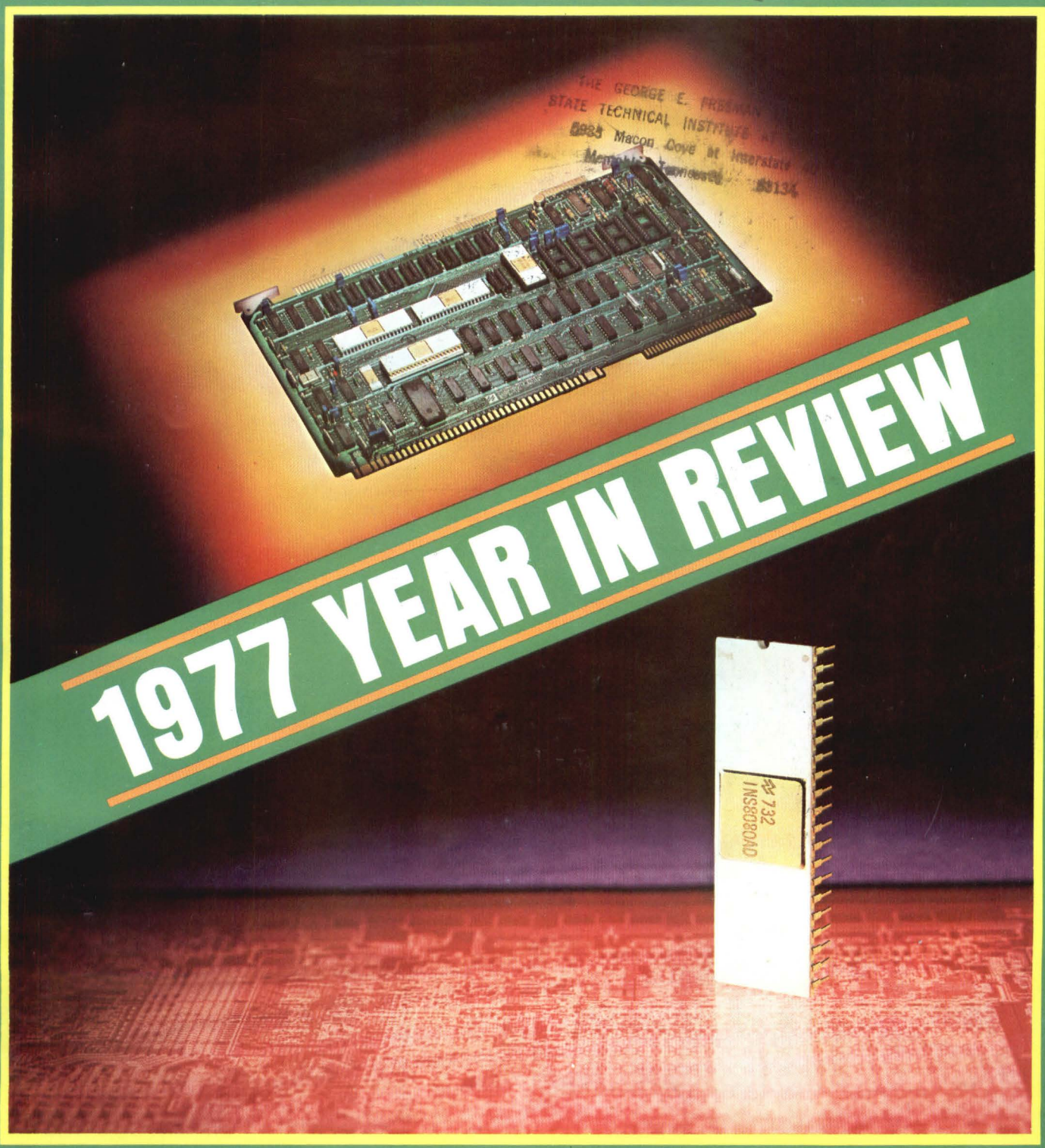
December, 1977

Minicomputers ▪ Microcomputers ▪ Printers & Plotters

Tape & Disk Drives ▪ Memories ▪ Terminals

Digital Design

The Magazine of Digital Systems



is to take it apart piece by piece.

Compare the features of our S-100 bus system, the industry standard, to anyone else. After you've taken them apart piece by piece, you'll know why IMSAI is the system you can grow with. At a price you can live with.

IMSAI 80/30 Integrated Video Computer (with Intelligent Keyboard–IKB-1) Standard Features:

□ **Price assembled $1499.** IMSAI is the only S-100 bus manufacturer that offers a microprocessor driven keyboard with "N" key roll over, 2¼K of RAM, 8 expansion slots, choice of 4K, 16K, 32K and 64K RAM expansion boards, 3K ROM monitor, synch/asynch serial interfaces, parallel and serial ports, high resolution CRT monitor, 24 x 80 display with graphic editing and data entry features, and 28 amp power supply for the incredibly low price of $1499.

□ **mpu Speed.** IMSAI is the only S-100 bus manufacturer that offers true 8080 compatibility, operating at 3 mHz.

□ **RAM Included.** 2¼K.

□ **Expansion Slots.** Eight expansion slots are provided in a new terminated and regulated motherboard (10 slots total).

□ **RAM Board Sizes.** IMSAI is the only S-100 bus manufacturer to supply 4K, 16K, 32K, and 64K RAM memory expansion boards.

□ **ROM Monitor.** IMSAI is the only S-100 bus manufacturer to provide 3K of ROM.

□ **Asynch/Synch.** Only one other S-100 bus manufacturer provides both methods of data communication.

□ **PIO/SIO.** IMSAI is the only S-100 bus manufacturer that provides two serial ports and one fully implemented parallel port at no extra charge.

□ **Video I/O.** IMSAI is the only S-100 bus manufacturer to include a high resolution (14 mHz) monitor as an integrated part of the computer.

□ **CRT Format.** IMSAI is the only S-100 bus manufacturer to provide a full 24 x 80 screen, which is two times the capacity of the common 16 x 64 screen.

□ **Graphic/Edit.** IMSAI is the only S-100 bus manufacturer that provides graphics and text editing features with character and line insert/delete for your CRT display.

□ **Keyboard Included.** IMSAI is the only S-100 bus manufacturer to supply a microprocessor driven keyboard with "N" key roll over and tiered construction for a true typewriter keyboard touch.

□ **28 amp Power Supply.** The world famous IMSAI power supply assures stability and reliability of performance.

Options: IMSAI is the only S-100 bus manufacturer to provide a comprehensive array of fully integrated options including: line and character printers, CRT terminals, intelligent keyboard, ACR storage, standard and mini floppies, TTY BASIC with OS, 4K, 8K and 12K BASIC, audio cassette BASIC with OS, 8K disk operating system (DOS) based upon CP/M,* scientifically and commercially oriented disc BASIC and level 2 FORTRAN IV compiler.

□ **Printers.** Only one other S-100 bus manufacturer can supply both line and character printers.

□ **CRT/Keyboard.** IMSAI is the only S-100 bus manufacturer to provide both CRT terminal and intelligent keyboard as separate options.

□ **ACR Storage.** Available.

□ **Floppies.** IMSAI is one of the few S-100 bus manufacturers to provide both standard and mini floppies and the only S-100 bus manufacturer that supplies double density standard floppies.

□ **TTY BASIC.** IMSAI is one of the few S-100 bus manufacturers that provides self-contained operating systems with 4K, 8K and 12K BASIC.

□ **ACR BASIC.** IMSAI supports ACR BASIC with an 8K version.

□ **DOS.** IMSAI is the only S-100 bus manufacturer to provide an enhanced version of the control program monitor (CP/M*) that can support up to 18 disk drives.

□ **Disc BASIC.** IMSAI is the only S-100 bus manufacturer that provides both scientific and commercial versions of compiler oriented BASIC.

□ **FORTRAN IV.** IMSAI is the only S-100 bus manufacturer that offers a level 2 FORTRAN IV compiler that operates under an enhanced version of CP/M.*

Prices and specifications subject to change without notice.
*CP/M is a trademark of Digital Research Corporation.

Price/Performance no one else has put together.

IMSAI®

IMSAI Manufacturing Corporation, 14860 Wicks Blvd., San Leandro, CA 94577 (415) 483-2093 TWX 910-366-7287

The Standard of Excellence in Microcomputer Systems

CIRCLE 1

The $6,000* DP Center.

IMSAI Introduces the VDP-80

Until now, owning real computing power meant paying unreal prices. Announcing the IMSAI VDP-80 Video Data Processor, a complete computer, intelligent terminal and megabyte floppy disk mass storage system. All in one compact cabinet. All for just **$5995*** A complete desk top DP center.

For small business applications, the VDP-80 places a stand-alone computer at your fingertips. And, our full line of add-on peripherals, assures that the system can be expanded as your needs do.

For the large business user, with an existing central mainframe, the VDP-80 is the ultimate remote processor. You have the advantage of powerful local processing capability, plus the epitome in cost-effectiveness for implementing a distributed data communications network.

Take a close look at the following features. Then you'll know why we call our VDP-80 the desk top DP center.

□ **Powerful, High-Speed, Central Processor.** 3 mHz Intel 8085 microprocessor. 32K RAM memory (expandable to 196K). Parallel and serial I/O. Asynch, synch and bisynch communications. Programmable baud rates (.05-56 KB).

□ **Megabyte Mass Storage.** PerSci dual floppy, double density disk drive standard. One million byte storage capacity. Three floppy disk drives can be added-on, providing 4 million bytes of on-line storage.

□ **Drives Printers, Plotters, Terminals, Modems and Tape Drives.** Supports up to six terminals or modems, and four tape drives. Drives plotters, serial printers and line printers (up to 300 lpm).

□ **12" CRT, 24x80 Field, User Programmable Font.** Character and line insert/delete allows fast program correction and text editing. Inverse video and programmable field allows highlighting or enlarging graphics of information display. Titled fields protect information blocks from being written over accidentally. Programmable font (up to 256 different characters) allows foreign language and special purpose character forms.

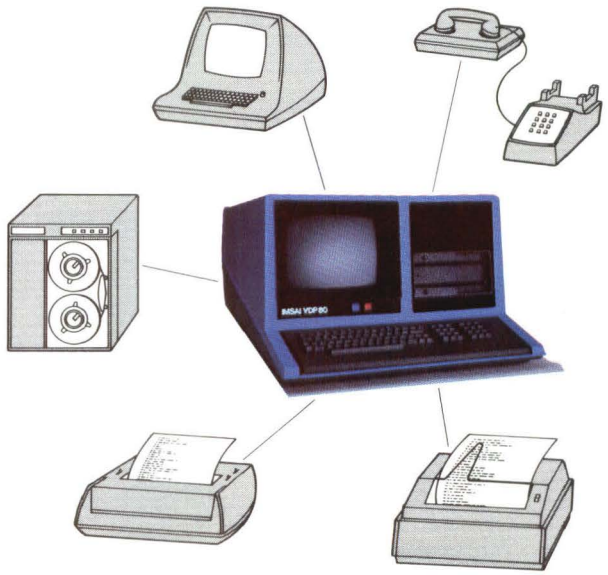
□ **Alphanumeric Intelligent Keyboard.** 62-pad main keyboard. Programmable 12-pad numeric keyboard. 12-pad control keyboard. Standard typewriter and calculator keyboard layouts. "N" key roll over reduces operator error during high-speed data entry.

□ **Commercial BASIC, FORTRAN IV, DOS Software.** Built-in ROM monitor allows extensive debugging and diagnostics. BASIC, interactive or compiler version. FORTRAN IV level 2 ANSI compiler. DOS-enhanced CP/M.**

Distributed processing, financial reporting and analysis, word processing, whatever your application, the VDP-80 is your answer.

Dial (415) 483-2093, and we'll tell you how you can put our $5995* DP Center on your desk top. When it comes to small business computers, Just Ask IMSAI.

*Base price VDP-80/1000, $5995, with 32K RAM memory and dual double density floppy disk drive. U.S. Domestic Price Only. Features and prices subject to change without notice.
**CP/M is a trademark of Digital Research Corporation.



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the best way to build your system....

PCS-80/30 Integrated Video Computer

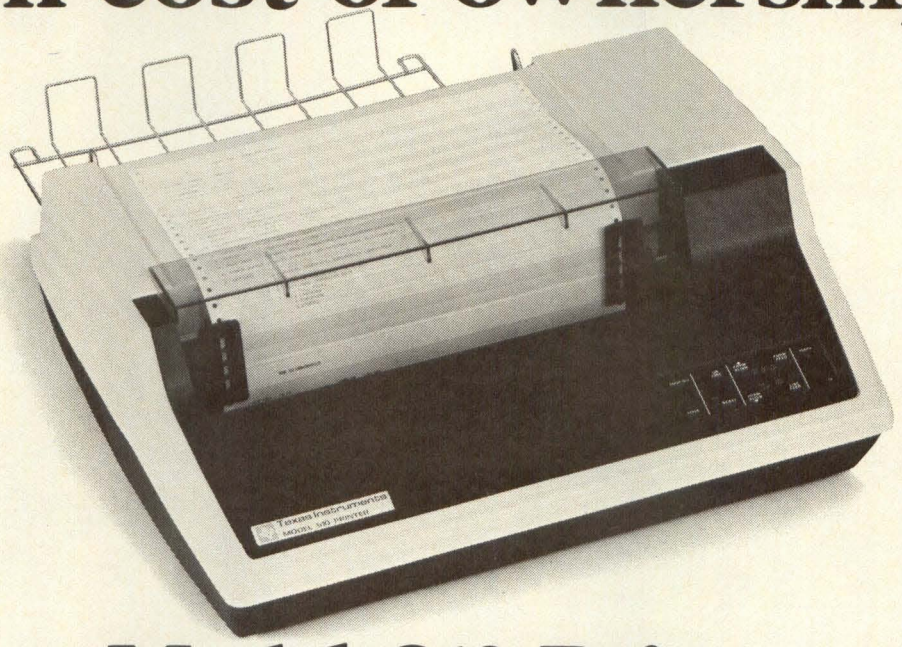
PCS-80/15 (w/IKB-11)

PCS-80/30, 80-25A, DHMO

PCS-80/ Components

IMSAI introduces the PCS-80 component system...

Now, a better impact on cost of ownership.



Model 810 Printer

$1705.50

The low cost of ownership for the Model 810 Printer is now even lower!

With an OEM quantity 1 purchase price of just $1705.50 and lower maintenance rates, the 810 impact serial printer can significantly reduce your cost of printing. And, the purchase price goes much lower with higher quantities.

New maintenance rates on the 810 are $24 per month billed annually, or $26 per month billed monthly. And now the 810 can be leased from $95 per month on a 48-month lease plan to $110 per month on a 12-month lease plan, including maintenance.

The 150-cps Model 810 Printer has all the standard features you expect, such as smart bi-directional printing, an EIA RS-232C interface, limited ASCII character set, built-in self-test capability, speeds from 110 to 9600 baud and outstanding 9x7 wire matrix character printing of an original and five copies.

Options include international character sets, full ASCII character set, expanded and compressed printing, forms length and vertical forms controls, and a variety of line interfaces.

All this adds up to a fully capable impact printer with an even lower cost of ownership. To see for yourself the kind of impact the 810 can have on your printing costs, fill out and mail the coupon, or call your nearest TI sales office, or Terminals and Peripherals Marketing at (713) 491-5115, extension 2124.

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INCORPORATED

Yes! I am interested in the 810 Printer. 16-12-DD

☐ Please have your representative call me.

☐ Please send me more information.

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Company _____

Phone _____

Address _____

City _____ State _____ Zip _____

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P.O. Box 1444, M/S 784, Houston, Texas 77001

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TEXAS INSTRUMENTS.

CIRCLE 5

Quality is known by the company it keeps

Quality is known by the company it keeps and here are eight reasons why CØMPLØT® is outstanding in the field:

DP-101 All-new microprocessor-controlled plotter—$3495

DP-1 Classic 11″ wide plotter—$3550

DP-11 Our newest 11″ wide plotter at speeds up to 4000 steps/sec.— $3995

DP-3 Plotting on a 22″ wide surface at 400 steps—$5150

DP-8 One pen or three, 36″ wide, super quiet, three models from—$7600 to $9500

PTC-5A The new Remote Time Share Plotter Controller—two models—$1945 & $2595

BTC-7 Series Adds inexpensive graphic output to the CDC 734 and Cyber 18-5 Batch Terminals—$2595

MTR-4 Magnetic Tape Reader/Controller $15,500
1600 CPI Phase Encoded Model— $19,950

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Single board, fully embedded, dual density tape system for PE and NRZ formats. Total Operating System compatibility. Allows up to 4 drives with any mix of NRZ 7 Track, NRZ 9 Track, PE and PE/NRZ to be operated from a single controller. That isn't all! You may select any two speeds in the range of 12.5 to 125 ips. Enhanced Command Set and Extended Status Register are standard in all TC-140's for those requiring a level of performance never before available.

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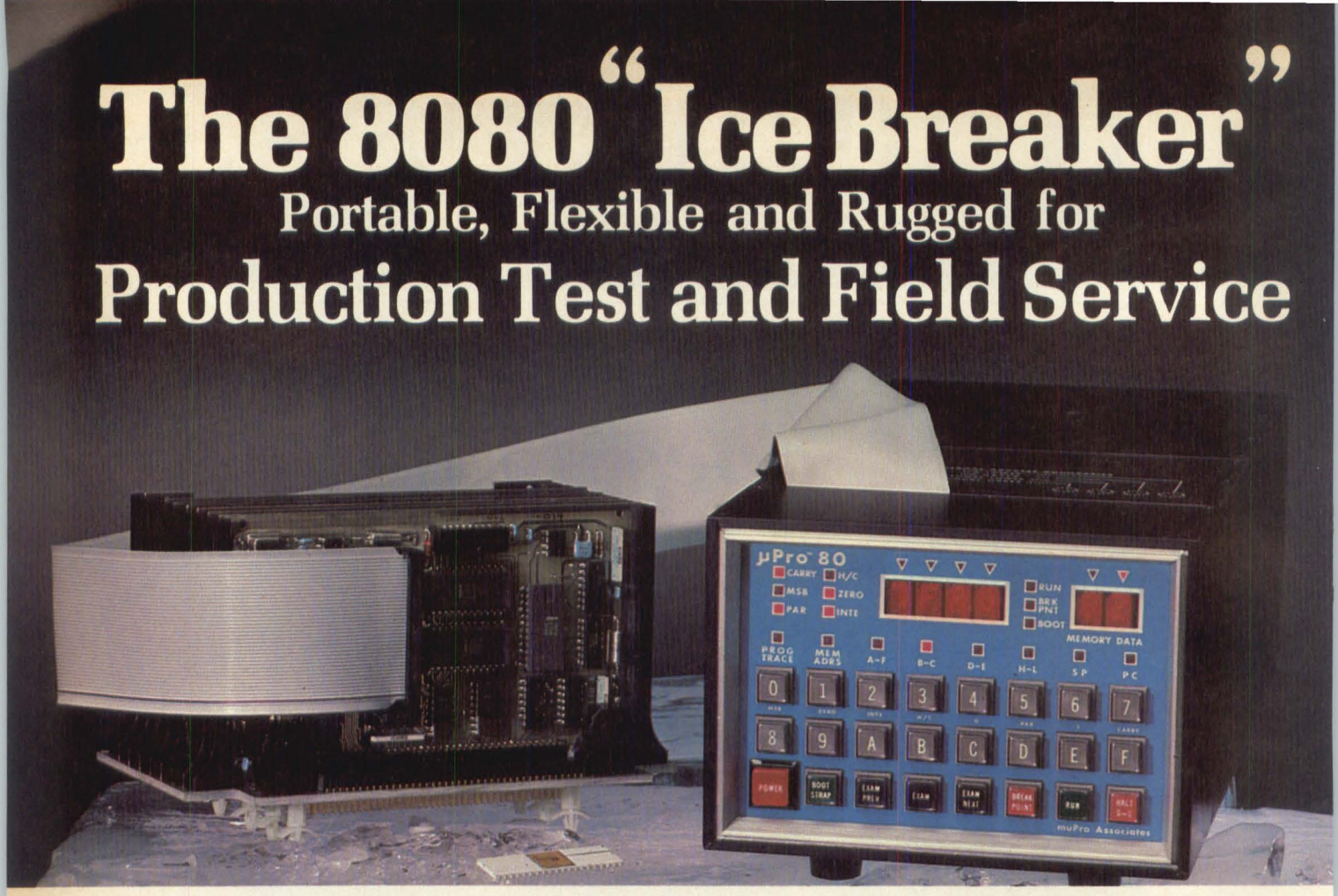
CIRCLE 6

The 8080 "Ice Breaker"

Portable, Flexible and Rugged for Production Test and Field Service



MUPRO 80E Emulator

MUPRO FEATURES

Real-Time Execution from emulator or user's system memory (no restrictions, no wait states)

Transparent Control/Display Console (terminal is not required)

Debug system totally implemented in emulator hardware

Hardware breakpoint, pass count and 64-instruction program trace

No overhead memory requirements

Optional plug-in Prom programmer card

Compact and ruggedized system packaging (4.6"H x 6.6"W x 15"L, 18 lbs)

The complete solution

YOUR BENEFITS

More thorough and flexible system test capability

Provides total use of microprocessor. No memory, I/O or interrupt restrictions.

No costly peripherals are required e.g. keyboard display, printer, etc.

Efficient control of program execution for hardware and software testing

All emulator memory available to user's program (up to 64K bytes)

Programs up to eight Proms simultaneously with same or different data

Single system provides total solution to production test and field service needs

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SUPPORT SYSTEMS

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Circle 4 for demo and technical data

Circle 100 for technical data

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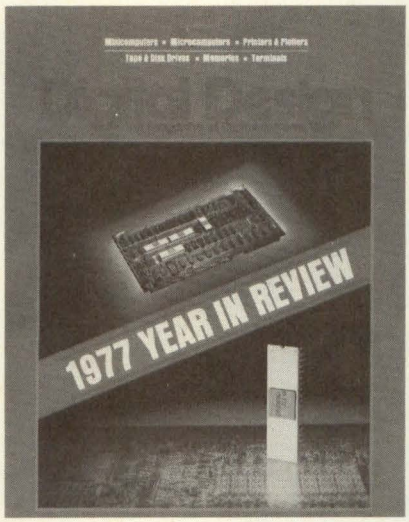
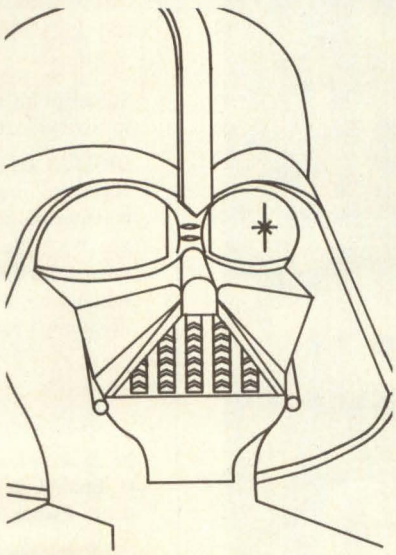


December, 1977

Vol. 7 No. 12

This month's cover depicts National Semiconductor's microcomputer in three stages: microcircuit, central processor chip and single-board computer. Cover design by Richard D. Sarno.



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Alpha Bits

Transducers Serve Control Applications.

Selecting a Computer.

Using the ICU.

Microprocessors: How to Use Them.

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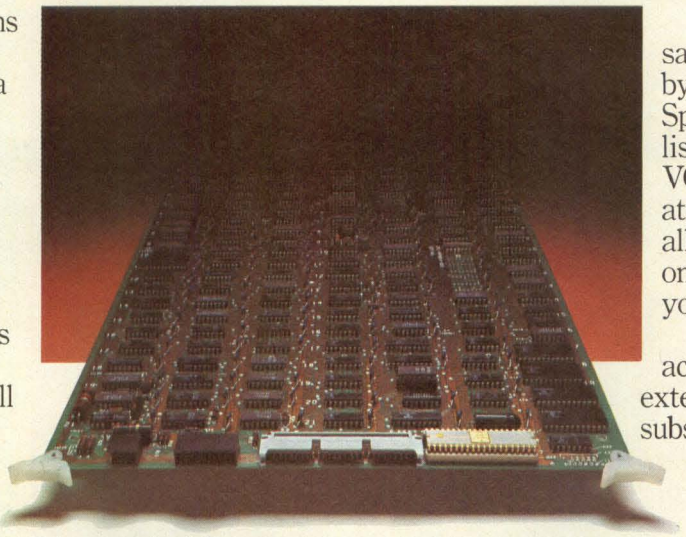
Sperry Univac's new mainframe-on-a-board: What you do with it is your business.



Whether your systems business is scientific, instrument control, or data communications, know this:

Our new V77-200 delivers more computing power than any other computer-on-a-board you can buy. Handling up to 32K/16-bit words of 660ns MOS memory.

Reason enough to call it the world's first mainframe-on-a-board. But there's more.

Because our new V77-200 comes loaded with "big machine" features. Like 8 programmable registers with byte, word and double word manipulation. Up to 32-bits of arithmetic precision. A powerful set of 187 instructions. Hardware multiply/divide. Direct memory access. Programed I/O. Multi-device automatic program loaders. A real-time clock. And a teletype/CRT controller. All standard. And all on a single 10.8" x 17" board.

There's even Virtual Console Logic that eliminates the need for a programmer's console by allowing you to control the V77-200 from a teletype or CRT keyboard.

You get "big machine" performance, too. Example: a microinstruction cycle time of 165ns that allows multiplication functions to be handled in just 4.9 microseconds—divide in just 8.

Plus your choice of OEM-tailored options. Like a variety of connector planes and general purpose interface boards for custom I/O designs. Three different 660ns memory boards (in 8K, 16K, and 32K-word modules). An operator's console. Power-fail detect and data save. Memory parity. Hardware for up to 64 priority vectored interrupts. An integral or modular power supply. And a system chassis. All the "unbundled" pieces you need for quick and easy system integrations.

The new V77-200 also saves you time and money by allowing you to use Sperry Univac's well-established floppy or disk-based VORTEX real-time operating system. In effect, allowing you to concentrate on the development of your application software.

And giving you access to Sperry Univac's extensive library of software subsystems, language processors, and system utilities.

Best of all, the world's first mainframe-on-a-board has a base price of just $1200. Plus a discount plan designed to give even modest-volume OEM buyers a big break. And you can take delivery in a matter of days—not months.

No matter how you configure it, the new V77-200 is the most economical Sperry Univac yet. Delivering the kind of price/performance value that just makes good sense. No matter what business your systems are in.

For more information on the world's first mainframe-on-a-board, please contact: Sperry Univac Mini-Computer Operations, 2722 Michelson Drive, P.O. Box C-19504, Irvine, California 92713, Telephone (714) 833-2400.

SPERRY UNIVAC

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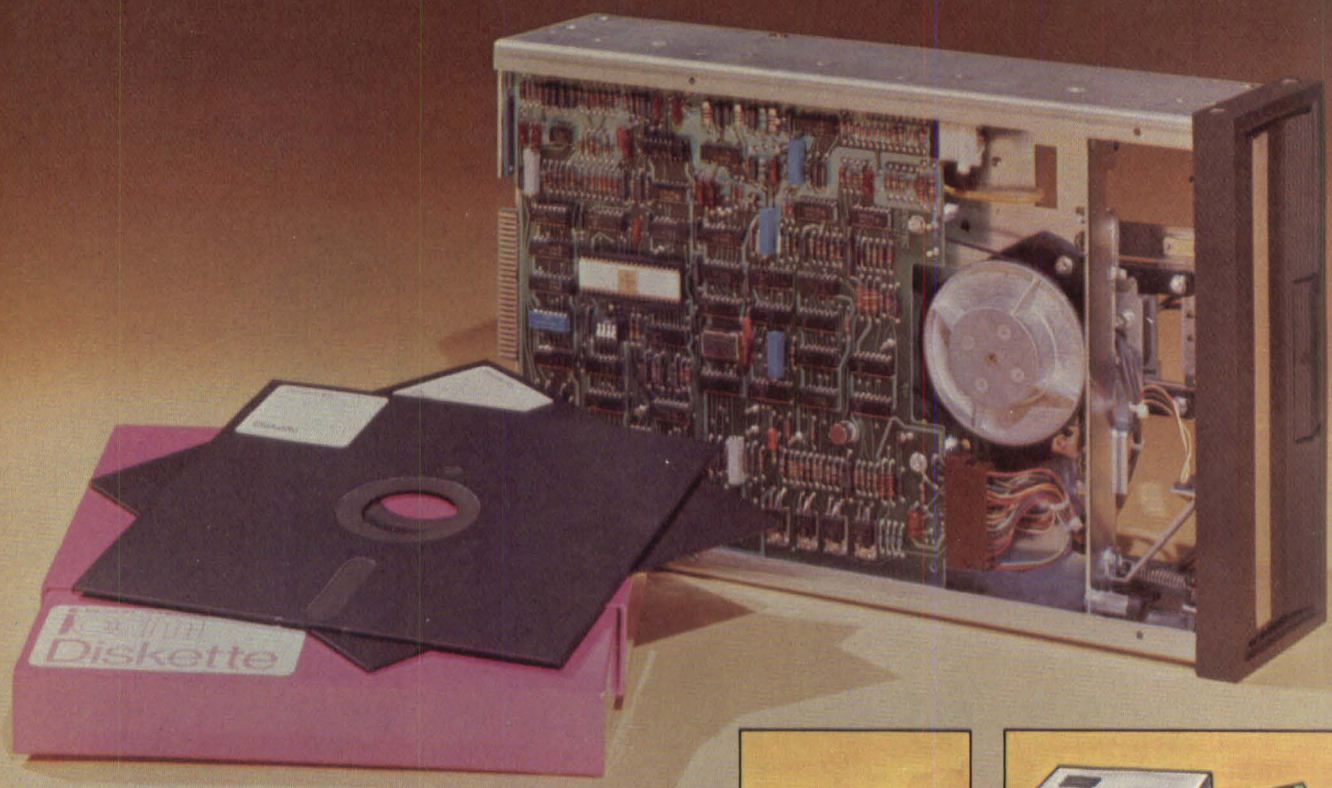
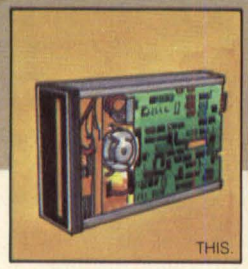
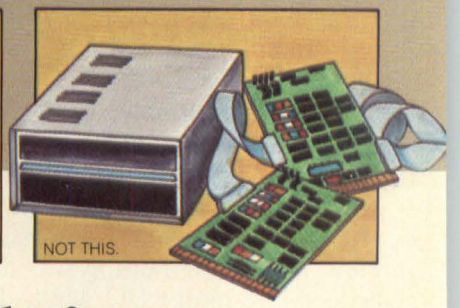
CIRCLE 8

iCOM's Intelligent Floppy.™




THIS.


NOT THIS.

Controller/Formatter built-in. Packaging problems designed out.

When designing a floppy disk into a compact microcomputer-based system, engineers have been plagued with the problem of where to mount the controller/formatter cards and associated cables.

Our new FD5200 Intelligent Floppy™ solves this packaging dilemma by mounting all circuitry, including the single chip LSI controller/formatter, as an integral part of the disk drive chassis. A neat idea!

The 8 bit bi-directional bus makes it simple to integrate the iCOM® FD5200 into any system. Accrued benefits include: reduced hardware costs, smaller size, shorter assembly time, easier software development, improved reliability and lower maintenance. A mighty impressive list!

Compatibility to IBM 3740 Format... and Others

The special LSI controller/formatter chip provides the complex logic needed to write data on the diskette in IBM 3740 format — or other user selected formats as well. Another big plus is a phase-locked-loop for data and clock bit separation, and address word detection, which maximizes data reliability.

Pertec Makes the Driving Easy...

Since a floppy disk drive system is only as good as the mechanics, we use our field proven Pertec drive with three step-per-track head positioning for better accuracy and the unique head retract system for longer media life.

Why iCOM®?

iCOM®, part of Pertec Computer Corporation, is one of the world's largest manufacturers of Microperipherals.® Thousands of our floppy disk systems are operating reliably in the field. And many major computer manufacturers have incorporated iCOM® floppies into their systems. Which means we deliver — and will be around to give you service whenever and wherever you may need it.

Speaking of Delivery...and Price

Our new FD5200 Intelligent Floppy™ is available now at a unit price of just $795. Naturally, OEM discounts are available.

So phone us today. Or send for our brochure.

icom MICROPERIPHERALS®

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LETTERS

Lost Logic Analyzer

Dear Editor:

The article "What Do Logic Analyzers Do?" (September 1977) presents good, basic information about logic analyzers. Included in the article, on page 66, is a table that presents specific information on logic analyzing instruments. While the table represents a conscientious attempt to convey accurate product information to your readers, it contains several errors with respect to the Tektronix LA 501W, 7D01 and 7D01F Logic Analyzers. The LA 501W memory format is 4 x 1024, 8 x 512, and 16 x 256. The LA 501W, 7D01, and 7D01F all provide timing diagrams; in addition, the 7D01F has state diagram capabilities, including a memory map feature.

Although Tektronix was listed in the the "Manufacturer's Guide to Logic Analyzers", Tektronix was left out of the discussion "Logic Analyzers: What You Can Buy" that starts on page 72 of the September issue. The Tektronix 7D01F Logic Analyzer with Display Formatter, as shown on page 54, makes a complete, basic logic analysis system when installed in a 7000-Series laboratory oscilloscope. Data sampling can be asynchronous or synchronous. The 7D01F provides four methods of obtaining a trigger, including word recognition, to store and display data which occurs before, after, or surrounding the trigger. 7D01 features such as EXCLUSIVE OR and auto SEARCH modes are particularly useful in engineering and production applications.

James H. Geisman
Tektronix, Inc.
Beaverton, OR 97077

Misprinter

In our printer report, MFE Corp. was listed as manufacturing a Medium to Large printer. MFE Corp. does not make printers; please do not contact them in this regard. They do make digital cassette drives and floppy disk drives.

TECHNOLOGY TRENDS

New Breed of Prospector: Microcomputer on a Backpack

Backpackers usually carry food, clothes, a stove and recreational material in their packs. Now, a geophysical exploration team carries a microcomputer on a pack frame.

Using a specially modified Kelty backpack, geophysicists can pack a National IMP-16 microcomputer card into places inaccessible to motorized vehicles. Designed into an extra-low-frequency (ELF) digital receiver called Geophase, the unit serves as a survey tool for detecting commercially attractive concentrations of metals, uranium, coal or petroleum, according to the designers, Exploration Data Consultants, Inc. (Edcon) of Denver, CO. It can also be used for geothermal exploration to locate feasible sites for geyser-powered electrical generators.

To conduct these mineral or geothermal explorations, a separate transmitter injects a high-current, low-frequency signal into the earth. The Geophase receiver measures the resultant signal over a specified grid pattern surrounding the transmitter site. Signals are logged, analyzed, and used to deduce the geophysical characteristics of the area.

Typically, the transmitter sends out square waves in a frequency range of 0.001 Hz to 10 Hz with power output on the order of 20KW. Attenuation at the higher frequencies limits penetration; deeper measurements must therefore be made at lower frequencies. Signals detected by the receiver range upward from the one millivolt level.

Methods of signal detection currently in use include portable analog receivers and truck-mounted minicomputer systems. Analog receivers measure the strength of reflected signals, providing either chart records or a meter indication of signal strength that usually require manual tabulation. After reception at the analog device, the data must then be brought back to the office for data reduction and analysis, often a long and laborious process.

Fig 1 Geophase digital ELF receiver employs an IMP-16C microcomputer card to give high precision data and reduce field exploration time for geological surveys to a fraction of the time required by earlier systems.

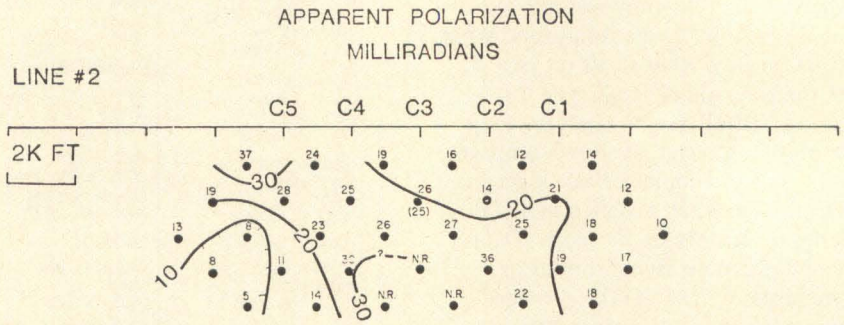

Fig 2 Isograph of apparent polarization aids geologists in determining metal or mineral content of the strata.

Truck-mounted minicomputer systems allow data processing in the field, improving noise immunity and easing data-reduction tasks. Disadvantages of this method are the systems' relatively high cost and their inability to operate in rugged terrain.

By combining high noise reflection with the portability of previous analog units and the data processing capability of minicomputers, the lightweight, battery-powered Geophase receivers alleviate the disadvantages of the two current methods. They pack easily to locations inaccessible to motor vehicles, adjust quickly and take measurements, with operator prompting if necessary.

The method of signal measurement – induced polarization – uses multi-frequency, phase-sensitive measurement of electrical signals passing through the earth. Isograms connect two different sets of points determined from the signals, apparent resistivity in ohm-meters and phase shift in milliradians, which indicate the presence of metallic minerals in the strata. The electromagnetic effect (EM) is considered "noise" to be removed from most metallic- or or clay-mineral exploration signals; in oil surveys, however, EM becomes important.

Digital combines with analog

National Semiconductor's IMP-16C/400 microcomputer card forms the keystone of the Geophase receiver. A true microcomputer, the IMP-16C/400 in-

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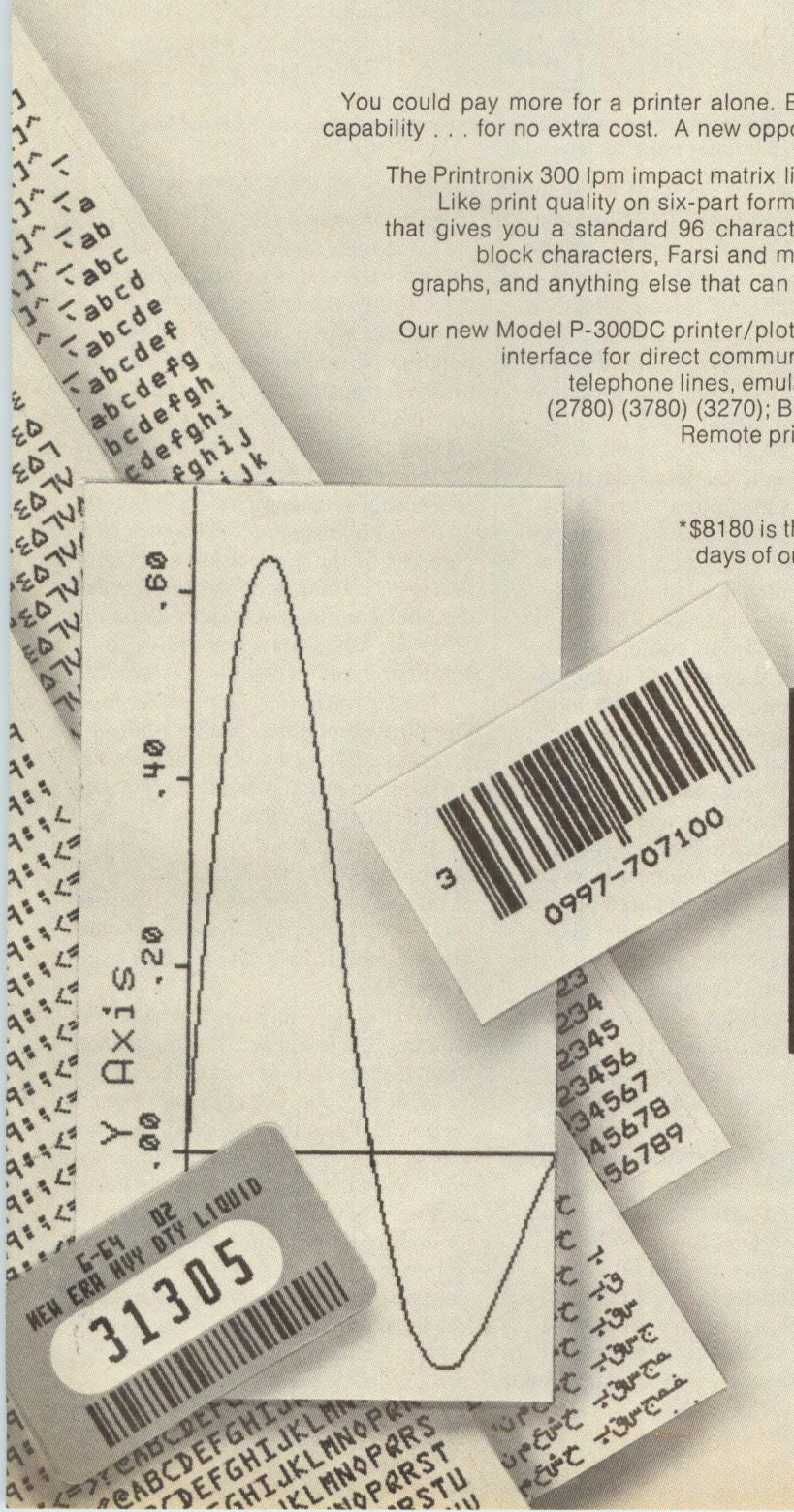

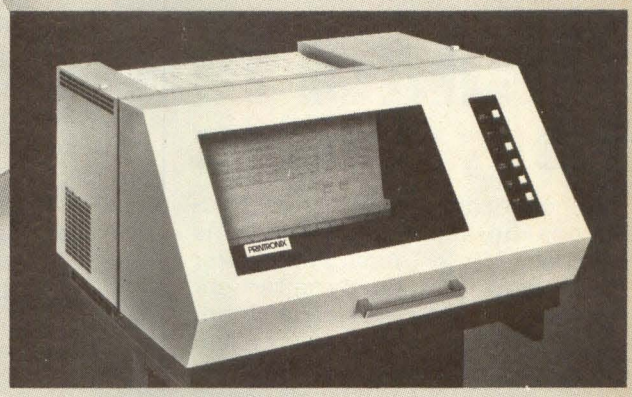

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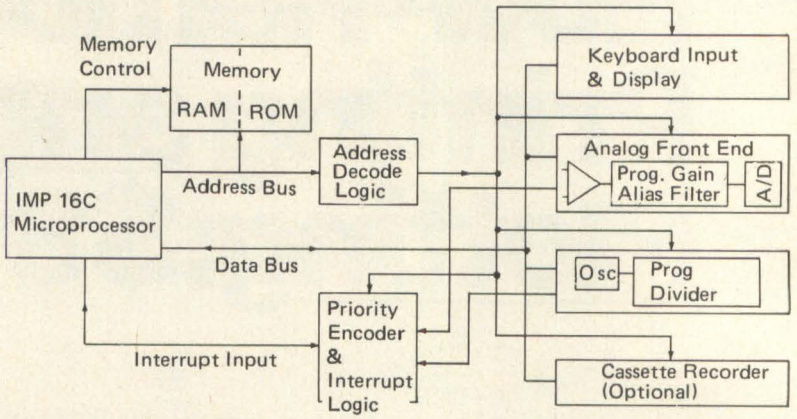

Fig 3 Block diagram of Edcon's microcomputer-controlled digital ELF receiver, Geophase, illustrates major components.

cludes 1K of 16-bit words of RAM and 1K of 16-bit words of PROM located on the circuit board. It also has a control read-only memory (CROM) containing 17 additional instructions such as double-precision add, double-precision substract, multiply and divide.

According to Edcon Vice President Donald D. Snyder, the IMP-16C/400 was selected because the 16-bit processor accepts digital data from the converter at a maximum rate of 90K words per second, permitting accumulation of at least 128 data-points per cycle with better than four decimal-digit acquisition accuracy. The extended instruction set conserves memory because it allows resident double-precision memory without additional memory-resident subroutines.

One alternative to the IMP-16C/400, the 8080 8-bit processor, was determined to be just barely adequate for the job, according to Snyder, if quadruple-precision mathematical techniques were used. He said an 8-bit processor would restrict the frequency range over which the receiver could be applied since the frequency range depends upon both the number of data-points/cycle digitized and the amount of real-time processing performed.

System peripherals include an analog input subsystem, an analog-to-digital converter and a precision interval timer, as well as a keyboard & display module and an optional cassette transport.

Incorporating a high-input impedance isolation-amplifier, a 60Hz reflection filter, a low-pass filter and a gain amplifier, the analog portion of the Geophase receiver inputs subsystem signals to a ten-bit A/D CMOS converter with conversion rates to 512 points per cycle under processor control.

The interval timer and synchronous clock follow the analog subsystem in importance. An oven-stabilized precision quartz oscillator gives the precise time reference necessary to make accurate quadrature measurements. According to Snyder, a periodic synchronization with an identical clock at the transmitter provides a local phase reference without the inconvenience of a wire link or the imprecision of a radio link in mountainous territory. Typical drift between the two clocks is less than 30 μs per 8-hour day, amounting to less than 2 milliradian error at 100Hz.

The Geophase receiver uses a synchronous-demodulation algorithm to determine in-phase and quadrature signal components at a particular frequency. The digitized value of the transmitted signal is multiplied by the sine and cosine of the transmitted signal, as referenced by the receiver's synchronous clock. 16-bit sine and cosine values are obtained from look-up tables stored in PROM.

According to Snyder, "the detection method is essentially a digital heterodyning technique where the cosine product is proportional to the in-phase component and the sine product is proportional to the quadrature component." With digital data available, detection amounts to determining the Fourier coefficients for a single harmonic frequency of a periodic signal. Received signals at the same frequency as the local oscillator pass through with no amplitude attenuation. To eliminate amplitude components of har-

monically-related frequencies and to attenuate non-harmonically related noise, the IMP-16 integrates over several cycles.

The frequency range of the Geophase receiver depends mostly on the real-time processing requirement of the detection algorithm. Using the POWR I/O CROM for the IMP-16C provides an upper limit for the transfer of peripheral data to the memory of 90K words/sec. Hence, if a non-real time detection algorithm were used, the practical upper frequency limit of the receiver would be about 1KHz.

After the required integration, the results appear on two four-digit LCDs. Savings in field-computation time have already been dramatic, according to Snyder. Previously an operator spent two to three times as long at each site, tuning the receiver, determining the values, using a handheld calculator and logging the data. Now when the cassette is used, an operator using the Geophase receiver does not even have to log the values. The cassette resident data can be input directly to a minicomputer in order to generate the resistivity and polarization isograms.

Semiconductor Memory System Adds New Dimension to Weather Study

Once a folk art practiced primarily by arthritics and other sufferers, weather prediction has entered the domain of science in recent years. The scientists involved in weather forecasting depend heavily on satellite television pictures for their work; because of this, image processing has become a central concern in weather science. One study currently taking place at Colorado State University, Fort Collins, CO, uses advanced semiconductor memory technology to obtain better satellite weather pictures.

According to Eric Smith of CSU's Department of Atmospheric Sciences, objectives of the research include the development of near-automatic weather maps that will translate satellite data into superior video pictures with less human interaction; the tracing of invisible weather features (such as hot air masses) as visible color areas; and the combining of color with black-and-white in order to etch details more clearly. Smith points out that the key to such developments lies in the ability to use large amount of data in many different ways. Rather than employ a conventional computer system, CSU scientists and engineers worked with engineers from Intel Memory Systems to develop a system that incorporates an Intel-designed semiconductor memory system, a Hewlett-Packard HP2100 digital

computer and a video subsystem consisting of a video overlay (512 x 512 x 8 bits), five digital-to-analog converters and five television monitors.

Special features of the memory system provide the unique capabilities that allow the sophisticated processing to take place. An array of Intel in-477 memories store and retrieve digital video image data while in-50 enhancement table memories provide image improvement. According to Bob Christensen, a systems engineer for Intel, the in-477 is designed specifically for television applications and has 'the unique ability to write data in as a 16 bit word, as in a standard memory board, or to write and read a single bit.' Thus you can assemble the memories, he explains, for unusual configuration requirements. In the CSU system, eight boards are used so that eight bits can be read at one time; because each dot on the video display consists of eight bits, this memory arrangement allows the meteorologists to work with partial dots, to overlay dots on one another and to manipulate the picture data in any number of ways. Also, each dot can be adjusted to one of 256 contrast levels.

As 'middle-man' between the HP2100's central processing unit and the video system, the in-477's must accomodate the data rates of both. Programmed from the CPU at 1600

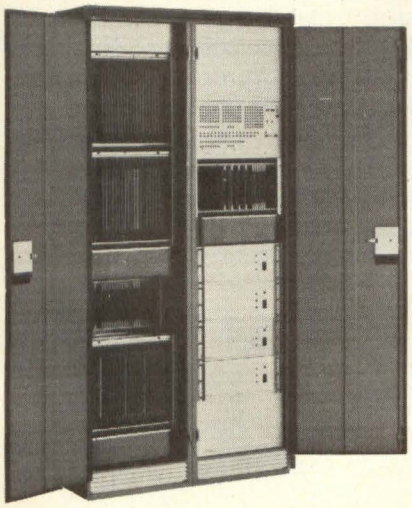

Fig 1 90" high and 38' wide, this cabinet houses memory and interface boards, power supplies, a control panel and the fast in-50 memories.

ns per 8-bit word, the memory transmits the data to a video monitor via its built-in shift register at 100 ns per word, or 10 MHz. At a slower transmission rate, the human eye would see flicker in the final television image.

Designing in this high-speed capability entailed considerable engineering ingenuity. Christensen says that the boards were modified to convert the 10 MHz serial data out to differential ECL. Further, Christensen says that he 'used a twisted pair from there to the I/O board that would receive the data and multiplex it to the output lines.' He pointed out that this setup ensured that there would be reliable transmission at 10 MHz

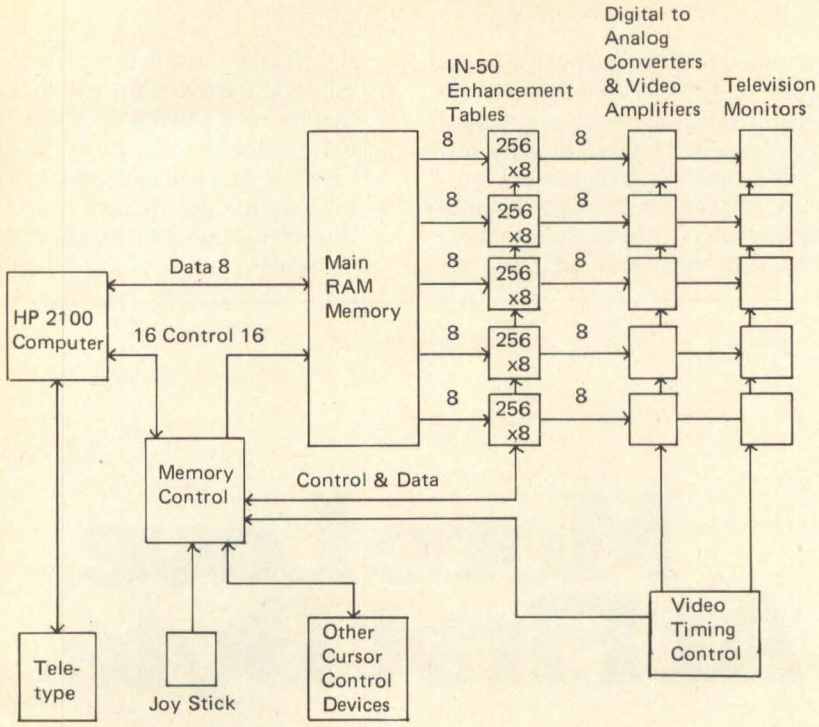

Fig 2 This block diagram shows how the Intel memory system fits into Colorado State University's image processing system.

for the output date.

En route to the video subsystem, the in-477's high-speed data output reaches the smaller, faster in-50 memories and acts as address input, causing the data to be relayed on from the in-50's in appropriately modified form (higher or lower contrast) and routed to the digital-to-analog converters. From there the data travels to the television monitor for display.

Christensen singles out two significant advantages that the memory system provides. First, it enables the scientists to handle immense amounts of data very quickly; otherwise, this data might be handled by very tedious methods such as writing data into tables and then reading it. Second, the data comes from satellites at a slow rate (thus ensuring accurate transmission); the data can then be processed at high speed.

For further information, write Intel Memory Systems, 1302 N. Mathilda Avenue, Sunnyvale, CA 94086 or call (408) 745-7120.

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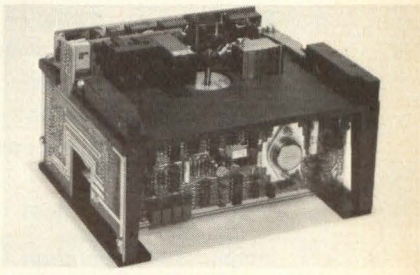

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CIRCLE 16

TECHNOLOGY TRENDS

RS-449 Ousts RS-232

Developed to provide a functional interface between data terminal equipment (DTE) and data-circuit terminating equipment (DCE), Electronics Industries Standard (EIA) RS-449 retains all functional capabilities of EIA RS-232C and introduces ten new interchange circuits to enhance interface capabilities. RS-449 provides standardized 37-pin and 9-pin interface connectors together with latching arrangements for these connectors.

The resulting interface, said by the EIA to be compatible with the current state-of-the-art of integrated circuit technology, offers greater immunity to noise, increases the data signalling rate to 2 Mbit/sec and permits an increase up to 200 meters in the length of interconnecting cable.

The ten new interchange ciruits defined in RS-449 not appearing in RS-232C include three circuits for control and status of testing functions in the DCE (Circuit LL – Local Loopback; Circuit RL – Remote Loopback; and Circuit TM – Test Mode), two circuits for control and status of the transfer of the DCE to a standby telecommunication facility (Circuit SS – Select Standby and Circuit SB – Standby Indicator) and a circuit for DCE transmit and receive frequency selection (Circuit SF – Select Frequency). The standard also defines a circuit providing an 'out-of-service' function under the control of the DTE (Circuit IS – Terminal in Service) and a circuit to provide a new signal function (Circuit NS – New Signal).

When necessary, equipment designed to use RS449 can operate with existing, unmodified RS-232C equipment, subject to the restrictions and technical limitations of RS-232C. The EIA provides detailed information on this matter in EIA Industrial Electronics Bulletin No. 12, 'Application Notes on Interconnection Between Interface Circuits RS-449 and RS-232C.'

To obtain a copy of RS-449, send $9.50 to the Standard Sales Office, EIA, 2001 Eye St., N.W., Washington, D.C. 20006. To correctly interpret RS-449 and to facilitate the transition between RS-232 equipment and the equipment described in RS-449, the EIA recommends purchasing IEB Bulletin No. 12, available for $4.25 from the Standard Sales Office.

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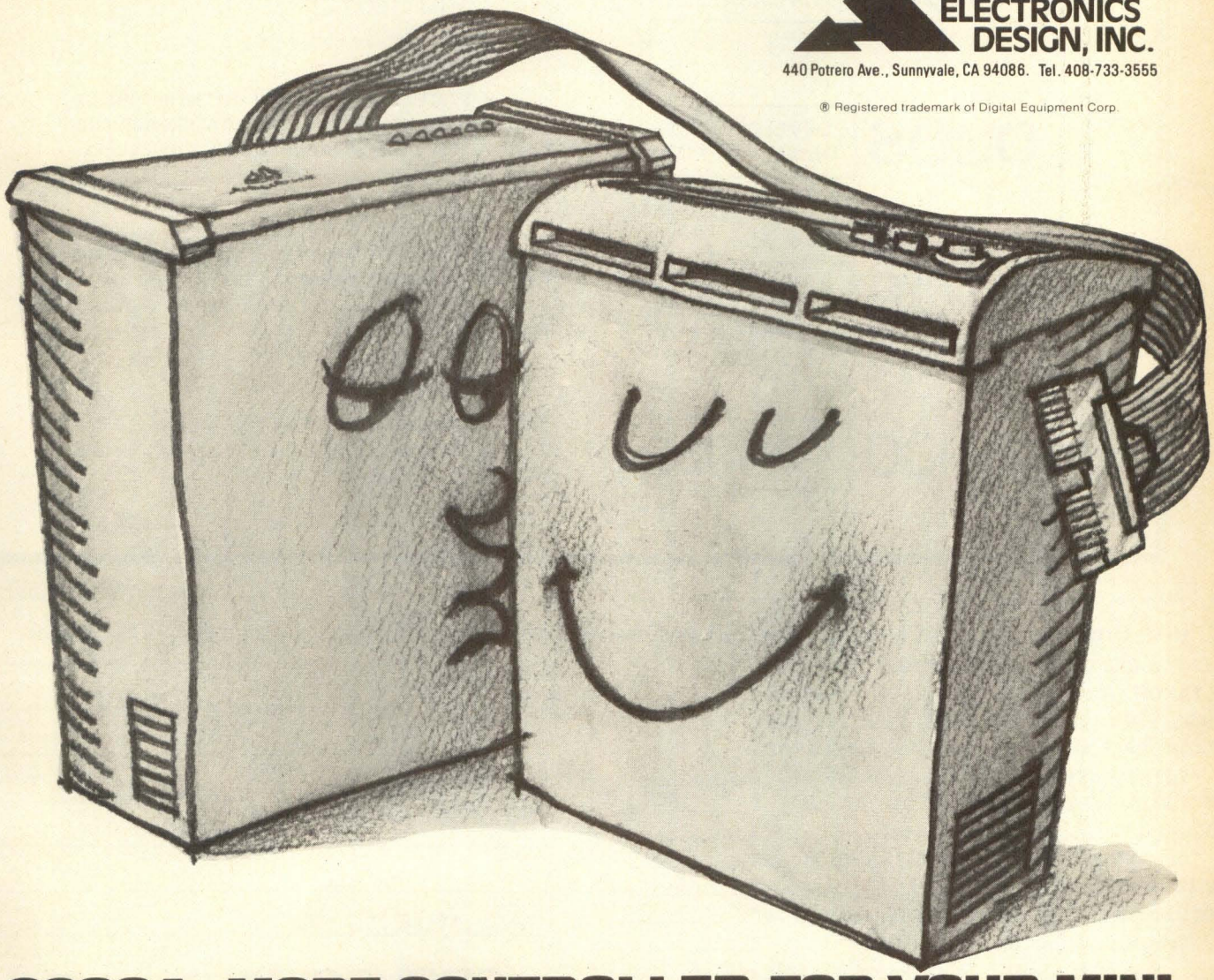

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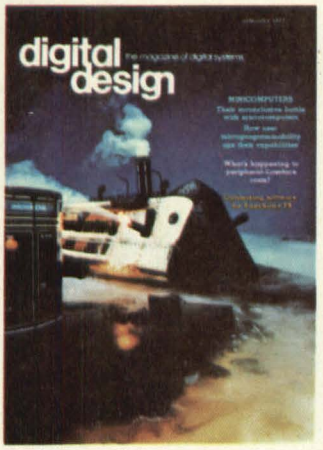

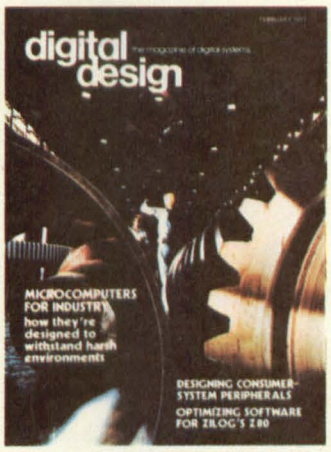

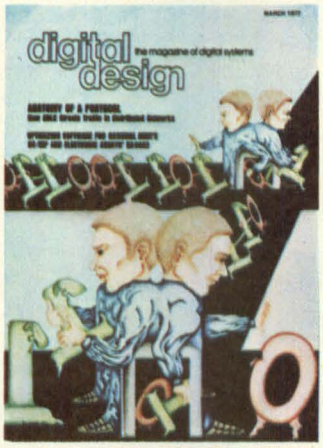

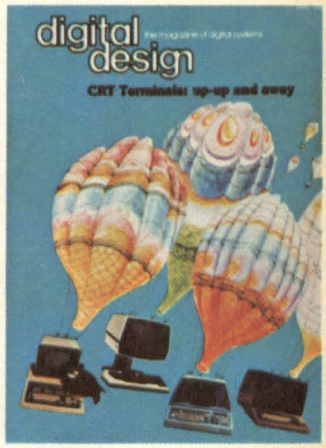

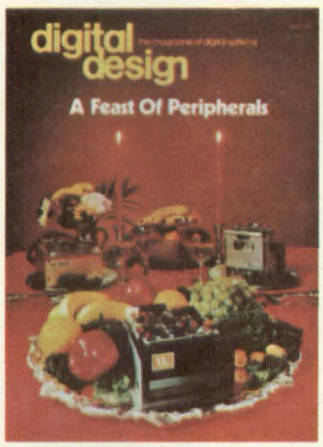

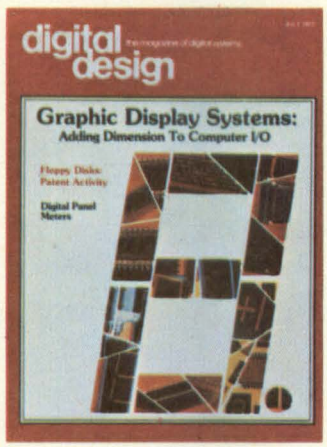

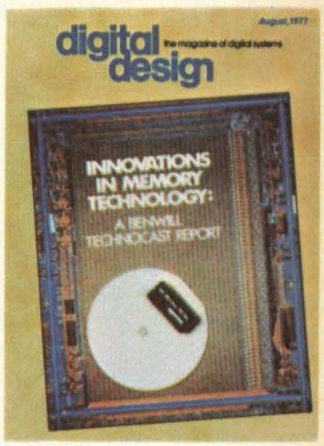

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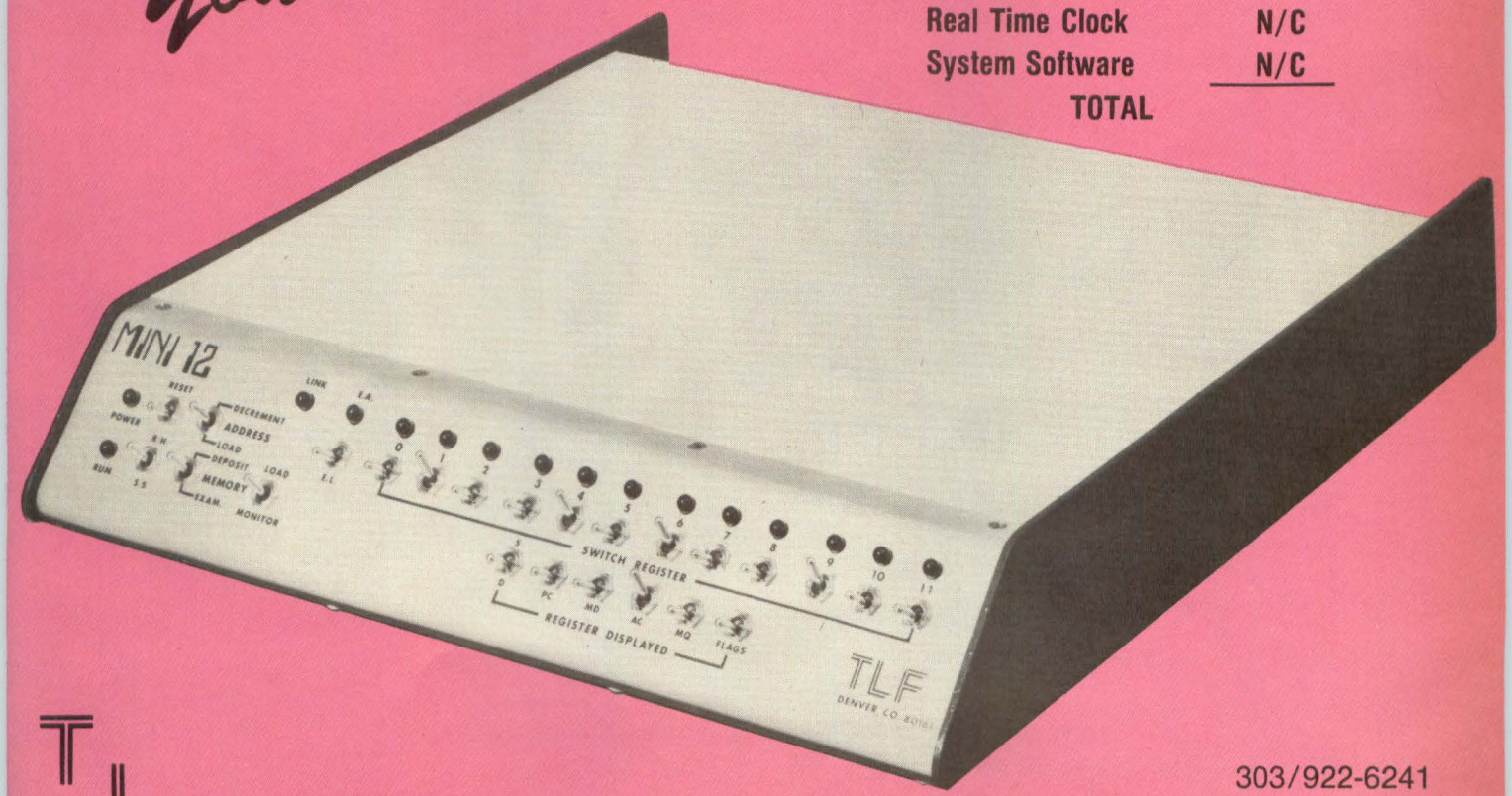

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77 IT WAS A GOOD YEAR

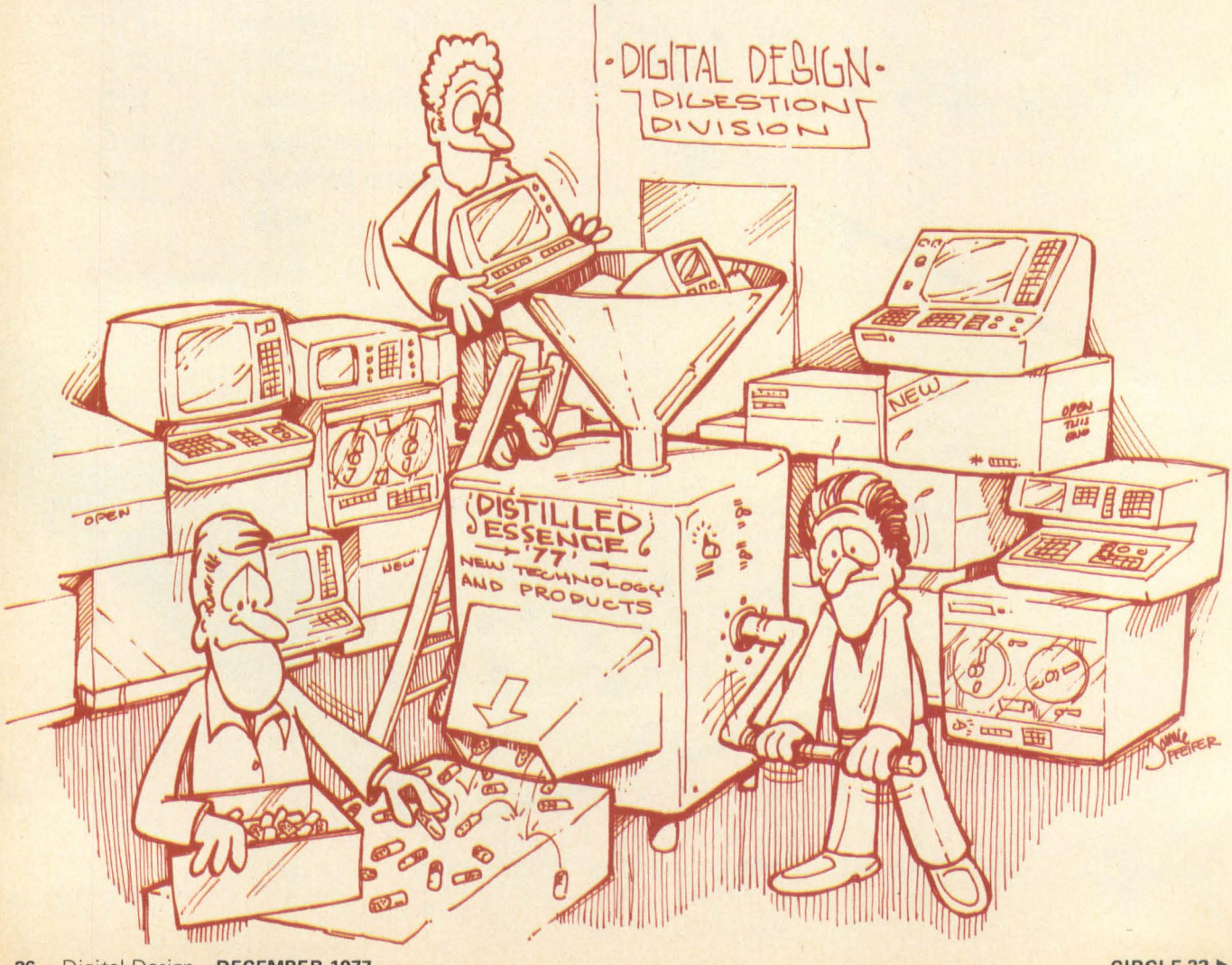
A major part of all changes and improvements in digital system technology during 1977 involved the microprocessor and associated LSI devices. One industry spokesman called it "the year of the microprocessor."

In the reviews of most of the subjects that follow this introduction you will find the effect of the microprocessor in these areas emphasized again and again. But finding out what happened was no problem for DIGITAL DESIGN's editorial staff. What did bother us was the scope of this review. If we could cover every area and describe all changes — major and minor — we obviously would have had to reprint not only the information that appeared in these pages in the last 11 issues, but a large part of what other trade journals published during the last year.

A World of Information on the Head of a Pin

How do you compress this enormous amount of information into a wieldy compendium? Obviously, you can't. So, what do you do? You choose a number of areas in which either major changes have taken place in 1977 or are expected to occur in 1978 and beyond.

We cannot relate in detail why we chose the topics that follow. Nor are we sure that we chose wisely or well. But we do know that, to the best of our ability, we are presenting a valid description of the changes in the state-of-the-art in 1977 and what to expect in 1978 in at least those areas covered in the ensuing pages.



CIRCLE 22 ▶

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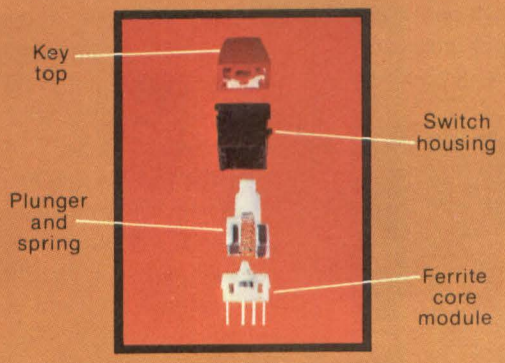

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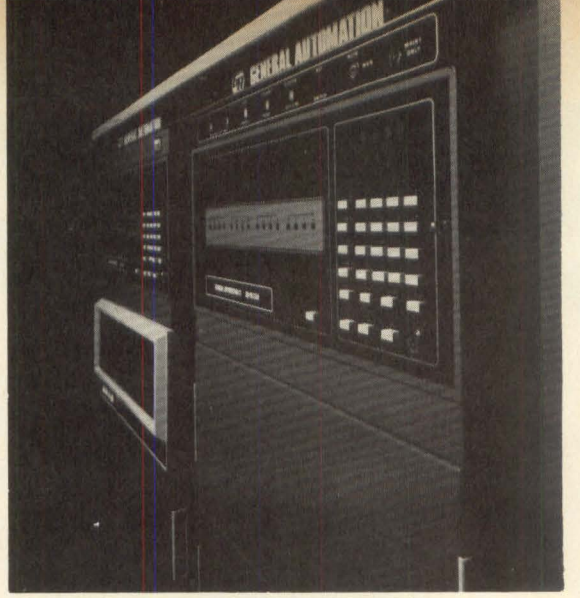


General Automation dual GA-16/550 Multiprocessor system interconnects two processors to same memory bank and achieves Multiprocessor capability.

Micros look more like minis, minis look more like mainframes

Minicomputer manufacturers didn't seem concerned by the onrush of the microcomputer. On the whole, they seemed ready to embrace LSI technology. They also pointed out that their minicomputers are putting pressure on mainframe manufacturers. These two themes – micro pushing mini and mini pushing mainframe – recur in much of what follows.

"In 1977 we witnessed an increased crossover between minis and micros," said John Bond, marketing communication manager for the DEC PDP-8 minicomputers. "Wait another year and there probably won't be much of a distinction. If you look at it right now, you can see that a lot of mini people use bit-slice microprocessors for designing minis. It's only a matter of time before we get the kind of speeds we want out of LSI devices, and then we'll be building a whole minicomputer on one board. The LSI-11 is on one board. We call it a microcomputer, but in fact in a lot of ways it's a minicomputer – when you put it in a PDP-11/03 with power supply and interfaces and so forth, it really becomes a minicomputer – it has the mini functionality. It's not quite as fast as a regular mini, but it's a lot cheaper."

Bond also felt that there was an increasing crossover between the more powerful minicomputers and mainframes. "At the high end of the mini field, you have a hard time distinguishing between mini and mainframe. The PDP-11/70 with a lot of disks and so on has a hell of a lot of throughput and actually functions a lot like a mainframe."

"In 1977 we witnessed an increased crossover between minis and micros"

"In 1977, some of the competitive aspects between minicompuers and microcomputers became clarified," said Frank Madren, manager of product marketing for Data General. Madren felt that the microcomputer industry as a whole "grew up a little" during the year, and that the high performance end of the microcomputer industry was very active. "The 16-bit micro became much more of a reality, appearing in systems, software and products compatible with minicomputers – that sort of thing," Madren said. "I think there are still substantial differences between minis and micros – particularly in systems and software. Micros are getting more powerful every day – more software, more peripherals and so on – and they can be used in more powerful applications. Still, I think that the differentiation between the level of support and service that goes with minis became somewhat clarified during '77. People tend to think that a micro is just like a mini and that you can run it if you have a chip that executes mini instructions. But that is not quite the case. The chip people are struggling to supply the software and services that typically go with a mini, and meantime the minicomputer manufacturers are continuing to sell what they've been selling all along."

Frank Madren of Data General.

Madren added that he thought that it was somewhat misleading to concentrate on the differences between minis and micros, noting that his own firm manufactures both and uses the same microprocessor – mN601 – in both. Rather, he would prefer to view the market as a "continuum" – from the simplest micro to the most elaborate mini – and stress the match between user requirements and available products. Stressing differences tends to cloud the continuity of the marketplace.

Fig 1 IBM Series/1 "small computers," first offered late in 1976 on a purchase-only basis, are available with memory capacity from 1 to 131 K bytes, depending upon model.

IBM Gets into the Act

Among the more interesting events of the year were IBM's entry into the minicomputer market with the Series/1 line and Univac's acquisition of a Varian division that builds minicomputers.

A spokesman for IBM said that the Series/1 line of computers was introduced late in 1976 and enhanced in 1977. IBM does not use the term "mini" in describing the Series/1 "because we have seen this term applied in so many different ways that it's not really clear what it means. Instead, we prefer to use the term 'small computer.' "

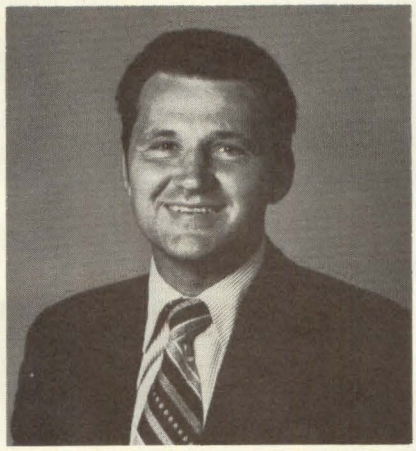
The spokesman said that IBM's entry into this market was far from revolutionary. "If you look at the record," he said, "you'll see that we've been in the small computer business for a long time. We were manufacturing machines for users who didn't need or couldn't afford a mainframe back in 1961. Look, for example, at the 1710 and 1130. At IBM we look upon the Series/1 as a natural extension of what we've been doing all along – to meet the needs of our customers."

The same spokesman refused to comment on IBM's possible entry into the microcomputer market. "Like every other company," he said, "we have an ongoing development program. We don't speculate on new products."

Improved Software for Minis

In 1977, makers of minicomputers introduced increasingly sophisticated software – particularly for teleprocessing monitors and operating systems, according to Jim Orris, division marketing manager with Sperry Univac (Varian). An example of a teleprocessing monitor that Orris cited is Sperry's PRONTO, a unit that allows the minicomputer to insert itself between an IBM mainframe and terminal. "This takes up some of the workload from the mainframe using the distributed processing technique," Orris explained. "The mainframe doesn't know it's there." Orris also cited the closing gap between minicomputer and mainframe software: "All the leading mini manufacturers now offer about the same software as the mainframe manufacturers."

"The most prominent evolutionary step in the mini area was the increasing sophistication of available software," said Chris Hoppin of Interdata. "We introduced COBOL in '74 and at the time that was a big step. COBOL is fairly common in minis today – that's an example of a mainframe language in a mini."



Jim Orris of Sperry Univac (Varian).

"Smart" Peripherals for Minis

Peripherals "grew up" in 1977, according to Frank Madren of Data General. "These days you don't just design a disk controller that'll read and write," he said. "Now you design one that'll read and write – if it reads incorrectly it'll find the error and correct it and offset the track automatically. We're building higher and higher degrees of sophistication into machine controllers and peripherals to make them more and more reliable and easier to use – with error correcting memories, file handling techniques and so on."

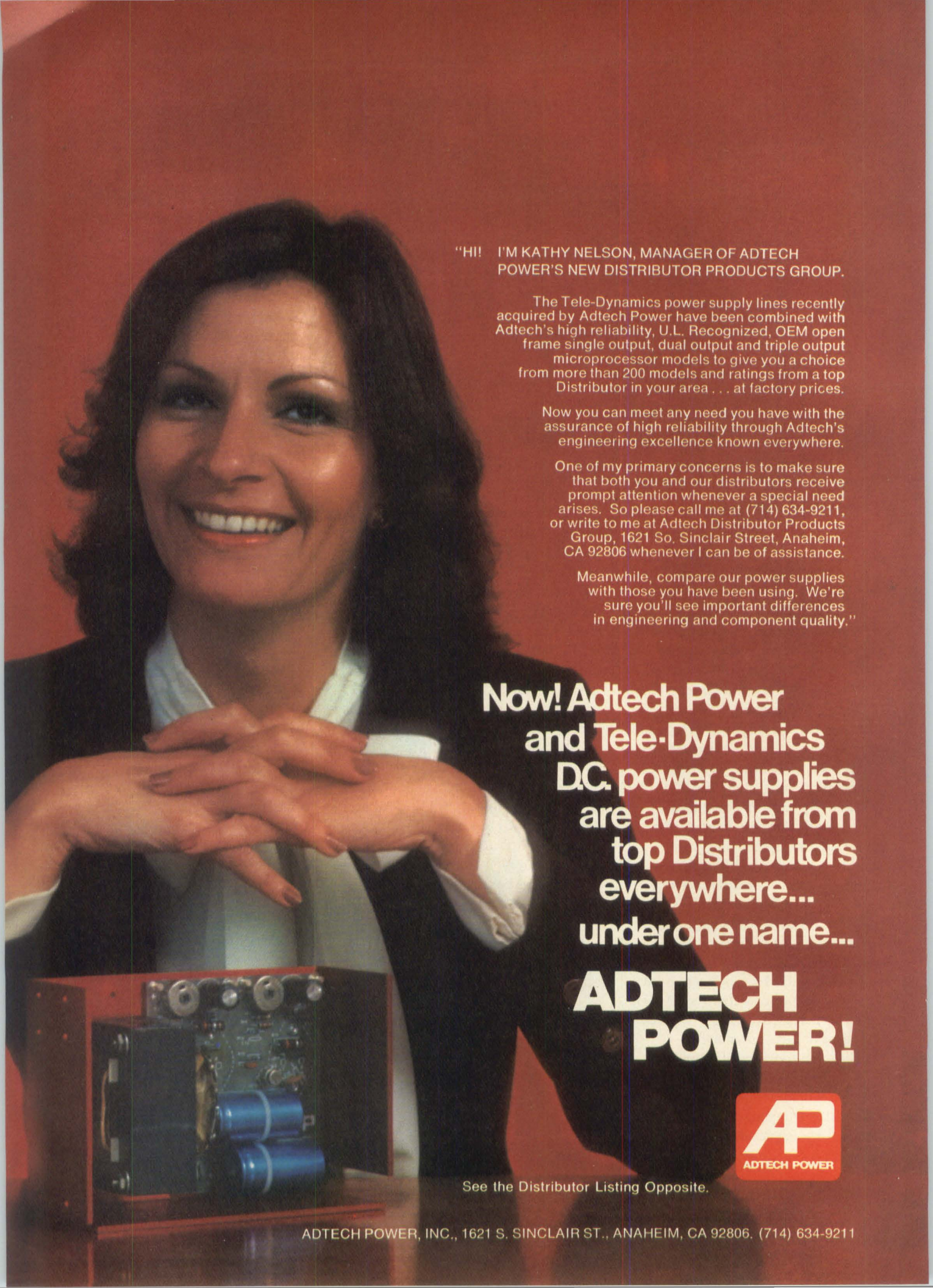
Sperry Univac (Varian) recently introduced a disk controller that uses microprocessors, according to Jim Orris. "It's a very smart controller,"

"At the high end of the mini field, you have a hard time distinguishing between mini and mainframe"

he said. "A lot smarter than a dumb one. What has happened is that the basic mini has gotten so powerful that we are now offloading it with microprocessor controllers. All of the controllers we produce now are smart controllers – we wouldn't think of building one now without microprocessors."

More Packaged Systems

Minicomputer manufacturers were doing more for the customer in 1977 than in the past, according to Chris Hoppin of Interdata. He added that this was another way in which the minicomputer and mainframe businesses were converging. "Historically," he said, "mainframe companies have done more for the customer in terms of packaged systems, peripherals, software and so on, but now I think we see many of the mini manufacturers offering these same kinds of things. We recently introduced the LS-16 laboratory system, for example, a completely packaged FORTRAN



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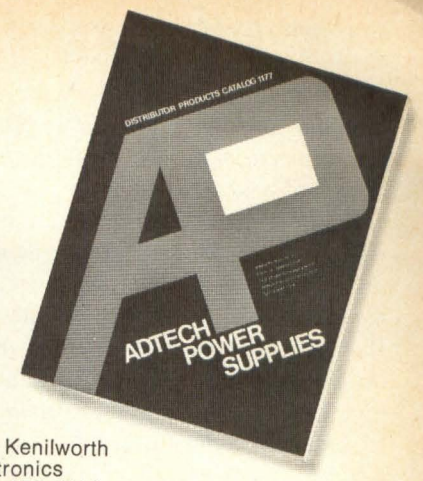

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processing system with large storage and high speed number-crunching capabilities. This is characteristic of the evolution in the mini business to provide more packaged systems to the user instead of boxes."

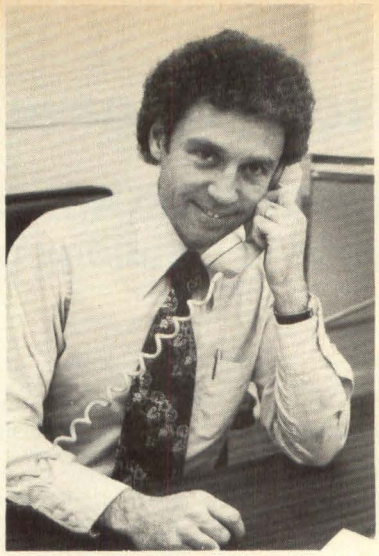
A greater trend toward vertical integration – with more in-house memories, disk drives and interfacing techniques for I/O – was seen by Frank Madren of Data General. "We had an outstanding year for vertical integration," he said. "Early in the year we introduced a number of products and now we're delivering them in quantity. One of our more interesting products in '77 was our CS-40 family of COBOL-based small business computers, with broad vertical integration."

"Two application areas are heating up right now," said Henry Heisler, promotion manager for the PDP-11 series at DEC. "One is small business computers for people with limited computer knowledge who just want to plug a system in and use it. The other is the personal computer market, which presently lacks only one thing – software. But the software base is building up and more and more people are getting into personal computing. Digital is in the market right now with the LSI-11 board, which Heathkit is putting into its 16-bit personal computer. That system, unlike many personal computers, has a broad software base. It can use PDP-11 software."

Minicomputers Evolve

"The important event for the PDP-8 during 1977 was the introduction of the DECstation, which incorporates an LSI PDP-8, 16K of memory and interfaces, built into a terminal with floppy disk mass storage – all selling for under $8000," said John Bond, marketing communication manager for DEC's PDP-8 series minicomputers. DEC classifies the DECstation as a minicomputer, despite its small size, because it uses an LSI version of the PDP-8 CPU.

Although the PDP-8 has changed over the years, Bond said that in certain fundamental ways it has remained the same. "The basic architecture has not changed, despite the various modifications we have made, so the software remains compatible. The PDP-8 has been around for several years, but still sells very briskly. We just introduced three MOS memory models, and also introduced the capability to address 128K words of memory. In the past we could never address more than 32K. What we did was to put in a memory manager that enables the larger memory capacity without changing software."

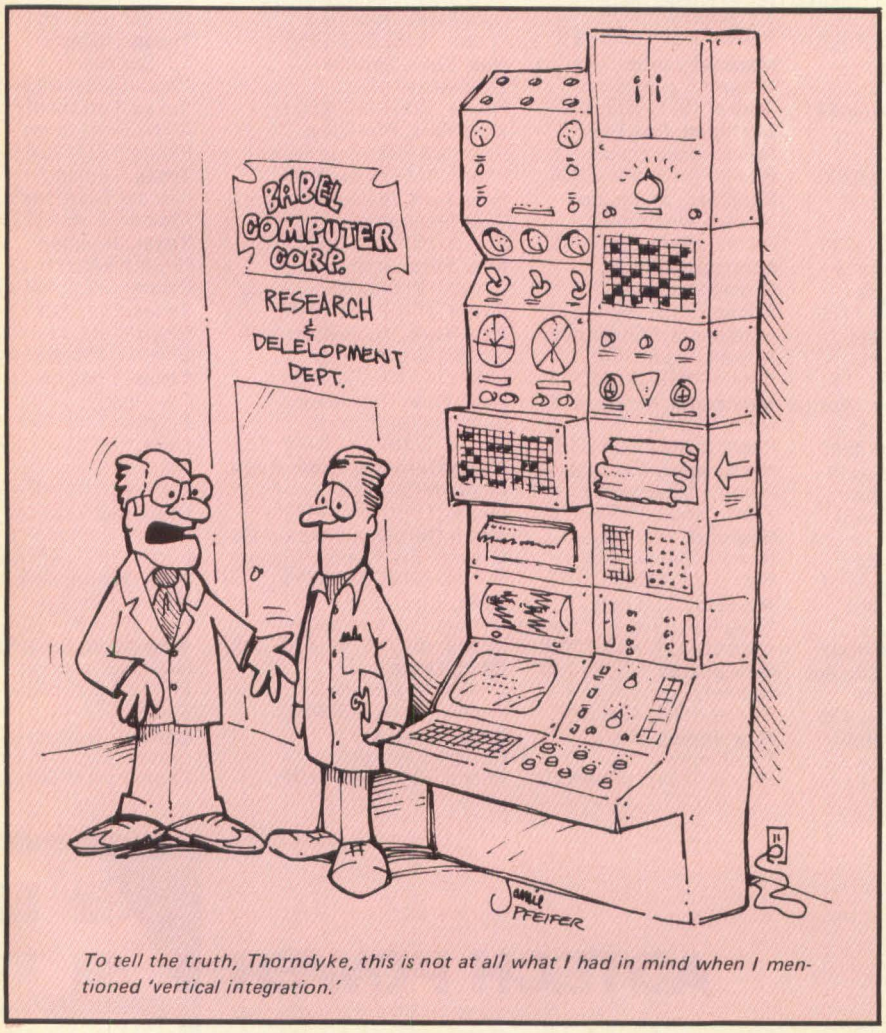


Neal Young of General Automation.

Bond said that DEC would continue to employ new technology in the PDP-8, as it became feasible to do so. "This is a growing business," he said. "There are 40,000 PDP-8s out there and people still want them."

Looking across the minicomputer business as a whole, Bond predicted the increased emergence of 32-bit minicomputers and 16-bit microcomputers. Chris Hoppin of Interdata also foresaw increased popularity for 32-bit minicomputers. "We pioneered the 32-bit mini, bringing out ours first in '73. Like others, we have heard rumors of a 32-bit machine from DEC."

General Automation's most significant entry during 1977 was the 550 supermini processor, according to Neal Young, director of market planning for the firm. "The 550 has the ability to interconnect two processors – it actually allows two processors to be connected to the same memory bank," he explained. "I suspect that we'll see more of that from other manufacturers for certain applications. It comes out of our experience with a communication system that was used in a network



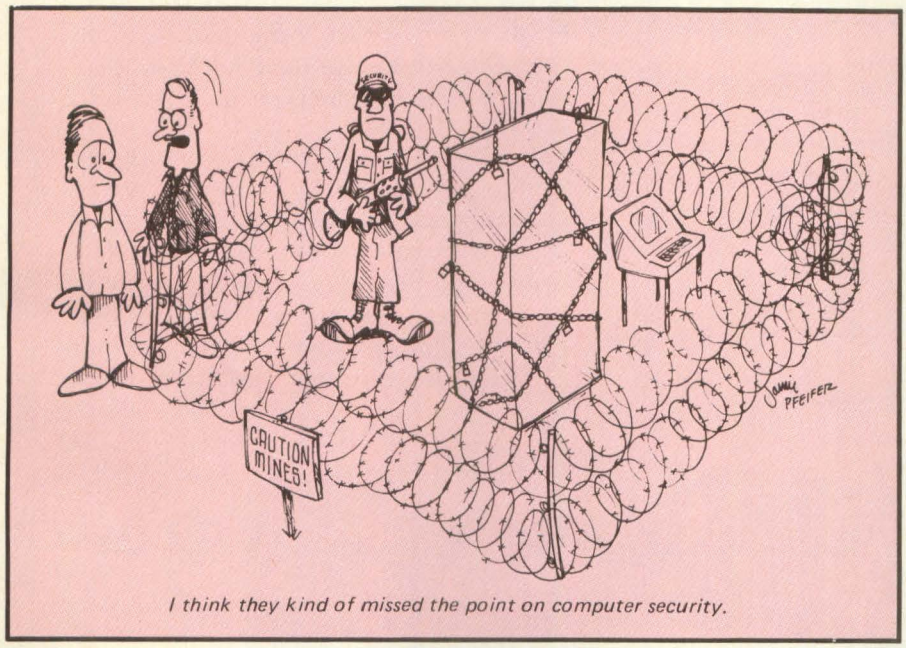
To tell the truth, Thorndyke, this is not at all what I had in mind when I mentioned 'vertical integration.'

to interconnect processors in a similar way. It takes a significant step toward achieving multiprocessor capability because the real connection between processors must happen on the memory side. This is somewhat like the 6800 microprocessor, whose peripherals are addressed through memory. We call this hookup 'tight-coupled,' as opposed to 'channel-coupled,' which we used a year ago. The 550 has under 500 ns cache memory, and the bus between memory and processor is 32-bits wide. Actually, this is a 16-bit machine, with a 32-bit memory."

Young explained that the multiprocessor capability is important in two different types of design – the first, to provide redundant processors in certain critical applications, such as nuclear power plant control; the second, to allow modular expansion of computing capability.

The most important addition to the PDP-11 line during 1977 was the PDP-11/60 computer, according to Henry Heisler of DEC. PDP-11/60, a mid-range supermini replacement for the PDP-11/45, features integral bipolar cache memory which gives an effective cycle time of 532 ns and built-in floating point allowing very fast FORTRAN. The 11/60 also has writeable control-store option that allows users to enter their own function – for banking, fast Fourier transform, and other applications – in microcode. "User microcode is relatively new," Heisler said, "but many of our customers are sophisticated and want it. I'm talking about high-technology users, of course. User microcoding has been evolving, but has become available as an option in minis only recently. Several major minicomputer manufacturers do not presently supply it and will probably announce it. I don't know when it will get down to the smaller computer companies, but I think it's coming – perhaps in '79."

Data General's S-130 minicomputer features user microprogramming, according to Frank Madren of Data General. "Microprogramming is nothing new," Madren said, "but this system brings the capability out in a form users can get their hands on. We are presently into the second generation of this product; other vendors in 1977 brought out their first generation of user-microprogrammable systems. This is a continuing trend and we expect to see more of it in the future."



I think they kind of missed the point on computer security.

"One of the major new products to appear during the year was the 16K RAM," said Roger Ueltzen, product marketing manager for the Data Systems Division of Hewlett-Packard. Ueltzen added that HP is using these RAMs in its 21 MX minicomputer and its 1000 mini-based system. He said that over the years the average memory size of minicomputers has grown – that the memory capacity of HP's own product had quadrupled to 2 megabytes. HP has invested "upwards of 15 million dollars" in the SOS (silicon on sapphire) technology, and Ueltzen believes that this technology will "blossom" in 1978. SOS products

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"Product introductions in the mini field are decreasing. The customer is looking more and more into the kinds of services provided."

are presently being used in HP minicomputers.

Minicomputers and Security

Security is becoming increasingly important to users of minicomputers, according to Frank Madren of Data General. "Two or three years ago you didn't have to worry about security on a mini, because they were put in a lab or someplace where they were locked up. Now, with multiprogramming and more use in the commercial marketplace, we must make minis more reliable and sophisticated. We must be able to guard certain sectors. We're doing that in our commercial product line presently and a number of other manufacturers are doing it also."

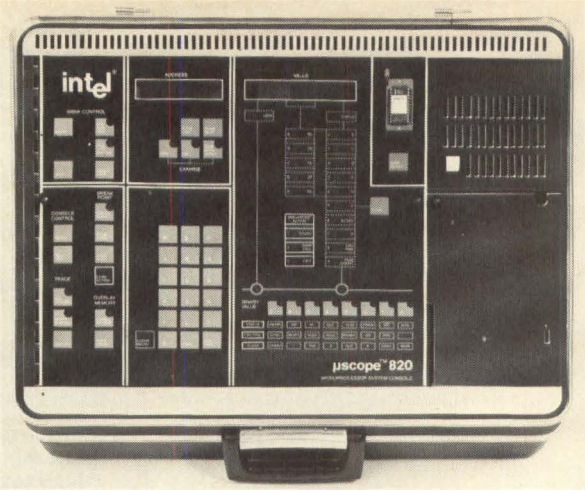
Minis – A Look into the Future

In the future, suggests Jim Orris of Sperry Univac (Varian), the minicomputer market will stabilize with customers looking increasingly for service and the kind of support that goes with a mature product. "The mini market has always been driven by products," he said. "New product introductions in the mini field are decreasing. The customer is looking more and more into the kinds of services the manufacturer provides after purchase and considering them seriously."

"There is definitely a trend in the industry toward higher-level languages in minicomputers," said Roger Ueltzen of Hewlett Packard. Ueltzen added that he saw this trend continuing and also anticipates reduced hardware costs – by as much as 25%. Another important trend, he observed, is toward distributed processing. "During the year," he said, "many mini and mainframe manufacturers announced long-term network strategies."

"In the future, cost will be more critical than ever before," said Chris Hoppin of Interdata. "I believe the competition will continue to have a significant impact on the minicomputer market." **DD**

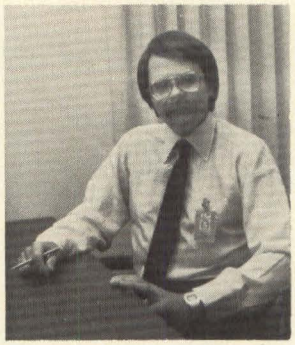
Microcomputers
Microprocessors



Intel's new Scope™ tool for field emulation enables user to "pull the microprocessor, plug in the emulator and step through a problem."

One-chip microcomputers arrive

"The emergence of one-chip microcomputers is very important," said Robert Walker, marketing communications manager for Intel. Some of these micros, announced in late '76, did not become a reality until '77."



Robert Walker of Intel

In agreement was George Vashel, marketing manager for Signetics. "The 8048 and 3870 (from Intel and Mostek, respectively) made very significant statements," said Vashel, "and we at Signetics have taken a position to be a source of the 8048 family." Vashel believes that these small computers open up many applications in stand-alone controllers and distributed processing systems.

Ed Huber, marketing manager of MOS microprocessors for Texas Instruments, which in 1977 introduced a 16-bit single-chip microcomputer, felt that 1977 was the year in which single-chip microcomputer technology "came of age. We can put most of the memory requirements on a single chip and I think that we will see a definite trend away from multiple-chip processors and toward the single chip. We've already seen some evidence of that with Intel's 8048, Mostek's 3870 and of course TI's 9940. Our 9940 has considerable power – a 16-bit machine with 2K of program storage in ROM or EPROM and 128 bytes of RAM. You just look at over half of the microcomputer applications and you see that they can use a single-chip microcomputer like that. The counter-argument is that there are a lot of cases where additional memory will be required. But as the memory technology grows, we will take advantage of it. The memory of the 9940, for example, will accommodate a capacity of 64K. We can't do it now because the memory technology is not there, but it will be in the future and we will be able to do it."

Four bit microcomputers, traditionally limited to simple control applications in such devices as microwave ovens, color television receivers and stereo systems, have become increasingly sophisticated, and now serve in programmable calculators, electronic cash registers and point-of-sale terminals. These new applications have come about, according to William Bottari, Product Manager for Panasonic Electronic Components, because the four-bit micros have become increasingly more complex. Bottari points out that Panasonic's MN1400 Series, introduced in 1977, has 75 instructions and runs with an instruction cycle time of less than 10 μs. He adds that newer four bit micros, such as the MN1400 Series, incorporate a number of functions previously found on auxiliary chips: the MN1400 Series chips include an 8-bit presettable counter, a lock generator, a 1024 x 8 instruction ROM, a 64 x 4 RAM, I/O ports and the arithmetic logic unit.

More Development Aids for Hardware and Software

An important event during the year was the advent of floppy-based software development systems for high-end users, according to Ed Huber of Texas Instruments. Texas Instruments introduced its AMPL development system, and several other vendors, notably Tektronix, also made entries. Huber said that he saw two trends in software development systems – one toward multiple-chip systems such as the Tektronix 8000-series, and the other toward lower-cost systems dedicated to particular families of processors.

Huber said that hardware emulation had made some progress with the introduction of hardware emulation boards. "We introduced a hardware emulator for the TMS 1100 that we call an SC-1 board, selling for about $200 a copy. You can load the program in EPROM, which is included on the board, plug it into your system and emulate the microcomputer. Mostek introduced something similar for their 3870. These boards are different from what was available before, which required you to use an MDS system or something like that with an umbilical cord. This is a lot simpler."

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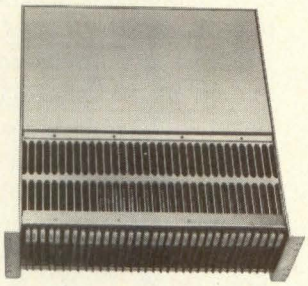

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Increased sophistication in development systems and their support software was particularly important during the year, according to Jim Moon, engineering vice president of MuPro, manufacturer of 8080-based microcomputers and development systems. A notable entry during the year, according to Moon, was Tektronix with its 8000-series development system, which supports several different microprocessors. He cited this entry, and HP's rumored entry into the development system market, as indications that larger companies are beginning to realize the importance of the development system market and are going to get into it with both feet.

Fig 1 Tektronix 8002 microprocessor development system presently supports 8080, 6800, Z-80, 9900 and 8085 microprocessors, with other microprocessors to be added in future.

"Tektronix and Hewlett-Packard are traditionally makers of instrumentation," said Robert Walker of Intel. "Apparently they recognize the growing importance of development tools for system designers." Walker also cited Intel's new μScope™, a tool for field emulation enabling the user to "pull the microprocessor, plug in the emulator and step through a problem. This is the kind of thing the instrumentation people would have done," Walker said. "We're getting into it at the same time they're getting into the development system market."

"The continuing evolution of software development tools during the year is evidence of a maturing in the microprocessor industry," said George Vashel of Signetics. "It is a condition of the business nowadays that one has to support his products in this fashion." Vashel said that he had not seen any revolutionary software but does anticipate a revolution in compilers for microprocessor-based products. "In the future, compilers will be optimized around instruction sets of particular microprocessors, and will really be much more efficient than today's cross-assemblers," he said.

More Software

An overall trend during the year was toward "increased sophistication of operating systems for microcomputers," said Jim Moon of MuPro, who then cited MuPro's multiuser multi-task operating system, which supports several terminals. Across the entire field, he saw increasing availability of higher-level languages for microcomputers, pushing microcomputers ever more into minicomputer applications. In the future he sees this trend continuing, with an interesting example being an increased number of microcomputers offered for small business applications, as higher level languages become increasingly available for them.

Another trend, Moon observed, was toward software becoming an "off-the-shelf" item. "People are starting to look at software as off-the-shelf material, much like hardware," he said. "Important entries during the year are our multitask operating system, Intel's announced RMX-80 operating system and several introductions made by software houses of FORTRAN and COBOL compilers for 8080, Z-80 and other microprocessors. BASIC has been out there for a long time, but '77 saw the introduction of reasonably well-debugged FORTRAN that you can count on getting up and running with minimal pain and strain."

More "Smart" Peripherals

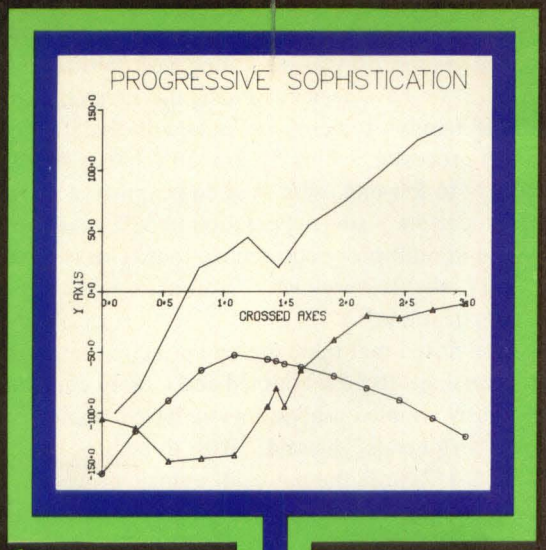
"Peripherals were particularly important during 1977," said Robert Walker of Intel. He anticipates increasing emphasis on peripherals such as floppy disk controllers in the future. Walker cited two opposing industrial trends which presently exist side by side and with at present no clear movement from one to the other. "We are introducing a chip that is really a universal interface processor. If you want it to be a printer controller you program it to be that, but it is really a general-purpose processor. At the same time, we are introducing special-purpose processors – floppy controller, CRT controller and so forth. These two types of controller are at odds with each other. One does only one type of job; the other is general-purpose. Right now they coexist. Will that continue?"

"There was an expansion of computer peripherals during 1977 – what could be termed the big push on microprocessor-controlled peripherals to make line products smarter to do more things," said George Vashel of Signetics. In 1977 Signetics introduced its 2651 programmable communications interface and 2652 multi protocol communications circuit; both products are fairly representative of the trend Vashel mentioned.

In 1978, Vashel anticipates continued emphasis on peripherals throughout the industry. "This is a major emphasis with Signetics," he said, "and we expect to make a number of new introductions."

Microprocessor Developments

"Microprocessor CPU developments leveled off somewhat during 1977," said Jim Moon of MuPro. "The years '75 and '76 marked the entry of a number of new CPUs," he said, "but '77 indicates that manufacturers are putting more into LSI controllers for various peripherals such as floppy disks, CRTs and the like." Moon believes that further upgrades in CPUs are not presently justified from the manufacturer's standpoint in terms of investment until breakthroughs in the semiconductor manufacturing process occur. On the other hand, semiconductor manufacturers can offer new controllers to extract greater value at the system level. An exception to the leveling off that Moon saw was the appearance of several single-chip microcomputers. "These are notable entries into the marketplace," Moon said, "particularly for low-end users who want dedicated processors for particular applications such as controllers. The Intel 8048 is a significant entry."



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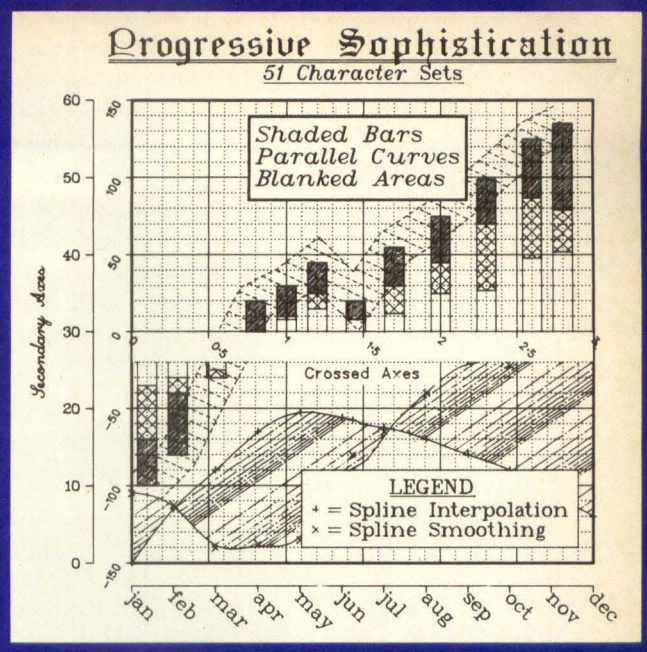

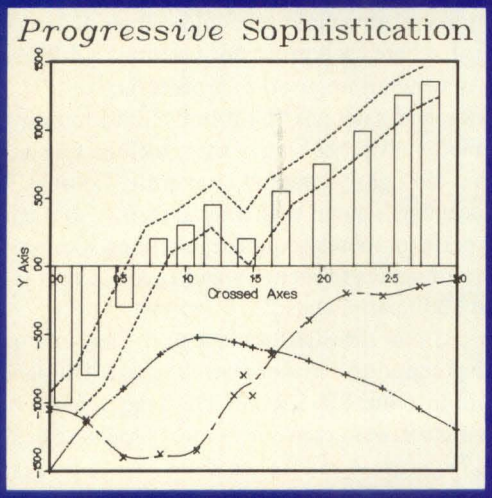

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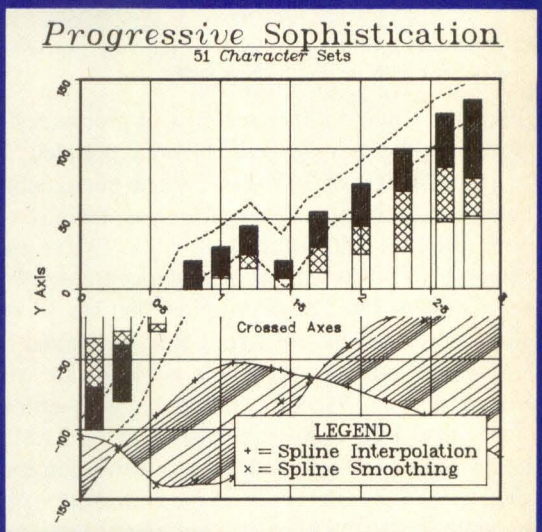

3

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Moon believes that 1978 will witness the introduction of a "pretty good range of new development and test tools. It will also to some extent shake out the processor market. Siemens' and NEC's commitments to the 8085 as opposed to the 8080 microprocessor will provide necessary time to show which way the industry will eventually go – whether most manufacturers will swing with multisourced devices or with something that has more capability like the Z-80. By the end of the year it should be clear whether 8080, 8085 or Z-80 will dominate the long term market. It will also enable us to see what the manufacturers will do about new technology such as Hewlett Packard with the SOS technology it will begin to offer in its own products."

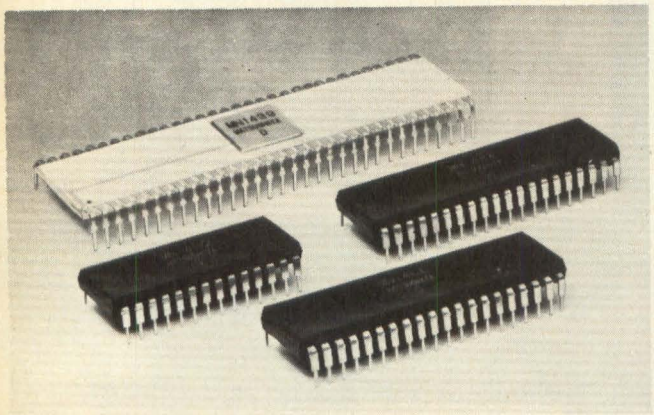

Fig 2 Panasonic's 4-bit, one chip microcomputers offer from 57 to 75 instructions with up to 256 bits RAM.

Taking a somewhat different view of processor developments during the year was Milt Hubatka, president of Space Byte, manufacturer of 8085-based single board computers. "The most significant product of the year from our viewpoint was the Intel 8085," said Hubatka. "We've used it in our single-card S-100 compatible microcomputer. What we've done is combine three cards onto one that has 3K system monitor, peripheral interface for CRT, printer and floppy disk – this has not been done before." Hubatka also cited as important the Intel 8155 I/O device that goes with the 8085 chip set and the Texas Instruments' 4K static RAM, which Hubatka said was a "tremendous step forward in the technology – and 6 months ahead of the competition." In 1978 Hubatka foresees a "tremendous amount of integration at the systems level. A lot of devices we are still at the point of reaching for. At the systems level we need to catch up with the technology available."

Hubatka added that another significant development of 1077 was increased acceptance of the S-100 bus. "We are an S-100 company," he said, "and we are biased toward that, but we saw a lot of money invested in it by the industry in the last year." For a long time S-100 compatible microcomputers were considered part of the hobbyist industry, but he believes that "vertical integration" of the industry has now begun. He cited the acquisition of MITS by Pertec and of Polymorphic by EM & M as evidence that the base of the hobby computer industry is expanding. S-100 compatible microcomputers are very cost-effective, according to Hubatka. "The bottom line is that completely integrated floppy disk development systems with higher-level languages based on the very inexpensive S-100 bus can be made available for under $10,000."

"We saw a lot of growth in multiprocessing applications for microprocessors during 1977," said Howard Raphael, director of microprocessor marketing with National Semiconductor. "We have been enhancing the capabilities of our SC/MP family of microprocessors with the 8060 8-bit N-channel processor, selling for around $5, that appeals particularly to low-end users. A good proportion of our SC/MP processors – somewhere around 50% – are now being used in multiprocessor applications. This is a very cheap, very reliable, very high performance way to go for certain applications."

Raphael noted that there are two principal forms of multiprocessing – tightly coupled and loosely coupled. "With tightly coupled processors you have common memories and peripherals," he said. "With three processors you get about 2-1/2 times the power of a single processor, but with four or more processors, the power increments are not very great. But at $5 per processor, multiprocessing becomes very feasible. With loosely coupled processors, each processor has its own memory and I/O facilities and communicates by a common bus or memory. Whether tightly or loosely coupled, the multiprocessor system may be symmetrical – where the processors each perform the same function and are what you could call redundant – or asymmetrical, where each processor performs a different function and is dependent upon other processors."

SC/MP, Raphael said, has "built-in facilities to enable tightly-coupled multiprocessing – these include special pins and logic that aid tightly-coupled processing. Loosely-coupled processing is aided with a serial facility that enables the chip to perform loosely-coupled functions – essentially one bus that interfaces to memory and I/O, and that is compatible with 8080 peripherals."

Rapheal said that the 8080 was the only "low-end microprocessor that supports a higher-level language. Our language, NIBL, is built into our 8295 ROM. This takes what is basically an esoteric software concept to most hardware engineers – high-level language – and makes it possible to program the processor in English language commands." Raphael added that National also offers higher-level language capability for the 8080 microprocessor in the form of the 8298 ROM.

"Single board computers matured during the year," said Robert Walker of Intel. "If you look at them you see that the ones the mini people make tend to have a little better software and the ones the semi people make tend to be less expensive, but all in all they're pretty close. Both mini and semi people are introducing cards and there is not a lot to choose between them. Relative cost is 2 or 3 to 1 for mini versus micro." The prices of cardsets are coming down, Walker added, mentioning Intel's recent introduction of microcomputer cardsets selling in the under $100 price range.

"A major thrust of 1978 will be the appearance of 16-bit microcomputers," predicted George Vashel of Signetics. "Available to date have been fairly humble offerings. The 16-bit microcomputers from mini manufacturers are not necessarily humble, but they come from the mini-type guy who extends downward into the microcomputer market under the software umbrella of his minicomputers. Semi guys don't have that kind of software presence, but have the technology to bring high performance to the market. I expect significant products from the semi guys." **DD**

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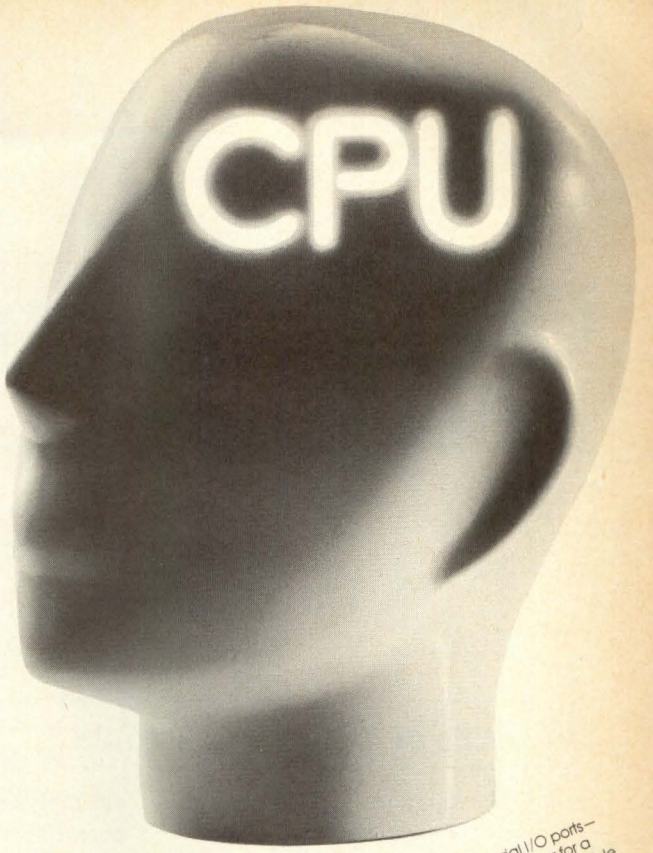

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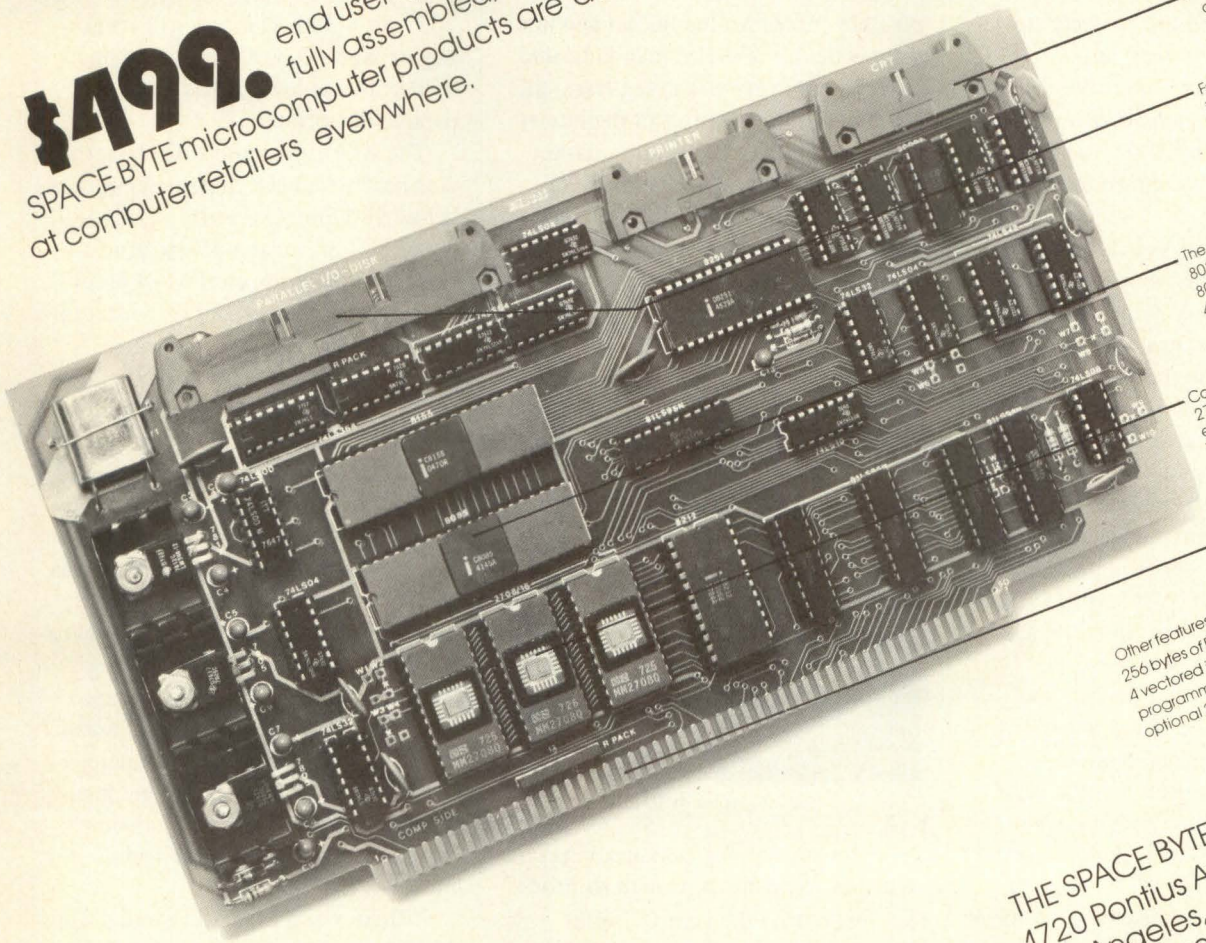

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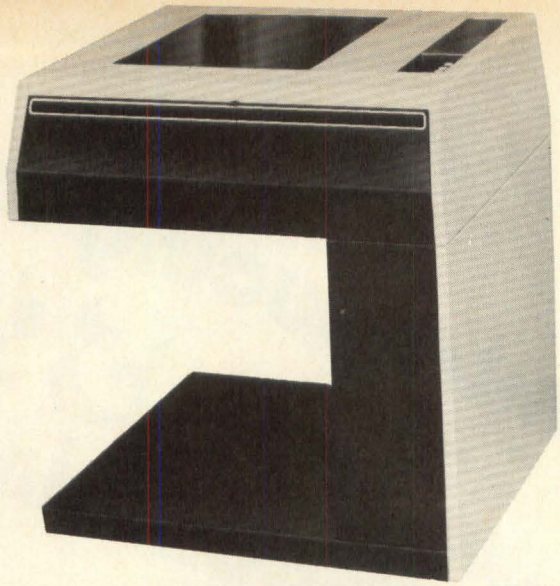

Model 5560 600-lpm printer contains microprocessor electronics, a replaceable character cartridge and an interface capable of emulating other popular line and serial printers.

Makers broaden their lines

Among the significant developments of 1977 was the broadening of the product lines of two major printer manufacturers. Both now provide printers ranging in speed from relatively slow to very fast. In this year, another maker extended its printer line by providing new, less expensive printers in its traditional under 300 lpm speed range and by introducing a new 600 lpm model.

A Centronics spokesman said that during the year the company had extended its inventory of printers by adding the 6000 series of fully-formed character line printers, with speeds of 75 through 1100 lpm, and the Micro-1 electric discharge printer, a compact, low-cost unit aimed at home, hobby and microprocessor markets. Late in 1976 Centronics introduced the eleven models of its 700-series impact serial dot matrix printers, with speeds ranging from 60 to 180 cps in 80 or 132-column format, depending upon model. "The big thing for us," the spokesman said, "is that instead of being only in one area, below the medium speed range, Centronics now runs the gamut – everything from microprinter to 1100 lpm line printer, in serial dot matrix or fully-formed character or electric discharge methods. We offer various technologies at various speeds, though we do not make large, fast electrostatic printers. We've considerably expanded our market area potential – one estimate is by five times."

Asked to comment on Centronics' possible entry into the ink jet and laser printer field, the spokesman indicated that the company was doing research, but had nothing to offer in the immediate future. "I see the printer market stabilizing," he said. "Non-impact technologies are gaining greater acceptance and opening new market areas, but I don't see them threatening impact technologies, at least not in the near future."

Jerry Kaplan of OEM

A spokesman for Dataproducts said that the company expanded its product line during the year to "offer lower cost to the consumer" and to broaden our market. Dataproducts pioneered and has been the leading independent supplier of over 300 lpm machines," he said. "In June we introduced a new generation of band line printers, the B-series, starting with the 300 lpm B-300. This line will eventually expand upward, offering higher speeds, but at lower costs than comparable line printers."

The spokesman said that Dataproducts has introduced three new printers below 300 lpm. One entry, the B-180, is "a 180 lpm version of our band printer, oriented toward word processing applications." Dataproducts for the first time offered a dot matrix printer, the M-200, which uses a "dual column, 14-element, bidirectional printhead." The M-200, first member of a matrix printer family that eventually will expand to include other printers, prints at 330 cps (200 lpm). The final new Dataproducts entry was the T-80 thermal printer, a compact, 80 cps machine whose primary application is CRT printout.

The spokesman said that Dataproducts was in the "definition and research phase" with new printing technologies such as xerographic, ink jet and laser. He would not speculate on possible product entries using these technologies.

"There was a dramatic trend during 1977 toward low-speed (under 300 lpm), lower duty cycle, lower cost line printers," said Jerry Kaplan, director

of OEM marketing for Data 100. "In general," he continued, "people are looking for more printer for the buck, and do not require a heavy-duty workhorse in this speed range. Data 100 has been in this market for several years," Kaplan continued," and intends to enhance its under 300 lpm printers in 1978 by adding more intelligence."

Another trend, Kaplan said, was that people would like to purchase as much as they could from one company. To broaden its market, Data 100 intends to expand its line of higher-speed line printers in 1978. The company earlier this year introduced the model 5560 processor-based 600 lpm line printer. A processor controls the internal workings of the machine and also performs diagnostic functions to determine type and location of malfunction. " The 5560 represents a market trend toward increased recognition of total cost of ownership," Kaplan said. "The diagnostic function saves a lot of service time and this means added cost savings to the customer." The 5560 also has an interchangeable print cartridge, which enables change of character set in "about a minute," according to Kaplan.

Like other companies, Data 100 is looking into non-impact printing technologies, Kaplan said. "However," he added, "we do not envision these technologies taking over from impact printers. People still need multiple copies."

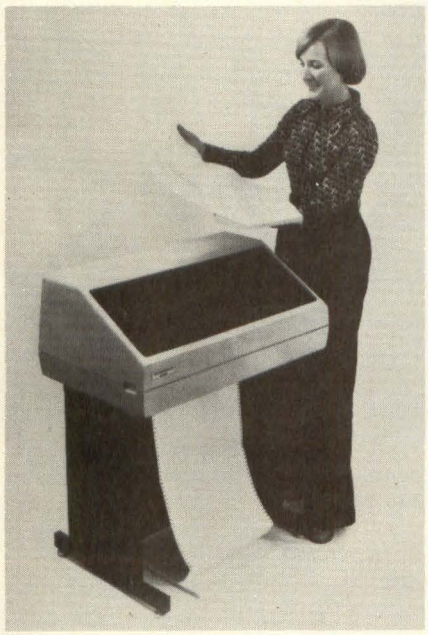

Fig 1 One of several new Centronics' printer entries during 1977 was the 6000 Series of fully-formed character line printers with speeds between 75 and 100 lpm.

Fig 2 One of several new Dataproducts' printer entries during 1977 was the M-200 impact serial matrix printer, with a 14-element head and speed of 200 lpm

Smart Printer Comes of Age

"The most significant factor during the year was the coming of age of the smart printer," said Bill Bennett, director of printer products for Lear Siegler. This happened throughout the industry, he said. "In our own product line," Bennett continued, "microprocessors have allowed us to add several printer capabilities. For example, we are able to store multiple print formats within the machine, remotely call for forms, tabbing and so on, to extend into formless printing, so that in some cases it is feasible for our users to print on plain paper to generate forms on the fly. This is a real time-saver, because you don't have to stop the machine and change forms. We store the forms information locally, and access it as need be to generate the forms.

"Another capability we've added is for remote polling-addressing, to get the printer to emulate some other device, so that it can go into a communications system with existing terminals. You can then force the printer to emulate other terminals.

"One of the more interesting things we've done," Bennett went on, "is to give our communications terminal total code independence. We can make the same communications terminal listen to EBCDIC, Baudot, ASCII and several other communication codes, and dynamically reconfigure itself in what you could refer to as an 'adaptive' way. The processor listens to the incoming data, determines the code and tells the front end what code conversion table to use.

"Like many printer manufacturers, we've been able to increase the speed of our printers by using microprocessors. We have a feature for throughput maximizing that we call 'addressable tabulation' which is a kind of vector addressing of particular print locations – instead of using conventional tabs and space codes we give a vector address that saves bits and time. Some of our users have been able to increase throughput by 3:1."

Matrix Printer Evolution

"One of the notable achievements of 1977 was the higher speed obtainable with impact serial matrix printers," said Glen Harmon, director of marketing for Florida Data. "A few years ago these printers ran much slower," he said, "but now matrix printer speeds are approaching line printer speeds. Our single moving head matrix printer prints at 600 cps, which translates to 240 to 1465 lpm."

Harmon said that the new Florida Data printer capable of these speeds, the PB-600, uses a Motorola 6800 microprocessor to control the printing head. "The speed is achieved with clever mechanical design," he said, "though I wouldn't classify it as a technical breakthrough." Harmon said that the microprocessor also contributed

to increased printer throughput capability.

Harmon said that his own company was doing developmental work on a matrix printer, to be available in mid-1978, that will print "solid characters using matrix techniques. We're using a microprocessor to control head and paper movement to the degree that we can put a dot anywhere on the paper and fill in the gaps left in matrix characters. The printer will have a speed of 600 cps with conventional matrix characters or 200 cps with solid characters."

There were no breakthroughs in basic printing mechanism technology during 1977, according to Bill Bennett of Lear Siegler, though he added that his own company has introduced an impact serial matrix printhead variant that is being picked up by several other printer manufacturers – NCR,

Len Wilker of Qume.

Hewlett Packard, Datapoint and Anderson Jacobs, to mention a few. The so called "ballistic printhead" has no armature coupled to the print wire; instead, it propels the wire against paper and lets it bounce back on its own, after very short dwell. Bennett claims that the printhead allows "on the order of one billion characters" to be printed by a single head, enough to last the life of the average printer. Speed is comparable to other impact serial matrix printheads – 150-180 cps – but power requirements are lower, about 15 W. "This low power requirement decreases heat and we have customers running some of these printers around the clock seven days a week," Bennett added.

Bennett believes printer users are becoming more demanding and expecting printers to have such features as continuous duty capability, low service cost and long lives. "In the past," Bennett said, "people expected and accepted that printers were no damn good and that they broke down every six months or so and that you had to have a service man out, but they are changing and looking for greater reliability. This is a trend."

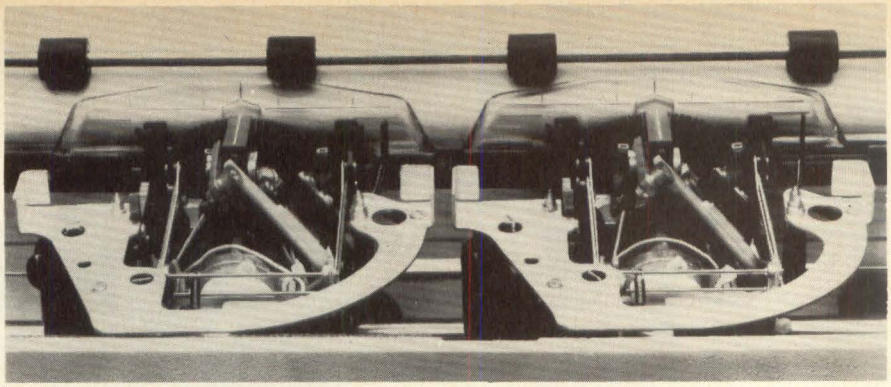

Fig 3 Qume Twintrack™ printer uses two daisy wheels to print at up to 75 cps with one character set (96 characters) or 45 cps with two different character sets (192 characters).

Small Printer Developments

One of Qume's most important introductions during 1977 was the Twintrack™, according to Len Wilker, national sales manager for the firm. The Twintrack, a daisy wheel printer with two daisy wheels, can print with two different 96 character sets (for a total of 192 characters) or at higher print speeds with two identical printwheels. Other improvements to the Qume printers during the year were a stack loader (called "speed feed") and an RS-232 interface to make the Qume printer more broadly compatible with data processing equipment.

One of the more interesting stories of the year came from Simon Harrison, executive vice-president of Axiom, manufacturer of small, low-cost electrostatic printers and plotters, who considers one of the most important events in 1977 to be "the impact of competition on the small electrostatic printer/plotter marketplace. The arrival of competition," Harrison said, "endorses the technology that we have been using for a couple of years. We are committed to electrosensitive printing, which we feel represents the simplest printing technique and is also the most cost-effective." Harrison added that in the last year a number of companies have gotten into or are about to enter the small electrostatic printer market – notably SCI and Centronics, and possibly IBM – and that such companies recognize that these small printers appeal in applications previously limited to more expensive impact line printers. Small electrostatic printers are not suitable in all applications, Harrison noted, but they are "very cost effective in terms of cps per dollar. The EX-800, a moving-head printer using 5″ paper, has been quite successfully making inroads with customers who want a line printer, but cannot afford the price of an impact machine and who find the low parts count and high reliability of the small electrostatic printer appealing." Harrison pointed out that his firm has in the last year sold 500 such printers to the government, to whom the low cost and high reliability particularly appealed. "Though we make a totally different kind of product," Harrison said, "we compete with manufacturers of the larger line printers."

Fig 4 Axiom EX-800 electrostatic printer prints 80 columns of data on 5″ paper at 160 cps.

Paper size is smaller with the EX-800 than with larger impact line printers – 5″ instead of the usual 8.5″ or wider paper – but the EX-800, using variable dot size, generates smaller size characters and can still print 80 columns. Harrison said that such printers

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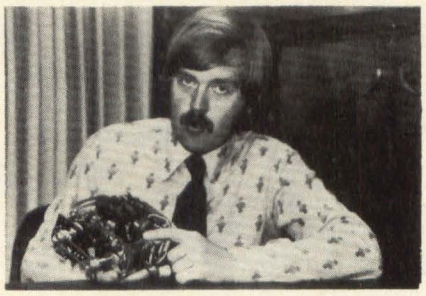
CIRCLE 29

in some cases appeal to OEMs, who use them in line printer applications that would not be cost effective for larger impact line printers. To a certain degree these printers may also appeal to hobbyists, Harrison said, though Axiom is not actively pursuing the hobbyist market at present.

Axiom also manufacturers the EX-810 graphics printer which Harrison said particularly suits medical applications requiring the simultaneous presentation of graphic and alphanumeric information. "This printer, which can be OEMed for about $500, lets you lay a dot anywhere on paper and puts down about 8000 dots per second, using the scanning principle," Harrison said.

Axiom will bring out a new graphic printer that can generate 8-level halftones using a "dot burst" principle, according to Harrison, 8 pulses from each dot, with duty cycle varied to change dot density. This printer, designated VP-100, with a 520 styli fixed head (EX-800 line printer and EX-810 plotter use 8-wire moving printhead), can generate high speed alphanumerics (3200 cps), graphs or photographs with an 8-level halftone scale.

Harrison believes that 1978 will be the "big year for electrostatic printers." His own company will introduce its video printer and a ticket printer; a number of other companies will enter the field with their own products. He does not expect a revolution in printer technology, but believes that users will increasingly recognize the suitability of electrostatic printers in certain applications.



Simon Harrison of Axiom.

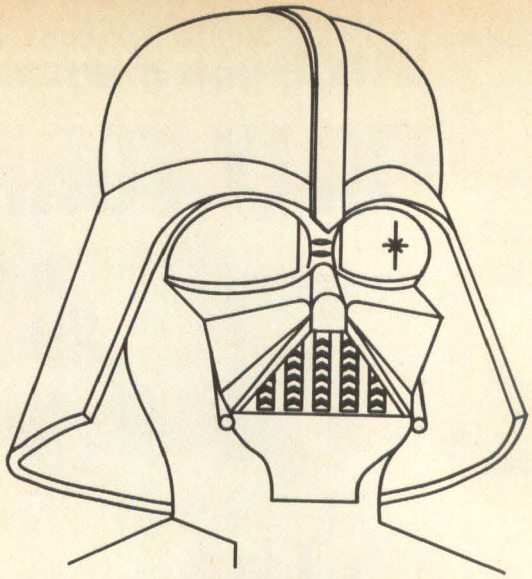
Microprocessors Increase Flexibility

"1977 was the year of the microprocessor," said Tom Hall, national sales manager of Houston Instrument. "In '75 and '76 a lot of people talked about doing things with microprocessors, but in '77 they actually started doing them. This seemed to happen en masse (on MOS?) in the industry."

Microprocessors have had significant impact on Houston Instrument's electrosensitive printer, Hall explained. "They allowed us to expand our character set to 192 characters, under software control," and have also expanded other printer capabilities.

Hall said that Houston Instruments' electrosensitive printer introduced late in 1976, was not attempting to compete with impact line printers. "We see ours as a fairly specialized product," he said. "When we brought our printer on the market it seemed as though no one had a screamingly fast, low-cost printer for use in applications where paper cost didn't matter. It is particularly good for development systems. We are not attempting to compete in the line printer market. Our paper is expensive – about four times what regular paper costs – but our printers are less expensive and you can buy more speed for the price. If you consider the cost of having a human waiting on the output of your system, a printer such as ours is often a very sensible choice." DD

Computer Plotting Equipment



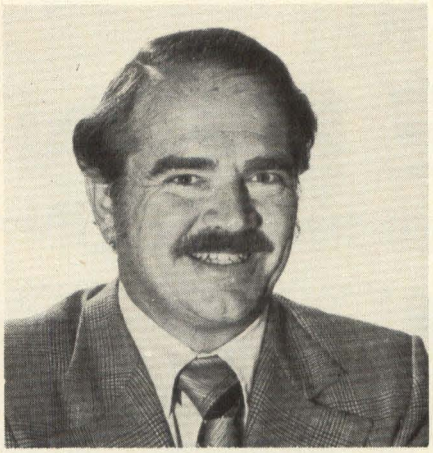
Microprocessor control speeds operation

Manufacturers were universal in their agreement that 1977 was the year for microprocessor-controlled "smart" plotters. Processors not only increased plotter speed, but unburdened mainframe CPUs thereby reducing CPU and telephone line costs. The impact of processors was felt by manufacturers of pen plotters and electrostatic plotters.

Electrostatic Plotter Developments

"The most significant occurence of the year in plotters was the increase in on-line printing speeds obtainable with electrostatic plotters," said Peter Dietz, director of marketing for Varian Data, manufacturers of electrostatic plotters. "In the past," he said, "electrostatic plotters operated at high speed at relatively low cost, but could never take full advantage of that speed in on-line printing applications. This year we have introduced as options specialized processors that have enabled us for the first time to get full speed capability from our plotters. What we have developed is a control-store processor, a 40-bit microcomputer that operates at 5MHz, speeding up the whole plotting process. Versatec also increased the speed of their plotters, using a minicomputer – this seems to be a direction the industry is headed."

Dietz pointed out that the electrostatic process takes three steps: Generating a vector to locate a line; sorting vectors in sequence; and rasterizing vectors. The last step is "especially complex for most general-purpose computers, because none was developed to optimize rasters. Our own processor is optimized for this application and can run from 20 to 200 times faster than with a mini."



Peter Dietz of Varian Data.

At the present time, according to Dietz, plotters with processor capability can keep up with computer data output in "99% of cases" without going off line, recording and playing back. One example of this type of plotter is Varian Data's Graphware 1. Dietz believes that the industry trend is toward higher electrostatic plotter speeds, achieved by putting more "smarts," in the form of microprocessors, into computer plotting equipment.

Dietz added that increased on-line plotting speed is not the only advantage of making plotters smart. "This also opens up remote plotting applications," he said. "Remote plotting across telephone lines used to be very slow, because the bandwidth was so lousy and it took so long to broadcast the data. But now, with Graphware 1, you can broadcast just the vectors and decrease the amount of information you pump over the line by a factor of 20 to 1 and get a plot much faster."

Pen Plotter Developments

"Microprocessors had a significant impact on plotters during 1977," said Ralph Manildi, marketing administrator of Zeta Research. "Microprocessors were extensively used in plotter controllers. A large proportion of the computing that would have been done in the host computer is now being done in the plotter."

During the year, Zeta introduced new software called GML (graphic machine language), used with microprocessor controllers, that Manildi claims reduces the load on the host computer by 70%. "Two-thirds of the computing that was formerly done in the host computer is now done in the plotter," he said. "This reduces the cost if you are paying for CPU and telephone line time."

Another way that microprocessors have affected plotters is by increasing the available character sets, according to Manildi. "We now have multiple character sets," Manildi explained. "You can have just about what you want – ASCII, APL – by adding a chip and extending the firmware."

Manildi noted that the speed of plotters produced by his own firm and others had increased during the year.

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Modular construction of the TDC 3000 enables the user to configure a system to individual needs. Applications include minicomputer input/output, minicomputer peripheral storage, terminal peripheral storage, software distribution, data entry via keyboard, local data collection, data transmission, and text editing. And a few other things yet to be dreamed up.

Besides RS-232, Tandberg Data provides TDC 3000 interfaces for HP 21MX, PDP 11, 8080 Microprocessor, AN/UYK-20 and 8-bit parallel general purpose. All give up to 48K bits transfer rate.

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He felt that Zeta had on the whole been faster, but that other manufacturers were "catching up."

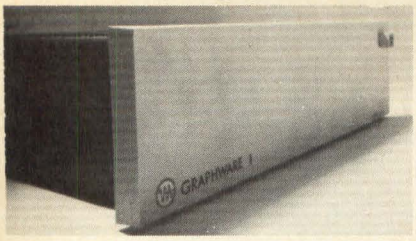


Fig 1 Varian Data's GRAPHWARE 1™ processor enables on-line plotting.

He also felt that plotter users were becoming more sophisticated in the use of multicolors and that there had been a real effort by plotter manufacturers to expand the multicolor plotter market. He noted that Zeta recently introduced a 4-pen programmable 12" plotter, aimed largely at the business market. "This has traditionally been a 12"plotter market," he said, "but until now there has been no 4-pen plotter available. For a long time we have had a 4-pen 36" plotter, and another manufacturer has had a 3-pen 36" plotter. We had a 12" plotter with 2-pen option. But business users want the 4-color capability in their size and so we introduced the Model 1400."

Manildi said that Zeta had also recently announced its second generation general purpose PDP-11/04 computer system, used as the control electronics for its off-line plotting system, with magtape drive and terminal. "This gives you a general-purpose computing system with hard copy output for system communication plus plotter," Manildi said. "You can use it for plotting or as a stand-alone computing system, with all the PDP-11 software, add-on memories and other options."

Looking into the future, Manildi anticipated several developments. "I think you'll see other manufacturers come out with multicolor pen hardware," he said. " I think we'll see additional uses of microprocessors and microcomputers in controllers, either built-in or in separate chassis.

"Generally, I think you'll see more sophisticated plotting systems. Two years ago you would buy a plotter and run it on-line with an interface to a computer, run it on remote with a controller or run it in an off-line system. Now we're seeing that where you have a stand-alone computer system with plotting capability you gain some additional flexibility.

"On-line plotting is becoming increasingly feasible. With our GML software, for example, we can achieve maximum plotting speed on any of our plotters – plot as fast as these machines can go. There's no longer any limitation in the controller end of it. The only limit is the plotter mechanism itself.

"One other area of microprocessor impact is in figure storage and retrieval. This will be made available in some of our products and probably will come from some of our competitors. What this lets you do is store figures you want to use from time to time – for example, Darth Vader of 'Star Wars' fame – in the controller and call them up for printout. This distributes the figure storage and retrieval function from the host computer and also lets you transform these figures at the controller level – scale up and down in size, rotate, slant, change aspect ratio and so on."

Manildi said that Zeta had reduced prices on two of its older plotters, but did not see any large price decreases forthcoming in its own product line.

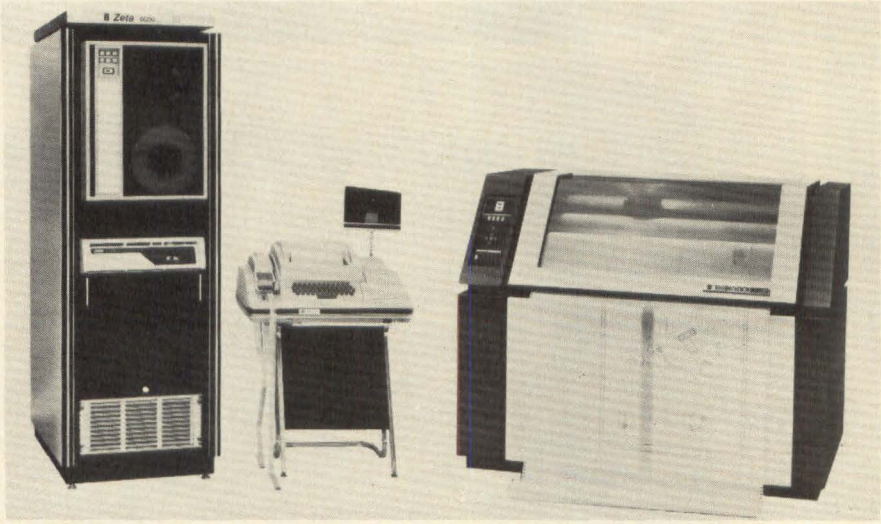


Fig 2 Zeta Research's second generation 6000 Series off-line controller uses PDP-11/04 computer, magtape drive and terminal for plotting or stand-alone computing.

The microcomputer controllers in newer Zeta plotters can be produced for about the same price as the controllers in older models and so buyers are able to obtain higher capability for comparable prices, he added.

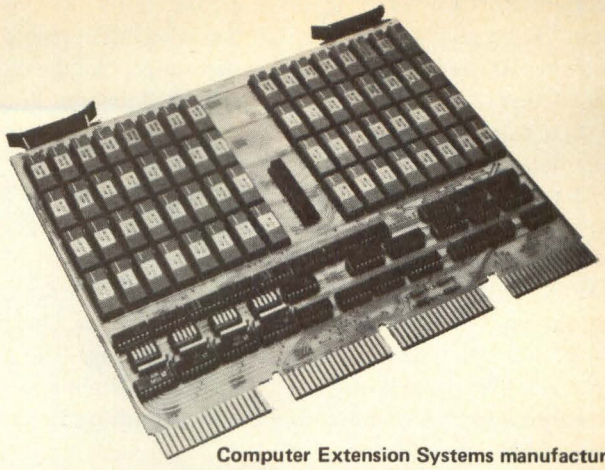
Significant events during 1977 for CalComp included introduction of products with added intelligence through microprocessors, said a spokesman for the firm. New products included four drum plotters and two controller interface devices. These products have enabled CalComp to enter a new marketplace, the spokesman explained. "Previously we had been mainly in off-line graphics, but the new model 906 can operate remotely, with timesharing systems or on-line to minis. What we're really acknowledging is the start of distributed processing and the placement of more, smaller pieces of equipment and intelligent terminals. Users are becoming more sophisticated and increasingly demanding of more options at each of these locations."

Microprocessors have made plotters more flexible, the spokesman continued, by making them usable in a wider range of situations. "This is an industry-wide trend, the direct result of microprocessors. The dropping cost of processors has made it feasible for us to employ them and distribute intelligence to remote stations. We can transmit data in highly-compacted form, cut down line time and do the translation to drive the plotters at remote stations. Other plotter manufacturers are doing the same thing. It makes a lot of sense."

The spokesman felt that the marketplace for plotters was expanding, because more and more people were becoming interested in obtaining graphic outputs. "They'll feel a need for graphics, get an inexpensive device, use it for a while, then want something fancier."

Looking to the future, the spokesman felt that the plotter marketplace would continue to expand, with graphic devices finding many users. DD

Core and Semiconductor Memories

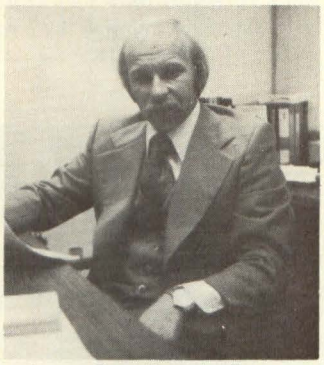


Computer Extension Systems manufactures this semiconductor memory.

Size increases in all categories

The year 1977 saw the entry of a large number of new semiconductor memories, using bipolar, MOS and bubble technologies. The extended core memory was another area of considerable action.

Semiconductor Memories



Gene Hnatek of Monolithic Memories

Gene Hnatek, manager of sales and marketing support for Monolithic Memories, had been researching a paper on semiconductor memories before we called, and gave us several of his impressions and opinions on significant memory developments during the year. Hnatek is well known in the semiconductor memory field – he has written a book and several articles on the subject. According to Hnatek, important developments took place in bipolar, MOS and magnetic bubble memories in 1977.

Significant bipolar entries appearing during the year, said Hnatek, included 8K PROMs (Monolithic Memories, Signetics), 16K ROMs (Monolithic) and 4K dynamic RAMs (Fairchild).

Hnatek cited several new MOS memories. These include 16K EPROMs (Intel, Texas Instruments) and a nonvolatile, low-power 8K EPROM from General Instrument. ROMs with up to 64K capacity for bulk storage became available from Mostek, Signetics, National and AMI – Hnatek felt that the makers of these new ROMs were "pushing the technology about as far as you can go with existing photolithographic techniques." RAMs were a "big area in MOS, with everybody souping up their dynamic RAMs and going for lower power and higher speeds," he added. During the year, 16K RAMs became available from Mostek, Motorola, Texas Instruments and Intel. "Static 4K RAMs really caught on this year," Hnatek said. "These are available in 1 x 4 and 4 x 1 configurations. Pioneered by the semi division of EM & M, they are now available from Mostek, AMD, Semi, Intel and Texas Instruments. Intel uses HMOS – scaled MOS – and can run at 55 to 70 ns maximum access time; it looks like they're going after the bipolar market. The VMOS technology, pioneered by AMI is just coming into its own with 1K RAMs having 80 ns access times." He predicted that many users of bipolar 4K RAMs might want to switch over to Intel or AMI scaled MOS devices, with their under 100 ns access times. "A real battle could develop there," he added. "Several manufacturers brought out 64K CCD devices for bulk storage this year," Hnatek said. "The manufacturer's list includes Fairchild, Texas Instruments and Intel. These are slow devices and the price has to come down for them to take over from disks and drums."

"A lot of companies have done work with bubble memories but TI actually entered the market with a device."

Looking toward the future, Hnatek predicted the appearance of a 64K dynamic RAM and 16K static RAM in early 1978. CCD memories, he felt, would go to 256K, bypassing 131K sizes.

He felt that one of the important events of the year was Texas Instruments' introduction of a 92K magnetic bubble memory. "A lot of companies have done work with bubble memories but TI actually entered the market with a device. They also put one in their line of Silent 700™ printing terminals. Magnetic bubble memories need a lot of circuits to go with them. You can't really predict at this point where they'll go."

The most significant memory product entries of 1977 were Texas Instruments' bubble memory chips and Silent 700™ bubble memory terminal, according to Gary Wagner, president of Computer Extension Systems, independent supplier of DEC-compatible memory products. "I can see tremendous use for these memory chips in certain applications such as geodetic survey-type work," he said.

Another memory product that he found significant was the 4K static RAM, which his company uses in its own products. "Right now we use primarily the Texas Instruments 4K static," he said. "This is a true static device, like the old 2102. Other statics on the market are clocked devices. Prices on these parts are dropping, but they're still more expensive than dynamics."

The most important memory development during 1977 was a new process for making higher-density CMOS semiconductor memories, according to Charles Hochstedler, MOS memory applications engineer with Harris. "We are now able to get a 4K CMOS static RAM into a reasonable size die and make the memory in an 18-pin package," he explained. "We make both 4K x 1 and 1K x 4. Right now we make two versions, but before the year is out we'll have a family of six."

Hochstedler said that until Harris's introduction there hadn't been a 4K CMOS static RAM on the market. "The 6504 and 6514 are the first two being made with any feasibility at all. There have been N-channel devices before, but never CMOS. To get this density we are using what we call a self-aligned silicon gate process in which we use a second layer of polysilicon interconnect. Earlier we had used only one layer. This second layer has allowed us to go to much higher density, somewhere in the neighborhood of 27,000 devices on a single chip with a 156-mil by 212-mil die. The CMOS RAM has low power requirements, is very temperature stable and tolerates a wide voltage range."

Advances in process control allowed enhanced design, Hochstedler added. "We are getting a step closer now to the density required for 16K CMOS dynamic RAMs, but right now they are still over the horizon – some may appear in '78 or '79."

(Cont. on p. 54)

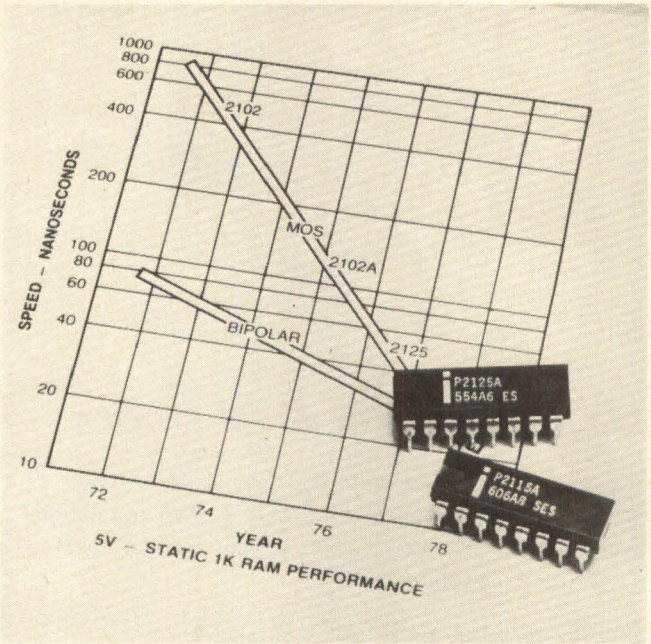


Fig 1 Speeds of MOS static RAMs are increasing, approaching bipolar speeds, as shown in this graph from Intel that compares speeds of two of their new 1K MOS static RAMs with earlier static RAMs.

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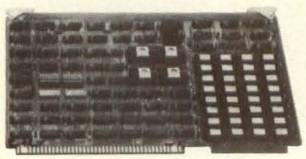

MSC 4502

64K RAM Version

Up to 64K × 8 of RAM and up to 8K × 8 of EPROM on the same board.

RAM expandable in 16K × 8 increments and EPROM expandable in 1K × 8 or 2K × 8 increments.

On-board DIP switches to select any of 16 address start locations for RAM and 16 address start locations for EPROM.

Cycle times:
Read, 350 nsec.
Write, 500 nsec.
Refresh, 500 nsec.

Totally SBC 80 and Intellec MDS hardware and software compatible.

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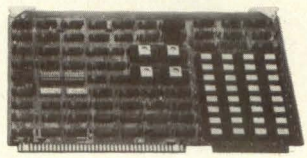

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CIRCLE 38

Looking at the industry as a whole, Hochstedler felt that significant entries were 8K and 16K bipolar RAMs. These RAMs are available from many sources now, and at reasonable prices, he said.

Harris brought out the "world's first CMOS PROM this year," Hochstedler said. "Also we are producing a family of 1K CMOS devices in 1K x 1 and 256 x 4 formats with 100 ns access times. These speeds were previously unheard-of for CMOS."

"The Japanese were a big area of impact on the semiconductor market during 1977 with RAMs, PROMs and EPROMs."

"The new 5 volt EPROM technology that became widely used during 1977 was extremely important," said Robert Walker of Intel. "We now have three or four new products using this technology, including a 16K RAM," he said. "Another important technology during the year, HMOS, enables you to get bipolar performance with MOS. We produce a 4K RAM that has the highest performance you can get in *any* technology – 55 ns – and also a 1K RAM with 35 ns performance. These are fully as fast as the bipolars on the market."

"The Japanese were a big area of impact on the semiconductor market during 1977," said Gene Hnatek of Monolithic Memories. "They're really going great guns with bipolar and MOS RAMs, PROMs and EPROMs. It looks like they're going all out and trying to take over. Their marketing organizations became more active while trying to get a bigger chunk of the market. The Japanese government is sponsoring research by the four top Japanese semi manufacturers – Nippon Electric, Fujitsu, Matsushita, Mitsubishi. By 1980 they want to come out with a one megabit CCD memory. They have developed a 131K bit CCD memory now and they're really pushing the technology."

Extended Core Memory

During 1977 core or bulk core memory usage grew, according to John Gilligan, president of Dataram. "People are extending memory with semiconductor or CCD or core, interfacing it as a peripheral," he said. "We introduced bulk core and have been supplying it to Microcomp. We developed an interface to emulate a fixed-head disk."

Gilligan said that he had seen people move to larger and larger core modules during the year. He also felt that small independent suppliers such as Dataram were gaining increased acceptance from users.

In the competition between core and semiconductor memories, Gilligan agreed that semiconductor manufacturers had increased their market share, but said that the sales of his own company had also been rising. "Our growth is mainly because of bulk core, which is just starting to catch on now. Our market share continues to grow, not at a huge rate, but it's growing. We sell reliability and nonvolatility." **DD**

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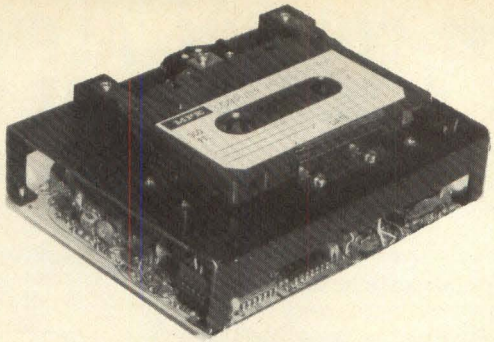
CIRCLE 40

Cartridge and Cassette Drives



MFE's Model 250B digital cassette tape transport offers 15,000 MTBF and ANSI/ECMA compatability.

Full size and minis can store more data

The name of the game in 1977 seems to have been improved storage capacity, for the more data each cartridge or cassette can hold, the more competitive the drives become with each other and with other types of memory. Since most manufacturers belive that neither of these two tape media have reached the theoretical capacity limit, they are still working to increase bit density and the number of tracks on each side of the tape. The results of this development work may not appear in 1978, but surely by 1979 some makers may announce drives with even greater storage capacity.

Cartridge Drives

During 1977, the number of cartridge tape drives that record data at the 3200-bpi density increased rapidly, declared Herm Brooks, director of operations, Tandberg Data. In round numbers, 80% of the machines sold record at 1600 bpi and 20% at 3200 bpi. In 1978, the rates will change to 70% and 30% respectively, he predicted.

Pointing out that the medium has not improved measurably during the past year, Brooks noted that though a 6400-bpi density is theoretically possible, the extra expense of the more complex electronics seems to work against this potential increase, because increased product volume has been lowering the price of drives and making higher-priced machines less attractive.

Customers want drives with more sophisticated I/O schemes, such as IEEE bus as well as SDLC (synchronous data link control) interfaces, introduced by IBM for protocol. Many cartridge drive manufacturers now offer this protocol in their products.

Cartridge limitations have kept tape speed for data transfer unchanged at 30 and 45 ips. These speeds are not expected to increase in 1978, because increased tape speed does not improve the transfer rate as much as an increase in bit density, according to Brooks, though the 120-ips rewind speed offered by manufacturers does help throughput.

A 6400-bpi density is theoretically possible in tape cartridges

Mechanism problems in cartridge drives are gradually disappearing, Brooks believes. Drives from different manufacturers are now more nearly competitive with each other for reliability than they were in the past.

In 1978 some manufacturers of low-end cartridge drives will introduce ECMA- and ANSI-compatible models to replace cassette drives in the hobby computer market, Brooks predicted.

Minicartridge Drives

"In early 1977, 3M introduced its DC-1 tape drive to use DC-100A minicartridges. A short time later my company began selling a similar unit, which we call Model 200 Minidrive," said Leon Malmed, sales manager, Qantex. "Like most manufacturers, we offer interface electronics to our customers. At the present time, we market an interface for the Motorola 6800 microprocessor, but we are developing interfaces for other microprocessors and computers, such as the 8080 and the LSI-11."

Soon after introducing minicartridge tape drives, 3M, Qantex and others began marketing a two-track drive, thus doubling cartridge capacity from 160K to 32K bytes unformatted, according to Malmed. By doubling bit density from 800 to 1600 bpi, Qantex can now offer drives capable of storing up to 640K bytes of unformatted data. Although he doesn't expect bit density to increase in 1978, Malmed said that his company and its competitors are working on increased bit density drives.

In 1978, manufacturers will design and build militarized versions of their minicartridge tape drives. Since commercial units already offer about a 20,000-hour MTBF, Malmed expects that military models will experience about 40,000-hour MTBFs. He attributes this reliability to the drive's inherent simplicity – only one moving part, the motor shaft.

Minicartridge drives can compete successfully with 5.25" floppy units in many applications, claimed Malmed.

They store more data per unit of media, they consume less power – under 15 watts, they require only 2 voltages – +5 and +12, and occupy less space.

Cassette Drives

"Not until 1977 did cassette drives finally overcome all the objections held by the industry against their use for digital data storage," began Jim H. Bartley, sales manager of OEM digital products, MFE Corp. "Because the cassette was originally designed for audio, not digital, applications, the early problems encountered by users turned them off. But by late 1976 and early 1977, cassette drive manufacturers convinced the industry that they had licked all the problems."

Claiming that his company's drives offer a greater reliability than floppy disk machines, Bartley said that buyer confidence in product capability and quality rather than technological changes has boosted sales by about 40% in 1977. Users have begun to realize that digital cassette drives offer a low-cost method of loading programs into CPUs. Other applications include buffer storage, data acquisition and logging and even virtual memory. Cassette drives with a 32000 bps transfer rate can handle throughput fast enough for many microcomputer applications.

The application of cassette drives in instruments and systems operating in a hostile environment will grow in 1978, declared Jim Bartley. Since cassette drives can withstand hostile conditions encountered in field operation, manufacturers will install cassette storage in their products, such as surveying instruments and geophones. Growing in popularity, distributed processing systems with terminals at a large number of remote locations require buffer storage and perhaps local program loading. These terminals will absorbe a large number of cassette drives in 1978.

Manufacturers will offer ceramic heads for their cassette drives in 1978, Bartley predicted. These heads will wear longer and prolong media life. Increased cassette drive volume will allow manufacturers to use customized LSI chips in the electronics to improve reliability and reduce costs to remain very competitive with floppy disk drives.

Digital cassette drives offer a low-cost method of loading programs into CPUs

The European market for cassette drives grew in 1977, especially in Germany, Great Britain, France and Switzerland, said Bartley. Although these drives now sell better than floppy disk machines, the rivalry will intensify in 1978. But business volume should remain good, because many European computer companies are just starting to grow. These firms use mostly American peripherals, because few European companies manufacture this type of equipment. However, the Japenese have gone into peripherals manufacturing and will compete strongly with U.S. makers in Europe.

Minicassette Drives

"In 1977, the computer industry began to accept miniature cassette drives as useful products for instrumentation and program loading applications that require low-cost, low-power and small-size storage units," declared Bud Gould, sales manager, Raycorder Products Div. of Raymond Engineering. "We believe that our customers are buying miniature cassette drives because they get the same reliability and quality they expect from standard-size units. They use these drives when they don't need as fast a data transfer rate and as much storage capacity as provided by full-size drives."

Manufacturers of the minicassette improved the package in 1977 by replacing the pin guides with rollers, said Gould. That change extended the expected number of passes across the head by an order of magnitude – from about 200 to about 2000.

In 1977, and during 1978, makers began or will start offering, built-in interface electronics in their minicassette drives. For example, explained Gould, his company will shortly introduce RS-232C interface circuitry, so that customers can connect the drives to their CPUs, terminals or other gear without designing and building special electronics. In the future, his company expects to expand the number of interfaces to include most standard and some dedicated special types. **DD**

Fig 1 The Qantex Minidrive uses a minicartridge developed by 3M that contains 140 feet of 0.150-inch tape in a package measuring 2.4 x 3.2 x 0.5 inches. The transport employs a servo loop that includes a solid state optical tachometer for precise speed control of the low inertia DC motor.

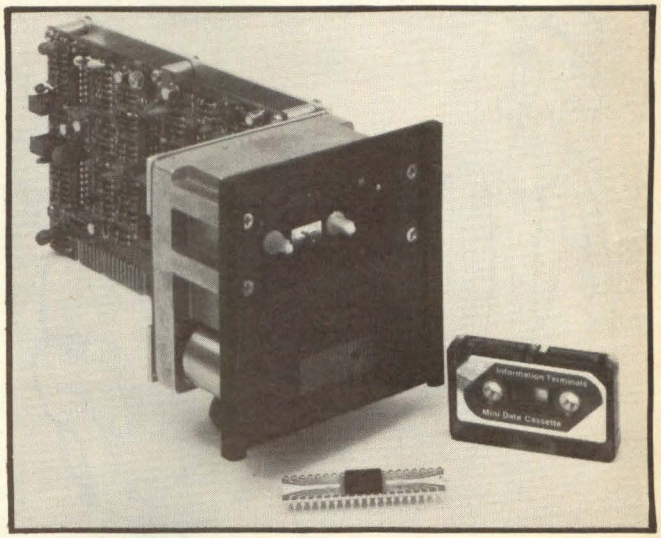
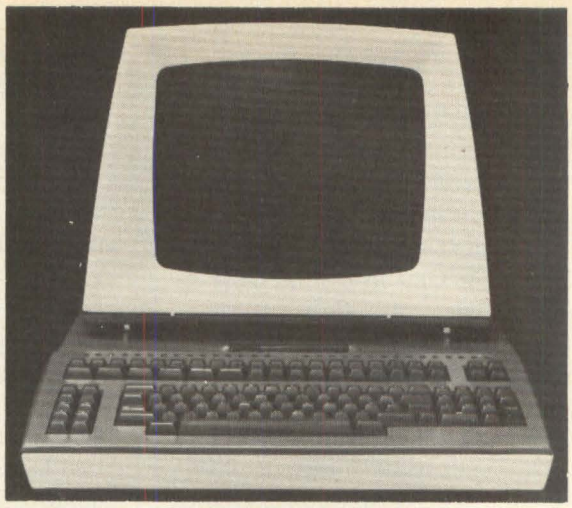


Fig 2 Model 6409 minicassette recorder from Raymond Engineering packs 64 Kbytes of unformatted information onto each side of the tape.

Terminals: Smart and Dumb



VDP-400 from the Data Products Group of Lear Siegler's Electronic Instrumentation Div. consists of 3 modules: keyboard, minicomputer and video display.

Microprocessors made them intelligent

Terminal manufacturers generally agreed that 1977 had seen the increased emergence of low cost terminals that use microprocessors. These terminals possess more power than previously available for the cost. Price drops for microprocessors and memory chips made the production of these terminals feasible, and also contributed to price drops of the more powerful "intelligent" terminals.

The emergence of low-cost microprocessor-controlled CRT terminals is the most significant event of 1977," said Jim Folts, terminal division vice president for Perkin-Elmer Data Systems. "What led to the price reduction," Folts continued, "was the dramatic reduction in the price of microprocessors and RAMs. The major part of manufacturing cost reduction was realized by replacing hard-wired logic with the microprocessor.

"Microprocessor-controlled terminals have been around for a while," Folts said, "and their basic technology was not actually new. What was new was the appearance of relatively low-cost terminals in the "dumb" and "smart" classes. Folts placed terminals with "intelligence" into three classes: "dumb," teletype replacements; "smart" or "editing" terminals; with built-in functions but non-programmable; and "intelligent;" or programmable terminals. "In the last two years," Folts said, "we saw the microprocessor applied in intelligent terminals. In 1977 we saw processors used in dumb and smart terminals – a direct result of reduced microprocessor costs."

Folts said that Perkin-Elmer led the industrial trend toward added intelligence in dumb and smart terminals with its announcement in January of the Fox™ and

If you ask me, this terminal is a little too smart!

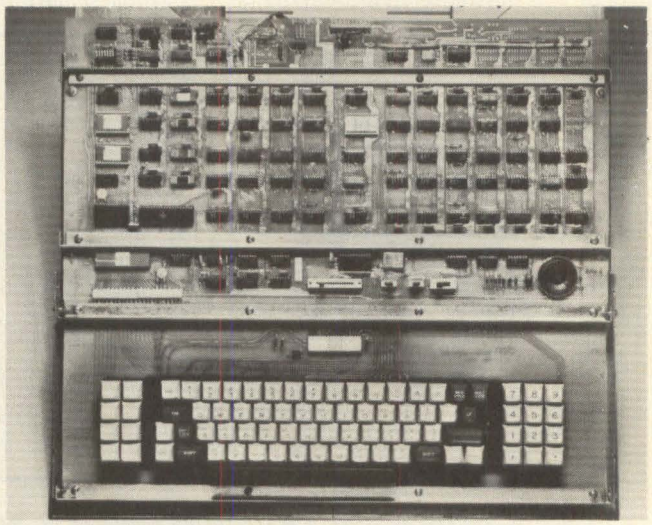


Fig 1 Perkin-Elmer Data Systems assembles its CRT terminals from basic building blocks designed around the 6800 microprocessor and various peripherals and communication interface chips.

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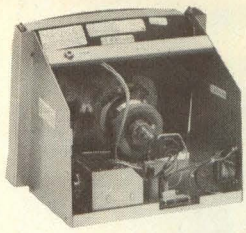

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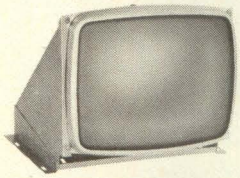

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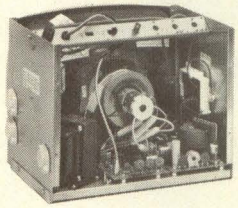

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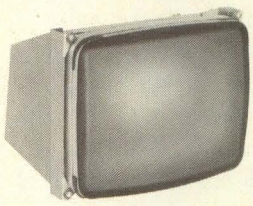

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CIRCLE 41

Owl™ terminals. Many similar low cost terminals have since been introduced by other manufacturers, he added. The Fox model 1100 "dumb" terminal, a teletype replacement with CRT, uses a Motorola 6800 microprocessor.

Fig 2 TEC's Model 70 microprocessor-based video display terminal uses Intel 8080 firmware to direct all video control logic and I/O functions.

"With the processor," Folts said, "we achieved a parts count 25-30% lower than any equivalent device while at the same time making a bunch of functions that used to be optional standard – typomatic keyboard (where holding down a key makes it repeat), tab set and clear for any column of the CRT and so on." The Owl model 1200 "smart" terminal also uses a Motorola 6800. "Parts count was down 30-35%," Folts said. "With this kind of terminal you can really exploit the power of the microprocessor to make the terminal easy to program from the standpoint of the host computer and also taking the load off the host. One of the things we did with this terminal was make it give status information on the host computer to the operator. Heretofore this kind of information has only been available with high cost terminals, but we've made it available with a low cost one."

Folts said that the changes he had cited were happening throughout the industry; he expected increasing power in lower cost terminals in the future.

"The microprocessor had an impact on the entire electronics industry this year, not only on terminals," said Steve Marriott, applications engineering manager for TEC. "In our own product line, microprocessors allowed us to provide terminals that have more capability, at lower prices and in smaller enclosures than before. Major factors in terminal price reductions have been dropping costs for microprocessors and RAMs."

The microprocessor used in the TEC model 70 "smart" terminal enables TEC to "tailor our machine to customer specs," according to Marriott. The processor is also used in the design of different terminal interfaces – for Honeywell

"Microprocessors allowed us to provide terminals that have more capability, at lower prices and in smaller enclosures than before."

6600, Uniscope 100 and Burroughs TD 800, for example. Marriott said that the processor also serviced the monitor, accepted keystroke inputs from the operator and handled the communication line for CPU inputs.

"Today's typical low cost terminal is a teletype replacement," Marriott said. "The next generation of low cost terminals will have many of the features presently found in more expensive machines – programmability, edit functions, video enhancement capabilities." Marriott believed that there would be increased demand in the future for low cost terminals and that more would appear on the market in 1978.

Reduced microprocessor costs have enabled Tandberg Data to lower the cost of its TDV-2114 terminal, according to Gary Pyles, regional marketing manager. The TDV-2114, recently introduced to the U.S. market following use in the European market for over two years, may serve as a teletype replacement, intelligent terminal or stand-alone processor, according to Pyles.

"I think that it's fairly clear industrywide that the 16-bit processor has arrived," said Tom Viggers, marketing manager for Lear Siegler. "We can see the evidence in our own backyard in the VDP-400, a 16-bit terminal that comes standard with a 6K memory extendable to 32K. Eventually we will expand the VDP-400 into a more powerful intelligent terminal, the VDP-1000, that we will introduce sometime before mid-year in 1978. The VDP-1000 has even more memory than the VDP-400 and can stand alone a little bit more – you can edit with it, and it takes keystroke programming, for example."

Tom Viggers of Lear Siegler

Viggers said that there was a very definite trend in the industry toward less expensive "dumb" terminals. "Lear Siegler originated the Dumb™ terminal with a product introduced in 1976 and then selling for about $1300. There has been a lot of competition in the dumb terminal market and prices have eroded. We're now selling a comparable terminal which the distributors market in the $850-900 price range."

Viggers said he foresaw continued interest in dumb, smart and intelligent terminals. He noted that the power of intelligent terminals has increased, as exemplified in Lear Siegler's announced VDP-1000. "That kind of terminal has considerable power," he said. "The end user in general business applications can do quite a bit of his own computing right there, as well as down line with the mainframe. The terminal with its CRT, hard copy printer and substantial memory gets to be a lot like a mini."

The advent of LSI peripheral support chips and 16K erasable ROMs, in addition to the availability of the Z-80 micro-

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CIRCLE 42

"MOS RAM and IC chip prices have come down and eroded the end user cost for graphic display units."

processor in production quantities, enabled Design 100 to enhance its daisy wheel printing terminal, according to Dave Crellen, engineering vice president. "This terminal was first introduced in '75," said Crellen, "and was limited by the power of the chip we were then using. With the Z-80, new peripheral support chips and the 16K ROMs, we've reduced the terminal to a desk top unit, reduced our parts count to achieve greater reliability, reduced our production costs by about 30% and been able to pass the cost reductions on to the user."

Crellen said that beside reducing the cost of the Design 100 daisy wheel terminal, the microprocessor enabled addition of features such as automatic justification of copy, centering and flush left or flush right margins.

Tyler Hunt of Magnavox Display Systems

The wider availability of intelligent terminals at increasingly competitive prices was the major breakthrough of 1977, according to Tyler Hunt, product manager for Magnavox Display Systems, manufacturer of terminals with plasma panel displays. "Microprocessor and memory costs have decreased," Hunt said. "Last year this enabled us to reduce the price of our Orion graphics terminal. We have also expanded this system into three grades of user programmability."

Hunt explained that the Orion terminal has as an option an integrated, random access 35-mm slide projector that enables projected optical data in the form of charts, background maps and the like to be combined on the plasma panel display with terminal-generated alphanumeric data. According to Hunt the terminal has found its widest applications in medical education and process control.

Joseph Morris of Ramtek Corporation

Hunt said that the plasma panel display technology is still new and that prices are still high in comparison with older technologies such as CRTs. He believed that cost reductions would occur as production volume increased and manufacturing costs went down.

Reduced microprocessor and memory costs enabled manufacturers of color terminals to produce and market less expensive terminals, according to Joe Morris, marketing vice president of Ramtek, manufacturer of color terminals. "This year we introduced our Micrographic™ 6000 series terminal," Morris said. "This terminal is sold at a price 75% cheaper than color terminals previously available. High-speed PROMs and microprocessor technology have made it possible. We use the Z-80 in this terminal, a nice little device, relatively fast, with a good instruction set. Basically, we're offering an easily pro-

grammable true vector system with a full repertoire of RBG colors and their combinations. The big breakthrough is being able to offer this capability at low price. We use 64 instead of the 4000 colors of our more expensive terminal and get by without doing D/A conversion for we do our processing in a simpler manner."

Morris said that color costs have come down throughout the entire field of color terminal manufacturers. He also observed that competition in the field has increased. "At last count there were about 27 companies making color terminals of one kind or another, many of them very specialized. Three or four were in direct competition with us. This year seven or eight new companies entered the field. I know Hewlett-Packard is working on a terminal, but they have not yet made an announcement."

Morris foresaw higher-resolution color displays coming in the future. He also anticipated color printer/plotters for printing out the display screens of color terminals. "Applicon has a color printer," he said, "and Xerox is coming out with one. They'll become increasingly common."

Fig 3 Ramtek's 6000 series Micrographic terminal displays graphics and alphanumerics in color or black and white.

"The major thing this year is that MOS RAM and IC chip prices have come down and eroded the end user cost for graphic display units," said Bill Huber, marketing vice president for Genisco Computers, manufacturer of raster-scan graphic display terminals. "The price reductions have really affected us," Huber continued. "Our units are MOS RAM-oriented, with 80 RAM chips on a board. Our system is 80% memory. RAM chip prices have dropped by one-half. We've reduced our prices by 40% since September of '76."

Huber felt that the price impact had been greatest for raster scan displays since "a very large percent of the system is bit planes, which are mostly RAM. The storage tube people are stuck with the cost of their monitor and the stroke writer people are stuck with their technology. Prices haven't dropped as much for them."

Huber said that in the last year he had seen "development of demographic need for image type raster displays. Demand has gone up tremendously in the last 12 months for displaying such things as ERTS satellite information. For these users, instead of shipping systems with three color planes we're shipping systems with up to 24 planes."

Huber said he foresaw continued price drops in display systems using raster scan technology. **DD**

Monday 8:30 AM Next Generation of Electronics	Tuesday 8:30 AM Next Generation of Electronics	Wednesday 8:30 AM Next Generation of Electronics
1. **Introducing the R6500 Microprocessor Family.** Designing with this 13-addressing-mode microprocessor series is simplified by use of the "System 65" hardware and software system. Ron Eufinger, Rockwell, Anaheim, CA	1. **Introducing a New Family of Single-Chip, Stand-Alone Microcomputers.** This series of ICs includes the μCom42 for applications involving simple keyboards/display interfacing such as found in electronic cash register and point-of-sale applications; and the μCom-43-45 for general-purpose controller applications. Dwain Aidala, NEC Microcomputers, Lexington, MA	1. **Design Example: How to Design a Low-Cost Printing Terminal Using the TMS9940 Microprocessor.** Designing with the 9940 will be contrasted against an existing design employing the 8080 microprocessor. Hardware and software differences will be analyzed and cost reduction implications will be discussed. Tom Miller, Texas Instruments, Houston, TX
2. **PROM Programming Techniques.** PROM programming hardware is now available to satisfy all the requirements that the engineering laboratory or production line might present. A new microprocessor-based programmer for MOS PROMs can program 16 devices at a time. Dick Woods, Data I/O, Issaquah, WA	2. **A Low-Cost Z80 Development System.** The SDB-80 single-board computer includes a Z80 CPU with a ROM-based relocating assembler, editor, linking loader and operating system. The system software ROM may be easily removed and replaced by user ROM or PROM to provide a fully tested OEM system board. Ron Baldridge, Mostek, Carrollton, TX	2. **Considerations for Implementing a Double-Density Floppy Disc Controller Using the 8X300.** The 8X300 bipolar 8-bit microcontroller is intended for control applications. It is bit-addressable at the I/O ports. Frank Brunot, Signetics, Sunnyvale, CA
3. **Introducing the "Micromachine' Microprocessor Family.** Scheduled for sampling in early 1978, the F-3870 Micromachine series of 8-bit MOS microprocessor is intended for low-cost, low-power industrial and consumer applications. The family includes a μP with 2 k of ROM, another with 4 k of ROM, and a third with 2 k of EROM. Dave Hollinbeck, Fairchild, San Jose, CA	3. **The 16-Bit 9440 Microprocessor Family.** The 9440 bipolar minicomputer, using I^3L technology, combines the high speed of bipolar construction with the low power usually associated with MOS. Structurally different from the Data General NOVA, the 9440 executes the same instruction set. Dan Wilnai, Fairchild, San Jose, CA	3. **Applying an 8-Bit by 8-Bit Serial/Parallel Multiplier with Accumulator.** Discussion includes programming the multiplier. Two cascaded devices perform full 16-bit multiplication. Using 2's complement, carry-save arithmetic, the 40-pin 25LS2516 delivers a 16-bit product in 8 clock cycles. Vernon Coleman, AMD, Sunnyvale, CA
MID-MORNING BREAK	MID-MORNING BREAK	MID-MORNING BREAK
4. **Interfacing Between Microprocessors and Programmable Instrumentation.** The MC68488 general-purpose interface adaptor provides the means for interfacing between IEEE Standard 488 standard digital interface and programmable instrumentation. Fifteen locations are accessable to the microprocessor data bus. George Nelson, Motorola Semiconductor, Austin, TX	4. **The 8048 Single-Chip Microcomputer.** The single-chip microcomputer not only provides the engineer with a powerful stand-alone controller, it also changes the concepts governing use of peripheral control with a master microprocessor. The 8048 has on-chip ROM and RAM. Larry Goss, Intel, Santa Clara, CA	4. **The Micro Assembler.** For a microprogrammed design, the Micro Assembler can be a valuable development tool. Use of this softwre package is explained. Steve Lau, Signetics, Sunnyvale, CA
5. **In-Circuit Emulation as a Microprocessor Development Tool.** With one tool, the engineer can observe the interaction of hardware and software. Problems can be immediately pinpointed. Gordon Reid, Intel, Santa Clara, CA	5. **The 8085 Microprocessor.** What is happening to maintain the 8080 as an industry standard? The 8085, a program-compatible version of the 8080, uses the 8080 peripheral family but provides a higher level of integration, eliminating the need for a clock generator and bus controller. Bruce Burkhart, Intel, Santa Clara, CA	5. **A New CMOS 4096-Bit Static RAM.** Several systems applications for CMOS circuitry, with emphasis on need for memory non-volatility will be described. Advantages provided by 4096-bit RAMs will be discussed. Steve Diamond, Intersil, Cupertino, CA
LUNCH	LUNCH	LUNCH
6. **Microprocessor Interface Circuits and National's "Microbus."** The Microbus can be used for interfacing with complex peripheral circuits including a floppy disc controller, an SDLC communications controller and a single-chip data acquisition system. Art Gruszynski, National Semiconductor, Santa Clara, CA	6. **Interfacing 16-Pin Dynamic RAMs to the Z80A Microprocessor.** The Z80A allows transparent refresh for dynamic RAMs without the need for a refresh counter and its associated multiplexer. This does away with the necessity of stealing cycles or stopping the CPU, as would otherwise be required. A design example involving 4 k and 16 k RAMs is presented. Roy Blacksher, Zilog, Cupertino, CA	6. **Applying the 4096-Bit Ultraviolet Eraseable Complementary MOS PROM.** Particularly suited for low-power, high-speed operation in hostile noise and temperature environments, this IC provides TTL compatibility over the entire CMOS power supply range and may be accessed at 200-ns by TTL circuitry. Steve Diamond, Intersil, Cupertino, CA
7. **Interfacing the F8 Microprocessor to a Bulk Semiconductor Memory.** Techniques to be used and pitfalls to be avoided. A design example using a 64 k charge-coupled-device (CCD) memory is included. Bruce Threewitt, Fairchild, Mt. View, CA	7. **Edge-Activated Memory Integrated Circuits.** Considerations for designing with edge-activated memory products will be discussed; static RAMs, ROMs and dynamic RAMs are covered. Also treated are benefits of edge-activated ICs to users, design of the 5-volt edge-activated RAM and reliability aspects of edge-activated RAMs. Sam Young, Mostek, Carrollton, TX	7. **Advanced Microprocessor Prototyping Lab.** The AMPL is an integrated hardware and software development system for the TI 9900 family. It provides software development in either assembler or high-level langauges. Bob Roosth, Texas Instruments, Dallas, TX
MID-AFTERNOON BREAK	MID-AFTERNOON BREAK	MID-AFTERNOON BREAK
8. **Digital Signal Processing Using an 8 by 8 Multiplier.** The single-chip MMI67558 can multiply two 8-bit numbers in 100 ns, yet it dissipates only one watt. Shlomo Waser, Monolithic Memories, Sunnyvale, CA	8. **Announcing the 12-Bit AM2910 Bipolar Microprocessor Sequencer.** This device can address up to 4096 words of microprogram memory. The 2910 has a 5 by 12 subroutine stack and internal register/counter. Vernon Coleman, AMD, Sunnyvale, CA	8. **Designing with the Tektronix Microprocessor Development Laboratory.** How to set up and use the MDA8002 laboratory is described. The system includes computer, terminal, line printer, floppy disk, in-circuit emulator and real-time analyzer probe. Can be used with Z80, 8085, 9900, 8080, and 6800 microprocessors. Bill Burton, Tektronix, Beaverton, OR
9. **A 6800 Microprocessor Evaluation Board.** Used in conjunction with a touch-control capacitive keyboard and an MOS top octave synthesizer, a 6800 microprocessor evaluation board can control a powersonic electronic organ with tune memory. Roff Scott, AMI, Santa Clara, CA	9. **Next Generation of 4-Bit Bipolar Microprocessor Slices and Memory Slices.** The 2903 performs all the functions provided by the AM2901A, but offers much additional capability. The memory IC is infintely expandable, has 3-address architecture and 3-bus architecture. Byte swapping is among applications covered. Vernon Coleman, AMD, Sunnyvale, CA	9. **WD40 Single-Chip Microprocessor Applications.** The 4-bit WD40 microprocessor directly handles keyboard and display switch matrices. It can drive up to 16 solenoid and on/off devices. Bud Sherman, Western Digital, Newport Beach, CA

Thursday

Next Generation of Electronics

1. **Designing with CRT Display Controller ICs.** The use of CRT display controller ICs in microprocessor-based systems is explored. Applications covered include split-screen and variable-format.
   Don Lewis, Standard Micro Systems, Hauppauge, NY
2. **Introducing the HI-562 12-Bit Monolithic Digital-to-Analog Converter.** This bipolar monolithic converter with current mode output features 200-ns settling time. It has an absolute accuracy over temperature of 1.5 least-significant bits.
   Dick Tung, Harris Semiconductor, Melbourne, FL
3. **Designing with Dedicated Controller ICs.** Applications for a multiprotocol communications controller are discussed. Areas covered include synchronous data-link control, high-level data-link contact, advanced data communication control protocol, Bisync, and DEC digital communication protocol.
   Don Lewis, Standard Micro Systems, Hauppauge, NY

MID-MORNING BREAK

4. **Two New Families of IC Op Amps.** The Op-8 and Op-12 are very high-performance versions of the low-power 108A op amp. The BiFET op amp Op-15 through Op-17 series are high-speed op amps with low-offset voltage and drift.
   Shelby Givens, Precision Monolithics, Santa Clara, CA
5. **Applying BiFET Op Amps.** The TLO-81 family of BiFET op amps combined high impedance junction FET inputs with low-distortion bipolar output circuitry. A low-noise and a low-power series complement the general-purpose TLO-81 series.
   Joe King, Texas Instruments, Dallas, TX

LUNCH

6. **Band-Gap Circuits Make Good Current Sources and Low-Drift References.** The LM134 current source is programmable by one resistor over the range 1 microampere to 5 milliamperes and regulates nicely from 1 V to 40 V.
   Bob Dobkin, National Semiconductor, Santa Clara, CA
7. **The 9400 Voltage-to-Frequency Converter.** Combining bipolar and CMOS technology on the same chip the 9400 accepts a variable analog input signal and generates an output pulse train whose frequency is linearly proportional to the input voltage. Applications include interfacing with microprocessors, analog division, analog data transmission and tone decoding.
   Mike Taiva, Teledyne Semiconductor, Mt. View, CA

MID-AFTERNOON BREAK

8. **Introducing the LM137 and the LM150.** The LM137 is an adjustable negative regulator; the LM150 is a 3-amp positive adjustable regulator. The LM137 can supply -1.2 to -37 V at 1.5 A with excellent regulation. Its accuracy is assured by a new specification for thermal regulation.
   Bob Pease, National Semiconductor, Santa Clara, CA
9. **New Consumer ICs.** By applying delta modulation speech and voice recording, storage can be accomplished. New circuits for use in this area offer great flexibility to the designer.
   Tom Hilleary, Consumer Microcircuits, Galesburg, IL

Friday

Next Generation of Electronics

1. **Introducing RCA's New Dual Linear ICs.** Included are the CA3240, a dual BiMOS op amp; the CA3290, a dual BiMOS comparator; and the CA3280, a dual voltage control amplifier. The 3290 is the industry's first BiMOS dual comparator. All three devices will be commercially available during the first quarter of 1978.
   George Granieri, RCA, Somerville, NJ
2. **A New Family of Power Interface ICs.** Discussion includes the UDN2840B series of 1.5 amp Darlington drivers and their use in electronic discharge printers, bipolar dc motor drives, etc.; the UDS5790 and 5791 quad 120-V peripheral drivers; and the UDN2580A 8-channel, high-current sourcing driver for use with NMOS LSI.
   Paul Emerald, Sprague, Worcester, MA
3. **New Components for Analog Sensing and Data Acquisition.** Three new ICs—a 10-bit A/D converter, a transducer, and a high-accuracy rms dc conversion IC are introduced.
   Dave Kress, Analog Devices, Norwood, MA

MID-MORNING BREAK

4. **New Advances in Linear Power ICs.** A new switching regulator, the μA7840, which operates in several modes is described. Switching regulators, although somewhat more complex than fixed or adjustable output series pass regulators, offer designers greater flexibility and higher efficiency.
   Ted Vaeches, Fairchild, Mt. View, CA
5. **Advanced Developments in ICs for AM/FM Receivers.** The ULN2204 and the 2242 represent the latest state-of-the-art in ICs for the general communications market. The 2204 requires only an FM tuner and a power source with a minimum number of external components to form a complete receiver design.
   Oliver Richards, Sprague, Worcester, MA

LUNCH

6. **TheRC4200, a New Analog Multiplier.** This device is the industry's first monolithic analog multiplier to offer compensation for nonlinearity, the primary source of error and distortion. It is also the first IC multiplier to have three on-board op amps designed specifically for use in multiplier logging circuits.
   Tom Cate, Raytheon, Mt. View, CA
7. **A New Companding Converter Chip Set.** The DF331/32 Codec chip set offers the telecommunications industry an alternative to classical channel bank design. These ICs are the first commercially available analog-to-digital, digital-to-analog converters to use the capacitive array conversion technique.
   Tom Mroz, Siliconix, Santa Clara, CA

MID-AFTERNOON BREAK

8. **Local and Remote Data Logging Systems Using the 7103 and 7104.** Both strobed and handshaking interfaces with UARTs and microprocessors are covered. The 7103 is a 4-1/2-digit chip pair.
   Bill O'Neil, Intersil, Cupertino, CA
9. **Summary and Closing Remarks.** Jerry Eimbinder, *Electronic Engineering Times,* Manhasset, NY

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Rigid and Floppy Disk Drives

The 5.25" floppy disk in this Micropolis 1054 Mod II System stores 1.26 megabytes.

Lower prices and increased disk capacity made news

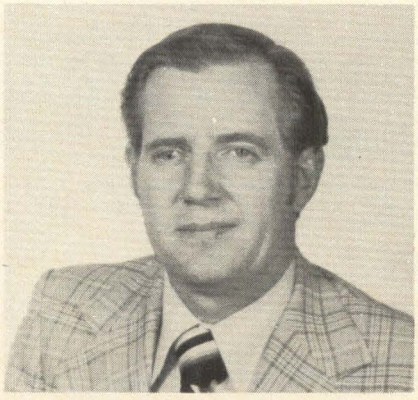
Lower prices per bit for rigid disk drives and improved capacities for floppy disk drives headlined the events for 1977. Undoubtedly, the same trends will continue in 1978, but our informants say that some interesting technological changes in rigid disk drives will also take place in 1978. Although none of our informants would predict that improved density in floppy disk drives would also push prices per bit down, you know that competition from Japanese as well as this country's manufacturers probably will force floppy prices lower. The only question seems to be how much and how fast.

Rigid Disk Drives

The cost per bit for moving-head and fixed-head disk drives dropped by about one-third in 1977 and will continue to fall by about 20% in 1978, according to Mark Mougel, marketing manager for Dataflux Corporation. Since no important technological changes occurred in 1977, he attributed this drop in price to two causes. The first is a willingness by disk drive manufacturers to accept lower profit margins due to competitive pressures. The second is the outgrowth of Winchester technology for producing better heads and disks for greater packing density. The drive manufacturer may not use the Winchester technology in its entirety. For example, Dataflux, which manufactures fixed-head drives, uses Winchester media, but not heads, to improve density and performance. Some manufacturers have reduced prices via mass production, continued Mougel, because they have been selling more and more units.

Cartridge-type and fixed-platter rigid disk drives of lower range capacity began appearing in 1977 with double-density storage, points out Jerome D. Kennedy, vice president of marketing, Advanced Electronics Design. Doubling the bit density gives the buyer more bits per dollar invested. Dual spindles for fixed and removable disks also became popular in 1977 – since each spindle and head shares the electronics, the dual arrangement lowers system cost per spindle.

Some companies now make controllers capable of handling a sizable number of spindles. For example, Kennedy points out that his company now markets a disk controller capable of handling up to 8 spindles. Consequently, the electronics cost per spindle is about one-eighth of the price of a single-spindle unit. This type of multispindle controller allows designers to implement systems with a number of CPUs connected to one mass storage system.



Jerry Kennedy, Advanced Electronic Design

Fixed disk drives with moving flying heads entered the marketplace in 1977, Kennedy continued, and will become more popular in 1978 for two reasons: They offer higher medium and head life and operating reliability, because they use an environment protected by air filters; and the price will follow the usual new product pattern of dropping from 25 to 50% in a relatively short period of time.

Mass storage capacity per rigid disk drive module also grew rapidly in 1977, Kennedy went on. Capacity grew from 80 Mbytes to 200 and 300 Mbytes per spindle of 11 platters.

In 1978 or 1979, plated Winchester disk drives will provide much greater track and bit densities than oxide-coated disks. Although track density as well as bit density will double to provide a fourfold increase in stored data, both increases will not occur simultaneously. For example, Dataflux has already developed a drive with double track density, but does not expect to release it until mid-1978.

Anticipating changes in technology, Dataflux plans to develop a hybrid disk system using a charge-coupled device in conjunction with a fixed-head disk. By providing improved performance at a relatively low cost per bit, this system is expected to be an interim version of a

KERONIX

- MINI COMPUTERS
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mass store, filling a need that will exist until the price of CCD or bubble memories drops low enough to make them economically competitive, a condition that could occur in 1979, according to Mougel.

By planning to develop a semi-intelligent microprocessor-based controller for its mass storage systems, Dataflux expects that the controller will perform many of the functions now supplied by the host CPU. For example, the controller could supply the file management function for converting mass memory to a virtual device. It could also provide interdevice transfers without tying up the computer.

Some companies already use, or expect to use, microprocessors to provide feedback information to cut access time in moving-head disk systems. The feedback provides such information as the position of the head in relation to the tracks and its angular location. Lower access times for moving-head disk systems will affect fixed head disk sales, concluded Mougel.

"I don't believe bubble memories are going to make it as a mass storage device when competing with disk drives," said Mougel. "For one, they are too slow and expensive. A staff member at one of the semiconductor houses pointed out to me that since bubble memories do not use semiconductor technology, most semiconductor manufacturers – except possibly for TI, which already markets a bubble memory – will not produce these devices. Consequently, the usual sharp drop in price that almost always takes place after the introduction of a specific device may not occur. Without this price reduction, bubble memories will never make it."

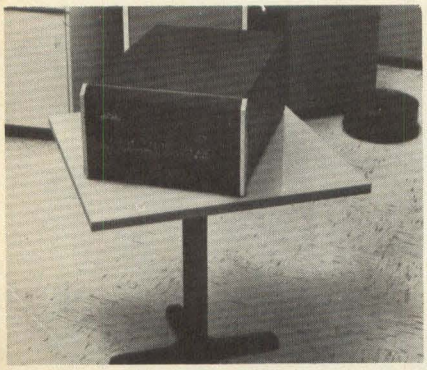


Fig 1 AED8000 controller from Advanced Electronics Design controls as many as eight rigid disk spindles.

Floppy Disk Drives

Three significant events connected with floppy disk drives occurred during 1977, according to Henry T. Meyer, the director of small disk operations for California Computer Products: The first involves the introduction of two-sided recording; the second, the introduction of minifloppy drives; and the third, the IBM announcement that it expects to begin marketing double-density floppy disk drives. Since IBM product distribution has not yet taken place, the industry is guessing what format IBM will use in its diskette systems.

Mark Mougel, Dataflux

IBM's introduction of the double-sided floppy drive forced most other makers to develop double-sided systems, stated Jim H. Bartley, sales manager of OEM digital products, MFE Corp. This development plus lower prices created by higher manufacturing volume has increased the number of applications for these drives, particularly in the hobby computer market.

Although IBM announced in 1977 that it was going to introduce a double density drive, it did not tip its hand on the format it was going to use. Consequently, many customers are holding off buying double-density machines until they know which format it will use in the units it expects to ship in January 1978. Will the format be MFM, M^2FM or GCR? "We think that we have solved that problem; our double-density floppy disk drives can accommodate all standard formats, because the electronics can handle the bandpass characteristics, encoding schemes and phase shifting problems of the different formats," declared Bartley.

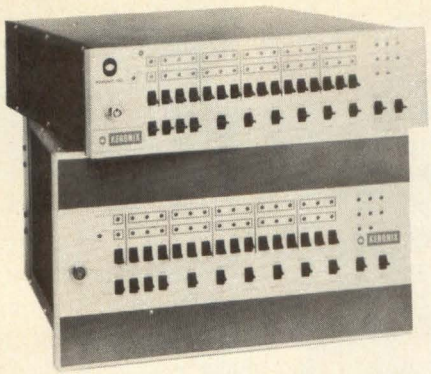
Almost all manufacturers except IBM already sell double-density drives, Hank Meyer pointed out. However, present volume of these drives is low, because customers would rather buy equipment that conforms to an IBM format (which is expected to become a de facto standard) rather than originate their own.

Floppy disk drive manufacturers have increased the use of LSI devices in their products for a number of reasons, declared Meyer. The changeover to microprocessors and other chips displaces discrete logic and reduces the size of printed wiring boards – hence reducing the size of the drive. Microprocessor capabilities invite designers to add RAMs and ROMs, thus configuring controllers to preprocess data at the drive rather than at the CPU. These controllers relieve CPUs of some utility, editing and merging functions. Although not more than 10% of the OEMs incorporate a microprocessor in their drives at the present time, this configuration will grow more popular in 1978.

Some manufacturers originally bought floppy disk drives, developed or purchased controllers from others and marketed these assemblies as subsystems or peripherals, Meyer went on. Now these companies are buying CPUs and configuring a total system, including software. A limited number of minicomputer suppliers and nearly all manufacturers of microprocessors have entered the business of putting together and marketing computer systems, which usually include controllers as well as floppy disk drives, CRT terminals and printers. Similarly, floppy disk makers are adding value to the equipment they sell by incorporating controllers and adaptors for various makes of CPUs. If the drive manufacturers were to take the next logical step, they would add the CPU to the floppy to configure a more

Fig 2 Dataflux DC-111 fixed-head disk drive controller for the PDP-11 handles up to 8-daisy-chained drives.

A Total Systems Capability



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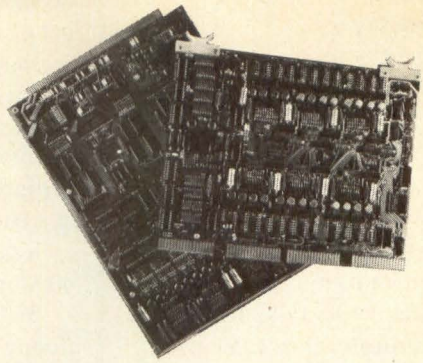

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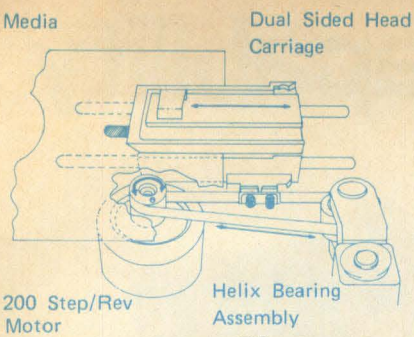

Fig 3 The Heli-Band™ mechanism in MFE's 700 Series floppy drive links the stepper motor to the head carriage.

complete system for software houses, which would, in turn, marry the system to a specific user task. This trend of passing through added value will continue to grow. It will provide more sources for products from which users may choose the system best suited for their needs.

Competition will become intensive in 1978, predicted MFE's Bartley. To indicate what could happen he mentioned an industry rumor forecasting that a major manufacturer will stop producing drives because of price erosion. This loss in profitability will hit those companies unable to sell drives in large volumes.

In 1978 increased track density will become a reality, declared Hank Meyer. It may not necessarily double; it may first go to 1.5 to 1.75 times its 1977 level. What will happen depends on what IBM will do and the quality of the medium that disk manufacturers can provide to reduce the limiting effects of the thermal coefficient of expansion, dirt and water vapor.

Many floppy disk drive makers are guessing that IBM will next increase disk track density, from 48 to 96 tpi, or even up to 144 tpi, according to Bartley. Limitations of the medium seems to be the major factor in holding back increased density.

A movement towards a miniature rigid disk drive is beginning to appear, Meyer said. Implemented basically as floppies, minidisk drives can rotate at higher speeds and can provide a high data transfer rate from the disk to the host CPU memory. The rigid disk acts as a buffer or swapping store. A few companies are presently developing these drives for use in this type of application, and Meyer expects some vendors to begin marketing rigid minidisk drives in 1978.

Confirming Meyer's disclosure of a trend towards miniature rigid plated disk drives, Pravin Patel, vice president of Poly-Disc Systems, which manufactures disks only, described the systems under development. Refusing to divulge names, Patel said that a number of manufacturers he knows are developing 2- and 4-disk machines with 8" dia. by 0.075" thick disks in place of the same size floppies. These high-density disk drives can store 8000 bits per inch now and up to 10,000 bpi at a later date. At 8000 bpi density, each side stores up to 20 Mbytes, or 40 Mbytes per platter.

Bubble memories will coexist with floppy drives in the future, Meyer forecasted. Since the drives use replaceable media that can implement a library of information and bubble memories cannot, bubble memories will only displace floppies in a limited number of applications.

Since the price of bubble memories is still quite high and the makers have not solved all of their production problems, and since the number of companies with the expertise to use them is small, bubble memories will not compete too strongly in 1978, Bartley predicted. Eventually – by 1979 or 1980 – bubble memories will capture a meaningful segment of the floppy market. And only after manufacturers learn to produce low-cost pluggable bubble memories will these devices begin to replace floppy disk drives on a large scale.

5.25-inch Floppies

The rapid development of the 5.25" floppy disk drive was one of the major events in 1977, according to Stuart P. Mabon, president of Micropolis. Shugart originated the concept of the 5.25" floppy disk machine, which

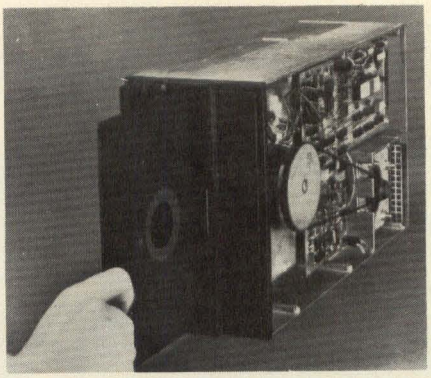

Fig 4 CalComp 143M two-sided, double-density floppy disk drive 12.8 megabits of unformatted data.

Henry T. Meyer, California Computer Products

it designed for very low-cost, low-capacity applications. In those applications, drives patterned after the Shugart model make sense when used for software distribution to customers and program loading.

Micropolos took a different view of potential applications of the 5.25" floppy, declared Mabon. "We elected to go with a more expensive, higher capacity, more industrial-type of a product. We use the same basic diskette to provide much more capacity than the Shugart version. Therefore, we made it a more useful tool for microcomputers that require data files of large capacity. So we developed a large-capacity drive by replacing the usual 48 tracks per inch (tpi) with 100 tpi. The drive remains toleranceable within the temperature and humidity specifications of the oxide medium on a worst case basis. We also made the decision to double the density of the number of bits per track over the Shugart model."

In 1978, makers of 5.25" floppy disk drives will bring out two-sided versions, predicted Mabon. He also stated that his company will increase bit density by 50% in 1978; a 5.25" disk will thus be able to store 0.5 megabyte per side, or a total of one megabyte of data.

Although industry gossip indicates that one or more companies will market an 8" floppy disk machine with a density of 100 tpi in 1978, Mabon said, " I think that it's unlikely that we will see one next year, because the physical size of the medium and the machine makes it difficult to tolerance the floppy in a worst case mode."

Rumors are rife that smaller than minifloppy disks will soon appear, reported Meyer. He expects that the hobby computer market will first use these drives. **DD**

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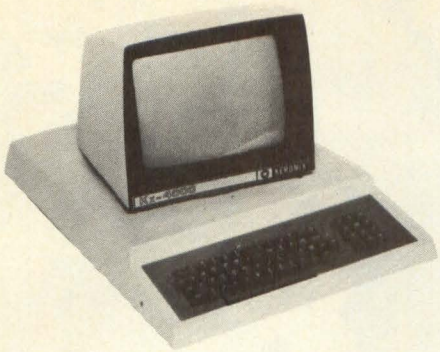

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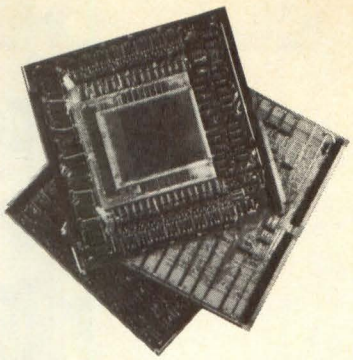

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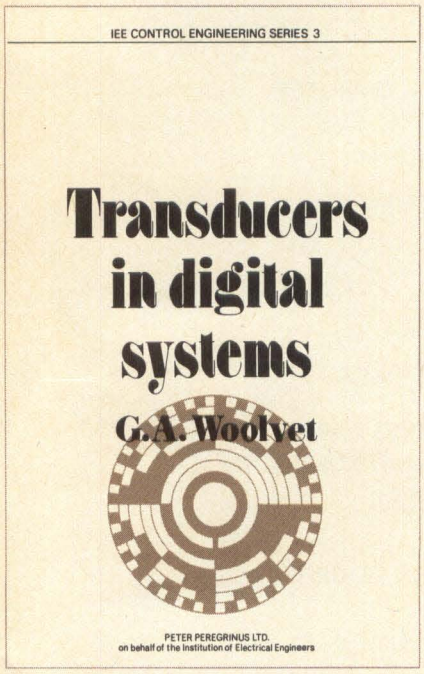
ALPHA BITS

Transducers Serve Control Applications

The use of computers in control engineering systems will continue to increase during the coming years. Many digitally controlled systems require input from transducers, and hence there is a need for transducers that produce a digital output. *Transducers in Digital Systems* by G.A. Wollvet describes



some of the developments that have gained popularity and some that are still in an infant stage. It explains how these devices operate and their role in digital systems, referring to transducers for measuring rotation, position, pressure, and temperature, and considers the advantages and disadvantages of each and their particular applications. Hardcover, $19.95 from International Scholarly Book Services, P.O. Box 555, Forest Grove, OR 97116.

Selecting a Computer

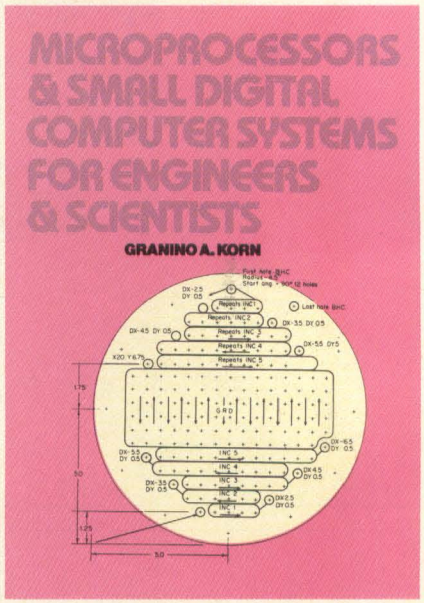
Edward O. Joslin's **Computer Selection: An Augmented Edition** is a reference for management decision-making. An augmented version of the original edition, the book covers some significant aspects of selecting computers. Using a nontechnical approach to the management problems involved, Joslin shows how to establish procedures for selecting computer systems without resorting to complex techniques. He explains how to interact with vendors, evaluate proposals submitted by vendors and write specifications for the required computer system. New material in five additional chapters guides the reader in determining management's role, requirements costing, procurement plans, workload descriptions and small computer systems. This 216 page, hard cover book is available for $20 from The Technology Press, Inc., Box 125, Fairfax Station, VA 22039.

Using the ICU

Designers of control systems often find themselves caught between using discrete logic or a microprocessor, when an in-between solution might prove more functional and cost-effective. Programmable logic controllers can provide the solution with one-bit programmable processing. Motorola's MC14500B Industrial Control Unit performs 16 instructions and serves such applications as relay ladder processing, moderate speed serial data manipulations and the unloading of overtaxed microprocessor-based systems. Showing you how to use this device in your control application, Motorola's Industrial Control Unit Handbook details programming of different structures including the IF-THEN structure, the IF-THEN-ELSE structure and the While structure. One application, the design of a traffic controller using the MC14500B, is discussed in depth, complete with state diagrams, flow charts, program listings and a schematic showing the required hardware. A useful final chapter demonstrates the reduction of Boolean equations to ICU code. The handbook costs $3.00 and can be obtained from Motorola Semiconductor Products, 5005 East McDowell Road, Phoenix, AZ 85008.

Microprocessors: How to Use Them

Thanks to mass production, microprocessor circuits are now making possible advances in data processing power at low cost. To make the most of this technology, you have to leave behind many conventional design concepts and think in terms of the new system components. *Microprocessors and Small Digital Computer Systems for Engineers and Scientists* by Granino A. Korn, helps you do that by bringing you up to date on the latest equipment and applications, and giving you a grounding in the theory and practice of microprocessor technology. Material in the chapters includes: The Ingredients of Mini/Microcomputation; Processors and Instruction Sets; Programming with Assemblers and Macroassemblers; Interfacing Microprocessors



and Minicomputers with Real-World Devices; Computer Operations, Software, and Program Preparation; Microcomputer Systems and Design Decisions; and Micro/Minicomputer Families. Including two appendices and an index, 390 pages. $24.50 hardcover from McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020.

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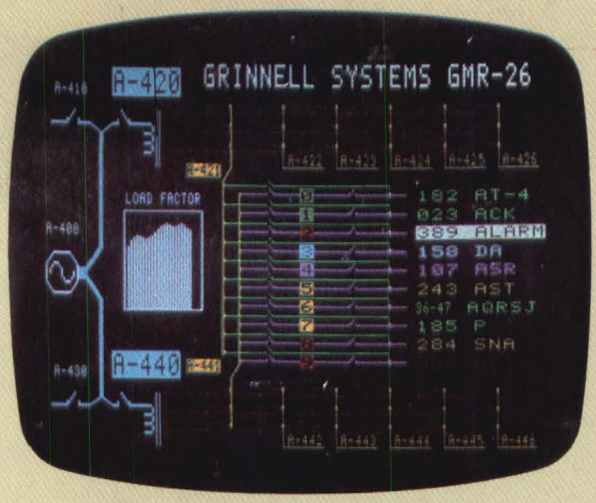

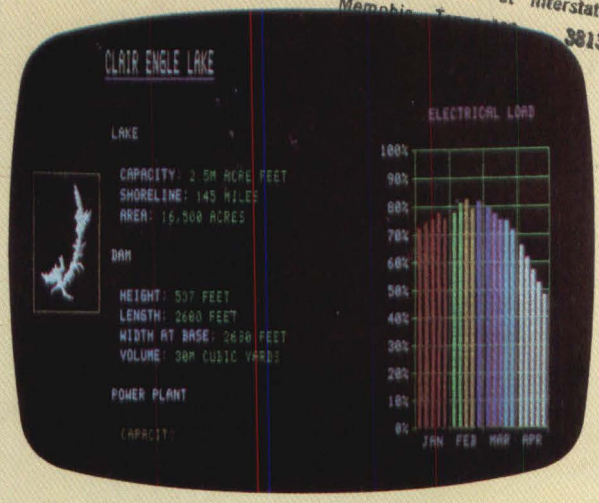

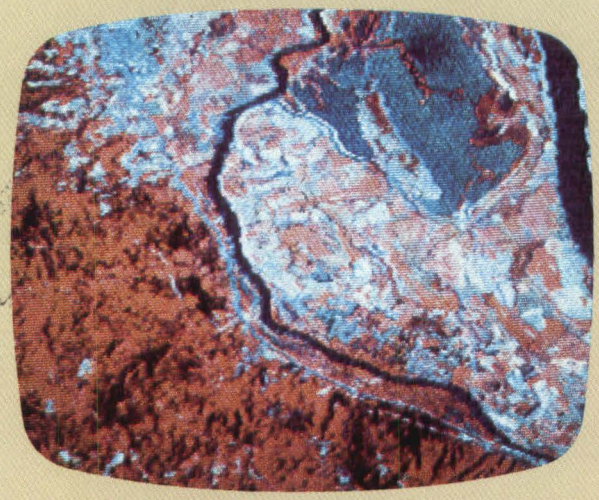

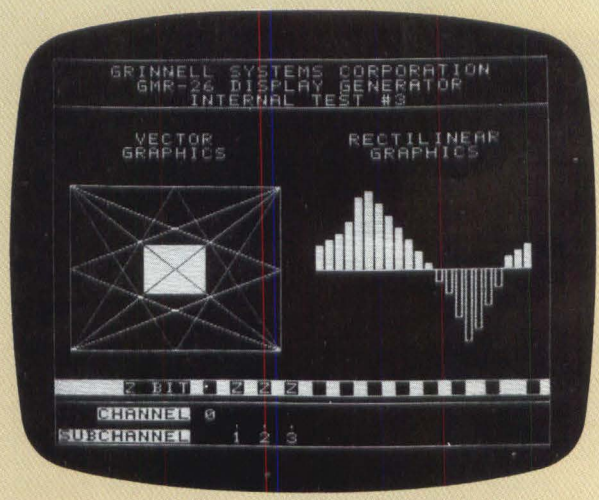

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