

DECEMBER 1976

mini-micro systems

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**MICROCOMPUTER
KITS AND
DEVELOPMENT
SYSTEMS**



**Booming Micro Markets
New Micro Products**

Universal One

The Microprocessor Development System for the 8080, 2650, and 6800.

It's universal. Millennium's Universal One System interfaces to the most commonly used microprocessors today and others in the near future.

And, it's universally accepted. It's so well accepted that design engineers call it a hardware development aid. It's so powerful, application programmers call it a complete software development system. And project managers? They know it as a great time and money saver and don't worry about what it's called.

Can the project manager be right?

The ability to interface with the different microprocessors of today and the new microprocessors of the future is the key benefit of Universal One. Universal One will never be obsolete and therefore provides the greatest *Return On Investment* of any microprocessor development system available today.

The universality of the system is based on Universal One's innovative multiple CPU architecture. One CPU, the Master CPU, is the controlling element of the system and executes all application *independent* functions; file management, text editing, system utilities, system I/O and software debugging.

The second CPU, the slave, which is controlled by the master, executes those functions that are *application dependent*; the microprocessor Assembler, in-circuit testing, user application programs, and user I/O. Additional microprocessor slaves are readily added by interfacing the new slave to the system bus and integrating it into the system software.

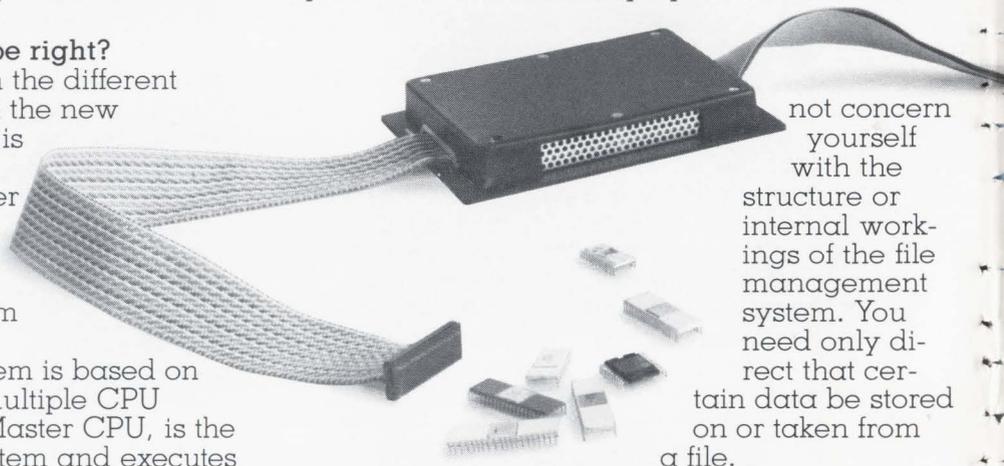
By meeting all the staff's needs, Universal One cuts costs. It's not necessary to have special test fixtures for design engineers and software development systems for programmers. Universal One saves on personnel training expenses since only one system interface need be learned.

Can the programmer be right?

Universal One's software capabilities rival those found on many powerful minicomputer systems. *Universal Disk Operating System* (UDOS) was developed specifically for and tailored to the multiple CPU architecture. The

operating system is executed by the Master CPU in its own totally protected Master memory to prevent disruptions by application programs.

UDOS is floppy disk file oriented. The system was designed specifically for the characteristics and peculiarities of a floppy disk and as such makes maximum use of its benefits. Many file management functions, normally required to be performed by the user, are performed automatically by UDOS. You need



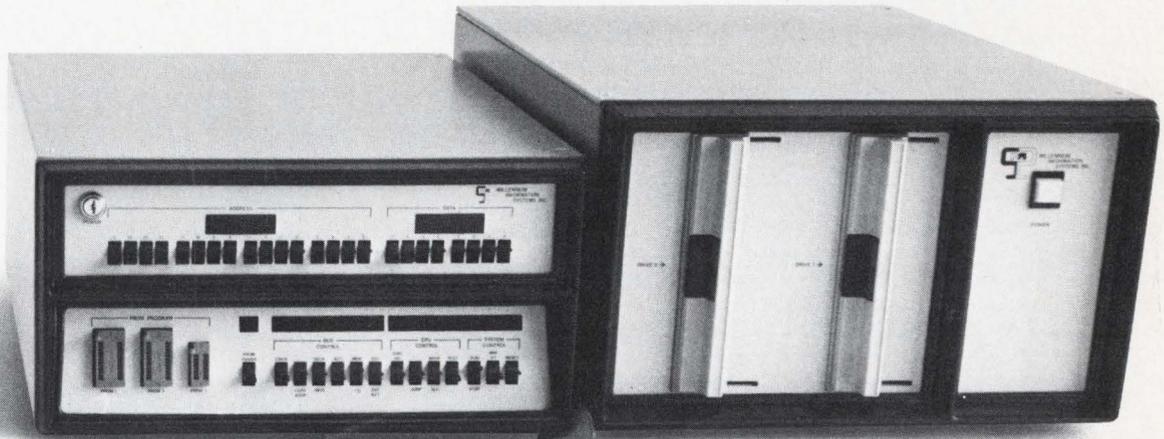
not concern yourself with the structure or internal workings of the file management system. You need only direct that certain data be stored on or taken from a file.

μ BASIC™, Millennium's proprietary high level compiler, is a flexible version of BASIC tailored for microprocessor development applications. Unlike interpretive systems the final output of μ BASIC is the object code for the microprocessor. μ BASIC can also be intermixed with Assembly for memory space reduction and faster program execution.

With Universal One's dynamic trace capability, the activity of a program is traced, instruction by instruction. For break-point analysis two hardware registers provide a break and display of the breakpoint address and contents on memory fetch only, memory write only or on memory read/write access.

Universal One contains a powerful text editor which is file oriented and has macro and iteration capabilities for combining commands.

Millennium provides comprehensive diagnostics which not only test the system's processors, memory & I/O but also check peripheral devices and interrupt logic.



Can the design engineer be right?

Universal One provides two modes of development system emulation for saving time during initial hardware debug and during hardware/software integration. In the first mode, Universal One emulates the prototype's microprocessor and its memory, while I/O functions are controlled by the user hardware. In the second mode, the prototype uses its own memory and I/O. Universal One's two-stage emulation eases the transition from initial test to full prototype implementation.

The front panel PROM sockets accommodate the most commonly used PROMs, the *2708, the 1702A MOS erasable and 82S115 family of bipolar PROMs. Others will be added in the future.

Can they all be right?

Obviously yes! Universal One has the capabilities to get development projects completed on time and within budget. And, Universal One will be just as valuable in the future as it is today. The universal architecture assures the product will never be obsolete.

Universal One's powerful operating system is easy to use so personnel get the most out of it whether they are inexperienced or advanced programmers. μ BASIC saves vast amounts of software development and maintenance time.

Last but not least, development system emulation simplifies hardware and software integration. Put it all together, it's the Universal One for 8080s, 2650s, *6800s, application programmers and design engineers.

* Available January, 1977

A better hardware solution

If you already have good techniques for assembling and debugging your programs but need hardware and PROM programming capabilities, Millennium has a solution. It's Universal Emulator, an advanced product that provides all the hardware emulation and PROM programming capabilities of Universal One at a lower price. And, it can be upgraded to the Universal One in the field at any time.

You can be right, too!

Universal One and Universal Emulator are available for immediate delivery. A complete Universal One System with a single slave and dual flexible disc is \$8,900. Additional slaves are \$1,250. A single slave Universal Emulator is \$4,500. For a prompt direct reply, return the coupon.

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The compact DataGard comes with casters and a textured off-white finish. Options include second door colors and a functional formica work top. The DataGard fire safe will economically store two 3348 Data Modules, ten 2315 Disk Cartridges or numerous other combinations of magnetic media including floppy disks, computer tape, microfilm, and cassettes.

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SUBSCRIPTIONS: Circulated without charge by name and title to U.S.-based corporate and technical management, systems engineers, and other personnel who qualify under our qualification procedures. Available to others at the rate of \$18.00 per year; single issues \$1.75. Subscription rate for all foreign subscriptions is \$25.00 per year (12 issues).

POSTMASTER: Send Form 3579 to: Circulation Dept., Mini-Micro Systems, 5 Kane Industrial Drive, Hudson, MA 01749. Controlled Circulation postage paid at Long Prairie, MN.

Back issues of MINI-MICRO SYSTEMS (formerly Modern Data) are available on microfilm. Contact University Microfilms, 300 North Zeeb Rd., Ann Arbor, Michigan 48106 for ordering information.



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DATA COMM NEWS

COVER: Digital Equipment Corp.'s microcomputer development system, PDP-11V03, shown with the LSI-11 microcomputer in the foreground. Photo by Steve Grohe.

DEPARTMENTS

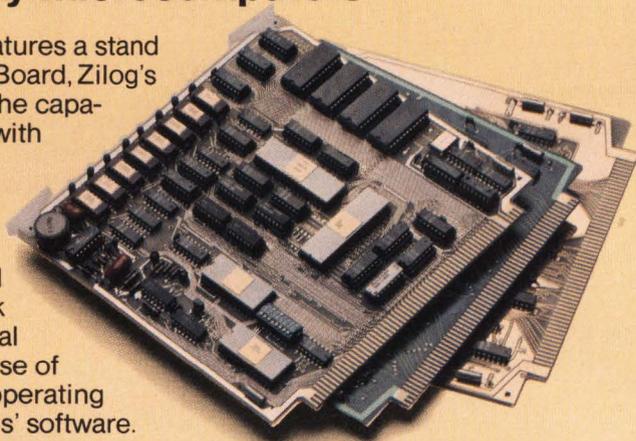
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More weapons for The Battle of the 80's

**Now a multiple attack against outmoded,
large and bulky microcomputers.**

This multiple attack features a stand alone Microcomputer Board, Zilog's mighty MCB, that has the capability to communicate with both serial and parallel I/O devices, has its own RAM and ROM capability and is backed up by a second board containing a disk controller and additional memory allowing the use of Zilog's complete disk operating system and applications' software.



Announcing the Z80-MCB. An assault against big board computers.

A single 5-volt power supply does it. And it's small—only 7.7 x 7.5 inches with a standard 122 pin edge connector with 100 mil spacing that is designed for ease of use.

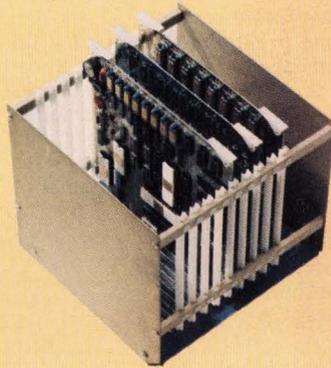
A squad of fighters against obsolete hardware.

Here's what Zilog's new weapon gives you:

- Z80-CPU single-chip n-channel processor with 158 instructions.
- 19.6608MHz crystal oscillator divided to 2.457MHz for Z80-CPU operation and dividable by Z80-CTC to provide any other desired system frequencies.
- 4K bytes dynamic RAM.
- Capacity for 4K bytes on non-volatile memory.
- Programmable serial I/O port with RS-232 or current loop interface.
- Universal parallel I/O with two independent 8 bit ports.
- Z80-CTC for programmable baud rate generation or other user functions such as real time clock.
- Bus drivers are provided for memory and I/O expansion to other boards.
- One-half K-byte monitor software has terminal handler, load and punch routines as well as set and display memory commands. A GoTo command begins execution of user programs. The 1K-byte version adds more debug aids such as set and display registers and breakpoints. The 2K and 4K-byte versions include a floppy disk controller and even more debug capability.

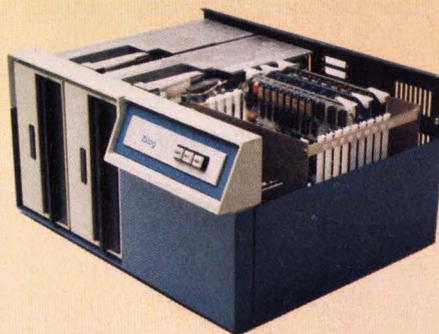
A second board gives you the advantage.

A second board gives you a 4-drive floppy disk controller and additional RAM backed up by a full disk operating system. Plus, you get the applications software you need: file, edit, assemble, debug, and high level languages such as BASIC, and more will be announced soon. This second board contains 12K of dynamic memory and additional 8 bit programmable parallel I/O ports.



Both cards are easily interfaced in a simple, low-cost card cage.

The Mighty Weapon: Zilog's Z80-OEM System.



Start out with a strong front and get performance unmatched by any other microcomputer system in the field.

You get:

- Z80-MCB Microcomputer Board
- Z80-MDC Disk Controller/Memory Board with disk controller capability for up to 4 floppy disk drives.
- Z80-RMB 16K-byte RAM Board with memory expandable to 64K bytes in 16K-byte increments.
- Z80-SCC Standard Card Cage holds up to 9 P.C. cards.
- Z80-MCS Microcomputer System includes a standard card cage, up to 2 floppy disks, power supplies and a push button front panel.

A versatility of attack: you can buy only as much as you need.

We provide a modular approach to complete computing and processing systems. Zilog products are available as a basic CPU card, a card set or a complete self-contained computer with floppy disks and power supplies in one unit.

Behind all this is Zilog's pledge to stay a generation ahead. We're the specialists who are responsible for the development of the most successful first and second generation microprocessors. And we're hard at work on the next step—an advance that will keep us out in front in The Battle of the 80's.

Appropriate assistance will be dispatched upon your written request or telephone call.

CIRCLE NO. 4 ON INQUIRY CARD

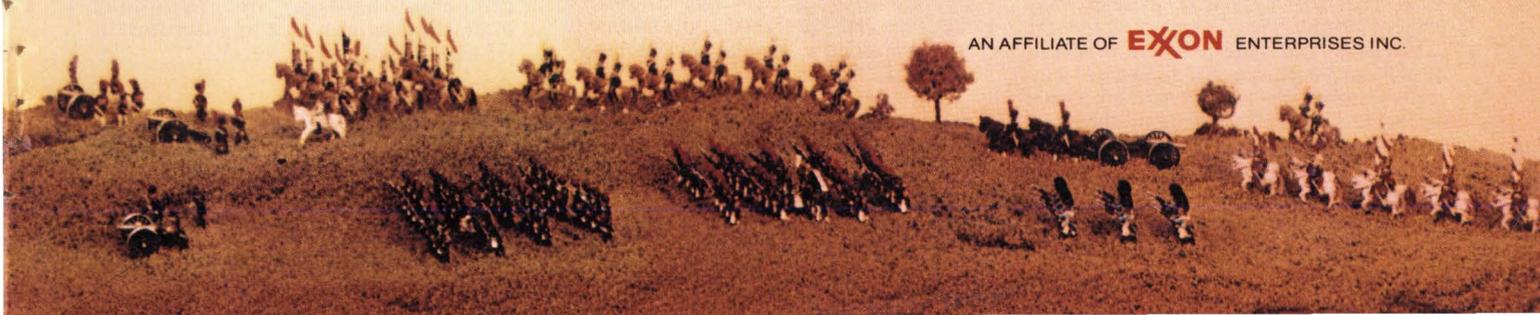


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A HYPO FOR HIPO

To the Editor:

I must take exception with Malcolm L. Stiefel's review of the book, "Systems Design and Documentation - an Introduction to the HYPO Method" by Harry Katzan, Jr. (October). It is apparent that Stiefel has never used HYPO or he would not have given the book such a poor review. Montgomery Ward has used HYPOs for more than two years, and we find HYPO documentation to be very useful, particularly at the system design level. I feel that HYPO, when properly used, has significant advantages over conventional techniques.

I also recommend that Stiefel read the IBM installation guide titled "HIPO - A Design Aid and Documentation Technique." The manual will provide a description and actual samples of HIPO documentation. Montgomery Ward has drawn most of their HIPO techniques from this particular manual.

**E.J. Talbot, Project Manager
Montgomery Ward
Chicago, IL**

(Editor's Note: Please note Talbot's switch in spelling from "HYPO" in his first paragraph to "HIPO," in his second paragraph. This, obviously, is a dig on Stiefel, since "HYPO" was erroneously used throughout the book review. That was our fault. Stiefel had telephoned in his review, and the transcription produced the erroneous spelling. Otherwise, Talbot's comments reflect a legitimate difference of opinion.)

THE WRONG SOLUTION

To the Editor:

A microprocessor of any variety is certainly the wrong solution for the application described by Robert Giuli in his article, Mastering the Micro, (October). Consider the following points:

- The overall market for waste disposal facilities for poison gas canisters is a limited one (hopefully!) at best. The price difference between a micro vs mini is seldom justified if only a single system is under consideration.

- The extreme time constraints under which Mr. Giuli was operating (\$250,000.00 extra for each week of project delay) more than justified the use of a mini, especially since Giuli was forced to write a special purpose operating system for the two Intel 4040's along with the relatively simple application software.

- The problems that arose in mid project could have been predicted far in advance, and were totally a function of the initial choice to 'go micro.' The programmers in Denver had no cross assembler, no PROM programmer and no on-line debugger! Only a last minute watts line hook-up to Giuli's facilities in California saved the day.

- The system, instead, should have been based around a widely available minicomputer to gain the following advantages. The operating system and support software (editors, assemblers, debuggers) would have been available from the beginning. Given the extensive proliferation of the minicomputer, all programmers, despite their geographical location, would have had access to one, as well as having knowledge of their instruction sets. Interfacing efforts would have been minimal, since a wide variety of minicomputer A/D and D/A peripherals already exist. Finally, the standard foreground/background monitors offered could have met all requirements by running on just one computer.

That the project was completed on schedule speaks volumes on the dedication of the people involved, and goes to prove once again that, given enough good men, a capable manager can quickly have a large hole dug with teaspoons. An alternative approach, of course, is to specify a shovel.

**Ronald Kleinman,
Senior Software Specialist
Digital Equipment Corp.
Santa Clara, CA**

SERVICE IS OUR BUSINESS, TOO

To the Editor:

The article "A New Way to Sell Industrial Computers" (October) contained an erroneous statement regarding MITS computer dealerships. The article stated that the "dealers do not give support or service." This is quite untrue in the case of MITS Altair Computer Centers where repair service, advice, system planning, custom software, and training courses are available to all customers.

Altair Computer Center customers range from hobbyists to small business system users to industrial users, and all the centers provide service and support to back the MITS products they sell.

**Andrea Lewis, Vice President
MITS
Albuquerque, NM**

MASTERING THE MICRO . . . ON A SHOESTRING

To the Editor:

I read with great interest - and sympathy - the article, "Mastering the Micro," by Richard Shapiro (September). At the School of Physics here at Georgia Tech, I teach two courses on the use and interfacing of minicomputers applied to typical physics experiments. In the courses, we try to give the students the basic information they would need to choose an instrumentation system and perhaps to design the specialized controller needed to handle a particular data gathering

and control situation. Because our resources are somewhat limited, we were forced to develop an approach to microprocessor implementation that I believe will interest your readers.

We chose the Intersil IM6100, since we have a backlog of experience in the use of PDP-8's dating back to early 1968. We designed a debug interface to interface the PDP-8/e Omnibus to the IM6100 "micro-bus." It also allows the 8/e to access and alter the micro's memory and to control the running of its programs under an ODT-like debugging program resident in the 8/e. This debugger with the PDP-8/e operating system then allows relatively painless and quick microprogram changes (including complete reassembly if necessary) in an essentially on-line environment without the need for a front panel or costly peripherals for the micro. The debugger is essentially transparent to the micro system, and the micro can "do its own thing" in the environment that it will eventually be used without the expense and pit-falls inherent in the use of simulators or full-blown microcomputer development systems. The ideas could be adapted to other micros and minis, of course.

We are currently constructing a floppy controller based on the IM6100 and have designed a rather unique interface between the 8/e and the micro that is essentially independent of the specific device the micro is controlling.

**N.S. Kendrick
Georgia Institute of Technology
Atlanta, GA**

AULD LANG SYNE

To the Editor:

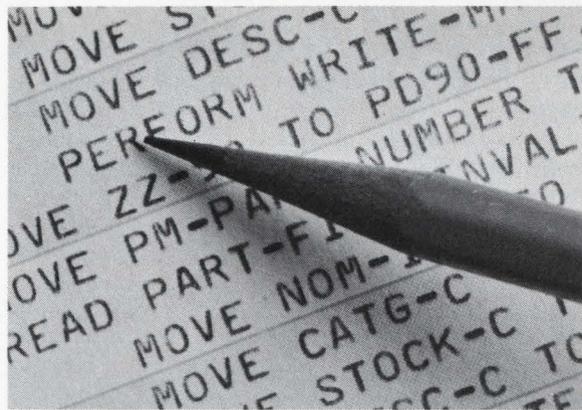
Interest in computer nostalgia and antique computers appears to be growing as an offset to fast changing microprocessor technology. Antique computers include the desk-size drum and vacuum-tube machines of the 50's, early magnetic core minis of the 60's, and the first Wang and H-P desk-top calculators of the late 60's. The oldest antique computers include the Royal-McBee LGP-30, Bendix G-15, Burrough E101, IBM 650, Elcon 125, Alwac, Monrobot VI, Univac I and II, and the IBM 700 and 7000 series.

But a danger looms. These machines may become extinct, since only a few of each were ever built, and some may have already disappeared. Can't MINI-MICRO SYSTEMS help preserve our computer heritage by publishing interesting articles on computer nostalgia and antique computers?

**Don Nyre
Newport Beach, CA**

(Editor's Note: Reader Don, we would be responsive to a specific article proposal and an outline.)

PERFORM



COBOL with ISAM

If you've got the business application, Interdata's got the COBOL. Right now. In stock. Field proven.

We've packaged our ANSI X3.23—1974 COBOL/32 with ISAM—an enhanced file management system which works with COBOL for a wide range of commercial data base applications.

The rich array of ISAM (Indexed Sequential Access Method) utilities provide for the allocation and dedication of up to 32 contiguous files on each of 32 different disc volumes. COBOL acts as the data description and manipulation language. And maximizes transportability while providing interprogram communication with FORTRAN, CAL assembler and other COBOL programs.

Interdata COBOL/32 with ISAM has been working for more than a year at a variety of sites. Such as one of the largest banks in the U.S. A major retail chain. A large hospital group.

For your business application needs, run our COBOL/32 with ISAM. Write or call for documentation...or immediate delivery.

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CIRCLE NO. 5 ON INQUIRY CARD

PLASMA DISPLAY TERMINALS LURE ANOTHER COMPANY

Interstate Electronics Corp. in Anaheim, CA, will introduce a standard line of plasma display terminals early in 1977, according to Thomas C. Weston, Jr., vice president of marketing. The company already has a number of military contracts for plasma display terminals and has begun to deliver custom units. "Plasma technology is a budding industry," Weston states.

Interstate Electronics, a subsidiary of A-T-O Inc., a diversified international operating company with annual sales at \$500 million, has formed a military products group to specialize in plasma displays. Sid Wing is marketing manager.

WHERE MINIS ARE TWO-FACED

When it comes to the timesharing industry, minicomputers are proving two-faced. On one hand, the mini is hurting timesharing because its customers are switching to in-house mini-based business systems as processing costs continue to come down. On the other hand, minis are lending a hand to timesharing companies. Here's how:

The timesharing industry load factor was a meager 30 percent in 1970. It was so low because the big mainframes, then widely used, had lots of capacity. And so, not until the early 1970's did the industry turn profitable, when that capacity finally became utilized.

But now, timesharing companies are buying minis whenever they need incremental capacity. And as a result, load factors no longer are dropping below 70 percent, and the low point occurs immediately when a new unit comes on stream. This is comfortably above the 65 percent load factor regarded as minimum for a break-even operation.

MINIS OUTSHINE MAXIS

In the mini vs. maxi battle, securities analyst Harry Edelson at Drexel Burnham & Co. finds that the small computer now outnumbers the mainframes by about 270,000 to 140,000. The mini's growth rate is also heftier by about 2-1/2 times. The trend is to continue, Edelson forecasts. "minicomputer revenues to mainframe revenues will climb from a ration of one-fifth currently to one-third by 1985."

REMOTE TERMINALS CAN CAUSE A POLITICAL HULLABALOO

The widespread and growing use of computer terminals is giving rise to "another explosive political factor" in industry, writes minicomputer and peripheral consultant Ron Henderson, as a guest columnist in *Record Times* published by the Industrial Controls Div. of Emerson Electric Co.

As more and more data processing moves to remote sites, he explains, central data processing managers are suddenly seeing their empires crumble. And these managers, to defend their turf, do fight over "a simple thing like a terminal," Henderson says. Nevertheless, the outcome is clear. Eventually, he forecasts, some 50 percent of all data processing will be pulled away from mainframe computers and moved to remote sites.

A PRESS PICNIC

In the fiercely competitive world of minis, micros, and peripherals, marketing is the key to success. Simply getting attention can be crucial. With this in mind, MINI-MICRO SYSTEMS tells you about an unusual "press conference."

The Terminal Communications Inc. subsidiary of United Technologies Corp. called the press conference to announce its new "REACT" intelligent data terminal system. But MINI-MICRO editors did not go to the conference. Indeed, nobody went to the conference! Instead, we all received picnic baskets filled with cheese, crackers, olives, and a bottle of wine. The press conference, you see, took place in our own offices. Rather than have editors of magazines come to a central meeting place, TCI sent the luncheon to editors to demonstrate the beauty of distributed processing and TCI's commitment to it.

The company even included an agenda. Lunch was to be eaten at 12:00 noon . . . sharp. Remarks by TCI president, William K. Marrinan, followed at 12:30 in the form of a cassette that contained his recorded presentation. And at 1:00 pm, the press was invited to ask questions by dialing a toll-free telephone number.

PLATO VS. TICCIT

Hazeltine Corp. in Greenlawn, NY, has acquired commercial rights to "TICCIT," a computer aided instruction system from Mitre Corp. on an exclusive basis for two years. TICCIT, which stands for timeshared, interactive, computer-controlled, instructional television, uses minicomputers and modified color television sets as terminals to provide individual instruction to as many as 128 students simultaneously. The approach is diametrically opposite to that of the big computer-based PLATO system that Control Data Corp. recently commercialized.

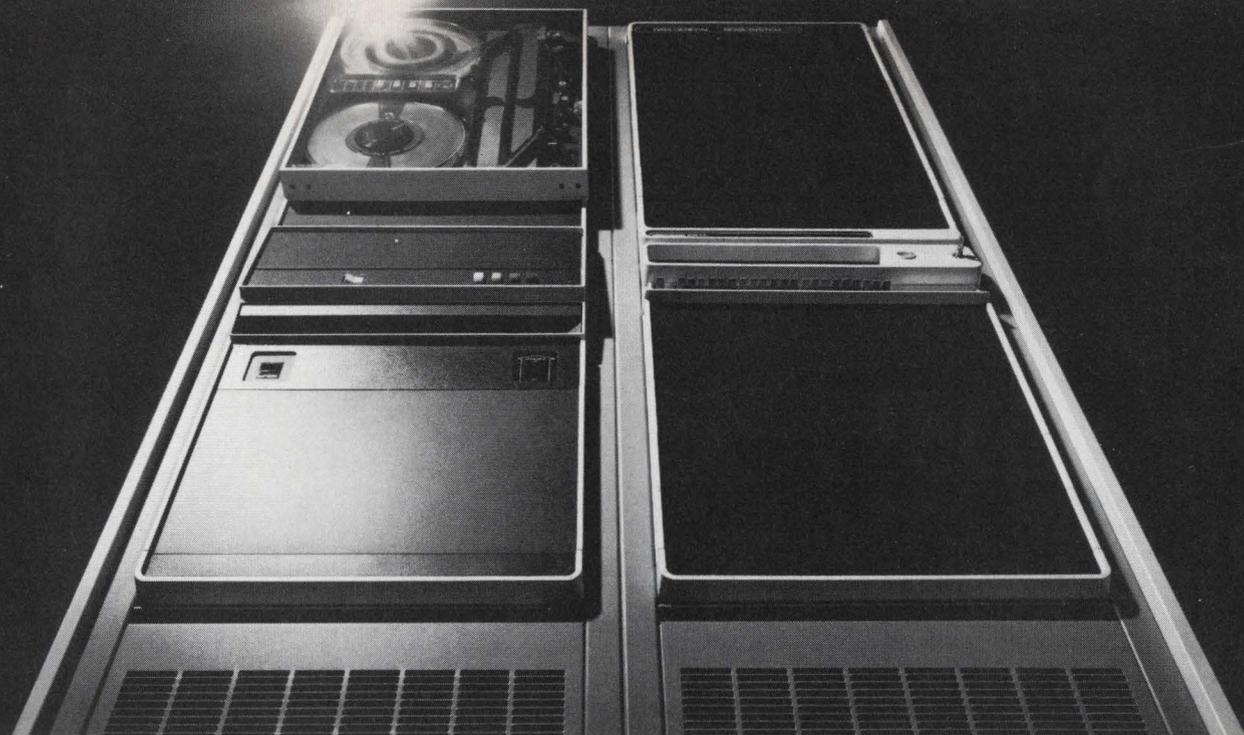
Brigham Young University, Northern Virginia, Phoenix Community Colleges, and several military installations already use TICCIT, and the Model Secondary School for the Deaf at Gallaudet College is also now installing a system. Hazeltine plans to market the TICCIT system through a new facility in the Washington, DC, area.

THE SUPER MICROCOMPUTER

Here is what the super microcomputer of the 1980s will be like. It will consist of a single, 300-mils-square chip to hold an 8-bit CPU, 16K PROM, 1K RAM, 8-bit ADC, 8-channel mux, registers, I/O, and other devices. The projection comes from William D. Baker, group director for microprocessors at National Semiconductor Corp. When will such a computer on a chip arrive? By 1981, Baker forecasts.

BAKER ON SOFTWARE

Also by 1981, National Semiconductor's Baker projects that users will find "microprocessor hardware costs become trivial as software costs rise rapidly to become a major percentage of total development cost." Software use is already changing, Baker points out. Most users currently favor assembly language, he says, but a trend to high-level languages is emerging as memory becomes cheaper and languages improve.



Announcing a giant increase in the NOVA line.

Towering above is the new top of the NOVA® line. The NOVA 3/D.

It features a new Memory Management and Protection Unit that lets you do both on-line multitasking and batch operations. Concurrently. For instance, applications that need real-time multi-terminal software and on-going program development.

Plus, the NOVA 3/D features a new, economical, 32K-word MOS memory module. Which is something no other major minimaker has.

All of which makes the NOVA 3/D more NOVA computer, at a lower price, than you've ever seen before.

What's more, the NOVA 3/D also has all the things that have made NOVA the most popular name in minicomputers.

Things like extended NOVA line instructions. Reliable high-speed MOS and economical 16K-word core memory modules.

The single-board CPU design concept Data General pioneered. The same concept that led to our removeable single-board power supply module.

Plus all the other things you've come to expect from a company like Data General.

Things like field-proven, real-time operating systems: our mapped Real-time Disc Operating System, diskette-based Disc Operating System, and our Real-Time Operating System. They're compatible with the entire NOVA line of computers.

Things like high-level FORTRAN IV and FORTRAN 5, as well as easy-to-work-with extended BASIC. Also fully NOVA-line compatible.

Things like the complete and completely-compatible line of Data General peripherals. All you could ever need to put together any system you could ever need. Including 10 to 90 megabyte discs, diskettes, and our new 30 and 60 cps terminal printers.

And when you do business with Data General, you get the kind of total systems support you can only get from a major computer manufacturer. Everything from sales and systems engineering to field service, training, and special systems design.

Write for information on the new NOVA 3/D. Or call your local sales office.

And see what the NOVA line is up to now.

NOVA 3/D

Data General

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EL SALVADOR INVESTIGATES COMMUNICATIONS

El Salvador plans to study its voice and data communication requirements so it can build a total common carrier telephone and telegraph system over the next 20 years. E-Systems subsidiary, TAI, Inc., of Falls Church, VA, has the \$260,000 study contract, a good part of which the World Bank will fund.

2 MILLION EUROPEAN TERMINALS

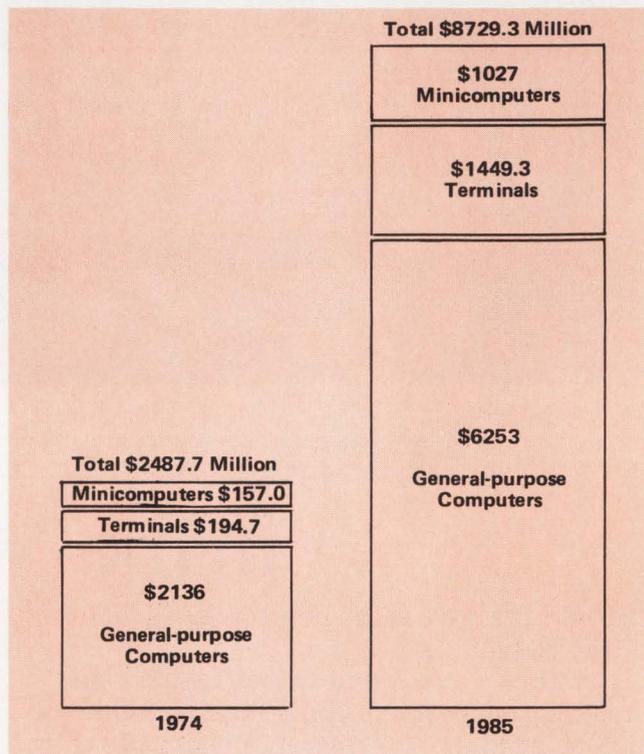
By 1985, 2 million terminals will be communicating in Western Europe, compared to today's 420,000, says the London-based research firm of PA International Management Consultants, Ltd. The firm's recent study on data communications and terminals also explores other topics like the impact of new technologies, IBM's European strategy and economic trends in individual countries. For more information, contact Mr. Richard Peters, PO Box 1275, Palo Alto, CA 94301.

U.S. TERMINALS FOR PHILIPS

A U.S. firm specializing in phototypesetting equipment is manufacturing CRT terminals for Philips small business systems. Varisystems Corp. of Plainview, NY, will ship the first units this quarter to the Netherlands-based electronics firm.

JAPANESE GROWTH

The Japanese computer industry will grow 14 percent annually to an \$8 billion market by 1985 estimates the Japan Electronic Computer Co. The firm predicts by that time Japan will export over \$1 billion in computers, but will import close to \$2 billion. One finding, however, varies



with the projections for the U.S. market. According to the report, most of Japan's growth will occur in the general purpose area, which will increase from 1974's \$2 billion to \$6 billion in 1985. Minis, on the other hand, will capture \$1 billion of 1985's market. For more information, write Japan Electronic Computer Co., New Kokusai Bldg., 4-1, Marunouchi 3-Chome, Chiyoda-Ku, Tokyo 100, Japan.

TRW BUYS ANOTHER DISTRIBUTOR

Shortly after it bought 40 percent of its British distributor, Ventek, Ltd., TRW Datacom International scooped up 45 percent of its French distributor. Distributor Matra Informatique S.A. is actually a division of Matra S.A., but will incorporate as a new company. TRW Datacom, marketer of small business and data communications systems for various vendors, is investigating other potential purchase targets.

MADE IN IRELAND

Not too long ago, Japan was the low cost manufacturing haven. Ireland has now taken over the honor — at least for goods shipped in Europe — because it has lower labor costs and fewer duties and taxes. Following other mini and peripheral manufacturers to Ireland will be Centronics Data Computer Corp. Robert Howard, company president, says, "Centronics printers manufactured in Ireland will be priced more competitively in the European marketplace and enable Centronics to gain a greater share of the printer market."

GRAPHICS



MOVE TO INTERMEDIA SYSTEMS GRAPHICS

DEC PDP-11^{*} series
HP 2100 series

IMMEDIATELY AVAILABLE FROM



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*Reg. TM Digital Equipment Corporation

CIRCLE NO. 7 ON INQUIRY CARD

ADDS announces good news for Burroughs users. (Bad news for Burroughs.)

ADDS new Consul 980B is a highly sophisticated, cost-effective alternative to Burroughs' own TD 700/800 terminal series.

Here's the bad news, Burroughs: ADDS Consul 980B costs about \$2000 less than the comparable Burroughs model.

Sorry, Burroughs, there's more good news for your customers. ADDS standard features include:

Graphics; security key-lock; program attention and program function keys; separate function and numeric keypads; parallel and serial peripheral interfaces; and speeds up to 9600 bps.

There you have it.

ADDS new Consul 980B. Sorry, Burroughs. Ever so.

You won't be sorry; for more information complete and clip this coupon and mail it to:

ADDS Applied Digital Data Systems Inc.
100 Marcus Blvd., Hauppauge, N.Y. 11787
(516) 231-5400

Name _____

Firm _____ Title _____

Address _____

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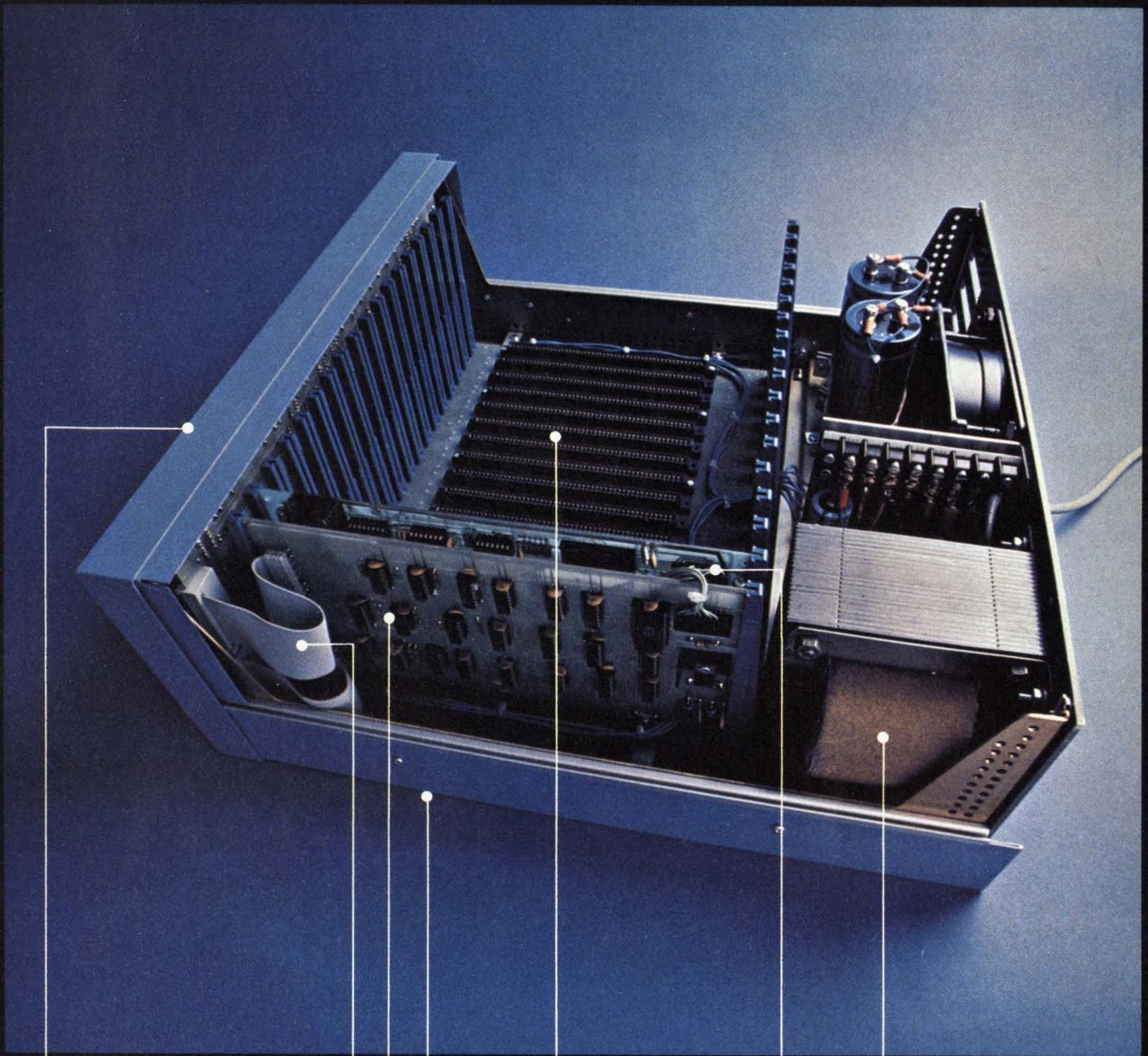
Phone _____

CIRCLE NO. 8 ON INQUIRY CARD

Sorry, Burroughs.



ADDS CONSUL 980B



Redesigned front panel. Totally synchronous logic design. Same switch and LED arrangement as original Altair 8800. New back-lit Duralith (laminated plastic and mylar, bonded to aluminum) dress panel with multi-color graphics. New longer, flat toggle switches. Five new functions stored on front panel PROM including: DISPLAY ACCUMULATOR (displays contents of accumulator), LOAD ACCUMULATOR (loads contents of the 8 data switches (A7-A0) into accumulator), OUTPUT ACCUMULATOR (Outputs contents of accumulator to I/O device addressed by the upper 8 address switches), INPUT ACCUMULATOR (inputs to the accumulator from the I/O device), and SLOW (causes program execution at a rate of about 5 cycles per second—for program debugging).

Full 18 slot motherboard.

Rugged, commercial grade Optima cabinet.

New front panel interface board buffers all lines to and from 8800b bus.

Two, 34 conductor ribbon cable assemblies. Connects front panel board to front panel interface board. Eliminates need for complicated front panel/bus wiring.

New, heavy duty power supply: +8 volts at 18 amps, +18 volts at 2 amps, -18 volts at 2 amps. 110 volt or 220 volt operation (50/60 Hz). Primary tapped for either high or low line operation.

New CPU board with 8080A microprocessor and Intel 8224 clock generator and 8216 bus drivers. Clock pulse widths and phasing as well as frequency are crystal controlled. Compatible with all current Altair 8800 software and hardware.

altair 8800-b

CIRCLE NO. 9 ON INQUIRY CARD

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The choice is yours.

A \$1995 8-Color CRT. Complete.

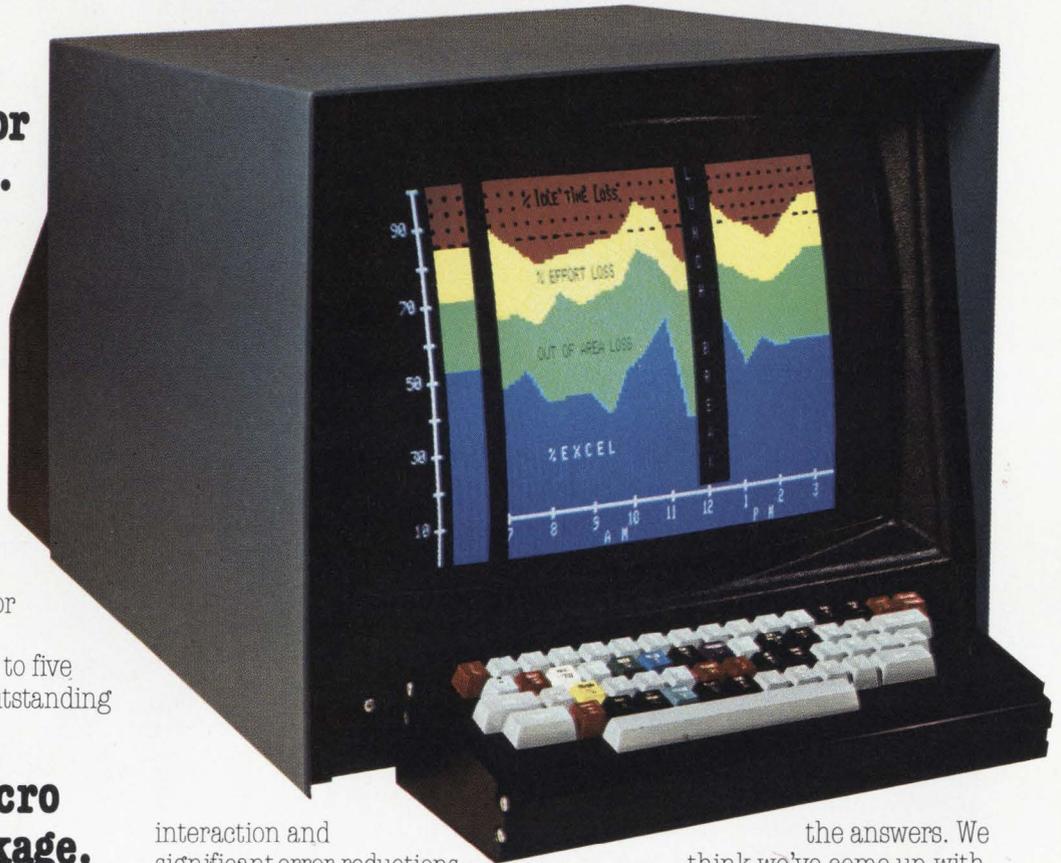
When we say complete, we mean complete. The **Intecolor 8001** has 8080 CPU, 4K RAM Refresh, Selectable Baud Rate to 9600, Keyboard, RS232 I/O, and ASCII Character Set. All in one package. It's a complete stand-alone system which features our unique **Intecolor 8001 NINE SECTOR CONVERGENCE SYSTEM** for minimum set-up time and exceptional stability. Three to five minutes is all it takes for outstanding color registration.

The \$1495 Micro Computer Package.

You just give us the word and we'll convert the **Intecolor 8001** into a stand-alone micro computer with BASIC, Roll, Insert/Delete, Additional 8K RAM Work Space, Graphics Mode with 160X192 Elements, Background Color, Lower Case ASCII, 48 Line X 80 Characters/Line, and 2X Character Height. Plus additional features which make your **Intecolor** personal computer the best buy in the industry.

Which System Is Right For You?

The **Intecolor 8001** CRT is a smart, inexpensive way to upgrade the CRT's in your present system from black and white to color. And color has definite sales advantages. Like more efficient man-machine



interaction and significant error reductions in data entry and recognition. The **Intecolor 8001** CRT can also be used or marketed as a complete stand-alone micro computer system with computation or control capabilities. It might even replace your whole system!

Whatever your needs, market or application — Process Control, Medical, Credit Checking, Order Entry, Financial Analysis, Research and Development, or for your own personal computer — you won't find a more usable terminal, color or black and white.

Write Or Call For More Information

We know you're going to have some more questions, and we've got

the answers. We think we've come up with a CRT and computer package that's hard to beat. And one thing for sure. The **Intecolor 8001** is by far your best buy today in a color CRT micro computer or intelligent terminal. Make us prove it to you with a demonstration by one of our authorized representatives. Or call us direct and talk to an applications engineer.



Intelligent Systems Corp.®

5965 Peachtree Corners East
Norcross, Georgia 30071
Telephone (404) 449-5961

*Quantity 100 Price.
Unit Price \$2,495. Domestic USA Prices

CIRCLE NO. 10 ON INQUIRY CARD



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Through These Authorized
Sales Representatives

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MISSISSIPPI	Cleveland
GEORGIA	216/267-0445
NORTH CAROLINA	NEW HAMPSHIRE
SOUTH CAROLINA	RHODE ISLAND
Col-Ins-Co., Inc.	MAINE
800/327-6600	VERMONT
ALASKA	MASSACHUSETTS
Contact ISC direct	Bartlett Assocs., Inc.
ARIZONA	Framingham
The Thorson Company	617/879-7530
Phoenix	MICHIGAN
602/956-5300	WKM Assocs., Inc.
ARKANSAS	Madison Hts.
TEXAS	313/588-2300
LOUISIANA	NEW MEXICO
Data Marketing	The Thorson Company
Assocs., Inc.	Albuquerque
Houston	505/265-5655
713/780-2511	OKLAHOMA
NEVADA	Data Marketing
CALIFORNIA	Assocs., Inc.
The Thorson Company	Norman
Los Angeles	405/364-8320
213/476-1241	PENNSYLVANIA
UTAH	Bartlett Assocs., Inc.
WYOMING	Wayne
COLORADO	215/688-7325
The Thorson Company	WKM Assocs., Inc.
Denver	Pittsburgh
303/759-0809	412/892-2953
NEW JERSEY	TENNESSEE
CONNECTICUT	(KNOXVILLE
NEW YORK	ONLY)
Bartlett Assocs., Inc.	McCain Electric
White Plains	Equipment Co.
914/949-6476	Knoxville
DISTRICT OF	615/584-8411
COLUMBIA	WEST VIRGINIA
MARYLAND	(See Pittsburgh, Pa.)
DELAWARE	EUROPE
VIRGINIA	Techexport, Inc.
Bartlett Assocs., Inc.	Cambridge, Ma.
Bethesda	617/661-9424
301/656-3061	AUSTRALIA
HAWAII	Anderson Digital
Contact ISC direct	Electronics
MONTANA	Victoria, Austl.
OREGON	03/543-2077
IDAHO	CANADA
WASHINGTON	Louis Albert
The Thorson Company	Assocs., Inc.
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WISCONSIN	Cybernetics
INDIANA	Control LTD.
Bexdata LTD	Montreal
Munster	514/934-0000
312/221-1411	JAPAN
MINNESOTA	Munzig International
NORTH DAKOTA	Japan, Inc.
NEBRASKA	Tokyo, Japan
SOUTH DAKOTA	586-2701
IOWA	Or contact us
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KANSAS	5965 Peachtree
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St. Louis	30071
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Corporate & financial

ZILOG ON THE RAMPAGE

Zilog moved this month into a new 32,000 sq. ft. headquarters and manufacturing building in Cupertino, CA, that includes a 4-inch wafer fabrication facility for volume microcomputer parts production. Federico Faggin, Zilog president, also reports that the company doubled its work force over the past 90 days.

TALLY LOWERS PRINTER PRICES

OEM price reductions from 5 percent to as much as 20 percent on big orders have been announced by Tally Corp. on its 132-column Model T-2200 line printer. Increased production volume accounts for the price break, according to the company which has delivered more than 10,000 line printers to date.

A \$10 MILLION TERMINAL ORDER TO ONTEL

Peripheral maker Ontel Corp. in Woodbury, NY, a subsidiary of Caesars World Inc., has received a contract from AEG-Telefunken valued in excess of \$10 million. Ontel will supply its OP-1 user programmable intelligent terminal over a four year period to the \$6 billion-a-year Frankfurt (Germany)-based electronics company. AEG-Telefunken, in turn, will market the terminal principally in Germany, Austria and Switzerland under its own brand name on a non-exclusive basis.

INTEL'S DOWNS AND UPS

Manufacturing yields again are turning out to be the bugaboo that is slowing the full-scale commercialization of advance semiconductor computer devices. The 16K RAM is giving the problems this time. Intel, for example, "has taken longer than expected to achieve high yields in production," reports board chairman Robert N. Noyce. Noyce adds, however, that "Intel expects to be shipping in production quantities by year-end." On a happier note, Noyce reports that the shift in demand "seems to be taking place" from LED-style displays on digital watches toward the liquid crystal type that give a continuous display. Intel, by using LCDs on its Microma line of watches, bet on such eventual consumer acceptance. Early last month the company's entire capacity was booked for the remainder of 1976.

DEC AIMS AT TYPESETTING MARKET

Digital Equipment Corp. has introduced a commercial computerized text management and typesetting system, called COMtype. The PDP-8-based system accepts text input from teleprinters, video display terminals, optical character recognition (OCR) units, industry-standard magnetic tape, and word processing system floppy disks, permitting final drafts to be prepared in computer-compatible form at remote sites. At the same time, the system's text management scheme provides each editing terminal operator with simultaneous, independent access to all files or documents for proofreading, editing or review. Prices start at \$95,000.

A DATAPoint ACQUISITION

Datapoint Corp., distributed processing pioneer, has agreed to acquire Sunnyvale (CA)-based Amcomp, Inc., a producer of tape and disk drives. The move is another step by Datapoint to expand its line of peripheral products. The agreement is subject to board approval by both companies and by Amcomp shareholders.

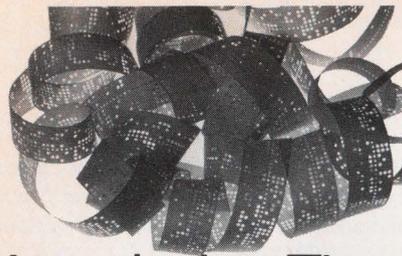
A \$3 MILLION ORDER

Systems Development Corp. in Santa Monica, CA, has purchased 17 Systems Engineering Laboratories' 32/55 computers, worth more than \$3 million, for use in a Telemetry Integrated Processing System at Vandenberg Air Force Base in California. The SEL front end computers link to a Control Data Corp. Cyber 173 host computer, to acquire and process real-time information from up to six simultaneous telemetry data streams.

ON THE MOVE

Advanced Micro Devices (Sunnyvale, CA) has leased 1.7 acres in Manila (Philippines) and expects to have a 40,000-square-foot assembly facility there during the first quarter of next year. The company just completed a 20,000-square-foot addition to its Penang (Malaysia) assembly plant, bringing its operational area to 40,000 square feet on four acres of land.

Computer Automation, Inc. has broken ground on a new facility that will add 75,000 square feet to the company's operating space by January, 1977. The new \$2-million facility will be located on a six-acre site at 2181 Dupont Drive,



Introducing The FlexiFile Family From Tri-Data... FlexiFile 10



...requires
NO software modification
in your present system. Tri Data provides
an RS-232 coupler for data communi-
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device for both units. And you can re-
place high speed paper ... 816 feet per
single floppy disk.

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is user-defined. It's as easy as pushing
the reset switch. 8 LED'S indicate each
operating mode. 6 input switches let
you determine the operating mode ...
using your own protocols, control words,
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CIRCLE NO. 11 ON INQUIRY CARD

Irvine, CA, directly behind the com-
pany's existing 73,000-square-foot
facility at 18651 Von Karman.

Harris Corp. (Cleveland, OH) has agreed
to purchase 25 acres of land in Dallas
for \$5.1 million. The company will
construct a 200,000-square-foot manu-
facturing plant and office building for
its Data Communications Division.

Beehive Medical Electronics, Inc. (Salt
Lake City, UT) has broken ground for
its new 80,000 square foot headquarter
facility. The \$2.3 million project covers
nine acres adjacent to the Salt Lake
City International Airport.

Hewlett-Packard Co. will consolidate
all its disk product activities under a
Disc Memory Division, and move it to
Boise, ID. HP's printer and mag tape
division has been in Boise since 1973.

Digital Equipment Corp. is moving its
Graphic Arts business groups from the
Maynard headquarters to Hudson, NH.
The company has leased a new, 24,000-
square-foot building at 5 Flagstone
Drive in Hudson.

Entrex, Inc. has purchased an addi-
tional building at its Burlington, MA,
home office, thereby doubling its man-
ufacturing capabilities. Including the
new building, the central Burlington
facility now has approximately 100,000
square feet of space.

Data 100 Corp. is transferring its mag-
netic disk operations (Iomec) to Min-
nesota in order to close its Santa Clara,
CA, plant by January 1, 1977. The
group will occupy a smaller 27,000
square foot plant near the company's
Minnetonka, MN, headquarters.

Harris Corp. has purchased 25 acres of
land in Dallas, TX, to construct a
200,000-square foot manufacturing
plant and office building for its com-
munications division.

Ampex Corp. has moved its memory
products division and certain lines of
its data products division from Marina
del Rey into a 200,000 square foot
facility at 200 N. Nash Street, El
Segundo, CA.

Analog Devices opened a new 32,000
square foot plant in Wakefield, MA.
The Norwood (MA)-based firm also
has plants in Westwood, Holliston and
Wilmington, MA.

TEC, Inc. has added 75,000 square
feet of manufacturing area to its pres-
ent 75,000 square feet in Tucson, AZ.

MORE FINANCING FOR TELENET

Telenet Communications Corp. (Wash-
ington, DC) sold \$4.8 million in com-
mon stock to a group of institutional

investors, completing the third phase
of its equity financing program. Bowne
& Company is the principal participant
in the current financing, with \$2 mil-
lion. Other investors are Bolt Beranek
and Newman, Inc., Bessemer Securi-
ties Corp., Time, Inc. and Lehman
Brothers, Inc.

BACKLOG UP 67 PERCENT

Incoterm Inc. in Wellesley Hills, MA,
reports that backlog reached a record
\$27.5 million, or 67 percent above the
backlog for the corresponding period
last year and 32 percent above that for
the first quarter of this year. The com-
pany hit another record: Orders re-
ceived in the second quarter totalled
\$15.5 million dollars.

CONTRACTS TO TALK ABOUT

TRW is going to purchase \$15 million
in OCR Wands over a 20-month period
from Dallas (TX)-based **Recognition
Products, Inc.**, a subsidiary of **Recogni-
tion Equipment, Inc.** This is the largest
order ever for REI.

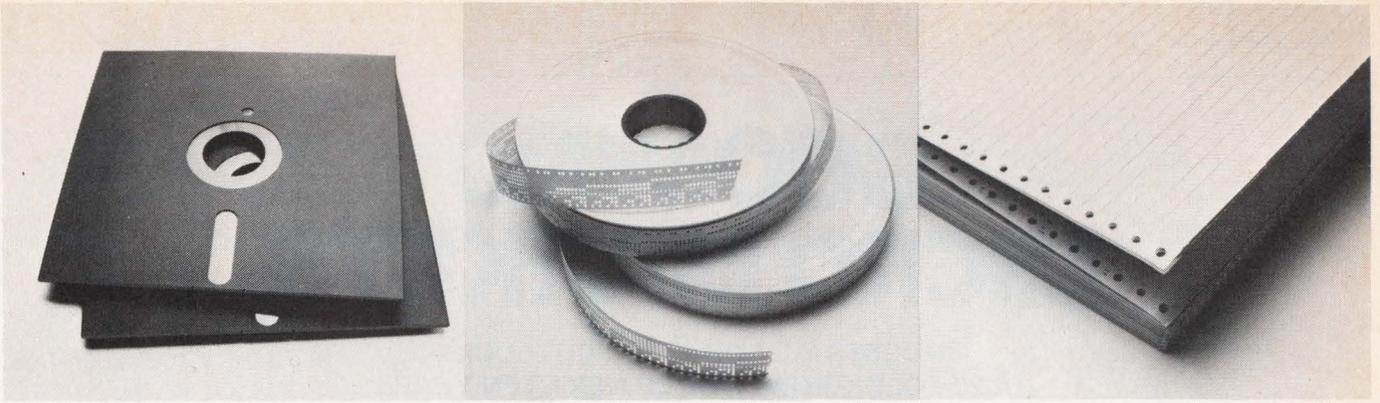
NCR Corp. extended its OEM agree-
ment with Hauppauge (NY)-based
Applied Digital Data Systems, Inc.
(ADDS) for teletype-compatible
CRTs. ADDS management estimates
that over the life of the contract which
runs to 1980, the value of shipments
to NCR should exceed \$40 million.

System Industries (Sunnyvale, CA) is
buying an additional \$5 million in disk
drives from **Control Data**. For the first
time, 300 MB versions of the 9760
drive will be supplied in addition to the
40 MB and 80 MB drives.

Beehive Medical Electronics, Inc. (Salt
Lake City, UT) will supply the U.S.
Customs Service with \$6.1 million in
Super Bee CRTs.

**Southwestern States Bankcard Assci-
ation**, Master Charge's second largest
processing center, has signed a \$2 mil-
lion contract with **Sycor, Inc.** (Ann
Arbor, MI) for a minimum of 200
Model 350 floppy terminals and mag-
netic tape drives for its regional net-
work. The terminals and tape drives
will be used to collect and transmit
debit card files for the Association's
new EFTS services.

Wavetek has acquired Compata, a soft-
ware and systems engineering firm,
specializing in online banking.



WE'LL READ, TYPE, RECORD, PRINT, PUNCH, SPOOL AND REPRODUCE FOR JUST ABOUT ANYBODY.

We believe everybody has the right to choose the best computer system to fit specific business needs.

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We have a whole group of matrix printers to pick from, in various speed ranges and all with superb accuracy and neatness.

For instance, there's our new 4540 matrix, with a revolutionary printing head, high speed printing, and economical cost.

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If paper tape meets your needs, we've got high quality readers, spoolers, or punches for your choosing.

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And, if you're looking for flexible disk drive, we can work together, too.

Our single floppy disks are expertly designed for easy installation, safe disk handling, and one of the fastest access times around.

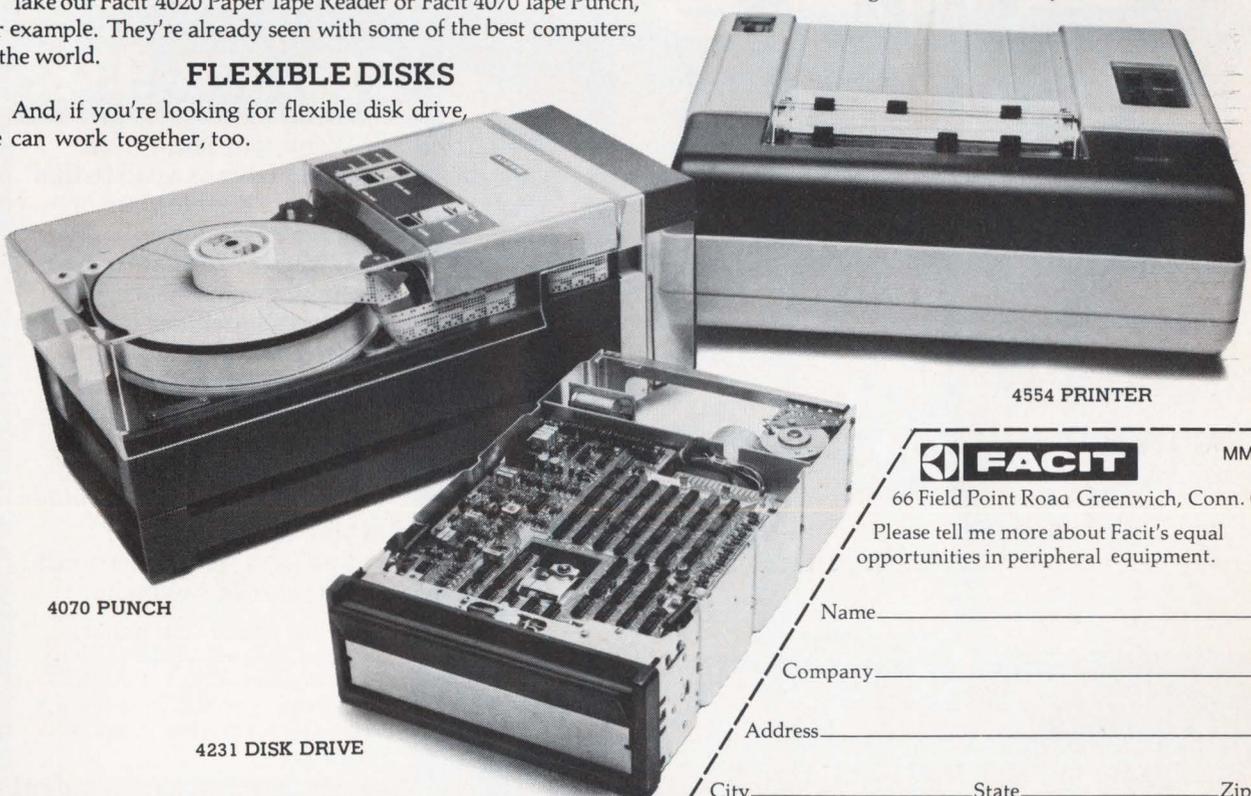
Even better, our dual floppy disks give you all the same precision and accuracy, plus twice the data capacity of the single machine for only a fraction more investment.

And the special box-in-a-box construction, with its ability to reduce the problems created by heat and increase reliability, is something you won't find in any other flexible disk drive.

So, whatever Facit peripheral you choose for your needs, you've selected our choice piece. Because they're all made to work hard, work long, and require a minimum amount of maintenance.

In fact, we honestly feel that no other OEM manufacturer offers a better performance to price ratio. It's just part of the Facit belief that all our equipment should make work easier and more efficient for everybody.

If you'd like more information about our equal opportunities in peripheral equipment, send us the coupon below. We think you'll find Facit has the right idea about all your business needs.



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4231 DISK DRIVE

4554 PRINTER



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Please tell me more about Facit's equal opportunities in peripheral equipment.

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CIRCLE NO. 12 ON INQUIRY CARD

BOOMING MICRO MARKETS

INDUSTRIAL COMPUTER OUTLOOK:
A 20-FOLD GROWTH OVER NEXT TEN YEARS

16-Bit Micros to Star; 4-Bit and 12-Bit Micros To Disappear

Shipments of microcomputer equipment for use in industrial applications at \$45 million in 1975 will soar to \$1.2 billion by 1985, according to a new study on industrial microcomputers by market research specialists Frost & Sullivan, Inc. in New York City. Shipments of industrial microprocessors alone at \$22 million in 1975 will rise to \$405 million; memory products at \$18 million will climb to \$570 million; and input/output and interface components at a mere \$5 million last year will reach \$200 million.

Within the I/O category, data conversion devices comprise "the fastest growing market" segment. Its revenues, which accounted for 25 percent of the total I/O market in 1975, will rise by as much as 50 percent by 1985. Here is

where "non-microprocessor manufacturers stand a good chance to capture a major market share," the study adds.

OUTLOOK BIT BY BIT

The study makes some controversial projections: Bit-slice microprocessors, it forecasts, are to undergo very big growth. Its share of the CPU market, at virtually nil today, will rise to 5 percent in 1977 and to 20 percent in 1985. "Industrial designers will come to appreciate the superior processing capability of bipolar bit-slice units," the study says.

The 8-bit microprocessor, which in 1965 accounted for 60 percent of mpu unit shipments, will decline to a 35 per-

Want a good one?

(213) 378-9385

The collage features several distinct advertisements:

- PDP-11 & NOVA users: Ask your boss for a raise.** (with a man holding a check)
- You can buy this microcomputer for \$39.95, but...** (with a computer monitor)
- How to take the work out of paperwork. Economically.** (with a computer terminal)
- Wafers never had it so good.** (with a wafer)
- The great 11th-hour wrap-up.** (with a keyboard)
- It's all over.** (with a computer component)
- It's about time.** (with a computer component)
- Good-bye big expenses, hello.** (with a computer component)
- Compare all three.** (with a person holding a document)
- Connect the dots for \$1095.** (with a computer component)
- 4 ports. No waiting.** (with a computer component)
- THE \$3000 MICROCOMPUTER MISTAKE.** (with a computer monitor)
- YOU FAILED. AND IT'S OUR FAULT.** (with a person sitting at a desk)
- LaMantia MARKETING COMMUNICATIONS, INC.** (with the company logo)
- Dial (714) 224-2721 for free economics lesson.** (with a computer component)

Want your share of the market? Give us a call to find out how to double your average ad response.

With over 20 years of high technology experience, La Mantia provides top creative marketing communications to work twice as hard for your money.

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Send this ad and your business card to LaMantia, 1848 S. Elena Ave., Redondo Beach, CA 90277. We'll send you FREE: 50 ways to reach your market market analysis.



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CIRCLE NO. 40 ON INQUIRY CARD

cent market share by 1985; the 16-bit micro, having a 10 percent market share currently, on the other hand, will jump to 45 percent. Indeed, shipments of 16-bit units at \$2 million in 1975 are projected to soar to \$183 million by 1985.

A BIT OF GLOOM

The four-bit microprocessor, however, awaits a gloomy fate. Shipments, at \$5-1/2 million in 1975, will inch up to \$7 million by 1977, but then decline to a negligible amount by the decades's end. The twelve-bit microprocessor shares a similar destiny. Sales are less than 1 million currently and account for less than 3 percent of the total mpu industrial market. This will increase to 5 percent over the near term. But starting about 1978, the 12-bit mpu "will begin to fade from the scene," the study says.

Frost & Sullivan defines the role of an industrial microcomputer as having a use in measurement, monitoring, and control of production operations. And it cites two big growth fields, among others:

Process analytical instrumentation: The process control industry is eager to exploit new analytical instruments in online applications, such as Fourier, transform, infrared, mass spectrometry, microwave rotational spectrometry, and raman spectrophotometry. These very sophisticated instruments would produce comprehensive, interference-free, and reliable information to be used directly to control a process. But high cost has deterred their widespread application. Microcomputer technology, however, now promises "to impart instrument-control and data-handling capability to make such instruments very cost effective," the study notes.

In-Plant Wiring: According to the study, in-plant wiring costs can be reduced greatly by use of multiplexed, two-wire digital data communications, and microcomputers "appear to be an effective vehicle for realizing this potential." In petroleum refining, for example, digital data communications can reduce the total installed cost of a control system by as much as 30 percent, the study says.

Industries to feel the microcomputer's impress are shown in the table below:

INDUSTRIAL MICRO-COMPUTER MARKET (1975-1985)

(Millions of Dollars)

	1975	1976	1979	1985
Process Industries	\$12	\$29	\$93	\$425
Manufacturing	23	46	110	365
Utilities	3	7	32	125
Export	6	16	70	210

MICROPROCESSORS TO SCORE BIG IN COIN OPERATED GAMES

Watch for another micro market to boom: electronic games, both coin operated machines and home video types. True, most *home* games currently on the market use custom designed LSI chips, otherwise any game based on an off-the-shelf microprocessor could be easily copied. Nevertheless,

some custom designed chips have microprocessor characteristics. They are programmable, such as Fairchild's FCC-approved TV video games, and in this way, they permit new games to be added. RCA Corp., however, is working on a programmable home electronic game that employs a true microprocessor to allow a bored user to program in new games.

THE BIGGEST ROLE

But the micro will play its biggest role in coin operated games intended for commercial installation. Executive Games Inc., for example, whose game development work is handled by the Innovation Center at the Massachusetts Institute of Technology on an exclusive basis, is working on a microprocessor game application, as is Allied Leisure Industries Inc. Also, Micro Games Inc. uses a microprocessor chip in its new electronic pinball machine, dubbed The Spirit of '76. And Midway Manufacturing Co. uses a microprocessor in a new "Gunfight" game. Another potential micro market: A video style game that sits under a glass cocktail table; Micro Games uses a microprocessor in one such new unit called "PT-109."

WHY A MICRO

Micro Games' Spirit of '76 illustrates the kind of job a microprocessor does in a game application. Spirit uses what is believed to be either a Fairchild F-8 or a Motorola 6800 micro to allow an operator to automatically check out the game should it malfunction. And, as for the game action itself, the micro creates special audio-visual effects at certain critical points during the play. This introduces variety into the game, and sustains the player's interest, thus leading to a longer life cycle for the machine.

"The use of a microprocessor is inevitable in future pinball machine designs," according to market research specialists Frost & Sullivan Inc. in New York City, which recently published an important market study on the industry. Currently, some 50 manufacturers in the U.S. produce coin operated electronic games, and they could expand their markets dramatically by turning to micro-based products. Game arcades in shopping malls, for example, have grown dramatically over the past five years. Motels and hotels are increasingly setting up game rooms that feature pinball machines and other stand-up type coin operated electronic games. College recreation rooms and snack bars have become another important market outlet, and down the pike, hospital waiting rooms, automobile dealer showrooms, and other such business and institutional waiting areas are likely to install coin operated electronic games as a way to keep people busy while simultaneously generating additional revenue.

In such commercial applications, the micro can be extremely important because customers easily tire of playing the same game, and a machine that an operator can program to create different amusements could become a real winner. Traditionally, operators frequently rotate the games among establishments to keep interest alive, but this is a cumbersome and costly procedure. Says the F&S study: "The microprocessor promises high attractiveness to the coin operated electronic games manufacturer."

product profile:

MICROCOMPUTER KITS AND DEVELOPMENT SYSTEMS

INTRODUCTION

Microcomputer applications are on a strong trajectory upward and industry vendors have begun to produce a great variety of products and tools to meet user needs... and budgets. This profile focuses both on kits to be used by skilled persons who do not face time pressures and on development systems for the professional computer applier who faces tight time constraints to turn out commercial products. The lead-off article, reported by technical editor Dan Bowers and edited by MINI-MICRO SYSTEMS' staff, emphasizes the limitations on the use of kits. This is followed by an overview article on development systems that includes a vendor directory, also reported by technical editor Bowers. More focused articles follow the two introductory pieces. James Moon, vice-president for engineering at muPro, Inc. in Cupertino, CA, discusses what constitutes an ideal development system. Gerald S. Casilli, president of Millennium, Inc. in Santa Clara, CA, evaluates alternatives to a development system and concludes that this technique is the fastest. Finally, Edward Lee, president of Pro-Log Corp. in Monterey, CA, raises a warning flag that development systems are not the way to go under certain circumstances and suggests a different approach. In part, the articles are controversial, but they will impart to a reader a feel for the state-of-the-art in microcomputer systems development and some guidance on how he or she might approach a microcomputer application.

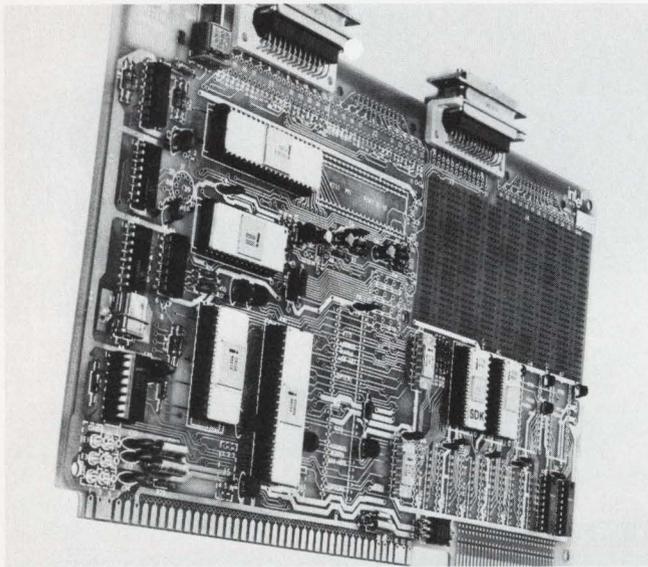


Photo by Cramer Electronics, Inc.

MICROCOMPUTER KITS

Hobby electronic kits came on strong shortly after World War I when the Heathkit Co. introduced such consumer products put together out of war surplus parts. Since then, the hobby kit concept has expanded to include, not only high fidelity components in kit form, but also depth finder kits, treasure hunting kits, electronic organ kits, and even a color television kit. The high point in the marketplace undoubtedly occurred in 1926 when the Heathkit Co. introduced a kit airplane at a cost of \$199 – minus the engine.

All kits come with step-by-step instructions, of course, so that persons without any formal technical training or experience can assemble them. But, now, the microcomputer kit, first introduced by Cramer Electronics in 1975,



Intel SDK-80 kit assembled

makes the concept a whole new ballgame. When conventional kits are assembled, the builder need have no special skills to operate the completed products, since the controls on a high fidelity set or television receiver are very simple. Not so with the microcomputer kit. Upon its completion, one's work has only begun. To do anything worthwhile, the microcomputer needs to be programmed.

NOT FOR JOE, THE TRUCKER

As a result, the microcomputer kit poses a formidable challenge. Assembling and operating a kit in no way appeals to Joe, the truck driver, or Harry, the used car salesman. Indeed, the complex devices are not even likely to be built by Mike, the electronic engineer or Betty, the programmer.

Knowing the content of a typical microcomputer kit explains why this is so. For as little as \$100, we can buy a basic microcomputer kit to contain a microprocessor chip, 1K or 2K RAM memory, ROM memory that includes a rudimentary debugging program, input-output buffer, teletypewriter interface circuit, crystal and timing circuits, voltage regulator, DIP sockets, printed circuit board, and other miscellaneous items. Roughly five pounds of literature – assembly instructions, debugging materials, theoretical explanations, and the like – are included in the package.

The \$100 budget, however, does not afford a power supply. But no matter. After assembling the kit, we run into many other missing elements. We have no way to communicate with the presumably, powerful computer, and, as a result, we cannot know what tricks the computer can perform. That takes more of an outlay; the cheapest solution is to connect switches and lamps to the computer as basic I/O devices.

GENIUS WANTED

Now, at last, we can communicate with the machine, though only in its own terms – in binary or hexadecimal language. Communicating this way to any substantial extent, unfortunately, is beyond the mental capacity of most mortals. So, we must turn to a more accommodating, human-oriented device if we are to use the computer, and this means still another expenditure to purchase an alphanumeric display and keyboard. Hence, add another \$100, at least, to the microcomputer kit budget.



National Semiconductor SC/MP kit and materials

At long last, now, we are on the way. Because an alphanumeric terminal accommodates the 10 numerals and 6 letters required to describe the hexadecimal codes, we can begin to exercise the microcomputer by using the debug

MICROCOMPUTER KITS

Vendor	Microprocessor Type	(Bytes of Mem)		Peripheral Options	Software	Price
		RAM	ROM			
Advanced Micro Devices Sunnyvale, CA	AM 2900	64 Std		No	No	\$289
American Microsystems, Inc. Santa Clara, CA	AMI 6800	512	2K ROM 2K EPROM	No	Tiny Basic	\$950
	AMI 6800	512	2K ROM 512 EPROM	No	No	\$595
	AMI 6800	512	2K ROM	No	No	\$295
Compsultants Inc. Huntsville, AL	Intel 8080	256 Std 2K Opt		TTY, Console	No	\$175
Cramer Electronics Newton, MA	Intel 8080A	1K Std 13K Opt	1K Std 13K Opt	Terminal, Cassette	Good	\$750
	TI TMS 9900	2K Std 13K Opt	2K Std 13K Opt	Same	Same	
	Motorola 6800	Same	1K Std 13K Opt	Same	Same	\$495
Fairchild Microsystems San Jose, CA	Fairchild F8	1K Std 64K Opt	1K Std	Minimal	Minimal	\$185
General Instrument Hicksville, NY	GI CP 1600	8K Opt	4K Opt	Console, TTY, PT	Adequate	\$495
IMS Assoc. Inc. San Leandro, CA	Intel 8080	1K Std 64K Opt	4K Opt	Excellent	Excellent	\$599
Intel Corp. Santa Clara, CA	Intel 8080	2K Std 4K Opt	256 Std 1K Opt	Minimal	Minimal	\$350
Martin Research Northbrook, IL	Intel 8008	1K Opt	2K Opt	Console	Minimal	\$ 95
MITS/Altair Albuquerque, NM	Intel 8080	4K Opt	2K Opt	Good	Good	\$310
	Motorola 6800	1K Std 8K Opt	1K Std	Console Cassette	Adequate	\$180
Microcomputer Associates Santa Clara, CA	MOS Technology MCS 6502	512 Std 8K Opt	1K Std	Minimal	Good	\$159
Motorola Semiconductor Phoenix, AZ	Motorola 6800	128 Std 640 Opt		No	Minimal	\$149
	Motorola 6800	256 Std		No	Minimal	\$795
National Semiconductor Corp. Santa Clara, CA	National SC/MP	256 Std	512 Std	TTY	Minimal	\$ 99
Polymorphic Systems Goleta, CA	Intel 8080	512 Std 8K Opt	1K Std 3K Opt	Excellent	Good	\$595
Quay Corp. Freehold, NJ	Zilog Z 80	1K Std	1K Std 4K Opt	Minimal	Good, includes PROM Programmer	\$450
RCA Solid State Division Somerville, NJ	CDP 1802 Cosmac	256 Std 4K Opt	512 Std	No	No	\$249
Signetics Corp. Sunnyvale, CA	Signetics 2650	512 Std	1K Std	No	No	\$190

software that is supplied in the ROM and which comes with the kit. What does our \$200 capital investment now buy us? Sad to say, nothing but an academic exercise in microprocessor operations. Even the casual hobbyist, it may be assumed, ultimately wants to see his microcomputer perform a useful or entertaining function. But to do this, a kit enthusiast must be able to code an instruction sequence in assembly language and, manually, enter the set of rules into the

machine. And he must go through the chore each time he powers up the microcomputer unless he opts to leave the power on all the time.

A KICK IN THE HEAD

So now our recreational budget gets a real kick in the head. To do any serious work, we need a teletypewriter to communicate with the machine easily and to write and de-

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kaboodle.**

whole kit &



the kit \$95

the kaboodle \$99

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- FAST BASIC I ROM
- FAST BASIC II ROM
- TC-30 Real Time Clock
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*a product of Hewlett-Packard

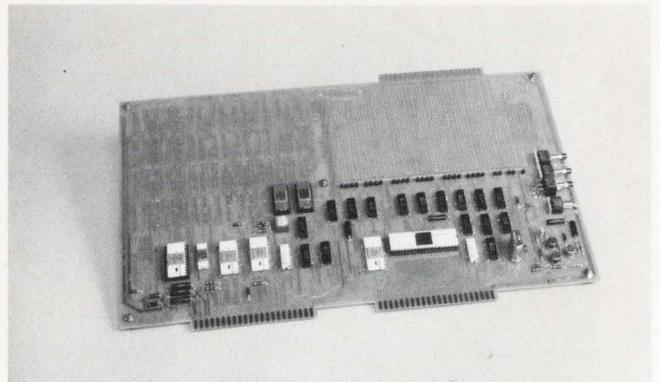


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bug programs. Or, we can buy a CRT keyboard to do the same job, but in either case, we bring our kit budget up to the \$1000 mark.

And if we want to attach the microcomputer to real world devices in an actual application, then we must not forget the cost of either an oscilloscope or a larger test unit to do this work. If we go this route, we have passed the experimental phase and maybe have even developed some computer programs. Any smile of success at this point, however, will not last too long. Almost immediately, another problem arises and a very expensive one: How do we make



RCA evaluation kit

the application programs resident in the microcomputer? Now, our costs can really soar, because this task requires either a punch paper tape, tape cassette, floppy disk, or similar device to input the program into the RAM memory. Alternatively, we could buy a ROM programming unit to do the same job. Whatever the choice, now the micro kit budget is headed toward the \$3000 range.

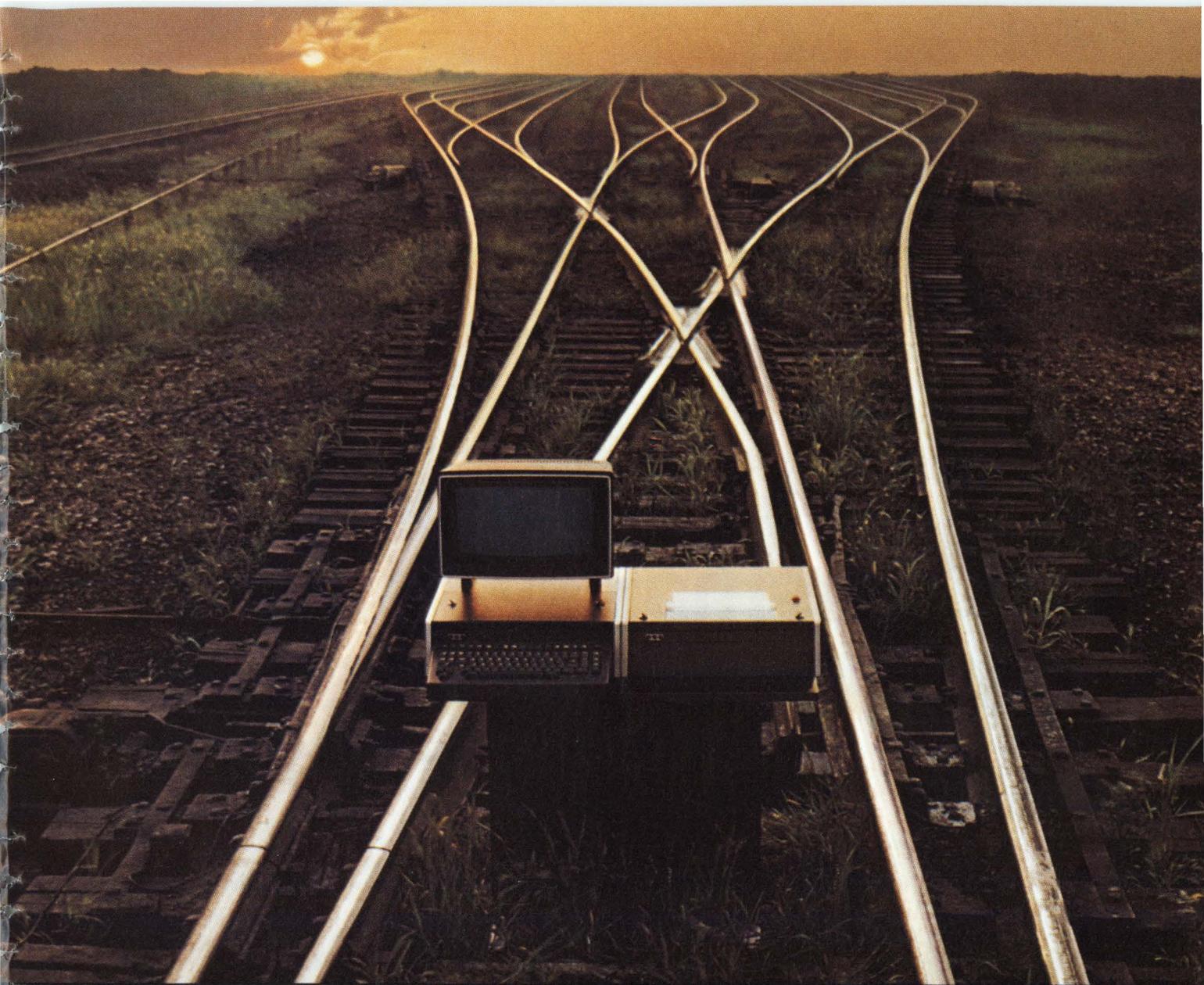
WHO SHOULD BUY KIT?

Most professionals working on an industry project of course, do not bother with a kit. They turn directly to a microcomputer development system to be discussed in the succeeding article. Who then should buy a kit? The credentials one must have to put a microcomputer kit to good use are impressive. First, any prospective builder should be proficient at programming a minicomputer, at least, and preferably have degrees in electronic engineering and com-

REFERENCE LITERATURE

For further information on kits, use the reader inquiry numbers listed below

COMPANY	READER INQUIRY NO.
Advanced Micro Devices, Sunnyvale, CA	103
American Microsystems, Inc., Santa Clara, CA	104
Compsultants Inc., Huntsville, AL	105
Cramer Electronics, Newton, MA	106
Fairchild Microsystems, San Jose, CA	107
General Instrument, Hicksville, NY	108
IMS Assoc. Inc., San Leandro, CA	109
Intel Corp., Santa Clara, CA	110
Martin Research, Northbrook, IL	111
MIT/Altair, Albuquerque, NM	112
Microcomputer Associates, Santa Clara, CA	113
Motorola Semiconductor, Phoenix, AZ	114
National Semiconductor Corp., Santa Clara, CA	115
Polymorphic Systems, Goleta, CA	116
Quay Corp., Freehold, NJ	117
RCA Solid State Division, Somerville, NJ	118
Signetics Corp., Sunnyvale, CA	119



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puter sciences. Indeed, an IBM-370/135, which uses higher level assembly languages, takes much less training and expertise to program than does a fully assembled \$100 microcomputer kit that can be programmed only in machine language — a very difficult task.

Joe the truck driver and Harry the used car salesman, indeed, are some four years of night school away from ever doing anything useful with a microcomputer kit. Moreover, Mike the engineer and Betty the programmer will have to spend many nights at studying manuals before even they can utilize the device, which presumably is “right down their alley.”

The most likely person to make use of a microcomputer kit, indeed, would be someone knowledgeable about computers who wants to extend his professional capabilities

while, at the same time, trying his hand at automating a home furnace, lights, burglar alarm, TV set, or other household appliances.

Students at the Massachusetts Institute of Technology or other universities may also enjoy a microcomputer kit. They should keep the students harmlessly preoccupied, so that they need not seek entertainment by trying to break privacy codes on local time sharing networks. Still other potential users of kits are small business proprietors or physicians and dentists and other professionals who want to computerize their paperwork. But most conspicuous of all, MINI-MICRO SYSTEMS' own 85,000 subscribers, given their background as dyed-in-the-wool computer professionals, may make the most likely prospects of all to dive into the do-it-yourself world of a microcomputer kit. ■

MICROCOMPUTER DEVELOPMENT SYSTEMS

The most vexing problem facing a person who is developing a microprocessor-based system, or microcomputer, is to create and then debug the computer's programs. A rudimentary microcomputer can be assembled from parts very cheaply, as described in the preceding article, and such a device can carry out very powerful processing functions. But, first the device must be loaded with an effective instruction sequence. This entails an I/O format that is convenient to use, the use of high-level languages, and diagnostic aids to do the job efficiently. Therefore, a commercial project to be undertaken by professionals needs the support of a large configuration of conventional computer equipment, though the microcomputer hardware may consist of but a few hundred dollars worth of components.

Program development can be accomplished in different ways:

CROSS COMPILING/ASSEMBLING: This probably is the most cost-efficient software development method overall, since no investment in equipment is necessary. An existing minicomputer, large computer, or even a time sharing service can be used to write and debug what will become the microcomputer program. The advantage is that the designer has access to all of the conventional peripherals and the object code he produces on them can in the final stage be loaded into his microcomputer system.

But this technique has a serious drawback. Using cross compiling/assembling alone, the microcomputer's interface with sensors, data acquisition components, and other real world devices cannot be easily debugged. The designer must resort to cumbersome, time consuming, and costly iterations by trial and error.

MICROCOMPUTER SYSTEMS: These are full-blown operating systems having a complete range of peripherals that nearly rival the assortment offered by minicomputer vendors. Programs can be developed directly on such systems, but then the peripherals are removed to put the

microcomputer-based system into production. Use of the approach is generally limited to applications where the peripherals are either to be part of the system for sale or where they can be used elsewhere when a project is completed.

Microcomputer development systems, which differ from microcomputer systems, are specially designed tools to facilitate microcomputer programming, and do not necessarily employ a full complement of conventional computer peripherals. An investment in a complete development system, which reaches into the \$10,000 range, makes sense only if a company plans to develop an assortment of microcomputer-based systems on a continuing basis.

Development systems come in a variety of formats:

- Exercisers, the simplest type, consists of a hexadecimal keyboard and display. The device, which is designed to handle a specific microprocessor, enables a user to create and debug programs, interfaces, and so on by manual means. An exerciser is sometimes an analyzer and an evaluation module.

- Emulators, do not actually employ the microprocessor directly, but rather emulate it in TTL logic. By means of this indirect technique, a designer can regulate the performance of a microcomputer more precisely. Internal registers, that are inaccessible in a monolithic micro, for example, can be partitioned in an emulator to result in more fully-tuned programs and interfaces. Programs developed in this fashion, of course, eventually run on the microcomputer itself.

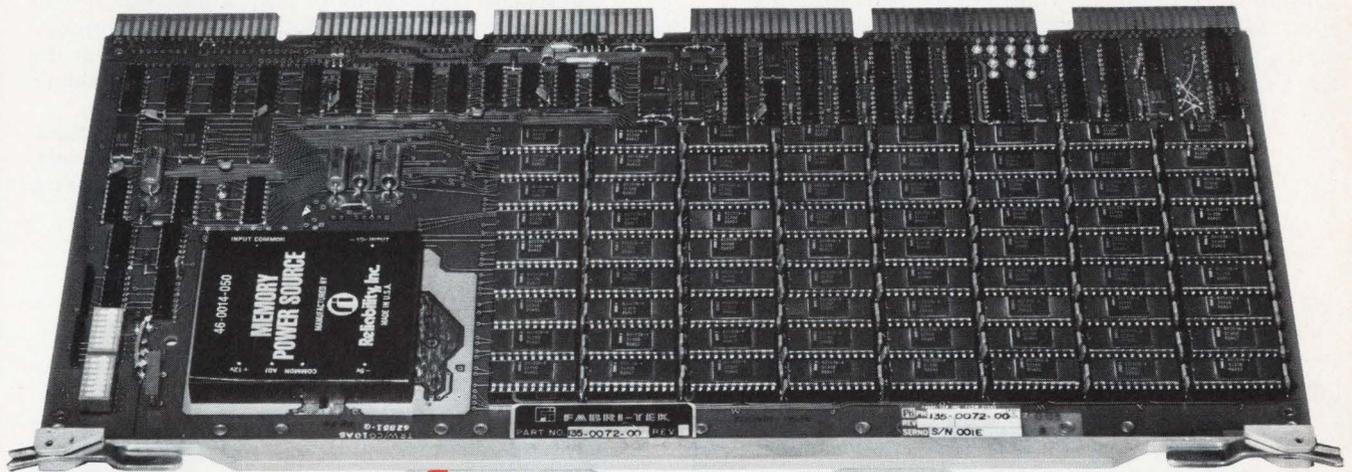
- A full blown development system, which eliminates manual I/O and the need for a user to be fluent in hexadecimal, employs either a teletypewriter terminal, perforated tape, tape cassette, floppy disk, or a CRT keyboard. And they come in a wide variety of options. development systems based on 8080 microprocessor. The bottom-of-the-line unit at \$4919 contains 16K memory and standard utility, editing, debug, and link and load software.

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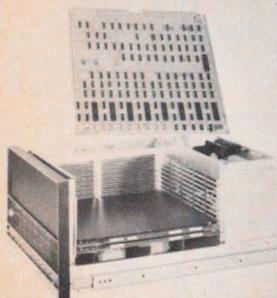
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CIRCLE NO. 18 ON INQUIRY CARD

The next higher model at \$9351 has 24K memory plus a floppy disk and disk operating system. And a top-of-the-line unit at \$13,194 contains 32K of memory, two floppy disk drives, and a line printer as well as a comprehensive software package.

Initially, a development system could accommodate only a single type of microprocessor — largely because such a system was sold by a micro manufacturer itself. But now, development systems that have replaceable front ends to accommodate different microprocessors are beginning to appear on the market. Millennium Inc. in Santa Clara, CA, for example, produces the "Universal One" development system to be used to develop software for the 8080, 2650, and 6800, with an extension of the capability to other microprocessors soon to follow.

A UNIVERSAL INSTRUMENT

Most development systems accommodate but one type of microprocessor, but now Millennium Inc. in Santa Clara, CA, claims to have a universal system that supports the 8080, 6800, and 2650 microprocessors, "with additional devices to be supported in the future," according to Gerald Casilli, Millennium's president.

A universal instrument promises many advantages. For example, it can simplify training and support, since a microcomputer development staff need learn



only one system. In addition, the system can accommodate new microprocessors. Finally, a designer can use the instrument to choose among alternative micros; similarly, different designers can use the same instrument to work on projects that use different microprocessors.

Millennium achieves the universal feature through use of a dual CPU architecture. The company's "Universal One" instrument accommodates the different micros as full PC cards each having in-circuit emulation, and these are contained in a "slave" cpu. Through use of simple operator commands, the slave handles the hardware and interface tasks that relate to the application software. A "master" CPU, based on the 2650 microprocessor and its assembly language, handles the hardware and interface tasks that relate to the application software.

"With this set-up," says Casilli "we never have to redo the operating software again regardless of the microprocessor being used, except for some minor changes in the trace program."

For More Information
Circle No. 56 on Inquiry Card

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General Automation SPC-16	16K Words	\$4,600	\$ 2,000
DEC PDP-11 Core Add-On Unibus	32K Words	\$9,800	\$ 5,190
DEC PDP-11 NMOS Add-On Fast Bus	64K Words	Not Avail.	\$19,000
DEC PDP-11 Core Add-In	16K Words	\$4,500	\$ 1,825
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example, can pay \$24 an hour to rent time at any one of 12 Cramer Electronics design centers. This is an attractive alternative when a company has only a few microcomputer applications at stake. Use of a center affords other advantages too: It can enable a user to try different microcom-

puters. It also enables a user to take immediate advantage of any new devices or advance features that come along. But the convenience of having a microcomputer development system in-house makes it an essential tool for any company intending to use micros for keeps.

REPRESENTATIVE VENDORS OF MICROCOMPUTER DEVELOPMENT SYSTEMS

This directory on microcomputer development systems vendors illustrates the plethora of such equipment that is now on the market to aid microcomputer hardware and software design. The list is not complete, of course, but it does highlight those vendors who are aggressive in supplying such aids.

AMERICAN MICROSYSTEMS INC.

AMI's development system for use with the AMI 6800 microprocessor consists of a CRT-keyboard terminal, dual floppy disk with disk operating system, PROM programmer, RS-232 interface, 16K RAM memory, and software including debug, editor and assembler. The CRT is itself, an intelligent terminal that is microprocessor controlled.

COMPUTER APPLICATIONS CORP.

Computer Applications' MINmic, in a new approach, uses the PDP-11 memory and peripherals to support the design of microprocessor-based systems. MINmic contains an MOS Technology 6502 processor and also logic to interface with the PDP-11 bus. Here is how it works in brief: MINmic software, when loaded into the PDP-11, emulates some or all of the 6502 memory and maps 6502 memory references into the PDP-11 address space. The board contains space for additional RAM, ROM, I/O, etc.

CONTROL LOGIC

Control Logic, one of the first independent microcomputer companies, offers twelve development systems to be used on Control Logic's own line of microcomputers and modules. The product line ranges from a basic development system having an integral microcomputer, Teletype interface, PROM programmer, and basic utility software, including control program and tape conversion program, to an advanced development system that includes dual drive floppy disks, 12K of memory, operating system software, editor and assembler and resident Fortran compiler.

CROMEMCO

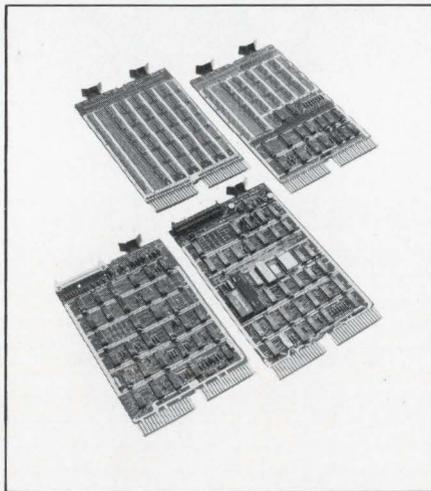
Cromemco's development system for use with the Zilog Z-80 microprocessor includes a Z-80 microprocessor, 8K RAM, 8K PROM, PROM programmer, monitor software, and serial I/O interface. Memory is expandable up to 64K.

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 - Card equipment
 - Paper tape equipment
 - Plotters
- Communications/Terminal Modules
 - Asynchronous Serial Line
 - Synchronous Serial Line



- MDB Backplane/Card Guide Assembly (8 Quad slots) Rack mount chassis 5 1/4" front panel.
- Special Purpose Modules and Accessories
 - System monitoring unit provides front panel switch addressing, power on/off sequencing; line frequency clock.

- Bus extenders/terminators. E-PROM and PROM modules. Bus connectors for backplane assemblies.

MDB Systems products always equal and usually exceed the host manufacturer's specifications and performance for a similar interface. MDB interfaces are software and diagnostic transparent to the host computer. MDB products are competitively priced; delivery is usually within 14 days ARO or sooner.

MDB also supplies interface modules for DEC PDP*-11 Data General NOVA* and Interdata minicomputers.

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*TMs Digital Equipment Corp. & Data General Corp.

CIRCLE NO. 19 FOR LSI-11; 20 FOR PDP-11; 21 FOR NOVA; 22 FOR INTERDATA

DATA GENERAL

Data General development systems used to develop micro-Nova software can also be used to debug interfaces and to maintain and troubleshoot boards in the microNova family. The system is based on an 18-slot minicomputer that includes a 16-bit CPU having 4K-words of dynamic RAM, 12K of additional RAM on two boards, a terminal interface board, power supply, battery backup, and operator's panel. The packaged version is housed in a cabinet that contains a dual diskette and a hand-held programmer's console.

DYNALOGIC CORP. LTD.

The Dynalogic system that is used to develop 6800 software includes a dual drive disk and 8K memory expandable to



Dynalogic Microcomputer System

64K. It also has ports for interfacing terminal and line printer. The software includes a file management system, virtual memory editor, assembler, and debug.

INFORMATION CONTROL CORP.

Both the company's Abacus microsystem and Commander development system are based on the 8080 CPU. They have 8K memory, with half the capacity dedicated to the system software; monitor, editor and assembler. Four of eight I/O

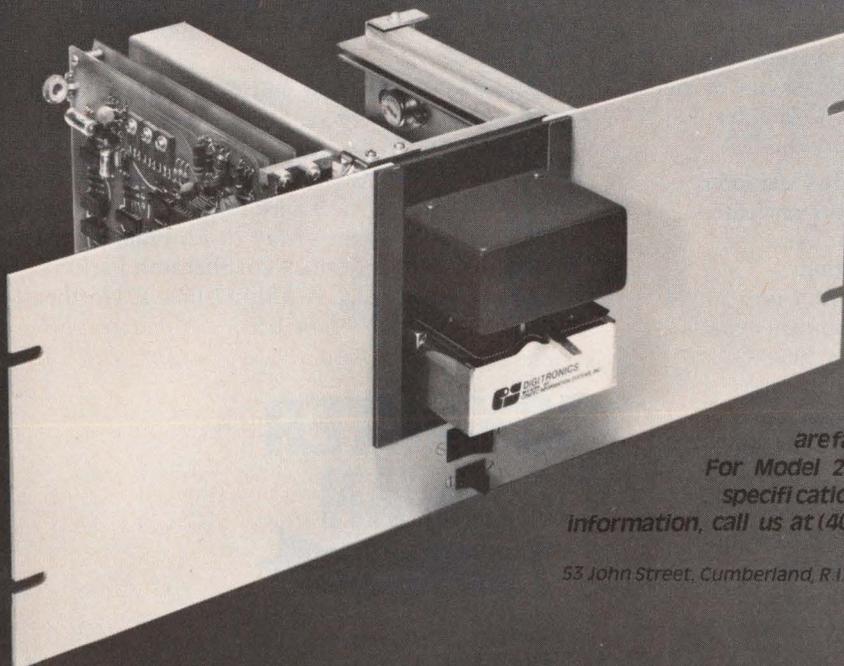


Information Control Corp. "Commander MDS" micro development system.

ports are dedicated to the system peripherals — read tape, write tape, keyboard, and CRT. The real-time clock uses another port, and the user is given access to two other ports via RS-232C interfaces. A final port drives either the Abacus microsystem or the PROM programmer. A 960-character CRT with 53-character keyboard and two cassette tape units complete the package.

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In addition to Computer Expo, there are Computer Designer Forums in the five major US design centers. In San Francisco, Los Angeles, Chicago, New York and Boston, we'll also be conducting Designer Forums from 9AM to 1PM each Caravan day. Leading local designers and independent experts will present tutorials and workshops on these important topics:

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INTEL CORP.

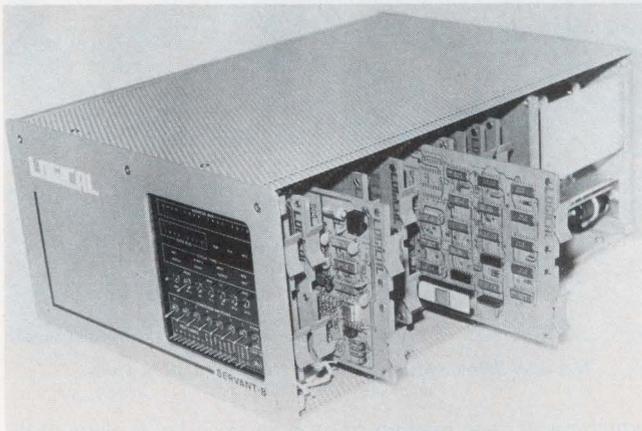
Intel offers a full range of hardware and software development equipment. Its latest system, the MDS, can be used either for hardware and software development or as an in-circuit-emulator. The unit has an 8080-based CPU, 16K bits of RAM expandable to 64K, 2K ROM, and 256 PROM expandable in 6K increments. Peripherals include dual disk, PROM programmer, paper tape, CRT terminal, and printer. Software includes a disk operating system, assembler, monitor/debug, and editor, along with access to an extensive program library. The MDS can also be used as a hardware design aid for the 3000 bipolar microcomputing series.

INTERSIL

Intersil's Intercept prototype evaluation and development system to be applied to the IM 6100 microprocessor uses PDP-8/E paper tape software as control. The Intercept system contains the IM 6100 microprocessor, control panel, 4K RAM and a Teletype interface. The systems also uses a specially developed interactive terminal language and debug program.

LOGICAL SERVICES, INC.

Logical's Servant-8 that is used to develop 8080A software contains a CRT-keyboard or Teletype, monitor, assembler and editor to execute programs in real time. Options include



Logical Services Inc. Servant-8 Microcomputer

paper tape reader and punch, floppy disk, line printer and PROM programmer. A basic terminal-based system has 4K RAM and 6K ROM, including debug software.

MICROKIT INC.

The Microkit-8/16, a stand alone development system, can be used to write, debug, and execute programs on either the 8080 or 6800 microprocessor. Conversion packages are available to convert one type to handle the other in the field and to other microprocessors as well. The system comes with 8K memory, monitor, debugger, editor, and assembler. Optional additions are PROM programmers, add-on memory, line printers, "semiconductor disk" (CCD) memory with resident operating systems, and floppy disk with disk operating systems. The Microkit system can also be used as a self-contained microcomputer system.

MOSTEK CORP.

The company's floppy disk development system supports Zilog's Z-80 microcomputer that Mostek also manufactures and markets. A user's program is placed in RAM instead of PROM, and an in-circuit emulation bus accepts the user's own peripheral devices or memory. A powerful debug module keeps up to 256 transactions in a special memory.

MOTOROLA SEMICONDUCTOR PRODUCTS, INC.

The Motorola's EXORciser is an emulator that is used to develop 6800-based systems. The basic EXORciser has a processor module, debug module, and baud rate module which controls data transfer to an external terminal. The debug module contains the firmware used to evaluate and debug the system. Memory up to 65K bytes and input-output modules can readily be added to the EXORciser; the input-output modules are addressed as memory. A PROM programmer module can also be added. Optional peripherals include dual floppy disk and punched paper tape. Software consists of editor, assembler, linking loader, and Fortran resident compiler.

Motorola also offers the M6800B evaluation module, a microcomputer which allows the user to evaluate a M6800 microcomputer using only a Teletype terminal; it includes 250 bytes of RAM, and a self-contained display and debug program.

MULTISONICS

Multisonics markets three microcomputer development systems based on the 8080 microprocessor and operated through teletype or CRT terminal. Basic and Fortran are also available.

muPRO, INC.

The muPro 80 development system that applies to 8080-based systems has a display console, 16K RAM, dynamic refresh controller, power supply, peripheral interface, and CPU in a chassis alone with three empty card slots. The specially developed BSAL-80 software contains a relocating assembler, linking loader, and text editor. Options include floppies, PROM programmers, paper tape devices, and line printers.

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MYCRON

An 8080-based development system, the basic Mycro-1 package includes a microcomputer module with 1K RAM and space for 2K EPROM, one asynchronous serial interface with 20 mA I/O circuits, system bus drivers, baud rate selector and eight interrupt lines. Mycron, which uses a U.S. distributor, is based in Oslo, Norway, so the microcomputer cards use a double Euroboard standard. An optional floating point arithmetic module can be used to boost the system's speed.

NATIONAL SEMICONDUCTOR CORP.

National offers the SC/MP development system, a simple controller configured to develop and test hardware and software for the SC/MP microcomputer. The minimum configuration consists of a CPU card, a hexadecimal keyboard, four function keys, and a six-digit hexadecimal display. It allows the user, using integral scratchpad memory and RAM-base firmware, to examine and alter the SC/MP registers and memory and to run programs in continuous or single instruction mode. A teletype connection, through



*National Semiconductor SC/MP Development System
with Keyboard Kit.*

which paper tape loading of programs can be implemented, is optional. The system is expandable to 2K of RAM and 4K of ROM.

National also offers the PACER console development system that enables a designer to develop PACE microprocessor-based systems manually. PACER employs a hex keyboard and display with interface to a Teletype terminal.

NEC MICROCOMPUTERS INC.

NEC's PDA-80 is a self-contained, general-purpose microcomputer system designed to do 8080A program development. It is intended for use with an interactive terminal, but can also support a high-speed paper tape reader or punch. The system controls and programs its own PROMs and provides front panel control to enable a user to single step through any program, either by instruction or by machine cycle, and to display and change all internal registers, pointers, and memory. Programs, supplied on punch tape, include editor, debug, assembler, and diagnostics.

OMNICAL CORP.

The Econ-80 emulator by Omnical, for use with the 8080 microprocessor, provides front panel display on all registers, flags, and memory; it also allows direct alteration from the console, though, more typically, it employs Teletypewriter to do the input-output. Econ-80 also contains utility routines and a single-pass assembler that uses paper tape.

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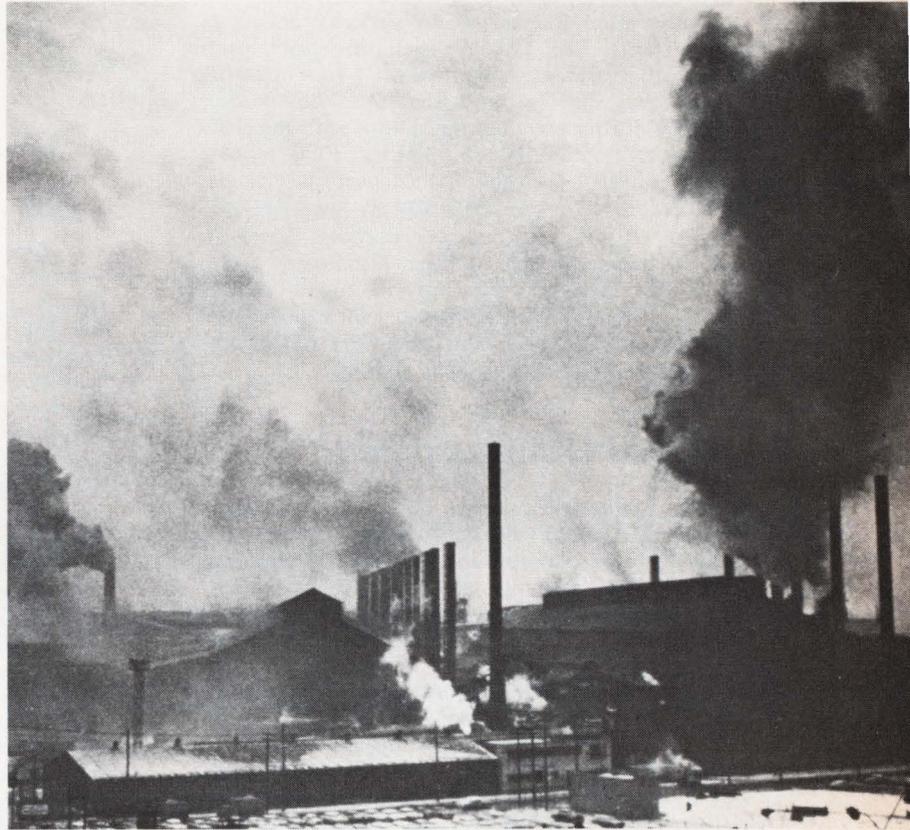
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SIGNETICS CORP.

Signetics claims that its dual-processor prototyping and developing system, called TWIN (Test Wear Instrument), is the first "crash-proof" development system. Application program malfunctions or operating errors frequently destroy or radically alter the operating systems on other development systems. But TWIN's dual processors, each monitoring the other, is said to safeguard all vital information. The two CPUs built around Signetics 2650 microprocessors are in a master slave configuration, with the slave CPU eventually to handle Signetics' other 3000 bipolar micro series plus micros from other manufacturers.

The TWIN system includes dual PROM programmers, dual-drive floppy disks, and operator console. Software includes disk operating system, editor, assembler, debug and diagnostic capabilities. A larger version, super-TWIN is a full-configured microcomputer system including CRT terminal, printer, floppy disk, and dual-CPU microcomputer. Basic memory is 16K expandable to 64K.

TEXAS INSTRUMENTS, INC.

TI markets prototyping and program development systems for use with its TMS 9900 microprocessor and also the 990/4 and 990/10 microcomputers. The prototyping system contains a 990/4 microcomputer with 4K RAM expandable to 20K, a keyboard data terminal, front panel control, and PROM programmer. Software includes debug, monitor, dump, editor and assembler. The microcomputer development systems are based on the 990/4 microcomputer, or 990/10 microcomputer, and the TI 733 ASR data terminal. The system also has a monitor, debug, assembler, and editor software. Memory in the larger unit is expandable to 32K, and it contains both a disk operating system and macro-assembler. Disk and CRT display are options. The 990/10 can be expanded to include a card reader and line printer with Fortran, Cobol or Basic as options.

ZILOG

Zilog markets the Z-80 LSI component set which includes an 8080A-compatible microprocessor and all ancillary circuits. The system can be bought as a development package that also contains a floppy disk operating system, real time debug module, 16K memory expandable to 60K, and a CRT terminal, and line printer. The package can also be used as a self-contained microcomputer system.

REFERENCE LITERATURE

For further information on development systems, use reader inquiry numbers listed below.

COMPANY	READER INQUIRY NO.
American Microsystems Inc., Santa Clara, CA	60
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Control Logic, Natick, MA	62
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THE IDEAL DEVELOPMENT SYSTEM

JAMES MOON / muPro, Inc.

The cost effectiveness of a microprocessor-based system depends largely on hardware and software design. The procedures to do this development work, however, have evolved around simulation techniques that degrade the microprocessor as a systems element, and such techniques often lead to



JIM MOON is vice president for engineering at muPro, Inc., in Cupertino, CA. The company manufactures microprocessor development aids which, Moon says, meet all of the requirements noted in his article.

fickle end products. Problems frequently show up in the final system that did not appear during the development. This occurs because the microprocessor is monolithic, and, therefore, we cannot examine and control the various architectural features. Indeed, the very attempt to do so could lead to their alteration.

Emulation and simulation techniques pose such problems because of the transition that occurs when a development system is unplugged and the program is loaded into the actual micro system. This can cause timing to be off, logic levels to be inadequate, and noise margins to be excessive. Such problems can hurt the development effort either at the component or the system level, and, they can be arduous to pinpoint as well.

ANOTHER LIMITING FACTOR

Programming languages pose yet another limiting factor. The software provided by microprocessor manufacturers are still limited to very basic assembly languages or to high-level languages which generate inefficient object code and, thereby, require additional memory.

All of these extraordinary problems associated with traditional microprocessor development techniques call out for system aids that meet a corresponding stiff set of specifications. Such aids will greatly facilitate not only hardware and software development, but also manufacturing and field support, and thereby lower all costs.

THE CRUCIAL CRITERION

As a generality, here's the most crucial need: Any development system should be completely "transparent" to the product under development. This entails that the aid fulfill all of the following requirements.

- It should run in real time, regardless of whether the program is executed via the micro-based memory or the development system memory.
- It should accommodate the system hardware exactly as if it were in its final form, including the microprocessor chip itself, memory, peripherals, and so on.
- It should not restrict the system architecture on how it can use the available memory or handle the I/O device assignments. It should be able to handle any number of interrupts and accept all priorities. And it should not use any control functions at the chip level.
- It should be completely independent on how the system program employs the microprocessor architectural features, such as the registers, flags, stack, stack pointer, interrupts, and so on.
- It should be able to function with any type of memory — ROM, PROM, static or dynamic RAM.
- It should not have any need to use interface hardware or to require that special software be resident in the system.

- It should not impose any logic loading that differs significantly from that on the chip which is to be emulated.

SOFTWARE CONSIDERATIONS

Software considerations are also critical to a microprocessor application, of course, with efficiency often the key to meeting the real-time requirements, or when volume production is at stake, to reduce any recurring memory costs. Here is the rub, however: Either of these requirements conflict with another — the need to reduce software developments costs via use of a high-level language. Hence, a trade-off is necessary to achieve an optimum balance, and this entails adhering to the following criteria when selecting a program language.

CLARITY AND READABILITY: A programmer should be able to use the language to describe an operation exactly. The statement should be clear to others as well as to the writer. Hence, the language should be easy to learn. Finally, any code that is generated should not destroy registers or flags unless clearly specified to do so.

FULL ACCESS TO MACHINE ARCHITECTURE: A designer must be able to utilize every instruction that a computer can execute. Efficient code generation depends on this.

PROGRAMS EASILY RELOCATED: For the efficient implementation of structured and top-down programming techniques, it is necessary that programs and data storage be relocatable. This allows a designer to concentrate on each specific module, or logical program unit, without having to do manual bookkeeping on addresses or having to manipulate large programs when editing or assembling. To achieve this, in turn, appropriate declarations must be available to render the programs truly independent of any location. The designer must be able to access the labels and variables declared in one program module through access to other modules as well.

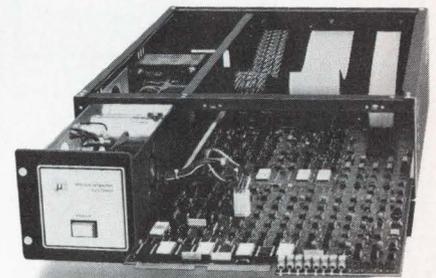
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CIRCLE NO. 27 ON INQUIRY CARD

WHEN TIME IS OF THE ESSENCE

GERALD S. CASILLI / Millennium Inc.

Engineers who incorporate microcomputers into end products can use any one of a great variety of development aids, ranging from a simple PROM programmer to a sophisticated disk-based microcomputer development system. Many options exist because microcomputer development work encompasses both hardware design and software programming, and few products can satisfy all the needs of both

Microcomputer applications themselves also vary greatly, and this, too, accounts for the plethora of development techniques. On one hand, engineers are using microcomputers as controllers simply to replace hard-wired logic. Other engineers are applying microcomputers to sophisticated industrial and process control applications where the complexity is comparable to a minicomputer application.

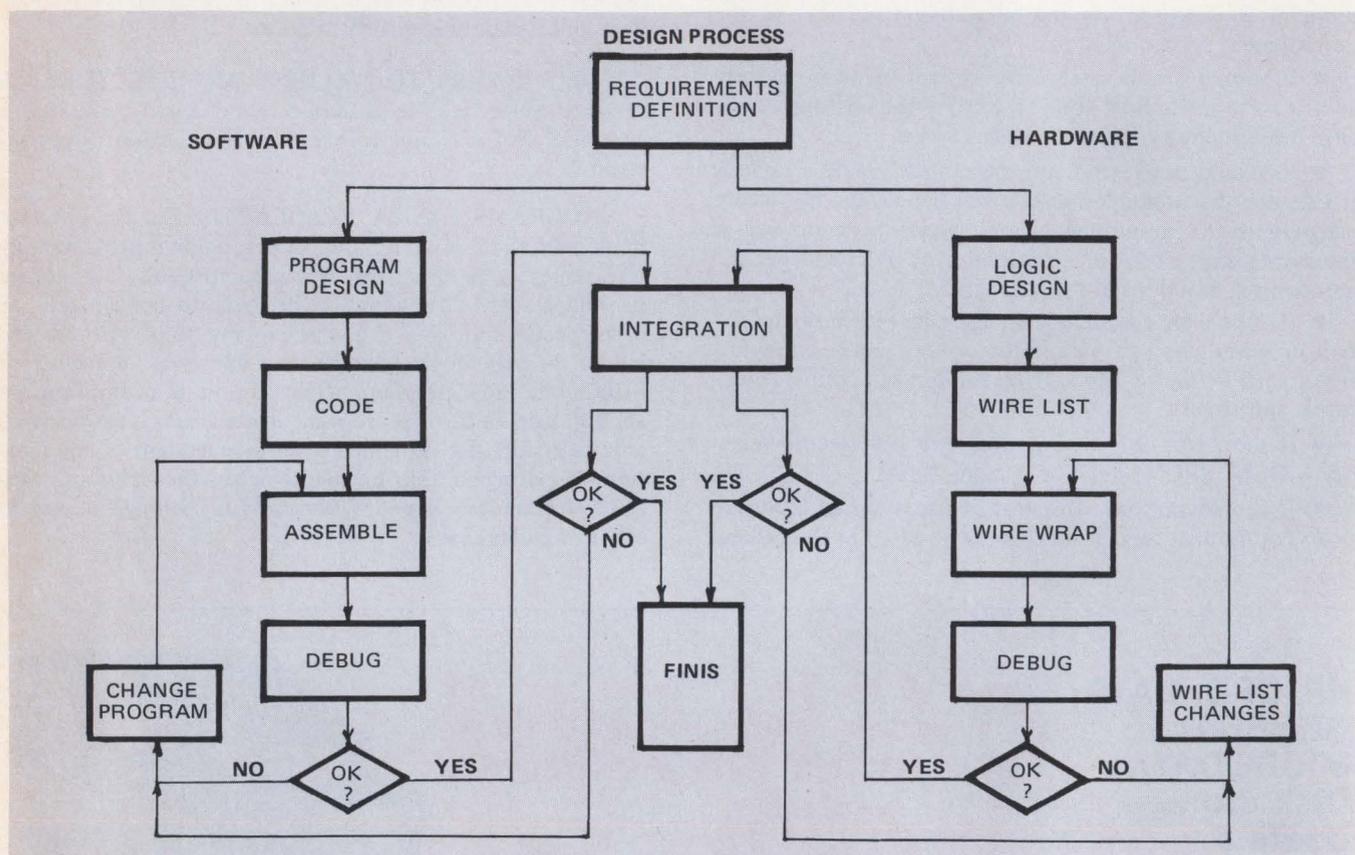


Fig. 1. Design Process

jobs. Some design aids, like logic analyzers, primarily assist hardware development. Other aids, such as high-level languages, cross assemblers, and editors typically offered by time-sharing services, primarily assist software creation.

The most effective development method therefore depends on the project complexity, staff experience and time pressures.

ALL ARE THE SAME

The design process to create a microcomputer-based system, however, is fundamentally the same, whether a project is large or small, complex or simple. That process can be divided into three basic functions (Fig. 1). This includes the software development that entails flow charting, coding, assembly, debugging, patching, and reassembly. It also includes hardware development which entails a schematic preparation, prototype assembly, and then prototype testing, debugging, and modifications. The third function —



JERRY CASILLI is president of Millennium Inc. in Santa Clara, CA, manufacturer of the Universal One microcomputer development system.



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integration of software and hardware — can be the most critical . . . and interesting phase. The key to success? The work of both the hardware designers and software programmers must be coordinated starting at the project's inception, and the two teams must continue to work closely together throughout.

Microcomputer programming may be the limiting factor because it is a new ballgame. A programming staff experienced on minicomputer or big mainframe software development may not be able to handle microcomputer software

as adroitly. Consequently, effective software development tools become imperative to achieve efficiency. Many programmers, nevertheless, have recourse only to a ten character-a-second ASR-33 Teleprinter. Indeed, as many as 50 percent of all development projects adopt this approach. Yet, it is error prone and time consuming (Fig. 2).

EXPENSE JUSTIFIED

Use of such a slow speed teleprinter also leads to a high cost, and a time study would quickly reveal that the time

	Edit, Assemble & List Errors Only	Edit, Assemble To Object & List Entire Program	Load Object Code	Final Test-Edit Assembly & Load	Totals
ASR 33 Papertape-Based Prototyping	485 min.	716 min.	4 min.	720 min.	32 hours
Papertape-Based Prototyping With Hi-Speed Reader	228 min.	239 min.	8 sec.	293 min.	12.6 hours
Time-Sharing Service	3 min.	12.6 min.	4 min.	10 min.	.45 hours*
Complete Self- Contained Floppy Disk-Based System with Printer	4 min.	15.5 min.	0.5 sec.	17 min.	.62 hours

*Output time not included

Fig. 2. PROGRAM ASSEMBLY TIMES. These estimates of the time it takes to assemble microcomputer programs is based on use of the 8080 microprocessor and a 1000-line program. They assume that the designer undertakes an initial assembly and then another to correct errors, a test and debug cycle assembly (but not the actual debugging); and a final assembly. The estimates also exclude the time that it takes to do program design and source coding.

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circuitry which permits operation with low line voltages of 105 v. without affecting picture quality. Normal input power required is low . . . 1,170 watts compared with 1,750 watts, or higher, for other professional television projectors. The handsome PJ5000 is easily transportable and ready to move from your boardroom, to your training center, to your auditorium for intimate or large audiences. And, it operates from standard 120v/20 amp appliance outlets.

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product profile

savings accorded by a faster peripheral, such as a high-speed paper tape reader, and a random storage device would justify the added expense. This significantly reduces program development time as shown in Fig. 2. Nevertheless, the cost to carry out a development remains too high.

Assembly time can be cut still further through use of a time-sharing service or a large inhouse computer system. Such alternatives usually offer powerful file management and text editing to simply and speed program development. The high-level languages enhance programming productivity as well, and the debug software tends to be powerful and complete.

Not everything is gain, however. Development activity on a microcomputer project will typically generate as much as \$5000-a-month in time-share charges. Even an inhouse system does not mean that the programmers' efforts come free or that the resource is free. For one reason, lengthy program listings and object programs are often generated off-line, and the data from the computer center must be physically transported to the development lab. This, too, can cause considerable delay, though it is not factored into

Fig. 2. The technique, though, suffers from a more serious drawback: It affords little support when the hardware and software components are to be integrated.

HOORAY, FOR THE DEVELOPMENT SYSTEM

Here, then, is where the microcomputer development system overshadows all other techniques in many applications. Such a system, if well designed, will include all the tools necessary to handle the hardware design and software development independently and then to facilitate the merger. It will be built around a random access storage unit, such as a floppy disk to provide a flexible disk operating system, and have debug software, use high-level language, and provide in-circuit emulation with sequential program stepping, dynamic trace, and memory mapping. The system should also eliminate paper tape assembly to reduce the assembly time from hours to minutes on lengthy programs.

All of the increased capability, however, becomes reflected in a \$12,000 to \$15,000 price tag (including peripherals). Nevertheless, the investment is justified by the increased productivity, especially when the cost is amortized over many microcomputer development projects. ■

AN ALTERNATIVE TO DEVELOPMENT SYSTEMS

EDWARD LEE / Pro-Log Corp.

It is my belief that microcomputer development systems rather than helping an engineer to achieve a cost effective design, hampers him in attaining that goal, especially when applied to dedicated control functions that have less than 2000 instructions. Assemblers, emulators, and other software tools that comprise a development system are but remnants of a lingering data processing culture that still dominates our industry. Microprocessors, however, are not EDP-type computers — they are control elements, and as such, they can be viewed as logic elements. An engineer is more proficient when working with this approach, and as a result he would do better, in lieu of a development system, to design and debug a microcomputer-based program from the bottom up with a pencil, paper and a lab testing workbench.

MAKING IT SIMPLE

An engineer will find microcomputer system design much simpler to execute if he can view software development in the same light as he approaches hardware design — with each software procedure along the way having an equivalent step within the more familiar world of hardware design (Fig. 1). Flow charts and coding used in programming, for example, parallel block diagrams and schematics used in

hardware design. PROM programming, too, can be viewed as an equivalent to breadboarding.

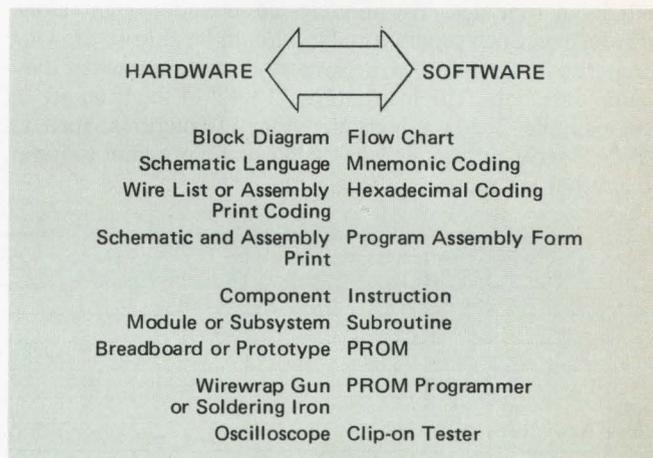


Fig. 1. Hardware and Software Counterparts

Pro-Log Corp. follows just this kind of an approach that makes programming similar to hardware development (Fig. 2), and it begins when an engineer writes a product's specifications. He uses these to construct hardware block diagrams and to determine what functions are to be implemented in hardware and in software. He then lays out the hardware elements to show how each will connect to the microprocessor. Next comes the detail software design, and this starts with a flowchart to break the system into easy-to-use-modules. This produces an immediate advantage: Coding of the modules can be divided among several engineers to shorten the design cycle.



ED LEE is president of Pro-Log Corp. in Monterey, CA. The company markets a wide range of four- and eight-bit microprocessor design aids.

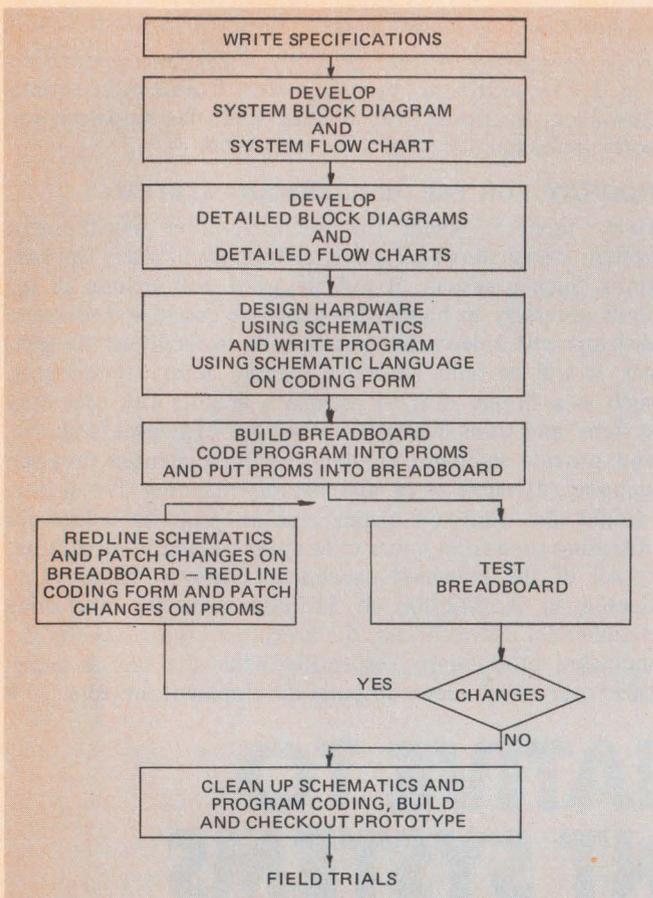


Fig. 2. Pro-Log Design Procedure

THE PRO-LOG WAY

To code a program the Pro-Log way, the engineer writes a program overview along with the jump instructions to the individual modules. The modules are coded as stand-alone subroutines. Such program coding should be akin to drawing a schematic. Certain instructions act like components; they manipulate data. The instruction, "FIM," in the Intel 4040, for example, loads a register. Other instructions, such as "JUN," serve as jumper wires and cause a program to jump to another instruction.



Pro-Log design technique, modeled after how an engineer works, incorporates block diagrams, flow charts, schematics, pencil, paper, scotch tape and scissors rather than assemblers, compilers, and high-level languages.

The Pro-Log coding procedure differs from other programming techniques in another way, too. The documentation is intended to be understood by a technician, even one having no program training. This is done via a "comments" column in the Pro-Log "assembly form" that explains the instruction's impact on the hardware design. In Fig. 3, the example shows that "FIM" sets a register to 12 o'clock. The column, if prepared correctly, reads just as a flow chart does and a technician will then be able to locate a faulty module quickly.

THE NEXT STEP

The next step in programming development again parallels hardware design. An engineer translates the coding into

HEXADECIMAL			MNEMONIC		INSTRUCTION		TITLE	DATE
Page	Line	Instr	LABEL	Operation	Operand		COMMENTS	
0	00	00		NOP				
	1	50		JMS				
	2	60				(CLR DISP)		
	3	2E		FIM	P7		SET TO 12 O'CLOCK	
	4	12		I	R		HOURS	
	5	2C		FIM	P6			
	6	00		O	O		MINUTES	
	7	2A		FIM	P5			
	8	00		O			SECONDS	
	09	50	CLOCK	JMS			SHOW TIME	
	A	BE				[DISPLAY]		
	B	50		JMS			WAIT 1 SEC	
	C	E4				(1 SEC)		
	D	50		JMS			SET CLOCK PER KEY INPUT	
	E	20				(SET)		
	F	50		JMS			COUNT TIME BY 1 SEC	
0	10	80				(COUNT)		
	1	40		JUN				
	2	09				CLOCK		
	3							

			REG PAIR	
E	HOURS	P7	HOURS	F
C	MIN	P6	MIN	0
A	SEC	P5	SEC	8
B	DISPLAY	P4	DISPLAY	9
8		P3		7
4		P2		5
2	Δ	P1	Δ	3
0	Δ	P0	Δ	1

Fig. 3. (using Intel 4040) Main Program for a 12-Hour Clock System

hexadecimal, just as he would generate a hardware wire list from the schematic (Fig. 4). Most hexadecimal instructions are eight bit or two hexadecimal characters, and they are superior to octal or binary when it comes to address and instruction coding. Binary is hellish to apply, and octal lacks specific time slots on four- and eight-bit processors.

Putting the code in PROM and placing the wire design on a breadboard completes the design. The next step occurs at the engineer's workbench that is equipped with an oscil-

HEX CODING	MNEMONIC		DESCRIPTION OF OPERATION
	OPR	OPA	
0 0	NOP		No operation.
0 X	4040 Instructions		
1 0	SKP		Skip the next instruction word.
1 C _x A ₂ A ₁	JCN LABEL	C _x	Jump on condition C _x to the program memory address A ₁ . A ₂ , otherwise continue in sequence.
2 P _x 0 D ₂ D ₁	FIM D ₂	P _x D ₁	Fetch immediate from program memory data D ₁ . D ₂ to index register pair P _x .
2 P _x 1	SRC	P _x	Send register control. Send the contents of index register pair P _x to I/O ports and RAM register as ship select and RAM character address.
3 P _x 0	FIN	P _x	Fetch indirect. Send contents of register pair 0 out as a program memory address. Data fetched is placed into register pair P _x .
3 P _x 1	JIN	P _x	Jump indirect. Jump to the program memory address designated by contents of register pair P _x .
4 A ₃ A ₂ A ₁	JUN LABEL		Jump unconditional to program memory address A ₁ . A ₂ . A ₃ .
5 A ₃ A ₂ A ₁	JMS LABEL		Jump to subroutine located at program memory address A ₁ . A ₂ . A ₃ . Save previous address (push down in stack).
6 R _x	INC	R _x	Increment contents of register R _x .
7 R _x A ₂ A ₁	ISZ LABEL	R _x	Increment and step on zero. Increment contents of register R _x . if result is not 0 go to program memory address A ₁ . A ₂ . otherwise step to the next instruction in sequence.
8 R _x	ADD	R _x	Add contents of register R _x to accumulator.
9 R _x	SUB	R _x	Subtract contents of register R _x to accumulator with borrow.
A R _x	LD	R _x	Load contents of register R _x to accumulator.
B R _x	XCH	R _x	Exchange contents of index register R _x and accumulator.
C D _x	BBL	D _x	Branch back one level in stack to the program memory address stored by a prior JMS instruction. Load data D _x to accumulator.
D D _x	LDM	D _x	Load data D _x to accumulator.
E X	I/O and RAM register instructions		
F X	Accumulator instructions		

Fig. 4. Hexadecimal Translation Table

loscope, power supplies, voltmeter, PROM programmer and a clip-on system analyzer. Here he does program debugging. The clip-on analyzer does not wind up as part of the end system, as does the control panel that is built into a development system, and this lowers the final product cost. Meanwhile, the analyzer, which clips directly to the microprocessor, enables the engineer to observe all data that flows into or out of a chip. By simply setting address switches, he can synchronize the analyzer on any program step to determine the status of any instruction. The analyzer also generates a scope synch on an oscilloscope so that the engineer can check the hardware should he suspect any fault.

WHEN AN ERROR OCCURS

If a program is in error, the engineer "redlines" the incorrect coding and then, while copying the master PROM, burns in the corrected codes. The big advantage: If the program change is also incorrect, an engineer can return to the original master PROM. In a development system, the origi-

nal coding is usually lost when program changes are made, unless the engineer has an unusual memory.

After designing and debugging each module, the engineer next repeats the procedure on each subsystem and the final system. All of this leads to better field maintenance, as well. Because the system was designed, developed, and documented as a collection of modules, technicians can test it out more readily.

THE GAINS

When it comes to design time, it is a toss up as to which method is faster: the Pro-Log technique or a development system. An engineer accustomed to the Pro-Log technique can code a 700-instruction program in about 40 hours. Likewise, it takes about the same amount of time when using the high level language available in a development system. True, it is faster to code a line using a high level language, but the approach also entails about double the lines of coding to accomplish the same task.

The Pro-Log technique does, however, result in more organized programming and a substantial cost saving as well. A Pro-Log starter set that contains a one-card programmed logic system, power supply, four PROMs, PROM programmer, and system analyzer, costs \$2950. In addition, a week-long design course to learn the Pro-Log technique costs \$350, and the price of an oscilloscope and voltmeter must also be added if none are already on hand. But all of this comes nowhere near the cost of an effective development system — typically, \$10,000. ■

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Microcomputer pro with the Iasis Co

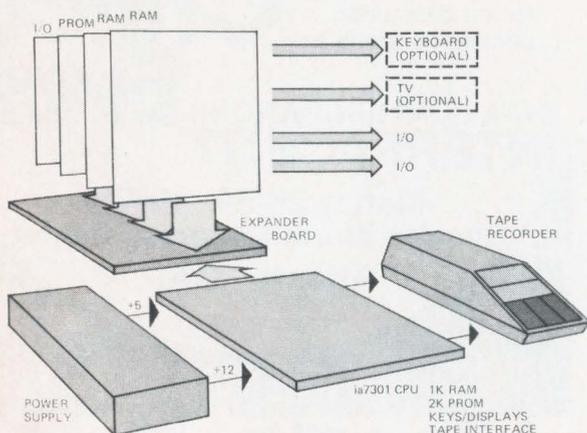
The fact is that right now microcomputer programming is a bear. Microprocessors are loaded with subtleties which make software development a long, arduous process. That's why we developed the ia7301 Computer in a Book*. It's a fully operational microcomputer system and a 250 page programming course all contained in a 3-ring binder. This is not a kit or a toy but a powerful, microcomputer system (based on the industry standard, the 8080) and a practical programming course specifically designed to quickly bring you up to a high level of understanding and proficiency in programming 8080 based microcomputer systems.

The Computer in a Book comes to you completely assembled and tested. All you need is an inexpensive dual voltage (+12V & +5V) power supply. The -5V is generated internally in the computer. There is nothing else to buy.

A super programming course

The programming course text is easy to follow and begins with a one instruction program to determine if a switch is open or closed. This is built upon and expanded through all 78 instructions until 250 pages later, you become adept at programming complex problems like multi-byte arithmetic and games of skill like Pong.TM Only with Iasis Computer in a Book can you have the advantages of a handy programming text together with an operational computer to load and test programs each step of the way and thereby learn the intricacies of microcomputer programming at a comfortable pace.

And since this microcomputer has a special built in monitor program which allows you to look into the operational parts of the system you'll never get bogged down in debugging or editing. The ia7301 Computer in a Book is the fastest way to learn everything about microcomputer programming.



*U.S. Patent Pending
Pong is a trademark of Atari, Inc.

Some great microcomputer features, too

The microcomputer system features a 24 pad keyboard, 8 seven segment LED readouts that display information in hexadecimal code which is far more versatile and advanced than binary or octal coded systems, and an onboard cassette tape interface for saving programs. The hexadecimal keyboard also contains 6 special mode keys which allow you to call up and change any data or instructions in the CPU registers or in the system's RAM memory. Likewise programs can be executed instantly or they can be stepped through one instruction at a time using the appropriate mode key, so that you learn your way around the inner working of an entire microcomputer system.

Also the write tape and read tape mode keys have been carefully designed for accurate and convenient operation with any home cassette tape recorder that has an earphone and remote microphone jack. Two LED indicator lamps tell how long it takes to dump or reload programs from the system's memory onto tape and back again. But in the reloading cycle, if any errors have occurred such as a lost piece of data or the volume knob is too low, the readout displays will indicate errors. This little feature prevents untold problems in debugging a reloaded program.

Upwards expandability from the start

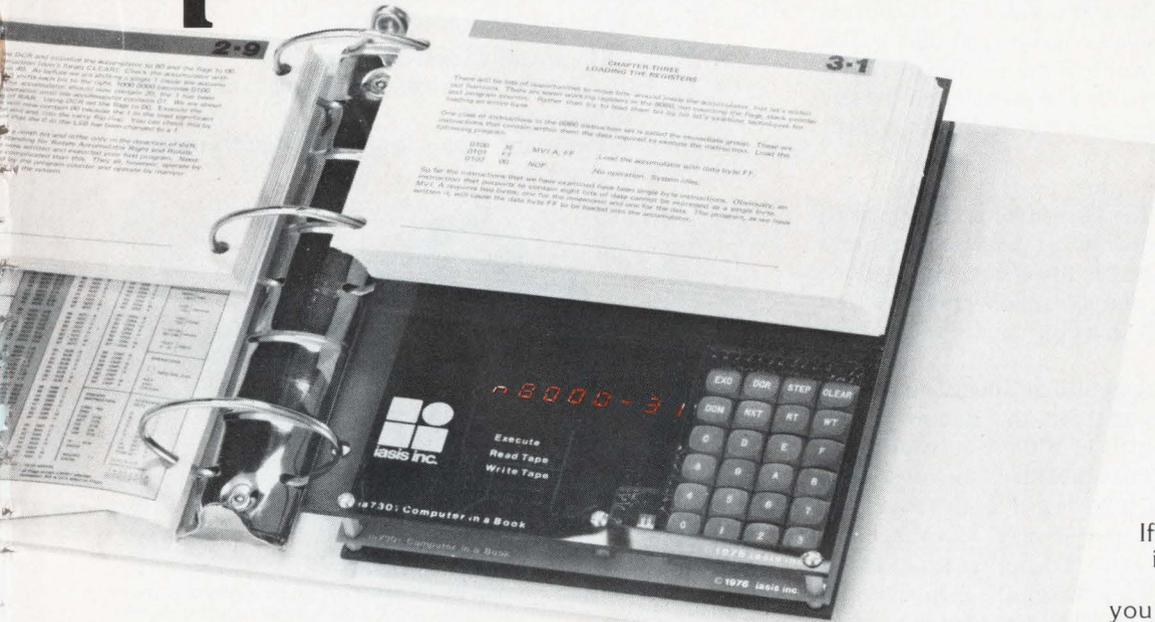
We designed the Computer in a Book to be upwards expandable and not become a kluge in the process. The microcomputer contains 1K bytes of RAM memory, 1K bytes of PROM memory (containing the monitor program), and 2 I/O ports. The Computer in a Book is expandable to virtually any level you want, i.e. up to 65K bytes of memory and 256 I/O ports.

Optional expander boards are available and attach to the ia7301 computer at the top edge connector. A wide variety of standard interface boards can be plugged into the system to give add on memory, TV and teletype interface, and much more.

Thus what served as an educational system can now be upgraded for many new applications. We've included a machine language coding pad for writing and documenting programs, working out subroutines and pro-

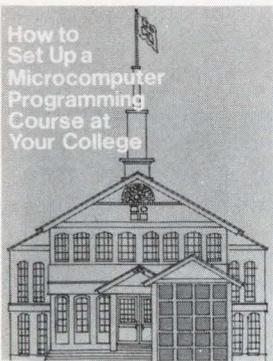


programming is a snap computer in a Book



viding general support to a development system when extensive programming or debugging is necessary. The Computer in a Book may also be used to train field service technicians by putting verbal information and programs on cassette tapes. We are coming out with preprogrammed PROM and extension tapes containing new application packages such as floating point arithmetic and micro-assembler programs. Our goal is simple. We want to provide microcomputers that are useful and practical.

A college assistance program



programming and get valuable hands-on experience with operational systems at very reasonable prices.

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The complete Computer in a Book which includes an operational 8080 based system, 250 page programming course, machine code pad, hexadecimal conversion card all in a 3-ring binder is offered for only \$450. The Computer in a Book has a 90 day parts and service warranty. Iasis also provides a check out list and start up instructions with each system. Please allow 30 days for delivery.

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SINGLE BOARD COMPUTER:

Zilog Emphasizes Throughput

A microcomputer board set, based on the Z80-CPU, has been introduced by Zilog in Cupertino, CA. The set consists most notably of a microcomputer board, and also a disk controller board with RAM memory and a 16K byte RAM card. "This microcomputer board is physically half the size of the nearest competitor," exclaims Robert Sumbs, Zilog's director of marketing.

The Z80-CPU, announced just a few months ago, accounts for Sumbs' claim. The N-channel processor has a 158-instruction set that includes the 78 instructions in Intel's 8080A. The Z80 also incorporates three functions — clock generator, system controller, and dynamic memory refresh controller — that the 8080A handles as three separate peripheral chips.

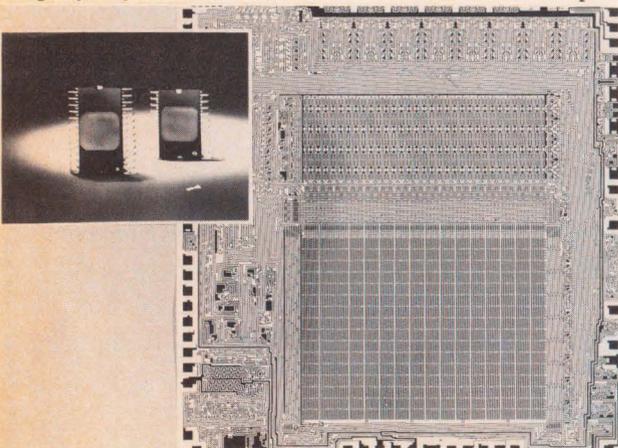
All of this results in a throughput that Zilog claims is five times that of the 8080A. In addition, the microcomputer board, which sells for \$300 each in 100 lot quantities, has 4K bytes of RAM. Exudes Sumbs, "This is the most compact and powerful microcomputer board available today."

Each board in the set operates at only +5 volts, has a standard 122-pin connector with 100 mil. spacing, is 7.7 inch x 7.5 inch in size, and fits between 0.5-inch spacings. Zilog offers the boards as a complete system, including card cage, system chassis, power supply, two floppy disks, and a front panel. Or the boards may be purchased as separate items:

MICROPROCESSOR BOARD: In addition to the 4K bytes of RAM, this board has sockets for 4K bytes of ROM, PROM or EPROM, one serial channel for use by a CRT, and finally, two channels of parallel I/O. Other features include four programmable counter-timer circuits; full flexibility when buffering and terminating the parallel ports; and universal parallel I/O programming.

The PPS-8/2: Rockwell Plays Leapfrog

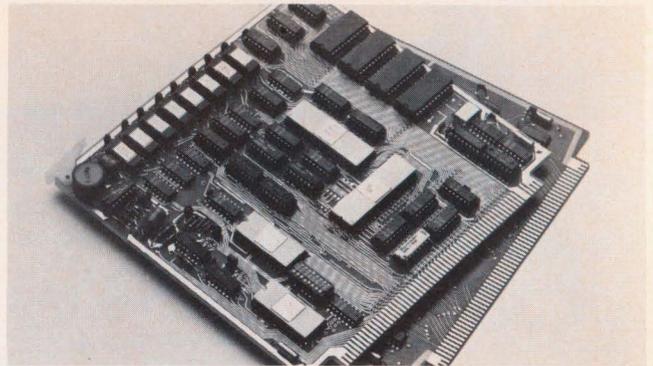
The Microelectronic Device Div. of Rockwell International has developed two 8-bit microprocessor systems that the company says reduces the cost of a basic microcomputer



A 52-lead quad-in-line package is necessary on the PPS-8/2 microprocessor system to accommodate the "great functional density."

DISK CONTROLLER: This board, which contains 12K bytes of dynamic RAM with full buffering and control, allows a user to store and retrieve data from as many as four floppy disks. The controller includes:

- 16-bit CRC generation and checking
- Z80-P10 used for disk status reading and control under CPU software control
- Data separator and data encoder that can be used for single density drives



Zilog's microcomputer board set consists of a Z80 based microprocessor board, a disk controller, and a 16K byte random access memory card.

- Parallel/serial converter and wait control logic to allow Z80-CPU to transfer data to or from the disk under software control
- Parallel I/O port

Zilog also provides a disk operating system, and a memory board that uses high speed RAMs allows the user to expand to 65K bytes in 16K increments. ■

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"by 50 percent" in many applications. Designated the PPS-8/2 family, the two systems form complete 8-bit microcomputers on only two chips and, thereby, functionally replace systems formerly requiring five LSI circuits. Only one other component is necessary to complete the microcomputer — a comparatively low-cost 3.5 MHz TV crystal.

Each of the systems are equipped with a CPU chip and a combination ROM-RAM-I/O chip that features one automatic serial and 16 parallel I/O ports, 16-bit interval timer, 3-level interrupt, clock circuit, 64x8 RAM, and either 1024x8 or 2048x8 ROM. Both have 109 instructions. Price of the 1K ROM microcomputer starts at \$25 a piece in 1000-lot quantities; the comparative price for the 2K ROM microcomputer is \$30.

The Rockwell spokesman points to cash registers, electronic typewriters, instrumentation, consumer games, gas pump controls, and similar equipment as "economic" application areas for the PPS-8/2. The two-chip microcomputers can be expanded though to handle more complex applications, because "they use the same instructions as

Rockwell's more powerful PPS-8 system." In addition, either micro can be combined with some PPS-8 LSI circuit options to structure full-scale systems.

The two PPS-8/2 chips are organized as follows:

- A CPU chip (P/N 12806) contains logic to handle system operations, math and data manipulations and to respond to three interrupt request lines that provide a total of 15 sublevel interrupts. In addition, as many as four A21XX or A22XX circuits can be added to the 42-pin CPU without need to tack on support circuitry.

- A combination ROM-RAM-I/O chip with two options — either a 2K ROM (P/N A21XX) or 1K ROM (P/N A22XX). Both use 52-pin quad-in-line packages to accom-

A Bipolar Micro Is Used To Control Floppies

Most microprocessors on the market employ MOS technology, but the Scientific Micro Systems subsidiary of Corning Glass Works has instead turned to LSI bipolar microprocessors to take advantage of the greater cycle time speed. The so-called SMS 300 bipolar device has other things going for it too: It is the only bipolar CPU that contains a clock and sequential logic on a single chip to make the device both compact and suited to control applications.

Unlike an Intel and Motorola, SMS has also stayed away from mass applications, and instead has pursued custom design business, touting its higher speed micro as a marketing point. The approach has been so successful that SMS is now offering a production version of a floppy-disk controller that incorporates the unique bipolar microprocessor and is to be used with minis and micros.

The new, microprogrammable controller, the FD series, can be hooked onto virtually any disk drive — interfacing requires only a change in the programming of a 2K PROM. In a hard-wired controller, the interfacing entails a rewiring job in the PC board. By using firmware, SMS was also able to pack the controller with more features. The controller, for example, offloads much of the DMA function from the host computer so that after the CPU issues a simple I/O command to the controller to initiate a disk operation, it does not need to intervene again. Another gain: The CRC calculations are performed by firmware, as well. "This is unknown to an MOS processor," says Mike Liccardo, SMS's product manager.

Interfacing the controller to a host computer, which can be a PDP-8 or PDP-11, various microprocessors, and other byte-oriented systems, is also a simple task because of the controller's microprogramming feature. To make the controller plug- and instruction-compatible with the PDP-8, for example, the company had simply to add logic to the standard interface and use firmware to perform the control sequences.

SMS is still developing the software driver for the PDP-8, but this will also be easy to do because the microprocessor can offload many of the functions that otherwise would be handled by the driver. Nevertheless, a lot of work is ahead to make the controller compatible with all minis on the market. This is because each mini turned out by some 50 vendors requires a different interface. "Microprogramming should make the job easier, however," says Liccardo.

modate "a unique functional density" that includes I/O ports, 16-bit interval timer, and the RAM and ROM.

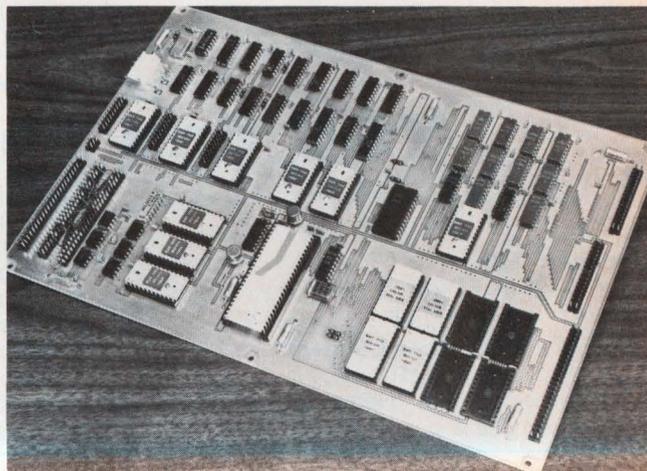
The number of I/O control lines available on each device can be readily expanded because each contains an automatic serial port. Also available is direct I/O line manipulation with set, reset, test with skip, and byte compare instructions.

The company makes yet another claim for the PPS-8/2 system with regards to its bus structure and the way the CPU and ROM, RAM and I/O are partitioned. "The design," says a spokesman, "eliminates the severe compromise between architecture and ease of expandability that is commonly encountered in other minimum chip microcomputers." ■

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A similar set of circumstances holds true with the floppy-disk drives. Now, the FD controller is programmed to be compatible only with IBM-3740-formatted single-density drives that are available from Shugart, Orbis, CDC, and others. But, by changing the PROM programming, the FD controllers can be made compatible with other drive types as well, including double density, dual-sided, and other types.

Liccardo reports that Shugart, in fact, is buying an FD-0300 to be used on a mini diskette that Shugart introduced over the summer and which is smaller and less expensive than the standard IBM floppy-disk drive. The custom controller uses a smaller, 6x9-inch board, but otherwise it em-

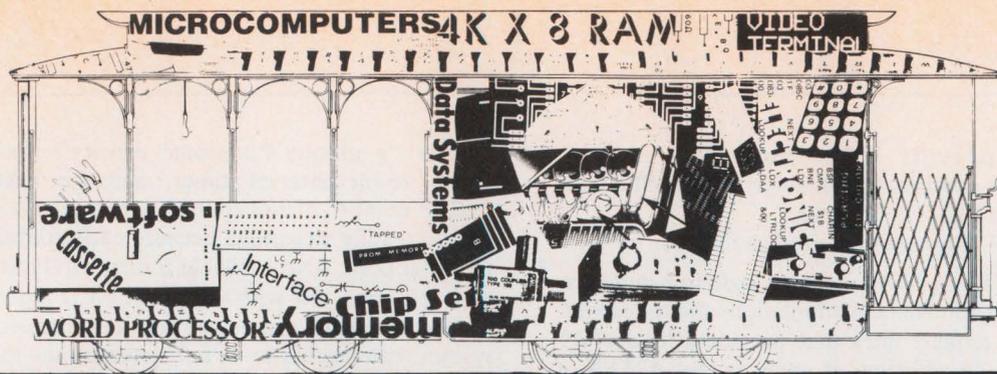


Scientific Micro Systems' FD0300 Floppy Disk Controller

plies the same design, microprocessor, and 1K RAM as in the general purpose controller. "All we really had to do," Liccardo explains, "was to change the firmware to account for the differences in data rate, signal line, and format."

SMS's controllers intended for the PDP-8 and 11 contain 2K PROM and handle up to four single density formatted drives with overlapped head seek. The 8.5-inch x 15.7-inch board is priced at \$460 when used with the PDP-11 and \$440 with the PDP-8 in quantities of 100. The FD0300 general purpose controller, which also handles up to four IBM-formatted drives, is priced at \$320 a unit in 100 lot quantities, but its smaller 8-inch x 12-inch board does not contain as much logic as the custom DEC boards. The mini diskette controller, meanwhile, sells at \$275 each in 100-lot quantities. ■

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ACCT TRIES TO STOP BULLY BELL

Among the groups fighting the Bell muscle in Congress on the Communications Reform Act is the Ad Hoc Committee for Competitive Telecommunications. Ironically, one ACCT member, Datran has dropped from sight due to Bell's successful anti-competitive measures. Although the FCC declared Bell's DDS rate anticompetitive, the decision came too late for competitor Datran to survive.

While the heavily funded Bell lobby in Congress argues competition in the telecommunications industry has actually caused higher rates for the consumer, the ACCT, with its present members, MCI Telecommunications Corp., Southern Pacific Communications Co., and the United States Transmission Co., contends that competition has not hurt Bell and has helped the consumer. ACCT President C. Gus Grant says Bell's growth was four times that of the combined competitors last year. While AT&T revenues grew \$2.8 billion from 1974's \$26.8 billion, the combined revenues of Bell competitors in the specialized carrier and interconnect industries, according to Grant, grew \$72 million from 1974's \$114 million.

COMPETITION HELPS

FCC Chairman Richard E. Wiley supports Grant's contention. "This competitive environment which emerged following Carterfone," says Wiley, "has sparked innovation, reduced costs for terminals and stimulated a consumer responsiveness on the part of the telephone industry." Among the services the competition, not Bell, innovated, according to Wiley, are:

1. The first switched network just for digital data, which meant faster and more error free transmission. (Unfortunately, Datran didn't live to enjoy it.)
2. Packet switching transmission for lower cost in volume data communications.
3. Faster data and facsimile transmission.
4. Satellite transmission with rates insensitive to distance.

Competition not only helps, it's not new to the market of telecommunications, says ACCT's Grant.

COMPETITION SINCE 1894

Bell had the telecommunications market all to itself from 1876 to 1893 at which time the Bell patent expired. Within four years after that, 6000 in-

dependent telephone companies sprouted. The competition at that time, according to the 1938 Walker Report by the FCC, fostered "expansion of telephone use, improvement in technical developments, stimulation of long distance service, reduction in rates, inauguration of rural services and duplication of facilities.

By 1910, the Mann-Elkins Act amendment to the Interstate Commerce Act protected AT&T from competitors and guaranteed AT&T's profits for local and long distance voice telephone service. One portion of the telecommunication market not controlled by Bell was the record portion held by Western Union. The Bell monopoly of voice communications continued to grow until 1959 when the "Above 890 MHz Proceedings" allowed private microwave systems between two points if the volume were sufficient.

The 1968 FCC decision gave Carterfone and private parties permission to connect their own terminal devices to the telephone lines. One year later, the FCC gave MCI the green light to build the first specialized common carrier microwave facility for transmitting

messages between subscribers. The 1971 Specialized Common Carrier Decision extended this ruling. And by 1972, the FCC gave any technically and financially qualified organization permission to set up satellite communication systems.

THE MONOPOLY JUSTIFICATION

The government originally gave Bell the monopoly for voice communications and permission to cross subsidize so the populous of a town of 500 could have the same telephone service and rate structure as a town of 500,000. As the definition of telecommunications broadened, so did the Bell monopoly. Until 1968, Bell monopolized not only voice communications, but also terminals connected to Bell lines and most nonvoice services. Then the FCC decided Bell would still be able to make a profit even with some competition in the nonvoice areas of the industry.

The FCC and the courts have defined Bell's monopoly as it is now. But time will tell if money and muscle can help Bell regain and expand its monopoly.

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PACX SYSTEM

PACX II from *Gandalf Data, Inc.*, (Wheeling, IL) is an enhanced version of the company's original Private Automatic Computer Exchange. A remote computer port in PACX II lets users monitor requested connections and disconnections. Both PACX I and PACX II systems have optional asynchronous hardware to allow computer port selection and contention at speeds up to 9600 bps.

Circle No. 90 on Inquiry Card

MESSAGES FROM OUTER SPACE

A combination of Western Union Information System's C-2100 front-ends and Sperry Univac's 494 message switching system will channel information from NASA's satellite network, NASCOM, to 12 control centers at the Goddard space center and 20 NASCOM network sites throughout the country. Western Union's front end will replace six multiplexers and will compress 224 teleprinter traffic signals from such satellites as Landsat, Atmospheric Explorer, Orbiting Solar Observatory and the High Energy Astronomical Observatory.

ACOUSTIC COUPLER

The FM30 acoustic coupler operates at data rates up to 300 bps in the originate mode. The unit has both EIA RS-232C and 20mA current loop interfaces and full or half duplex operation. Price is \$270. *Multi-Tech Systems, Inc.*, Minneapolis, MN.

Circle No. 91 on Inquiry Card

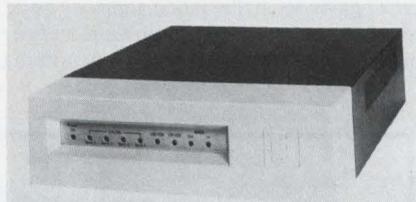
µP-BASED COMM PROCESSOR

The Process Control side of Honeywell, Inc. has designed a microprocessor-based communications processor for remote unattended operation. Both asynchronous and synchronous channels can communicate with other network components at up to 230K bits per second. Prices start at \$7300.

Circle No. 92 on Inquiry Card

MODEM SHARING

The Multiple Access Unit with four terminal ports operates at data rates to 96,200 bps. In a polled network, the



MAU-1 provides the EIA RS-232C or CCITT V24 interface between four synchronous or asynchronous terminals at the same location and a single modem or data service unit. *General DataComm Industries Inc.*, Wilton, CT.

Circle No. 94 on Inquiry Card

INTERSTATE NETWORKS: ONE OUT, ONE IN

Private carrier Datran no sooner closed its doors than ITT Corporate Communication Services, Inc. announced it was spending \$13.5 million to build a private telephone and data network. Rockwell International will build the coast to coast network for the New York-based ITT subsidiary and hopefully complete it by January, 1978. Rockwell's Collins Commercial Telecommunication Division will build switching systems in Atlanta, Chicago, Cleveland, Dallas, Los Angeles, Memphis, and New York. The Switched Private Network Service for small users will offer such special features as per call billing, traffic statistics and abbreviated dialing. Corporate users can take advantage of the company's corporate communications switching equipment.

DATA BASES CROSS THE SEAS

Western Union International has extended its European Datel communications access service to an international data base access service. The initial 4800-bps line for the Database Service will run between WUI's New York office and the British Post Office. In the U.S., users can access lines through the public switched telephone network or through Tymshare's Tymnet packet switching network with terminals operating at 110, 135, 150, 300 or 1200 bits per second. With the service, a UK user can access, for example, the National Library of Medicine Medline service over British telephone lines. The U.S. rate is \$10 per hour and \$.50 per kilocharacter, plus a monthly access charge. WUI plans to start the service this month if the UK approves and hopes to extend the Database Service to other countries and other networks.

MODEMS AND MUXES

Both DDS and conventional facilities can use the Timeline 290 Mini-multiplexer. The synchronous time division multiplexer splits a 2400, 4800, or 9600-bps facility, into two, three or four separate channels. Inputs may be a mix of DDS and conventional at speeds of 600, 1200, 2400, 4800 and 7200 bps. A switch for each channel sets it in local loop or test mode. High speed channel diagnostics are also included. Price of a four-channel mini-multiplexer is \$1500. *Infotron Systems Corp.*, Pennsauken, NJ.

Circle No. 98 on Inquiry Card

This multiport communications interface with four or eight channels slips into one slot of a Data General mini. Each 15x15-inch board has all necessary control logic. The system handles from four lines to a maximum of 64. Prices start at \$1250. *Custom Systems, Inc.*, Minneapolis, Minnesota.

Circle No. 100 on Inquiry Card

The Model 720 multiplexer splits DDS links operating at 4800, 9600, or 56,000 bps into two or more channels, synchronous or asynchronous. The multiplexed channels may be dial-up or leased, full-duplex or half-duplex. Half-duplex, polled multipoint circuits can also be multiplexed. Prices start at less than \$1400 per end. *Micom Systems, Inc.*, Chatsworth, CA.

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TERMINALS

The Design 2400 KSR/T teleprinter from *MI² Corp. (Columbus, OH)* has a microprocessor-based programmable protocol interface board so it can adapt to various line protocols.



The terminal transmits data at selectable speeds of 75 to 9600 bps in half duplex, echoplex or full duplex modes.

Circle No. 96 on Inquiry Card

Olivetti Corp. of America (New York, NY) is going to market its TE 400 modular teleprinter in the U.S. The system can be used on a dedicated or switched network using five-level Baudot code.

Circle No. 95 on Inquiry Card

Randal Data Systems (Torrance, CA) is marketing the Digital's LA-180 Decwriter with an RS-232 interface. The terminal also features block transmission and error correction capability. Price is \$3735.

Circle No. 97 on Inquiry Card

NEW PRODUCTS FOR NEW INTERFACES

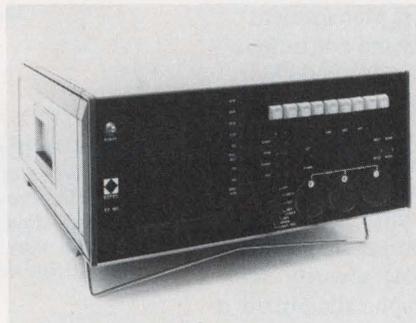
Motorola Semiconductor Products, Inc. has a new quad line receiver and quad line driver to go along with the new RS-422 balanced line interface and RS-423 unbalanced line interface approved by the Electronic Industries Association. RS-422 and RS-423 interfaces specify longer cable lengths and higher data rates than the popular RS-232C interface. The MC3486 receiver and MC3487 driver are Schottky TTL-compatible, have three-state outputs and operate from a single +5 volt supply. National Semiconductor will second source the 16-pin packages.

TIMES DATA BASE JOINS TELENET

It's easier now for users to access the massive New York Times information base with over 1 million abstracts from the New York Times and 65 other English journals. The new access method - Telenet's packet switching network - connects users from 46 U.S. and Canadian cities with the Times service.

PORTABLE COMM TEST

The TT-101 portable communications test unit can monitor speeds from 50 to 9600 bps in the asynchronous mode or up to 1 megabit per second in the synchronous mode. All monitored



data can be stored in from 1K to 4K of memory. The CRT displays the nine-channel logic recorder levels as well as the ASCII, EBCDIC and hexadecimal codes. *EOTEC, Santa Clara, CA.*

Circle No. 93 on Inquiry Card

SATELLITE DELAY COMPENSATOR

American Satellite Corp. may have a solution for propagation delay in satellite data transmission. When a satellite circuit is used for data transmission at rates above 2400 bps with IBM's Bisynch or HASP Multileaving, there's always a loss in throughput. The company's Satellite Delay Compensation Unit improved throughput by 3.5 times in a 7200-bps test transmission between Los Angeles and New York using the Bisynch mode at 80 characters per block. The SDCU is directly compatible with the terminal device, which it emulates in its response. Consequently, the SDCU will allow throughput limited primarily by the basic transmission rate of the line and by the capability of the data terminal to use the line. Internally, the SDCU restructures the data blocks before transmission. At the remote end, the data blocks are restored to their original formats. *American Satellite Corp., Germantown, MD.*

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CIRCLE NO. 2 ON INQUIRY CARD

book review

PRINCIPLES OF DATA BASE MANAGEMENT, by James Martin, Prentice-Hall, Inc., Englewood Cliffs, NJ, 352 pages plus index. \$18.50.

Reviewed by Kenneth Falor

When I first picked up this book, I said to myself: "Here must be another dust-dry professional thesis on the metaphysics of data bases!" But then I flipped through the book, and it astonished me. Although author James Martin has a Physics degree from Oxford University, the book shows that he has spent most of his life in the real world. I recommend this book to virtually anyone who either wants to understand the DBMS concept or to justify its use to upper management. Indeed "Principles of Data Base Management" should be read by detail-oriented presidents and controllers as well as edp managers and systems analysts. It would help them to make important decisions concerning DBMS, such as: Why should we use the technique at all? How can we best ease into DBMS? How do we design schema-subschema structures to be used in a specific application?

Though the book does not talk to the mini/micro world per se, the concepts fully apply to small computer systems. The author gives valuable insights into DBMS security and privacy matters, on-line requirements, geographically distributed data bases, query languages and systems, data dictionaries, and centralized data base administration. It also contains some practical advice on how to avoid catastrophes when designing a DBMS.

The book excels even in the way it handles detail. Though it provides brief examples on DBMS coding, it does not attempt to teach a programmer how to do a data base code; it is not that specific. The author's strategy is to work his way from a discussion on the practical aspects of the DBMS philosophy to details on:

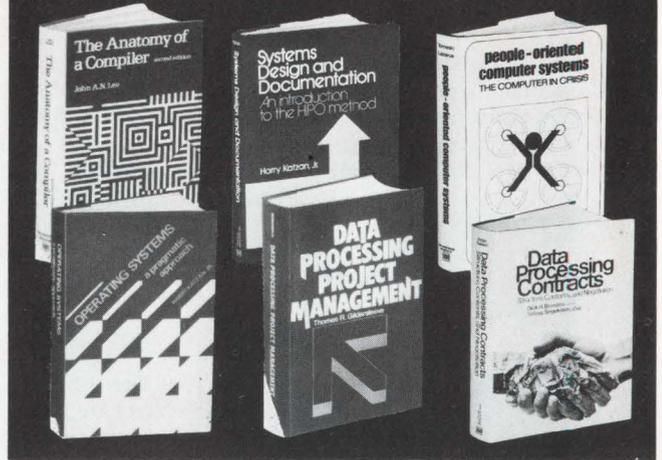
- The relationships possible with IMS
- Example coding with CODASYL Data Description Language
- The exact mechanisms for various record search techniques (block, binary, etc.)
- The addressing mechanisms behind lists/chains with multiple keys

All of this is clearly described and illustrated through the use of many appropriate diagrams. Drawbacks do exist, but these are minor. One nuisance is the way Martin inserts too many pro-IBM viewpoints. This is not only unbecoming, but also they are tiresome. But Martin works at IBM, and that is a price we must pay to gain access to his expertise.

The volume also concentrates too much on IBM's IMS data base routine, and hopefully, Martin will add chapters eventually on other data bases, such as TOTAL, IDMS, ADATABASE, IDS. The book also draws upon manufacturing for examples on data base structures. Thus, the volume will be especially useful to computer workers in an industry environment.

(Ken Falor is vice president for marketing at The Management Group in Norwood, MA.)

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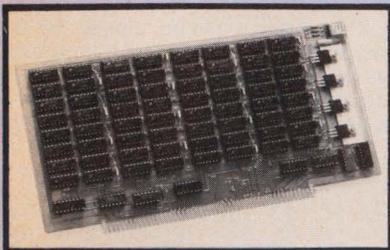
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MINI/MICRO MEMORIES

8K RAM for Micros. Vector Graphic, Inc. (Thousand Oaks, CA) has an 8K board compatible with the



MITS and Imsai backplanes. The board has buffered address, memory protect and 450-nsec access.

Circle No. 132 on Inquiry Card

More 8K Micro Ram. The MB6 8K board from Solid State Music (Santa Clara, CA) is compatible with the MITS and Imsai microcomputers. The 500-nsec memory with memory protect sells for \$295 assembled and \$250 unassembled.

Circle No. 134 on Inquiry Card

11/70 Core Memory System. The Ecom 70 memory system from Standard Memories (Newport Beach, CA) comes in a 17-1/2x19x22-inch rack mount chassis assembly that attaches to DEC's 11/70 bus. The cabinet houses from two to 16 32K-byte core memory modules and a remote programming box with reconfiguration controls so the user can select the address range of the memory. Price of 64K-byte system is \$7100.

Circle No. 133 on Inquiry Card

11/70 RAM Memory System. Intel Memory Systems (Sunnyvale, CA) has a 10-1/2x19x25-inch box that holds from 128K to 4M bytes of add-on memory for DEC's 11/70. The in-1670 has error correction checking, error logging circuits, 750-nsec cycle time and 550-nsec access time.

Circle No. 135 on Inquiry Card

6800 DEBUGGING

The Microprocessor Analyzer for Motorola 6800s displays system status, analyzer status, address bus and data bus. Unique features are a slow memory speed simulator and an execute control that allows instructions to be submitted independent of normal program flow. An optional sequence recorder stores up to 128 instruction addresses and displays program sequence forward or backward. Price of the MPA AO 6800 is \$695. AO Systems, Inc., Yorktown Heights, NY.

Circle No. 168 on Inquiry Card

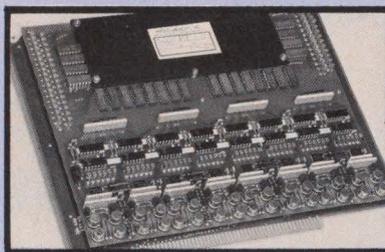
60-Nsec Bipolar Module. The 4Kx18 module from Nanodata Corp. (Williamsville, NY) has a dedicated I/O bus and memory select circuitry for operation on 512-word boundaries. Price for the module, measuring 6x7-1/2 inches, is \$2500 in OEM quantities.

Circle No. 129 on Inquiry Card

8K Core for IMP. The 8Kx16 RAM core from Micro Memory, Inc. (Chatsworth, CA) is designed for use with National's IMP-16P microprocessor. The memory's access time is 350 nanoseconds and cycle time is 1 microsecond. Size of the board is 8.5x11 inches.

Circle No. 130 on Inquiry Card

6800 Core. The MM6800 8K core module from Micro Memory, Inc. (Chatsworth, CA) plugs into Motorola's connectors for the EXORciser



development system and MEC 6800 evaluation module. Price of the memory with 350-nsec access time and 1- μ sec cycle time is \$592.

Circle No. 136 on Inquiry Card

16K and 8K NMOS for LSI-11. The Monostore XI/Planar from Monolithic Systems Corp. (Englewood, CO) allows LSI-11 users to add up to 24K memory using only two slots of the bus instead of the six required for DEC's 4K memory. DEC uses "burst refresh." Monostore uses "cycle steal refresh." Access time is 450 nsec; cycle time is 600 nsec. Price for a 16K board is \$1195.

Circle No. 131 on Inquiry Card

INVENTORY CONTROL SYSTEM

This mini-based production and inventory control system is written in Ball's DASL language. The basic \$37,900 system has a 16-bit mini with 64K bytes of core, two CRTs, 5.8-megabyte disk, control console with hard copy printer and disk-based operating system and data base software. Application modules, selling for \$3000 to \$8000, can be added to the basic system for inventory control, order entry and sales analysis. Ball Computer Products, Inc., Sunnyvale, CA.

Circle No. 148 on Inquiry Card

160-CPS PRINTER

The bidirectional Model T-1602 matrix printer uses a microprocessor to compute the shortest distance to the next print position to achieve throughput up to 200 lines per minute. Standard



features include a 7x7 matrix font, double width character capability, upper/lower case, forms length selection, and self-test. OEM prices start at \$3115. Tally Corp., San Francisco, CA.

Circle No. 163 on Inquiry Card

PLASMA DISPLAY

The Self Scan Series C4101 displays between 19 and 96 characters depending on character format desired. The device has 17 horizontal rows by 192 columns which can be easily adapted for displays of graphs, signatures, waveforms, etc. Burroughs Corp., Plainfield, New Jersey.

Circle No. 188 on Inquiry Card

ONLINE CLASSROOM

The Online Classroom teaching terminal system has a CRT display for online operation and control by the instructor, auxiliary keyboards that are used by the students, large video display monitors to facilitate easy viewing in the classroom or lecture hall, a printer interface for keeping a record of the class's transactions, and an instructor control module which is used to enable the individual student keyboards. The number of keyboards used depends on the size of the classroom, number of students in the class, and the application itself. Digi-Log Systems, Inc., Horsham, PA.

Circle No. 189 on Inquiry Card

PULSE RECORDER INTERFACE

This module interfaces a DEC PDP-11 mini and the company's pulse and transient recorder. Users can address the module for changes. Price of the interface is \$1075. American Electronic Laboratories, Inc., Lansdale, PA.

Circle No. 190 on Inquiry Card

MULTITERMINAL BUSINESS SYSTEM

Basic/Four Corp.'s System 700 includes the company's own microprogrammed CPU, four display terminals, 300-lpm printer, two 50-megabyte disk drives, and 64K memory (40K user, 24K operating system). The disk storage subsystem is organized around a programmable bipolar LSI microprocessor to handle many of the time-consuming housekeeping chores normally performed by the CPU. The CPU is equipped with an eight-page firmware set, giving it a large machine language instruction capability especially suited for executing the system's Business Basic II. Prices start at \$115,000. *Basic/Four Corp., Irvine, CA.*

Circle No. 181 on Inquiry Card

PAGE PLOTTERS

The Series 600 desktop page plotters start at about \$2600. The Model 600-502 acts as an intelligent controller for keyboard printers. It selects plot commands from the data stream and passes the data to the terminal to be printed. A compressed data code, combined with a line generator and a character generator in the plotter, allows the plotter to operate at a maximum speed over a 300 baud line. Large quantities of text can be mixed with the graphic data without loss of throughput. The other two Series 600 models come with serial or parallel inputs. All Series 600 plotters can be converted from one configuration to another in the field, simply by changing one pc board. *Broomall Industries, Inc., Broomall, PA.*

Circle No. 141 on Inquiry Card

PORTABLE SOURCE DATA

The electronic notebook can collect, store and transmit information. The terminal is about the size, shape and weight of the commonly used clip board, measuring 9x13x3/4 inches and weighing only 1-1/2 pounds. Users can key in codes of up to seven digits, which are then displayed on LEDs. A



built-in battery pack provides for over 10 hours of operation. Standard memory is 2K, and is optionally expandable up to 12K. Price is \$1000 in single quantity. *Azur Data, Richland, WA.*

Circle No. 173 on Inquiry Card

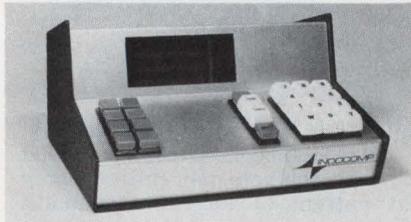
FLOATING POINT UNIT FOR 8080

The Floating Point Unit extends the 8080 instruction set to include binary-to-floating point decimal conversion, trigonometric functions, logarithms and powers, coordinate transformation and mean and standard deviation. To perform a function, you must load the argument pointer, answer buffer pointer and function code into the CPU registers. The FPU is then called as a subroutine would be. *Cybernetic Micro Systems, Palo Alto, CA.*

Circle No. 152 on Inquiry Card

DATA COLLECTION

The Concept terminals for industrial data collection feature CMOS logic, 16-character displays and 12-character keyboards. They communicate with the computer via a full-duplex, asynch-



ronous current loop or modem interface. Options include a 22-column badge/80-column punched card reader, 32-character expanded display, full alphanumeric keyboard and 32-character back page buffer. Single unit prices start at \$1350. *Indocomp, Inc., Royal Oak, MI.*

Circle No. 157 on Inquiry Card

2K CACHE BUFFER FOR 11/45

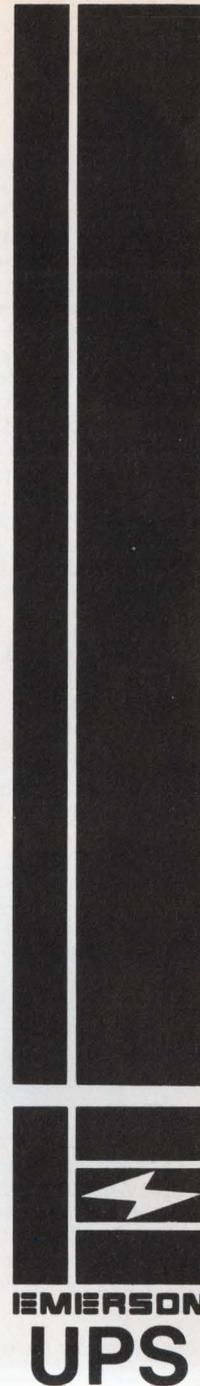
Cache/45 provides buffer control over every core memory address location on the DEC 11/45 Unibus for improved performance of the 0-124K address field. The 2K-byte cache buffer is mounted on a PC board that plugs into the chassis. Price in single quantity is \$7000. *Able Computer Technology, Santa Ana, CA.*

Circle No. 174 on Inquiry Card

REEL-TO-REEL TAPE TRANSPORT

The Qantex Model TDX/8 tape transport uses a floating shuttle buffering method instead of vacuum column buffering. This means fewer parts, lower weight, reduced complexity, improved MTBF, simpler operation and lower power consumption. The shuttle can be operated at reduced atmospheric pressures so it's ideal for avionics applications. The transport uses small 8-1/2-inch reels, but has a speed of 75 ips. This gives the 7/9-track unit a 120KB/sec transfer rate. Price is less than \$5600. *North Atlantic Industries, Inc., Qantex, Div., Plainview, NY.*

Circle No. 167 on Inquiry Card



Accupower™, the uninterruptible power system from Emerson is now keeping over 200 computer installations on line.

You'll get an all solid-state design ...and protection from outages, brownouts and fluctuations. Plus complete voltage frequency and transient control.

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CIRCLE NO. 33 ON INQUIRY CARD

μC WITH I/O

The Sol Terminal Computer has memory, processor and I/O interfaces all on one board so it can be used as a micro-computer, low cost CRT terminal or editing terminal. Built around the 8080, the Sol terminal consists of a PC board with the microprocessor, 512 eight-bit bytes of PROM on a plug-in personality module, 2048 eight-bit words of RAM, a 1024-character video display generator, keyboard interface, serial and parallel interfaces for connection to external devices and an edge connector for memory expansion. Memory can be expanded to 65K bytes. Sol is completely compatible with Imsai, Altair and other S-100 bus computers. Price is \$475 in kit form. *Processor Technology, San Francisco, California.*

Circle No. 147 on Inquiry Card

IN-CIRCUIT EMULATOR

The muPro-80-E adds in-circuit emulation capabilities to 8080A or 8080A-2 microprocessors. It can segment memory and I/O devices between the sys-



tem under test and the muPro-80-E. The modular package has a hexadecimal control/display console, the 8080 emulator, a power supply, two interchangeable 40-pin headers, interconnecting flat cable and user's manuals. Single unit price is \$3250. *muPro, Inc., San Jose, CA.*

Circle No. 144 on Inquiry Card

DEC DRIVES

Digital has four new disk drives. The RP05 and RP06 are latest members of the RP family of disk pack drives, designed for PDP-11, Decsystem-10 and Decsystem-20 computers. The RK06 cartridge drive operates with Unibus-based PDP-11 computers. The RK05F is used with the PDP-8 and PDP-11 families. Price for the formatted 176-megabyte RP06 drive is \$34,900. The RP05 uses the older RP04 disk pack and carries a \$29,900 price. The top loading RK06 drive has a new dual-disk cartridge with a storage capacity of 14 megabytes and a \$9500 price. The \$6500 RK05F with a fixed, double density cartridge complements the RK05 disk cartridge drive. *Digital Equipment Corp., Maynard, MA.*

Circle No. 149 on Inquiry Card

HOLOGRAPHIC MEMORY TERMINAL

The Holofile Data Terminal features a holofile memory that stores up to 200 million bits on a 4x6-inch holographic fiche. The terminal developed by TRW consists of a reader housing the memory, a laser, an optical sensing array, associated electronics — plus a keypad/



display for addressing the memory. When the laser beam strikes a particular hologram, the hologram emits a binary light pattern of its entire contents. This pattern is converted to electronic data by the optical sensing array, and clocked out at rates to 5 megabits per second. Price in production quantities is under \$500. *Holofile Industries Ltd., Woodland Hills, CA.*

Circle No. 145 on Inquiry Card

NUMERIC DATA ENTRY

The HP 3070A and HP 3071A desktop terminals are designed for operators in industrial or commercial environments with little or no experience in using computers. The HP 3070A interfaces with the HP 1000, 2100 and 21MX computers. The HP 3071A takes care of most other manufacturers' computers. Both models have numeric-only keypads for entering data and have 16-digit numeric displays. A special keyboard and prompting-light labeling technique makes it easy to customize the terminals for a wide range of applications. Price for the 3070A in quantities of 10 is \$1308. *Hewlett-Packard Co., Palo Alto, CA.*

Circle No. 192 on Inquiry Card

FLOPPY FOR SYSTEM/7

The 3100 diskette interfaces to IBM's System/7 for use in various businesses, libraries, colleges, and in manufacturing. The 3100 diskette format is compatible with the IBM 3741, System/32, and 360-370 diskette devices also. With four drives per controller, the 3100 provides System/7 users with 1 megabyte of storage. *Advanced Electronics Design, Inc., Sunnyvale, CA.*

Circle No. 140 on Inquiry Card

SCIENTIFIC ECLIPSE

The Eclipse S/230 computer is the scientific version of the recently announced business Eclipse C/330 mini with the new memory mapping and protection unit. Also featured on the new Eclipse is a 64K-byte MOS memory module, allowing a maximum 512K-byte 500-nsec memory. *Data General Corp., Southboro, MA.*

Circle No. 153 on Inquiry Card

LSI-11 BACKPLANE

The MDB backplane increases the card capacity of DEC's LSI-11 to 10, instead of six, terminal posts for housing eight quad modules or 16 dual modules. An expander chassis holds the cooling, front panel and optional power supply modules. Price of the backplane is \$295; the expander chassis is \$350. *MDB Systems, Inc., Orange, CA.*

Circle No. 198 on Inquiry Card

TABLETOP BURSTER

The 260 burster puts out data and word processing forms at either 82 or 125 feet per minute. A patented



tear bar measures the forms length, ensures smooth forms feed, and eliminates jams. *Tion Equipment Co., Oakland, CA.*

Circle No. 185 on Inquiry Card

COLOR GRAPHIC DISPLAY

The Model 2000 memory and display buffer produces a color graphic image with input from a 16-bit mini or a nine-track tape drive. Images are refreshed 30 times per second to present a bright flicker-free display and can be photographed for permanent record storage. The Model 2000 accepts sequential pixels (picture elements), originating at the upper left hand corner, moving left to right, a line at a time, top to bottom, for a total of 480 lines of 512 pixels. One major application for the new system, according to the company, will be animation production. *Comtal Corp., Pasadena, CA.*

Circle No. 197 on Inquiry Card

DISK CONTROLLER FOR INTERDATA

This \$1900 controller makes a 50 MB Trident disk system possible for less than \$8000. The single-card TDC 803 interfaces to Interdata minis and five sizes of Calcomp Trident drives. The



controller comes complete with cables to the first drive, a diagnostic/formatter package, and drivers for any current Interdata operating system. *MiniComputer Technology, Mountain View, CA.*

Circle No. 176 on Inquiry Card

TERMINAL WITH DUAL μ P

With its dual 8080s, the React intelligent terminal system can either communicate with a host or operate offline in a free-standing mode. Users can program in Intel's PL/M high level language and can access from 250K to 1M bytes of floppy storage and 16K to 32K bytes of RAM. Also part of the system are up to three CRTs and a serial impact printer. Teletype 33/35 protocol is standard, but the system can also operate under binary synchronous and IBM's SDLC. *Terminal Communications, Inc., Raleigh, NC.*

Circle No. 196 on Inquiry Card

CARTRIDGE DISK

Wangco's "Super Generation" of cartridge disk drives offer 5, 10 or 20 megabytes of storage. The Wangco Super T, using an IBM 5540 type cartridge in combination with a fixed disk, has data densities to 4400 bpi; the Super F, using IBM 2315-type car-



tridges, provides up to 2200 bpi. Wangco reduced the vertical rack space to 7-3/4 inches with its new "side throw" voice coil positioning system. The new light weight magnesium positioner also speeds access time. Drive prices range from \$3100 to \$4470. *Wangco Inc., Los Angeles, CA.*

Circle No. 164 on Inquiry Card

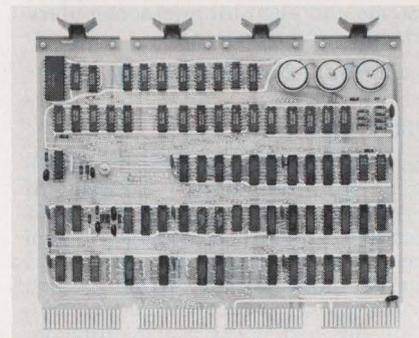
12-BIT CMOS μ P

Harris Corp.'s new single-chip 12-bit microprocessor recognizes the DEC PDP-8/E instruction set. Since the bus structure of the HM-6100 can be adapted to provide a subset of the 8/E Omnibus signals, all programmed I/O interface will operate with the microprocessor without hardware or software modification. To go along with the microprocessor, Harris has a full supply of CMOS circuits, including 64-1024-bit memories, 256-4096-bit PROMs, linear interface circuits, keyboard encoders, analog switches and comparators. *Harris Semiconductor, Melbourne, Florida.*

Circle No. 155 on Inquiry Card

PDP-11 TIMEKEEPER

The Timing Control Unit-100 for DEC's PDP-11 tells you what month and day and hour it is. It doesn't have to be



initialized everytime the computer is turned on. While the computer is off, the TCU-100 continues to operate on its own rechargeable battery. Price is \$495. *Digital Pathway's Inc., Palo Alto, California.*

Circle No. 193 on Inquiry Card

μ P POWER SUPPLIES

The Model MPS-1 microprocessor power supply is rated at 5 vdc at 3 amps, 12 vdc at 0.6 amps, and 9-12 vdc adjustable at 0.6 amps or 5 vdc at 0.38 amps. Model MPS-2 is rated at 5 vdc at 7.0 amps, 12 vdc at 1 amp, and 9 vdc. at 1.2 amps or 5 vdc at 0.75 amps. Model MPS-1 costs \$77 and Model MPS-2 costs \$88 in single quantity. *Deltron Inc., North Wales, PA.*

Circle No. 170 on Inquiry Card

SC/MP EVALUATION BOARD

For the beginning hobbyist, National Semi has a preassembled version of its SC/MP kit, the SC-8 board. It contains the SC/MP microprocessor, 4K ROM, 2 1K RAMs, one voltage regulator, one eight-bit data buffer, one timing crystal, one teletype interface device. Price is \$125 in quantities from one to 10. *National Semiconductor Corp., Santa Clara, CA.*

Circle No. 195 on Inquiry Card

DECwriter II

MODEL LA36 PRINTER TERMINAL
10-15-30 CHARACTERS PER SECOND
REMOTE OR CONSOLE USE
132 PRINT POSITIONS

\$1,645 each

DECscope

VIDEO DISPLAY TERMINAL
MODEL VT50 12 LINES, 80 CHARACTERS

\$1,095 each

MODEL VT52 24 LINES, 80 CHARACTERS
NUMERIC PAD • HOLD-SCREEN MODE
SPECIAL FEATURES

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DECprinter I

MODEL LA180 HIGH-SPEED PRINTER
180 CHARACTERS PER SECOND
132 PRINT POSITIONS

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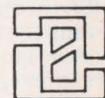
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STAND ALONE PUNCH GNT-3424



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- Paper or Mylar tape
- Parallel Interface (RS232 available)
- 5, 6, 7 or 8 channels or TTS

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CIRCLE NO. 37 ON INQUIRY CARD

ELECTRONIC MODELING

In the latest release of ISPICE, circuits containing a virtually unlimited number of components may be simulated in a single operation. The calculations that may be performed in an ISPICE circuit simulation on the National CSS time sharing network include: nonlinear DC analysis, AC small signal sinusoidal steady-state analysis, nonlinear transient analysis, parametric analysis, temperature analysis, and sensitivity analysis. *National CSS, Inc., Norwalk, Connecticut.*

Circle No. 219 on Inquiry Card

TIME SHARING IN DC

A new time sharing service to accounting firms and small businesses in the Washington, DC area provides unlimited use of the system over dial-up lines 24 hours a day, seven days a week. Software packages include inventory, accounts receivable, payroll and general ledger. Basic charge, \$500 per month, covers a Bedford daisy-wheel hardcopy terminal and up to 6000 disk records. *Dynamic Computers, Inc., Reston, VA.*

Circle No. 220 on Inquiry Card

CENSUS DATA BASE

SITE II, an expanded version of Tymshare's SITE 74, operates with a census data base compiled from the 1975 national census. It provides detailed census tract-level coverage of the populations of all 50 states and the District of Columbia. Detailed information is provided for more than 60,000 geographic areas throughout the United States in categories such as population, incomes, ages, occupations, and education. *Tymshare, Inc., Cupertino, CA.*

Circle No. 221 on Inquiry Card

DATA ENTRY TRAINING

This training program is intended to reduce the time required for conversion from old to new data entry equipment. Major elements include: customized functions which address the particular aspects of the new data entry equipment; development of a conversion plan including schedules for training, installation, job conversion and changeover to new equipment; operator training; and supervisor training. *Advanced Keyboarding Systems, New York, NY.*

Circle No. 218 on Inquiry Card

PTS/1200 ENHANCEMENT

New software for Raytheon's PTS/1200 Distributed Processing System includes a data base subsystem incorporating a built-in file creation and access method, and autoquery and query high-level preprogrammed commands for keyboard entry to the data base. *Raytheon Data Systems, Norwood, MA.*

Circle No. 212 on Inquiry Card

PDP-8 CROSS ASSEMBLERS

The X8 series of microprocessor cross assemblers, run on DEC's PDP-8 mini-computers. The cross-assemblers run in 8K of memory under the OS/8 operating system. X8 series assemblers are available for the 6502, 6800, and 8080 microprocessors. Each X8 assembler is priced at \$400 and distributed in PDP-8 binary format on papertape, Dectape, or DEC floppy diskette. *Sierra Digital Systems, Reno, NV.*

Circle No. 207 on Inquiry Card

µC HOME COURSE

For \$99.50, users can learn micro-computer system design in the comfort of their own home with the lasis programmed learning course. Six volumes or about 600 pages of programmed learning sequences take the student through binary arithmetic, microcomputer architecture, four-bit microcomputers, assemblers and prototyping systems and eight-bit microcomputers. *lasis, Inc., Sunnyvale, CA.*

Circle No. 225 on Inquiry Card

8080 BASIC

The BASIC ETC interpreter for 8080-based microcomputers is a variant of Dartmouth Basic. An interpreter translates and executes the user's program directly, while a compiler generates a separate machine code program, which is subsequently executed independently of the high level source program. BASIC ETC uses the lower 8K bytes of memory plus at least 1K byte of RAM for scratchpad. The BASIC ETC kit on either paper tape or cassette tape with a 32-page user's manual sells for \$25. *Binary Systems, Inc., Richardson, TX.*

Circle No. 209 on Inquiry Card

µC SUBROUTINES

The UT1 package written in 8080 assembly contains commonly used code conversions, I/O routines for numbers and character strings, and I/O drivers for commonly used peripherals. Source listings of the program with user documentation are \$3.00 each plus \$.35 for shipping and handling. *Pragmatic Systems, Mountain View, CA.*

Circle No. 210 on Inquiry Card

FORTRAN SORT

SORT80 runs as a Fortran IV subroutine to sort up to five variable length sort fields in ascending or descending order. Written in ANS Fortran IV, SORT80 requires 3 to 4K memory on a DEC PDP-11, PDP-10, General Automation SPC-16, Interdata, Data General Nova, IBM 360/370, or System/3. One-time lease fee is \$150. *Software '70, Anaheim, CA.*

Circle No. 205 on Inquiry Card

SYSTEM/3 AUDIT

SYSAUDIT, an audit and retrieval package, operates on a 16K IBM System/3 with one disk, printer and reader. The basic package provides for parameter value extraction, sequential internal extraction, multiple free format report outputs, selective report sorting, calculation, sub-totalling, file footings, record counts, numeric data error detection, automatic parameter card sorting and editing, two file handling, automatic bypass facilities and user exits. Confirmation printing, aging, file outputs, proportional sampling, frequency estimation, random sampling, and special file handling modules are optional. *Computer Audit Systems, Inc., West Orange, NJ.*

Circle No. 213 on Inquiry Card

SYSTEM/3 TO 90/30 CONVERSION AIDS

Intended to smooth the way for IBM System/3 users looking to switch to the Univac 90/30, the conversion aids include: transcription methods to convert System/3 source program libraries and data files to Operating System/3 format; Indexed Random Access Method, which is functionally equivalent to the System/3 disk data management method; a compatible RPG II programming language; a sort/merge program which can sort data files in IRAM format; and an Operations Control Language processor which permits the user to utilize familiar job control formats. *Sperry Univac, Blue Bell, PA.*

Circle No. 217 on Inquiry Card

EXORCISER FORTRAN

The Fortran compiler package for EXORciser microprocessor development systems is a subset of the ANSI standard Fortran IV. The compiler on a floppy disk requires a floppy disk driver, such as the EXORdisk, to load the compiler into 16K bytes of RAM. Price is \$500. *Motorola Semiconductor Products, Inc., Phoenix, AZ.*

Circle No. 203 on Inquiry Card

DISCRETE/CONTINUOUS SIMULATION PACKAGE

GASP IV consists of a set of Fortran subroutines, requiring about 20K words of storage, to assist the user in conducting simulation studies. Applications include the modeling of hospital facilities scheduling, resource constrained project scheduling, and analysis of complex ecosystems. Methods are provided for writing discrete event simulation programs, as well as programs involving continuous variables and differential equations. Several output reporting and statistical collection routines are included. *Pritsker & Associates, Lafayette, IN.*

Circle No. 215 on Inquiry Card

μP DISPLAY INTERFACE

Users can interface microprocessors to Burroughs Self-Scan plasma displays with the techniques described in this six-page application note. The note also explains how to achieve a broad variety of special display effects such as display blinking, letter or word blinking, and display of a wide variety of alphanumeric fonts and special symbols. *Burroughs Corp., Plainfield, NJ.*

Circle No. 271 on Inquiry Card

TI MICROPROCESSORS

Texas Instruments' entire microprocessor product line, including CPUs, software, support hardware and memory components are covered in this eight-page brochure. Support ranges from software assemblers, compilers, simulators, hardware evaluation and debug units to complete documentation and hands-on tutorial classes for field located application assistance. *Texas Instruments, Inc., Dallas, TX.*

Circle No. 261 on Inquiry Card

VARIAN SOFTWARE

VORTEX, Varian's powerful real-time operating system, is the subject of this six-page brochure. Subsystems operating under VORTEX are also presented, including TOTAL for data base management, VTAM for data communications, PRONTO for transaction processing control, HASP for remote job entry, TSS for multi-user editing, and time shared BASIC. *Varian Data Machines, Irvine, CA.*

Circle No. 253 on Inquiry Card

MINI MEMORIES

User and OEM memories are part of this new literature package. The OEM section includes separate bulletins for the company's Pincomm A, I, and N Series of replacement and add-on memories for most major minicomputers. End users can look over the System/3 add-on memory system and the complete line of the SMART add-on and replacement memory systems for the IBM 360 Series. *Standard Memories, Newport Beach, CA.*

Circle No. 259 on Inquiry Card

LSI-11 ENERGY MANAGEMENT

DEC's LSI-11 is the heart of the energy management system described in this four-page brochure. The system monitors and controls such systems as air conditioning, heating, lighting, and elevators. The brochure describes the microcomputer, as well as such display options as CRTs, Teletype, annunciator panels, individual indicators, special map displays, audio tape message systems, etc. *Receptors, Inc., Torrance, California.*

Circle No. 252 on Inquiry Card

OEM PRINTER

Data 100's Model 2424 OEM Line Printer is described in this two-page data sheet. The belt printer prints 300 lines per minute using a 132-column line and 64-character font. With a 96-character font, the print speed is 200 lpm. *Data 100 Corp., Minnetonka, MN.*

Circle No. 283 on Inquiry Card

LSI-11 ADAPTER

Described in this data sheet is the Univerter interface adapter that plugs into the card cage of an LSI-11 or PDP 11/03 and provides the signal conversion necessary for operation with a Unibus-compatible memory or peripheral device. *Able Computer Technology, Santa Ana, CA.*

Circle No. 270 on Inquiry Card

SDLC AND GA

SDLC's hardware and software features as they relate to General Automation's 1578 and 1579 SDLC controllers are described in four data sheets, the controllers and the 1575 16-line DMA port multiplexer provide communication interconnections between various minicomputers in networks for data transmission at rates from 9600 baud to 2.5 million bits per second. *General Automation, Inc., Anaheim, CA.*

Circle No. 281 on Inquiry Card

COMMUNICATION SWITCHES

T-Bar, Inc.'s series of pushbutton communication switches is described in this 12-page catalog. The switches are used in RS-232 interface or telephone line applications, including fall back, monitoring, spare modem and bypass switching. *T-Bar, Inc., Wilton, CT.*

Circle No. 255 on Inquiry Card

UV ERASER

The Model 30 TD PROM Eraser described in this spec sheet, delivers a calibrated dose of uv at the correct wavelength and intensity for the safe effective processing of 60 or less erasable programmable read-only memories per loading. The literature shows the instrument with its three separate metal loading trays and provides detailed specifications. *Turner Designs, Mountain View, CA.*

Circle No. 279 on Inquiry Card

RAM TESTING

Core and semiconductor memory testing procedures are described in this four-page booklet. Concept Development's system allows up to 15 auto-sequenced or selectable test programs plus an instantaneous set-up feature. *Concept Development, Inc., Costa Mesa, CA.*

Circle No. 278 on Inquiry Card

3-D DISPLAYS

The 3-D display system, the subject of this eight-page catalog, generates various depth cues to achieve three-dimensional CRT images. The catalog discusses the basic principles of 3-D displays and diagrams various systems. *Optical Electronics, Inc., Tucson, AZ.*

Circle No. 276 on Inquiry Card

SOFTWARE DESIGN

Michael Jackson's new design methodology for programming is described in this 48-page handbook. This handbook summarizes the experiences of 500 users, some of which report gains in productivity of up to 40 percent. *Infotech International, Pasadena, CA.*

Circle No. 256 on Inquiry Card

DECNET

Digital Equipment Corp.'s communication network is the subject of this brochure. Sample applications, Decnet commands and functions, structure and design, and a technical summary of Decnet operation are included. *Digital Equipment Corp., Northboro, MA.*

Circle No. 258 on Inquiry Card

The POLY 88 Microcomputer System is here!



POLY 88 is a complete, solid and trustworthy personal computer. No technological background is required to enjoy this versatile machine.

The POLY 88 is the invaluable tool for the home and office. With it, children can play or even develop their own mathematical and scientific games. Simple or Complex equations and projections can be programmed, stored and altered in the BASIC programming language. The POLY 88 starts at \$595 in kit form.

If you are in need of a quality tool, the POLY 88 is it.

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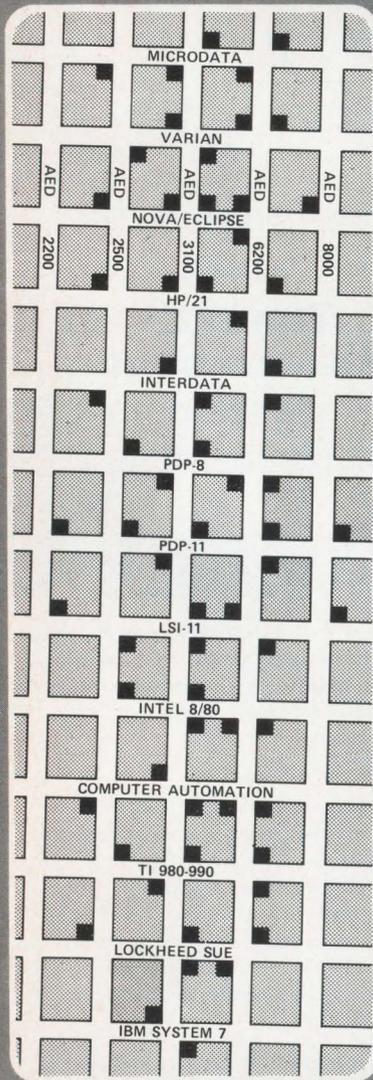
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Come to Disk City

Deep in California lies Disk City, a rapidly-growing metropolis offering the world's most complete selection of rigid and floppy disk systems. The streets are computers and the avenues plug-compatible disk controllers.

Cost-effective disk systems appear at no less than sixty-six locations. These systems range in size from the tiny hard-sectored AED 2500 floppy to the AED 8000 skyscraper, which fully emulates RP11-C/RPO3 or 4231/4231A. Middle range units include the soft-sectored floppies: IBM-compatible 3100's and double-density 6200's, and the RK-11/RK-05 compatible 2200 Cartridge Disk System.

So come to Disk City—it may be the best move for you and your data.



**ADVANCED
ELECTRONICS
DESIGN, INC.**

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CIRCLE NO. 38 ON INQUIRY CARD

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