JUNE 1976

mini·micro systems

formerly MODERN DATA

Minicomputers and Microcomputers
Source Data Automation
Mini/Micros in the Automotive Industry

THE MATCHMAKER

Telefile introduces the only disk system flexible enough to match any minicomputer with any of the hot, new 3330-type drives. Big disk storage at a mini price.

Telefile now has available the most flexible large capacity disk system for minicomputers on the market today. The Matchmaker. It comes two ways:

As a disk system for users (DS-16-C) where we match your minicomputer with *any* of the latest 3330-type technology drives you want. Telefile supplies the complete package.

As an OEM disk controller. You can order just controllers alone (DC-16-C) and mix and match minicomputers and drives to satisfy your customer's whims and storage requirements.

Either way, disk system or controllers alone, you are assured of flexibility, performance features, and price no one else can match.

Each system stores up to 1.2 billion bytes.

You can match just the right drives to meet your storage capacity needs all the way from *13.3 million to 1.2 billion bytes per controller.* Each DC-16-C Matchmaker controller handles up to four drives. Minicomputers never had it so good.

Choose any of the latest drives.

You've seen them announced one-by-one and they're coming on strong. CalComp's Trident. Control Data's Storage Module. Diablo's 400 Series. The Ampex 9000's and Memorex 677's. Each builds upon IBM 3330 technology, which means higher storage densities and new circuitry for superior reliability.

To switch drives, simply change one controller circuit board. We've timed it at 63 seconds flat!

Compatible interfaces to eleven minicomputers.

We're designing a complete line of compatible interface boards to match up to many minis: Data General, DEC, Interdata, Keronix, D.C.C., Microdata, Honeywell, Lockheed, H-P, Varian, and Cincinnati Milacron. Simply fit our tailor-made computer interface module inside your computer chassis and you're in business. If you have another type mini, we'd be glad to design one for you.

Or you can design your own interface.

Your designers may want a piece of the action. Our general interface board makes it easy. Your board will tie in directly, bringing big disk storage to *any* 16-bit minicomputer.

A controller so small you can even hide it.

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We'll even make you a faceplate.

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Easy "front door" maintenance.

Five circuit boards slip right in from the front of the DC-16-C Matchmaker. A disk interface board, a general interface board, a command/timing board, a memory/address board, and an optional maintenance board for offline disk pack formatting and test exercising.

Unmatched features

- Contains 512-byte buffer for data rate matching
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- Multi-sector operations across head and cylinder boundaries

We wrote the book on disk controllers, and you can get it free.

For years, we've helped minicomputer users grow their disk capacities. Now our Matchmaker system is a quantum leap forward. A new in-depth, hot-off-the-presses Matchmaker technical manual gives you all the facts. Write for it. Prove to yourself that this is one disk controller no one else can match.

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Turning minis into maxis with moxie

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CIRCLE NO. 1 ON INQUIRY CARD

This Tally printer knows the shortest way to double or triple your throughput.

You get there faster if you don't have as far to go. Tally's Model T-1202 optimized bi-directional serial printer prints left to right and right to left while its microprocessor looks ahead for the shortest path to the next line of print. These short cuts add up fast to slash your throughput time by two to three fold. (Of course, throughput savings are tied directly to the amount of white space in your format.)

"Optimized" means moving the print head—left or right—to pick up the closest character on the next print line. There's no lost time with conventional carriage returns. And coupled with a 7 ips slew speed, the T-1202 moves the print head at an accelerated rate to the next print position.

And remember, you get this bonus throughput without taxing the machine—the printing rate remains at 120 characters per second so you haven't sacrificed reliability or increased wear.

The Model T-1202 is the newest member of the T-1000 Series —Tally's fine line of serial printers that offer microprocessor electronics, low acoustic noise level, digitally controlled print head advancement, dual tractor engagement and a convenient snap-in ribbon cartridge.

There's more to tell, so call your nearest Tally sales office. Tally Corporation, 8301 S. 180th Street, Kent, WA 98031. Phone (206) 251-5524.

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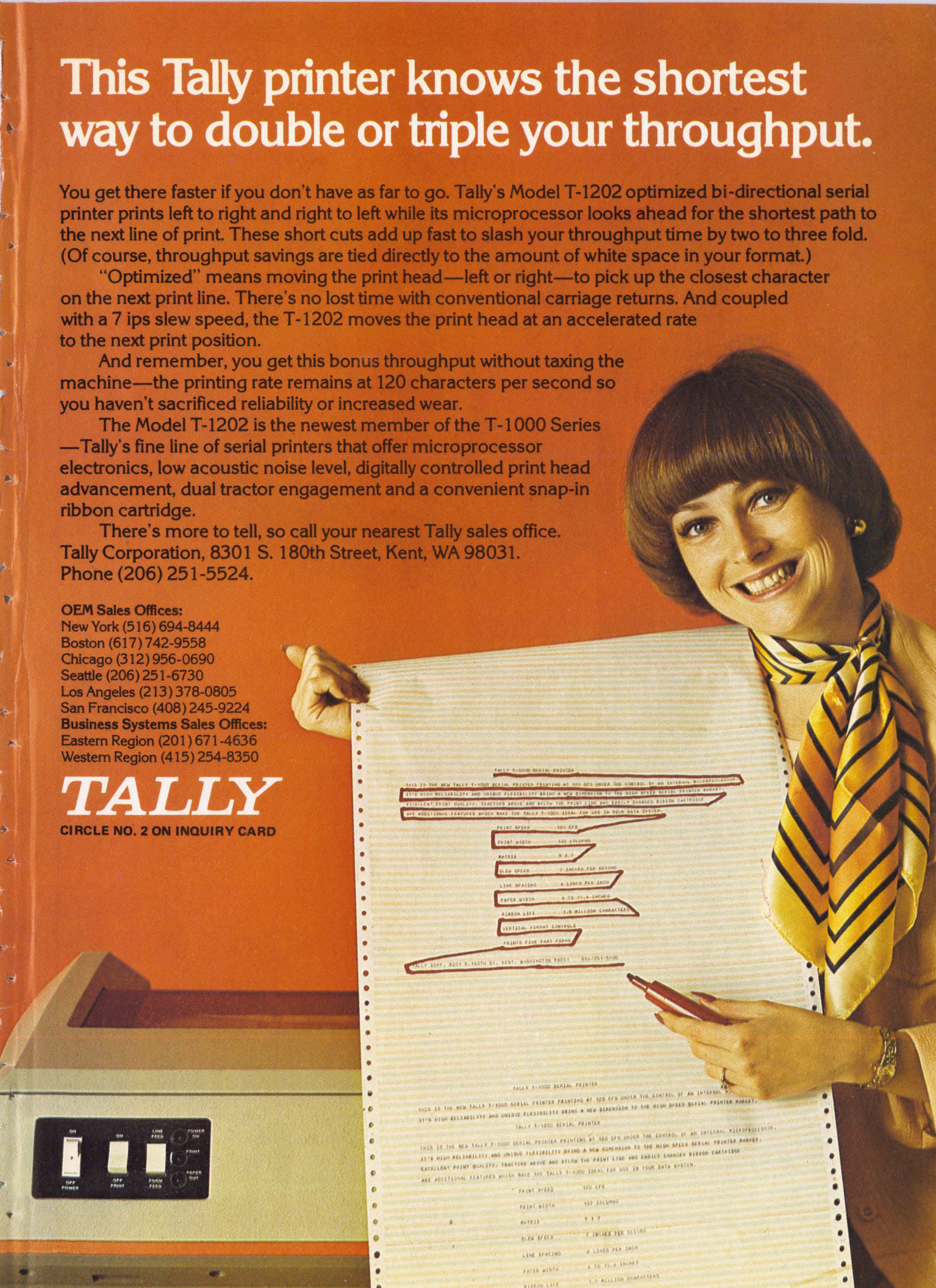

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All correspondence regarding circulation, advertising, and editorial should be addressed to the publication offices at:

MINI-MICRO SYSTEMS
5 Kane Industrial Drive
Hudson, MA 01749
(617)562-9305

SALES OFFICES
Sales Mgr. . . . . .Robert J. Bandini
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NEW ENGLAND
Melvin L. Hayden, 5 Kane Industrial Drive, Hudson, MA 01749 (617)562-9305

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BPA

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mini-micro systems

formerly Modern Data

COVER CREDIT:

Entrex's 600/50 model is one of three communications-based business systems in the 600 series of remote processing systems. Featuring both batch and interactive communication, the 600 series is oriented primarily toward the distributed processing market.

DEPARTMENTS

NCR'S NEW GENERATION

Criterion will be replacing Century as NCR's computer line First models of the new series will be the Criterion 8550 and 8570 for medium to large-scale users. The Criterion series will use firmware extensively, which will enable the systems to act as Century machines, or as Cobol or multiprogramming systems. The firmware is grouped into tailored sets of microprograms, which execute the software in programming language object commands. Since more than one set is available, NCR calls the Criterion a *multiple virtual machine.* The firmware selected is loaded into a dedicated, high-speed memory area from a read-only flexible disk. New to the hardware architecture is an internal transfer bus, similar to DEC's Unibus. The new models, which according to NCR span the Century 200, 201, 251 and go beyond the 300, use MOS memory, expandable to 1 million bytes, a processor with a 56- or 112-nanosecond cycle time, a dedicated service processor to act as a diagnostic control center, a miniprocessor for disk interface and a microprocessor for communication interface. Price for a basic 8550 system with 128K memory, 112-nsec processor, 600-card per minute reader, 1200-line per minute printer, and 200-megabyte disk is $258,950. The 8570 with 256K-byte memory, 56-nsec processor, same printer and card reader, and 300-megabyte disk is priced at $458,250.

Criterion was almost upstaged by NCR's other announcement. Following the move of other mainframe manufacturers, NCR is unbundling its software.

COMPUTER SECURITY WITH A KERNEL

A hardware/software security package "smaller than a breadbox" is being developed by the Electronic Systems Division of the Air Force and the Mitre Corp. (Bedford, MA). The kernel will provide centralized control of multilevel computer access, which the Air Force maintains has not been possible. The joint group has broken the Honeywell Multics system, which has been the most secure system. While Mitre is verifying the kernel on a DEC mini, Honeywell is developing a similar kernel for Multics. Prototype testing of a "secure" Multics system is planned for 1979.

HOW THE GARDEN GROWS

The microprocessor market will increase an average of 48 percent per year from now until 1979, according to an American Microsystems (Santa Clara, CA) study. That means growing from 1975's $64 million to $298 million in 1979, with U.S. firms accounting for 87 percent of the total. But that growth rate is dwarfed by that of ancillary memories. There, a 113 percent annual increase is predicted, or growth from $11 million in 1975 to $190 million in 1979. Minis should keep pace with microprocessors, at least for 1976. International Data Corp. (Waltham, MA) predicts a 43 percent growth; Modern Data Services predicts 38 percent. This is in contrast to overall hardware spending, which IDC expects to increase on the average of 11 percent in 1976 (8 percent real; 3 percent price increase). That's even lower than 1975's increase in spending, which was 13 percent (9 percent real). The large system market, IDC expects, to grow from $1.6 billion to $1.9 billion in 1976. Teleprocessing hardware spending should increase 10 percent to $3.4 billion in 1976.

H-P GOES WITH 18-PIN RAMS

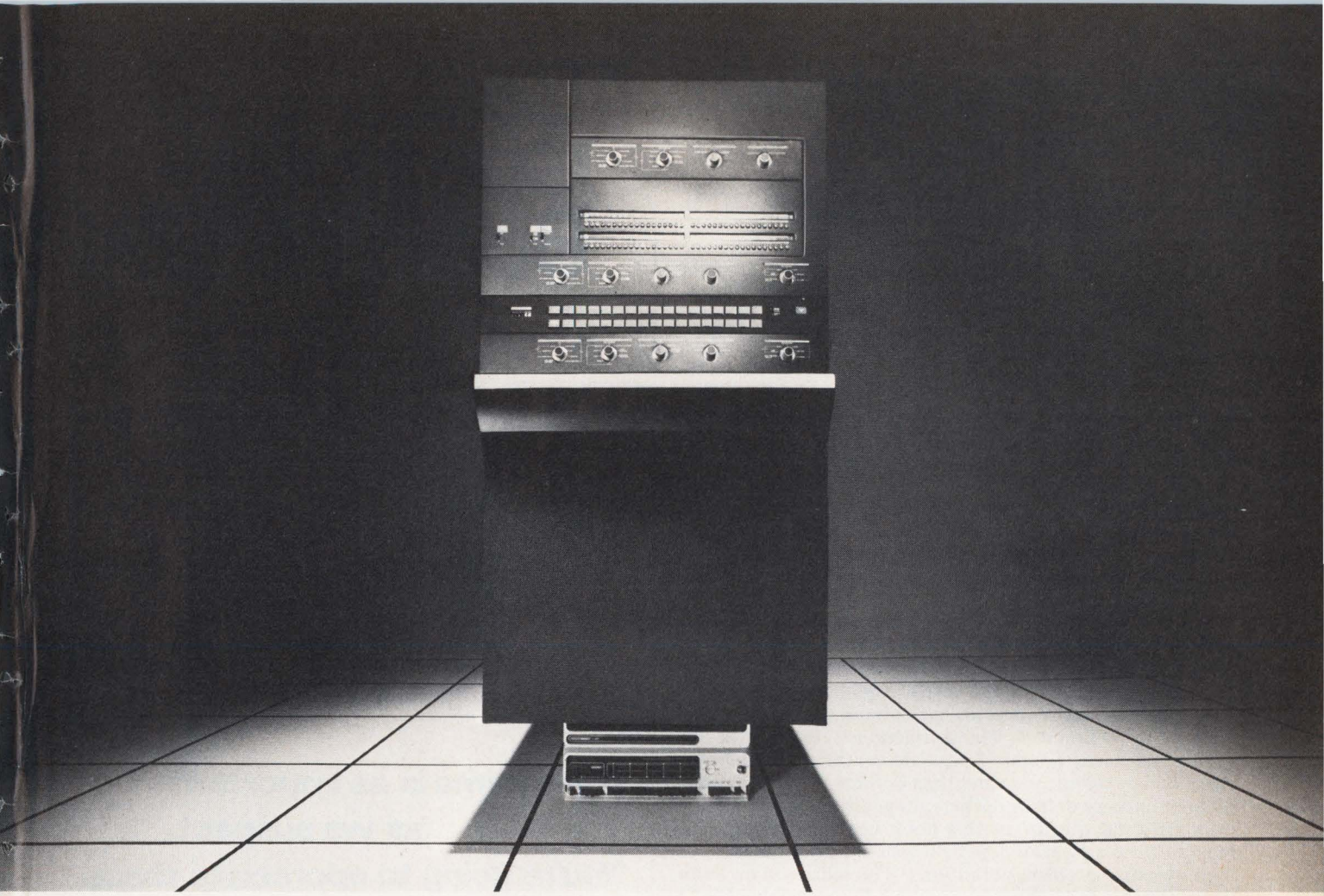
It took two years of extensive testing and working with Texas Instruments for Hewlett-Packard to release an 18-pin 4K RAM it felt was satisfactory. H-P began using RAMs in 1974 with the 21MX. But the 22-pin versions were often being rejected at a 20 percent rate. Major problems that had to be solved with the 18-pin RAMs included temperature-sensitive refresh requirements, oxide layer breakdown under temperature and voltage stress and crosstalk internal to the chip that led to pattern sensitivities when the parts were imbedded in memory systems. H-P developed a 21MX microprogrammed proprietary diagnostic to identify the ICs likely to fail. After an incoming test and sort, every part got an extended burn-in at 125°C. Batches were then tested on a standard Xincom tester and then underwent a pattern check on the PC boards. After being placed in the mini, they were tested again for 24 hours at temperatures between 0 and 55°C and then again at normal operating temperatures for five days. So at last H-P feels it has a relaible 18-pin RAM – even more reliable than core and less expensive. The list price for a 16K memory with the 22-pin RAM was $3000; the price for the 18-pin version is $2100 ($1386 in OEM quantities).

HOT-LINE MAINTENANCE

Within two hours after your phone call, a packaged bid price for third-party maintenance can be ready through Comma-Quotes. This service is offered by Comma, a Control Data maintenance service for non-Control Data equipment. The telephone number for the hot quotes is (800)527-3280.

WHAT'S COMING

July-August	**Sixth Annual Institute in Computer Science.** University of California, Santa Cruz. Contact Joleen Kelsey, University of California Ext., Santa Cruz, CA 95064.
August 2-6	**Computer Organization and Programming Course.** Georgia Institute of Technology, Atlanta, GA. Contact Director, Dept. of Continuing Education, Georgia Institute of Technology, Atlanta, GA 30332.
8-13	**Minicomputer and Microcomputer Institutes.** Pheasant Run Lodge, St. Charles, IL. Sponsored by National Engineering Consortium, Inc., 1301 W. 22nd St., Oak Brook, IL 60521.
23-27	**Microprogramming: Concepts Design and Practice Course.** Georgia Institute of Technology, Atlanta, GA. (See above.)
Sept. 14-17	**Wescon/76.** Los Angeles Convention Center, Los Angeles, CA. Contact Wescon, 999 North Sepulveda Blvd., Suite 410, El Segundo, CA 90245.
20-22	**Data Entry Management and Supervision.** Cherry Hill Inn, Cherry Hill, NJ. Contact Management Information Corp., 140 Barclay Center, Cherry Hill, NJ 08034.
20-24	**Convention Informatique (Data Processing: Today and Tomorrow).** Paris, France. Contact Convention Informatique, 6, place de Valois, 75001 Paris.
22-24	**APL 76.** Ottawa, Ontario. Contact Comshare Ltd. 304-11 Adelaide St. West, Toronto, Ontario M5H 1m2.
23-25	**Microcomputer Interfacing Workshop.** Blacksburg, VA. Contact Dr. Norris Bell, Virginia Polytechnic Institute and State University Continuing Education Center, Blacksburg, VA 24061.
27-29	**Micro-9 (Ninth Annual Workshop on Microprogramming).** New Orleans, LA. Contact Micro-9 Computer Science Dept., University of Southwestern Louisiana, Box 4-4330, Lafayette, LA 70504.
28-Oct. 1	**Data-Kontor 76 (International Computer and Business Efficiency Exhibition).** Stockholm, Sweden. Contact Radley Communications Ltd., 509 Madison Ave., New York, NY 10022.



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Some small computers have a little COBOL.

Data General's ECLIPSE C/300 is the first to have a big one: a COBOL that not only meets the ANSI '74 standards (ANSI-X3-23-1974) for the most commonly used modules, but is also implemented at the highest levels.

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And because the ECLIPSE C/300 COBOL is a complete language system, it has extensive development aids you can't get on any other small computer. An interactive debugger with COBOL-like verbs such as COMPUTE and DISPLAY, for example. And free format input of source programs from any terminal. All of which helps you get your programs up and running sooner.

And this COBOL takes advantage of the C/300's instruction set that's tailor-made for commercial applications. Which keeps both your programmers and your programs efficient.

And the ECLIPSE C/300 COBOL runs under our mature Real-time Disc Operating System. So you can concentrate on your software instead of ours.

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mini·micro systems bookstore

book reviews

PROBLEMS FOR COMPUTER SOLUTION *by Stephen John Rogowski. Educomp Corporation, Hartford, CT. Student Edition, 90 pages plus appendix, $3.95 (paper). Teacher Edition, 253 pages plus appendix, $9.95 (paper).*

First, the good news. This is a nice collection of 90 mathematical problems that will challenge high school or college students, not just to use a computer but also to think hard about their method of attack. Furthermore, many of the problems are ideal for demonstrating what a computer can do that a human can't – at least a human who doesn't want to spend most of his life doing tedious calculations. For example, problem 43 asks the student to write a program to identify as many self-generating integers as possible. There are only four such numbers known, and finding them all may be too expensive in terms of CPU time. (What's a self-generating integer? Write us.) Now for the bad news. In an apparent effort to satisfy a variety of audience levels, Rogowski has intermixed very simple (even trivial) mathematical puzzles with some really complex posers. What's worse, he's inconsistent in his background detail: He speaks casually of "Lorentz' Transformations" (by which we assume he means Lorentz-Fitzgerald contractions) and relativity theory on one page and then bothers to explain prime numbers in some detail elsewhere. In addition, the extremely poor editorial quality of this book not only offends the reader ("fold a piece of paper a whole bunch of times") but even obscures problem definition ("The square of any term when added to the previous term is a Fibonacci number.") Add, then square? Square, then add? Neither? Graphics are mostly of the "cutesy" cartoon variety, and the book's typography is old reliable office typewriter – at least it wasn't computer-generated! But let's end with two positives. The book is comprehensive, covering arithmetic, algebra, geometry, trigonometry, number theory, probability, statistics, calculus, and some classical unsolved problems. The excellent bibliography testifies to the breadth of the author's research. In summary, an educational and enjoyable problem book, but in rough-draft form. Educomp, start over!

– Ernst Barlach

FLOWCHARTING: PROGRAMMING, SOFTWARE DESIGNING, AND COMPUTER PROBLEM SOLVING *by Bernard B. Bycer. John Wiley & Sons, New York. 266 pages plus index, $13.95 (cloth), $9.95 (paper).*

It's good for an author to be deeply involved in his subject, but the involvement sometimes has its drawbacks. It's obvious that the author of this text is deeply committed to excellence in flowcharting techniques. And that's good, because the student who uses this book in class – or reads it on his own – will start his programming career with a firm understanding of the details of ANSI-standard flowcharting, and will have learned many good habits. The drawbacks? In this case the professorial tone of the "expert" detracts from a generally good presentation. In addition, Bycer displays some signs of infatuation with his subject – for example, he refers to flowcharting as "natural," which reminds us of the Briton who was sure non-British people could understand English as long as it was spoken "clearly and distinctly." Other areas of weakness: editing is not always good, and resulted in some undefined terms; printouts reproduced in the text are very light, and in one case illegible. And a parting shot at Mr. Bycer: dedications that ridicule one's spouse's discomfort during a book's creation are oafish – and that was true long before feminism became popular.

– Ernst Barlach

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***March, 1975 Issue of Library Journal**

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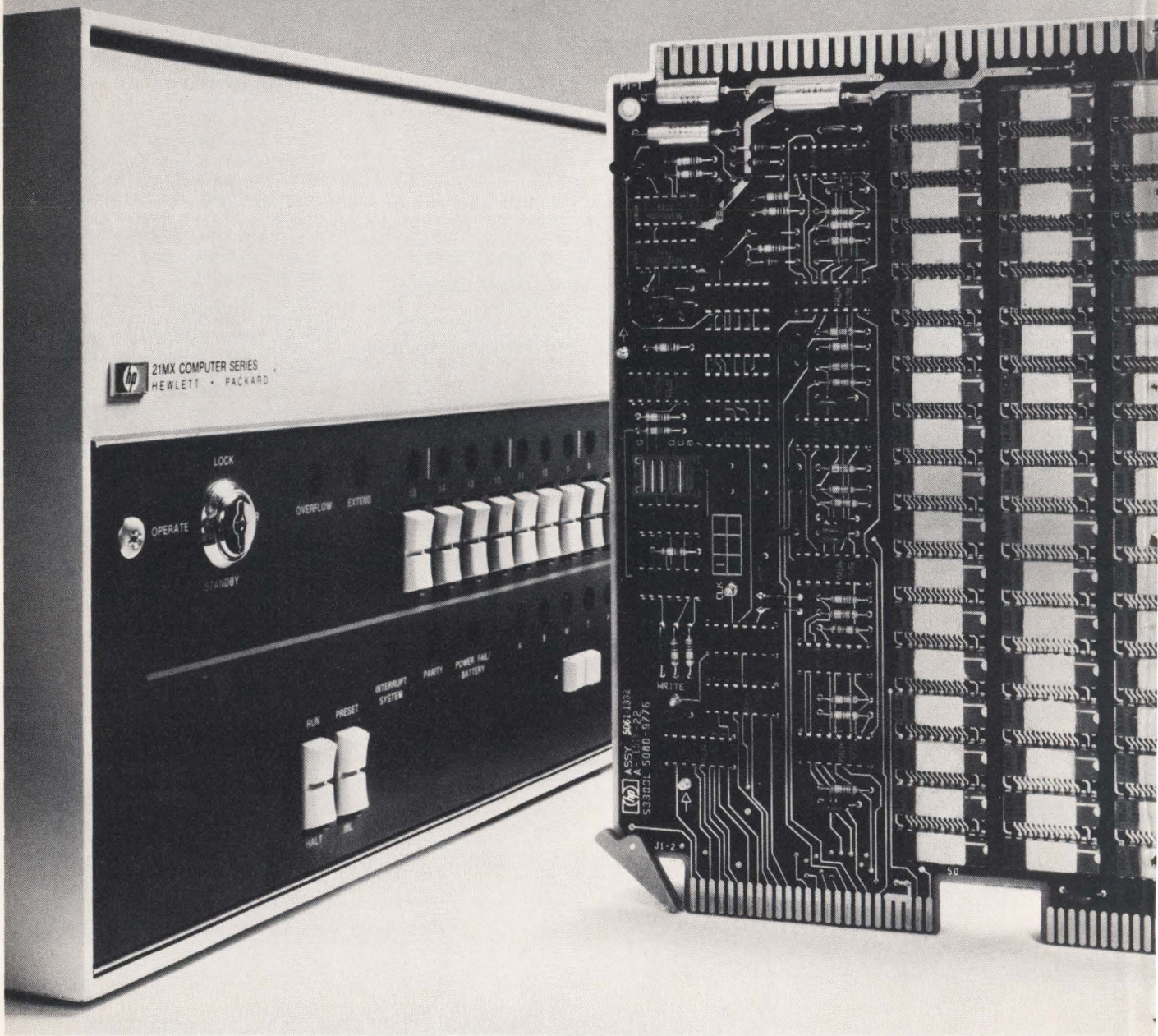
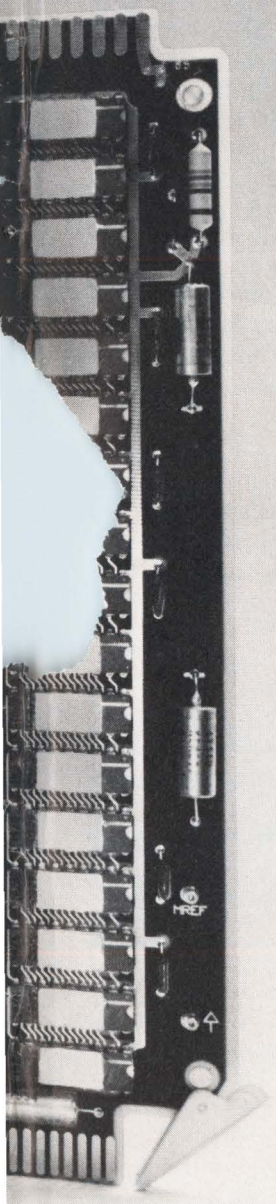
The Hewlett-Packard 21MX minicomputer sets a new price/performance standard.



Announcing 16K word memory with parity for $1386.*



Because the majority of a minicomputer's cost is its memory, the $1386 price for HP's new 16K word parity memory module is a significant price/performance breakthrough. And when you consider the low-cost memory along with the other features of the 21MX, it's a combination that's hard to beat. At any price.

Proven 4K RAM Reliability. Hewlett-Packard pioneered minicomputers with 4K RAM memory. Our unequalled field experience with more than 250,000 4K RAMS has proven their reliability. Solidly.

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We're Shipping Now. The 21MX minicomputer family with the new 16K memory board is available and being shipped today.

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	16K Add On Parity Memory	Computer† with 64K Word Memory
HP 21MX	$1386.*	$11,038.*
DEC 11/34	$2046.*	$12,995.*
Nova 3/12	$2368.*	$14,528.*

†Includes CPU, parity memory, memory management, EAU and battery backup. Source: Datapro
*U.S. domestic price. OEM quantity 50.

There's More. Every HP minicomputer and peripheral is designed from the start for easy, "building block" integration. Spend less time on design, and put your system to work faster. Other HP benefits range from installation and software to providing the level of service you specify. Or HP training, if you prefer to do it yourself. If you want more, call your nearest HP field office. Hewlett-Packard, the leader in 4K RAM minicomputers — and a lot more.

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international news

THE FAIR AT HANNOVER

In the spring of every year, many of the citizens of Hannover pack up and migrate to the country – not because they fear a natural disaster, but because they rent their apartments during the Hannover Messe (fair). For the fair is not only the biggest thing in Hannover, but the biggest thing in Germany. All of German and foreign industry turns out to show their goods. Although last year's weak economic conditions slowed things down, this year's number of exhibitors swelled to 4777, representing 5575 companies (30 percent foreign). There were 22 buildings, one for each industry – industry being anything from refuse removal to construction material. For the computer people, CeBIT (Centrum fuer Buero-und Informationstechnik) became the home base. The Center for Office and Data Technology had 638 exhibitors spread over two halls, showing reproduction equipment, technical drawing equipment, word processing and data processing equipment. Small business systems, work station systems and word processing systems were everywhere. IBM was there with its 5100, Centronics with its Series 700 printers, Diablo with the Series 400 disk, Honeywell-Bull with the 61/40, Nixdorf with the 8870, ICL with the 2903 and Sperry Univac with the UTS/400 and 700 terminal system – to name just a few. Even Anker Werke, a fairly large German terminal company, was there although it had announced it was calling it quits the day before the fair's opening. The Hannover Messe is not just a technology exhibit, but the year's largest selling opportunity in Europe. Although CeBIT had one floor, many booths had two levels – one to exhibit and one to sell. Judging from the action this year, the economy in Europe has picked up – Europeans were buying small computers in what could be described as a frenzied manner.

NIXDORF COMBINES WORD AND DATA PROCESSING

Nixdorf has decided to combine the two fastest grow European markets: word and small business processing. 8815 word processing system acts as a workstation co nected to an 8870 processor. The 8815 cannot perfor processing on its own, but can access information from th

A EUROPEAN FIRST. *With Nixdorf's 8815, word processing and data processing are possible on the same multiterminal 8870 system.*

central processor. Nixdorf also announced an addition to its German 8870 line. The German 8870 line has until now consisted of the 2, 4 and 6 models and has been Cobol-oriented. The U.S. 8870 line has consisted of the 8870-1, an interactive Basic system introduced last year. Now the Germans also have this version of the 8870, but the Americans will apparently never see the German 2, 4 and 6 models. As explained by Nixdorf, this is due to the difference in the American and European markets.

We'll pit our FORTRAN machine against anyone's.

You've heard the claims. How this FORTRAN machine can outperform that FORTRAN machine. Well, we figure it's time to introduce you to a FORTRAN machine that's not only fast, but could save you thousands of dollars as well.

It's the V76 system. Varian's FORTRAN machine. It's not only excellent for any scientific, industrial or real-time computation application, it costs up to 30% less than our competitors, such as the DEC T55 or DG-Eclipse.

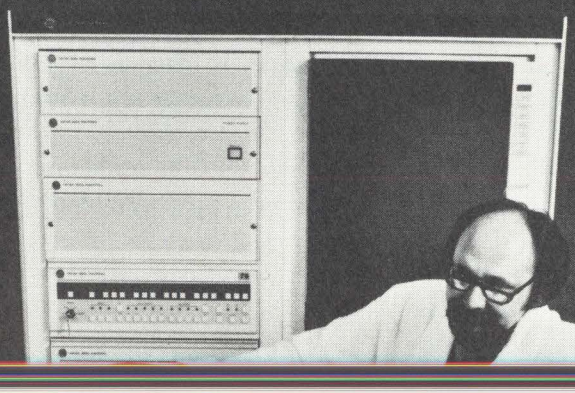
What about performance? Well, just for the record, we've used VDM's FORTEST program to evaluate both our V76 system and a series of competitive systems. FORTEST takes the 20 most fundamental of FORTRAN operations, repeats each thousands of times, and then determines an average time for the execution of each function.

While we have to admit that we're behind our competitors on a few FORTRAN functions, we definitely come out as a leader of the pack. If you'd like to see for yourself, we'll send you our special report on benchmark results and price comparisons.

Actually, the results came as no surprise to us. We've taken a group of exceptionally fast system components and totally integrated them for throughput speed. Firmware has been created and integrated into FORTRAN's run time to implement repetitious routines, special algorithms, and other functions.

In addition, the V76 high performance hardware—such as a floating point processor and cache memory—accelerate the execution of FORTRAN programs to a level unmatched by any other system in its class.

If you don't believe us we'll be happy to run one of your programs on our machine. Just call one of our 38 world wide offices or write Varian Data Machines, 2722 Michelson Drive, P.O. Box C-19504, Irvine, California 92713, (714) 833-2400. In Europe, contact Varian Associate, Ltd., Molesey Road, Walton-on-Thames, Surrey, England, Telephone 28971. And, if you'd like a copy of the FORTEST



varian

Helping a Fast World Move Faster

CIRCLE NO. 8 ON INQUIRY CARD

announcing

1976 minicomputer-microprocessor market survey

The results of the fifth annual market survey among buyers of minicomputers, microprocessors and miniperipherals are now available in a special 80-page report.

The report features over 60 cross tabulations showing share-of-market statistics for all major vendors of minicomputers, microprocessors, microcomputers and miniperipherals.

The survey participants reported having 39,000 minis in place as of January 1, 1976 – accounting for nearly 30% of the total installed base of minicomputers in North America.

The survey respondents took delivery on more than 21,000 minicomputers in 1975 at a reported value of $536 million. The respondents' purchase plans for 1976 include 28,000 minis at a total value of $733 million.

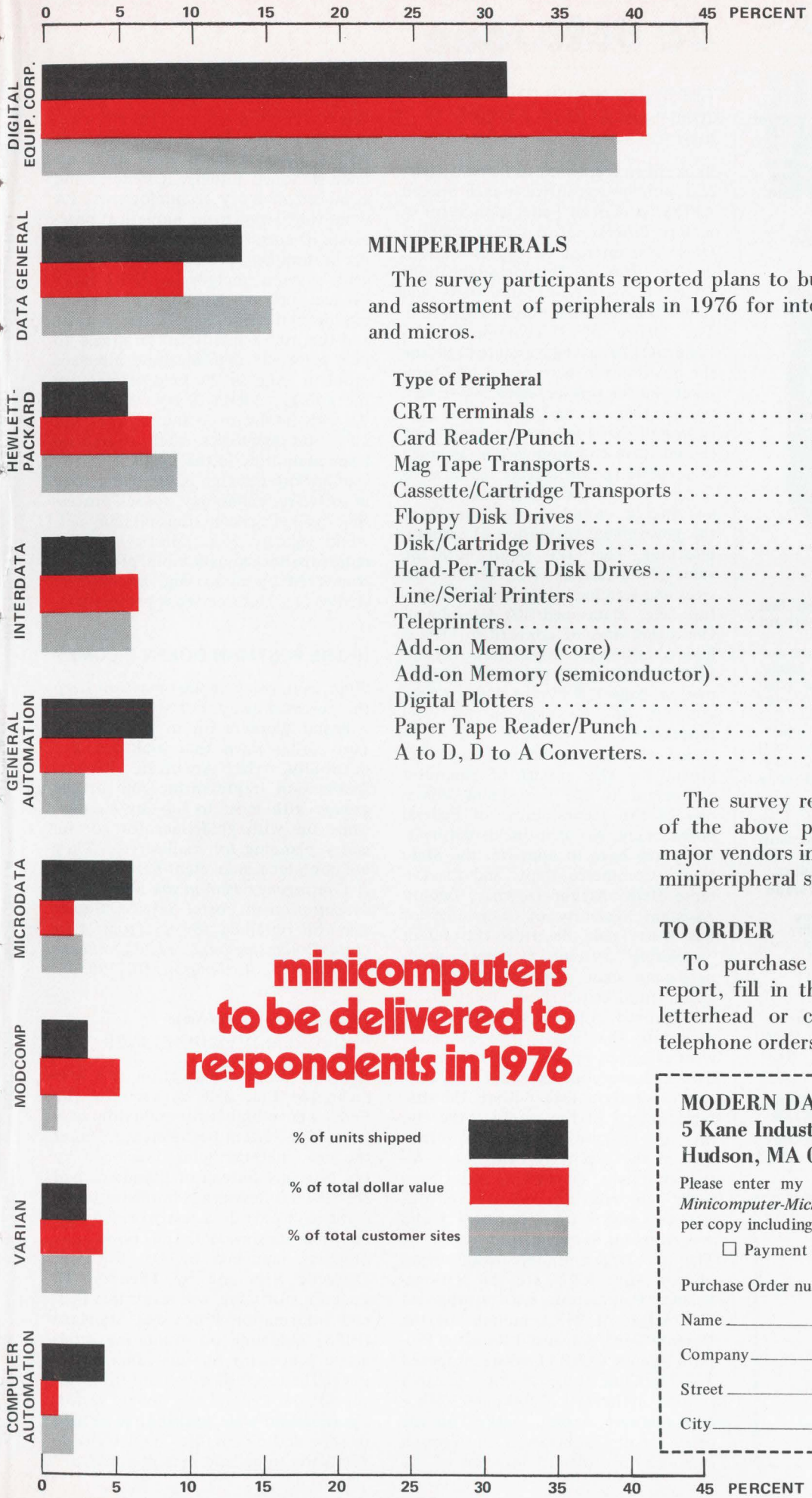
Worldwide minicomputer shipments in 1976 are projected to increase by more than 30% in terms of units and dollars. This projected growth is nearly double the gain that was achieved during the economic slowdown of 1975.

MICROPROCESSORS

Nearly one-half of the 5,700 sites represented among the survey replies reported having an active interest in microprocessors. About 8.3% of these were considering micros as substitutes for minis while 35.8% were planning to use micros as replacements for hard-wired logic or for entirely new applications.

The respondents reported plans to buy 362,000 microprocessors in 1976 and another 576,000 (up 59%) in 1977. The microprocessor vendors being considered, the distribution by application and word length, and the factors considered most important by prospective buyers of micros when choosing a vendor are tabulated and analyzed in this year's survey report.

minicomputer shipments to survey respondents in 1975



minicomputers to be delivered to respondents in 1976

MINIPERIPHERALS

The survey participants reported plans to buy an unprecedented quantity and assortment of peripherals in 1976 for interconnection with their minis and micros.

Type of Peripheral	Qty to be Purchased By Survey Participants
CRT Terminals	45,558
Card Reader/Punch	2,067
Mag Tape Transports	10,276
Cassette/Cartridge Transports	4,257
Floppy Disk Drives	9,909
Disk/Cartridge Drives	13,285
Head-Per-Track Disk Drives	3,033
Line/Serial Printers	12,357
Teleprinters	18,466
Add-on Memory (core)	7,412
Add-on Memory (semiconductor)	2,650
Digital Plotters	809
Paper Tape Reader/Punch	3,659
A to D, D to A Converters	7,413

The survey report charts the percent share of the above prospective orders for all the major vendors including over 100 independent miniperipheral suppliers.

TO ORDER

To purchase a copy of the 1976 survey report, fill in the coupon and clip it to your letterhead or company purchase order. No telephone orders accepted.

MODERN DATA SERVICES, INC
5 Kane Industrial Drive
Hudson, MA 01749

Please enter my order for one copy of the *1976 Minicomputer-Microprocessor Market Survey* at **$295** per copy including U.S. postage.

☐ Payment enclosed ☐ Bill me

Purchase Order number _____

Name _____

Company _____

Street _____

City _____ State _____ Zip _____

dc datascan

THE WHITE HOUSE ON COMMUNICATIONS, EXPORT AND RESEARCH

Spokesmen from various Federal agencies and the Executive branch briefed AFIPS (American Federation of Information Processing Societies) recently. Of special interest were presentations on the Office of Telecommunications Policy, East-West computer trade, and research in information processing.

The Office of Telecommunications Policy (OTP) has the mandate to decide the relationship between the Government and the private sector in telecommunications. Acting Director John Eger suggested that the Federal government should leave communications as much as possible to the private sector so as not to become a competitor with it and that it should eliminate much of the government regulation of communications. The OTP wants both the value-added carriers (e.g., Telenet) services and terminal equipment manufacture (e.g., Dataspeed 40) deregulated. One other area of concern to OTP is how to ensure privacy in networks and EFT systems, particularly when information collected by the Federal government can be revealed by legal process.

Those who have attempted to get approval for the export of computer equipment to the East know this is one of the deepest areas of Federal bureaucracy. Not just one department, but three have to approve: the State Dept., Commerce Dept. and the Defense Dept. Arthur Downey, Deputy Assistant Secretary of Commerce for East-West Trade, described the present "workable" system. Computer products come under "special license" requirements, i.e., each shipment has to be approved. All goes smoothly unless export to the East is involved. Then worries about national security take over and everyone gets involved. Factors presently considered are: the strategic impact of the product, the end user, the end use and the risk of diversion of the export to other users. Although many suggestions have been made on relaxing export controls, Downey said it was Congress (?) who was reluctant to decontrol.

The two largest-funded organizations of computer R&D are the National Science Foundation, with a proposed '77 budget of $15.8 million and the Defense Dept. Advanced Research Projects Agency (ARPA), with a proposed $37.7 million budget. NSA's research centers on theoretical computer science and software design. ARPA, on the other hand, is involved in research oriented only toward missions of the Dept. of Defense, according to Col. David Russell, director of the Information Processing Techniques Office of ARPA. Basic research areas are image understanding, intelligent systems and advanced memory technology. ARPA is moving away from numerical processing of images into symbolic processing techniques. Projects under intelligent systems include artificial intelligence, natural language processing, intelligent distributed data base systems and the use of intelligent terminals to help solve the man/machine interface problem. And in the field of memory technology, ARPA is trying to come up with hardware to support 10^{15} to 10^{21} -bit memories, such as archival beam memories, in the 1990s.

Exploratory research is also being done in software technology, speech processing, packet speech transmission, network security (e.g., Multics) packet radio (distributed net of mini processors connected by radio) and internetting studies (e.g., internetwork protocols).

IF THE POSTMAN DOESN'T COME

Wind, rain, snow or sleet may not keep the postman away, but something like a Postal Workers Union strike could. Last spring when that looked like a possibility, the American Bankers Association, representing one of the groups with most to lose by a strike, came up with guidelines for contingency planning for mail service. They are contained in an eight-page booklet, *A Contingency Plan in the Event of an Interruption in Postal Service.* Copies may be obtained for $5 from *ABA Order Processing Dept., 1120 Connecticut Ave. NW, Washington, DC 20036.*

CHANGING NETWORK PROCUREMENT GUIDELINES

Remote terminal emulation is a new technique that will be used by the Federal government for evaluating teleprocessing system performance. Under the new method being developed by the National Bureau of Standards and the General Services Administration, a driver will provide a test workload for the processing system. The cooperative program, launched by Dr. Ruth M. Davis of NBS and by Theodore D. Puckorius of GSA, will result in a Federal Information Processing Standard (FIPS) guideline on evaluating interactive processing by this summer. Input to the standard will come from surveys of the Federal and private sector, a government-wide workshop to be held in June and a computer industry-wide workshop to be held in September.

PUBLIC UTILITIES NEED TERMINALS THAT ARE MORE THAN JUST UTILITARIAN.

THE WORD IS RAYTHEON.

Raytheon PTS-100 terminal displays help utility companies cope with all kinds of daily detail — service orders, meter maintenance, repair and transportation records, inventories, billing, payrolls and other financial matters.

What's more, they can process such data right at any remote site, so central computers can be used more effectively and line costs can be controlled.

Raytheon's terminals are economical, fast and versatile.

- They're direct replacement equipment for 2260, 3270, U-100 or VIP-7700 display systems.
- They're competitively priced and offer extended-lease plans.
- They're available with high-speed character or line printers and card readers.
- They control local printing; no okay is needed from the host computer.
- They offer local format storage.
- They're intelligent — so you can design your own applications and modify them easily.

For the complete word, and a demonstration, write Raytheon Data Systems, Marketing Dept., 1415 Boston-Providence Turnpike, Norwood, MA 02062 — or call 617-762-6700. (Outside Massachusetts, call 800-225-9874 toll-free.) When you build better information processing systems . . . **the Word gets around.**

INTELLIGENT TERMINALS, MINICOMPUTERS AND TELECOMMUNICATIONS SYSTEMS

RAYTHEON DATA SYSTEMS

RAYTHEON

CIRCLE NO. 10 ON INQUIRY CARD

H-P TO LEASE TERMINALS

Hewlett-Packard Company announced plans to begin a short-term lease program for its CRT data-terminal product line in early summer. The move is expected to expand HP's data terminal market to those segments which choose not to acquire terminals on a cash or full payout basis. Under the program, customers may select from leases of 6, 12 and 18 months in length. The amount of monthly payments, depending on lease duration, are 8 percent, 5-1/4 percent and 4-3/4 percent of product list prices respectively. During the lease, HP will provide full weekday service at no additional cost. "This is a new marketing strategy for the division," said Edward J. Hayes, Data Terminals Division marketing manager. "Similar to rental programs, the HP plan is tailored to the financial needs of users who wish to limit capital investment in equipment. It also gives potential customers an opportunity to evaluate fully the HP 2640 Series terminals including all options and accessories before committing to buy."

AUERBACH SPINS OFF CONSULTING GROUP

Isaac L. Auerbach, Chairman and President of Auerbach Corp. for Science and Technology, announced the spin-off of its wholly-owned consulting subsidiary, Auerbach Associates, Inc., to a group of the current management and other employee-owners. Auerbach Associates, Inc., are information system designers and computer and management consultants. Mr. Auerbach added that for the first time in years he can now devote a major portion of his time and energy to the growth of Auerbach Publishers.

ON THE MOVE

Advanced Micro Devices (Sunnyvale, CA) has broken ground for an expansion of its Penang (Malaysia) assembly facility that will double floor space to 40,000 square feet and more than double production capacity. . . . . .

MDB Systems, Inc. has expanded threefold in size with the purchase of new facilities at 1995 North Batavia St. in Orange, California. MDB Systems specializes in general purpose logic modules and peripheral device controllers for PDP-8 and 11, Nova, and Interdata computers. . . . . .

The Singer Company announced that it has signed an agreement with Digital Equipment Corp. which, after the fulfillment of certain conditions, will transfer Singer's interest in its Albuquerque, NM factory to DEC effective July 1, 1976.

EARNINGS (LOSSES)

Raytheon reported record first quarter earnings of $1.18 a share, compared with $1.06 a share a year ago. Sales and net income also rose to record highs for the quarter. In the quarter ended March 28, Raytheon had net income of $17,900,000 on net sales of $572,416,000. This compares with net income of $15,901,000 on sales of $529,949,000 a year ago.

Sales and earnings of **Digital Computer Controls** (NASDAQ-DGTC) reached record levels in the fiscal year ended Feb. 29, 1976, and the uptrend is continuing, Harold Rapaport, chairman and chief executive officer, told a meeting of security analysts and brokers here today. "Although audited figures are not yet available," he said, "we know that sales topped $11.3 million against $9,756,140 a year ago and that earnings more than doubled the fiscal 1975 net of $230,697 or $.15 per share."

Applied Digital Data Systems Inc. (ADDS) earned $969,437 or $.25 a share on a fully taxed basis in the first quarter ended February 28, 1976. This compares to $512,906 earnings in similar quarter last year.

Donald W. Fuller, President of **Microdata** reported revenues of $6,255,064 for the three months ended February 29, 1976 and net income of $587,471 or $.34 per share. In the prior year's second quarter ended February 29, 1975 revenues were $3,417,502 with a net income of $193,664 or $.12 per share.

Revenues of **Cambridge Memories, Inc.** for its second quarter ended February 28, 1976, were $6,859,000 as compared with $5,233,000 in the comparable period last year. Net income was $54,000 or three cents per share compared with $46,000 or three cents per share in 1975.

Data General Corporation reported sales and earnings for the 12 weeks ended March 13, 1976, the second period of its 1976 fiscal year. Sales for the 12-week period were $34,089,000, an increase over sales of $24,639,000 for the second period of the previous fiscal year. Earnings after taxes for the second period were $4,018,000 or $.42 per share. This compares with earnings after taxes of $2,866,000 or $.35 per share for the comparable period last year.

For the three months ended March 31, 1976 worldwide consolidated net earnings of **IBM** were $544,384,997 after taxes. Earnings per share were $3.63 on 150,017,300 shares, the average number of shares outstanding during the period. Net earnings for the corresponding period in 1975 amounted to $437,223,122, equivalent to $2.95 per share on 148,446,680 shares. Consolidated gross income for the three months ended March 31, 1976 amounted to $3,814,817,123 compared with $3,271,997,715 in the corresponding 1975 period.

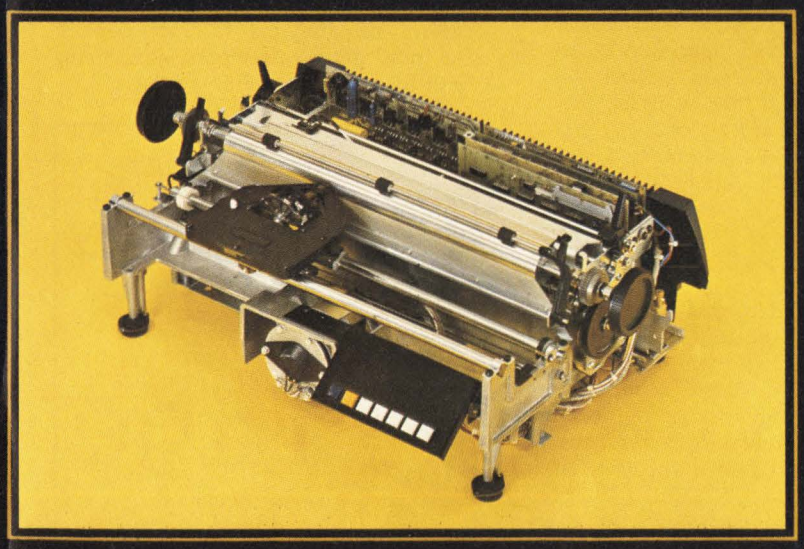
Computer Automation, Inc. reported that income for the third quarter of fiscal 1976 tripled that of last year, with net income of $841,500, or earnings of 43 cents a share, from sales of $7,967,455. In reporting operating results for this year's third quarter ended March 28, 1976, President D.H. Methvin noted that earnings per share (fully diluted) of 43 cents more than doubled the 17 cents per share earned in the same period last year, based on net income of $277,042. Sales for the quarter just ended were up 49 percent from last year's $5,359,606.

Earnings for **Advanced Micro Devices'** fiscal year, which ended March 28, 1976, were $1,434,000 or $0.54 per share as annual sales increased more than 30 percent to a record high of $34,387,000. For the previous year, the company's sales were $25,815,000 with a net loss of $2,472,000 or $1.03 per share. Included in last year's loss was a charge of $1,483,000 or $0.62 per share for the cumulative effect on prior years of a change in accounting for sales to Advanced Micro Devices' distributors.

Memorex Corp. earned record quarterly net income of $9,083,000, or $1.66 per share, for the first quarter of 1976. This compares to net income of $1,583,000, or 36 cents per share, reported for the comparable 1975 period. Total revenues for the first quarter of this year were $79,419,000, an increase of 29 percent above the similar 1975 period of $61,625,000.

Bidirectional printing
High speed tabbing
Skip-over spacing
Incremental printing
Upper and lower case print
Internal self-testing
Snap-in ribbon cartridge
Microprocessor control
Greater throughput
Lower cost...

What else do you want to know about the new Diablo Matrix Printer?



Our new Series 2300 Matrix printer firmly establishes the breadth of the Diablo printer line. From 40 cps to 200 cps there is a Diablo daisy wheel or matrix printer to suit your application. The Series 2300 Matrix is based on the heritage of Diablo HyType experience, servo knowledge and modern manufacturing capabilities. For more information, write Diablo Systems, Inc., 24500 Industrial Blvd., Hayward, CA 94545 or, Diablo Systems, S.A., Avenue de Fre 263, 1180 Brussels, Belgium.

Diablo

Diablo Systems Incorporated
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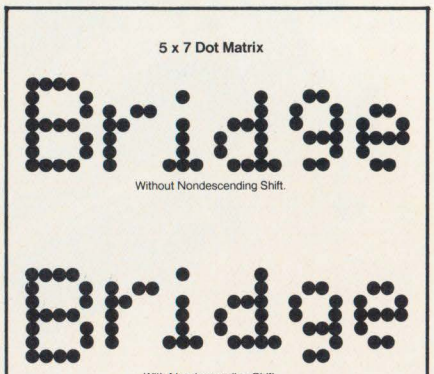
CIRCLE NO. 11 ON INQUIRY CARD

AT&T ATTACK

In our April issue, we warned of AT&T's impending legislative attack (see "AT&T Never Says Die"). The bill was recently filed in the U.S. House of Representatives by Rep. Teno Roncalio (D-WY) and is being supported by intense lobbying by AT&T. Called the "Consumer Communications Reform Act of 1976," the bill (H.R. 12323) would reform the Communications Act of 1934, which among other wide-ranging measures established the FCC as the primary regulatory agency over interstate telephone, telegraph, and radio communication. The Roncalio bill asserts that direct competition between the specialized carriers on the one hand, and AT&T and the independents on the other, "involves higher charges for users of telephone exchange service . . . fosters inefficiencies in the utilization of national telecommunications resources . . . significantly impairs the technical integrity, the coordinated planning, design, installation, improvement, management, operation and maintenance of the integrated nationwide telecommunications network . . . and . . . has an adverse impact on the national objectives of maintaining stability of consumer price levels . . ." After reciting this list of damages, which sounds like a summary of AT&T Board Chairman John D. deButts' recent speeches, H.R. 12323 proceeds to reaffirm the intent of Congress (as Roncalio reads the Communications Act of 1934) "that the complete authority to regulate terminal and station equipment used for telephone exchange service shall rest with the States even though such terminal and station equipment also may be used in connection with interstate services." The Roncalio bill is apparently only the latest battle in AT &T's two-year aggressive position on national telecommunications policy. Lately, of course, the carrier has been losing more than it's been winning. Not only did the FCC recently shoot down AT&T's requirement for Data Access Arrangements (DAA) on non-Bell interconnect equipment, but the Federal Appeals Court upheld the FCC's prominence in such matters when it refused to allow North Carolina to set its own interconnect policy. The Roncalio bill, introduced earlier than the Appeals Court decision, would move in the opposite direction. Unfortunately for AT&T, the latest news on H.R. 12323 was an expression of strong opposition by the Chairman of the House Subcommittee on Communications, Torbert H. MacDonald (D-MA). Meanwhile, AT&T's position on competition was weakened further as the telephone company complied with a January FCC order to submit a new interstate private line tariff to replace AT&T's two-year "Hi-Lo" rate structure for these services. Called Multi-Schedule Private Line, the new plan will naturally result in rate increases for many AT&T customers – about 75 percent, according to the carrier's estimate. Most of those who will be paying more are short-haul users. AT&T filed Hi-Lo in response to competition from specialized carriers such as MCI and Datran. Although the FCC's official philosophy was then and still is one of open competition, the commission found Hi-Lo – AT&T's first departure from nationwide averaged rates – to be "unlawful."

NETWORKS AND SERVICES

General Electric has announced plans to expand its international Mark III re remote computing service by adding a third "Supercenter" near Amsterdam, The Netherlands. Representing a total investment of $17 million, the proposed computing center is scheduled to begin operation during the first quarter of 1977, at which time it will be integrated into GE's two U.S. Supercenters in Maryland and Ohio. Currently, Mark III serves European customers via satellite circuits and undersea cables. In another announcement, GE introduced a new online order entry service/inventory control capability on Mark III. The new system can be accessed via a wide variety of standard and high-speed terminals, and via the network's telephone information processing (TIP) feature . . . **Control Data** reported the beginning of operations on its first Canadian Cybernet data center. Located in Mississauga, Ontario, the new center includes a Cyber 70 Model 74 computer system . . . Approved by Study Group VII of the CCITT in March, the X.25 packet mode interface specification will be used on Telenet, according to **Telenet Communications Corp.** With the internationally-approved interface, computers can utilize packet networks and exchange data with otherwise incompatible terminals and computers . . . **Western Union** is now offering 50 to 7500 Hz (Type II) audio broadcasting channels on 19 routes between seven WU "Satellite Access Cities" . . . WU also enhanced its Hot/Line point-to-point telephone service by adding a metered tie-line feature that can terminate Hot/Line phones in PBXs owned by either the customer or the telephone company. In addition to allowing access via all handsets on a PBX, the new feature provides compatibility with many PBX features such as station call transfer and add-on. Hot/Line began on an experimental basis in 1965 and is now used by brokers, banks, insurance companies and other types of corporations with heavy point-to-point traffic . . . If the FCC approves, **RCA Global Communications** will have a new Datel tariff this fall. Under the proposed tariff, RCA Globcom will offer dial-up, 4800/9600-bps transmission between the U.S. and The Netherlands. The new, higher-speed Datel service will be called Datel II. Also in the FCC in-basket is a Globcom-proposed tariff for a cost-reduced Datel I, under which this 2400-bps service would be billed at rates comparable to those for operator-handled, station-to-station overseas telephone calls . . . At the Interface '76 Conference, **Rapidfax Corp.** sent and received 8-1/2x11-inch documents in 20 seconds each, according to the facsimile system manufacturer. The transmission was accomplished via Rapidfax 100 digital fax equipment, 9600-bps modems, and the Atlantic INTELSAT IV communications satellite. The Rapidfax 100 transceivers are designed to operate with the new digital networks now being built by several carriers.



LEAR SIEGLER'S MODIFIED DOT MATRIX. By modifying the 5x7 dot matrix on its ADM-3 "Dumb" terminal, Lear Siegler now offers full lowercase capability. The retrofittable features works by shifting the nondescending characters up one line so the uppercase letters "straddle" the lowercase letters.

AUDIO RESPONSE MODEMS

A new line of Touch-Tone/Audio Response modems has been developed by **TransCom Inc.** The TransCom Audioport 400 Multiple Modem Pack provides two-way communication between a voice or tone response computer and Touch-Tone terminals over voice-grade communication lines. Two models and several options allow the Audioport 400 to be compatible with or act as a replacement for Western Electric 401J and 403 E or D modems. The modem pack consists of a cabinet that contains all necessary electronics to support up to 12 modem cards and that is about the same size as one 403.

Circle No. 112 on Inquiry Card

SOFTWARE LINE PERFORMANCE ANALYSIS

DMW Telecommunications Corp. (Ann Arbor, MI) has an interactive software package that analyzes multipoint polled lines with fixed equipment configurations and arbitrary traffic patterns. Developed as a custom design tool for end users, the Response 2 package is currently being used by several of DMW's online network clients to compare response times on individual multipoint lines. For each multipoint line, the program enables the user to evaluate different line speeds, line protocols, modem delays, line propogation delays, numbers of terminals and controllers, central site delays, message arrival rates, and message length distributions. The program produces the average response time for terminal users sharing the line, plus additional statistical information on polling overhead, poll wait time and line transmission time. The package requires Fortran IV and approximately 30K bytes of storage. Purchase price is $3950 on a standalone basis or $1950 for customers who have already purchased DMW's companion performance analyzer product, Response 1. Prices do not include installation, training or documentation.

TRW USES TRANSACTION PHONE

TRW Validata has extended its nationwide credit and check verification service to small businesses in Los Angeles via AT&T's new Transaction Telephone. According to TRW, this is the first time the service has been economically feasible for small businesses, such as restaurants, liquor stores and drug stores. The new Los Angeles service is part of a pilot program, which TRW plans to expand to local merchants in other U.S. cities as Transaction Telephones become available through local phone companies. The Transaction Telephone gives the merchant an easy-to-use data entry and response system. Thus, the telephone becomes a low-cost computer terminal. And this makes the Validata service affordable to most businesses who accept credit cards and checks. To use the Transaction Telephone, the clerk or cashier slides a Validata-supplied plastic dialing card through a slot on the telephone. The card automatically dials and connects the business to the computer verification system. The clerk then slides the customer's magnetically encoded credit card through the same slot, and enters the amount of the transaction on the keyboard (which is similar to a standard Touch-tone array). Within seconds, an appropriate response is displayed by a light signal on the phone.

MA CELEBRATES HER CENTENNIAL

Situated just across the Charles River from the Boston street where Alexander Graham Bell invented the telephone in 1876, the Massachusetts Institute of Technology was an appropriate place for the Convocation on Communications in celebration of the telephone's centennial. Appropriate, too, because Convocation sponsors M.I.T. and AT&T had often worked together during those hundred years. The observance of a century of technological progress is a heady event, to be sure, and most of the papers, books and workshops involved were concerned with rather abstract and wide-ranging matters. Many scholars naturally pondered the future of communications, computers and society over the next few decades. They were spearheaded by science writer Arthur C. Clarke, who, apparently unable to restrict himself to short-range thinking, delivered an address called *Communications in the Second Century of the Telephone.* Clarke, who understandably if immodestly reminded the audience that he was the first to conceive of communications satellites (in 1945!), predicted that the present proliferation of satellite communications will some day unite mankind by overcoming the ignorance and cultural distance that now separates races and nations. The use of home computer consoles would link the individual to massive populations and massive collections of data, via keyboard, video display, video camera, and high-fidelity sound. This would also allow more people to work at home, because almost any kind of information could be transmitted between any two people. On a less optimistic note, the author of *2001: A Space Odyssey* warned that the assumption by machines of the responsibility for most nonintellectual work would eventually create a "workless world" in which only the highly educated might feel at home.

CPU SELECT FEATURE

Infotron has added "automatic computer select" (ACS) to its Timeline 450 Port Selector. ACS allows the terminal user, via the terminal keyboard, to choose among multiple CPUs. The port selector extends CPU terminal handling capability by putting up to 254 incoming lines in contention for available ports (up to 124), rather than dedicating ports to lines that may not be in use. Thus, all callers can use the same telephone number. In systems that already have front-ends with automatic speed recognition, Infotron's automatic baud recognition (ABR) feature, in combination with ACS, recognizes both terminal speed and computer selection character. The port selector connects the incoming call to the first available port in the desired computer and passes the ABR character through to the front-end. The ABR feature recognizes 110, 134.5, 150, and 300 baud.

Circle No. 108 on Inquiry Card

PROGRAMMABLE TESTER

Atlantic Research Corp.'s Intershake II is a programmable datacomm monitor and interactive tester that handles various codes and line disciplines at speeds up to 6400 bits per second with internal clock and up to 2560 bps with external clock. Intershake II provides for half and full-duplex testing, including the calculation of block check characters. Intershake II offers the unskilled operator pushbutton selection of up to 15 protocol diagnostic routines. The skilled operator can structure these routines manually from a library of 100 programmable test steps including jump and branch instructions and loop instructions for software-like test programming. A CRT option allows simultaneous display of the full-duplex data stream, in clear text or hexadecimal.

Circle No. 107 on Inquiry Card

HARRIS OFFERS DISTRIBUTED PROCESSING PRODUCTS

Harris is making a major move into the distributed processing market with the announcement of a series of software, hardware, and systems enhancements to its Harris 1600 Remote Communications Processor family. Key to the new series of enhancements is Harris' new disk-based operating system – ECOS (Extended Communications Operating System). By using an architecture similar to the multiprogram operating systems in mainframe computers, ECOS allows a user to operate in a multijob, multitask environment performing functions such as data entry, remote batch, file manipulation, media conversion and local batch processing concurrently on the 1600 system. In addition to ECOS, a number of new hardware components and software programs will be available to users. The first program is the Local Batch Processing System, a business-oriented software system featuring an ANSI Cobol compiler, sort/merge and supporting subroutines. Executing as a job under ECOS, Local Batch permits users to perform batch processing functions at the 1600 site with programs written in the Cobol language.

A second program also announced is Harris' Key Entry Processing (KEP), a software system enabling users to perform both local and remote data entry, file update, and file manipulation operations on the 1600. Making Key Entry Processing on the Harris 1600 possible, is the company's newly designed and manufactured Model 1675 CRT workstation. The Model 1675 includes such features as 960/1920-character screens, addressable cursor, four keyboard options, extensive editing features and a lower case alpha display feature. Supporting Key Entry Processing, is Harris' new Remote Generalized Application Language (REGAL), described as a high-level language enabling the 1600 system to solve a wide variety of business-oriented data manipulation programs. Through REGAL a user can create key entry programs tailored to fit specific requirements in areas such as source data entry, file manipulation and file update.

First customer shipments for ECOS with Local Batch Processing are slated for second quarter 1976. Deliveries for the Key Entry Processing enhancements will commence in the third quarter of 1976. For additional information, write *Harris Corp., Data Communications Div., 11262 Indian Trail, P.O. Box 44076, Dallas, TX 75234.*

CASSETTE RECORDER

The TermiCette 2020 available from **International Computer Products, Inc.**, uses digital cassettes for recording and playback at rates up to 1200 bits per second. Designed for program loading of microprocessors and minicomputers, the 2020 can also be used with teleprinters and CRT terminals where remote controls or unattended operation are not needed. The TermiCette 2020 measures 6-3/4 inches wide, 7-3/4 inches high, and 13-1/2 inches long; weighs 8-1/2 pounds; and sells for $690 in single-unit quantity.

Circle No. 106 on Inquiry Card

TELETPRINTERS RATED

Teleprinter users rate the products of Computer Transceiver Systems and Digital Equipment Corporation about equal in overall performance and substantially higher than the terminals produced by the six other leading suppliers of this type of equipment. That's one of the key findings of a recent survey documented in *All About Teleprinter Terminals,* a 42-page report just published by **Datapro Research Corp.** and available for $10.00 per copy. Reprinted from the March supplement to Datapro 70, the report also presents detailed characteristics of 149 teleprinter terminals from 57 vendors. The Datapro survey drew responses from 571 users with a total of 11,158 installed teleprinter terminals. The eight most widely used makes of terminals and the number of users who rated each make were as follows: Teletype, 117 users; IBM, 106; Texas Instruments, 58; Digital Equipment, 49; General Electric, 45; Anderson Jacobson, 33; Computer Devices Inc., 19; and Computer Transceiver Systems, 18. Contact ***Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075.***

TERMINAL POLLING SYSTEM

A new system designed to query disbursed networks of Silent 700 Model 742 Programmable Data Terminals has been announced by Texas Instruments, Houston, TX. The new 700 TPS Terminal Polling System consists of a TI 900 Series minicomputer with up to 64K bytes of RAM, a nine-track, 800 or 1600-bits per inch tape drive and a Silent 700 Model 733 ASR data terminal with dual magnetic tape cassettes. By using up to four built-in modems and auto call units, the system can poll as many as 200 Model 742 terminals over as many as four telephone lines. In an alternate configuration, the system can accommodate up to eight telephone lines with the addition of external modems and auto call units. The polling system collects and stores data in an IBM-compatible format. Following system startup, the 700 TPS automatically polls and stores data on a nine-track tape in a format compatible for processing by a host computer. In turn, resulting output from the host computer can be redistributed automatically via the TPS to the terminal network. Base purchase price for the TPS is $37,800; the 12-month lease rate is $1200, including maintenance.

Circle No. 105 on Inquiry Card

MICROPROCESSOR-BASED MULTIPLEXER HANDLES MIXED DATA

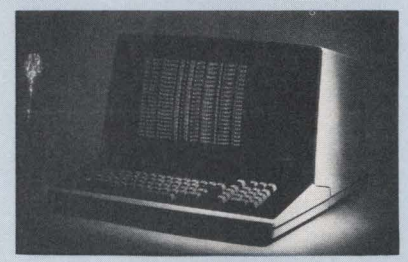
A low-cost microprocessor-based multiplexer from Computer Transmission Corp. (TRAN) accommodates up to 16 asynchronous, 8 synchronous digital data channels or a mix of both. Intended for simple point-to-point multiplexing between terminal clusters and computer centers, the M1308 Multitran multiplexer supports wide mixes of RJE terminals, synchronous CRT controllers and interactive asynchronous terminals over a single voice-grade telephone line. The M1308 multiplexer may connect terminals via dial-up or dedicated modems, TRAN short haul data sets, or direct EIA cabling. The basic M1308 costs $1800. Larger quantity discounts are available. A complete basic 16-channel, point-to-point multiplexing network between a terminal cluster and a computer center costs less than $8000.

Circle No. 111 on Inquiry Card

TERMINALS

A CRT terminal equipped with a 202-type modem has been announced by **Western Union Data Services** (Mahwah, NJ). Available as either a standalone configuration or with the company's cassette buffer, the Video 100 operates with various modem arrangements at speeds up to 1200 baud. The Video 100 features a 12-inch diagonal screen and a 64-character, 5x7 dot matrix display set. Standard display capacity is 1920 characters. The Video 100 with a manual 202-type modem is offered on a one-year lease for $86 per month; with automatic answer modem, $90 per month and manual or automatic answer with reverse channel, $95 per month . . . The **Tycom** (Fairfield, NJ) HyTerm System is a Teletype-compatible intelligent terminal. Incorporating microprocessor and ROM integrated circuits, the HyTerm ($3495) interfaces with a Bell-type 103A or equivalent. The Tycom terminal utilizes the Diablo HyType II printer mechanism, with appropriate software for the Diablo mechanism's graphics capability, horizontal and vertical tabbing, and backward printing feature. The HyTerm has an error light which indicates errors caused by noise on the communications link, and provides forms adaptability resulting from conventional tabbing, absolute tabbing, adjustable form length, and an electronic top-of-form and form-feed capability . . . **Carterfone** (Dallas, TX) is offering the DECwriter II (LA36) for monthly rental, including maintenance, of $79 per month . . . The Series 30 Printer from **Di/An Controls** (Boston, MA) is an asynchronous, matrix impact printer available in ASR, KSR, and RO versions. Desk-top or pedestal mounted, the 30-cps printer prints 80 or 132 columns . . . A new display size available from **Ann Arbor Terminals** (Ann Arbor, MI) offers a 20 line by 50 character format with a 96-character ASCII code set including upper- and lowercase. The 2050 terminal is available in KSR or RO versions. Characters are written on a 7x9 dot matrix in a 10 x12 dot field. Command functions include erase screen, line feed, and carriage return. Cursor positions are right, left, up, down, home, and x-y positioning. Baud rates of 110 through 9600 are available. Single quantity price of the 2050 display in a desktop"Design III" case is $1170 in RO version and $1675 KSR (keyboard included). OEM and quantity discounts are available . . . **Data Terminals and Communications (DTC)** (Campbell, CA) has announced the DTC-302 Hy-Writer KSR hard-copy terminal. Utilizing the Diablo HyType II printer and a microprocessor controller that is "upward feature compatible" with DTC's 300/S, the 302 Hy-Writer is offered in a desk-top model (standard) or the mobile pedestal stand version (optional). The 45-cps terminal, with a new buffer optimization and monitor technique, operates at optional data rates to 1200 baud. Price of the DTC Hy-Writer is $3490 in single quantities. OEM discounts are available . . . **RCA Service Co.** (Camden, NJ) is entering the high-speed terminal market by offering the General Electric TermiNet 30 KSR teleprinter. RCA will purchase the printers for lease to its own base. Lease prices, including maintenance, are $90 per month for the KSR, or $135 per month for the KSR with mag tape units.

Tycom's HyTerm System looks and acts like it contains a Diablo HyType II printer mechanism. It does.



Ann Arbor 2050 offers 20x50 capacity with upper- and lowercase.

DTC's new Hy-Writer KSR.

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MICROPROCESSOR ASSEMBLERS AND CROSS-ASSEMBLERS

MALCOLM L. STIEFEL / Contributing Editor

EDITOR'S NOTE:

This is the first in a regular series of columns on mini/microcomputer software — bootstrap loaders, assemblers, text editors, simulators, debuggers, linkage editors, compilers, file access methods, operating systems, sorts and other utilities, data base management systems, application programs and (have we left anything out?) documentation. We'll focus each month on a particular class of software to help educate readers who might not be directly acquainted with it and to impart new ideas to those of you who work with it everyday. We'll explore what manufacturers and independent vendors are doing, talk about concepts that appear in technical society publications and keep an eye on government actions, particularly ANSI standard committees. Finally, we'll report on what users are doing — what they're saying, what they want and don't want. That's where you come in. For this to be an interactive column, we need to hear from you. Address all comments to:

Mini/Micro Software Editor, Mini-Micro Systems, 5 Kane Industrial Drive, Hudson, MA 01749

One of the first problems faced by the designer of any microprocessor based system, whether a hobbyist or a professional, is, "How do I program it?" Depending on the chip he's chosen, he has a number of choices open to him: machine language; assembly language; or a higher-level language, or interpreter, such as Fortran or Basic. The decision is invariably cirtical since it will impact budget and schedule.

If he's a hobbyist, the strain on the pocketbook will govern his election. He'll take the cheapest way out. Machine language for him. He'll code each instruction, each address, each operand in hexadecimal, octal, or binary, sacrificing the hours to save the bucks.

For the pro, though, it isn't all that simple. In a competitive environment, time is of the essence, particularly in a volatile field like instrument design, where new product announcements always seem to be in the air, descending upon us in a perpetual blizzard. The designer, particularly the engineer accustomed to years of bit-chasing in logic circuits, may try his hand at machine language for a while before succumbing. We can see him now, bolting from the lab, screaming, "There *must* be a better way." Fortunately, there is. In fact, there are several better ways.

Not only are chip makers coming out with increasingly powerful program development packages, but many independent software houses have gotten into the act, usually drifting into the micros after years in the mini and maxi worlds.

As a result, the designer has a host of avenues open to him, no matter which chip he's using. *Assembly languages* have a one-to-one correspondence to machine language, instruction for instruction. *Higher level languages* can generate several lines of object code for each line of source code. The primary trade-off factors are quite clear. According to experts in the field, a given problem can be coded in assembly language using half the code generated by a high-level language compiler. But development time, including coding, testing, and debugging, will only take 40 percent as long with the compiler as with the assembler approach.

Of course, the arguments don't end there. Assembler advocates point out that assembler code will likely *execute* much faster than compiler code, an important consideration in many applications, especially in real-time control or monitoring of rapidly changing processes.

The compiler cult counters by saying that documentation and system support will be better with a high-level

Contributing Editor Malcolm Stiefel has logged 17 years in the computer field working as a systems analyst, systems engineer, programmer and writer.

TABLE 1: MICROPROCESSOR ASSEMBLERS

μP	VENDOR	CROSS	RESIDENT/ SYSTEM	RELOC
COSMAC	RCA	x	x	
F-8	Fairchild	x	x	Planned
	Micro Systems	x		
	Mostek	x	Planned	
M6800	Motorola	x	Exorciser	
	Micro Systems	x		
	Wintek	x		
	Zeno	x		
	Beacon		B6800	
MCS6500	MOS Technology	x		
	MAI	x	Jolt	
	Zeno	x		
MIPROC-16	Plessey	x	x	
PACE	Nat'l Semi	x	x	x
TLCS-12	Toshiba	x		
TMS9900	Texas Inst.	Planned		
μ-Com 8	NEC	x	x	
Z-80	Zilog	x	x	
1600	Gen. Inst.	x		x
2650	Signetics	x	Planned	Planned
4004	Intel	x	Intellec	
	Micro Systems	x		
4040	Intel	x	Intellec	
	Micro Systems	x		
8008	Intel	x	Intellec	
	Micro Systems	x		
	Zeno	x		
8080	Intel	x	Intellec	
	Micro Systems		x	
	Zeno	x		
	MITS		Altair 8800	

source. They also cite the superior adaptability of high-level languages to structured programming techniques; these factors may weigh heavily where a system is expected to undergo substantial modification over a period of time.

"Yes," the assembler fans answer, "But high-level languages don't lend themselves readily to bit-banging. Most of them quit at byte level, but we need to manipulate bits – to set them, clear them, examine them . . ."

And so it goes. The picture isn't clear as it would seem at first glance. In some cases, of course, the question is moot. Not all microprocessors have high-level languages, yet.

In any event, once the class of development language has been settled, the designer has further selections to make. Suppose he has opted for assembly language. Now he can pick a *resident* assembler, which runs on the microprocessor itself (augmented, of course, with enough memory and input-output devices to support the function). Or he can go for a *cross*-assembler, running on some other microprocessor in a stand-alone development system or on a commercial timesharing system. Does he want an ordinary assembler, or a *macro* assembler, in which he can define strings of instructions – as macros to be named in single mnemonic instructions whenever they are to be executed?

He may want an *absolute* assembler, in which all object code addresses are defined relative to memory location 0. Or maybe his application calls for a *relocatable* assembler, in which the object code addresses are defined relative to the starting point of the program (not necessarily zero) so that several programs may be developed separately and linked together by a *linkage editor* (alias *link loader*) placing each subroutine in its own memory slice before execution.

In a *one-pass assembler,* the source code on punched paper tape or cassette is read into the program once, and data symbols and location tags are converted to machine code on the fly. In a *two-pass* (or n-pass) *assembler,* a symbol table is established the first time the source code is read in, and location tags are translated into machine code addresses on subsequent passes.

Most resident assemblers are one-pass to keep I/O to a minimum, because the resident peripherals are often painfully slow. Cross-assemblers are usually two-pass. Some multi-pass resident assemblers are also on the market, designed to fit into systems with limited memory capacity. A typical one-pass resident assembler occupies 8K bytes of memory, but multi-pass systems can run in 2K bytes or less.

Table 1, taken from a recent paper,[1] indicates just a few of the bewildering array of assembler packages on the market from chip manufacturers, as of a couple of months ago. In the table, those strange names ("Exorciser;" "Jolt;" etc.) belong to standalone microprocessor development systems (MDS) offerred by the manufacturers. We'll look at the MDS separately in a future column.

So when does a user turn to a cross-assembler, as opposed to a resident assembler? "Any time he's intelligent," says Mike Rooney, president of Boston Systems Office, Inc., (BSO). His company, based in Waltham, MA, develops and sells cross-assemblers for commercial timesharing houses, and resident and cross-assemblers for others who have their own in-house development systems. BSO has written cross-assemblers for 13 different microprocessors; most are available on the DEC PDP-10 at First Data Corporation and other timesharing vendors.

Rooney argues that the total system development time on a fast, large-scale machine with high-speed peripherals and sophisticated text editors can be an order of magnitude less than the time needed with a severly input-output bound minicomputer- or microcomputer-based standalone unit. The savings realized in engineering labor can more than offset the connect time, CPU time, line, and terminal rental charges incurred by the timesharing user in many instances. He cites the case of a customer who told him, after a successful 2-1/2-hour terminal session, "This would have taken me 2-1/2 weeks on my own system."

Then, for in-house use, why would a user turn to an independent vendor such as BSO, rather than going to the chip manufacturer? Rooney replies that the chip-makers are not primarily in the software business, so they tend not to emphasize software efficiency. For example, he points out that every microprocessor maker who offers a cross-assembler has written the program in Fortran, whereas BSO always writes its cross-assemblers in the host machine's assembly language. BSO's programs run faster, reducing the user's costs accordingly.

BSO has also enhanced some of the cross-assemblers, offering macro capability and conditional assembly options (to produce different versions of a program by varying the conditional parameters) where the chip makers don't have them. ■

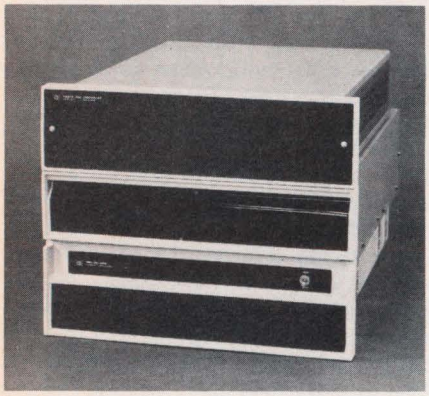
[1] "The State of the Art In Microprocessor Software," Dr. Geoffrey C. Leach, Electro 76 Professional Program, Session 3

product focus

BARBARA A. REYNOLDS / Associate Editor

AN IMPORTANT OMISSION

In January's Disk Cartridge Profile, we left out a very important parameter for the Hewlett-Packard 7905A disk cartridge drive (Table 2). The 7905A is one of a very few drives with a rota-



tional speed of 3600 rpm. This combined with the high bit density (4680 bits per inch) results in a data rate of 937.5K bytes per second, making it the fastest cartridge drive around. To maintain data integrity at the high speed, Hewlett-Packard uses a microprocessor-based controller for error correction, rotational position sensing, alternate track switching and track follower technology (first used on IBM's 3330). With this drive, H-P feels it has the ingredients to give Diablo a run for its money. The drive is not just for the H-P customer base, but especially for OEMs. And the company has a good head start – H-P is shipping 150 percent more disk drives today than it was one year ago.

UNIVAC MOVES INTO INTELLIGENT TERMINALS

Sperry-Univac chose the Hannover Fair to announce two new intelligent terminals in an attempt to capture a larger share of the distributed network market. Univac expects intelligent terminals to make up 34 percent of the U.S. total terminal market by 1980, compared to 1975's 11 percent. In Europe, Univac expects the share to grow from 11 to 16 percent. The Universal Terminal System (UTS) 400 is a microprocessor-based remote display terminal. The interrupt-driven microprocessor provides an eight-bit data bus, a 16-bit address bus and a 76-instruction set for the microprograms. A combination of ROM/RAM memory from 24K to 36K bytes is possible, a portion of which is programmable. The terminal can operate alone, or in a 96-station cluster using the Univac terminal multiplexer. A text editor version is also available. Price for a one-station configuration, including processor, memory, communications, device I/O and CRT/keyboard, starts at $9000.

Univac's UTS 700 is considered a remote batch system, offering disk file management, system control language and error logging. An RPG II compiler in conjunction with the disk operating system allows the user to write free-standing programs. The processor is a bit-parallel binary microprocessor with an eight-bit accumulator, six eight-bit registers and an eight-bit external data

UNIVAC'S INTELLIGENT TERMINAL. *The UTS 400 is a programmable, microprocessor-based display terminal which is compatible with Univac's Uniscope 100 and 200 communication procedures. Several peripherals can be added, including the Communications Output Printer, the Model 800 Terminal Printer and the Model 610 Tape Cassette.*

path. MOS memory is available in 16K increments, from 48K to 65K. The UTS 700 emulates Univac's 9200/9300 and 1004 systems, as well as IBM's 2780/3780. A variety of disk, printer, cartridge and tape equipment is available. Price for a UTS 700 with dual-diskette drive, 600-line per minute printer, 600-line per minute reader and CRT work station is $59,000.

Circle No. 94 on Inquiry Card

BURROUGHS' SMALL LARGE SYSTEM

Approaching mini-based system prices, but with large-systems software capability is one way to describe the Burroughs B 80 series. Like IBM's System/32, the B 80 is designed for small businesses or branch offices of large businesses. Configuration-wise it's also similar to the System/32. A basic system has 32K bytes of MOS memory, expandable to 61K, console, 60-character per second printer, two 1-megabyte floppy drives, tape cassette and 256-character display. As Burroughs' lowest-priced system, it sells for about $20,000. IBM's lowest is about $33,000, but that includes 5 megabytes of disk storage.

The B 80 microprogrammed processor uses nine LSI chips and has a look-ahead feature. Also special to the hardware is the "flippy" (two-sided floppy) disk, which IBM also recently introduced in its upgraded 3600 financial system. But Burroughs has also increased the density so that each floppy stores 1 million bytes instead of the usual 250,000 bytes. Random access time for the drive is 266 milliseconds.

The hardware is nice, but software makes the system stand out. The B 80 Computer Management System is an integrated system of operating and application software, which includes the Master Control Program, language compilers, utilities, Data Base Bridging System and Business Management System. The Master Control Program is the operating system, facilitating virtual memory and multiprogramming. *Multiple* high level languages are possible on the B 80 because of the microprogrammed architecture. They are Cobol, RPG, a network definition language and a message processor language. The Data Base Bridging System allows other small computer data bases to be transferred to the B 80 with tape. The Business Management System consists of optional application packages that give the B 80 its turnkey capabilities for businesses without professional programmers. All are written either in RPG

The performance of a B 80 basic system, with a 180 character-per-second console printer, is further increased by the addition of a 250-line per minute printer and two Burroughs dual-drive disk cartridge subsystems.

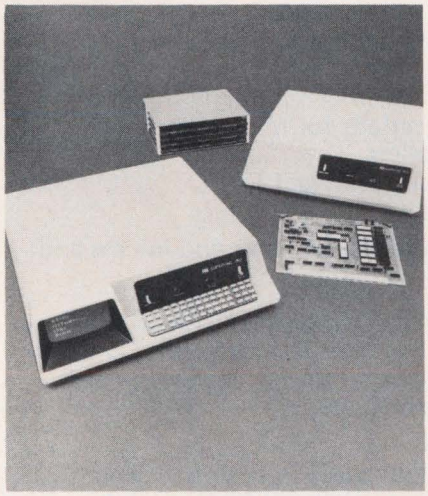
or Cobol. An example is Commercial BMS II, which includes billing, accounts/receivable/payable, payroll and general ledger, and has a one time charge of $4000.

From the Basic system, you can add up to six floppies, up to four tape cassette stations, three dual-disk cartridge drives, up to two line printers (160 or or 250 lines per minute), up to four display terminals, and up to four data communication channels, which brings the price to a maximum $150,270.

Circle No. 93 on Inquiry Card

MODULAR MICROS FOR INDUSTRIAL CONTROL

The people in Flint, MI – Process Computer Systems – have developed a line of microcomputer building blocks for industrial systems. The PCS 180 line uses CMOS circuitry to keep power dissipation and heat to a minimum. Tristate bus logic is used so both high- and low speed peripherals can be interfaced to the microcomputer. Two basic microcomputers are used as starting blocks for the family. Both are based on the 8080A and have five interval



The 180 line of microcomputers from PCS.

timers, external interrupt and DMA capability. The 1806 comes with a 1K-byte RAM, provision for 7K EROM/ROM, eight TTL inputs and outputs and sells for $265, quantity 50. For those needing battery backup and high-end digital inputs and outputs, the 1810 is available also for under $300. The 1810 has battery backup to support its 256 bytes of CMOS/RAM for up to 10 days, and has sixteen 3- to 30-volt digital inputs and sixteen 30-volt, 500-mA digital outputs. There are also provisions for 3K bytes of EROM/ROM. Users can add to this single-board micro by adding memory, I/O and communication options. Both the 1806 and 1810 also come with a four-slot chassis and power supply for $450 in quantity 50. Using the basic blocks, PCS also offers the rack-mountable MicroPac 180, which includes an 1806 (or 1810) as well as a four-slot chassis, power supply and front panel. Price in quantity 50 is $695. And if it's display capability you need, the SuperPac 180 includes a 1024-character display with keyboard and control module and is also based on the 1806. The price is less than most CRTs – $1000 in quantity 50.

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Mini/Micro

COMPUTER CONFERENCE AND EXPOSITION

October 19-20-21, 1976
Brooks Hall/Civic Auditorium, San Francisco

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Approximately twenty sessions consisting of eighty papers covering both application and design topics are planned.

Some session titles (and organizers) to date would include:

1. Distributed Processing with Minis.
   (Dan Zatyko - General Automation)
2. Military Applications for Microcomputers.
   (Joe Genna - Delco Electronics)
3. The Effect of LSI Technology on Memory Systems.
   (Dan Bowers - Bowers Engineering)
4. Interfacing the Analog World to Minis/Micros.
   (Larry Brown - Calex)
5. Integrating OEM Peripherals into Computer Systems for End-use.
   (Martin Himmelfarb - Digital Design)
6. Microcomputer Software and Hardware Development Aids.
   (Dave Millet - NEC Microcomputers)
7. History to Current Development of Memory Peripherals for Mini and Micro Computers.
   (Bill Frank - Cal Comp)
8. The Make or Buy Decision.
   (Robert Van Naarden - DEC)
9. Microcomputer Applications; Logic Replacement; Minicomputer Replacement, New Products.
   (Jerry Ogdin - Microcomputer Techniques)
10. Industrial Applications for Microcomputers and Microcontrollers.
    (Ian Ebel - Control Logic)

11.-20. Being organized.

PLUS . . . tutorial sessions on minis and micros and a special session for computer hobbyists!

Conference Program Committee — Chairman: Robert J. Frankenberg (Hewlett Packard); Co-Chairmen: Justin Rattner (Intel Corp.); Manny Lemas (Microcomputer Associates).

THE EXPOSITION:

The exposition floor space in both the Civic Auditorium and Brooks Hall will feature a full spectrum of product displays by leading computer suppliers. Minicomputer and microcomputer systems and sub-systems will be available for "hands-on" demonstration, along with a wide array of computer peripheral devices, software aids and information. This 1976 MINI/MICRO COMPUTER EXPOSITION is expected to be the largest such event in the greater San Francisco area in almost ten years.

If you design mini-micro computers, sub-systems, peripherals, or components, use them in your business--or plan to--the hundreds of product displays will also be of valuable interest to you.

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product focus

A NEW ERA FOR CENTRONICS

Centronics introduced its Series 700 as a whole new era of printing. What makes this a new era is the modularity of the impact printers. There's a print module, a forms handling module, keyboard and electronics module (consisting of one LSI printed circuit card). All models use the same box, but the print modules and forms handling modules can be matched to the OEM customer requirements. Each model has a different electronics module. Modularity gives the advantage of lower production cost and therefore lower price and fewer moving parts and therefore lower cost of ownership according to Centronics. The first of the Series 700 are the Models 700 and 701 60-character per second printers. The low-speed market is new for Centronics, but its part of the company's overall strategy to "cover" the printer market. In addition to its present market of medium-speed line and serial printers, Centronics also has the high-speed market through the acquisition of Data Printer Corp. Both the 700 and 701 use a 5x7 dot matrix and LSI technology. The 700 is unidirectional; the 701 is bidirectional. Also introduced as part of the Series 700 was the Model 761 teleprinter (KSR and RO). Again, the same box, but different electronics, print modules and forms handling. The 761 teleprinters operate at 300 baud, use a 7x7 dot matrix and perform bidirectional and incremental printing. The RO version uses LSI technology; the KSR version uses a microprocessor – a first for Centronics. As explained by Robert Howard, president, LSI is more than adequate for most printers, but the microprocessor capabilities are needed for the keyboard and transmission of the teleprinter. OEMs can pick and choose models and modules with these quantity 100 prices: 700 – $885, 701 – $1070, 761 RO – $1180 and 761 KSR – $1275. All will be available in September.

Circle No. 92 on Inquiry Card

A MORE PORTABLE PORTABLE

In the portable terminal market, one giant stands out above all the rest – Texas Instruments. With the announcement of the Model 745 13-pound terminal last year, TI seemed untouchable in this $30 million per year market. But the No. 2 portable terminal manufacturer is not ready to give up. As a replacement to its 1030 portable terminal (with built-in acoustic coupler), Computer Devices (Burlington, MA) has introduced the 15-pound Miniterm 1203 portable teleprinter. The Miniterm 1203 incorporates improvements made to the 1030 in the last few years plus more, such as reducing the size of the electronics. Computer Devices is not as price-and volume-oriented as TI. Rather, it emphasizes features and reliability. The Miniterm 1203 sells for $2185 compared to TI's price of $1995. Both lease for $125 per month. For the extra money, CDI gives a one-year warranty, a three-mode switch-

selectable keyboard, RS-232 interface and switch-selectable speed of 10, 15 or 30 characters per second. TI has a two-mode keyboard, optional RS-232 interface and a 90-day warranty. But perhaps most impressive about the Miniterm 1203 was that in showing the production process, a CDI engineer unassumingly snapped together the terminal in five minutes. That's modularity.

Circle No. 96 on Inquiry Card

MODCOMP'S NEW NETWORK PROCESSOR

Modular Computer Systems (Modcomp) is combining a new processor and semiconductor memory to offer a low-cost network mini – the Modcomp II/2. The one-board processor uses Modcomp's Maxnet software for network applications, as well as all other Modcomp II software. Access time for the memory is 400 nanoseconds; cycle time is 600 nanoseconds. Network computing systems seem to be becoming Modcomp's specialty. Of $39 million gross revenues last year, networking applications accounted for 65 percent. Prices for the Modcomp II/2 begin at $3995 and go to $6195 for the 48K version, with 25 percent discounts available for large volumes. Also introduced was a new Fortran IV compiler, said to offer improvements of as much as 60 percent in compilation, and a bulk core storage module that functions as an I/O device. "Memory +" will approach the price of storage peripherals, but will have the access and transfer rates of main memory. Memory + can be connected to the DMP channels of both Modcomp II and IV computers via the I/O bus. Or it can be connected to Modcomp IV's main memory using the lookahead, multiport memory interface system. A minimum configuration, consisting of one controller, one device file and one 256K-byte core module is $20,000. That means you're paying for speed, not capacity.

Circle No. 95 on Inquiry Card

data base
for the mini user

A MINI-MICRO SYSTEMS Staff Review

Once the sole property of medium- and large-scale computer users, data base management (DBM) systems will soon change the way minicomputer users store, handle, and even think about their data.

DBM systems are rapidly becoming available to the minicomputer user. As of this writing, Hewlett-Packard (IMAGE/3000), Varian (TOTAL), Digital Equipment (MUMPS) and Data General (INFOS) are members of the club. Originally made possible by improved data storage and access techniques (mostly on disk), DBM systems are now useable on minis thanks to larger main and secondary storage capacities and the availability of higher-level languages, especially COBOL.

WHAT ARE THEY?

DBM systems are designed to store the data of a business (or other) organization in a nonredundant fashion and allow concurrent access to that data by various users throughout the organization. Most important, a DBM system allows access to the same data for *different purposes.*

Traditional (non-DBM) data processing boils down to the processing of a data file by an application program. The logical structure of the file is known to the program (e.g., is defined in the Data Division of a COBOL program) and in fact was designed to be processed by that program alone. For example, a payroll file contains records organized into fields that contain exactly the data needed to produce payroll checks and earnings statements. Of course, many of the individual fields in the payroll record are also needed by other programs; these fields must be *duplicated* in the other files (e.g., employee master file). Because of this data redundancy, programmers must provide for the updating of the same data in more than one location. This requirement is complicated further by the different run schedules of the programs that process the redundant data.

In a well-designed data base management system, all data redundancies are eliminated. A given field (e.g., hourly rate of pay) need not be duplicated for use by more than one program, but can be defined once for all programs that may need access to it. This greatly simplifies updating, and complicates data management. But data management is what the DBM system takes over.

WHAT DO THEY CONSIST OF?

DBM systems take over the structural definition of data that was previously a function of the application languages. In other words, the definitions of data fields and their interrelationships becomes invisible to the application programmer (user). To accomplish this, a DBM system normally provides a data definition language (DDL), which defines *each data element* (field) that will be required by any existing (or foreseeable!) application program.

The DDL also defines which data is available to which programs. In other words, this is a "mapping" function over and above the normal logical-to-physical mapping performed by disk-based operating systems. After all the data is defined via the DDL, a given application program accesses data via a data manipulation language (DML), which is usually an extension to COBOL.

Finally, many systems DBM also provide a query language, a simplified, English-like language used for interactive terminal access to data for one-shot purposes, often by management. An example would be a management request to determine the number of employees earning more than a given amount of pay per hour.

ADVANTAGES AND DISADVANTAGES

The advantages of DBM systems are rather obvious: All data is up-to-date as of its last access, with no worries about duplicate data not being in agreement; multiple users can access the same data for different purposes; nonprogrammers, especially managers, can access the same data they need without help from the DP experts. In general, DBM systems bring the computer closer to its end users throughout the organization, which is, incidentally, one of the primary reasons for buying minis.

The disadvantages are not so obvious, at least until the user starts to plan the implementation of a DBM system. Generally, these systems will eat up more *main* storage space because of the requirements for data "mapping." Access speed may be impaired for the same reason. System software is very complex and probably will remain the sole domain of the *vendor's* specialists (which will make a lot of "do-it-yourself-type" mini users unhappy). Finally, the organization must review *all* of its data at one time – a DBM system cannot easily be implemented piecemeal. Thus the planning and startup costs in terms of manpower are considerable. In fact, most DBM experts recommend one person in the DP staff be dedicated as a data base administrator.

A NEW LOOK AT DATA

This last problem is really an opportunity in disguise. If a mini user goes about this properly, and hires or appoints a data base administrator who is as good a manager and diplomat as s/he is a computer specialist, the process of defining an entire data base can benefit every user department within the organization. As large-system users of data bases have discovered, a DBM system allows data to be organized and interrelated *as the user sees it,* as a representation of reality instead of a structure that has grown haphazardly within the constraints of batch processing or single-use interactive processing. ■

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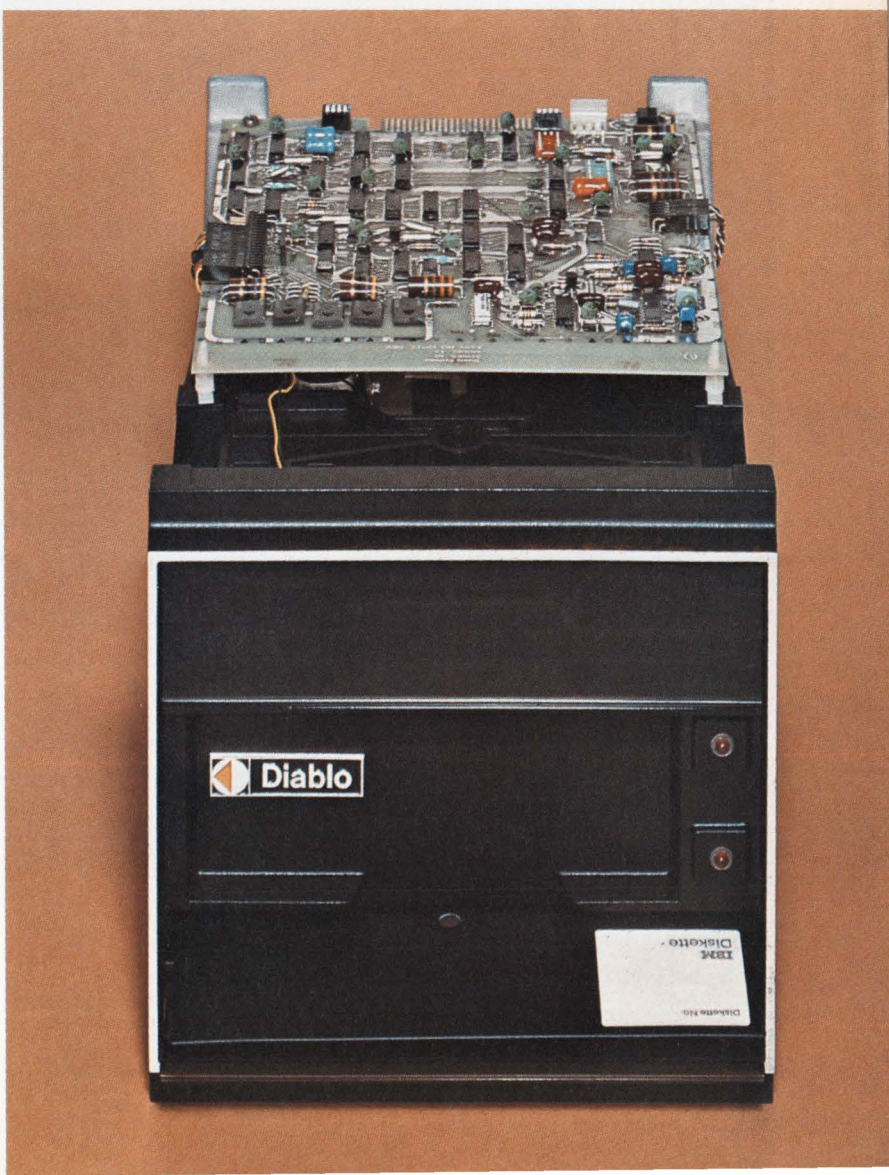

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CIRCLE NO. 20 ON INQUIRY CARD

MSI: Coming out of a corner

A leader in data entry terminals approaches the market from a new direction.

Within some industries, MSI's hand-held terminals are almost as ubiquitous as the push-button telephone. This is particularly true in the grocery industry. Of the 50,000 terminals MSI will have delivered by the time you read this, more than half will be in use by grocers. That's nice – until you consider that MSI expects the grocery market to be saturated at 40,000 terminals.

MSI did not just become aware of the problem. The company currently produces a range of allied communications and terminal gear that extends up to the very sophisticated Data System IV family of programmed data collection systems. But while no longer a one-product company, MSI does depend on a relatively few vertical markets for most of its revenues. Over half the $32 million worth of equipment it sold in 1975 came from just the grocery industry.

Recently MSI introduced a product that should move the company out of its corner. Ironically, the new "Source 7600" programmable off-line remote data entry terminal represents the very kind of product MSI has been selling its standard line of in-the-field data entry products *against* since the company's inception.

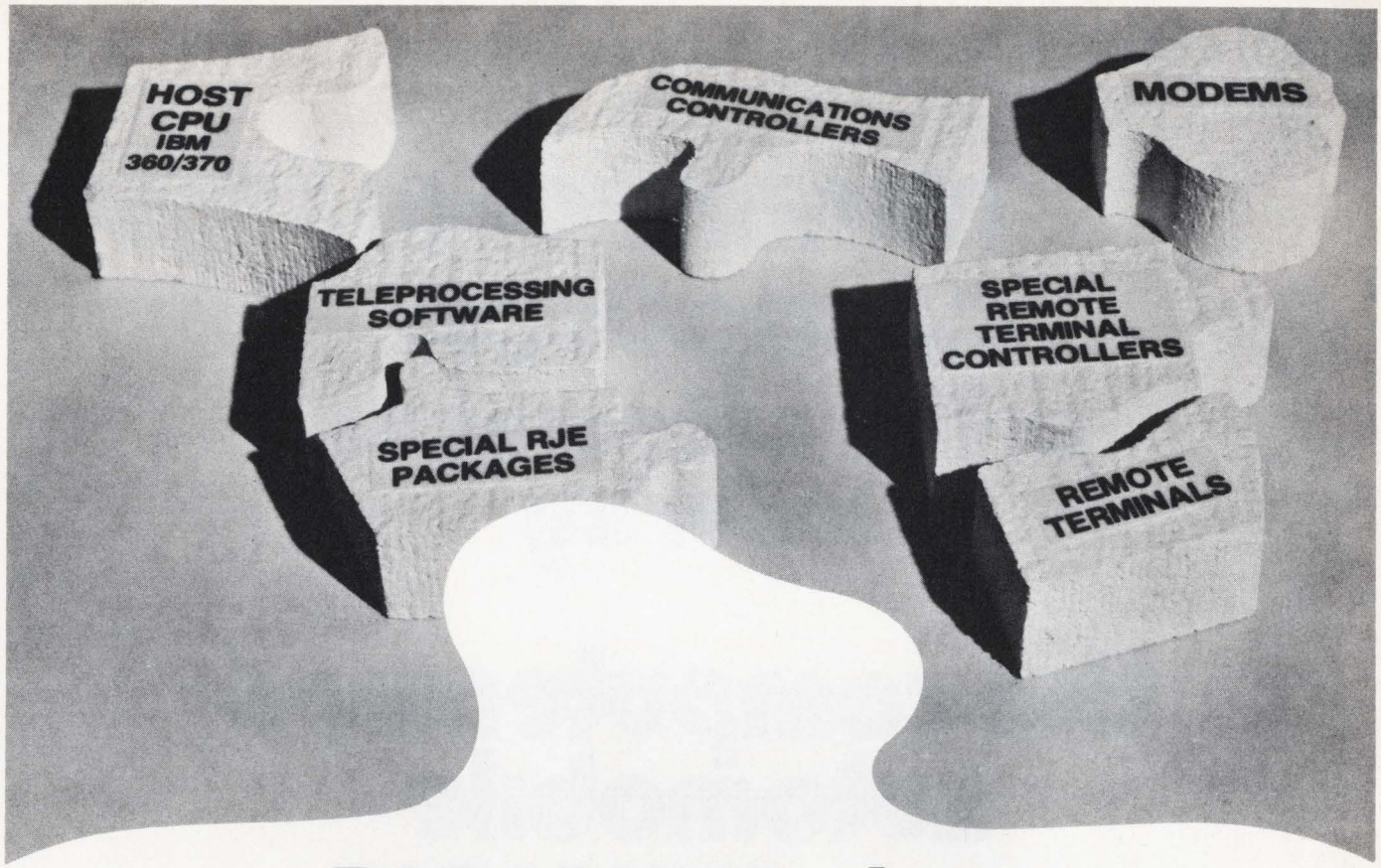
The Source 7600 is designed for office – rather than field – use. It incorporates one or two cassettes, separate alpha and numeric keyboards, journal printer, 32-character LED display and Intel 8080 microprocessor in a typewriter-sized unit. Both free-form and formatted data are entered, edited and batched on the cassette. At $3400 to $4500, the Source 7600 is well placed to compete with the bottom ends of any of a dozen similar terminal lines from such old hands as NCR, Sycor, IBM, TI and Datapoint. And although it is the first MSI terminal capable of two-way communication, it contains many features (e.g., plug-in function packs and telephone diagnostics) that even most of the old-timers don't provide.

But doesn't the Source 7600 compete with existing MSI terminals as well? "Not at all," counters MSI Vice President for Marketing Gary E. Liebl. "Source 7600 is a logical extension of our existing product base, allowing us to resell many of our current customers and to expand the boundaries of our marketplace."

MSI's Source 7600 – *A new multi-format data entry terminal from a (previously) fixed-format company.*

In other words, while MSI's field data entry terminals have always been sold as alternatives to office-use data entry terminals like the Source 7600, the need for one does not exclude a need for the other. The Source 7600 is designed to handle the varying and more detailed formats required for payroll, accounts receivable and other general ledger applications in such areas as branch banking operations (e.g., loan applications, new accounts), regional government offices, utility service centers and outpatient medical facilities. And, of course, the grocery industry.

For more information on Source 7600
Circle No. 110 on Reader Inquiry Card



PARADYNE pieces your data communications puzzle together.

Various manufacturers offer many software and hardware pieces for Data Communications, but they do not all necessarily fit together. These include Teleprocessing Software, special RJE Packages, Communications Controllers, Modems and Special Remote Terminals.

Whether you are just beginning to think about Remote Processing, or are already a battle-scarred veteran, **Paradyne's PIX II** System offers THE solution to your data communications puzzle.

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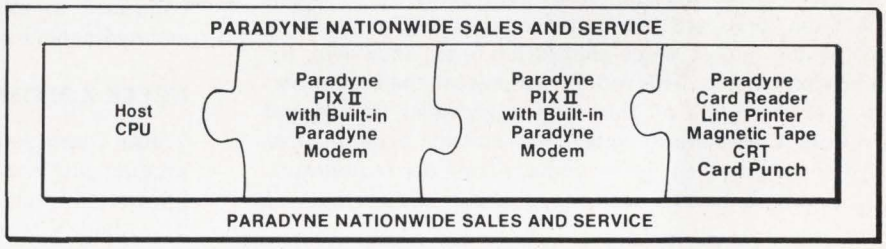

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CIRCLE NO. 21 ON INQUIRY CARD

DAN M. BOWERS / Technical Editor

mini/micro computers in the automotive industry

the computerized automobile

PART – 3

Editor's Note:

In the April installment of our continuing Applications Profile *Mini/Microcomputers in the Automotive Industry,* we relayed the opinion of Ford's Mayford L. Roark that the "on-board" computer for automobiles could become the largest single application, ever, anywhere, for microprocessors. This month we present the first of several explorations of this subject provided by General Motors Corporation, which has already experimented with nearly a dozen "generations" of on-board computers.

The motoring public has heard for years of the wonders of the electronic car: microcomputers to replace the gear, the lever, even the wheel, conventional mechanical functions to be henceforth electronic. A magic carpet you can talk to. But *when?*

There is no trick to digital displays, and General Motors electronics specialists can hide in the glove box the brains of Alpha V, the latest of their Greek-lettered wondercars. Delta III, another GM Advance Product Engineering electronic car prototype, can give itself a physical examination at the push of a button. When, then, will production cars be equally adept?

Today, five years after the auto and electronics industries began serious courtship and a GM team made the marriage its mission, the experts must still couch their answers in terms of *what* and *how* and, most important, why: the future of the electronic car remains first and foremost an economic matter.

Although electronic voltage regulators and electronic ignition systems have passed their pocketbook tests, the automobile remains principally a mechanical creature. Ninety years after the electric ignition made the horseless carriage possible, 63 years after GM's Charles "Boss" Kettering put the first self-starter on a Cadillac, mechanical engines connected to mechanical transmissions still make cars go and hydraulic brakes make them stop.

GREEK WONDERCARS BEGIN

Trevor Owen Jones came from General Motors' space and aviation guidance systems programs in 1970 to oversee the integration of electronic devices into GM's cars and trucks. The Alpha V is fruit of his labor, along with four predecessor Alphas, several Deltas, some Sigmas and a Beta. As examples of the miniaturization necessary to the application of electronics to automotive functions, they are to the ultimate computer car what the monstrous computers of 25 years ago are to the modern hand calculator.

Alpha I, one of the first attempts at controlling an automobile by computer, was a 1971 Pontiac Grand Prix with a central processor about the size of a two-drawer filing cabinet and enough auxiliary electronics to fill the trunk. In all, there were 4000 electronic components. Four years later, the single digital processor on Alpha V contains only four micro-electronic packages.

The team at Advance Product Engineering is pushing the state of the art this time with Omega, the first total automotive central processor system. The brains of Omega will be a one-package computer, the size of a cigarette pack, capable of handling the control, diagnostics and display functions of all its ancestors. As the prototype of what may be the first production computer car, it must prove itself in the cost effective performance of basic functions like cruise and

transmission control, fuel injection and the like: no voice-actuated doors, no automatic windshield wipers. For although the more functions the computer performs the more value it holds for the motorist, even exotica must be cost effective.

"You've got to admit the ordinary door latch serves its purpose pretty well," says John Auman, executive engineer of GM's Advance Product Engineering staff. "And while the benefits of screening potential heart attack victims and intoxicated persons by computer are obvious, there are a lot of technical and human engineering problems to overcome. You can speculate about all the wonderful things an on-board computer might accomplish. But wouldn't it be marvelous if a motorist could just find out with the push of a button whether all the spark plugs work right?"

So it would appear the computer car will exploit early on its unique self-diagnostic capability. An off-board computer might quiz the one in the car and produce for the motorist a scorecard detailing ailments, if any, and even prescribing treatment. Or the on-car device might monitor itself, alerting the driver when it detects a malfunction.

Dials and gauges would surrender to digital display panels, the transmission and brakes would be electronic; the computer would handle fuel management and emissions control devices. When braking, as the wheels start to lock, the computer would release the brake pressure until the wheel speed was almost equal to the vehicle speed, then reapply it, again and again, in milliseconds.

Tell the computer how far you're going, and it could compute arrival time and tell you whether there is enough fuel in the tank. Sensors might tell the computer when to turn on the windshield wipers and how fast, when headlights are needed and how bright, when a tire is too low, whether brake linings are adequate and the suspension system balanced.

The computer cannot be overworked, says Wesley A. Rogers, an Advance Product Engineering staff member. "A computer operates in microseconds, and very few things in a car run even into the millisecond range. So you have a 1000-to-one difference in speed right there."

MAKING THE SYSTEM WORK

Actually, it is not the computer that makes GM wary of predicting when the first computer car will roll off an assembly line.

"Developing a suitable central processor is a small problem compared to refining the rest of the system," says Ronald Colling, of the Advance Product Engineering staff. "After all, we're talking about something very similar to the typical digital calculator. And all we have to do is take this delicate instrument and make it indestructible, make it work perfectly for years in the worst environment imaginable."

"But the real challenge is to develop the sensors and the actuator components. You can have a sharp brain but it's not going to perform 100 percent unless you have good eyes and ears and a nerve system that'll get the right message to the right muscle."

And then there is the whole matter of how the various components interact with the computer and each other; and how they affect the most important element in the automobile environment – the human behind the wheel?

"Certainly, you can bomb a driver right out of his seat with information he doesn't need and can't handle. So we've

got to be careful. A continous miles-per-gallon readout would produce a wildly fluctuating mass of numbers in the in the normal course of driving, but it would help a motorist drive more economically, and it could also be an important diagnostic tool. Increased fuel consumption over time might be an early warning of an engine malfunction, for instance.

"Take tire pressure. It would be possible to present the driver with a continuous reading on each tire. But all he may want to know is when one is getting low."

According to Trevor Jones, the decade of the 1970s is characterized in part by consumer protection movements, computer and space age technology and inflationary economics.

"As the value of the dollar declines, people demand more from their automobiles at less cost, and the application of new technology is absolutely necessary. Electronics make it possible to do many things with a car's machinery that cannot be done with strictly mechanical components. And the computer makes it not only possible, but practical. People want cruise control, positive traction, electronic transmissions, fuel injection. They will all give the motorist more for his money. But because each presently requires a separate system, they cost a lot of money, too.

"Now, if we can bring them all together, get one little black box to do all the thinking for all of them plus a few other things besides, we can offer the motorist tremendous value."

"The automobile is so commonplace," says John Auman, "that people do not appreciate what a complex creature it is. You take something like an automatic radar braking system. People say, you ought to be able to hook up a radar beam so if you get too close to something in front of you, it'll actuate the brakes. But if radar is to be effective at freeway speeds, it must have a range of 300 feet. So you have this 300-foot telegraph pole attached to the front of your car, and anything that gets in its way – a hill, a curve, oncoming traffic – is going to actuate the brakes."

"When you talk about an alternative to the tried and true, you must consider whether it has some advantage to the customer. The solid state voltage regulator costs more than the old electromechanical regulator. But it is a lot more reliable. It does a better job. So you weigh the higher cost against the longer life and the greater customer satisfaction and you go whichever way the scales tilt. Unless we are forced into it before the benefits outweigh the costs, that's how the computer car will evolve."

Timothy R. Schlax (left) and Ronald L. Colling, General Motors Engineering Staff, examine one of the computer "chip" boards from the experimental Alpha IV passenger car, which utilizes a solid-state, digital four-bit, microprocessor for cruise control, four-wheel lock control, traction control, speed warning and limiting, ignition spark advance and dwell, automatic doorlocks and antitheft system. Its display functions include analog and ditital speedometer, odometer, trip odometer, tachometer, clock and elapsed time. The microprocessor itself (upper left) is mounted compactly beneath Alpha IV's instrument panel and above the front floorboard transmission hump.

But when?

"Well," says Mr. Jones, "seventy-five years elapsed from the time of the electromechanical ignition until the first electronic device was used in a basic vehicle subsystem of the automobile. That was the solid-state voltage regulator. It was 14 more years before we had the seat belt interlock. That was September, 1973. Today, the industry offers 13 electronic subsystems in the automobile besides entertainment and communications functions. I suppose you could get a consensus that the computer car will be a reality in 10 years or less. But 10 years ago, you'd probably have gotten the same consensus." ■

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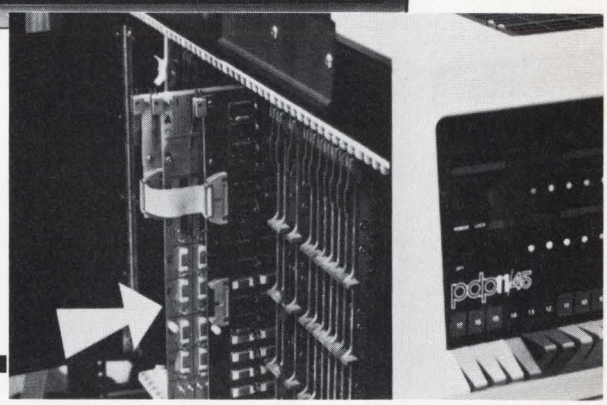

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CIRCLE NO. 23 ON INQUIRY CARD

MALCOLM L. STIEFEL / Contributing Editor

SOURCE DATA AUTOMATION

PART – 2

Last month, in Part 1 of this two-part series, we discussed the two major classes of source data automation systems – closed loop and open loop – from a systems point of view, and we considered some criteria for selecting a given technique. In Part 2, we will look at some of these techniques in detail, primarily those concerned with business applications: magnetic, optical, and key-to-storage.

A great deal of emphasis will be placed on point-of-sale systems because POS systems seem to incorporate virtually every SDA device in the book (Fig. 1): optical bar code readers, optical character readers, magnetic stripe readers, electronic cash registers with local storage and communications to mainframes. A POS system is actually several SDA systems welded together.

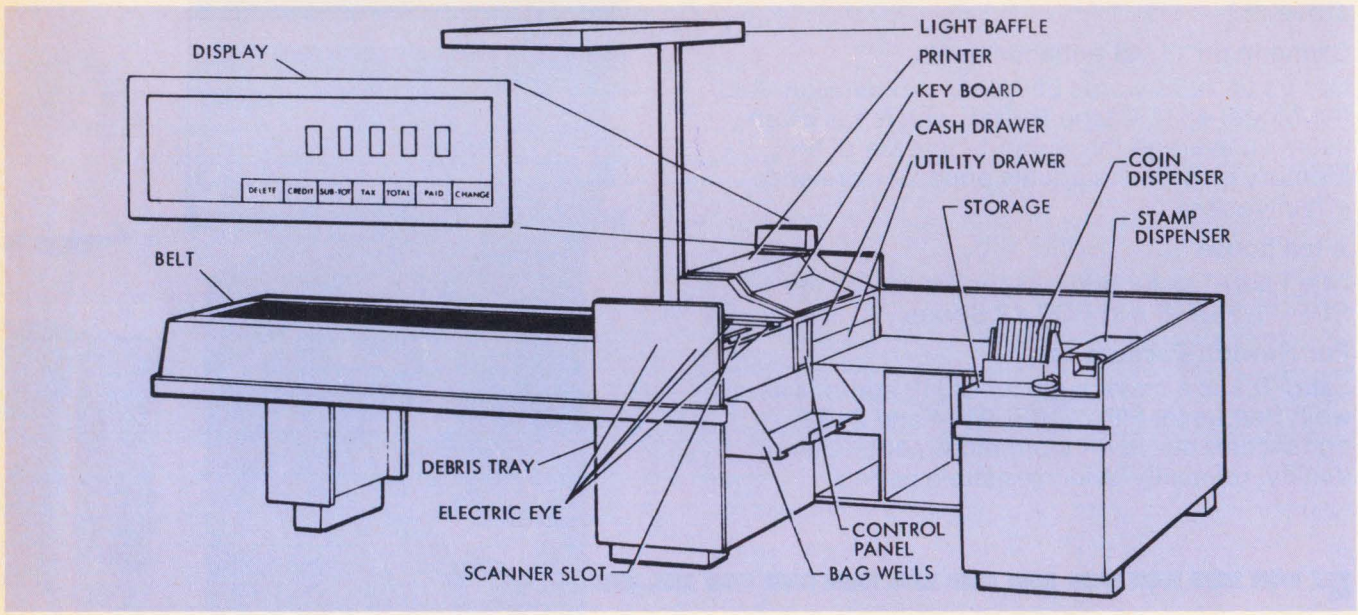


Fig. 1 – *Schematic example of a POS checkout stand. (Courtesy of Sperry Univac)*

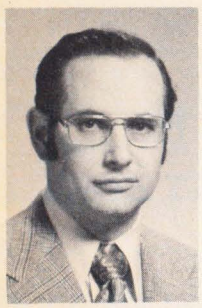
OPTICAL RECOGNITION SYSTEMS

Optical recognition systems form one of the major source data automation classes. The group encompasses a wide spectrum of techniques from the relatively straightforward, relatively inexpensive optical mark readers through the increasingly important bar code readers, to the standard preprinted character recognition systems and the sophisticated handprinted character readers.

The range of complexity and costs reflects the poor suitability of computers and digital systems in general to solve pattern recognition problems. The mark readers are easiest to implement because the presence or absence of a mark – any clear mark – in a little box defines one bit of data. On the other hand, the handprint reader has to deal with data that can't be interpreted with any consistency unless the person writing the characters observes rigid rules of character formation and placement. The less restrictive the rules, the more complex the processing algorithm becomes, and the longer the machine's decision-making process takes for each character. As a result, commercial optical handwritten character recognition systems still compromise – input flexibility is sacrificed – to keep costs down and throughput up. Until some brand new pattern recognition technique comes along which deals with each pattern as a whole instead of breaking it up into little bits and examining the bits, these limitations will continue to exist.

Each type of optical recognition system is suited to a given set of applications. Let's look at each in turn.

Optical Mark Readers. They first saw the light of day in automatic test marking systems. For years, most applications were limited to these and similar batch processing-oriented problems, such as inventory control. The data, marked on a carefully designed form, would be read into a



Malcom Stiefel, a senior systems analyst with Keystone Custodian Funds in Boston, has dealt with military command and control systems, hospital information systems, municipal information systems, and mutual fund accounting systems during his 17-year career as an independent consultant, systems engineer, systems analyst, programmer, and writer. He received a B.S.E.E. from the Polytechnic Institute of Brooklyn in 1959 and has completed graduate work at M.I.T.

reader, converted to magnetic tape, and processed. The technology received a boost with the introduction in the last three years of small, real-time mark-sensing systems designed primarily for the fast food and full service restaurants. All of these applications are characterized by a predetermined menu of choices, from which the customer makes his selec-

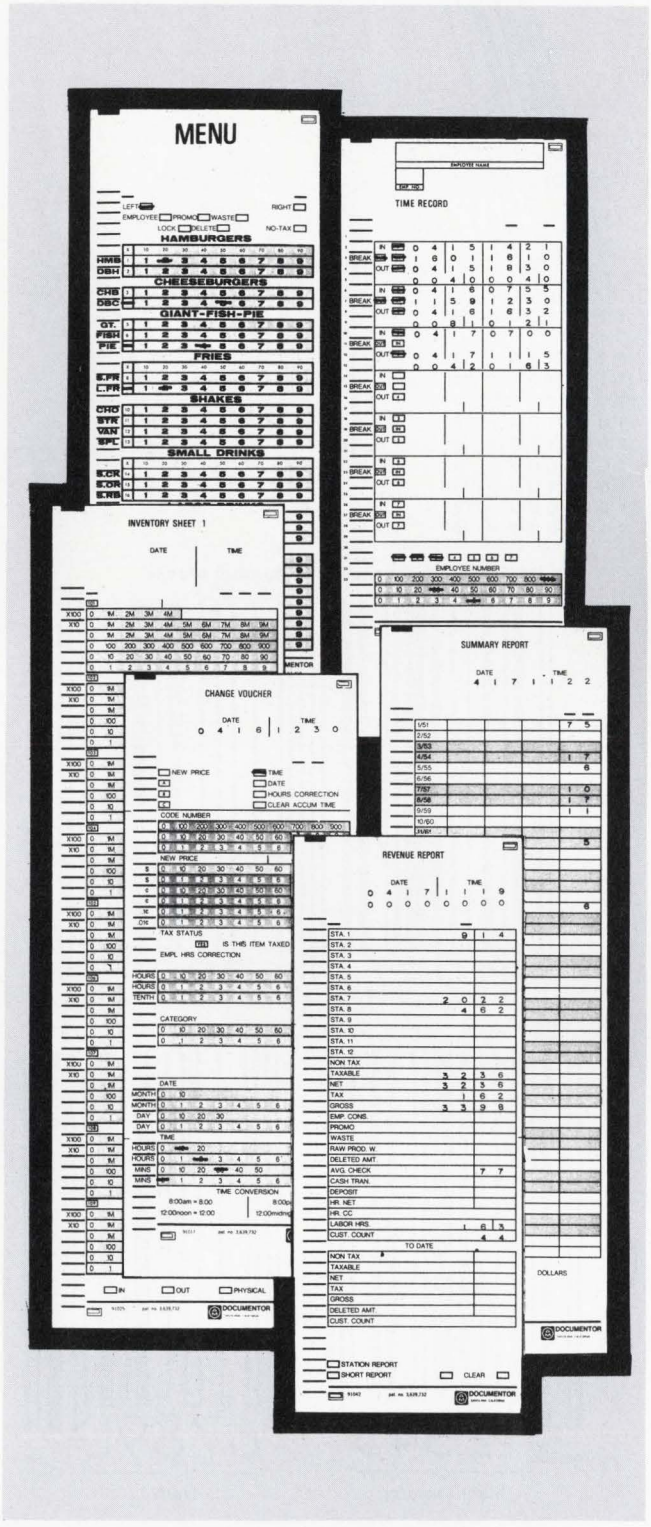


Fig. 2 – *Mark sense forms for fast-food industry. (Courtesy of Addressograph Multigraph, Data Systems Division)*

tions. The quantity of each item selected, along with clerical and control information, is marked on the form (Fig. 2). The form is then placed into the reader that can be on the counter in the fast food establishment or at the cashier's station in the conventional restaurant.

The digital data is processed immediately to yield a display of the total bill or a printed itemized bill. Invalid entries are rejected; corrections are usually made by marking up another form to replace the faulty one. A record of each transaction is kept at the checkout station or transmitted to a central facility for accounting at the end of the day. Like other POS systems, this one gives the store manager better control over cash and inventory and a fast look at each day's receipts almost as soon as the door is closed for the night.

The critical component in this system is the reader, which makes use of LSI technology, allowing a low-cost powerful device to be housed in a physically small package and to be operated by a clerk without technical training.

This is a quiet revolution of sorts, contrasted with the noisy one going on in the supermarket business where various consumer groups are having a field day blocking efforts to implement POS systems on the grounds that the failure to mark a price on each box of Froot Loops violates one of those inalienable rights we didn't know we had.

Optical Bar Code Readers. The supermarket fight has focused nationwide attention on the Universal Product Code, a bar code adopted by the grocery industry in 1973 as its standard. POS systems have been slow in penetrating the market because their cost-effectiveness is difficult to demonstrate even if supermarket operators can save by leaving prices off the products on the shelves. Already, several manufacturers have dropped out, the latest being Bunker Ramo, unable to wait forever for their investments to pay off, and unwilling to add to their substantial marketing costs in the area.

If POS succeeds in overcoming the formidable obstacles already strewn in its path, it will perpetuate the UPC (Fig. 3), accepted as a solution to a set of demanding and sometimes conflicting requirements established by the grocery industry when it was searching for the computer-readable element that could be adapted to the supermarket environment. Consider some of the functional characteristics required of the code symbol:

- Readable omnidirectionally (regardless of orientation of symbol with respect to scanning device)
- Machine-readable and human-readable
- Readable by handheld scanners (wands) as well as fixed scanners
- Scannable when in motion at up to 100 inches per second
- Scanning reject rate of less than 0.01
- Undetected error rate of less than 0.0001
- Scanning process not affected significantly by dirt, abrasion, and the like
- Symbol area less than 1.5 square inches
- Symbol able to be affixed at the packaging plant rather than at the supermarket
- Code with a 10-digit capacity initially
- Code expandable to more than 10 digits (the chosen code actually had 12 digits initially).

In the selected technique, the domain of each digit was divided into seven slots, or bits, as indicated in Fig. 3. The code has several different versions applicable to the grocery industry, health industry, and others. The basic version, shown in Fig. 3, has two fields of six digits each, together with separator bars (two on the left; two on the right; and four in the center, separating the left half from the right half). Reading from left to right, the digits include: version number (one digit; value zero in the standard version), five-digit manufacturer number, five-digit item number, one-digit modulo-10 check digit ("5" in the illustration). Left-half

Fig. 3 — *Universal Product Code (UPC) structure*

characters are odd parity and right-half characters are even parity, as indicated in Table 1. Each digit is composed by two *runs* of one-bits separated by zeros.

These design details illustrate the level of complexity of the design of any coding system with broad application. The UPC is unique because of the handheld scanner require-

ment and the omnidirectional capability. These specifications are far more demanding than, say, the MICR specifications, which require strict alignment and placement of readable symbols on the document and which assume that the reading will take place in a carefully controlled environment.

TABLE 1 – UPC CHARACTER SET

ODD PARITY ON THE LEFT
EVEN PARITY ON THE RIGHT

	LEFT CHARACTERS	RIGHT CHARACTERS
0	0001101	1110010
1	0011001	1100110
2	0010011	1101100
3	0111101	1000010
4	0100011	1011100
5	0110001	1001110
6	0101111	1010000
7	0111011	1000100
8	0110111	1001000
9	0001011	1110100

Other widely-used bar code systems, such as the American Association of Railroads' Freight Car identification scheme, do not face the omnidirectional reading requirement. All in all, the UPC is an impressive accomplishment. It has given additional impetus to designers considering source data automation approaches to take a hard look at optical bar code systems for their applications.

Optical Character Recognition (OCR). It's a study in contradictions, an anomalous technology, marked more by failure than by success. It has been with us more than 25 years and its use in some installations saves users tens or hundreds of thousands of dollars every month. But for all its power, OCR has not proliferated in the marketplace. As of this date, fewer than 2000 centralized units have been installed in the U.S.

Fig. 4 – *The ANSI OCR Size A Type Font (lower case omitted).*

Some of the reasons for this lack of use can be surmised. Users have consistently resisted techniques that require special forms with tight tolerances. They have been hard pressed, in all but the relatively-few super-high volume applications, to justify the initial cost of OCR which is likely to approach $250,000 for a multifont reader with handprint character recognition capability. Less expensive, single font systems, like those that can read and standard OCR-A character set (Fig. 4), have lacked the flexibility to meet the users' needs. Even in some large volume applications, OCR has failed miserably, particularly in systems aimed at our medieval Postal Service which still does not have an SDA technique for mail sorting.

This is not to imply that OCR doesn't work. It has been working beautifully for the oil companies in their credit slip processing applications for years. Health insurance firms find that a single multifont reader, coupled to a key-to-disk unit for error correction, can replace 40 keypunches and have plenty of room for growth in volume. Even more important, such a system can handle unpredictable increases in daily volume without missing a beat.

One major problem now being overcome with the multimedia approach has been the relatively high reject rates (sometimes more than 10 percent when input quality is poor) of centralized OCR systems. The reprocessing of unreadable documents has traditionally involved retyping them from scratch – an expensive, time-consuming procedure.

With the newer systems, the rejected documents are fed back into the reader a second time and rejected characters are displayed to an operator on a screen. The operator, sitting next to the reader, can examine the document and key in the corrections on the spot.

Progress is also being made with low-cost, handheld scanners, to read merchandise tags in POS systems. In that area, OCR may emerge a winner, although optical bar code techniques and magnetic stripe systems seem to be preferred by many users. The national Retail Merchants has adopted OCR as its standard SDA method, although not all manufacturers have rushed to conform.

MAGNETIC SENSOR SYSTEMS

Magnetic sensing techniques compete vigorously with optical methods in the source data automation marketplace. There are two discernible varieties of magnetic systems today: magnetic ink character recognition (MICR) and magnetic stripe sensors. MICR systems have much in common with their optical counterparts: the same limits on font design and form layout and the reliance on centralized, preprinting of most of the information to be sensed. But, as we shall see, the magnetic stripe technique is delightfully different, in a way that ensures its future in SDA systems.

Magnetic Stripe Systems. The magnetic stripe has only recently become a fixture on bank credit cards and debit cards (the ones that give a depositor access to his own bank funds). It had to wait until material manufacturing and bonding technology had developed to a high degree among plastic card makers. Until then, cards with magnetic stripes weren't practical commercially; they'd fall apart, or the magnetic material would peel off or wear out. When these problems were licked, the magnetic stripe made its debut.

Its availability has been a key in the development of the unattended offline bank terminal, which can update the debit card to record the date of last transaction and the total withdrawn since some starting date. The terminal in reading the card can check this information against stored limits to decide whether a given withdrawal request can be granted.

The magnetic stripe is still used by some retail merchandise POS systems, notably IBM's, although the National Retail Merchants Association has embraced OCR. But the mag stripe card is accepted as standard by the banking and airline industries. The published ANSI standard calls for a three-track format, with recording done serially by bit on each track.

Looking ahead a bit, it isn't too hard to imagine the credit card of the future having an imbedded microprocessor chip, using a high-density magnetic stripe as its memory. Powered by the reading unit or an internal battery, it could acquire a variety of data from remote sources, identify itself upon request, encrypt its own data for transmission. So, there you have a solution. Now all we need is a problem.

Magnetic Ink Character Recognition. MICR systems have been used for processing bank checks since the mid-1950s, when the American Bankers Association accepted the E13-B font (Fig. 5) as its standard. The systems usually encompass printers that imprint depositor account numbers on checks, sorting machines for clearing house and bank operation, and additional keying equipment to encode the amount on each check for crediting to the depositors' accounts.

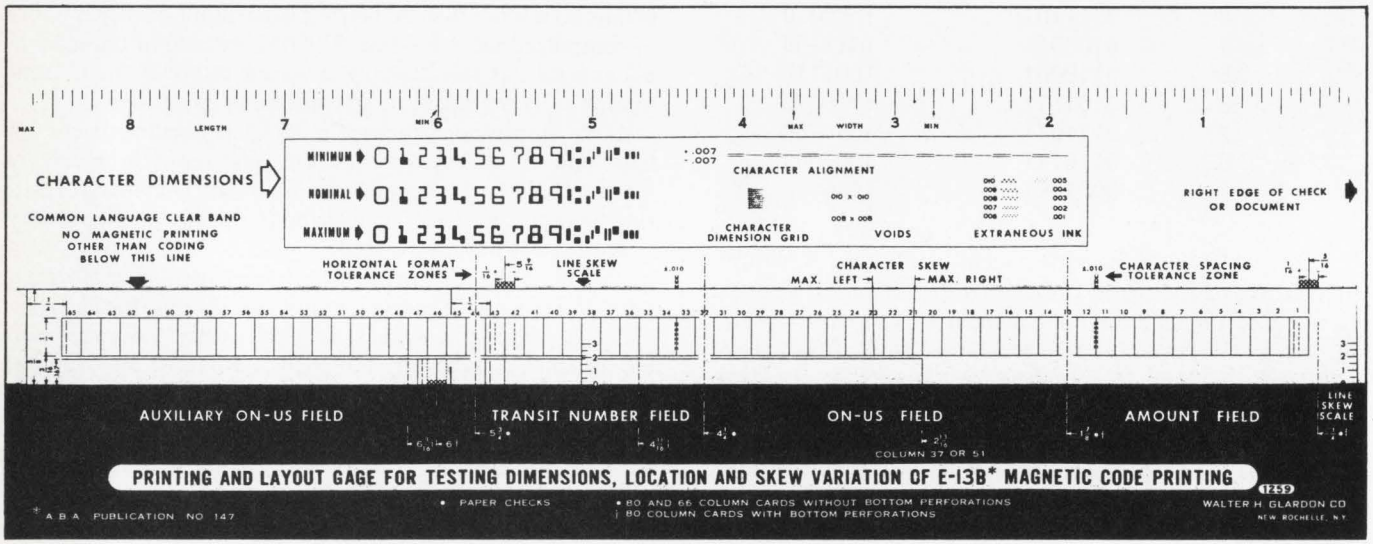


Fig 5 – *Glardon gauge for alignment of MICR symbols on bank checks.*

The characters are printed using a special ink with iron particles. The reader first magnetizes the ink by passing each check through an electric field; then the sensor "reads" the check by analyzing a series of electric analog signals, detected as the check passes through the reading mechanism. The font is designed so that each character has a unique, readily distinguishable "signature" signal, which the reader translates into a digital signal for computer entry and for physical sorting of the checks themselves.

The technique is reliable and quick; first-pass rejects by reader-sorters average 5 percent, and subsequent-pass rejects can go down to 0.3 percent with modern image-processing technology. Approximately 1 check in 50,000 is misread; the reader substitutes a wrong character for a correct one. The problem is overcome through the use of simple check-digit schemes incorporated into account numbers. Of course, check digits can't be added to the check amount field but batches of checks can be balanced against manually developed batch totals after processing, to detect money errors. This level of performance meets the needs of Federal Reserve clearing houses and local banks in handling the more than 30 billion checks that are written in this country each year.

Such throughput is possible because MICR readers aren't susceptible to smudges, smears, dirt, and stains on source documents like optical readers are. Still, the technology isn't going anywhere. The banking market was saturated long ago; new sales are limited to replacements. New product announcements are seen in bunches only when mainframes computer makers, particularly those that cater to the banking industry, announce new major lines. Then the scramble is on to produce reader/sorters that will interface with the new central processors. Even this need is circumvented in most cases since the MICR devices usually aren't online. Outputs go to magnetic tape or disk for subsequent batch processing by the mainframe.

About the only area of the MICR industry where some significant research and development is still going on is in the improvement of ink characteristics. Clearly, the reliability of the entire system is very much dependent upon the capability of the encoders to produce sharply defined characters with enough density, paper adherence, and permeability to permit error-free reading. The needs for special inks and tight tolerances on character placement and formation have inhibited penetration of new markets, captured instead by optical systems. In fact, the only discernible trend in the industry is the tendency toward multimedia devices that read the E13-B font optically, not magnetically, along with other fonts. In these systems, readability can be adversely affected by extraneous marks on the documents. However, the user's total investment in document handling equipment can be reduced which is certainly an offsetting advantage.

KEY-TO SYSTEMS

Key-to-disk/diskette/tape/cassette/local computer/remote computer systems (key-to for short) should not really be characterized as source data automation systems, but rather perhaps, as source data enhancement systems. The fundamental keying operation is still there, although the output doesn't appear on a (shudder!) punched card. The basic operation isn't changed when a battery of keypunches is replaced by a clustered key-to-disk system or a set of floppy disk machines. Certainly, it's easier to handle the output, or at least it should be. But throughput doesn't increase by orders of magnitude. Keying is still a labor-intensive function, regardless of how much computer assistance is provided. The trouble is that key-to systems are traditionally viewed as SDA systems. So be it.

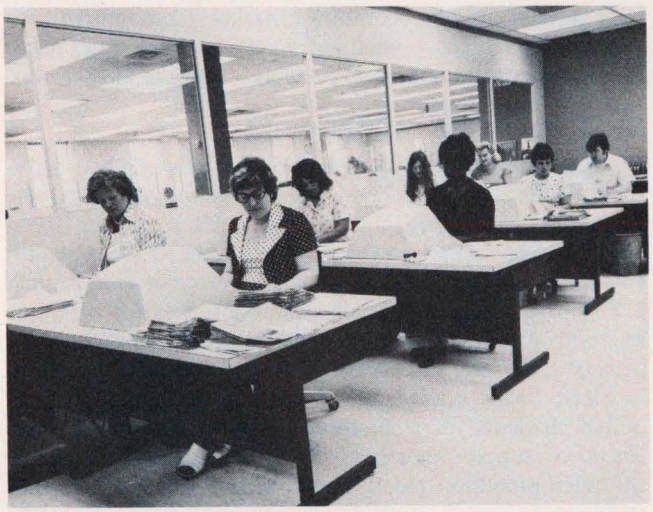
Key-to-Disk. First introduced in the late 1960s, key-to-disk systems have been quite successful in replacing keypunch installations where there are six or more machines and a relatively low fluctuation in keying volume from day to day. The consistency of the workload is an important

consideration. If the demand curve is marked by sharp peaks and deep valleys, the user may find himself sending overload work to a service bureau regularly, thereby reducing the effectiveness of the in-house installation.

But if the demand curve undulates gently, the key-to-disk system can serve very well. Keying rates are 20 to 50 percent higher than unbuffered keypunches. Outputs are easy to handle, although production suffers when the keying operation is shut down while data is being spooled to tape for mainframe entry.

Recognizing the seriousness of this deficiency, vendors began enhancing their products some time ago to allow spooling without disrupting the keying process, or to permit direct communication with the mainframe, eliminating the tape-handling problem entirely. At the same time, manufacturers began beefing up processor speeds and memory capacities to allow development of more powerful languages, such as COBOL, in place of machine language.

As a result, it becomes harder and harder to distinguish a top-of-the-line key-to-disk facility from a medium size central processing unit. All the bells and whistles are available, including communications, high-speed printers, and large disk storage capacities. Certainly, such systems can be considered online data entry systems, with their powerful editing capability and the ability to update a data base in real time. In fact, some users have acquired key-to-disk systems to use in business-oriented time sharing applications.



KEY-TO-DISK IN ACTION. *An example of a shared-processor key-to-disk data entry system is the Entrex System 580 in operation at the VariTyper Division of Addressogrpah Multigraph Corp. With this Entrex System 580, department personnel at VariTyper have immediate access to a 2.5 million character Index Sequential Access Method (ISAM) master file containing information about all parts utilized in VariTyper's manufacturing process.*

This trend is likely to continue, particularly as the low end of the product line, the four-terminal cluster with a minimal editing capability, sees increasing competition from the stand-alone key-to-floppy systems.

Key-to-Diskette. These key-to systems are offered as direct one-for-one keypunch replacements. One diskette holds about 2000 records, each up to 128 characters long in most cases. Since it is always advantageous to process each record independently instead of chaining two or more short input records together to form longer ones, the longer character capacity of the key-to-diskette (as well as the key-to-disk devices and virtually all of the other keypunch replacements) is beneficial to the user.

Like the key-to-disk system, key-to-diskette units can be furnished with communications capability and low-speed hard copy printers for retrieval of information from a diskette or for receiving transmissions from a remote source. Right now, editing capability in key-to-diskette devices doesn't begin to approach that of key-to-disk systems but it's safe to assume that this gap will be narrowed as time goes on.

Key-to-Tape. The first of the key-to units, dating back to the mid-60s, the key-to-tape installation has gradually been supplanted by key-to-disk. Key-to-tape stations have limited editing capability; primarily, they offer the user an increase in keying throughput but no way to retrieve and display a previously-keyed record.

When they arrived on the scene, the imminent death of the keypunch was declared. Instead, key-to-tape is fading away while the keypunch remains the most popular data entry device in the world.

Key-to-Cassette. Originally designed for remote communications with mainframes, key-to-cassette units have a distinct disadvantage that has slowed their progress. The cassette is invariably incompatible with anything except its parent terminal and a special pooling unit, which can prepare compatible tapes for mainframe entry. Contrast this situation with that of the floppies, which are supported by central computer input-output devices, then it is fair to assume that key-to-cassette has a somewhat limited future.

Online Entry. Online entry to the central processing unit, either locally or remotely, is spreading in popularity, although users find they must proceed cautiously. An improperly tuned online system will have poor response time. Moreover, an improperly designed entry scheme will permit updating of incorrect accounts in a file (receivables, payables, inventory, etc.), particularly if eyeball verification is counted on to replace machine verification. In many cases, there is a basic assumption that this can be done with impunity. The idea is, "If an error is made in an account number, the computer will catch it immediately, by looking it up in the online account file. Therefore, we don't need verification."

Unfortunately, you *do* need verification, even with the online account file, unless the account numbering scheme also incorporates a powerful check digit scheme to catch 98 percent of the errors before the account file is searched. Why? In any large file, what is the probability that a single digit error in an account number, or a transposition of two adjacent digits, will produce another legitimate account number? The larger the file, the higher the probability. Would you believe 50 percent or more in some instances? Going online can be an absolute disaster unless this and other similar issues are considered.

THE FUTURE OF SDA

It should be clear that the development of specific source data automation techniques has been spurred by the interest of major industry groups – bankers, groceries, retail merchants, oil companies, insurance companies, railroads. It is natural to assume that this trend will continue. Certainly there are still unfulfilled needs: Postal Service employees still put letters in pigeonholes; most railroads still don't know where all their freight cars are at a given moment; truckers have a similar problem; hospitals have to scramble to keep up with ever-increasing numbers of medical records; and there are more and more demands for reporting by government agencies and third-party insurers. Cost-effective source data automation will help solve such pressing problems. ■

product profile

MICHAEL D. TEENER / Mgr., Computer Center, Technology Service Corp., Santa Monica, CA

minicomputers and microcomputers

MICROCOMPUTERS – PART 2

EDITOR'S NOTE:
In the May issue, we began this Product Profile under the title "Minicomputers" under the assumption that we would cover microcomputers in another series. However, we believe that microcomputers logically belong with minicomputers. So this Product Profile series will consist of the May introduction, this survey of microcomputers, and a coming survey of OEM minicomputers.

In the past year the number of microcomputers available has increased almost beyond reason. At last count (which has to be wrong considering the dynamics of this business) there were over thirty *manufacturers* producing over sixty different models. The range of vendors goes from small consulting firms to the largest semiconductor and the largest minicomputer manufacturer; the machines themselves range from 4"x6" 4-bit single board devices to 64K word 16-bit computers with more features than you could get on an IBM7094 just ten years ago.

So what is this product that is attracting such a glut of eager marketeers? Very simply, it is a microprocessor with all the hardware development and packaging already done for you. (The many number of vendors is a sign of how relatively easy this is to do these days.) All of the memory and I/O interfacing is done for you, the clock works, software already exists, and (hopefully) there is someone to call when it won't work. So another description might be a computer that you would buy just like any other computer, except it has a microprocessor inside – which usually means it's cheaper and smaller than its more conventional minicomputer brethren.

Cheaper and smaller are the key words. The price of a perfectly usable system has dropped to less than $300 for controller-type applications and $1000 for data processing. If you want to dress it all up with an enclosure, power supply, floppy disk, keyboard/printer, and lots of memory it will cost about $6000. Less than a lot of VW's in 1976-type dollars. And the whole system could be kept in a single drawer of a filing cabinet with room left over for a month's supply of peanut butter sandwiches. This low cost means that "intelligence" can now easily be added to existing products and new products which could not be built (or even conceived of) are now within reach.

The rest of this article is a description of what exists right now in the microcomputer market – how microcomputers are packaged – what software is available (and needed) – a discussion of typical systems – and the alternatives.

Michael Teener is Manager, Computer Center, Technology Service Corporation of Santa Monica, CA. Some of his major responsibilities are the evaluation of hardware and development of software for data gathering and analysis. He has a B.S. in Engineering from Caltech and is currently a Masters candidate in the school of Engineering at UCLA.

MICROCOMPUTER PACKAGING

The first OEM microcomputers, available as single board systems, were mainly intended to be used as programmed logic controllers and provided only very small RAM and ROM capacity. They were, however, very simple to use and provided the user with a flexibility never before offered at such a low price. Similarly, most evaluation kits for different microprocessors are based upon the single board philosophy because they are so easy to use for evaluation purposes.

Single board systems are systems which contain all required elements for a microprocessor to function, except for power supply, on a single PC board. These elements are the microprocessor, clock, memory, input/output capabilities and associated logic (buffers, etc.) for system integration. The boards come in all sizes and have widely varying power supply requirements. For example, some boards only need a single supply voltage and produce all other voltages required on the board while others must have several supply voltages. Some systems additionally have on-board voltage regulation.

Some single board systems are extendable, that is, the memory address lines are provided on the board connectors, so that off-board memory can be added. Other systems require extensive modifications to extend the memory capability.

Not all single board systems are to be used as is. Some systems offer a part of the board as an empty wire-wrap section so that the user can add system specific hardware. This may be bad philosophy because locating user specific circuitry on a separate board results in better modular structure and functional decomposition; but if a standard product using a microcomputer has severe space limitations and some alterable circuitry has to be provided, this is a possible option.

As a logical extension of single board systems, the first multi-board system was developed largely due to increased demands for I/O capabilities and memory. The extra boards provided considerable flexibility in system configuration allowing memory and I/O expansion to the limits of the

microprocessor. Interface boards are also available allowing direct communication with teletypewriters, cassettes, floppy disks, RS232 standard devices and a variety of analog and control devices. Sometimes even a console board is available.

Most of what was said about single board power supply requirements hold for these systems. Each board in this system may have its own regulator or the system may share one common regulated power supply.

One major advantage of multi-board systems is in the ability to design a custom board which can easily interface with the system. Since most multi-board systems have the CPU and memory on separate boards, memory boards may be changed to increase the density, change from static to dynamic, or even to implement shared memory between more than one CPU card.

In this article only multi-board systems for which a complete functional microcomputer can be built by obtaining boards from one manufacturer are included. This restriction excludes such items as the Extra 80 from Display and Decisions, Ltd. which is a CPU board (an 8080 implemented by use of Intel 3000 slices) but which has no memory boards available, though it can be used with other manufacturers' memory boards with a certain amount of customizing.

Packaged systems come enclosed in a box. The internals of the box may be a single board or a multi-board set. If the boards are available separately then the cards are listed in this survey. Packaging is usually done to handle environmental problems, such as in some industrial or military applications, but often is done to make the system a more integrated package. If a user is going to have many of the boards provided by a single vendor, then it can be a big time saver to use a card cage and bus system designed for that system.

A console system is a packaged system with the addition of an operator's console. Many microcomputers which come in this configuration are designed and marketed as development aids and, as such, are not included in this survey. In fact, there even exists a TTL version of an 8080 microcomputer marketed as a development aid by Santek Systems.

The functions provided by the console are very dependent upon the microprocessor used; most, however, provide some way to examine and alter memory. Some of these systems allow memory expansion inside the packaging but do not offer expansion chassis for additional memory. All of these systems offer integrated power supplies.

As with packaged systems, these are only included if the boards cannot be bought separately. If a board system is listed, and is available as a packaged system and as a packaged system with console, the two packages may not be physically identical. A console is not necessarily a front panel console as in the minicomputer sense, but could just be an additional card with seven segment display and HEX keyboard entry mounted on an extender card or ribbon cable.

Minicomputer emulators contain microcomputers which are emulators of standard minicomputers, i.e., have same instruction set. These systems may be single- or multi-board systems, and may also come packaged. The LSI-11 and PDP 11/03 are board and packaged versions, respectively, of the same microcomputer. Currently all the systems in this category are available on cards as they are aimed for the low-end OEM minicomputer market. Because some of these systems were developed by microprogramming bit slices, it is possible to rewrite or modify the microcode to reproduce a specific machine, but care must be taken because the memory and I/O structure is already defined.

The number of emulators will grow as different LSI slices are microprogrammed to emulate several existing minicom-

puters and as more 16-bit parallel microprocessors are developed.

In addition to those microcomputers marketed as controllers and general purpose computers, there exist a large number of development and evaluation systems. Though these systems are not included in this survey, they may be usable. In the early days of evaluation boards, they were not sufficiently tested and debugged to be employed in an industrial environment or, in fact, anywhere outside the lab. Since those early days, these systems have been built up very completely and tested thoroughly. However, some manufacturers still do not recommend their development and evaluation systems for other than their intended use.

TYPES OF SOFTWARE SUPPORT

In spite of their small size, microcomputers are still incredibly complicated devices. Like their unbundled microprocessor parents, they require some software support to be useable. Actually, they require even more since the economics of microcomputers usage results in their being used in quite complex systems.

This support can come from a variety of sources including the microcomputer manufacturer, the microprocessor manufacturer, other microcomputer vendors and independent software houses. Most vendors provide at least a minimal system of assembler and debug package since without them, a microcomputer is a rather expensive paperweight. A few companies provide true operating systems and even higher level languages; Warner and Swasey, for instance, provide a Process Control Language for the COMSTAR series, and MITS has BASIC for the Altair 8800. Naturally, those systems that emulate existing minicomputers are the most complete. The DEC LSI-11 has one of the largest software catalogs in the known universe. There is such a thing as overkill, however. Not many microcomputer users are going to want COBOL.

The rest of this section describes the kinds of software available for microcomputers in the approximate order of importance. This does not include the minicomputer emulators, just assume they have everything.

ASSEMBLERS/EDITORS

Although it is possible to do programming in binary or hex using a debug monitor, sane people normally prefer to program symbolically using an assembler. The main question is whether to use a cross-assembler or a resident assembler. Quite often both are available from the vendor.

The cross-assembler allows software development to proceed in parallel with hardware construction, but since microcomputers are largely intended to be useable right from the box, that isn't a particularly good reason to use one. A much better reason is the relative convenience of big machine operation. A cross-assembler on a time-sharing system allows a programmer to quickly edit, assemble, and punch a program using minimal capital investment. The cross-assemblers themselves are usually quite powerful with full macro capability and nice formatting. The kicker in all this is the running cost. A small company that one of the authors consults for has run up a seven thousand dollar timeshare bill in five months, as much as one thousand in one week. If you have your own computer that can run FORTRAN, then you may not have this problem.

Resident asemblers, on the other hand, usually require significant capital expenses. You need a mass storage device and hard copy terminal. Although it is possible to get by just with a teletypewriter, you better not be in a hurry. A much better choice is a 30 CPS terminal and dual cassettes or floppy disk. Together with interfaces, this can easily set you back four to six thousand dollars, but once it's up and running you have low operating costs and 24 hour availability. Some resident assemblers are even available on ROM, which can significantly increase the programming convenience.

Along with the assembler, a programmer needs an editor to allow him to easily change his symbolic program to correct errors. If a cross-assembler is used, this can be the host machine's editor (or none at all if punch cards are used). For the resident asembler, a resident editor is necessary. This may be provided as a part of the assembler for the few in-place assemblers around, but is usually a separate program that can edit paper tape, cassette, or floppy disk source programs.

MINI OR MICRO – WHAT'S THE DIFFERENCE, ANYWAY?

The view of a microcomputer and minicomputer manufacturer

STEPHEN A. KALLIS, JR., Senior Communications Consultant
Digital Equipment Corp.

Currently, there are almost as many different definitions of minicomputer and microcomputer as there are manufacturers of these products – or so it seems. It may be inherently obvious that a gadget with a 16-bit wordlength, a rapid cycle time, and 128K words of memory should be classified as a minicomputer; and that something with a four-bit wordlength, slow cycle time, and a 256-word memory should be called a microprocessor. But there is a large gray area between these extremes that could legitimately be classified either way. Since there are several ways one could differentiate between minicomputers and microcomputers, developing such distinctions is not easy.

Historically, the minicomputer was "defined" by the parameters of the first generally available member of the breed – either the PDP-5 or PDP-8, depending upon whom you ask. Since both computers are logically equivalent – the PDP-8 was a direct outgrowth of the earlier machine – the only slight difference was the price. As a result, the minicomputer was originally defined as a programmable general-purpose device with a word length between 8 and 18 bits, a minimum of 4096 words of memory, and a minimum-configuration cost of $20,000 or less. It is worth noting that some parameters such as cycle time and mode of addressing are not included in this definition.

Some early minicomputers were quite slow compared to those available today; others had fairly limited memory expansion capabilities. Minicomputers were viewed *functionally*, and according to word length. By today's standards, with the rapidly decreasing costs for components, a minimum-configuration minicomputer would be nearly an order or magnitude less expensive than the price that first defined a minicomputer.

Among the factors that caused the development of the minicomputer in the first place were the need for an inexpensive programmable device to perform specific functions and the realization that the full resources of a larger computer were not needed for such tasks. As the minicomputer has evolved, it has started to acquire characteristics that previously were the exclusive province of larger computers; in many cases, using a full minicomputer

LOADER/DEBUG PACKAGES

So now you've got your program assembled and the object program ready to go. Next you have to load the program and test it. To facilitate this, almost all vendors supply a loader/debug program, sometimes called a monitor. This program should provide the following capabilities.

1. Provide some sort of operator communication using a teletypewriter or other interactive terminal.
2. Read/punch paper tapes or other object files into/from memory.
3. Examine and change memory locations and registers.
4. Set and clear program breakpoints.
5. Start program execution at any specified address.

Without at least these minimal features, program development on the prototype system will be laborious at best and very likely impossible. Even if a simulator is used, real time tasks are going to require some development work on the target system.

Fortunately, this kind of monitor is often available on ROM as an always-resident control program. For systems using the 6800, Motorola has a standard ROM containing their MIKBUG program. Control Logic and LSI and several others have monitors for the 8080. And, of course, there is the DEMON program for Microcomputer Associates' JOLT.

I/O DRIVERS

One of the messiest parts of programming is providing for communication with peripheral devices. Those vendors that provide peripheral interface cards should also provide the software to make those cards easy to use; after all, it is a lot easier for those who designed the hardware to get the software interface going as well. Although not all manufacturers do this, the trend is definitely in that direction.

for simple control functions became a case of overkill.

Thus, the microcomputer. The microcomputer is composed of one or more LSI chips that operate as a central processor and a memory unit, all mounted on a single printed circuit board. The equivalent chip set, considered by itself, is termed a microprocessor. Generally, the microprocessor employs a shorter wordlength than what is recognized as a minicomputer – 4 or 8 bits as opposed to 12 through 18. While many operations of most microprocessors are significantly slower than that of the average minicomputer, some minicomputers have been woefully slow. The original definition of "minicomputer" did not employ speed as a parameter.

Obviously, the smallest-capacity, shortest-wordlength microprocessor configuration has considerably fewer resources than a high-capacity, 16- or 18-bit minicomputer. Thus, considering the extreme cases once more, it is easy to say that a microprocessor is used in more limited applications than a minicomputer. It is easy to define jobs through extreme cases: Obviously it is considerably more cost effective – practical, if you will – to use a small microprocessor in, say, an intelligent terminal application than to use a minicomputer.

The internal organization of a chip or small chip set composing a microprocessor necessarily tends to be somewhat different than the organization of a minicomputer's processor section. Particularly when a microprocessor operates with a short wordlength, an operation that might be performed in a single step by a minicomputer's processor section may take several microprocessor steps.

As a result of the differences in organization, the assembly language for many microcomputers differs significantly from that of minicomputers, though there are exceptions. The physical process of writing code for microcomputers is both time-consuming and exhausting. Some have even developed compilers for minicomputers that translate programming statements into microcomputer code, even as some once wrote minicomputer code on larger machines.

While most microcomputers are restricted to low-level programming languages, some are acquiring high-level compilers such as Basic. This can compound the difficulties in making clean differentiations between minicomputers and microcomputers – for if one can program a device in a standard high-level language and get it to do meaningful work, it begins to matter less to the user whether the terminal is connected to a mini, a micro, or a maxi.

A perfect example wherein the "gray area" becomes very gray is the low end of Digital Equipment Corp.'s PDP-11 family, the LSI-11 (or PDP-11/03). From a pure hardware standpoint, it is a microcomputer. In its bareboard (LSI-11) form, it can be used as a subassembly for dedicated functions; in its "boxed" (PDP-11/03) version, it is employed as a minicomputer. It has been described as a "microcomputer-driven minicomputer," which further adds to the confusion. From a software fashion, it is a PDP-11, only slightly different from other PDP-11 family members. Depending upon one's perspective, it could be classified as a microcomputer, a minicomputer, or both.

One way to address the identity problem is to consider the computer arrangement as a "black box" and see how it looks from the outside. Any computer should be chosen from a standpoint of functionality, no matter what it is called. If the use is simple, requiring little memory, a limited number of alternatives for the device to handle, and simple installation, some devices *seen as black boxes* would make more sense than other devices. Alternatively, if the proposed application requires a large number of resources, sophisticated decision-making capabilities, and with cost a secondary consideration, a quite different class of devices would suggest themselves.

Using this approach, it immediately becomes clear that we don't have to worry about how we designate the devices – particularly when we consider the large gray area between the extremes of a simple microprocessor and a highly sophisticated multi-resource minicomputer. We are merely concerned with performance. And then we can concern ourselves with other features of possible candidate devices.

When obtaining any sort of computer system, it is wise to decide its future as well as its immediate application. If there is no thought about having the device performing expanded operations later, it is not necessary for the device to have the capability to grow. A nonflexible configuration performing simple functions suggest the traditional "microprocessor" role, whereas any requirements for expansion suggest an alternate approach.

A minicomputer, by its nature, is designed modularly, to permit expansion and flexibility. Thus, in situations where expansion either is called for or seems desirable, it is frequently a good idea to look at devices organized more along the lines of the classical (i.e., more-than-a-few-chip) processor configuration. It is not necessary to view the device much below the black box level to determine this; functionality, in terms of the job to be done, is the determining factor.

From this, it can be seen that the question of a rigid definition of whether a particular device is a microcomputer or a minicomputer is frequently not relevant. A specific device can assume the characteristics of either, depending upon the job to be done. The difference between a minicomputer and a microcomputer can be wide – or less than skin deep – depending upon how it is used. ■

HIGH LEVEL LANGUAGES

This is a very empty category at this time, though there is hope for the future. Currently there are four languages available, with only two of them really meeting their design objective. This is highly unfortunate, since a good language may increase programmer productivity by an order of magnitude. The simplest, and yet one of the best, is Warner and Swasey's Process Control Language for the COMSTAR series. The objective was modest (probably the reason for success) – to allow relay logic to be implemented directly. The compiler itself is actually a hardware box with a display, a bunch of keys (one for each language primitive) and a PROM programmer. The program is directly translated from key presses (language primatives) to machine instructions in the PROM. The programmer has to figure out his own locations, which is annoying, but for the simple programs PCL was designed for, it is not a major difficulty.

The other successful language is MITS BASIC. It seemed pretty silly when it was announced but now it appears to be a good thing. BASIC is a very simple language to use, it is interactive, and there are a positively enormous number of programs available. What seemed silly at first is that some OEM users could care less about a language that is slow, inflexible, and hoggish of memory. But that is not its market. MITS computers are largely aimed at end users and systems type OEM applications. BASIC is great for the small business application and perfect for the hobbyist. What's more, MITS BASIC uses just 4K bytes RAM in its small version and 8K and 12K in extended versions (including disk I/O). It also allows *direct* control of I/O ports – a nice feature in any language.

OPERATING SYSTEMS, SIMULATORS AND OTHER SOFTWARE

There are several operating systems that exist for program development available from development aids suppliers, but as yet there is no true real-time OS suitable for complex tasks, such as those available for the minicomputer emulators. This is really not too important for most microcomputer applications as a stand-alone program can usually suffice when combined with the loader/debug package described above.

Simulators are only useful when you don't have a working hardware system with alterable memory. This is true of such systems as the SMS Micro-controller and the Intel 4000 based systems. There are both hardware and software simulators available from various vendors.

Quite often specialized software can be obtained from the vendor, depending on what market the microcomputer is intended for. There are data communications protocol handlers, extended precision arithmetic, scientific subroutines, and character handling routines.

MICROCOMPUTERS BY PHYSICAL TYPE

The single board systems include 4, 8, and 16-bit processors. The first of these (actually, the first microcomputer ever marketed as such) was the Pro-Log PLS-401 which uses the Intel 4004. The block diagram of the PLS-401 in Fig. 1 shows the basic philosphy of the 4- and 8-bit single board systems. The PLS-401 requires an external +5 and -10 volt supply and is designed to be used with ROM program memory as a dedicated controller. (Because of this, the WPM (Write Program Memory) instruction is not used.) Memory

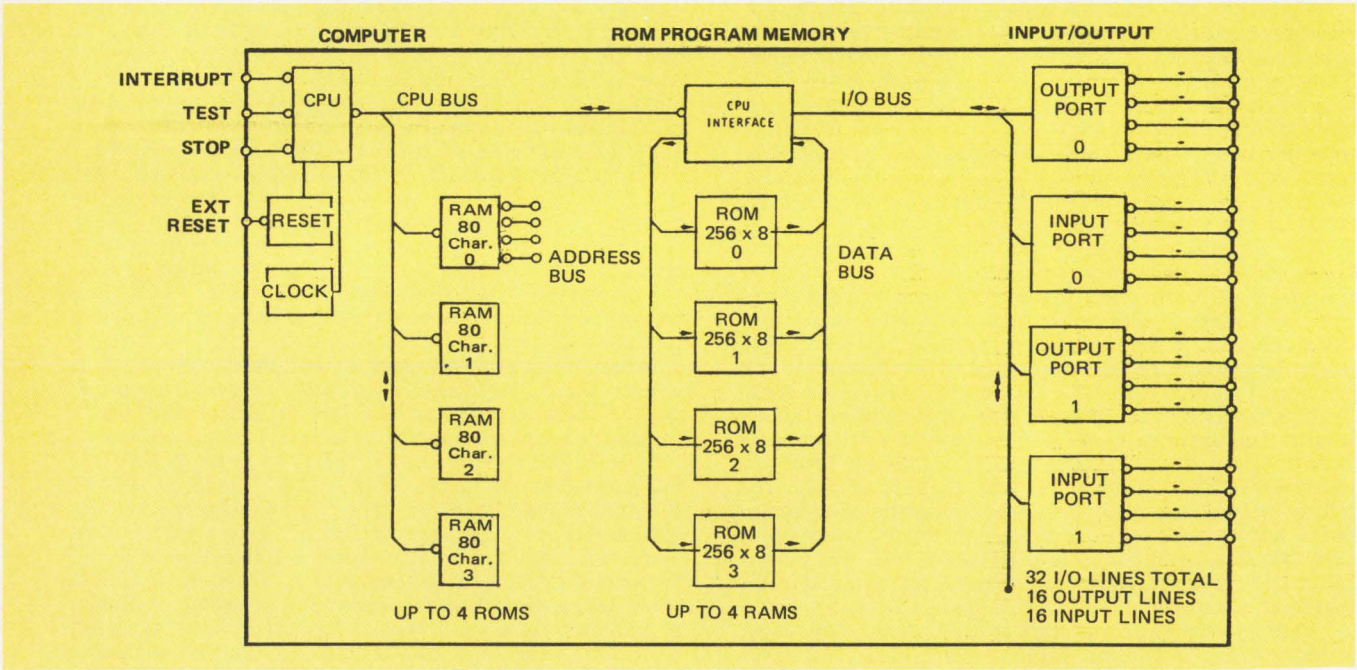


Fig. 1. Pro-Log PLS401

And then there is PL/M and its derivatives. It would be extremely nice if PL/M were done up well, but in its current form it is too rigid and inefficient to compete with assembly language. It is a cross-compiler as well. Suffice it to say that PL/M is useful for those who have rapidly changing program requirements and have a large DP budget on a big computer.

The fourth language is FORTRAN, available from Control Logic as part of their comprehensive M-series software. It will run a subset of FORTRAN on an M-800 system.

expansion is limited to that which can be accommodated by on-card sockets. Similarly, I/O capacity is limited to 16-input and 16-output lines. This is an example of how some of the capabilities of a microprocessor are not used in order to produce an easily managed microcomputer system. Approximately 1/3 of the card is occupied by discrete components to handle the two-phase clock and the chip interfaces. (This fact illustrates the basic rationale for microcomputer; rather than spending time and money doing design work on

microprocessor interface circuitry, effort can be concentrated on the entire hardware/software system.)

Another system from Pro-Log, the PLS-441, is also a single-board 4040 system. The block diagram is similar to that shown in Fig. 1, with the addition of more memory (both RAM and ROM) and interrupt and stop control lines. (Pro-Log was able to place more memory on the board because the 4040 incorporates some of the functions performed by discrete components with a 4004 chip.) Both the PLS-401 and PLS-441 boards are the same relatively compact size (4.5" x 6.5").

These two boards demonstrate the philosophy of Pro-Log. They design their boards strictly for dedicated controller applications and do not offer any software support. They even call them Programmed Logic Systems. Their multi-board systems are similar to single-card systems but expanded to allow increases in ROM/RAM and I/O ports. Pro-Log expects their customers to be digital logic designers and as such Pro-Log does not offer all the I/O interfaces that some of the other board suppliers do.

Applied Computing Technology also has a 4004 board called CBC-4N. As with Pro-Log, the WPM instruction is not supported. The same +5, -10 volt power supply is required. The card is larger (8" x 8") and the extra board space is occupied by RAM and ROM. The function block diagram is again similar to Fig. 1, but with the expanded memory.

The rest of the 4 bit boards which are included in this survey are either 4004 or 4040 based and the above comments hold.

Eight bit boards start to show more differences due to the variety of 8 bit microprocessors available. The processors include INTEL 8008 and 8080 and variants, MOS Technology 6502, Motorola 6800, and National Semiconductor IMP-8. Since the 8008-8080 chips are the most prevalent, they will be discussed first.

Applied Data Communications series 70 is a large (15.5 x 16) 8080 based system which can contain up to 4K ROM, 16K RAM on the board. From ADC, the customer can obtain floppy disk or cartridge tape, operating software, alphanumeric CRT terminal, line printer and even application software. Here we have an entirely different philosophy than Pro-Log. Whereas Pro-Log offers a wide variety of different card sets so that the customer can choose the best for his application, ADC offers only one large card, but with a lot of peripheral support. Standard on the ADC card is a RS232C interface. Pro-Log claims that most applications using their boards will not require an RS232C interface; that, in fact, very few will require a TTY. Pro-Log does not offer power supplies as they claim that their boards are part of a total system, and only the system designer can determine the computer power needs of both the microcomputer and the external hardware.

Some other units fall between Pro-Log and ADC. Two such units are the MosTechnology 6502 based JOLT by Microcomputer Associates, Inc., and Motorola 6800 based Altair 680 by MITS. Both of these units claim to be the lowest priced microcomputers available, but even though each of these machines are indeed very low priced, they are not really in the same market because of the difference in options. This is the major problem with comparing systems since no two card-oriented systems for the same microprocessor are truly comparable, and the problem is compounded by comparing systems based on different microprocessors. The JOLT and Altair 680 systems will be used to demonstrate this difficulty.

The JOLT CPU card consists of the 6502 CPU, RC

Clock, 576-byte RAM, 1K ROM (debug monitor), serial interface (20 MA or RS232C), and two interrupt lines. It sells for $249. The Altair 680 CPU board consists of 6800 CPU, crystal clock, 1K RAM, space for 1K 1702A PROMs, serial interface (20 MA, 60 MA, or RS232C) and two interrupt lines for $275. The JOLT CPU and power supply sells for $394. The complete Altair 680 including power supply, cabinet, and console sells for $420. The JOLT has a power supply available as a separate option, while the Altair 680 does not offer the power supply except bundled with a cabinet and console which are not available on the JOLT.

So even though the Altair is more expensive, some may argue that the console and extra RAM are worth the increase in price. But JOLT is designed to use its debug program running from a TTY to replace a console (similar to the philosophy used in the Motorola XORcisor and the RCA Cosmac microkit development systems and the Sphere 1 general purpose system). The Altair 680 also has a monitor on PROM available (not for free, however) as well as resident assembler, editor and debugger, and will have Basic on PROM if this product has similar user response as the Altair 8800. Additionally, both MITS and Motorola have excellent customer support, while MAI and MOS Technology do not have a track record yet.

contrast to other board systems which are on printed circuit boards. Also all chips on the DL-8A are inserted into sockets. Because of these two features, the board is 0.900" high, which may limit it for some OEM applications. The use of sockets also increases problems due to vibrations. The above two potential problems are offset by the fact that field modification can be performed using only a wire wrap gun and that it is possible to introduce modifications during the manufacturing phase.

From Norway, A/S Mycron Data Industri offers the MYCRO-1 complete on one board. Additional boards are available to increase the memory up to the 64K limit of the 8080. The board offers a unique advantage to certain users as the board fulfills the "Double Europe" standard. The MYCRO-1 comes with a lot of software and hardware support including subroutines to do floating point operations (add, subtract, multiply, divide, fixed to floating, and floating to fixed). As with most of the large 8-bit boards, there is a UART with the baud rate selectable by switches on the board.

The Sphere-1 is based upon a different philosophy than other systems described in this section because Sphere people wanted to design a *computer* system. The board can be upgraded by using the available TV typewriter and exten-

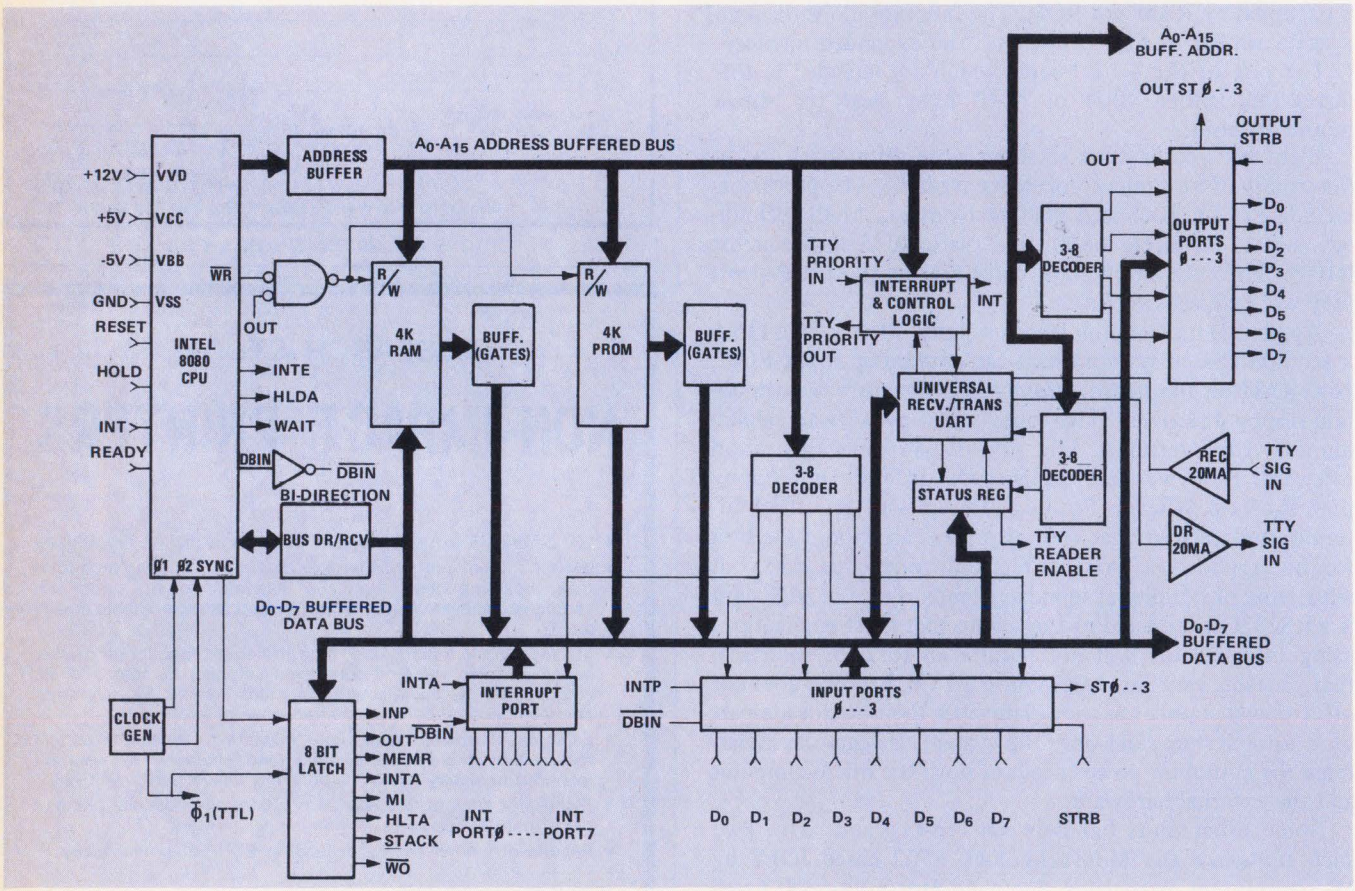


Fig. 2. System logic diagram of Data Numerics' DL8A microcomputer

The other end of the single board spectrum is represented by the Data Numerics DL-8A shown in Fig. 2. Comparing this with Fig. 1, you can easily see the difference between giving the user only a microprocessor and minimal support (Fig. 1) and giving the user the ability to use the entire address space and providing commonly used I/O interfaces (Fig. 2). The Data Numerics board is much larger (8" x 15.9") than the PLS-401 board and, of course, is also more expensive, but it is suitable for much more complex systems.

The Data Numerics system is on a wire wrap board in

sive software aids including a floppy disk operating system and the BASIC language. The single card is available OEM and the OEM'er is supported, but Sphere is most interested in systems.

The following board systems are from the chip manufacturers and these chips are not used on any other board system.

The first of these are the IMP8 C200 and IMP16 C200 from National Semiconductor, two boards offering basically the same interfaces. The IMP 16 board contains additional

circuitry since it has page addressing. These cards are the same as those used in National Semiconductor's Development Systems (IMP 8P, IMP 16P).

The Scientific Micro Systems' microcontroller is different than all other board systems, basically because the microprocessor itself is so different. It is designed solely for high-speed control applications. Two things show up because of this; (1) it executes every one of the basic eight instructions in 300 ns, and (2) maximum program memory is only 4K 16-bit words large and RAM is only 256 bytes (Fig. 3). Notice that the functions on the SMS board are very similar to that of the Pro-Log PLS-401 board; this is a result of both boards being designed for the same dedicated control applications with the I/O system being built around them. SMS also offers extensive development aids to support this device since the program memory is only PROM and not EPROM as in most of the other systems discussed. (The speed requirements are so severe that only bipolar PROM's can be used.)

MULTI-BOARD

Pro-Log was also responsible for the first multi-board systems from an independent supplier. The PLS-403 (Fig. 4) shows again how Pro-Log philosophy is applied. This is an Intel 4004 based system similar to the PLS-401 except expanded over three boards. Pro-Log does not add anything that is not of a completely general nature; there are no UART's, 20 ma current loops, etc. The 8008/8080/6800 based boards all give the same functional decomposition – CPU, RAM, ROM, I/O ports. Pro-Log does offer a general-purpose board for user-designed circuitry and interfaces.

The Control Logic 'L' series offers a similar low level per card approach. The CPU card contains a 8008, input data multiplexer and state decoder; even the clock is contained on another card. Each PROM card holds 512 bytes and RAM cards either 512 or 1K bytes. To add any I/O, other speicalized cards must be added. This system is very versatile because all necessary lines are brought to the edge connectors, and Control Logic offers a larger variety of I/O cards than Pro-Log. The 'M' series is the same system updated to use the 8080.

The Data Works Instrumentation card set starts out like Pro-Log and Control Logic but provides additional capability in the I/O area. These cards include a RS232C interface card, IBM-compatible magnetic tape controller cards handle vertical parity, CRCC generation and CRCC strobe, mux A/D card, D/A card, resistor divider, and display cards with 7 segment or 5 x 9 dot matrix LED's. Quite a complete line.

The MPS series by Digital Equipment Corp. also breaks down the system into functional divisions: CPU, Memory, I/O interface, TTY, and priority interrupt. These cards are standard DEC W-series modules and can be obtained with console and cabinet.

With the Servant-8, Logical Services, Inc. beefed up the design of these basic functional modules by adding to the CPU card LED state indicators, 500K byte/second pseudo DMA, and seven output control lines which are pulsed whenever the "MOV R, R" type no-ops are executed. The addition of the control panel module allows for breakpoint control.

The MITS' Altair 8800 board system has greatly influenced the microcomputer market, since they were the first to be successfully mass-marketed. The MITS' boards have been copied by many people providing the only second-sourcing in the business. MITS has available many standard peripheral interfaces such as TTY, floppy disk, audio cassette and line printer. Like many quality designs, all the boards contain a voltage regulator. MITS are somewhat deficient in process control hardware at the present time but improvement in this area is promised shortly.

The support provided by MITS is rather remarkable for this industry. Since much of their sales emphasis is on end-users, even naive users, an Altair is extremely easy to get going. Software support is complete with editor, assembler, debug, device drivers, and a very good BASIC. Altair 8800s are being used for development systems, educational systems, programmable controllers, dedicated controllers, and by hobbyists. MITS was the first major supplier to offer their complete system as a kit. A number of evaulation boards were previously offered as kits but since then more and more complete kit systems have entered the marketplace.

The SORD SMP80 microcomputer is unique because it is the only one surveyed available with a non-USA manufactured microprocessor. The standard microprocessor is the Intel 8080 but it can be purchased with a Japanese equivalent. It is also unique in that besides the usual dynamic RAM, static RAM, and PROM boards, it offers a core memory board of 4 or 8K bytes and the core can be set for read

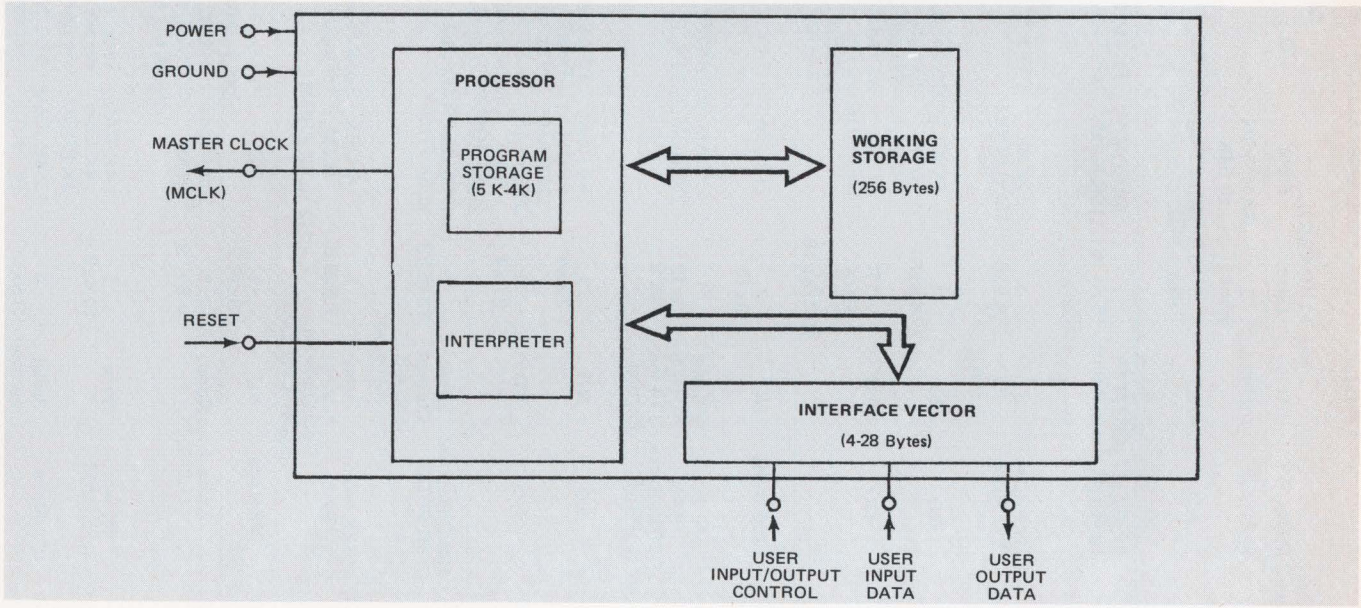


Fig. 3. SMS Microcontroller

TABLE 1: MICROCOMPUTER CHARACTERISTICS

	MICROPROCESSOR Manufacturer	Device	MEMORY	I/O	NO. of BOARDS (Size)	OPTIONS MEM	I/O	Packaged	Console	PS	SOFTWARE Assem/ CrossAssem.	High Level	Other	COST($)
ALDEN *STARCOMM*	Intel	8080	8KRAM	RS232	3 8.5x11	RAM/ROM to 64K	–	Standard	Standard	Included	NO/YES	NO	DEBUG	2900
APPLIED COMPUTING TECHNOLOGY *CBC-4N*	Intel	4004	NO	NO	1 8x8	4KPROM 9800 char.RAM	NO	YES	NO	YES	NO	NO	NO	395
APPLIED DATA COMMUNICATIONS *SERIES 70*	Intel	8080	4K RAM 1KPROM	CRT/TTY Serial Async.	1 15.5x16	4KROM, 16K RAM	Floppy LP,Tape	YES	YES	YES	YES/NO	NO	DEBUG,OS	1300
APPLIED SYSTEMS CORP. *ASC*	Intel	4004-4040	1KPROM 512 RAM	32 I/O Lines	1 4.5x6	2K-4K RAM-PROM	TTY	YES	YES	YES	YES	NO	DEBUG	300 (4004) 325 (4040)
ASC	Intel	8080	NO	NO	1 4.5x6	2K-4K RAM-PROM	Cassettes, Floppy Printer	YES	YES	YES	NO/YES	PL/M	NO	400
ASC RUGGED 8080	Intel	8080	NO	NO	ATR BOX 7-5/8-10-1/8 x16	to 16K RAM/PROM	ASYNC/SYNC to240K BAUD	Standard	NO	Standard	YES	PL/M	Arith.,Editor Debug, OS,PD, Communications	2000
COMP-SULTANTS, INC. *MICRO 440*	Intel	4040	256 Bytes	NO	1 9x12	2KRAM	TTY	YES	YES	YES	NO	NO	NO	175 kit 275 kit pkg.
COMPUTER PRODUCTS, INC. PROCOM I	Intel	8080	512 Bytes RAM 2048 Bytes PROM	2 Serial PORTS 32 Line Parallel	1 19x12.5 x3.5	4KRAM, 2KPROM	RS232, TTY,TTL	YES	YES	YES	NO	NO	FIRMWARE STD IBM 2260 PROTOCOL	2995 Note: Inten. as smart cont'lr in remote date col.
CONTROL LOGIC *L-SERIES*	Intel	8008	NO	NO	3 2.5x4	256 RAM/ PROM 2KRAM	TTY,Serial Parallel Digital	YES	YES	YES	YES	NO	Debug,OS	195 (8008)
M-SERIES	Intel	8080	NO	NO	1 2.5x4	256 to 1K RAM 256 PROM	TTY, Serial,Parallel Digital	YES	YES	YES	YES	FORTRAN	Debug OS	250 (8008-1)
DATA ARCHITECTS *CM 101*	Intel	4004	160 Char.RAM 1K PROM	20ma Current loop 4-8 bit parallel clock	1 13x6.88	to 1280 char.RAM to 3K PROM	NO	NO	NO	NO	YES	NO	EDITOR PROM PROGRAMMER	1420
DATA GENERAL *MICRO NOVA*	Data General	mN601	2K words RAM	Functionally Equivalent to Nova 47-Line BUS	1 7.5x9.5	4K, 8K RAM 1/2 to 4K PROM	Serial,Parallel Floppy	YES	YES	YES	MACRO ASSEM	Fortran,Basic Algol, Cobol	Debug,OS PD,Arith	800
DATA NUMERICS *DL-8A*	Intel	8080	4KRAM	NO	1 8x15.9	NO	PT,Mag Tape Floppy, Cassette	YES	YES	YES	NO/YES	NO	DEBUG	1175 Note: wire wrapped boards
DATA WORKS INSTRUMENTATION *226 MICRO CARD*	Intel	8080	None	None	1 4.6x3.9	256 ROM/ RAM	RS232, 4K RAM, D/A, Tape,64 I/O Latches	NO	NO	NO	NO	NO	ARITH.	395
DIGITAL EQUIP. CORP *LSI II*	Western Digital	–	4K words RAM	None	1 10.4x8.5	1-4K RAM, 4K Core 4K PROM	Serial & parallel line unit	YES „PDP 11/03	NO	NO	YES	Basic/Fortran All PDP 11 lang.	Debug, OS, PD, Arith.	995
MPS	Intel	8008	None	Serial Line Inter 8 Bit Parallel Mux into Data BUS	1 8.5x11	1-2-4K RAM 4K PROM	DEC W-Series Ext Event Detection	NO	YES	NO	NO/YES	NO	DEBUG	745 (1K RAM)

DIGITAL PRODUCTS *DPC 1000*	Intel	8008	1K RAM	NO	2 5.37x9.75	NO	NO	NO	NO	NO	NO	NO	NO	875
DMI, INC. *RIGEL II*	Intel	8008	156 Bytes (Room for 3584 bytes PROM)	8 lines 24V in 24Y out	B—8-3/4x17 x16. R—8-3/4 x19x16	4K RAM/ PROM	6 port Parallel,A/D, D/A, Freq. Ctr, Display	Standard	Standard	Standard	NO	NO	NO	1980 Note: Sys. of plug-in modules for bldg. indus. micro
ELECTRONIC PRODUCT ASSOCIATES, INC. *MICRO-68*	Motorola	M6800	128 RAM 512 PROM	2 Dual Port Bi-Dir. Prog Interface	Console Package	1K ROM 640 RAM	NO	N.A.	N.A.	N.A.	NO	NO	DEBUG	430
FAIRCHILD SYSTEMS TECHNOLOGY	Fairchild	F8	1K RAM 1K ROM	4 I/O ports	1 5.2x9.2	64K RAM	Serial	NO	NO	NO			Loader, Debug	185 KIT
GENERAL AUTOMATION														
GA-16/330	Synertek	—	NO	NO	1 17x23	4,8,16K Core	SPC-16 I/O	YES	YES	YES	YES/YES	Fortran,Basic, Cobol,RPG	All SPC-16 Software	1950
GA-16/110	Synertek	—	1K RAM	NO	1 7-3/4 x11	4,8K RAM/ROM	SPC-16 I/O+DMA	YES	YES	YES	YES/YES	Same as above	Same as above	585 (min.order-15)
GA-16/220	Synertek	—	1K RAM	Serial, DMA,Clock	2 7-3/4x11	4,8K RAM/ROM	SPC-16 I/O +DMA	YES	YES	YES	YES/YES	Same as above	Same as above	975
GENERAL INSTRUMENT *MC 1600/1601*	General Instrument	CP 1600	NO	NO	1 9.75x 9.25	2,8K words (16 bit) RAM, 4K PROM	TTY,PT, RS232 8 port Parallel	YES	YES	YES	YES	NO	Debug,OS PD, Arith.	495
IMS ASSOCIATES *IMSAI 8080*	Intel	8080	NO	NO	1 5x10	1, 4K Static RAM 2K EPROM	Parallel/ Serial,Printer 50 MEGA disk cassette	YES	YES	YES	NO	NO	NO	181 kit 209 assm
INFORMATION CONTROL *ABACUS MICROSYSTEM*	Intel	8080	NO	NO	! 2x3	256,512 RAM. 1-2K PROM	Program serial 8-bit port baud rate Generator	YES	NO	YES	YES/NO	NO	Debug Editor	199
INTEL														
Imm 4-42	Intel	4004	Space for 512 PROM	4-Bit Parallel	1 8x6.18	512 byte, 2K PROM 320,960 Char. RAM	TTY, Parallel	YES	YES	YES	NO/YES	NO	Debug,OS	395
Imm 4-43	Intel	4040												
Imm 8-82	Intel	8008	NO	NO	1 8x6.18	2K PROM, 4K RAM	TTY, Parallel	YES	YES	YES	YES	PL/M	Debug,OS PD,Arith.	360
Imm 8-83	Intel	8080												450
SBC 80/10	Intel	8080A	4K ROM 1K RAM	48 Program. I/O lines Serial,TTY	1 6.75x12	up to 128K	NO	NO	NO	NO	YES	PL/M	Debug, OS, PD, Arith.	495
LOGICAL SERVICES *9300 CPN Module*	Intel	8080	NO	NO	1 5x8	4K RAM, PROM	Serial parallel	YES	YES	YES	YES/NO	NO	OS, PD	300
MARTIN RESEARCH *MIKE 2-1*	Intel	8008	NO	NO	1 5.5x7	1K RAM, 2K PROM	8-bit Parallel	NO	YES	NO	NO	NO	DEBUG	94.95 kit 114.95 assm.
MICROCOMPUTER ASSOCIATES *JOLT*	MOS Technology	6502	512 bytes RAM 1K PROM	NO	1 5x7	4K Static RAM	32 I/O + 2 interrupt Links, TTY	NO	NO	YES	NO	NO	DEBUG	249 kit 248 assm.
MITS														
ALTAIR 8800	Intel	8080	NO	NO	1 5x10	1,2,4K RAM, 2KPROM	Serial, Parallel Floppy, Cassette, Printer	YES	YES	YES	YES	Basic	Debug,OS,PD, Arith,Editor,DOS	310 kit 360 assm.
ALTAIR 680	Motorola	6800	1K bytes RAM to 1K bytes PROM	Serial Inter-face	1 8.75x 10.4	8K RAM	Cassette, Serial Parallel	YES	YES	YES	YES/NO	NO	PROM, Monitor Debug, Editor	180 kit 275 assm.
MONOLITHIC MEMORIES *MICROMINI 304,301*	Monolithic Memories	570l/ 6701	NO	NO	1 6.6x7.6	16x16 bit words Dynamic	TTY, RS232	YES	YES	YES	NO	NO	OS	625 (304 at 600 NS) 1250 (301 at 300 NS) Note: Nova emulation
605	Monolithic Memories	5701	NO	PT,RS-232C, Serial Interface	1 15x15	32Kx16RAM	Nova Compatible	YES	YES	YES	NO	NO	Debug	1050 Note: Nova emulator

TABLE 1: MICROCOMPUTER CHARACTERISTICS (continued)

	MICROPROCESSOR Manufacturer	Device	MEMORY	I/O	NO. of BOARDS (Size)	OPTIONS MEM	I/O	Packaged	Console	PS	SOFTWARE Assem/ CrossAssem.	High Level	Other	COST($)
MOTOROLA														
MEK 6800	Motorola	6800	128 RAM	2 parallel 1 asynch.	1 5.5x9.75	640 RAM	–	NO	NO	NO	–	–	Debug (firmware)	149 kit
Evaluation Module 2	Motorola	6800	256 RAM	2 asynch 1 parallel	1 5.5x9.75	PROM Socket	–	NO	NO	NO	–	–	Debug (firmware)	795 kit
MULTISONICS														
808	Intel	8080	NO	NO	1 9.5x5	4K RAM	PT,Printer,Tape CRT,TTY	YES	YES	YES	YES/NO	NO	Debug,OS	900
808A	Intel	8080	NO	72 Bits, RS232C 20ma	1 9.25x12	14,16K RAM, 8K PROM	PT,Printer Tape,CRT TTY	YES	YES	YES	YES/NO	NO	Debug,OS	700-800
A/S MYCRON														
MICRO-1	Intel	8080	1K RAM 2K PROM	20 ma current	1 6.3x9.2	4K, 16K RAM, 4K PROM	PT,Parallel Floppy	YES	YES	YES	YES	NO	Debug,OS,PD, Arith. Editor	1300
NATIONAL SEMICONDUCTOR														
IMP 8 C200	Nat.Semi	IMP 8	256 Bytes RAM Space for 2 Kbytes PROM	NO	1 8.5x11	8KByte RAM	TTY Card Reader	YES	YES	YES	NO/YES	NO	Debug,OS,PD	725
IMP 16 C200	Nat.Semi	IMP 16	256x16 RAM Space for 512x 16 PROM	NO	1 8.5x11	4Kx16 RAM	TTY,Card Reader, Floppy	YES	YES	YES	NO	SM/PL	Debug,OS,PD, Arith	825
IPC 16 C100	Nat.Semi.	IPC 16 (PACE)	NO	NO	1 4.5x4.5	1Kx16 RAM 2Kx16.PROM	TTY,Card Reader	YES	YES	YES	YES	NO	Debug,OS, PD	375
PCS														
CM 4400	Intel	8080	NO	NO	1 4.96x9.65	8K RAM, 4K ROM	TTY, Serial/Parallel	YES	YES	YES	NO	NO	Debug,OS	630
PRO-LOG														
PLS-401	Intel	4004	256 PROM 80 Char. RAM	32 TTL Lines 4 MOS output	1 4.5x6.5	NO	NO	NO	NO	NO	NO	NO	NO	295
PLS-402	Intel	4004	256 PROM 80 Char. RAM	32 TTL lines 4 MOS Output	2 4.5x6.5	NO	32 TTL Lines	NO	NO	NO	NO	NO	NO	395
PLS-403	Intel	4004	256 PROM 80 Char. RAM	32 TTL lines 4 MOS output lines	3 4.5x6.5	2K PROM 640 char. RAM	32 TTL Lines	NO	NO	NO	NO	NO	NO	470
PLS-411	Intel	4004	256 PROM 80 Char. RAM	32TTL lines 4 MOS output lines	1 4.5x6.5	768 PROM 560 Char.RAM	NO	NO	NO	NO	NO	NO	NO	320
PLS-441	Intel	4040	256 PROM 80 Char. RAM	32 TTL lines 4 MOS output interrupt	1 4.5x6.5	1280 PROM 640 Char.RAM	NO	NO	NO	NO	NO	NO	NO	345
PLS-442	*Intel*	*4040*	256 PROM 80 Char. RAM	32 TTL lines 4 MOS output	2 4.5x6.5	1280 PROM 640 Char.RAM	NO	NO	NO	NO	NO	NO	NO	445
PLS-443	Intel	4040	256 PROM 80 Char. RAM	32 TTL lines 4 MOS output interrupt	3 4.5x6.5	4K PROM 1280 Char. RAM	NO	NO	NO	NO	NO	NO	NO	520
MPS-803	Intel	8008	256 PROM 1K RAM	28 TTL Lines	3 4.5x6.5	NO	NO	NO	NO	NO	NO	NO	NO	620
MPS-805	Intel	8008-1	256 PROM 1K RAM	28 TTL Lines	5 4.5x6.5	NO	NO	NO	NO	NO	NO	NO	NO	–
MPS-883	Intel	8080	256 PROM 1K RAM	28 TTL Lines DMA	3 4.5x6.5	1K PROM 2K RAM	NO	NO	NO	NO	NO	NO	NO	540
MPS-885	Intel	8080	256 PROM 1K RAM	32 TTL Lines	5 4.5x6.5	NO	TTL Boards	NO	NO	NO	NO	NO	NO	760
8611	Motorola	6800	NO	NO	1 4.5x6.5	8K PROM 1K RAM	TTL I/O	NO	NO	NO	NO	NO	NO	325

REAL. ETUDES *R2E MICRAL S**	Intel	8080	256 RAM	32 TTL Lines Serial TTY	Packaged	16K RAM	PT,MTCard Reader, Floppy, Printer	Standard	Standard	Standard	NO	Basic, Process Control	OS	750
SCELBI *SCELBI 8-H*	Intel	8008	256 RAM	NO	5	1K RAM	TTY,Cassette ASCII Keyboard	NO	YES	YES	YES	NO	Debug, OS PD, Arith	399 ass. 189 kit
SCIENTIFIC MICRO *SYSTEM 10*	Scientific Micro	SMS 330	512x16 bits ROM	32 Par lines	1 6-7/8x 2-5/8	256 RAM, 512x16 ROM	8-Bit Parallel	NO	NO	NO	NO/YES	NO	Hardware Simulator Assembler	457
SORD COMPUTER *BPU*	Intel	8080	NO	DMA	1 8-11/16 x11-13/16	8K PROM, 8K CORE, 8K, 16K RAM	TTY,CRT, FLoppy	YES	YES	YES	YES	NO	Debug,OS, PD,Arith., Editor	470
SPHERE CORP. *SPHERE I*	Motorola	6800	4K RAM 1K PROM	Serial Inter-face	1 8.5x11	4K,8K, 16K RAM	Serial,Parallel, Cassette, PT,Floppy,Printer	YES	YES	YES	YES/NO	Basic	Debug,OS,PD, Arith.,Debug on PROM	350
TELEDYNE GEOTECH *TC 20*	Intel	8008	NO	NO	1 8x6	1/2K,4K RAM, 2K ROM	D/A,A/D	YES	NO	NO	NO	NO	Debug	300
TC 20	Intel	8008	128 RAM 2K ROM	NO	1 18x10	2K ROM	D/A,A/D	YES	NO	NO	NO	NO	Debug	900
TELEDYNE SYSTEMS *TDY-52B*	Nat.Semi	IMP-16	NO	NO	Hybrid Sealed Package 2x2	NO	NO	NO	NO	NO	YES	NO	NO	1295 (Quan. 50)
TEXAS INSTRUMENTS *990/4*	TI	9900	256 Words RAM 768 Words (960 cpt.) PROM (or add.l RAM)	CRU Bus	1 11x14	4 to 20K RAM 1 to 16K PROM	Standard TI 960 Periph.	YES	YES	YES	YES	Fortran, Basic Cobol	Debug,OS PD Arith.	575
WARNER & SWASEY *COMSTAR 4A*	Intel	4040	NO	NO	3 6.4x4.5	1280 char. RAM 1K PROM	TTY,D/A, A/D,Floppy, Printer,Card Reader, Cassette	YES	YES	YES	YES	Process control Language	OS,PD	295
COMSTAR M8-A	Custom Chip		NO	NO	1 6.4 4.5	1K,4K RAM PROM, 64K CCD	Same as above	YES	YES	YES	YES/NO	Process control Language	Debug,OS, PD, Arith.	295

*Marketed by Warner & Swasey in U.S.

only operation. There are many applications for microcomputers which require non-volatile R/W memory and this unit is one of the few that is suitable.

PACKAGED

The Applied Systems Corp.'s rugged 8080 system is a good example of packaging due to environmental consideration. The standard enclosure is an air transport rack (ATR) package, but it is also available in a 1/2 ATR package or RETMA rack mounting. The packaging was also designed to withstand shock and vibration. This system was available before the Mil-Spec 8080 was announced.

Some work has been done in research organizations and universities to produce microcomputers in standard CAMAC packages, but at this time, no commercial versions are known.

The RIGEL II by Androtek Systems (a division of DMI) is designed for the process control field and consists of plug-in modules, each with front panels to build up an industrial microcomputer. The peripheral boards consist of general I/O modules, set point modules, display modules (up to 6 digit), ADC modules, DAC modules and frequency counter modules. The CPU module contains a 24 bit timing clock with 5 ms resolution. The RIGEL comes packaged for either bench or rack use. It has consoles to give the status of the

TABLE 2
REFERENCE INFORMATION

For more information on microcomputers surveyed in this article, use the reader service number keyed below.

Microcomputer Manufacturer	Reader Service No.
Alden Selftransit Systems Corp., Milford MA	51
Applied Computing Technology, Irvine, CA.	52
Applied Data Communications, Santa Ana, CA	53
Applied Systems Corporation, Detroit, MI.	54
Comp-Sultants, Inc., Huntsville, AL	55
Computer Products, Inc., Ft. Lauderdale, FL	56
Control Logic, Natick, MA.	57
Data Architects, Inc., Waltham, MA	58
Data General Corporation, Southboro, MA	59
Data Numerics, Farmingdale, NY	60
Data Works Instrumentation, Chatsworth, CA	61
Digital Equipment Corporation Digital Components Group, Marlboro, MA	62
Digital Products Corp., Ft. Lauderdale, FL	63
DMI, Inc., Androtek Systems Div., Columbus, OH	64
Electronic Product Associates, Inc., San Diego, CA.	65
Fairchild Semiconductor Components, Mountain View, CA	66
General Automation, Anaheim, CA.	67
General Instrument Corporation, Hicksville, NY	68
IMS Associates Inc., San Leandro, CA	69
Information Control Corp., Los Angeles, CA	70
Intel Corp., Santa Clara, CA	71
Logical Services Inc., Mountain View, CA	72
Martin Research, Northbrook, IL	73
Microcomputer Associates, Inc., Los Altos, CA	74
MITS Inc., Albuquerque, NM	75
Monolithic Memories, Inc., Sunnyvale, CA	76
Motorola, Phoenix, AZ	77
Multisonics, San Ramon, CA	78
A/S Mycron Data Industri, Oslo, Norway	79
National Semiconductor, Santa Clara, CA	80
Process Control Systems, Flint, MI	81
Pro-Log Corporation, Monterey, CA	82
Realizations Etudies Electroniques (see Warner and Swasey)	
Scelbi Computer Consulting Inc., Milford, CT.	83
Scientific Micro Systems A Subsidiary of Corning Glass Works, Mountain View, CA	84
SORD Computer Systems, Inc., Tokyo, Japan	85
Sphere Corp., Bountiful, UT.	86
Teledyne Geotech, Garland, TX.	87
Teledyne Systems Co., Northridge, CA.	88
Texas Instruments, Inc., Dallas, TX.	89
Warner and Swasey, Electronic Products Div., Solon, OH	90

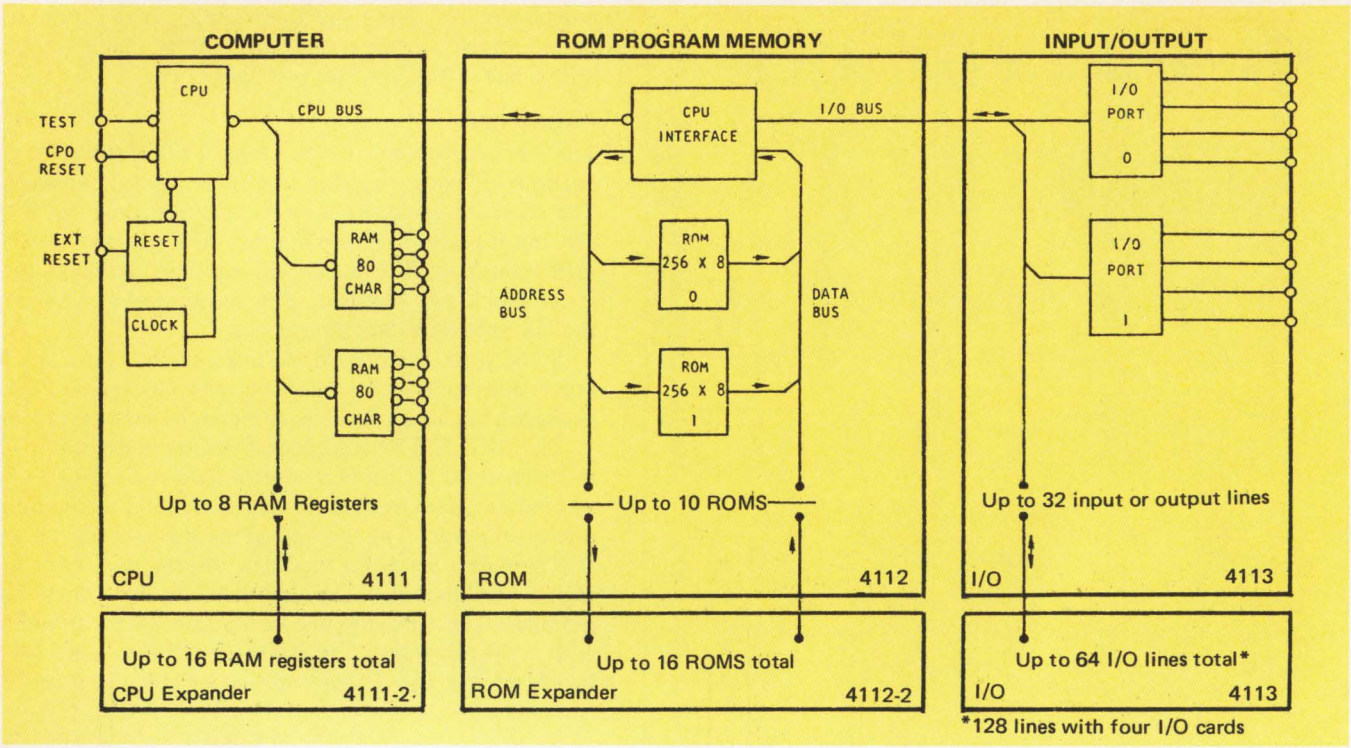


Fig. 4. Pro-Log PLS403

process control system, but it does not have a computer operating console in the traditional sense.

PACKAGE WITH CONSOLE

This category is small or large depending on one's outlook. Most systems which can be included in this category are available on the board level and have been discussed earlier. Some of those systems are not overly impressive taken as individual pieces of hardware, such as Altair 8800 and Altair 680 boards, but when considered as an entire system they are in many respects some of the best microcomputers available.

The MICRAL S is a fully packaged 8080 based system similar to a minicomputer. It was the first European microcomputer system (it is from France) and is being marketed in the U.S. by Warner & Swasey, who want to sell it in a minimal system with floppy disk and terminal peripherals.

MINICOMPUTERS EMULATORS

Here we come to the real powerhouses of the microcomputer world. These are microcomputer systems designed to emulate existing minicomputers, providing minicomputer flexibility and ease of programming with low microcomputer cost. To a large extent, this objective appears to have been met; the cost of a basic CPU with memory and serial I/O comes to under $1000 – very competitive with traditional (if such a word can be used in this business) Intel or Motorola based microcomputers. For most applications, this is a kind of overkill, but the savings in software development can be considerable – so for low volume, complex applications, this is an extremely attractive alternative.

The original entry in this category, and still one of the most attractive, is the Digital Equipment Corporation LSI-11. On one $995 board you get a four chip implementation of a PDP-11 CPU (five if you want multiply/divide and floating point); 4K 16-bit words of RAM, and a loader/debug system built into the microcode using no user address space. The versatile, though exceedingly complex, UNIBUS, has been dropped and replaced with a simpler LSI-11 bus. There are two basic interfaces available, one serial, one parallel, and 4K RAM, PROM, and core modules. The boxed version, the PDP-11/03, is available for a lot more money – $2500. For program development DEC offers the PDP-11-V03, a packaged LSI-11 with dual floppies, CRT or DEC writer, and real-time operating system.

Hot on the heels of the LSI-11 come the Texas Instruments' 990 series and General Automation's "Solution Series." Both are approximately the same price as the LSI-11 and both offer compatibility with that vendor's previous minicomputer offerings. As a matter of fact, both are extensions of the previous minicomputers with additonal features. This seems to be the trend of the future, with minicomputer makers extending their line down into microcomputer territory.

Coming from the other direction, Monolithic Memories has its two MicroMini computers using their 5701/6701 bit slice processors. These are both NOVA emulators, joining an already crowded field. The difference between the two is speed, with a choice of 300 ns or 600 ns cycle times.

The newest machine is the MicroNOVA from Data General – which truly is a NOVA emulator. Even the I/O bus is functionally the same. One of its more interesting features is a "console" that looks like a hand-held calculator with a cable connecting it to the computer. Software support, of course, is extensive.

ALTERNATIVES

High end microcomputers compete directly with low end OEM minis – the NOVA 3, the Naked Milli and Mini, the PDP-8/A, Fabri-Tek MP-12 and their brothers. What is the difference in performance and cost? How does a user choose between them?

Frankly, if you are considering using the minicomputer emulators, there is no difference. Both this type of micro and the OEM minis are designed for the same market and are competitive in both price and performance. You can get Computer Automation's Naked Milli for as low as $295 in

quantity and you can get that manufacturer's Naked Mini, or a DEC PDP-8/A, or a Data General NOVA 3 in a complete system, with box and memory for prices ranging from one to three thousand dollars, roughly the same range as the microprocessor-based minis. The only advice that we can provide is to constantly maintain a watch over the marketplace, look for the performance you desire and the price you can afford, and do not pay too much attention to labels.

INTERPRETING THE TABLES

The tables were organized by microcomputer manufacturer in alphabetical order. The subcategories will now be listed with a discussion of each.

Microprocessor Manufacturer – This is the firm name which produced the microprocessor. In cases of custom chip, the name is given, if known, but the chip may not be available.

Microprocessor Device – This is the part number of the microprocessor used. In cases of custom chips this number is not always known.

Memory – This is the amount of memory which is the standard for this microcomputer. For single board systems this number is always known; for multiboard systems, there may not be a minimum standard memory configuration. Memory is measured in 8-bit byte storage units except for the obvious 16-bit sysems that have 16-bit words and the 4-bit character devices which are measured in characters.

I/O – Some boards include standard I/O interfaces such as RS232C. The standard interfaces are listed here.

No. of Boards – This is the minimum number of boards, including the CPU, which is sold under the microcomputer surveyed. If there is no onboard memory listed, then this is part of a multiboard system.

(Size) – Size of board is given in inches.

Options – This category includes several subheadings.

Mem – This gives the amount of memory per board which can be added up to the system limit. Some systems have different size RAM boards, which produce multiple entries.

I/O – This lists the I/O interface options available from the manufacturer. Other interfaces may be available elsewhere.

Packaged – This term has been explained earlier.

Console – This means a computer operator console as in the traditional minicomputer sense although it may be on a card and not a front panel.

PS – Power supply is available from manufacturer.

Software – This category signifies the existence of assembler, cross-assembler, high-level languages, debug packages, operating systems (OS), peripheral interface drivers (PD), and arithmetic subroutines.

Cost – This is the cost for the number of boards given. An actual minimal system may be higher due to memory and I/O board cost.

SUMMARY

The microcomputer marketplace has many different systems in it, each firm expressing a design philosophy or just trying to outdo a competitor in a specific market. There are a large number of small firms, and it is somewhat similar to the early days of minicomputers when there was a hectic scramble to enter the minicomputer market.

Another parallel is in software. The early days of minicomputers saw very primitive and usually error-prone software packages. Now minicomputer software is very advanced in comparison with just a few years ago and compares favorably with much larger machines. Microcomputer software is progressing much the same way but at a faster rate.

One problem which is becoming apparent is that microcomputers are taking on the appearance of minicomputers with lots of software and peripheral support. This trend tends to hide the useful Pro-Log and SMS primitive systems because they do not try to act like big minicomputers but rather attempt to get the controller task done quickly and efficiently.

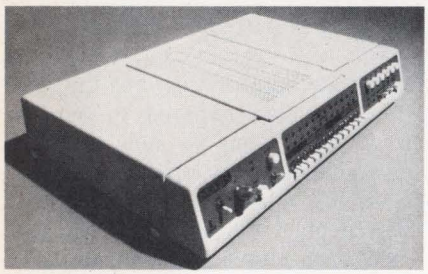
The price of most of these systems will drop as CPU and memory costs decrease. Among chip manufacturers, the current trend is to produce both more general and more special-purpose LSI I/O chips. This is exemplified by Motorola's PIA and ACIA chips and Rockwell's peripheral chips.

The first microprocessors were designed as an isolated unit, and therefore required skill and additional components to interface with clocks, memory, I/O, etc. Current microprocessors are being designed as part of a system so that there are direct interfaces with peripheral circuitry, as shown in the 6800 family. Because of this, and improvements in documentation, the skill required to produce microcomputers is not as great. Thus we may see more firms producing microcomputers as they predict fast development time and low costs. There may also be a decrease in microcomputer sales as systems designers will reason that since so little effort is needed to produce a microcomputer, they should do that job themselves. The market is going to be highly unsettled for a while.

We also feel that the hobbyist will remain as a voice in the microcomputer market demanding lower peripheral cost and providing a broader market. This will not, however, affect the dedicated controller application area, which is still the largest market. ■

MICROPROCESSOR DEVELOPMENT SYSTEM

Intercept can be used to prototype microprocessor-based systems utilizing Intersil's IM6100 12-bit CMOS microprocessor. The bench-top Intercept duplicates all functions and timing of the microprocessor and provides easy access for I/O devices through a built in Teletype interface, as well as plug-in capability for additional memory and a complete control panel for man-machine interface. Since the IM6100



is compatible with DEC's PDP-8/E software, Intercept will operate with basic PDP-8/E papertape programs without any software or hardware modifications. Intercept is priced at $2850 per unit. *Intersil, Inc., Cupertino, CA.*

Circle No. 133 on Inquiry Card

TECH CONTROL CENTER MODULES

The Mini-Tech control center modules combine programmable digital fallback switching and patching with four-wire VF signal patching, which permits rerouting signals at both the digital and analog side of modems. Sixteen full duplex, 25-wire RS-232C digital channels and 16 full-duplex four-wire VF channels can be handled. Up to 160 channels can be switched simultaneously using a special chaining feature. LEDs provide continuous monitoring of transmit data, receive data and data carrier detect for each channel. Price for the 16-channel system is $4175. *International Data Sciences, Inc., Providence, RI.*

Circle No. 153 on Inquiry Card

MINI TABLET INTERFACE

This data tablet/digitizer interface transfers X-Y coordinate information from the Summagraphics controller to a Nova mini and operates in either programmed I/O or interrupt mode. Other mini interfaces are also available. The 15-inch board with connecting cable is $1750. *Summagraphics Corp., Fairfield, CT.*

Circle No. 154 on Inquiry Card

DISK PACKS FOR TRIDENT

The 4460 Series five-high disk packs are compatible with CalComp Trident and similar disk storage drives. Available capacities are 27, 54 and 82 megabytes. *Nashua Corp., Nashua, NH.*

Circle No. 138 on Inquiry Card

POWER SUPPLIES

Modular Power, Inc. (San Diego, CA) PSC Series card-type power supplies feature typical efficiencies of greater than 50 percent for the 5-vdc models and 70 percent for all other models, under full load and normal line. Units are available in single output voltages of 5, 12, 15, 24, 28, 30 and 250 vdc. Current outputs range from 0.1 to 4 amps. OVP is optional on the 5, 12 and 15-vdc units. All models have full protection against short circuit and overload conditions.

Circle No. 143 on Inquiry Card

Elexon Power Systems (Santa Ana, CA) triple-output microprocessor supply may be used to power Intel 8080, TI TMS 8080, AMD 9080, Mostek F8, Motorola 6800 and other microprocessors with similar power requirements. Standard features include IC regulation, isolated outputs for positive or negative operation, remote sensing, foldback current limiting and spike suppression. Price in quantities of 100 is $49.

Circle No. 164 on Inquiry Card

Deltron, Inc. (North Wales, PA) QT Series triple-output power supplies consist of two models. Model QT-1 is rated at 5 vdc at 3 amps, and ± 12 to ± 15 vdc adjustable at 0.5 amps; Model QT-2 is rated at 5 vdc at 6 amps, and ±12 to ± 15 vdc adjustable at 1 amp. Price for QT-2 is $69 and for QT-1 is $89.

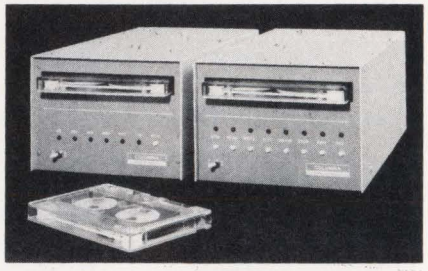
Circle No. 165 on Inquiry Card

Sola Electric (Elk Grove Village, IL) OEM microprocessor power supplies feature fully isolated, independent outputs to prevent interaction between microprocessor logic circuits. Four dual output models and four triple-output models provide the output-voltage combinations most often required by microprocessor manufacturers. Input voltage range is 104 to 127 or 208 to 254 vac, with frequency range of 50 to 400 hz. All models are equipped with automatic current limiting, short circuit protection and reverse voltage protection.

Circle No. 166 on Inquiry Card

3M DATA CARTRIDGE SYSTEMS

The Model 300-S data cartridge system features a computer grade dual gap head and a synchronous formatter for complete read after write and CRC error checking. The intelligent ANSI formatter/controller uses a parallel I/O structure ideal for simple interfacing to microprocessors and minicomputers. The price for the single-track Model



300-S (625,000 characters) is $1495; the four-track (2.5 million characters) is $1695. A buffered unit is also available. *Columbia Data Products, Baltimore, MD.*

Circle No. 142 on Inquiry Card

BANKING TERMINAL PERIPHERALS

The Model 2060 Administrative CRT Terminal, the Model 2092 Punched Card Reader and the Model 2069 Auxiliary Storage Device connect to Bunker Ramo's 2001 Universal Teller Terminal. The Administrative CRT is used as a platform device for opening new accounts, inquiring on CIF account status and interrogating various computer-stored information. The Punched Card Reader is used for entering mortgage and/or loan payments. The Auxiliary Storage Device supersedes earlier Model 2094/95. *Bunker Ramo, Trumbull, CT.*

Circle No. 132 on Inquiry Card

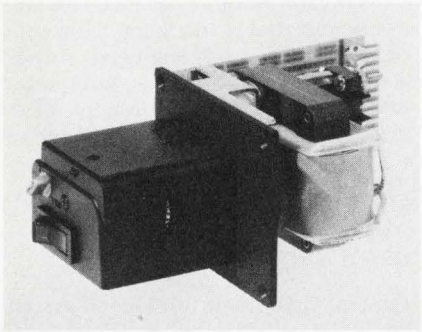
OCR WAND

The KT3 Datawand reads ANSI OCR-A numerals 0 through 9 and then displays them on a CRT screen. Typed lines can be read forwards or backwards at up to 10 inches per second. A fresh set of character signals is fed to the recognition circuitry for every .005 inch of travel. If the recognition circuit fails to identify a character, it emits a beep so the operator can type in the unclear character. Another model, the KT9, also handles OCR-A letters, numerals from other fonts and 14 hand-printed characters. The KT3 is priced at $3250. *Key Tronic Corp., Spokane, WA.*

Circle No. 187 on Inquiry Card

PAPER TAPE READER

The Model 640 Data Loader series of paper tape readers read all standard five, six, seven or eight-level tapes at 350 characters per second. They use



LED light sources and hermetically sealed phototransistors. Power requirements for the LEDs is 12 vdc. Price is $151. *Addmaster Corp., San Gabriel, California.*

Circle No. 174 on Inquiry Card

TABLETOP PLOTTER

The CalComp 836 drum plotter replaces the CalComp 563 drum plotter. The plotter's drum and carriage are driven by the servo motors to ensure quiet operation, and a linear motor pen mechanism eliminates pen noise. These features, coupled with the plotter's tabletop size – 51 by 18.75 inches – make the 836 suitable for design areas, laboratories, offices, and similar environments. The 836 has a drawing speed of 1.97 inches/sec and an increment size of .004 inches to ensure high-resolution drawings. Ballpoint or "Plastip" pens are standard with the plotter. Liquid ink pens are optionally available. The plotter is plug-compatible with any mini having an asynchronous RS-232C interface. Price is $8700. *California Computer Products, Anaheim, California.*

Circle No. 141 on Inquiry Card

SMALL BUSINESS MICRO

Sphere Corp.'s new series 500 microcomputers is similar to the company's 300 series, but has a 2000-character (upper and lowercase) display with full ASCII keyboard plus keypad and cursor control keys. Like the 300, the 500 is based on Motorola's 6800 microprocessor. Executive control programs are in read-only memory (1K to 5K). Basic is provided with the hardware. Software applications, such as product inventory control, accounting functions, mailing

lists, are optional. Depending on the model selected, a teleprinter tape cassette, floppy and printer are available as peripherals. *Sphere Corp., Bountiful, Utah.*

Circle No. 175 on Inquiry Card

DISK DRIVES AND SYSTEMS

Extra Reliable Drive. The BD-50 drive uses a standard 3330-type short-stack disk pack with 50 megabytes of data storage. For extra reliability, the drive has a triple cooling system, an actuator mechanism that is sealed in a clean-air environment and a constant-voltage power supply rather than a conventional power supply. The drive system is fully modular. Separate chassis are used for actuator and motor control mechanisms, power supply and logic. All electronic circuitry is on plug-in cards, arranged in functional groupings and provided with built-in test points. The servo drivers that position the head are on plug-in printed circuit boards, not hard-wired. A standalone 3330-formatter and interfaces for most minis will be announced later this year. *Ball Computer Products, Inc., Oakland, CA.*
Circle No. 131 on Inquiry Card

Fixed Disk for DG. The EMM 1000 Disk Subsystem can either replace or be added to a floppy system used on Data General and DG-emulating minis. The 3-megabyte moveable head, fixed disk drive is combined with a DC-220 controller. It is transparent to RDOS and compatible with IRIS software packages. Price in single quantities is $4995. *Electronic Memories and Magnetics (Caelus), San Jose, CA.*
Circle No. 134 on Inquiry Card

HPT Disk. The Series 700 disk drive is offered in increments of 32 tracks up to 128 tracks. Average access time is 8.5 milliseconds at 3600 rpm and the data rate is 4.5 megahertz. An important feature is the interchangeable head assemblies that can be replaced in the field without optical interlacing alignment. Price in quantities of 100 is $3985. *General Instrument Corp., Hawthorne, CA.*
Circle No. 137 on Inquiry Card

HPT Disk for DEC. The Model 4401 drum memory is functionally equivalent to Digital's RC11/RS 64 memory and is said to provide the OEM with drum reliability at a lower price per word than normally associated with disk systems. The 4401 has memory capacities up to two million 16-bit words and has an average access time of 8.5 milliseconds. *Vermont Research Corp., North Springfield, VT.*
Circle No. 130 on Inquiry Card

Trident Disk. The T-300 is the latest member of CalComp's Trident disk drive family. The 300-megabyte OEM disk drive takes an IBM 3336-II type pack and has a density of 6060 bits per inch. Transfer rate is 1.2 megabytes per second, and track-to-track access time is 10 milliseconds. Unit price is $11,750. *California Computer Products, Anaheim, CA.*
Circle No. 129 on Inquiry Card

BUFFERED DATA TERMINAL

MFE's Model 5000 buffered tape cassette terminal is built around its Model 250 tape cassette transport system. Controlling the buffering, editing, and communications is the Intel 8080A microprocessor. The Model 5000 conforms to ANSI/ECMA standards and has tape speeds up to 120 inches per second on cassettes capable of holding 155,000 characters of formatted data. *MFE Corp., Salem, NH.*

Circle No. 139 on Inquiry Card

LOW-COST DATA ACQUISITION

The Economy Series of data acquisition and control systems are software and mechanically compatible with Data General and Digital Equipment Corp. minis. The basic system configuration consists of 16 single-ended, 16 pseudo differential or 8 differential channels of multiplexor inputs, 12-bit A/D successive approximation converter, sample & hold, bus interface, DC/DC converter, and cable. The A/D system throughput rate is 35 kHz. With the $1295 price, the name is not a coincidence. *Adac Corp., Woburn, MA.*

Circle No. 151 on Inquiry Card

new products

LSI/UNIBUS CONVERTER

The Model 10001 Univerter converts DEC's LSI bus to a Unibus structure and permits full bidirectional communication between the two, so controllers already being used on the Unibus do not have to be redesigned. A pseudo status register returns control to the user over all four unibus interrupt levels, and an extended memory map provides a virtual memory scheme which extends addressing to 512K words. Quantity prices start at $480. *Able Computer Technology, Santa Ana, CA.*

Circle No. 150 on Inquiry Card

PAPER TAPE PUNCH STATION

The Model 3424 tabletop tape punch station incorporates a MOS/TTL/DTL hand-shaking interface and can punch at any speed up to 70 characters per second. The spooling can handle an 8-inch roll of tape and has both tape-out and tape-error contacts. The punch handles 5, 6/7, or 8-track tape without adjustment, has positive punch pin drive, can punch oiled and dry paper and mylar tape. Unit price is $1750. *GNT Automatic, Inc., Waltham, MA.*

Circle No. 140 on Inquiry Card

MINI/MICRO MEMORIES

OEM Core. The 94300 core memory module is plug-compatible with Electronic Memories & Magnetics' Micromemory 3000 products. The basic 16K x 20-bit module has a 650-nanosecond cycle time and 250-nsec access time. Additionally, 16K x 16-bit and 16K x 18-bit modules are available. Price for the 16K x 20-bit unit in small OEM quantities is $1340. *Control Data Corp., Minneapolis, MN.*
Circle No. 157 on Inquiry Card

Micro Core. Third in the Ampex microcomputer core memory family is the MCM-1814. (The MCM-1000 and MCM-4300 are described in our April 1976 issue.) Electrically alterable read-only memory (EAROM) and normal random access memory (RAM) are available in a single module. Operating in either full word or byte mode, the MCM-1814 provides 400-nanosecond access to 4096 words of up to 18 bits each. Price in OEM quantities is $600. *Ampex Corp., Marina del Rey, California.*
Circle No. 158 on Inquiry Card

More Micro Core. The PM-MP8 may be used as a 16K by eight-bit or 8K by 16bit memory and is fully compatible with National Semiconductor's microprocessors. It can replace the IMP-16P/ 004A RAM or can be used as an add-on memory module. An optional memory control card (Plessey PM-MP8C) enables the PM-MP8 to be used with the IMP-16L and other 16-bit and eightbit microprocessors. Access time is under 450 nanoseconds. *Plessey Microsystems, Irvine, CA.*
Circle No. 159 on Inquiry Card

NMOS for PDP-8. End users can purchase additional 4K or 8K 12-bit word boards for their PDP-8s. The WEVM8E board is designed with 1024 x 1 NMOS static RAM and occupies one slot on the Unibus. The DEC Memory Extension Option is needed to connect the board. Price for 4K is $475; for 8K, $750. *Computer Extension Systems, Houston, TX.*
Circle No. 160 on Inquiry Card

Extended Memory for HP 9830A. Called the EM-30 Extended Memory System, this double-density system expands the total read/write memory capacity of any Hewlett-Packard 9830A Basic programmable calculator to a full 32K bytes. The EM-30 features full compatibility with all Basic software and HP ROM options. It utilizes 4K RAM chips and requires less power from the mainframe than the standard 15K HP memory. Price is $5320. *Infotek Systems, Covina, CA.*
Circle No. 161 on Inquiry Card

Half-Card Core. On the same size card used for semiconductor memories, 1K and 4K 16-bit word memories are available. The memory is compatible with all other core and semiconductor memories from Computer Automation. Price in quantities of 100 for a 4K half-card is $837. *Computer Automation, Irvine, CA.*
Circle No. 162 on Inquiry Card

4K RAM for Micros. This 4K RAM board is compatible with the IMSAI 8080 and the Altair 8800 microcomputers. It allows 1K byte blocks of memory to be write protected or unprotected under program control or via the front panel switches. Cycle time is 450 nanoseconds. Price is $139. *IMS Associates, Inc., San Leandro, CA.*
Circle No. 163 on Inquiry Card

DATA LOGGERS

The 200W series of data loggers accept up to 16 channels of 0 to +10-volt analog signals, convert them to binary digital data, format the data and write it on standard Philips cassettes. The tapes can be inserted in the Wang 2200 series of computers and analyzed without additional interfacing. The units feature low power consumption and 12-bit resolution. Price is $1695. *Memodyne Corp., Newton, MA.*

Circle No. 169 on Inquiry Card

CDC'S NEW MINI LINE

Control Data's new mini-based systems are designed for the distributed data processing and small computer markets. The Cyber 18 family includes Models 18-10, -20 and -30. In distributed applications, the 18-10 can function as an intelligent terminal; controlware options allow it to emulate IBM 2780 and 3780 terminals. A broad range of business applications will be supported by the 18-20. The Cyber 18-30 features dual processors, serving up to 64 terminals and is intended for the small-to-medium scale educational time sharing area. Also part of the family is the Cyber 18-17 with a System 17 processor, which is designed for real-time applications such as production control and key-to-disk data entry. From 512 to 4096 microinstructions are available with each processor. Peripheral devices supporting the minis are disk units, floppies, CRT, card readers, line printers and mag tape units. Two operating systems – RTOS and disk-based MSOS 5 – are available.

A typical Cyper 18-10 system with 32K bytes of memory, 300-card per minute reader, 300-line per minute printer, CRT and synchronous communications can be purchased for $39,840. *Control Data Corp., Minneapolis, MN.*

Circle No. 127 on Inquiry Card

PAPER TAPE PROGRAM MASK

Program-pin locations are identified by standard eight-channel punched papertape used as a program mask on a miniature 8 x 20 matrix programming board. Color coding, applied to the paper mask idientifies the type of shorting pin or component-holding pin to be used. The 100 electrical cross-point-per-square inch format of the miniature programming board provides a 400 percent reduction in required space compared to standard size boards. *Sealectro Corp., Mamaroneck, NY.*

Circle No. 146 on Inquiry Card

COBOL AUTOMATIC FLOWCHARTER

FLOBOL is an automatic flowcharter for Cobol source programs. The system is composed of three Cobol programs with imbedded Cobol sorts. Input to FLOBOL are the source statements for the Cobol program to be flowcharted which may be on any input device. Also, programs to be flowcharted may be batched. Output from FLOBOL consists of three printer files: (1) a source listing of each of the programs to be flowcharted with reference numbers assigned by the first program in the FLOBOL system, (2) a cross reference listing, produced by the second FLOBOL program, containing all data names and procedure names in alphabetical order and reference line numbers in ascending order, and (3) a file containing the flowchart produced by FLOBOL generated in the same sequence as the Cobol statements in the procedure division of the program. FLOBOL is written in ANSI-standard Cobol and will run on machines supporting ANSI Cobol. Price is $480. *Cosmic, University of Georgia, Athens, Georgia.*

Circle No. 203 on Inquiry Card

APPLICATIONS MONITOR

Decision Strategy Corp. has an applications monitor, TAPS, available on the Interdata 7/32 and 8/32. TAPS supports multiple applications, an unlimited number of screen formats, and up to 256 terminals. The product uses preprogrammed modules and tables to reduce the amount of online applications code required for each online system. Included with the product are automatic recovery and batch simulation of online testing. *Decision Strategy, Kimberton, PA.*

Circle No. 209 on Inquiry Card

μP PROGRAM DEVELOPMENT

National CSS has been adding to its library of time-shared μp development programs with almost every new chip and chip set, resulting in what presently amounts to a library of nearly a score of cross-assemblers and simulators. The current list includes programs for the AMD 908A, TI 8080/1000, Intel 8080/8008/4040/4004, Fairchild/Mostek F-8, National IMP-16/PACE, AMI/Motorola 6800, MOS Technology MCS6501/MCS6502, Signetics 2650, and Rockwell PPS4/PPS8. *National CSS, Inc., Sunnyvale, CA.*

Circle No. 240 on Inquiry Card

MULTIUSER OS FOR INTERDATA

RDOS for Interdata 16-bit minis is a flexible multi-user operating system designed to provide efficient solutions to both real-time and multi-user applications. The system is structured to be upward compatible to DOS or BOSS OS, and designed to emulate the DOS file structure. The system is structured into variable DOS or BOSS partitions where each user may select the amount of memory he needs. All DOS system programs can be run in any RDOS partition with little or no modification. Any Interdata machine above Model 4 with 16K bytes of memory can accommodate RDOS. Price for RDOS, Linker, ABC Edit and M-Loader is $850. *American Business Computers, Inc., Santa Rosa, CA.*

Circle No. 206 on Inquiry Card

new software & services

PROCESS CONTROL SYSTEM

PRO as a standalone system requires no other software but the user's application program. After the PRO software – compiler, operating system, run-time system and I/O drivers – is loaded into the computer, the user defines his own hardware on a CRT or teleprinter, selects his automatic control algorithms and then defines his own management logic with Basic- and Fortran-like statements. The PRO online incremental compiler examines each user for system protection. All task and I/O compilation is performed in background mode. *Staff, Del Mar, CA.*

Circle No. 202 on Inquiry Card

PRIVACY LOCKS

By allowing separate data dictionaries for each user without requiring any physcial separation of dictionaries, data or requests for information, each user's dictionary with the TPF&C Retrieval System can be structured to ensure the privacy of the fields accessed. Users may, however, have access to overlapping or mutually exclusive sets of data, as circumstances require. Although the TPF&C Retrieval System is tied to no specific data base management system or file organization, the privacy locks have the same effect as the CODASYL specified system of *schema* and *subschema. Towers, Perrin, Forster & Crosby, Inc., Philadelphia, PA.*

Circle No. 201 on Inquiry Card

DEVELOPMENT AND DEBUGGING

CLIDEBUG is an advanced software development/debugging facility for IBM S/360 and S/370 assembler language programs under OS-MFT, OS-MVT, VS1 and VS2. CLIDEBUG is said to be the first completely integrated Assembler Language development facility for batch environments which provides all development and debugging services usually only found in timesharing systems and high level languages. Services include interruption monitoring and automatic recovery, temporary modification of data and instructions, externally specified execution breakpoints, externally specified snapshot dumps, externally invoked instruction-by-instruction tracing and external measurement of execution frequencies for performance evaluation. One-time license fee for source code is $3875. *Computer Linguistics, Inc., Albany, NY.*

Circle No. 207 on Inquiry Card

HP EDUCATIONAL SYSTEMS

Two Terminal-Oriented Administrative Data Systems (TOADS) software packages for educational users are available for Hewlett-Packard minis. The College Information System (CIS/2000) permits HP 2000 users to build and maintain a student data base, register students and process grade reports via an online, interactive system. The Student Assignment System (SAS/3000), for use with an HP 3000, helps build master schedules, assign students to classes, provide necessary reports and interactively maintain school and student files. It is designed for junior and senior high schools, and vocational schools. *Hewlett-Packard, Palo Alto, CA.*

Circle No. 222 on Inquiry Card

DATA BASE INFO

Auerbach Data Base Management (ADBM), a single loose-leaf volume, covers the basic components of a data base environment, planning and design considerations, the evaluation and selection of a data base management system, and profiles of current offerings. There are separate sections on the data base administration function, the user-system interface, and the data model and DBMS architecture, plus analyses of current trends and case histories of operational systems in various industries. The information service includes an initial issue of 20 reports and is available on a 30-day trial basis. An annual subscription, which includes bimonthly supplements of four to six reports, is available for $175. *Auerbach Publishers, Inc., Pennsauken, NJ.*

Circle No. 211 on Inquiry Card

MICRO ASSEMBLER/LOADER

Used with the PCS Micropac 80 microcomputer, the relocatable micro assembler and linking loader can combine separately assembled subprograms into a single operating program. This eliminates the need to assign absolute memory addresses for each subprogram at assembly time. With the assembler/loader package, a user can divide a large program into relatively small segments and subroutines. He then assembles these separately so each takes a minimum of assembly time. The MAS-80R relocating assembler and RLL-80 relocating and linking loader are available as a set for $100. *Process Computer Systems, Inc., Flint, MI.*

Circle No. 210 on Inquiry Card

ACCOUNTING PACKAGE

DEPREC is a Fortran program requiring 32K that computes straight line, double declining balance, 150 percent declining balance or sum-of-the-digits depreciation for either calendar or fiscal year. Assets acquired or completed during the current year are prorated according to the number of months depreciable during the year. Price is $300 including documentation. *Datamation Industries, Houston, Texas.*

Circle No. 228 on Inquiry Card

SWIFT FOR PDP-11

U.S. banks that are members of SWIFT (Society for World-Wide Financial Telecommunications) have a software alternative with the AIMS-11 operating system and its application package, SWIFT-11. Now banks can operate their PDP-11 computers instead of being confined to either Burroughs, General Automation or Singer computers. SWIFT-11 software was developed so that existing PDP-11 computers would be compatible with SWIFT data communications requirements.

SWIFT, which presently consists of several hundred European and North American banks, will begin operations in late 1976, and will provide banks with a private network and message switching system for the transmission of payments and related banking messages. Data will be transmitted to and from banks by way of national concentrators connected to two switching centers in Amsterdam and Brussels. *Arbat Systems, Ltd., New York, NY.*

Circle No. 208 on Inquiry Card

μP SOFTWARE ON CYBERNET

Microprocessor assembler and simulation software is available now on CDC's Cybernet network. The library of programs, developed by Microcomputer Technology (Sunnyvale, CA), is designed to facilitate programming and code verification of Intel, Motorola and Fairchild microprocessors and their second sources. The assemblers allow programming at an instruction level higher than machine language, with output consisting of a symbol table, source listing or object module. Simulators actually simulate the operations coded and ROM/RAM environment, allowing the programmer to observe the output at various points and identify any errors. *Control Data Corp., Minneapolis, MN.*

Circle No. 204 on Inquiry Card

new literature

POWER SUPPLY

GE's complete line of packaged motor-generator sets are presented in this four-page booklet. The motor-generator sets rated 30 through 200 kw, are designed to provide protection for computer systems and to isolate critical load equipment from power line voltage fluctuation. The bulletin includes application data, information on system operation and design, ratings and dimensions. *General Electric Co., Schenectady, NY.*

Circle No. 280 on Inquiry Card

DISKETTE DRIVE

The Orbis Model 76 diskette drive is described in this four-page illustrated brochure. An important illustrated feature is the uniball head positioner with zero backlash. Its construction gives improved head position accuracy because of low friction and lower power requirements, resulting in cooler operation. *Orbis Systems, Inc., Tustin, CA.*

Circle No. 279 on Inquiry Card

ICC 40+ CRT

The ICC 40+ Data Display System is described in this 12-page full color brochure. Included is a section on telecommunications business applications with illustrations of various types of communication networks. Detailed descriptions of the 40+ features and technical specifications are also included. *International Communications Corp., Miami, FL.*

Circle No. 276 on Inquiry Card

MINI ACCESSORIES

This mini accessories catalog consolidates all the products needed to support a successful minicomputer installation. Many new products including I/O cables and connectors for DEC, Data General, and H-P computers, disk cartridges and magnetic tapes are included. *Minicomputer Accessories, Palo Alto, CA.*

Circle No. 277 on Inquiry Card

DESIGNER'S HANDBOOK

Imaginative solutions to conventional power conditioning and ac/dc conversion problems are presented in this 32-page handbook. Two sections are devoted to technical descriptions of the company's Paraformer power converters and Varax line conditioners, accompanied by application suggestions. *Tele-Dynamics, Ft. Washington, PA.*

Circle No. 282 on Inquiry Card

POWER SUPPLY SWITCHERS

This eight-page brochure describes the Mighty Mites line of high power switching regulated power supplies. The new LH switchers pack up to 2.26 watts/in.^{3} into the smallest packages with the lowest weights in the industry. *LH Research, Inc., Irvine, CA.*

Circle No. 275 on Inquiry Card

TAPE MANAGEMENT PROGRAM

This four-page text includes everything you need to know about magnetic tape errors, program and equipment justification, actual costs of tape failure, and how to establish a tape maintenance program. A do-it-yourself worksheet helps you to evaluate your present annual cost for tape inefficiencies and your economic new tape replacement point. *Computer-Link Corp., Burlington, MA.*

Circle No. 273 on Inquiry Card

PROGRAMMER'S REFERENCE FOR TI 742

This Programmer's Reference Card provides a quick reference index for the binary/BCD and character manipulation instructions for remote editing on Texas Instruments' Model 742 Programmable Terminal. *Data Communications Systems Specialists, Oak Park, Illinois.*

Circle No. 254 on Inquiry Card

NOT FREE, BUT AFFORDABLE

Magnetic Tape and Disk Pack Maintenance. Devices for cleaning, testing, and certifying magnetic data storage media are described in this 10-page Datapro report. The current product lines of the seven leading vendors of media maintenance equipment are included. Price is $10. Write *Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075.*

National Semi Handbooks. The eight-bit ***SC/MP Technical Description*** starts with a general introduction for nontechnical users and follows up with complete details of the design of SC/MP-based applications. Price for the 65-page handbook is $3 . . . The ***Memory Data Book*** covers most of National's memory and memory-related products including bipolar, MOS, CMOS RAMs and PROMs. Price for the 544-page book is $3 . . . The ***TTL Data Handbook*** describes National's complete line of bipolar logic devices. A tri-state selection guide, industry cross-reference guide and functional index are also included. Price is $4 . . . The 16-bit ***Pace Technical Description*** describes both the full-feature CPU and the entire complement of hardware and software items. Price for the 96-page handbook is $3.

To obtain these handbooks, send check for amount (California residents add 6 percent sales tax) to *Marketing Services Dept., National Semiconductor Corp., 2900 Semiconductor Drive, Santa Clara, CA 95051.*

DEC Education Software Index. DEC's IDEAS (Index and Description of Educational Application Software) book describes more than 100 application packages for use on Digital's educational computer systems and on many other systems supporting Basic and Fortran programming languages. Nearly 85 percent of the program packages described can be used as supplementary instructional material in one or more curriculum areas. The remainder include administrative tools, language compilers and utilities. IDEAS is priced at $10, including postage and handling, and may be ordered (prepaid only) by requesting the IDEAS book, part EA 05857, from *Digital Equipment Corp., Communications Services NR2/M15, 444 Whitney St., Northboro, MA 01532.*

Small Business Computer Guide. Analyzing requirements and comparison shopping for small business computers is made easier with the recently published new edition of the ***Auerbach Guide to Small Business Computers.*** The Guide covers over 230 small business computers, with an in-depth analysis of 40, providing introductory and review material, evaluation and selection guidelines, current price information, individual product reports and specification charts. The 275-page guide is available for $29.95 from *Auerbach Publishers, Inc., 6560 N. Park Drive, Pennsauken, NJ 08109.*

Computer Book Bibliography. The ninth edition of the ***Annual Bibliography of Computer Oriented Books,*** published by the University of Colorado, contains over 1000 books from 224 publishers. Copies of the bibliography are available for $4 from *Computing Newsletter, Box 7345, Colorado Springs, CO 80933.*

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