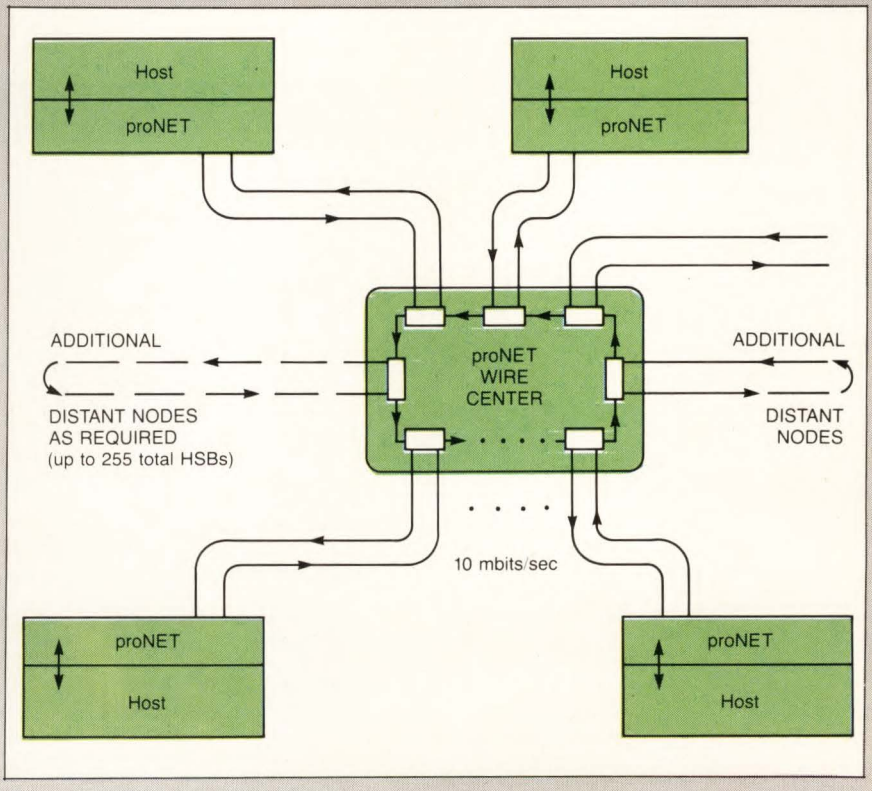

Figure 2: Basic Star-Shaped Ring.

iLBX Bus Interface/Signal Line Descriptions

The iLBX interface is divided into four functional classes of signal lines: address and data lines, control lines, command lines, and bus access lines. The 40 address and data lines defined by the iLBX Bus Specification consists of 16 data lines and 24 address lines. There are 16 bi-directional data lines exclusively used to handle 8-bit and 16-bit data transfers between the active bus master and the selected slave device. The iLBX bus uses these data lines for all data transfers, and are driven by tri-state drivers. The 24 address lines on the iLBX bus provide the ability to directly address 16 Mbytes of memory. These single-direction address lines are exclusively driven by the active bus master. The iLBX bus master uses them to select a specific slave device. Three control lines specify the type of data transfer between master and slave devices, while the three command lines initiate, control, and terminate the transfer. There are also three bus access lines used to transfer bus control between master devices.

iLBX Bus Pin Assignments

The iLBX uses the standard 60-pin Multibus P2 connector. The physical location of each pin asignment and its corresponding function is listed in **Table 2.** The four Multibus address extension lines (pins 55–58 on the P2 connector) retain the standard Multibus interface functions.

iLBX Bus Operation Protocol

The operation protocol for the iLBX bus is a straightforward set of procedures consisting of three basic operations: bus control access, write data to memory, read data from memory. These operations use asynchronous protocol with positive acknowledgement.

iLBX Bus Access

The iLBX is shared by at most two masters; one Primary Master and one Optional Secondary Master, each providing an alternate access path to iLBX bus memory resources. The mechanism for obtaining bus access is a simple request and acknowledgement process communicated between masters. Each master is a bus controller of similar capabilities, responsible for data transfer operations between devices, but the Primary Master has the added responsibility of controlling iLBX bus accesses. The Primary Master has default control of the iLBX bus. If the Secondary Master needs access to the bus, it must initiate a request and

LOWER ROW			UPPER ROW		
Pin	Mnemonic	Signal Name	Pin	Mnemonic	Signal Name
1	GND	GROUND	2	AD0/	ADDRESS DATA LINE 0
3	GND	GROUND	4	AD1/	ADDRESS DATA LINE 1
5	GND	GROUND	6	AD2/	ADDRESS DATA LINE 2
7	GND	GROUND	8	AD3/	ADDRESS DATA LINE 3
9	GND	GROUND	10	AD4/	ADDRESS DATA LINE 4
11	GND	GROUND	12	AD5/	ADDRESS DATA LINE 5
13	GND	GROUND	14	AD6/	ADDRESS DATA LINE 6
15	GND	GROUND	16	AD7/	ADDRESS DATA LINE 7
17	GND	GROUND	18	AD8/	ADDRESS DATA LINE 8
19	GND	GROUND	20	AD9/	ADDRESS DATA LINE 9
21	GND	GROUND	22	ADA/	ADDRESS DATA LINE 10
23	GND	GROUND	24	ADB/	ADDRESS DATA LINE 11
25	GND	GROUND	26	ADC/	ADDRESS DATA LINE 12
27	GND	GROUND	28	ADD/	ADDRESS DATA LINE 13
29	GND	GROUND	30	ADE/	ADDRESS DATA LINE 14
31	GND	GROUND	32	ADF/	ADDRESS DATA LINE 15
33	GND	GROUND	34	RESET/	RESET
35	GND	GROUND	36	AACC	ADDRESS MODE ACCEPT
37	GND	GROUND	38	SRQ/	SERVICE REQUEST
39	GND	GROUND	40	STO/	SUPERVISOR TAKE OVER
41	GND	GROUND	42	DACC/	DATA MODE ACCEPT
43	GND	GROUND	44	SA/	SUPERVISOR ACTIVE
45	PB*/	PARITY BIT (INV.)	46	PB/	PARITY BIT
47	R/W/	READ NOT WRITE (INV.)	48	R/W	READ NOT WRITE
49	A/D/	ADDRESS NOT DATA (INV.)	50	A/D	ADDRESS NOT DATA
51	DYDY*/	DATA READY (INV.)	52	DRDY/	DATA READY
53	RES	RESERVED	54	RES	RESERVED
55	RES	RESERVED	56	RES	RESERVED
57	RES	RESERVED	58	RES	RESERVED
59	RES	RESERVED	60	RES	RESERVED

Table 3: Multichannel bus connector pinouts.

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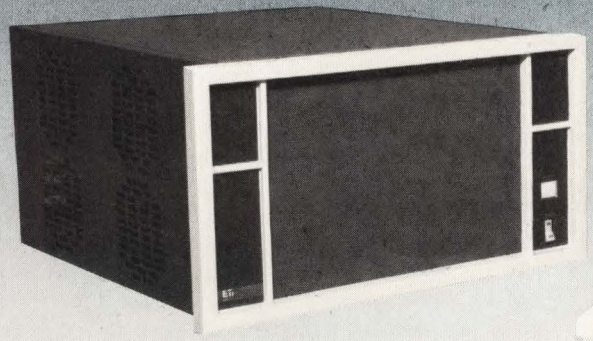
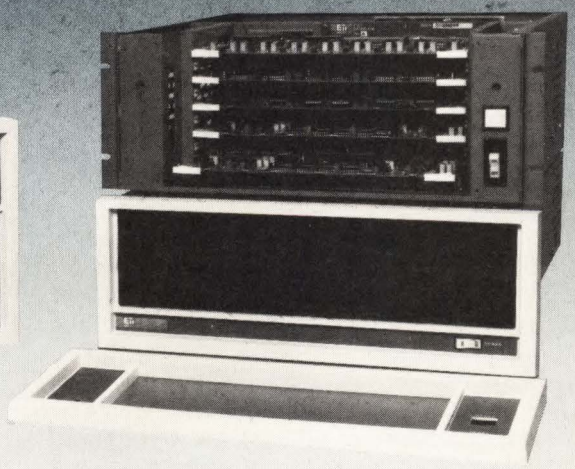
8300	Dual 8" diskette chassis (includes two disk drives)	$2510





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Multibus

wait for acknowledgement from the Primary Master. The choice of when to surrender control of the bus rests with the Primary Master, but if no data transfer is in progress, the Primary Master normally relinquishes control immediately to the Secondary Master.

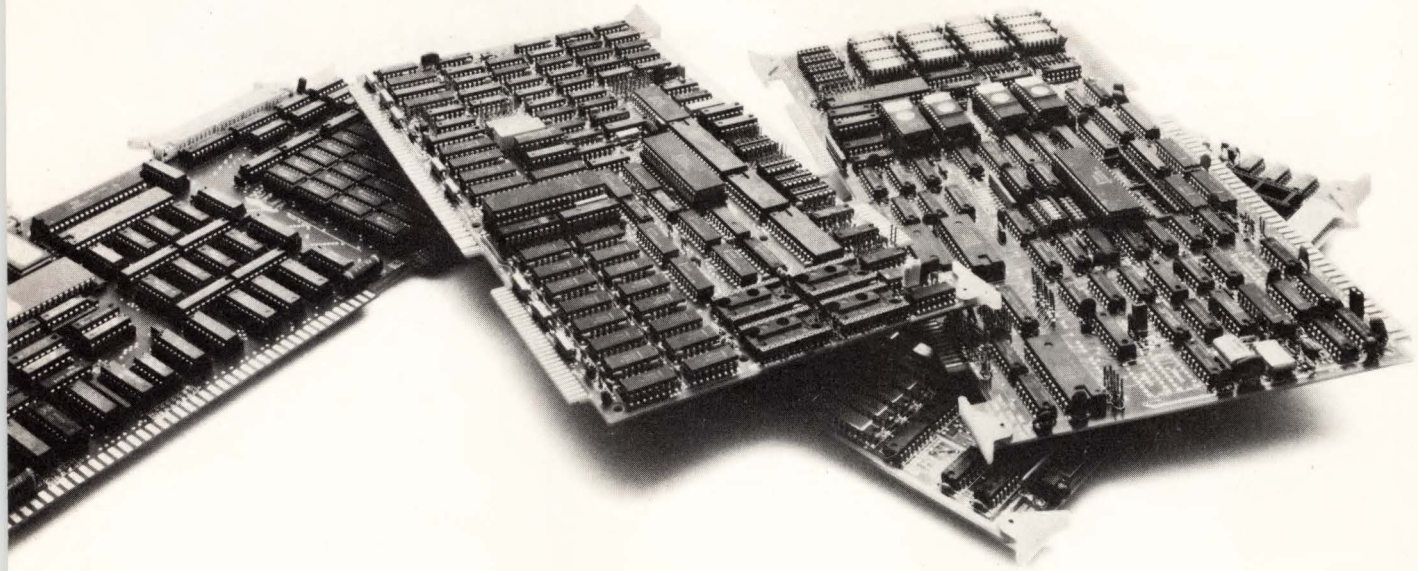
Data Transfer Operation

The iLBX bus supports two types of data transfer operations: write data to memory and read data from memory. These data transfer operations facilitate the passing of information between the active bus master and the selected slave device. The operation of these two transfer types is very similar; the only differences being the direction of the data transfer and the device driving the data lines. For either type of data transfer, the active bus master first initiates the transfer operation by placing the memory address on the address lines (AB23-AB0) and a control configuration on the control lines to select the slave device. Once the slave device is selected, the type of data transfer becomes the key factor. With the write operation, the active master maintains control of the data lines and provides valid data within the specified time. Upon accepting a data element, the slave sends a receipt acknowledgement signal to the master which completes the data transfer operation.

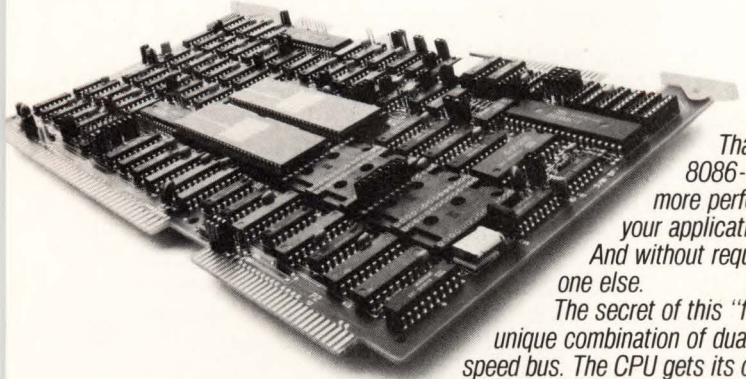
With the read operation, the slave device drives the data lines and places valid data on the data lines before sampling by the active master. The slave acknowledges the master to signal the end of the data transfer, and the master completes the operation.

The iLBX Bus Specification includes provisions for both optimized and non-optimized data transfers. Optimized operation uses pipelining and signal overlapping techniques to manage the data transfer timing relationships between the active bus master and the selected slave. The use of signal overlapping requires that every device attached to the iLBX bus provide a means for varying the timing of the slave request and acknowledge signals. The non-optimized operation uses fixed signal sequences, instead of signal overlapping, to assure a valid data transfer, and a device does not need a variable request or acknowledge to read data-valid timing on the iLBX bus.

FAST.



FAST AND A HALF.



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Mechanical Implementation

Because the iLBX bus uses the P2 connector of the Multibus form factor, the iLBX bus "shares" a Multibus chassis with the Multibus backplane system bus in the system design. The iLBX mechanical specifications are synonymous with the Multibus specifications for board-to-board spacing, board thickness, component lead length, and component height above the board.

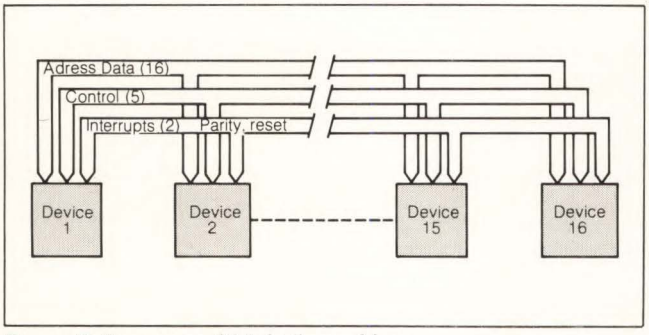
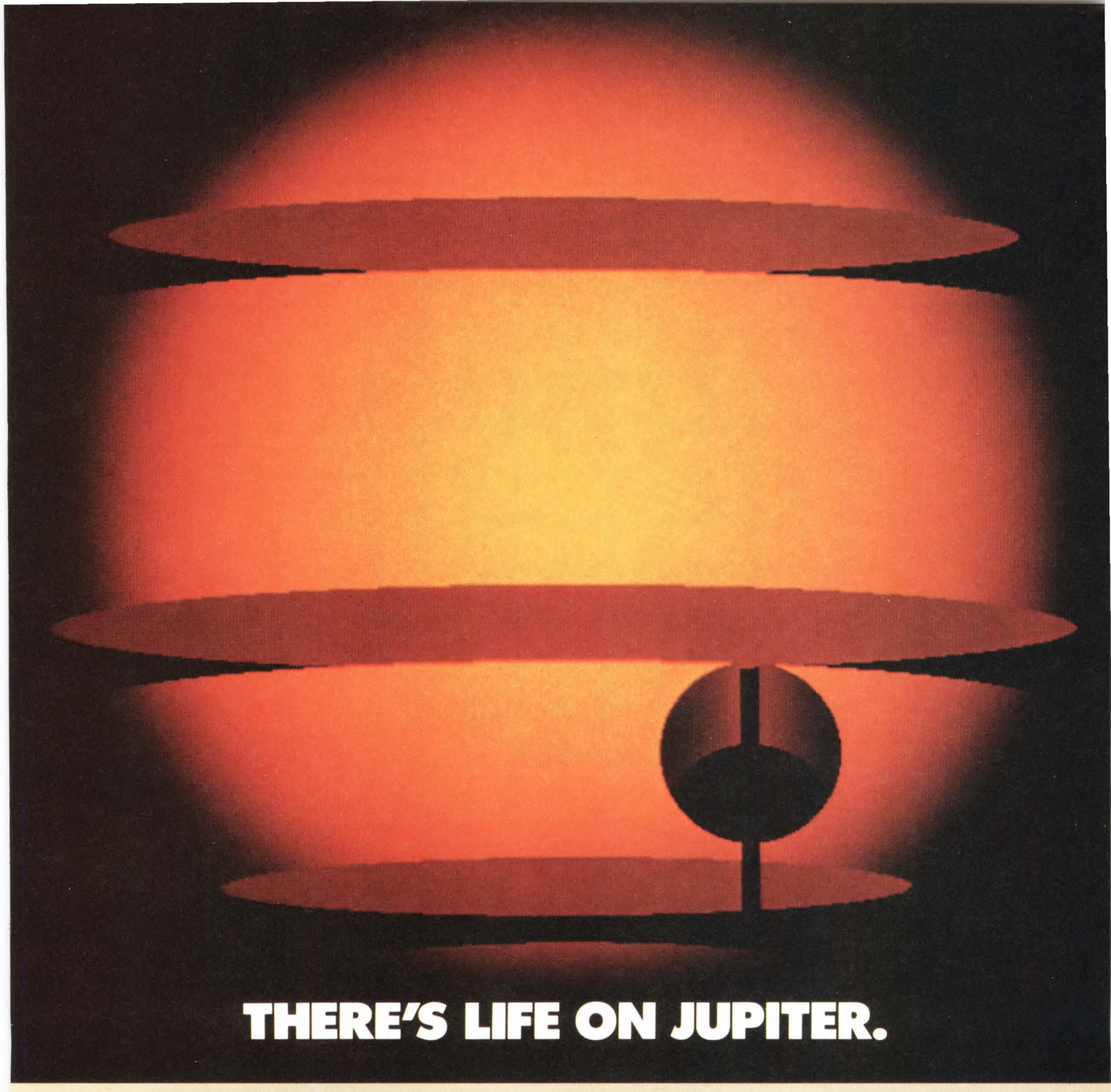


Figure 7: Structure of Multichannel bus.

The ILBX bus interconnection can either use flexible ribbon cable or a rigid backplane. The iLBX bus interconnect maximum length is limited to 10 cm (approximately 4 inches); that is sufficient to span 5 card slots across two connected chassis.

Multichannel I/O Bus

The Multichannel bus is a multiplexed, asynchronous, block transfer, 16-bit I/O bus designed to handle 8-bit and 16-bit transfers between peripherals and single board computers. Its structure (**Figure 7**) consists of 16 address/data lines, 6 control lines, 2 interrupt lines, plus parity and reset. Signals are implemented as either a 60 conductor flat ribbon cable or a twisted-pair cable spanning a distance of up to 15 meters. A 30/60-pin 3M connector is recommended for device connection to the Multichannel bus. The male connectors are installed on each Multichannel device and the female connectors are mounted on the cable. To insure system integrity, the Multichannel cable is terminated at both ends.



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Multichannel Bus Elements

Three device types—the Basic device, the bus Controller device, and the bus Supervisor device—each provide a different level of capability. The Basic Talker/Listener device has lowest capability, responding only to data transfer requests issued by a Supervisor or Controller. The bus Controller device has higher capability than a Basic Talker/Listener on the bus. It can respond to data transfer requests, control data transfers, and can program other Multichannel devices under direction from a bus Supervisor. Operating at the highest capability is the bus Supervisor device. It

Triple Bus Architecture For Minicomputer

Using Multiple processors combined with a triple bus, the MC-500 minicomputer is the first product from Masscomp, a year-old Littleton, MA company.

The performance of the MC-500 is achieved by distributing the processing capabilities to several processors within the system. The MC-500 incorporates twin 68000's, a third 68000 in a separate display processor subsystem, and a bit-slice machine in a data acquisition system. The minicomputer can be further enhanced with an integrated floating point array processor.

Physical memory is attached to the processor via Masscomp's proprietary MC–500 bus, designed to support 4-byte transfers using a block mode protocol. Memory system bandwidth is 8 Mbytes/sec. The CPU contains a Multibus adapter that provides an I/O map that translates the address of any DMA memory reference to an appropriate physical page number. The map contains translations for 1024 pages. A special 32-bit transfer mode enables the Multibus to offer a 6 Mbyte/sec. bandwidth.

Masscomp chose the Multibus as the MC–500 system peripheral bus because of the I/O options that are available. Masscomp supports multiple disk and multiple ASCII terminal configurations, network hardware and software, printers and plotters as well as the Masscomp Data Acquisition and Control Processor plus up to four Masscomp Independent Graphics Processors.

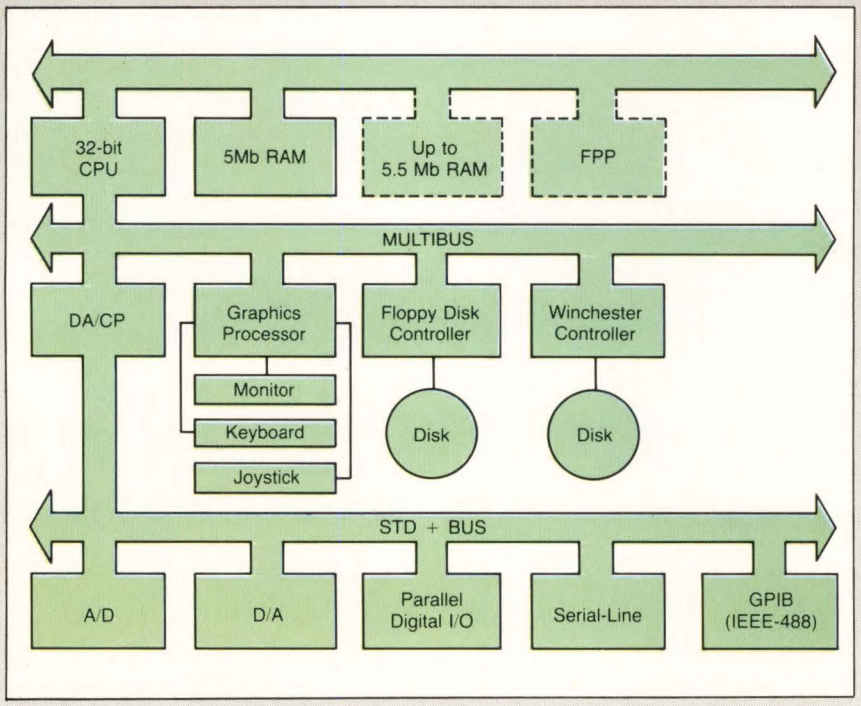


Figure 1: Masscomp's MC500 system architecture.

System Structure

The operating system for the MC–500 is based on Unix System III, enhanced by Masscomp to provide real-time services. Virtual memory support and other features were added using the UC Berkeley Unix extensions.

In addition, Masscomp's UNIX provides memory locked processes to prevent real-time processes from being swapped out. This ensures a predictable system response to external interrupts as well as ensuring that graphics display lists and data buffers remain in physical memory during critical operations.

Data Acquisition And Control

The DA/CP is based on a high-performance bipolar bit-slice processor that executes each instruction in 125ns. In addition to this processor, the DA/CP includes 1024 locations of 24-bit temporary data storage, two 16-element FIFOs, and one 64-element FIFO. These components enable devices on the STD bus to input or output data to data buffers within an application program.

STD+ Bus

The STD+ Bus was developed by Masscomp to enhance the industry

provides major control and management of the Multichannel bus. The bus Supervisor resolves and grants Multichannel bus priority, monitors bus status, handles interrupts, and controls the reset line, in addition to performing all bus Controller functions.

Multichannel bus devices are functionally flexible, creating overlaps between types of bus functions and types of bus devices performing those functions. These devices perform functions in various states of operation: master, slave, talker, listener. When a device is controlling the command/action lines, it is in the master state, and both the bus Supervisor and the bus

standard STD bus. The STD+ Bus consists of two side-by-side 9-slot STD Buses that share address lines but have separate data paths and read/write control lines. Most Z80 compatible STD boards will plug into the STD+ Bus. The data transfer rate of these devices is limited to the STD Bus maximum of 1 million bytes/second.

The STD+ interfaces from Masscomp are physically twice as high as conventional STD boards, and therefore, plug into two slots. Because the data are transferred from Masscomp interfaces using two seperate byte-wide paths, the STD+ Bus provides a data rate of up to 2 miiiion bytes/second.

Analog And Digital Interfaces

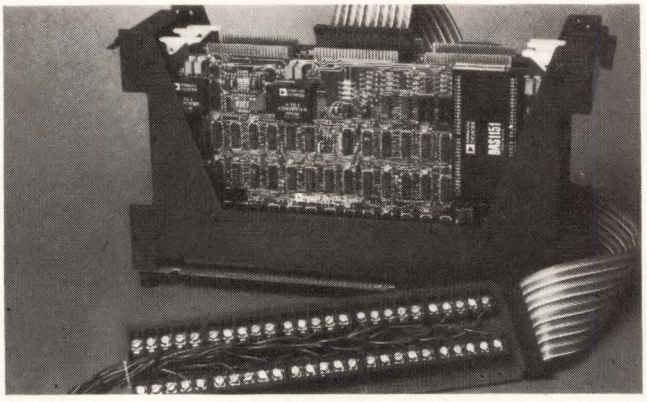
Masscomp offers a wide range of analog and digital interfaces for the STD+ Bus. The analog interfaces include a 40kHz and a 1 MHz A/D converter, each with a resolution of 12-bits. Both interfaces provide 16 single-ended or 8 different channels, and both may be expanded to provide 64 single-ended or 32 differential channels. The 1 MHz interface includes a programmable gain capability and is available with an 8-channel Simultaneous Sample-and-Hold option. As a complement to these interfaces, Masscomp offers 4 and 8 channel D/A converters which can output data at a rate of 500kHz per channel.

Masscomp digital interfaces include a 16-line parallel interface, a dual-port RS–232C serial-line interface, and a GPIB(IEEE–488 Bus) interface. These digital interfaces are able to support a wide range of laboratory instrumentation.

Controller can operate in this state, although not simultaneously. The slave state indicates a device that can monitor the command/action lines. Only Controllers and Basic Talker/Listeners operate as slaves. All three device types can operate in the talker state or the listener state, but not all at the same time. A Talker is any device selected by the bus master which is writing data to the bus. A Listener is any selected device which is reading data from the bus.

Multichannel Bus Interface/Signal Line Descriptions

The Multichannel bus signal lines are grouped into five basic classes based on the functions they perform: address/data, control, interrupt, parity, and reset. The 16 address/data lines are multiplexed by a control line to act either as 16 unidirectional address lines or 16 bidirectional data lines. When used as address lines, they transmit the device address to all devices attached to the Multichannel bus. When used as bidirectional data lines, they transmit and receive data to or from



Analog Devices' RTI-711, RTI-724 and RTI-732 bring data acquisition and control capability to Multibus compatible microcomputers.

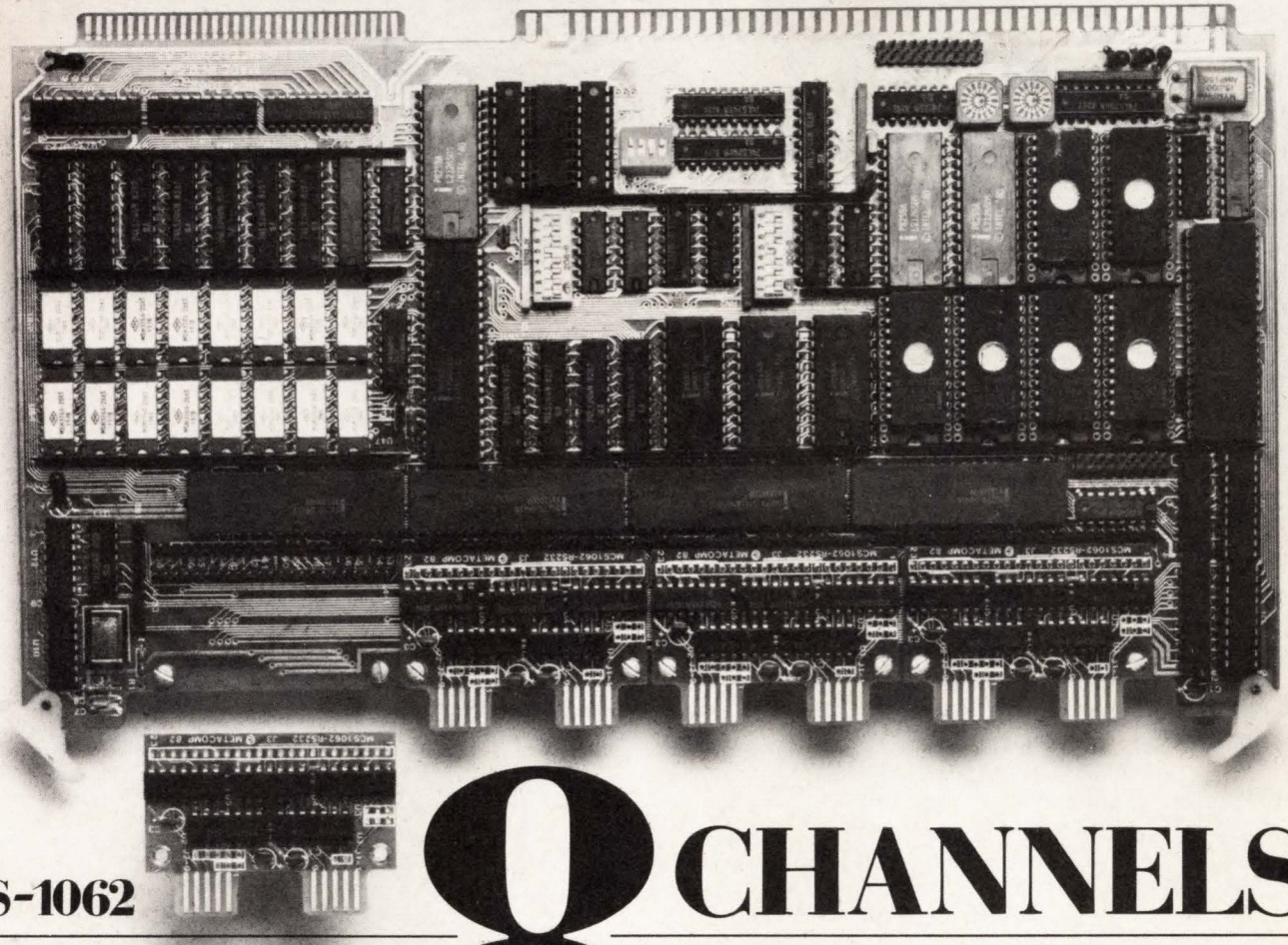
Multichannel devices. The six control lines determine the overall operation of the bus from specifying the type of data transfer to providing the handshake for data transfers between Multichannel devices. Two in-

Pin[1]	Menmonic	Description	Pin[1]	Mnemonic	Description
43	MD8	MDATA Bit 8	44	MD9	MDATA Bit 9
41	MDA	MDATA Bit A	42	MDB	MDATA Bit F
39	MDC	MDATA Bit C	40	MDD	MDATA Bit D
37	MDE	MDATA Bit E	38	MDF	MDATA Bit F
35	GND	Signal Gnd	36	+5V	+5 Volts
33	MD0	MDATA Bit 0	34	MDRQT	M DMA Request
31	MD1	MDATA Bit 1	32	MDACK/	M DMA Acknowledge
29	MD2	MDATA Bit 2	30	OPT0	Option 0
27	MD3	MDATA Bit 3	28	OPT1	Option 1
25	MD4	MDATA Bit 4	26	TMDA	Terminate DMA
23	MD5	MDATA Bit 5	24		Reserved
21	MD6	MDATA Bit 6	22	MCS0/	M Chip Select 0
19	MD7	MDATA Bit 7	20	MCS1/	M Chip Select 1
17	GND	Signal Gnd	18	+5V	+5 Volts
15	IORD/	I/O Read Cmd	16	MWAIT/	M Wait
13	IOWRT/	I/O Write Cmd	14	MINTR0	M Interrupt 0
11	MA0	M Address 0	12	MINTR1	M Interrupt 1
9	MA1	M Address 1	10		Reserved
7	MA2	M Address 2	8	MPST/	iSBX Multimodule Board Present
5	RESET	Reset	6	MCLK	M Clock
3	GND	Signal Gnd	4	+5V	+5 Volts
1	+12V	+12 Volts	2	−12V	−12 Volts

Notes:
1. Pins 37–44 are used only on 8/16-bit systems
2. All undefined pins are reserved for future use.

Table 4: iSBX signal/pin assignments.

THIS INTELLIGENT MULTIBUS* SERIAL CONTROLLER SUPPORTS



MCS-1062

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  - RS-422, two or four wire
  - Optical Current Loop
  - Many others available soon
- On-board INTEL 8088 CPU
  - 48K bytes EPROM (using 2764's)
  - 128K bytes RAM
- Simple "handshake" architecture for user software interface
- Dual Port RAM
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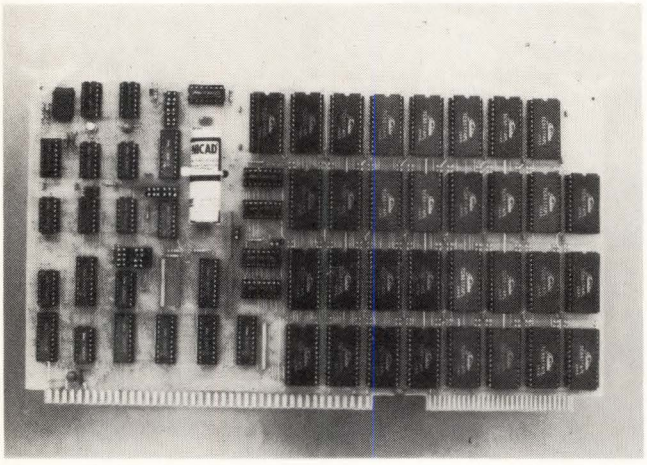
**Quantity 50 price, including RS-232 interface modules. Price may vary, depending on interface module options.

Write 43 on Reader Inquiry Card



Diversified Technologies' 64k CMOS Battery Backup RAM Board is aimed at applications in instrumentation, process control and remote or portable instruments.

terrupt lines are supplied to initiate and terminate data transfers, and to indicate device failures, memory failures, or parity errors. A parity line and a reset line provide support for a parity option and system reset capability whenever required.

Multichannel Bus Pin Assignments

For proper Multichannel implementation, a 60 conductor (twisted pair or flat) cable using a 30/60 pin 3M connector, is used for device connection to the bus. The Multichannel bus connector signal pin assignments are listed in **Table 3**. Cable termination is implemented at both cable ends to insure proper system integrity over a 15-meter cable.

iSBX Bus Elements

The iSBX Multimodule system is made up of two basic elements: base boards and iSBX Multimodule boards. In an iSBX system, the role of the base board is simple. It decodes I/O addresses and generates the chip selects for the iSBX Multimodule boards.

The iSBX bus supports two classes of base boards, those with direct memory access (DMA) support and those without. Base boards with DMA support have DMA controllers that work in conjunction with an iSBX Multimodule board (with DMA capability) to perform direct I/O to memory or memory to I/O operations. Base boards without DMA support use a subset of the iSBX bus and simply do not use the DMA feature of the iSBX Multimodule board.

The iSBX Multimodule boards are small, specialized, I/O mapped boards which plug into base boards. The iSBX boards connect to the iSBX bus connector and convert iSBX bus signals to a defined I/O interface.

iSBX Bus Interface/Signal Line Descriptions

The iSBX bus interface can be grouped into six functional classes: control lines, address and chip select lines, data lines, interrupt lines, option lines, and power lines. The iSBX provides nine control lines that define the communications protocol between base board and iSBX Multimodule boards. These control lines are used to manage the general operation of the bus by specifying the type of transfer, the coordination of the transfer between devices. The five address and chip select signal lines are used in conjunction with the command lines to establish the I/O port address being accessed, effectively selecting the proper iSBX Multimodule. The data lines on the iSBX bus can number 8 or 16, and are used to transmit or receive information to or from the iSBX Multimodule ports. Two interrupt lines are provided to make interrupt requests possible from the iSBX board to the base board. Two option lines are reserved on the bus for unique user requirements, while several power lines provide +5 and ±12 volts to the iSBX boards.

iSBX Bus Pin Assignments

The iSBX bus uses widely available connectors that are available in 18/36 pin for 8-bit devices and 22/44 pin for 16-bit devices. The male iSBX connector is attached to the iSBX Multimodule board and the female iSBX connector is attached to the base board. A unique scheme allows the 16-bit female connector to support 8 or 16-bit male Multimodule boards. **Table 4** lists the signal/pin assignments for the bus.

Summary

All of these structures form a consistent architecture for high performance, modular systems.

It is unique in how much of the system interfaces are standardized, ensuring compatibility with future technology. All eyes now rest on Intel to see how the Multibus II evolution will affect the integrator of future 32–bit systems, and just how compatible it will be with Multibus I.

For More Information

A complete up-to-date buyers guide of Multibus manufacturers is available from Ironoak Co., 3239 Caminito Ameca, La Jolla, CA 92037. Tel: 714-450-0191. □

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Making A Good Printer A Better Graphic Printer

by Joel S. Novak

The high volume printer manufacturer is forced to build products serving the central needs of the market because of the high cost of tooling and competition. They cannot, by the competitive nature of the marketplace, address the many smaller market segments with specialized needs. It is here that the retrofitting companies find opportunities to provide product enhancements that are not directly available from OEMs.

Fulfilling A Need

The DECwriter is one of the most popular printers and presents a large retrofit market. While the LA-120 provides for most user needs, graphics was one of only two major market segments not served.

The second major perceived need among LA120 users was for letter quality printing. There are three solid reasons however, against the choice of the LA120 as a retrofit product for this use: needle size, the use of the 7-dot-high head and the high-force head.

First, typical letter-quality dot-matrix printers use a 10 or 12 mil needle. With the 14 mil DEC needle, it would be difficult to properly form the smaller characters. Next, the DECwriter's 7-dot-high head was designed for upper case printing. Descenders or lower case letters and better quality letter formation need a minimum 9-dot vertical row. Using the DEC head would require frequent paper movement over a considerable distance—four-pass printing. Finally, DEC's head is designed to print multipart forms. Using this high-force head for over-printing to form letter-quality characters would tend to pucker the paper, at the least.

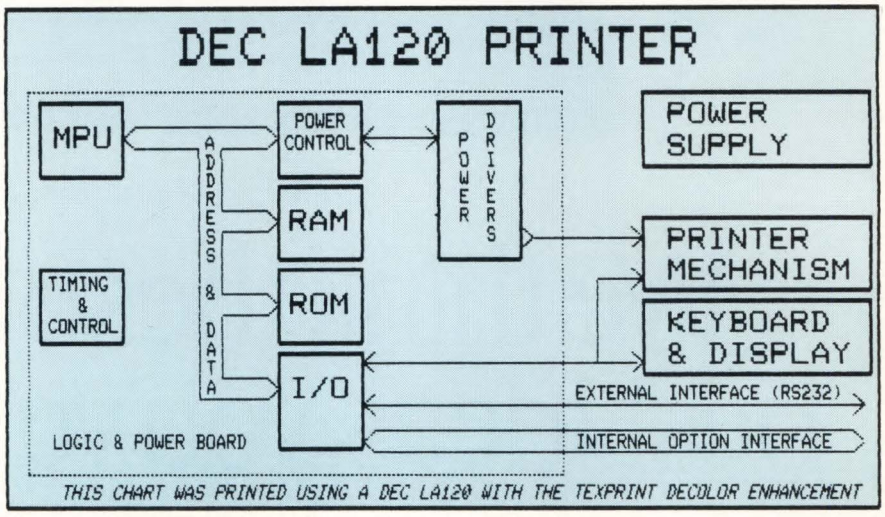

Figure 1: Diagram generated by the LA120 printer.

However, the needle size and head design shortcomings can all be overcome. Though not perfect, a reasonable quality could be achieved with the 14 mil needle. Printing columns, descenders, and underlining would be more difficult with a 7-dot-high row, but using the 4-pass method (instead of 2-pass) would overcome this. One can modulate the high-force head by shortening the print pulse-time upon entering special modes where it is known that less force is needed. That further complicates the algorithm by the need to know how many dots are being overprinted and the power requirements. Changing the head design is also possible, but the DEC head is a key reason for the reliability and ruggedness that attracts the retrofitter.

Perhaps the major factor against an LA120 letter quality enhancement is paper handling: the mechanics and paper path as they exist and the changes necessary for word processing. Mechanical alteration would defeat one of the primary design goals—that of ease of installation, if indeed such changes were economically practical.

Graphic representations are a different matter. Here the machine has the potential to do what customers want, and at a reasonable resolution, a high number of dots per page, and high reliability. Both the high satisfaction level among DEC's large installed printer base and the fact that DEC did not offer an LA120 product/option that fulfilled the graphics need, justified the decision to develop the DECPLOT option for the DECwriter.

Limitations Explored

Determining that the LA120 was appropriate for retrofit as a graphics printer was a case of reverse engineering—not to mimic someone's product but to determine the restrictions. Component histories had to be researched for reliability and for their potential for higher reliability or greater speed. The mechanical and electrical limitations of the components, their stability over a lifetime, and DEC's history in using them had to be determined to develop methods to utilize the

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printer mechanics in a more precise application where higher accuracy and speed were imperative.

Before the work begins, there is no way of knowing for sure whether there are mechanical restrictions or if there is sufficient computing power. Mechanically this refers to the printer's horizontal and vertical positioning, print rates in dots per second and the duty cycle relating to how fast the head can be pulsed.

To make a precise determination is a matter of testing, checking results and working on design—more specifically, as with the DECwriter, checking the many software parameters and algorithms controlling the positioning accuracy, print rates and duty cycles. In graphics (unlike printing characters), 100% of the head dots may be fired at any time. It was important to determine the duty cycle limitations of the printhead to ensure that its reliability would not be compromised. Overheating would lower its usable life.

Two areas of potential restrictions relating to motion had to be investigated. Using test programs that exercised the servo mechanism's absolute positioning capabilities and movement times produced encouraging results. The overall program involved examining the mathematics of the servo loop as well as the electrical, mechanical and software components. In the second area, however, use of a high torque stepper motor with low-accuracy controls and a gear train designed with little need to consider backlash caused very sloppy paper positioning. In this area, improvements to the fine line feed (LF) stepper motor were effected by rewriting the algorithms that control the motor's accuracy and braking. Here it was also necessary to add two mechanical backlash prevention shims to the installation kit and to prescribe an adjustment procedure for the gears.

To determine whether or not there was sufficient power in the 8080 μP required careful time measurements. Time available at critical points in the program was measured and compared with the additional time needed to perform the extra tasks. These measurements and calculations found a 90–95% utilization of the 8080 in many places. That pointed to a need for more memory, frequent pre-processing and critical decisions on the use of the foreground and background tasks. It was necessary to tightly schedule what processing was being done while motions were being performed, and determine what could be done while not effecting motions. But at all times, the concern was with being able to accept the next character from the 9600 baud input stream.

Enhancing an existing product by the addition of graphics demands a careful reliability analysis.

As a result, the graphic printer software does a significant amount of pre-processing: accepting a whole line of input data and preparing a bit map for printing. For the graphic printer the whole line is established in memory before the LA120 printhead moves, while for the basic printer the alphanumeric's bit map is generated as the character is printed.

Establish Guidelines

Specific guidelines were established once it was determined that the printer could be adapted. The question of CRT compatibility was not a difficult one to resolve as the LA120 is one of the most popular teleprinters. The fact that DEC's VT100 display is one of the most popular and most frequently emulated CRTs was important as the interface standard was being decided.

The interface protocol that was chosen permits compatibility in time-sharing environments, as a page printer and for printing graphics directly from the computer. It anticipates the need for character graphics, for dot addressable graphics, and for the diverse needs of current users of both multipurpose printers and graphic plotters. For these dissimilar needs, the 6-bit DEC SIXTELL standard was determined to be superior because it does not use any control characters which many computer systems may use or reserve. The data stream, therefore, is compatible with most operating systems having transmission facilities, and does not require either control characters or the 8th bit parity character. Though not quite as efficient in the character transmission mode as other standards, SIXTELL overcomes the need for blocked transmission, for the user to prepare groups of data, and to affix the character counts and other blocking format requirements. With the 6-bit data, parity checking is done on a character-by-character basis and repeat functions can be used to compress the data stream. The SIXTELL interface provides product compatibility as well as ease of use.

A considerable effort also went into making the setup mode easy to use. Driven by complex internal software, the interface and machine setup modes simplify the initial setups which make the graphic printer compatible with the major graphic CRT's, adjust the quality of the printed image and set the 32 user-setable DECwriter user parameters.

The user couldn't be expected to individually reset the 32 parameters every time the printer output changed. In the graphic printer, original configuration values now are stored, permitting their later recall, and since so many of the parameters are interrelated, they too were designed into a single-key setup mode. Essentially, this single-key setup permits the user to get started using graphics quickly, without the normal setup difficulty.

Software routines enable the user to compensate for worn needles or old printheads that cause poor print quality. By choosing one of eight settings the user tailors the dwell time of each machine to achieve quality printing.

Reverse printing is a user option and here again software provides a simple setup for servo registration. Slew rates, stopping distances, maximum velocities and accelera-

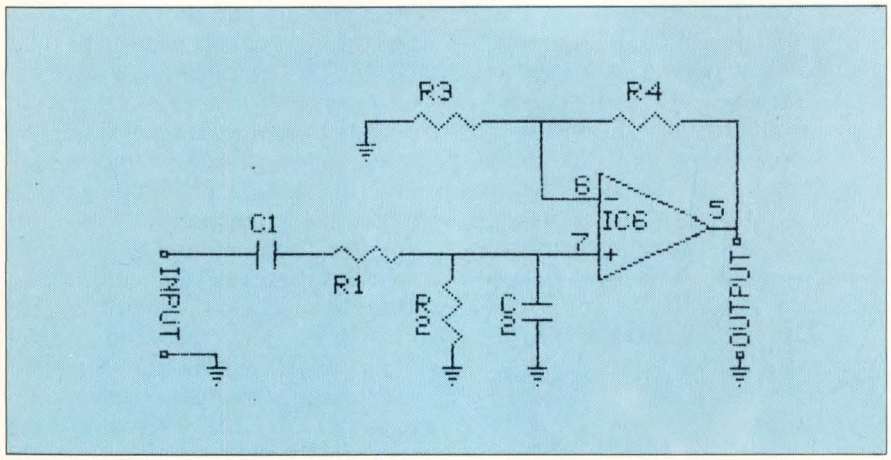


Figure 2: Example of DECPLOT engineering graphics.

tion are all indeterminate variables in any machine population. Through the software, a single selection from among 16 settings allows the printer to position itself accurately, both forward and backward over the same dot.

Critical to planning at this stage was one of the basic tenets of retrofit technology: the philosophy that kits should require only simple tools to install. Retrofit products more than face basic machine limitations; they must also be field-installable and require neither precision jiggling fixtures nor weeks of technical training on assembly and installation. Retrofit design demands very different answers from similar issues encountered in a new equipment environment.

As an example, for the LA120 graphic printer, improvements were made to the program logic enabling the unit to be more accurate. To do this without having to change the mechanism, a thorough understanding was necessary of how the servo and stepper mechanisms controlled the carriage and paper advance. Further, it was necessary to understand how these mechanisms respond to age and heavy use.

That is perhaps the most important design consideration because of the accuracy called for by the planned graphical output. Whereas new equipment manufacturer's product designs must work when coming off the line having new components, the retrofitter's task is to find a product design to tolerate and compensate for machines that are worn, have been improperly adjusted, or simply have been mistreated throughout their lifetimes.

Finally, when providing an optional function via retrofit, the device must present no variations in operational procedures when operating in the original mode. Good ergonomics demand that operators or other users, many of whom have used the device for years, still be able to use the original, manufacturer's operation manual.

Identify Issues

The first design task was aimed at overcoming some of the limitations of the LA120, a product not designed, nor manufactured, specifically for graphical output. The reborn LA120 graphic printer with a plot option would need the ability to place a dot at the same place on a page—all the time. The importance of accuracy in positioning the head and the repeatability of positioning is even more critical with the printer's bidirectional head.

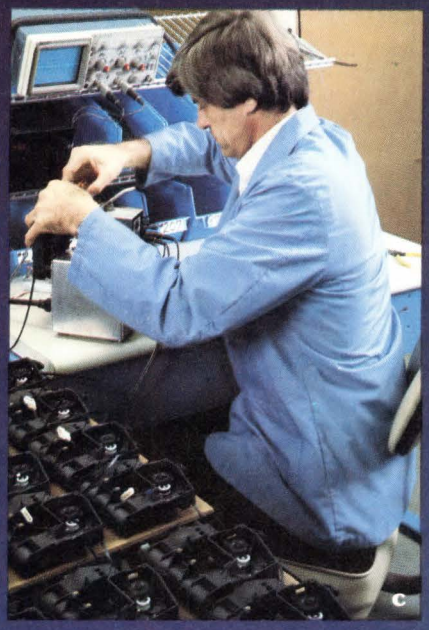
Accuracy and repeatability again are important graphic concerns where the paper feed mechanism and electronics are involved. Moving the paper a precise distance is an issue that is not as important when simply printing characters. The LA120 accuracy would be heavily impacted by tolerances, not only from machine to machine, but also in the same machine over its lifetime, and related to two specific areas: the printhead quality and the servo and stepper control systems.

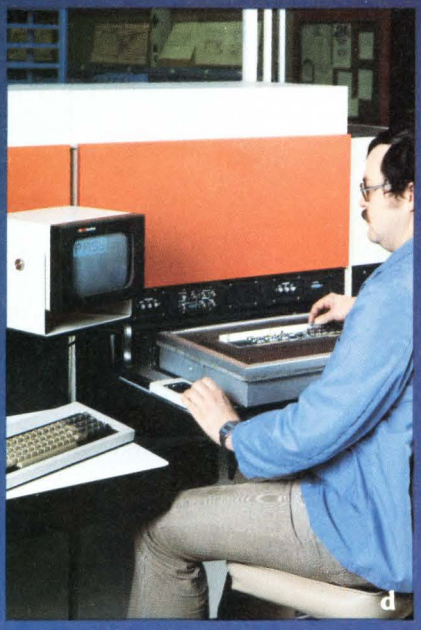
Printheads become worn and dirty as they grow older, are less responsive to electrical impulses, and generally suffer degradation of the printed image. The servo mechanism is critical to accurate positioning of the bidirectionally moving head. Accompanying the need to lay down denser dot patterns, steppers need to more precisely advance the paper.

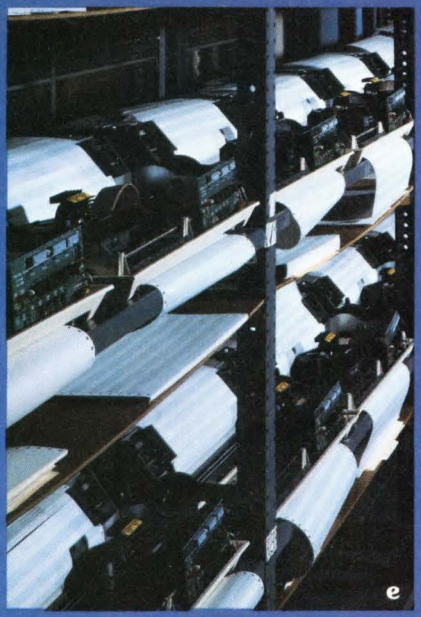
With the self-imposed guidelines of simplicity and field-upgradability, the solution must be in the software. But there is no single, reliable algorithm that can guarantee high quality printing regardless of the machine vintage or usage. Also, users with poor printheads must be able to improve a poor-to-unacceptable image to a good one, yet experience only minimum throughput reduction. Similarly, there is needed a user-setable method to compensate for the servo error and printhead flight time to ensure that dots can be printed in the same position. The problem is one of developing algorithms to enable a machine built a number of years ago, and built with tolerances related to character printing, to run dot addressable graphics.

To improve print quality, pulsetime often must increase, and both pulse repetition rate and servo speed must decrease. Meanwhile, the algorithm is printing and controlling the energy to the head while keeping track of the total energy product over a period of time. The algorithm looks at the energy supplied to the head in the form of the print-pulse and also at its duration. It must keep track of the total energy product to the head so that when a longer pulse is fired, the pulses are not fired too close together. That means also regulating servo speed to guarantee correct position on the paper. The algorithms are only able to regulate the rates by knowing what has been happening and what is about to happen.

Clearly, the installer must be able to quickly and simply adjust the software to compensate for a particular machine's intolerances. For the graphic printing LA120, a sin-







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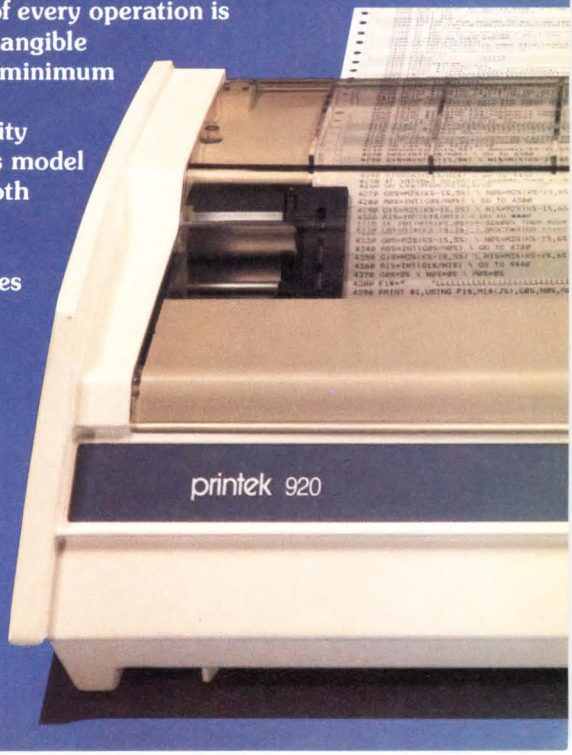

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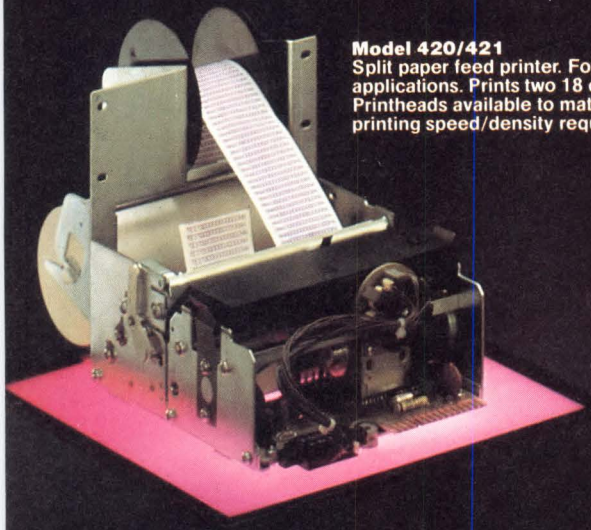
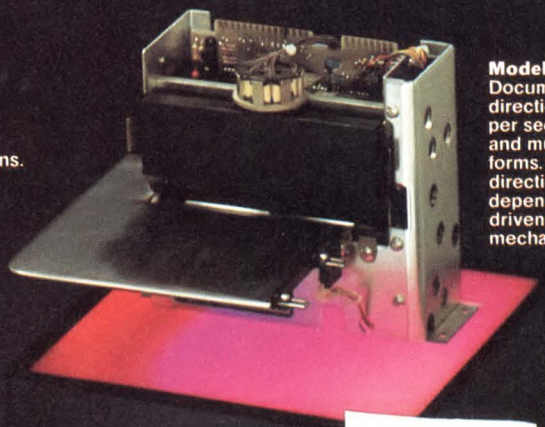


Model 420/421
Split paper feed printer. For receipt/audit applications. Prints two 18 character columns. Printheads available to match paper and printing speed/density requirements.



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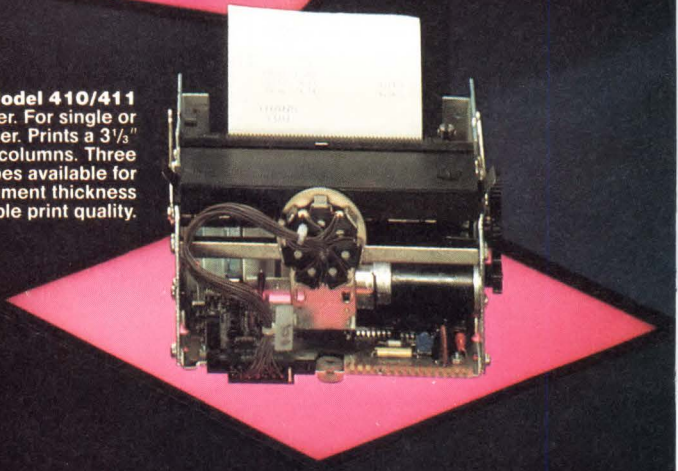

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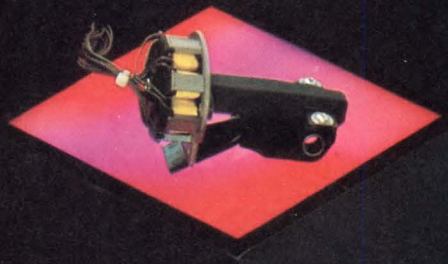

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EATON Printer Products

gle-key, software-compensating command mode permits this adjustment, giving the user a choice of less-than-optimum print time, or data path, with the result of achieving fine graphic images.

Design Process

A primary design consideration for printers, and one that nonprinter designers may fail to understand, is that printers can be very complex, simultaneously performing many tasks. Internal to the printer, in fact, is a multitasking operating system which at the same time can be reading the keyboard, causing the carriage to move, causing the printhead dots to print, doing a carriage return, effecting line feed motor movement, accepting characters from the line at 9600 baud, processing data, and working the many servo motor control algorithms. Printer software oversees many concurrent, real-time operations and deals with mechanisms that have mass and inertia.

Protecting Hardware

One of the initial stages of Texprint's printer design process is building hardware protection into the machine that is to be used for the software development. In the design of mechanical elements that have software as their controlling factors, one major problem is the need for protecting the mechanical components from the programmer.

Programmers are not always attentive to hardware needs and this electronic protection of the machine from the software designers is an expedient precaution. Machines remaining on in the wrong mode or occasionally having software written that doesn't function entirely correctly the first time, can burn out printheads or even vaporize and melt parts.

It is not difficult to provide hardware protection because maximum times and voltages that should be applied to the mechanical components are known. When these values are exceeded, hardware timers shut down the mechanism in danger of being damaged. Typically, one-shots and power switches such as relays or transistors are used to monitor the pulses going to the mechanical acuators—the solenoids, stepper motors and the printhead.

A further safety check is possible. Monitoring bus access can determine whether the processor has stopped. With no periodic memory access, chances are that the processor is not running. That means there is no reason for the progam to be actuating any electro-mechanical components and any that have power applied can be shut off.

Actual design begins with the software necessary to make the hardware perform as wanted: posi-

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tioning head and paper, controlling the buffer, and achieving the graphic output through extra memory functions. With these designs, software theories and mechanics are tested to ensure expected performance. The resulting mechanical and/or software modules represent the graphics additions or modifications to the LA120. These modules are pieced together with the operating system, once it is assembled to handle the graphics language. The changes and the tedious testing that follow are not all exciting algorithmic control and positioning challenges, but involve many simple changes in the logic of the printer's basic operation as well.

For instance, when the LA120 makes a vertical pitch change (i.e., from six to eight lines), the printer's software does not maintain the values of the forms length, vertical tabs, nor the vertical positioning parameters. When printing graphic images, however, maintenance of the exact position is imperative because of the frequent demands to change back and forth between text and plot data, often on one line. Maintaining these parameters is a simple yet easily overlooked change.

Color Considerations

Today, graphic printer design is focusing on producing inexpensive and high resolution dot-matrix color images from CRT dumps. Fueling this interest is the proliferation of color displays and the need to reproduce their graphics.

Color printing is far more complex than dot addressable graphic printing. It must be attentive not just to compatibility and color perception, but also to the fact that color CRTs deal with additive colors while color printers deal with both additive and subtractive colors. CRT color output consists of a larger amount of data-per-image than black and white, so the printer's already busy multitasking operating system has more concerns when presenting a color printout.

One important consideration is that color output requires both electrical and mechanical changes. The color producing enhancement for the LA120 from Texprint, for example, not only requires a four color ribbon, but also a mechanism that permits ribbon and head to select the proper color dots. Using a 'process color' ribbon, the different colored ribbon bands on the enhanced LA120 may be printed one over another to present as many as 15 different colors with numerous dot densities that effect shading.

Versatility and speed, once again, are the advantages of a dot matrix color printer. High graphic rates and intermixing text are necessary features in a low-cost graphics printer. □

Graphics Conversion Board Adds Extra Functionality To TI Printer

by J.L. Lawrence, Jr., D.L. Raymond, and R.A. Suchter

Value-added conversion of one company's product by another is a common occurrence in the electronics industry. This is exemplified in the graphics field by such companies as Digital Engineering, Matrox, Selanar, Trilog and Analog Technology Corporation (ATC). The former three companies manufacture plug-in raster graphic conversions for the DEC VT100 and other popular video terminals, while Trilog manufactures a number of graphic adaptations for the Printronix line printers. ATC designs and manufactures plug-in conversions for the Texas Instruments 810 RO printer with features ranging from raster graphics and software character printing to repetitive forms, label and barcode printing and direct vector-to-raster conversion.

Z80-based board transforms the TI 810 into a two processor machine.

ATC's first plug-in graphic conversion was designed to satisfy a requirement for a relatively low-cost, fast printer-plotter for analytical instrument data systems made by the company. The first conversion board simply plugged into a rear option slot and re-programmed the 810's processor to accomplish raster graphic plotting and software character printing in addition to all normal printing functions. Customer demand for more features and higher plotting speed led to the design of the 190 Series boards which transform the 810 into a two-processor machine. The addition of a Z80 and RAM and ROM provide interactive control of both processors for placing dots on the paper.

This two-processor requirement

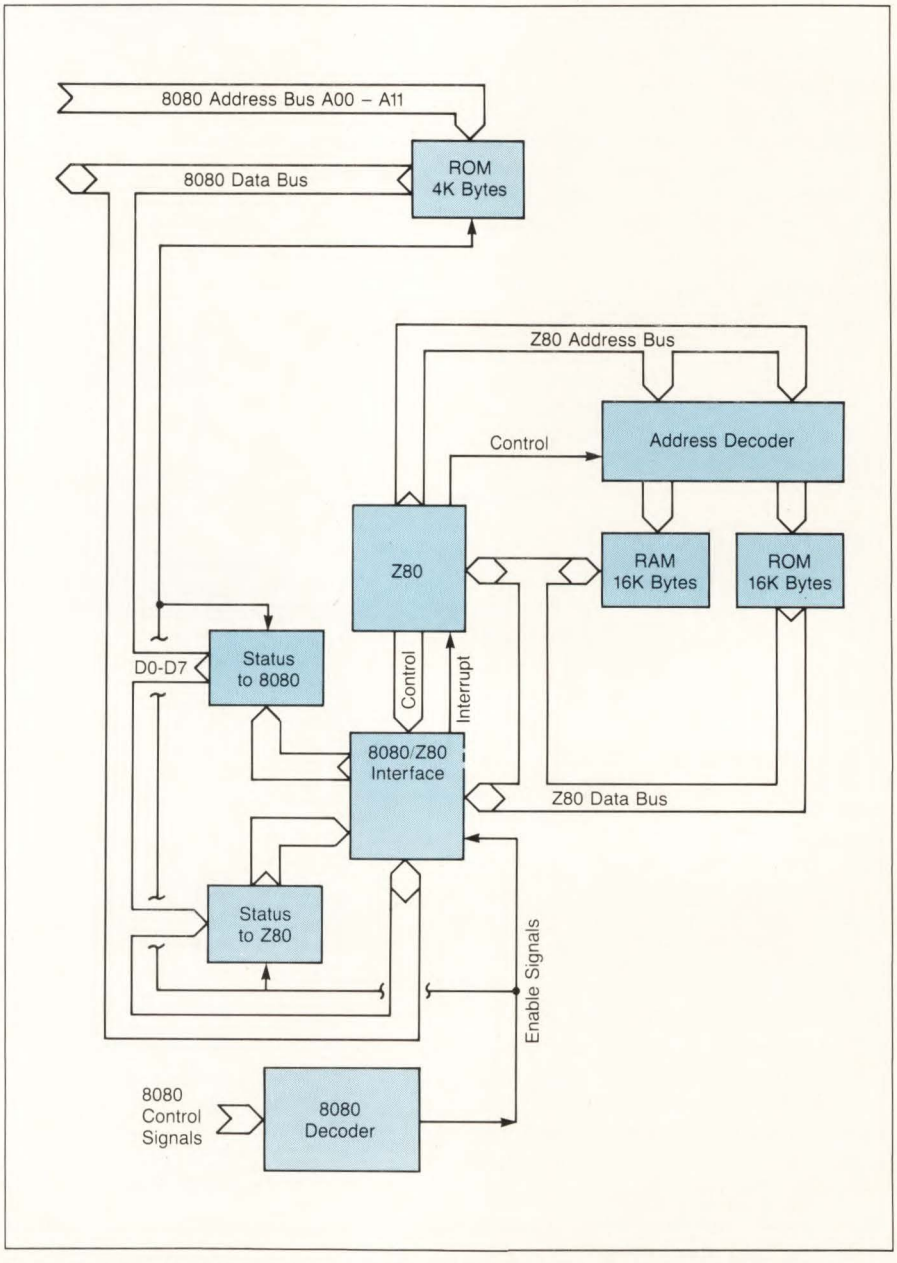

Figure 1: Simplified logic diagram of the TI 810 printer illustrates the inter-relationship of the Model 190 conversion and the other printer components.

J.L. Lawrence, Jr., D.L. Raymond, and R.A. Suchter are with Analog Technology Corp., 15859 East Edna Place, Irwindale, CA 91706.

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Not just more capacity; more capability

Motorola's 68000 is a winner, and using this popular microprocessor in a VERSAbus/VERSAboard configuration is a smart move. Dataram's new single-board 1.0 MB DR-680 can make it even smarter. Increased single-board memory capacity means lower power, less space, higher reliability, and lower cost...and the DR-680 provides a lot more!

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results from the fact that in the plot mode, the data handling rate increases by an order of magnitude. On a printer such as the TI 810, one byte of information is encoded at the input port to define a printed character cell of 12 × 7 pixels, but 12 bytes are necessary to define a plot of the same cell. As a result, the processors of most printers became very busy and subject to interrupt, and the printers then plot at a speed far below their theoretical plotting rate. This problem was solved by designing a board which accomplished a dual μP mechanization and provided increased plotting speed and other performance enhancements without further printer modification. One version, however, did include a substitute paper advance motor that increased the vertical dot addressability by a factor of four and thus allowed letter-quality print by producing characters in a 23 × 28 cell at 240 × 288 dots-per-inch resolution.

A simplified block diagram of the 810 printer **(Figure 1)** illustrates the inter-relationship of the Model 190 conversion and the other printer components. The 810 in normal configuration has three plug-in boards arranged by functions. The driver board (XA1) contains circuitry for the printhead wire drivers, the printhead carriage drive and encoder logic, and the paper advance motor drive. The board receives control signals for all of these functions from the 8080 processor on the XA2 board. The XA4 board contains the power supplies for printer excitation as well as the ribbon motor drive control. The operator control panel and serial RS-232 port or parallel port connectors, interface with the 8080 processor on the XA2 board.

The Model 190 board plugs into the printer's XA3 card slot, disables the first 4K addresses of the 810's 8080 processor on the XA2 board, and thus shunts the normal firmware control. It substitutes ROM firmware which utilizes the remaining addresses of the 8080 processor for control of all printing functions. It also causes the 810 processor to route all received data to a 3K character first-in-first-out (FIFO) buffer on the 190 board. Functions of the 190's Z80 processor include review of all received data routed from the FIFO decoding of control characters and escape sequence commands, and generation of all dot patterns for printing characters and rows of plotting data. All data received over the printer's interface ports must pass through the 8080 processor and then to the 190 board for processing. While a more efficient design would interpose the Z80 directly between the outside interfaces and the 8080, this approach would have required modification of the 810 hardware.

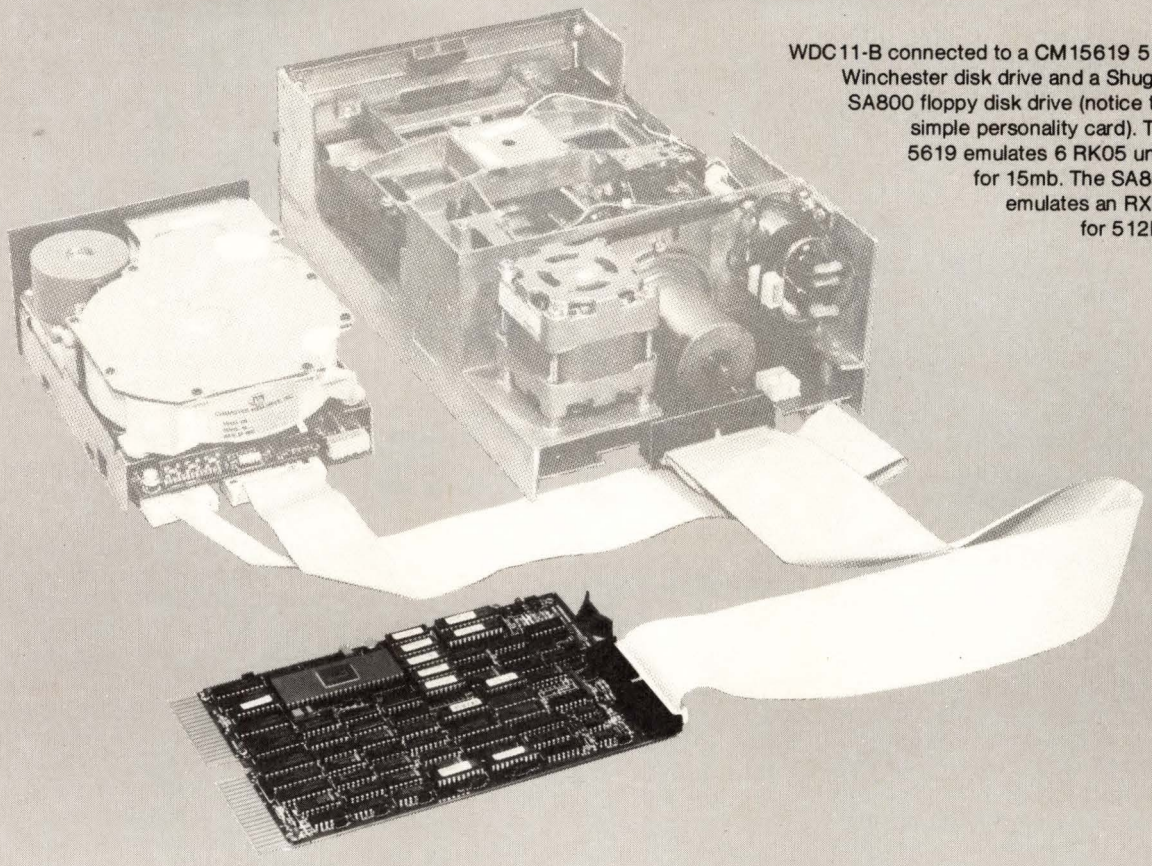
From the perspective of the Z80 μP on the 190 board, the rest of the printer appears as an intelligent printing engine that is controlled by transmission of 8-bit commands and data on one port, and by monitoring printer status indicated by 8-bit words on another port. The XA2 board and its 8080 processor function as in a normal 810 and provide communication interfacing, carriage motor and paper advance control, printhead control and operator control panel monitoring. However, all dot patterns required for character printing or graphics plotting are generated by the Z80 and transmitted to the 8080 during the time intervals when the carriage is moving across the paper.

The intricate relationship between the processors is controlled by the firmware programs on the 190 board. These programs also provide power-up initialization functions which include checkout of all RAM and ROM, carriage initialization, and setup of vertical and forms length format.

The hardware on the 190 board is allocated to four functions: 8080 μP program and addressing (4K ROM); Z80 μP system (16K RAM and 16K ROM); received character FIFO buffer; and, interprocessor communications. The Model 190 type design has expanded RAM and ROM to accomplish more complex functions. □

The WDC11 series...

The FIRST family of Winchester/Floppy controllers for the LSI-11/Q-Bus



WDC11-B connected to a CM15619 5¼" Winchester disk drive and a Shugart SA800 floppy disk drive (notice the simple personality card). The 5619 emulates 6 RK05 units for 15mb. The SA800 emulates an RX02 for 512kb.

Unsurpassed Freedom Of Choice

Choose the **disk drive sizes** that are right for YOUR application: The WDC11 controls 8" and 5.25" drives, Winchester and floppy.

The **DEC emulations** that YOU need: RK05, RL01/02, RP02 for the Winchester and RX02/03 for the floppy. All Winchester emulations provide 22-but addressing; RLV21-compatible.

The **disk drive vendors** that YOU want to use: The Following manufacturers build drives that are currently supported: Shugart, Quantum, Tandon, Qume, Computer Memories, Disctron (RMS), Rodime, Ampex, Micro Peripherals, Seagate. Any drive with a standard interface (SA1000, SA800/850, ST506, or TM100-4) can be controlled by the WDC11. A single PROM chip adapts the WDC11 to a specific drive configuration.

The **controller form-factor** YOU want: A single, dual-width card includes the Winchester controller, the floppy controller and an intelligent bootstrap. There is no external formatter board that you need to mount and supply power to. The WDC11 requires only 2.7A of +5V. Simple personality cards adapt the WDC11 to multiple drives, various pinouts and signal levels.

The **experience** YOU are looking for: Andromeda has been shipping WDC11's since the Summer of 1981.

The **growth potential** that YOU require: As new, higher capacity, higher performance disk drives become available, the WDC11 can be adapted to them by simply changing the configuration PROM. New emulations and data formats can be handled in a similar fashion.

DEC, LSI-11, RK05, RL01/02, RX02, and RP02 are trademarks of the Digital Equipment Corp.

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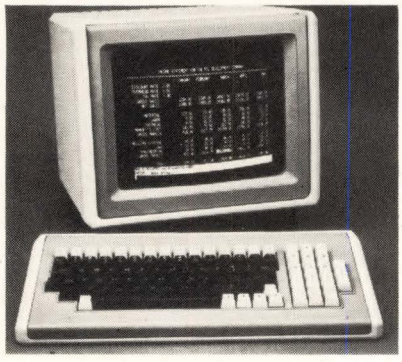
DUAL TERMINAL

Separate μP For Each Major Function

The basic CRT stand-alone terminal has a separate μP for each of its major functions: keyboard control and screen handling. It can be customized to emulate nearly any conventional CRT, with added capability. It has a contoured keyboard and high-resolution monitor to eliminate eye fatigue.



The enhanced IMS CRT has all the capability of a CRT but includes a general purpose Z80 μC complete with 2 high-speed RS422 serial ports, one RS232 printer port, 64K of RAM and a battery-backed-up real-time calendar clock. In the expanded mode this intelligent terminal now becomes a node processor in a multi-user, multiprocessor network environment. Basic CRT is $1095, expanded CRT is $1795. **IMS International,** 2800 Lockheed Way, Carson City, NV 89701. **Write 141**

SMALL BUSINESS COMPUTERS

Complete With Bundled Software

The 4000 Series are complete with bundled software consisting of word processing, spread sheet with graphics, data base management, mailing list, payroll, TELEX, executive time management and CP/M operating system. The basic system combines two 5.25″ double-sided, double-density floppy drives (1.2MB), with an 8085-based CPU, addressing 64 Kbytes of RAM upgradable to 8085/8088, 8/16 bit co-processor addressing 1,000 Kbytes of RAM. Up to 20 MB of plug-in hard disk storage is available. RS-422 and RS-232C ports are included. It is a compact, ergonomically designed self-contained system with a desk-top non-glare and sharp 12″ video monitor. The monitor has its own memory and uses an 8 × 12 matrix on a 10 × 14 grid (80 column by 24 lines) with a choice of three display colors. The Voyager 4000 is $4995 including bundled software with CP/M, communications capabilities and a 90

day warranty. OEM and dealer discounts available. **Voyager Systems, Inc.,** 2192 Anchor Court, Newbury Park, CA 91320. **Write 152**

SPEECH SYSTEM

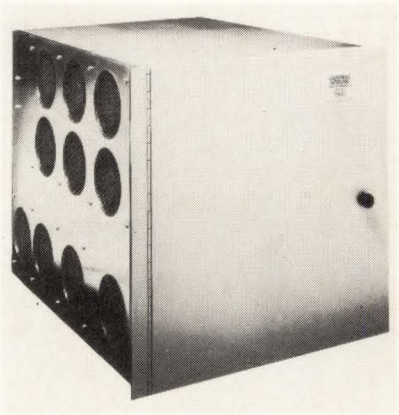
Produces Human-Quality Speech At Low Bit Rate

SPeachware combines low-cost hardware with superior voice-quality software suitable for all μC applications. It is capable of storing about 8 hours of continuous speech on a 20 Mbyte disk. SPeachware will be first introduced to enhance and simplify the presentation and understanding of existing Peachpak software. This added voice capability will make the software even easier to use by shortening learning time and improving the training aspects associated with the use of μCs and software. The SPeachware feature will initially be compatible with the IBM/PC. User investment will be about $400 to add the synthesizer board, which reproduces speech, to existing hardware. **Peachtree Software Inc.,** 3445 Peachtree Rd NE, 8th Floor, Atlanta, GA 30326. **Write 143**

GRAPHICS/IMAGE PROCESSING

Line of Image Processing, Image Display, And Computer Graphics Equipment

The 2800 Family will include the 28 Series for high performance computer graphics; the 280 Series for image display and enhancement; and the 2800 Series for image processing. All of these systems will be based on a series of modular, compatible elements and



chassis, and they will be available as either standard configurations or customized assemblies of the standard modules. The first member is the Model 2800-32 intended for sequential processing of RGB images. It has up to six 8-bit banks of 512 × 512 memory with program selectable resolutions of 512 or 480 lines and 512 or 640 pixels per line. A video digitizer and an MC68000 μP card with up to 512 Kbytes of program memory which is loadable from the host computer are also available. At the heart of the system is a high speed bit slice processor with up to 4K of 64-bit user loadable micro-code for system control and graphics processing. From $25,000, depending on options and accessories. **Grinnell Systems Corp,** 6410 Via Del Oro Dr, San Jose, CA 95119. **Write 138**

ANVIL-4000 SOFTWARE

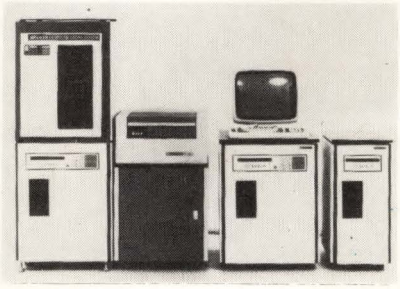
Now Available On MV Computer Family

ANVIL-4000 Mechanical CAD/CAM software system is now available from Manufacturing Consulting Services, Santa Ana, CA, on the entire DG family of 32-bit computer systems. ANVIL-4000 is an integrated system for mechanical design, drafting and manufacturing. Capabilities include geometric construction, manipulation, and analysis; view and scale manipulations; families of parts; file management; management of information; drafting and annotation; and numerical control. ANVIL-4000 on the MV computers provides CAD/CAM users an interactive design environment with direct control over their application and access to a wealth of additional software that ranges from statistical analysis to office automation and presentation graphics. **Data General,** 4400 Computer Dr., Westboro, MA 01580. **Write 136**

16-BIT COMPUTER

For Distributed Processing And Communications

Heart of the Lotus system is a distributed processing controller with such features as up to 3MB on-board memory, 4 communications interfaces for RS-232 and RS-422, bidirectional parallel and memory mapped interfaces for peripherals, direct memory access, and memory management addressing up to 128 independent memory segments. The Lotus processor can serve as a standalone system, a workstation controller, a node in a local network, a node in a global network or it can readily interface to other networks utilizing Bisync, 2780, 3780, HASP, SDLC/HDLC or X.25/SNA protocols. To match these varying requirements, the system is available in three major configurations—Executive, Basic and Advanced. The operating system can govern such operations as distributed processing and communications, device independent I/O, virtual terminals, and terminal window management for simultaneous multiple views. Languages supported include Pascal, C, ADA, Cobol, Fortran and Basic. Applications software includes network management, a decision support system including financial planning, business graphics and statistical analysis. Also included are office automation functions such as word processing, document filing and retrieval, time management, message delivery and document management, control/tracking. From $19,900 to $49,900. **Incomnet**, 2772 Johnson Dr, Ventura, CA 93003. **Write 139**



GRAPHICS SYSTEM

Based On The VAX-11/730 CPU

The basic Intergraph 730 package, balanced for the graphics environment with specialized Intergraph processors, includes 2 Mbytes of memory and is configured with either a color or monochromatic Intergraph workstation. The 730 is offered primarily as an entry level system into VAX-based graphics. As a standalone system, it provides all of the functional capabilities as Intergraph systems utilizing VAX-11/750 and VAX-11/780 processors, including the ability to create, manipulate, display, and plot any form of graphics information, and to simultaneously manage attribute data associated with the graphics. Additionally, total software compatibility has been maintained between the new system and other VAX-based systems available from Intergraph, facilitating 730 sytem use as a node in a distributed network environment. Any third-party application software written for VAX/VMS will run on a VAX-based system without modification. Base price of the new system is $145,000 with a monochromatic workstation, and $165,000 with a color workstation. **Intergraph Corp.**, One Madison Industrial Park, Huntsville, AL 35807. **Write 140**

8″ 45MB WINCHESTER

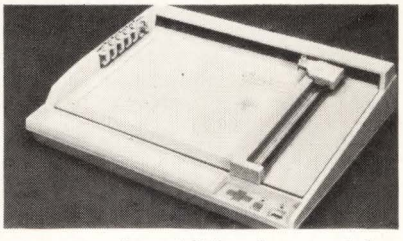
With Integrated Backup

Designed specifically for S-100 computers, the MICROMATE has a 13.4 Mbyte cartridge drive built into the system for compact Winchester backup. Both disk and cartridge drives are driven by a single power supply. The other major system component is the interface linking the drives to an S-100 computer. The system provides high-speed file-oriented disk-cartridge transfers at a rate of ½ Mbytes/minute. Principal software packages provided with the system are the TIP disk backup package and a CPM-oriented program for controlling the Winchester's operations. It uses the Model 1223 disk drive from Micropolis which has a capacity of 44.56 Mbytes, 42 ms access time and a transfer rate of 7.375 Mbits/sec. MICROMATE is $5495. **Alloy Computer Products,** 12 Mercer Rd, Natick, MA 01760. **Write 156**

6 COLOR PLOTTER

Low Cost X-Y Coordinate Plotter

AMPLOT II is compatible with most personal computers and features high-pen speed, automatic pen retrieval and .002″ resolution for fast, accurate plots. The μP-intelligent unit receives ASCII commands, and built-in software permits additional one alpha-character commands. 8-bit parallel and RS-232-C operation is standard. Effective plotting range is 10″ × 14″ and 6 fiber tip pens are furnished for plotting on ordinary paper or film. Chart hold-downs and a dust cover are furnished. $1290. **Amdek Corp.,** 2201 Lively Blvd, Elk Grove Village, IL 60007. **Write 157**



5¼″ STREAMING CARTRIDGE TAPE DRIVES

Capability Of 8″ Sidewinder In Mini-Floppy Footprint

The Scorpion series can back-up 5¼″ Winchester drives from 5–50+ MB with data transfer rates of 20 MB in just 4 minutes and 45 MB in 9 minutes. They offer a front-loading cartridge for ease of access in a 5¼″ package and are media-compatible with existing Archive products, using standard ¼″ 3M cartridge tape—DC300XL (450 ft.)—so that any tape recorded on the 8″ Archive drives can be read on the Scorpion. Both versions of Scorpion—20 and 45 MB formatted capacity—are available in an Intelligent version, providing high throughput, streaming at 30 or 90 ips, and eliminating the large inter-record

gaps associated with traditional start/stop tapes. From $800 in OEM qty. **Archive Corp,** 3540 Cadillac Ave., Costa Mesa, CA 92626. **Write 158**

ELECTROSTATIC PLOTTERS

400 Dot/Inch Resolution

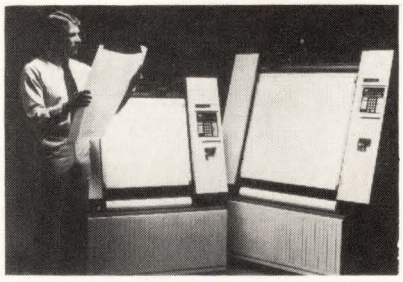
Suprascan 9600 Series electrostatic plotters will be available in 22″ and 36″ plotting widths. The 400 dpi MicroResolution results in computer graphics hardcopy that closely approximates the line quality of pen-and-ink drawings yet at many times the speed possible with a pen plotter. Suprascan was developed in response to mechanical design, architectural and seismic processing requirements. The 9622 plots at 0.4 ips across a 21.12″ writing width. A character generator is standard, providing 123 ASCII characters in Gothic font. The 9636 plotting speed is 0.15 ips across a 35.20″ writing width. Character generator with 123 ASCII characters in Gothic font is standard. The 9622 is $46,500; 9636 is $71,000. **Benson, Inc.,** 385 Ravendale Dr, PO Box 7280, Mountain View, CA 94039.

Write 159

BELTBED PLOTTERS

Improved Graphics Price/Performance Levels

The D-size 945 and E-size 965 offer 30 ips (42 ips diagonal) speed and meet both end-user and OEM system house applications. Users can select from 4 different pen types—pressurized ballpoint, liquid ballpoint, nylon tip and liquid ink. The use of pressurized ballpoint pens enables users to generate plots at maximum speeds. A Motorola MC68000 16-bit μP embedded in the 945/965 systems is the basis for a number of operational and ease-of-use features. The control panel



features a message display that prompts operators in English, not in alphanumeric codes that must be remembered or looked up. This makes the units easy to use by untrained operators. Electronic limit switches, also microcomputer-controlled, automatically set the X and Y axis limits for plots. To label plots, a user may choose from 10 resident character sets that contain 128 ASCII characters each. Text can be tailored to a particular plot by defining character size, rotation, aspect, slant, string spacing and string direction. The D-size 945 is $15,790; the E-size 965 is $20,500. **California Computer Products,** 2411 W. LaPalma Ave., Anaheim, CA 92801. **Write 160**

SOLID STATE DISK

Doubles Throughput Of Tektronix S-3200 Series Test Systems

The ExpandaSTOR-11 operates like the DEC RK05 2.5 Mbyte disk in the test system but speeds disk access and transfer time by a factor of 10 through use of solid state memory. A modification of the TEKTEST III operating system, OS-1 from TSSI (Test Systems Strategies, Inc.), allows the Cambex disk to augment the test system's disk. The result is an increase of two to three times in throughput and substantial decreases in wait time for background operations and TCM. Data transfer rate is 2.2 Mbyte/sec, seek time is 350 ns. Rotational latency and track-to-track seek are reduced to zero. The ExpandaSTOR-11 has a 2.5 Mbyte capacity and can be expanded by an additional 2.5 Mbyte. Rack-mountable, it connects directly to the PDP-11 Unibus and, using OS-1, is software compatible with the RK11/RK05 disk. $25,000. **Cambex Corp.,** 360 Second Ave., Waltham, MA 02154. **Write 161**

LINE PRINTER

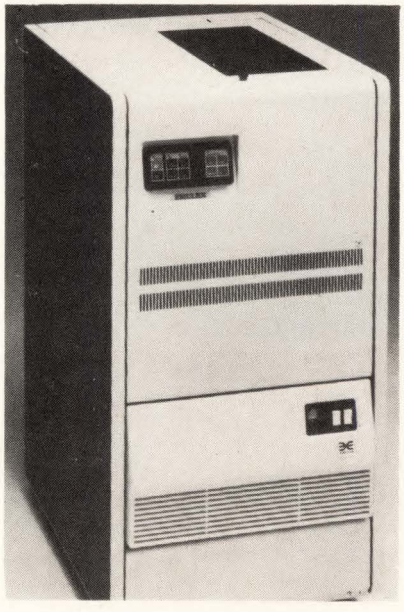
Extends Speed Of E-Series To 2400 lpm

The basic design and construction of the Model III extends the same family approach of all the E-Series printers and provides 80% parts commonality across the line. Standard user oriented features of the Model III include: a troublefree, two million line, towel ribbon for extended life and low replacement cost, front panel touch controls and an LED status display, built in diagnostics, fast paper loading and handling, powered paper stacker, quietized enclosure, and a large library of interchangeable print bands with 48, 64, 96 and 128 character sets. Minimum OEM quantities are $15,000 per unit. **Centronics Data Computer Corp.,** Hudson, NH 03051. **Write 162**

STORAGE SUBSYSTEM

Provides Combined Disk And Tape Capability In 42″ Cabinet

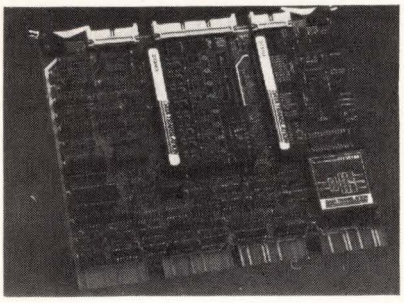
The FXS51 Series unites Emulex's DEC compatible disk and tape controllers with Fujitsu Limited's M2351A Eagle disk drive and Control Data Corporation's 92181 Keystone tape drive. In addition to performing the usual backup functions, the Keystone offers archival storage and journaling capability—plus the benefit of complete media interchangability associated with half inch magnetic tape. The disk may be used in conjunction with tape for program storage, data exchange, system backup, and other system needs. Start/stop functions may be mixed with streaming for extreme flexibility. The Eagle transfers data at 1.8 MB/sec. **Emulex Corp,** 2001 East Deere Ave, Santa Ana, CA 92705. **Write 166**



SIMULTANEOUS SAMPLE AND HOLD BOARD

Plugs Into LSI-11 Systems

The DT3388 analog input board allows the user to take a snapshot of up to twelve high level analog input channels, freezing their values within

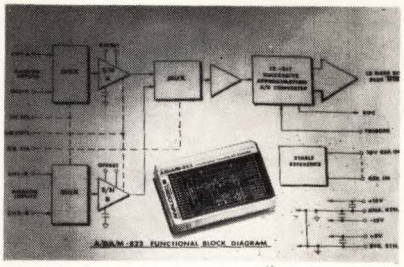


a +/−5ns aperture uncertainty period, and to transfer the analog data to continuous disk files at rates of up to 90,000 samples per second. Supported by the CPLIB software package, the DT3388 is suited for applications in physiological research, high speed materials testing, acoustic research, signal processing, and simulation. Available in four and twelve channel versions, the DT3388 is a complete LSI-11 Bus compatible system with analog input functions, simultaneous sample and hold circuitry, a high speed 12-bit 100kHz A/D converter, and control and bus interface logic all contained on a single quad height board. Analog input ranges are either 0 to +10V or +/−10V, jumper selectable, with the input gain fixed at unity. The DT3388 has a sample and hold aperture delay of less than 100ns with an aperture uncertainty of +/−5ns across all 12 channels. The sample and hold circuits have a drop rate of 0.5mV/ms. Prices for the DT3388 in 1–9 quantities are $2795 for the four channel version and $3295 for the twelve channel version. CPLIB is priced separately at $1495. **Data Translation,** 100 Locke Drive, Marlboro, MA 01752. **Write 126**

SIMULTANEOUSLY SAMPLING A/D

Simplifies Time- and Phase-Correlations

This self-contained two-channel A/D conversion module has its own input sample-and-hold amplifiers, stable reference source, and 12-bit A/D converter. The Model A/D/A/M-822 is a simultaneously sampling, 0.025% accurate system with an aperture uncer-

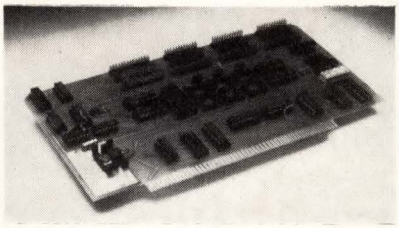


tainty time of 5ns. Available output codes are natural binary, offset binary, or two's complement, depending upon user requirements. An added feature of the Model A/D/A/M-822 is the fact that there are four analog inputs which can be chosen in two groups of two each. This allows either of two sets of dual input channels to be simultaneously sampled. Two separate sample-and-hold amplifiers ensure better than 110 dB interchannel crosstalk isolation. Offset error on any channel, adjustable to zero, is less than 25 mV for a full scale input of ±10V, even without adjustment. Price is $134 in hundreds, with higher quantity discounts available; delivery is four to six weeks. **Analogic Corp,** Audubon Rd, Wakefield, MA 01880. **Write 127**

ROM SIMULATOR

Faster Micro System Development

One of the biggest time-gobblers in new system development and debugging is burning in a new PROM or EPROM every time a new code sequence, memory configuration or timing profile is desired. The P&E ROM simulator allows any of these changes to be made almost instantly. The simulator occupies one card slot of any IEEE Standard S100-Bus computer. The contents of the simulated ROM is manipulated simply by using a stan-

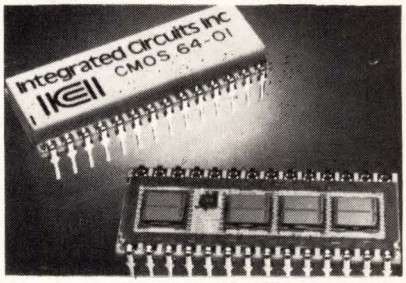


dard CP/M debug program or a simple user-supplied program on the S100 host computer. The board also simulates memory response time for experimenting with various timing possibilities. Single quantity price, with 2K RAM and complete manual is $600. **P&E Microcomputer Systems, Inc.,** PO Box 2044, Woburn, MA 01880. **Write 146**

64K CMOS STATIC RAM

1 Micro-Amp Current

With an extremely low standby current of 1μA typical, the CMOS 64-01 thick-film hybrid combines four 16K CMOS RAM chips with a decoder chip to produce a hybrid 64K CMOS Static RAM. The CMOS 64-01 8K word by 8 bit CMOS RAM is packaged in a standard 28 pin, 0.6″ wide DIP. Configured in the JEDEC approved pin-out for 28 Pin Byte organized memories, the hybrid is pin-for-pin compatible with the industry standard 64K Bit EPROM as well as



the single chip 64K Bit CMOS RAM scheduled for next year. Operating from a 5VDC supply at 500 mW max, the CMOS 64-01 gives a fast memory access of 100 nsec. Priced at $105 (100) the unit is available with 30 day delivery. **Integrated Circuits Inc,** 13256 Northup Way, Bellevue, WA 98005. **Write 128**

TRANSCEIVER BOARD

Avionics Applications

The ARX-429 Transceiver Board connects the full spectrum of ARINC-429 functions to the Multibus, one of the most flexible and widely used standard μP data buses. The ARX-429 is configured as an iSBX submodule, an industry standard form which allows it to be simply plugged into a wide range of Multibus processor boards. A μP can monitor two incoming ARINC-429 data streams and concurrently transmit a third stream with the ARX-429. The Transceiver Board includes all the logic needed to interface the serial ARINC-429 bus to parallel μP data structures, to generate and check parity, to satisfy the timing requirements of the ARINC-429 standard, and to operate with either 8- or 16-bit μPs. Using this product enables the extensive range of Multibus processor, memory and peripheral controller products to be easily integrated into system applications which use the ARINC-429 bus. **Procise Corp,** P.O. Box 1011, Issaquah, WA 98027-1011. **Write 129**

16-Bit μP

With Eight-Bus Interface

The iAPX188 has a 16-bit CPU, but interfaces to the outside world via an 8-bit data bus. Performance of this μP is double that of the 8088, but it costs half of the combined price of the 8088 and the numerous peripheral devices necessary for 8088 operation. The iAPX 188 integrates the functions of 15 to 20 support chips that include an enhanced 8088-2 CPU, two-channel DMA controller, an 8 MHz clock generator (designed to work with a 16 MHz crystal or other external frequency source), timers, interrupt controller, chip-select logic and ready generator. $50 each in 100 qty. **Intel Corp,** 3065 Bowers Avenue, Santa Clara, CA 95051. **Write 130**

GRAPHICS CONTROLLER CHIP

Speed To 5.5 MHz; Video Data Rate To 88 MHz

NEC's Graphic Display Controller (GDC) the μPD7220-2 allows generation of high resolution color graphics on a CRT display. The device can address up to 4M bits of video display memory, programmable vertical and horizontal timing, and an internal vector generator that allows it to draw arbitrary vectors, arcs, circles, rectangles and characters. Other features include DMA interface, and the ability to perform zooming, panning, scrolling, split screen. The GDC comes in a 5V only, 40-pin DIP. The major application for the GDC is in CRT terminals, color terminals, personal computers, CAD/CAM work stations, and any other area where medium to high resolution color or B/W terminals are used. **NEC Electronics**, Microcomputer Division, One Natick Executive Park, Natick, MA 01760. **Write 131**

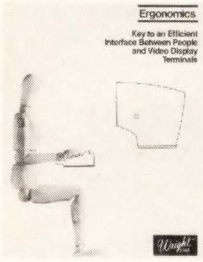
THIN-FILM R/W HEADS

Operate At 8,000–15,000 FCPI

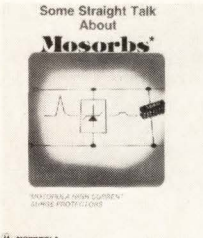
Designed specifically for use on either 5¼" or 8" Winchester rigid disk drives, the Cyber 100 series are dual-layer, 23-turn heads which operate at inner track flying heights of 13 micro-inches (plus or minus 1.5 micro-inches), and at flux densities ranging from 8,000 to 15,000 flux changes per inch (FCPI) depending on the drive's read-channel electronics and the type of media used. Overwrite at the outside track is less than −26 dB at a write current of 30 milliamps (peak-to-peak). They support track densities of 800 to 1,200 tpi. From $35 to $65 per head in OEM qty. depending on specifications. **Cybernex Corp.**, 6580 Via Del Oro, San Jose, CA 95119. **Write 144**

Erratum

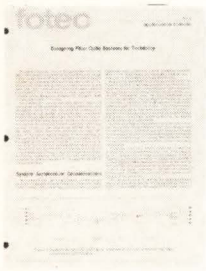
The schematic diagram submitted to illustrate Applications Notebook, "A Portable μP Analyzer" (**Digital Design**, November '82) was incorrect. To obtain a copy of the actual schematic, please contact: George Andrukevich, Pitney Bowes, 380 Main Ave., Norwalk, CT 06852.



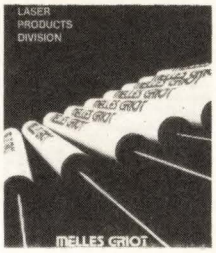
Ergonomic Workstations. Brochure identifies 11 specific problems associated with video display terminals and the workstation environment, and has an ergonomic checklist for workstation specification and purchase. Checklist categories include operator seating, keyboard location, viewing screen location, viewing screen attitude, Provisions for Non-terminal Tasks and Glare and Reflection Elimination.
Wright Line. **Write 250**



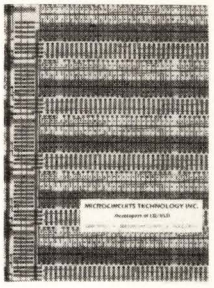
Semiconductor Manual. Motorola offers an 18 pp. manual featuring a new zener type silicon transient suppressor product line, better known as MOSORBS (Motorola Transient Absorber). Included are data sheets, applications information, a discussion of parameters and how to pick the proper device for your application.
Motorola Semiconductor **Write 255**



Fiber Optic Applications Note. This applications note describes system architectures that allow simplified testing, offers advice on component evaluation that will make testing easier at the systems level, and suggests variables in transmitter design that allow for compensation of component variability. The design ideas offered are appropriate for all fiber optic datalinks, low or high speed, long or short distance, in any system application.
Fotec **Write 269**



HeNe Laser Brochure. The Melles Griot Laser Products Division announces a 10 pp. brochure describing its range of helium neon lasers and companion power supplies. Complete operating and environmental specifications, dimensions and warranty details are included.
Melles Griot **Write 259**



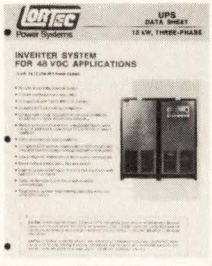
Microcircuits Brochure. A 3 μm silicon gate, selective oxide isolated isoplanar HCMOS gate array family, the SGAxx are illustrated. These arrays are available from nominal 500 to 6000 gates with 40 to 138 TTL/CMOS compatible I/O buffers per chip. Typical gate propagation delay is 1.8 to 2.5 ns achieving toggle rates to 40 MHz. In sizes to 1500 gates a single layer of metalization is used.
Microcircuits Technology **Write 263**

CMOS Board Data Book. A 62 pp. data booklet contains data sheets on the first 14 members of National Semiconductor's Series/800—CMOS Industrial Microcomputer board line that include CPU, memory expansion, digital and analog I/O boards. Also included is a real-time, multitasking operating system, BLMX-80C. Order #114300.
National Semiconductor **Write 254**

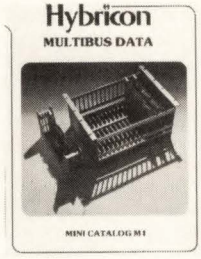
New Literature

Honeywell Product Catalog. Honeywell offers a 36 pp., full-color catalog of Honeywell Test Instruments Division's instrumentation products, comprising six product groups: Visicorder oscillographs, imaging recorders, Accudata signal conditioning, magnetic tape systems, industrial systems and special products. Descriptions and features are noted for each product available within each group.
Honeywell **Write 260**

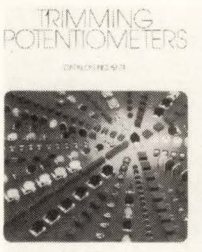
UPS Technology. A 4 pp. brochure details the company's Rotary Uniterruptible Power System. The brochure provides a chart outlining the advantages of CPP's new product as compared to static-type UPS's in terms of relative power protection provided, features, maintenance requirements and operating costs.
Computer Power Products **Write 261**



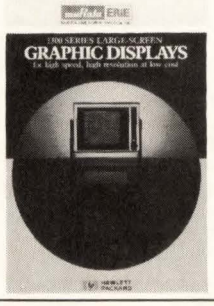
Inverter Data Sheet. A new 2-pp. illustrated data sheet describes LorTec's 15 kW, three-phase, Inverter System for 48 VDC applications. Providing specification data, including input, output, and environmental ratings, physical dimensions, weight, and DC noise specifications, it defines the system's ability to protect a critical load from blackouts, brownouts, line transients, and voltage fluctuations.
Lortec **Write 268**



Multibus Catalog. M-1 Catalog contains ordering information, dimensional drawings, and specifications. Includes the newest 6 slot version of the Multibus backplane and card frame series; the new socket boards with the continuous groundplane on the wiring side; extender cards for testing, debugging; related accessories and services from custom pinning to wire wrapping.
Hybricon Corporation **Write 251**



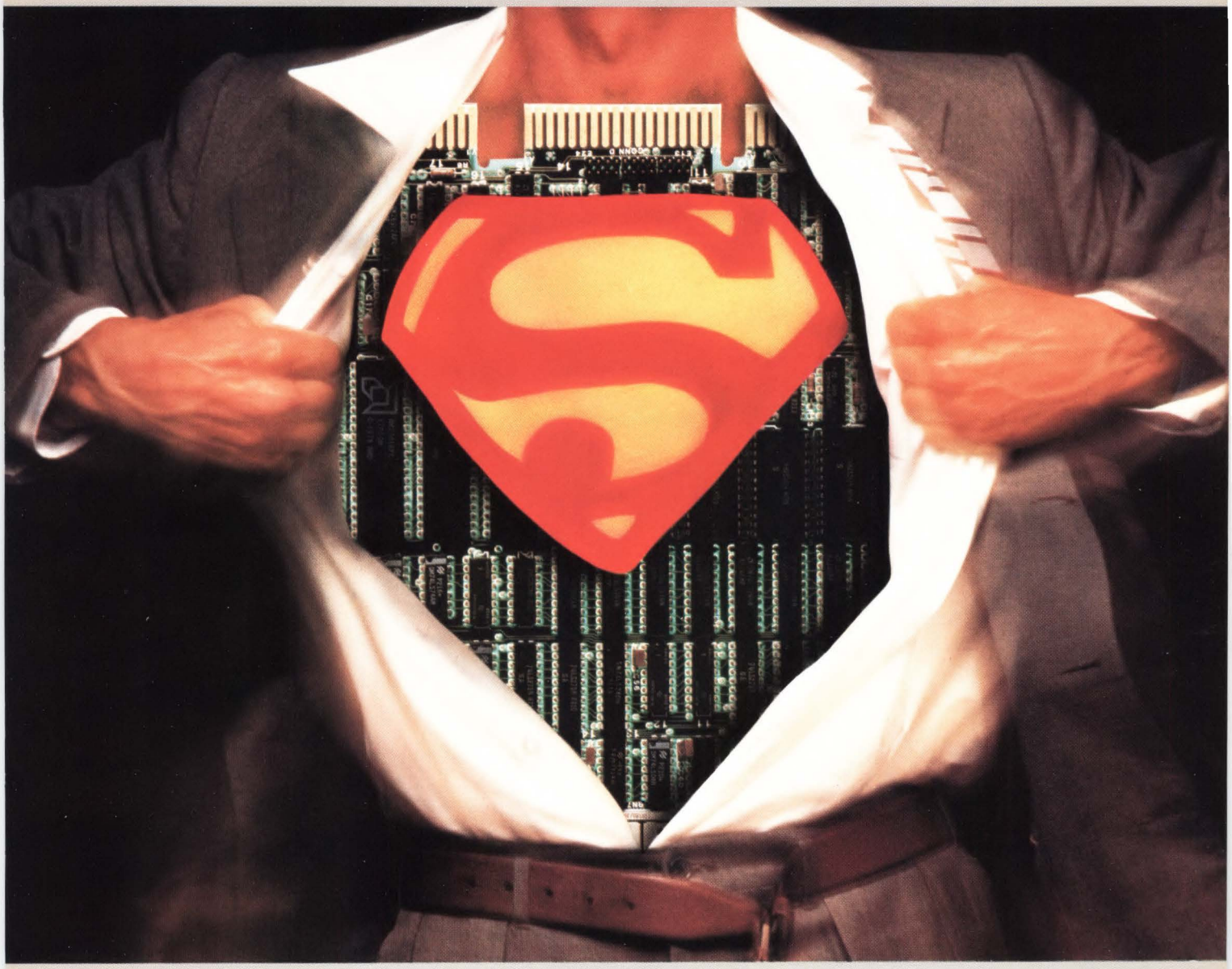
Potentiometer Catalog. A 32-page trimming potentiometer catalog is available from Murata Erie North America, Inc. providing electrical and mechanical specifications on the firm's line of sealed single- and multi-turn trimming potentiometers.
Murata Erie **Write 258**



CRT Display Brochure. A 6-pp. brochure (5953–3978) on large-screen electrostatic CRT displays describes HP's family of displays for instrumentation and design graphics. It lists specifications for displays and graphics-generator systems as well as pictures and descriptions of applications in design graphics, instrumentation systems, military/aerospace and radar training/simulation.
Hewlett-Packard **Write 267**

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.

It's the TS-6251 Supercontroller from Western Peripherals, the company that has put more magnetic tape on DEC Unibus computers than any other independent supplier. Call or write us for technical details.

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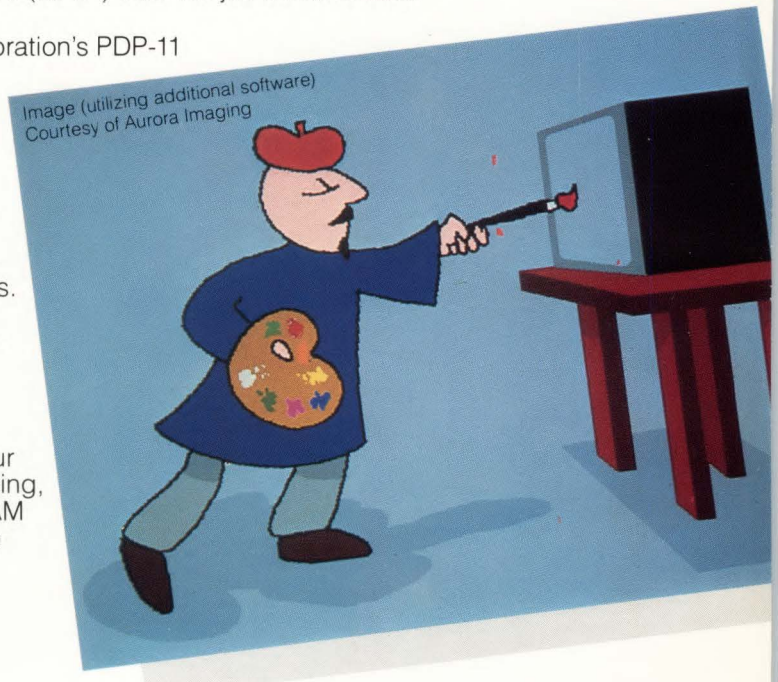
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