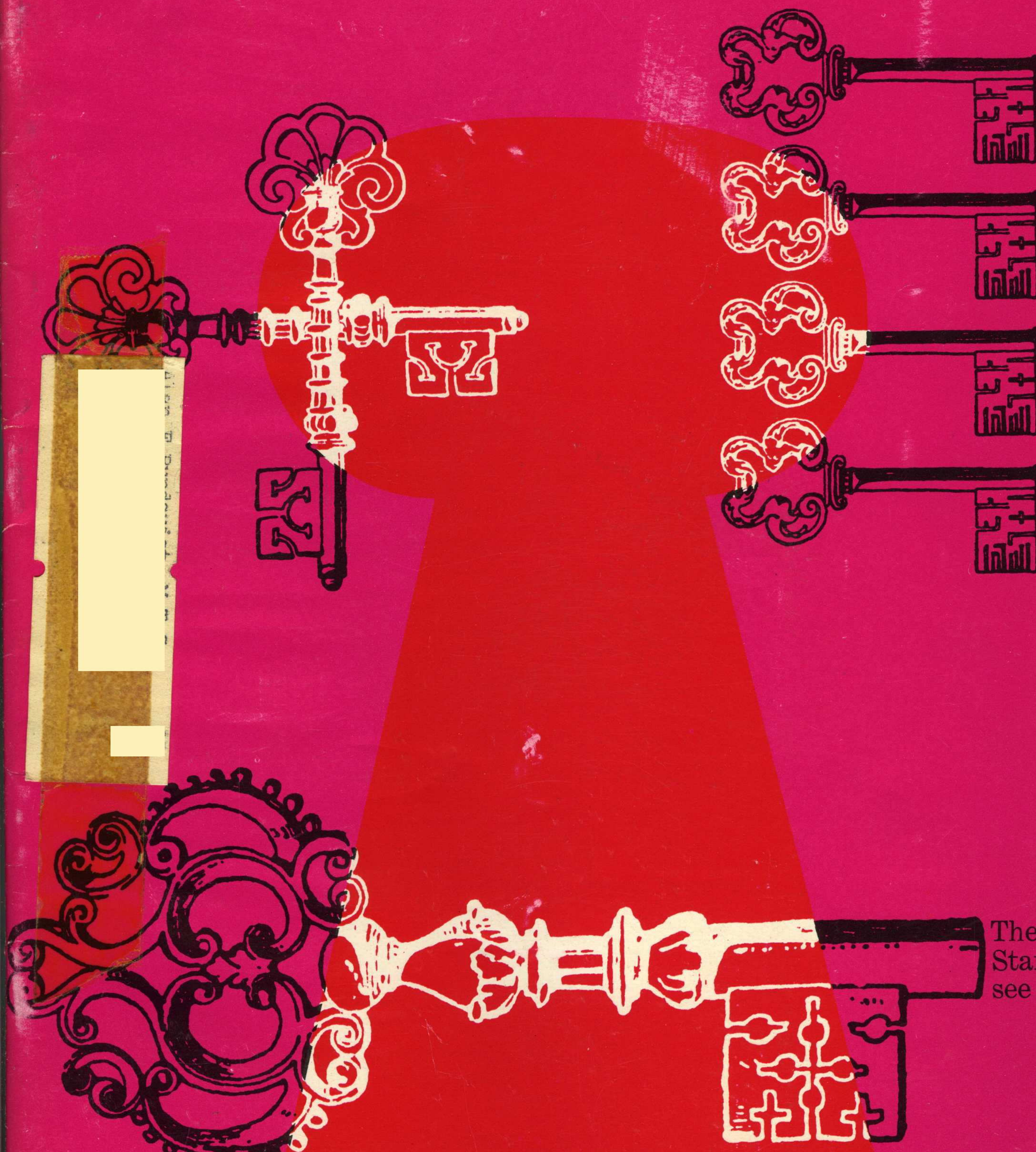
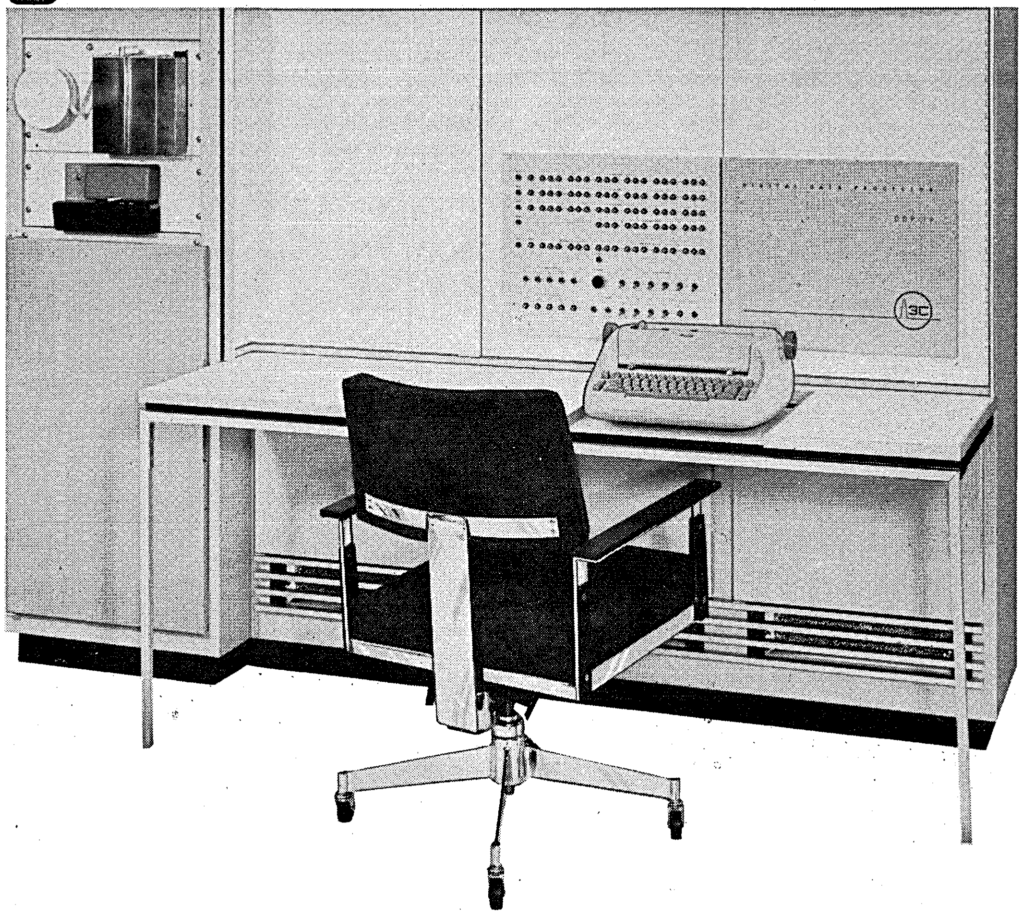
DATAMATION 62

December



The Key to Standards...
see page 17

DDP-19



Fastest real time medium-size computer

The DDP-19 Digital Data Processor handles complex on-line engineering data faster than comparable machines. Off-line too. Typical operation times, including instruction, operand access times:

ADD	10 microseconds
MULTIPLY	39 microseconds
DIVIDE	66 microseconds
DOUBLE PRECISION ADD	60 microseconds
FLOATING POINT — 37 BIT MANTISSA, 10 BIT EXPONENT:	
ADD	220 microseconds
MULTIPLY	347 microseconds
MEMORY CYCLE TIME	5 microseconds
MEMORY ACCESS TIME	3 microseconds

Computation speeds such as these are backed by a strong command structure with multiply, divide, and multiple precision commands, plus easy floating point operation. Indexing, of course.

RELIABLE. DDP-19 modules, 3C's standard S-PACs, have passed 800,000th PAC-hour of life test with no failures.

IN-OUT VARIETY. Program controlled data transfer. Multichannel interrupt with character buffers, word buffers, parallel transfer. Asynchronous full interrupt channels with 200,000 word/sec transfer rate. Fully buffered input-output channels with 200 kc word transfer rate — 3.8 million bits/sec.

EXPANDABLE. A full range of peripheral equipment, including magnetic tape units, is available. DDP-19 modular construction allows internal expansion.

PROGRAMMING AIDS. Algebraic compiler, symbolic assembler, and comprehensive subroutine library.

BASICS. DDP-19 Digital Data Processor is binary, parallel, single address. Core memory (4096 to 16,384 words), indexing, fixed point arithmetic, choice of 19, 22, or 24 bit word. Solid state. Brochure and applications portfolio available.

3C

COMPUTER CONTROL COMPANY, INC.

OLD CONNECTICUT PATH, FRAMINGHAM, MASS. • 2251 BARRY AVENUE, LOS ANGELES 64, CALIF.

CIRCLE 4 ON READER CARD

CSC OPENS DOORS OF NEW SERVICE BUREAU... REVEALS WORLD'S LARGEST AND FASTEST COMPUTER COMMERCIALLY AVAILABLE

Computer Sciences Corporation, with offices in New York, Houston, and Los Angeles, is one of the largest independent organizations devoted to the application of the computer sciences. CSC has now entered the service bureau field with the first installation of the new, thin-film, UNIVAC 1107 computer.

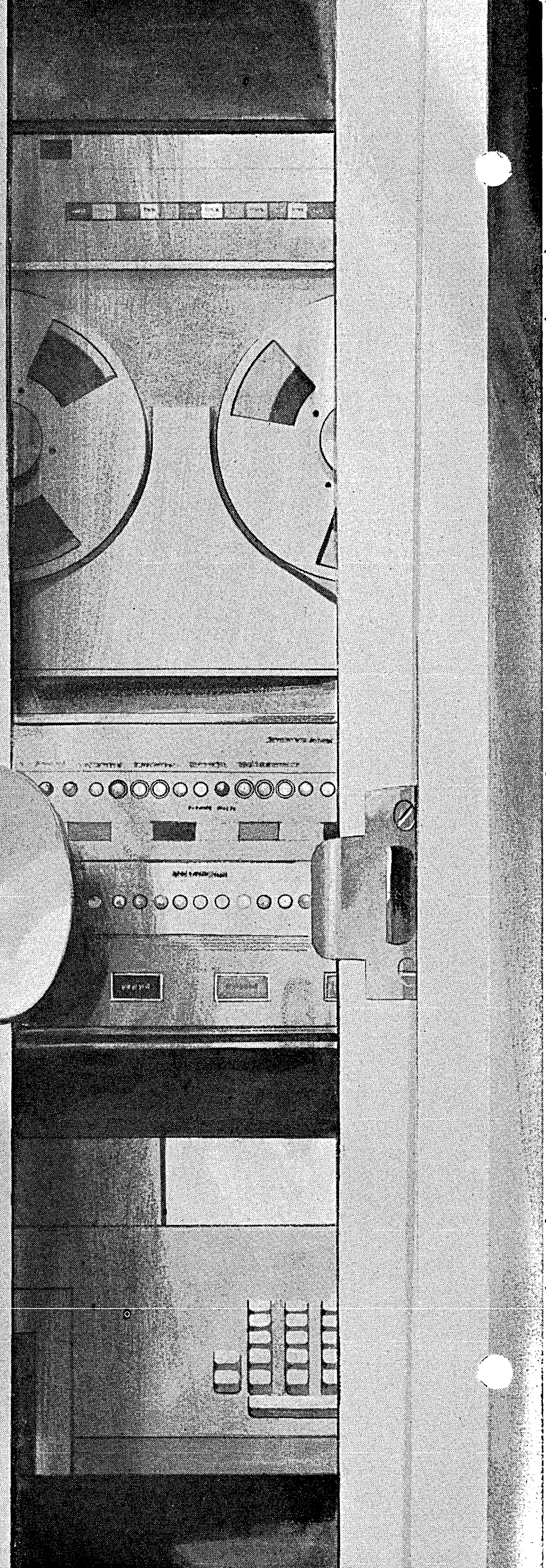
UNIVAC 1107 FACTS

- Core memory: 65,536 words.
- Drum capacity: in excess of 6,000,000 words.
- Thin-film access time: 300 nanoseconds.
- Tape speed: 62,500 characters per second.

CSC SERVICE BUREAU FACTS

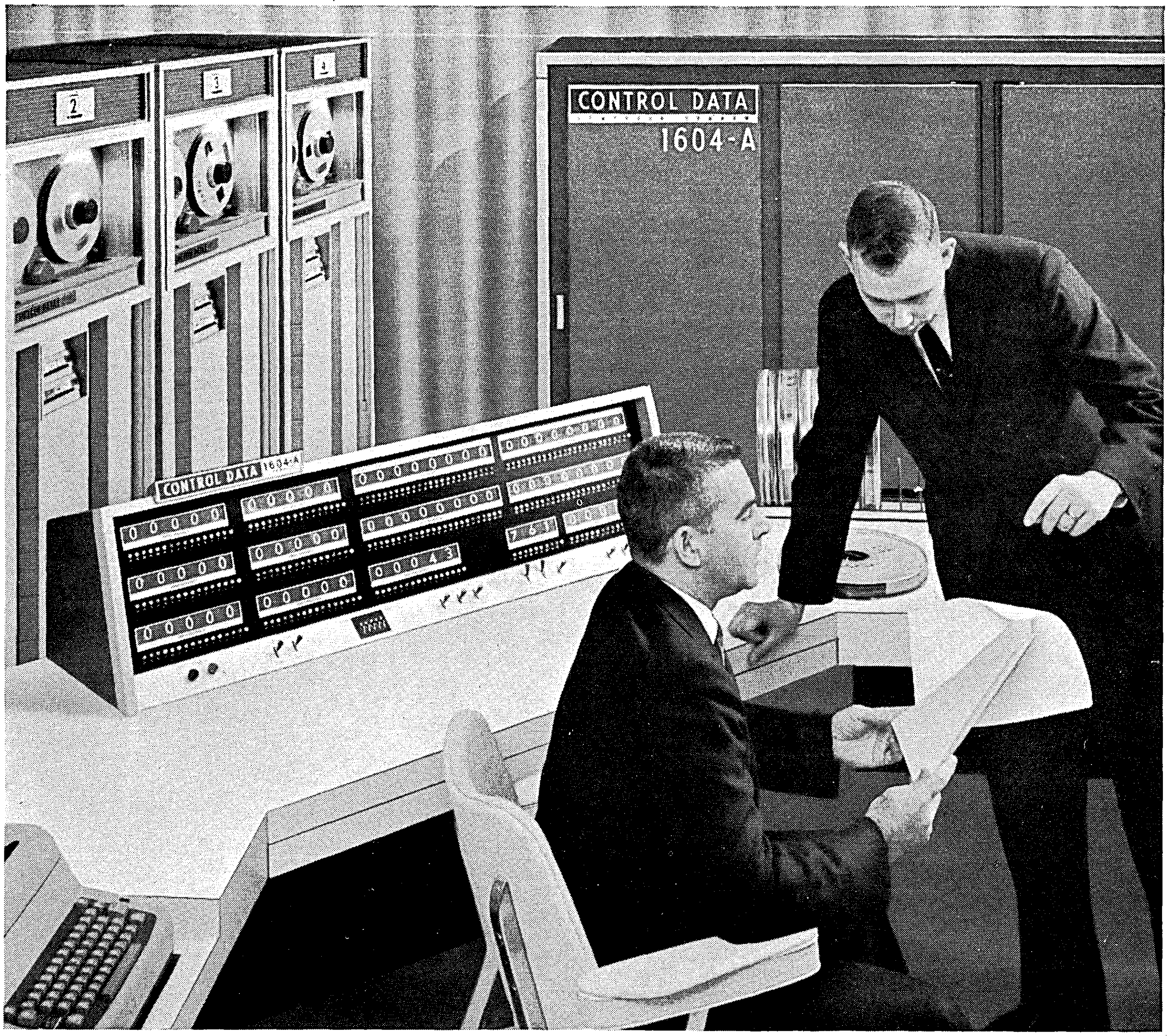
- First service bureau to offer multi-million word and nanosecond memory.
- Rates less than those of competitive bureaus, under a unique new time leasing plan.
- Complete advanced software package including FORTRAN and COBOL.
- Compatibility with other large machines.
- Advanced Input/Output equipment includes high-speed printers, card and paper-tape readers and punches.
- Convenient location near Los Angeles International Airport.
- Machine available with complete CSC staff and services...or for operation by your own staff.

If you have a problem too big for your equipment, or if you need to augment your staff or facility with outside capability, investigate the new CSC Service Bureau. For additional information, contact Dan Mason, CSC Service Bureau Manager. Phone: 678-0592.



CSC

COMPUTER SCIENCES CORPORATION
International Airport, Los Angeles 45, California



Why so many computer users prefer the Control Data 1604/1604-A

...and five reasons why it will pay you to know!

The Control Data 1604/1604-A Computer, demonstrated a leader in a competitive and demanding field, continues to prove its ability to scientists and engineers as the computer to solve their problems, and to management as the computer to help maintain their profit. Here are the reasons why!

RELIABILITY—An unusual history of "uptime" that sets a high standard of performance.

SERVICES—Programming Assistance • Programmer and Operator Training • Programming Systems Improvement • Installation Check Out • Post Installation Assistance • On-Site Customer Engineering.

APPLICATIONS—Real-time, on-line data reduction/data acquisition, large-scale problem-solving, large-scale data processing, biomedical and institutional research, weather prediction, oceanography, petroleum reservoir analysis, and flight simulation.

SOFTWARE—Pert, Cobol*, Codap, Co-op Monitor, Linear Programming, Algol*, Fortran 62, Fortran 63.*

LOW COST—The Control Data 1604/1604-A is available today at an amazingly low cost. With its proven performance, programming systems and services, the Control Data 1604/1604-A offers the most computer for the least dollars spent.

These are the main reasons why so many computer users prefer the Control Data 1604/1604-A. The names of these users are available to you. To learn more about how the 1604/1604-A can solve your computing problems now, contact the Control Data representative nearest you.

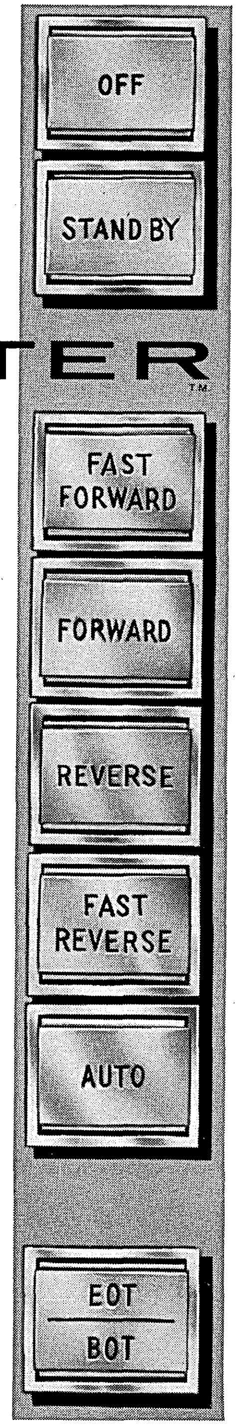
**Available in early 1963*

Offices: Albuquerque • Beverly Hills • Birmingham • Boston • Chicago • Cleveland • Dallas • Dayton • Denver • Detroit • Honolulu • Houston • Ithaca • Kansas City • Minneapolis • Newark • Norfolk • Orlando • Palo Alto • Philadelphia • San Francisco • San Diego • Washington, D.C.

CONTROL DATA
CORPORATION
8100 34th AVENUE SO. • MINNEAPOLIS 20, MINN.

← FOR COMPUTER SCIENCES CIRCLE 5 ON READER CARD

THE POTTER™ MT-120 eliminates program restrictions

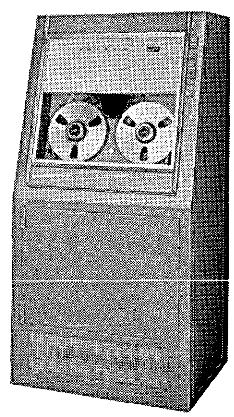


The new Potter MT-120 Magnetic Tape Transport features high performance in a COMPLETELY STANDARD, LOW COST PACKAGE. An evolutionary development of the reliable M906II tape deck, the MT-120 incorporates a patented tape handling system* that eliminates program restrictions. This unique engineering achievement permits Start/Stop, Reverse/Stop or Forward/Reverse operation at up to 200 commands per second and at tape speeds to 120 ips without external program delays.

The MT-120 delivers extremely high data transfer rates. Using the Potter Contiguous Double Transition** High Density recording technique, rates of 1.6 x 10^6 information bits per second are obtained. And with standard 7-channel format, 556 bits per inch are provided at speeds of 120 ips.

To learn more about the MT-120 and its unprecedented 1-year warranty of reliability, write to our Director of Marketing today . . .

**Potter Patent No. 3,016,207*
***Potter Patent No. 2,853,357*
(other patents pending)



POTTER INSTRUMENT CO., INC.
151 Sunnyside Boulevard • Plainview, New York

CIRCLE 6 ON READER CARD

DATAMATION

the automatic handling of information

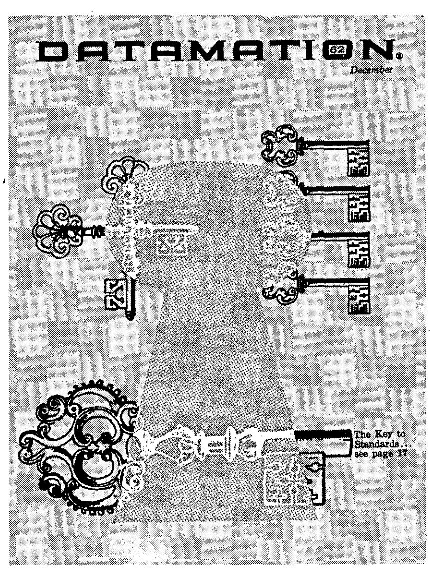
volume 8, number 12

Staff

Feature Articles

Departments

THIS ISSUE— 44,829 COPIES



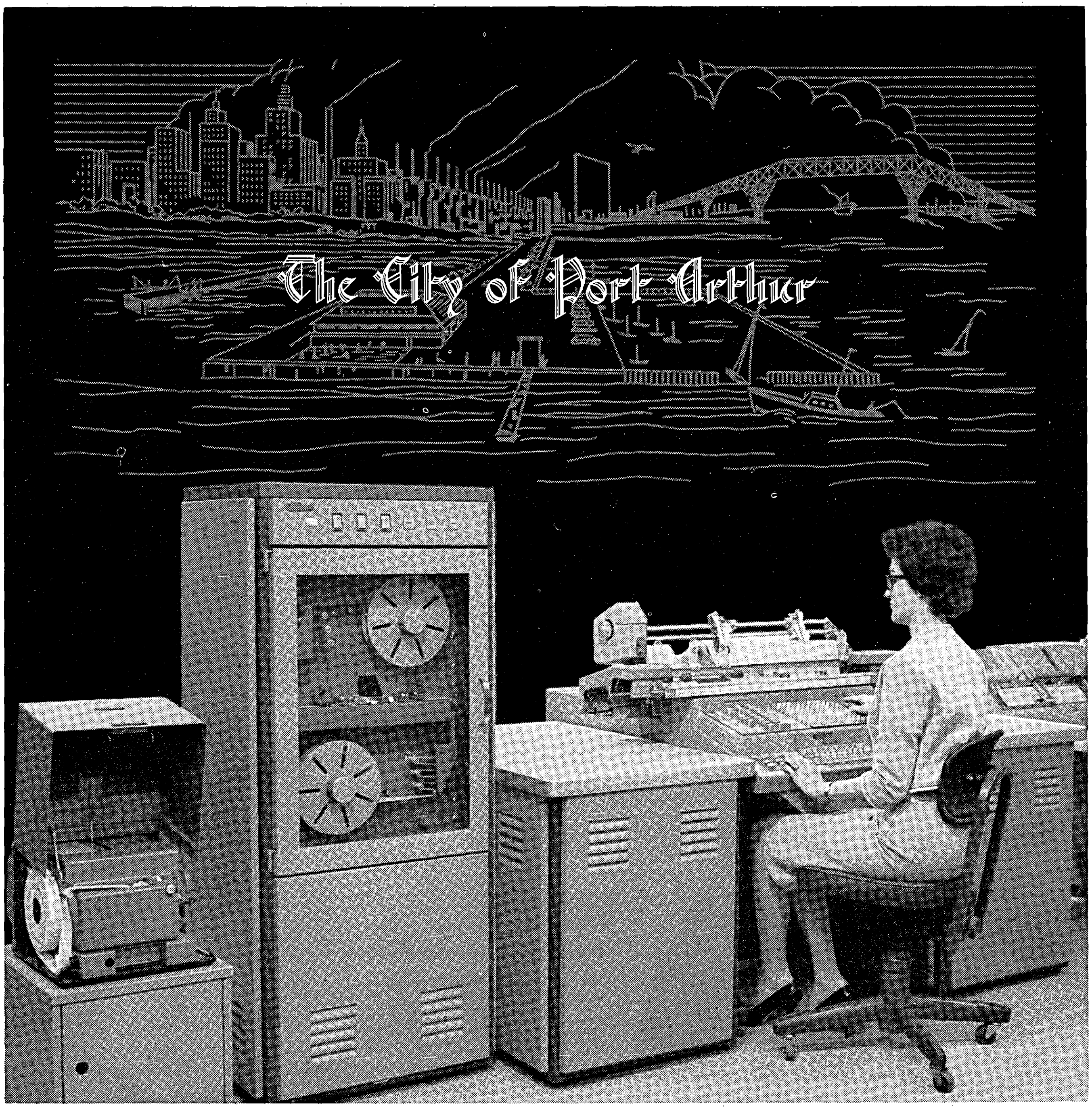
Cover

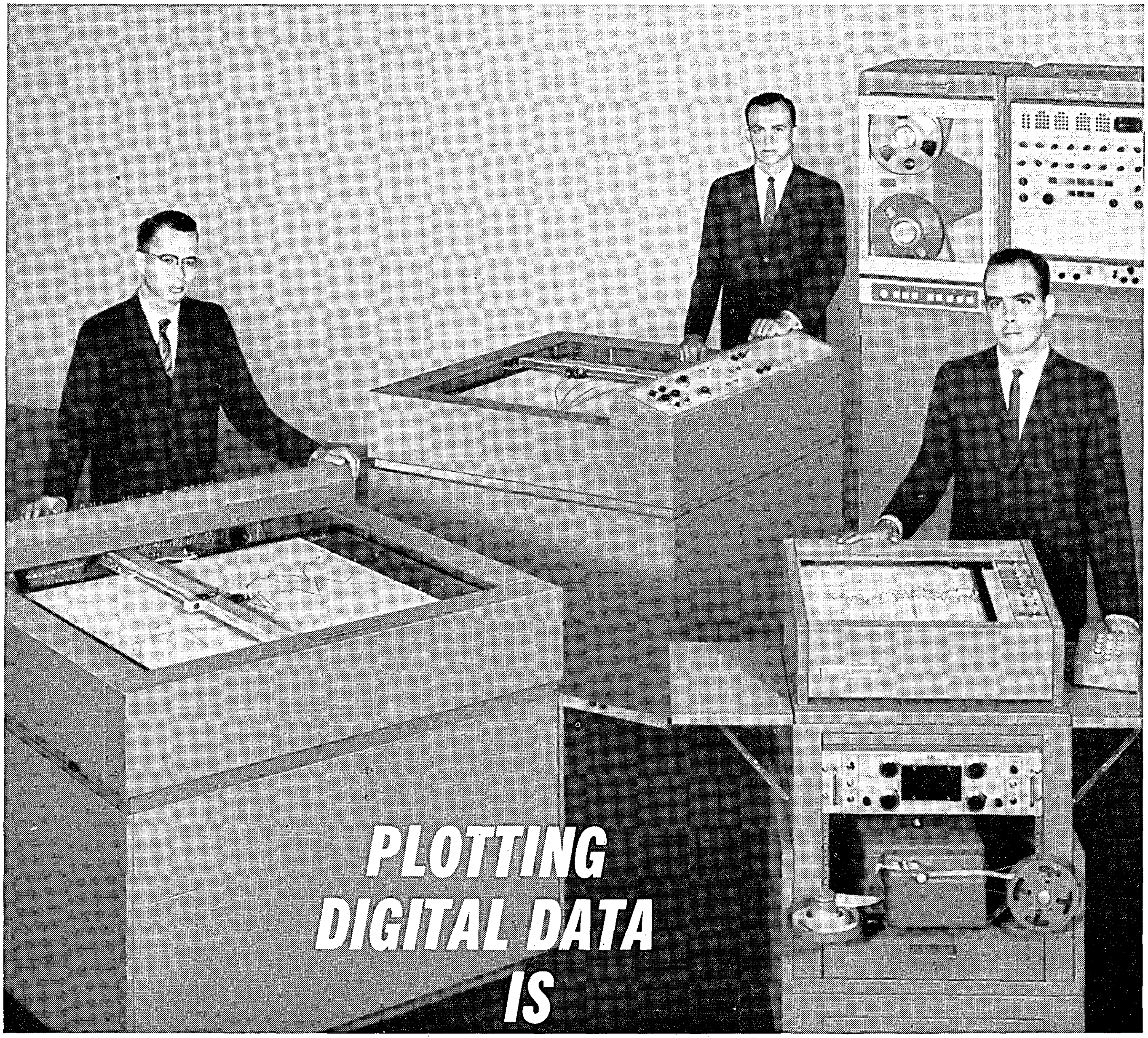
Selection of the appropriate key to standards for the computer industry is the problem that Art Director Cleve Boutell has presented in graphic form for this month's cover. The key that allows the reader to vault the threshold will be found on page 17, via the Editor's Readout.

Circulation audited by Business Publications Audit — BPA

Member, National Business Publications — NBP

DATAMATION is published monthly on or about the tenth day of every month by F. D. Thompson Publications, Inc., Frank D. Thompson, president. Executive Circulation and Advertising offices, 141 East 44th St., New York 17, N.Y. (MUrray Hill 7-5180). Editorial offices, 10373 West Pico Blvd., Los Angeles 64, Calif. (BRadshaw 2-0817). Published at Chicago, Ill. Accepted as controlled circulation at Columbus, O. Form 3579 to be sent to F. D. Thompson Publications, Inc., 201 N. Wells St., Chicago 6, Ill. Printed by Beslow Associates, Inc.


The City of Port Arthur



OUR SPECIALTY

Since 1952, EAI plotting equipment has been applied to a steadily lengthening list of data reduction applications — from simple, manual point plotting to high-speed magnetic tape input contour plotting. Again and again, the flexibility, speed and extreme accuracies of EAI plotters have dictated their selection over competing instruments. □ EAI standard plotters include 11"x 17", 30"x 30", and 45"x 60" boards. Operation can be either off-line from punched cards, punched tape and magnetic tape, or on-line with various computers. Output modes include point, line, symbol, and contour plotting. Plotting speeds up to 4500 line segments per minute can be provided. Reliability is assured by solid-state circuitry and superior mechanical design. □ You can draw upon EAI's wide application and design knowledge by describing your requirements. Write for information, detailing your needs, today.

EAI

ELECTRONIC ASSOCIATES, INC. *Long Branch, New Jersey*

CIRCLE 8 ON READER CARD

important DATES

• The Association of Data Processing Service Organizations will hold a Symposium in San Francisco on January 21. Hotel for the meeting to be announced.

• The IEEE Winter General Meeting, Jan. 27-Feb. 1, will feature special sessions on Artificial Intelligence. The meeting is scheduled for the Statler in New York City.

• The IEEE International Conference on Nonlinear Magnetics will be held at the Shoreham Hotel, Washington, D.C., April 17-19.

• The 1963 Spring Joint Computer Conference will be held May 21, 22 and 23rd at the Cobo Hall, Detroit, Michigan.

• The Fourth Joint Automatic Control Conference will be held at the University of Minnesota, Minneapolis, on June 19-21. Sponsors are the American Institute of Chemical Engineers, IEEE, and American Society of Mechanical Engineers.

• The annual International Data Processing Conference and Business Exposition, sponsored by the Data Processing Management Association, will be held June 25-28, at Cobo Hall, Detroit, Michigan.

• The 1963 ACM National Conference will be held Aug. 28, 29, and 30th in Denver, Colorado.

• The 1963 Fall Joint Computer Conference will be held in the Las Vegas, Nev., Convention Center, Nov. 12-14.

• The Fifth International Automation Congress & Exposition has been scheduled for November 19-21 at the Sheraton Hotel, Philadelphia.

• The 1964 Spring Joint Computer Conference will be held at the Washington Hilton Hotel, Washington, D.C., May 26-28.

• The 1964 ACM National Conference will be held in Philadelphia, Penna., Aug. 25-28.

• The IFIP Congress 65 is scheduled for New York City in May, 1965. It is the first International Congress scheduled for the United States.

This Control Data 160-A peripheral processing package was successfully demonstrated throughout the week of October 22, 1962.

Lower cost, higher off-line output with Control Data's new peripheral processing package

Many users are searching for an inexpensive method for processing an extremely large, daily volume of card and listing operations—one that does not require two, three, even four small-scale computer systems. A single desk-size Control Data 160-A Computer is the answer.

BASIC SYSTEM—The Control Data 160-A Computer can function as an off-line control unit in a processing package which operates four printers at a rate of up to 4000 lines/minute while simultaneously performing card-to-tape operations at the maximum rate of the card reader.

With the Control Data 160-A Computer, the entire process is under continuous program control without the need for an operator at the computer console. All tape-to-printer, card-to-printer pairs will operate continuously as determined by their "ready" conditions. If at any time one pair is receiving operator attention (for instance, changing tape, supplying additional cards, loading paper, or maintaining equipment), the remaining pairs continue to operate. In brief, the peripheral processing package will continue to operate at full capability as long as information exists to be processed.

Here's an inexpensive, efficient, high-speed way to accomplish daily listing without tying up the time and capability of your large-scale computer.

This peripheral processing package features:

- Simultaneous, full-speed operation (up to 4000 lines per minute; single line spacing).
- Operation without console supervision.
- IBM tape format compatibility: High 556 bits/in. and/or low 200 bits/in. densities.
- Automatic parity checking, automatic re-read on parity error (errors indicated on "hard copy").
- Continuous operations—all equipment operating whenever data exists and equipment is "ready."
- High "turn around."
- Blocked or unblocked print records.
- Expandability allows up to eight or more tape-to-printer pairs with simultaneous dual card-to-tape or tape-to-card operations.

EXPANDED SYSTEM—An expanded version of the basic peripheral processing package includes the Control Data 169 Auxiliary Memory Unit. This system allows a combination of any two card-to-tape or tape-to-card operations while driving from one to eight or more tape-to-printer pairs.

From a programming point of view, the expanded system utilizing the auxiliary memory unit can handle blocked print records of any number of lines per print record because of the external buffer channel and additional core storage.

If you need fast, daily servicing of your large-scale computer output, but have been processing this data at the expense of productive computer time, check Control Data's new peripheral processing package. Write today for publication #BR9 (11-62) or contact your nearest Control Data representative.

Offices: Albuquerque • Beverly Hills • Birmingham • Boston • Chicago • Cleveland • Dallas • Dayton • Denver • Detroit • Honolulu • Houston • Ithaca • Minneapolis • Newark • Norfolk • Orlando • Palo Alto • San Diego • San Francisco • Washington, D.C. • Wilmington

CONTROL DATA
CORPORATION
8100 34th AVENUE SO. • MINNEAPOLIS 20, MINN.

letters

solving the knockwurst problem

Sir:

The October, 1962, issue of DATAMATION included an article entitled "The Konscience of a Komputer Konservative," by I. V. Goody. The article was an excellent summary of some of the difficulties in implementing the proper use of computers.

However, the situation at the Konsolidated Knockwurst Kompany became so konfused that even the author, Mr. Goody, lost track of the original problem. The original problem arose when one of the technical people wanted to use a linear program. Toward the end of the article the author states "the technical people refused to use the Kludge on their LP problem" and "were agitating to get a computer of their own."

The real story is that the technical people finally went to the Komputer Konsulting Kompany to get their LP problem solved. The Komputer Konsulting Kompany rents time on its Kludge Komputer, K-9000, at a kost of 0.5 kilobucks per hour plus konsulting fees.

The technical people are happy. They are able to travel back and forth to the Komputer Konsulting Kompany which is located in another city. The financial people are happy. They have their komputer.

H. D. Applequist
Euclid 32, Ohio

algol limitations

Sir:

I differ with Mr. Cantrell in his opinion (DATAMATION, Aug. '62) that the ALGOL character set is too extensive and that it is doubtful that more than half this set will ever be implemented on any computer hardware. Quite the contrary, one of the major limitations of nearly all algorithmic compilers is the *linear* nature of their character set, which instead of being extensive is, in fact, quite restrictive and cumbersome, e.g., the requirement that subscripts or superscripts be written on the same line as the quantity subscripted or superscripted. That such a restriction can be obviated is indicated by the recent announcement of the subscripting-superscripting typewriter-key-punch in use at Los Alamos (Program Announcement WPM 13. 1, ACM Conference, Sept. 1962). I believe that it is not a relatively difficult task to implement — hardware-wise — a more flexible typewriter-like input device that would code an even more extensive (and more useful) character set than that specified in ALGOL.

The point that I am trying to establish is that a good deal of the present concern with the design and structure of compiler language arises from a confusion between hardware and software problems. Consider a device that could either read or print and code an equation in a form closely allied to normal mathematical usage, e.g., a string (but not restricted to *one* line) of operators, operands, subscripts, superscripts, constants, etc. Then most of the *source-language* design problems would disappear — *at least for the user!* In fact, the problem will have been shifted to where it belongs, away from the user and to the designer of the compiler. Thus, in a fundamental sense, the user need is a *hardware* need, i.e., the hardware that would permit a simply structured but highly powerful *operator* language to be effective.

Naturally, the professional compiler writer will be concerned with the sophisticated problems that arise in generating the procedures that are "called for" by the use of "operator-characters," but we have abundant faith that he will rise magnificently to meet his task.

MELVIN KLERER
Hudson Laboratories
Columbia University
Dobbs Ferry, N. Y.

requests for terms glossary

Sir:

Earlier this year a task committee was formed by the American Water Works Assn. for the purpose of updating a glossary of water and sewage control engineering terms. The glossary is under the joint sponsorship of the American Public Health Assn., the American Society of Civil Engineers, the American Water Works Assn. and the Federation of Sewage Works Assns. The last glossary published was dated 1949.

It occurred to me that you would have in your possession some type of a glossary on automation or you would know where I could obtain a glossary which is now in existence. If you do have any information regarding this subject, I would appreciate very much your sending it to me.

V. A. APPLEYARD,
Executive Manager
Chester Municipal Authority,
Chester, Pa.

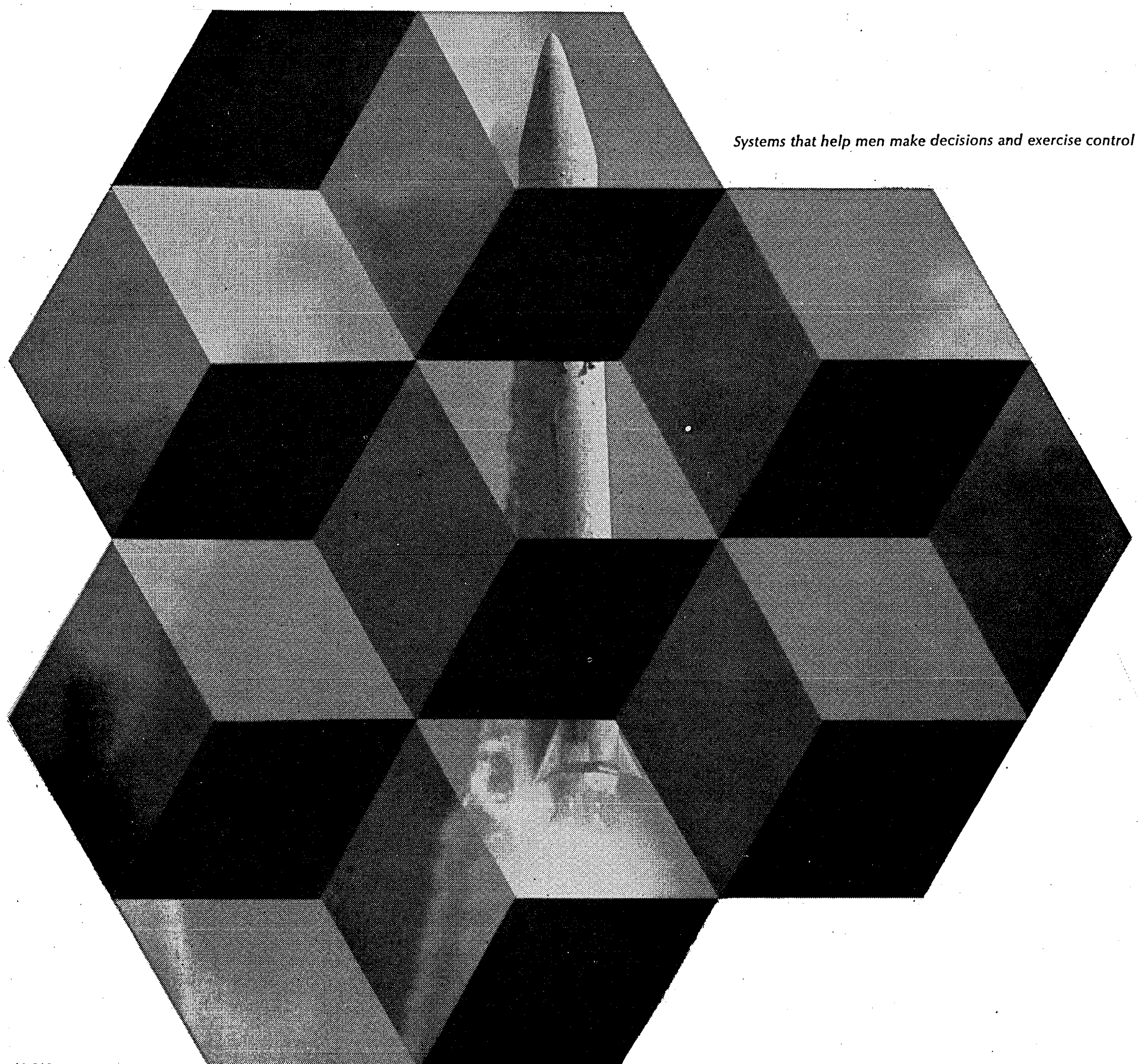
(*Editor's Note:* The preceding letter appeared in the November issue of *Control Engineering.*)

Decision-Making: Hostile or not Hostile?

A few years ago this decision was relatively simple. The action that followed was relatively simple. Today the consequences of this type of decision-making can be enormous, affecting world-wide forces and events. The decision itself may trigger an incredibly complex series of interacting decisions and controls. In making these compressed-time decisions, commanders use man-machine systems which provide information processing assistance. The development of these large systems is the work of scientists, engineers and computer programmers at System Development Corporation. The system is their concern, not the actual design of hardware. Specifically, they contribute in these key areas: defining the requirements of the system, synthesizing the system, instructing the computers within the system, training the system, evaluating the system. Throughout they seek to optimize man-computer relationships and to develop a system which grows and changes with the needs of the decision-makers who use it. Computer programmers, human factors scientists, operations research scientists and systems-oriented engineers interested in joining a close interdisciplinary effort are invited to write concerning new positions in this expanding field. Address Mr. A. D. Granville, Jr., SDC, 2401 Colorado Ave., Santa Monica, California. Positions are open at SDC facilities in Santa Monica; Washington, D.C., Lexington, Massachusetts; Paramus, New Jersey; and Dayton, Ohio. "An equal opportunity employer."

SDC

System Development Corporation



Systems that help men make decisions and exercise control

11-246

CIRCLE 76 ON READER CARD

PROGRESS IS A RELATIVE THING

As generaly recognized, international agreements are the result of long, tedious negotiations. The United States, the country with largest usage, is striving to obtain agreements without overwhelming the other negotiators. The second meeting of the ISO committee TC97 on international information processing was held in Paris on October 17 and 18. After reading the published press release of the session, one has grave doubts that the existing rate of progress is sufficient to give any direction to the domestic field for years to come.

The single accomplishment of note was the "acceptance for comment" of a draft proposal for six and seven bit codes for information interchange (could this be a character set?). The other work was related to a realignment of its sub-committee structure.

The topics under consideration and the countries to whom the computing industry looks for leadership are of interest. The sub-committees now functioning include: glossary, under Netherlands' leadership; character sets and coding, France; character recognition, U. S.; digital data transmission, U. S.; and problem description and analysis, Netherlands.

The United States will host the next meeting in the summer of 1964!

THE IBM FAMILY GROWS

Coming hard on the heels of the 1440 (See DATAMATION, pp. 17 and 76, Nov., 1962) IBM has unveiled its 7010. Allowing for user growth starting with the 1401, moving up to the 1410, and finally to the 7010, the key to this succession is programming compatability for the 7010 with the 1410, and as an optional feature, for most 1401 programs.

Advertised internal processing speeds are up to 3.5 times faster than the 1410 and 2.75 times faster than the 1410 with the "accelerator." This is made possible by means of a 2.4 usec memory cycle and two-character parallel storage access. The system features

a new 1442 card reader, Model 3, which reads 80 column cards at up to 400 cpm. Memory capacity is from 40K to 100K positions of core storage. A typical system will rent for $19,175 monthly and will sell for $945,900. First deliveries are scheduled for the first quarter of 1964.

RECIPROCAL TRADE

Elliott Brothers of London, a manufacturer of NCR 315s in England, is exporting 503s to New York. A New York firm, E-A Industrial Corp., will market the machine in the United States. The machine is single address, has 8K of 3.5 usec core and a variety of I/O devices.

A minimum system rents for $5,500. An average system rents for $13,000. To quote from Elliott's description of the computer: "Input to the 503 is by means of punched tape, generally recognized as the easiest method of recording information."

THE UPS AND DOWNS OF SPERRY RAND

Sperry Rand Corporation reports that although sales for the six months ending Sept. 30 were up, net income dropped to $6,905,492, from $9,695,026 recorded during the same period a year ago. According to S-R president Harry F. Vickers, one of the reasons behind the decline in earnings was the heavy outlay for UNIVAC Division's new line of large-scale computers, now being delivered to customers.

A CORRECTION

Apologies are extended by DATAMATION to the investing public for inadvertently omitting a zero from IBM's net earnings for the first six months of 1961, as reported in the October issue. The figure should have read $100,859,439. To further alleviate the threat of financial pànic, the balance of the figures stated in the DATAMATION news report are correct, as reported to the press by IBM.

(Harold Bergstein, editor of DATAMATION, has staged a remarkable recovery from his September 27 automobile accident, and will return to the helm for the January issue.--Frank D. Thompson, Publisher)

EDITOR'S READOUT

THE KEY TO STANDARDS

Here is a nice non-controversial statement:

> "It is definitely believed that our combiner efforts can achieve an accepted . . . standard glossary of programming terminology as well as a . . . glossary of computer terminology during the coming year."

The statement is dated September, 1960, under the letterhead of the ACM Sub-Committee on Programming Technology (SCOPT).

There are several glossary efforts currently underway. SCOPT held the record for tenure, 26 months. The IFIP crew is working to achieve international agreement. The British have scooped us. Their BSI glossary has been published as a British standard. BEMA is also in the act. Several U. S. corporations and innumerable government agencies are also publishing.

For many months DATAMATION has watched developments aimed at a standard glossary of terms for our field. With great sadness we noted the demise of SCOPT (DATAMATION, November '62, pg. 79). How did it happen? Why did it have to go?

And why worry? We all know what the words mean, don't we? Of course we do. A computer is *"a device capable of accepting, processing, and reporting information."* (IBM glossary.) There must be a million of them in this country, counting the gas pumps. Random access is *"a feature of certain internal memory systems, particularly magnetic drum type."* (Sperry Rand.) Maybe we'd better not leave our definitions to the manufacturers.

Perhaps we could fall back on the last official ACM glossary (1954). We wouldn't learn much about words like "sequence," "index register," or "coded switch," ('cause they aren't there) but we would find a fascinating definition of "time, no charge, non-machine fault" (that's one entry).

How can we possibly communicate in this field (with each other, with the public, and with legislative bodies) without defining our terms? One solution (the *only* one available today) is to have each person append his own glossary to his writings. Thus, each new book in the field contains a glossary in the back. They are all incomplete, of course; some are inconsistent; some are simply funny or fatuous. For the curious, a partial bibliography of glossaries appears on page 19 for ready reference.

Perhaps the full story of the untimely demise of SCOPT will never be told. We have watched the officials come and go. We knew agreement was nearer when we were permitted to view glossary galley proofs. Using these very pages we have encouraged this effort. True, from time to time we have teased a little, or heckled a lot, but we feel that **a standard accepted glossary is the cornerstone of all standardization and the very foundation of continued growth of our industry.** At one time we heard that a date had been chosen and that space in the COMMUNICATIONS was being held for initial publication. We have purposely declined to subvert this venture and have withheld publication of any conflicting definitions.

There are six important steps to establishing a standard glossary: (1) The first draft by a working group; (2) The review and approval by the full committee; (3) The initial publication for general review; (4) The adoption of a date by influential parties when such a glossary should see official use; (5) The revision of the initial publication by an appelate body and the printing of a working glossary; and (6) the mechanism whereby the working glossary is iteratively revised to keep pace with the field.

The now defunct SCOPT committee took 26 months and did not successfully attain the third plateau. Perhaps the fault lay in the voluntary, part-time nature of the endeavor. PARTIAL SUPPORT IS WORSE THAN NONE AT ALL. Perhaps the manufacturers should have used their own agency, taxed themselves, and had BEMA produce it. Perhaps some government agency, non-profit, or philanthropic foundation should be approached to fund an institute for the preparation of such a basic document. ■

It occurred to *Datamation* that perhaps all of our readers do not fully appreciate the breadth and scope of the standards effort in the United States. The computing profession gets credit for many unique and creative concepts. In addition, we take credit for many more.

The material below is abstracted from a Department of Commerce book entitled, "Standardization Activities in the United States," by Sherman F. Booth, Misc. Publ. 230, Supt. of Documents, $1.75, Aug., 1960. We quote from the introduction.

THE U. S. STANDARDS EFFORT

a voluntary and cooperative undertaking

The national technical societies of the United States of America are the very backbone of its standardization achievements. This fact sets our country apart from others wherein the results of standardization stem from a mandatory rather than a voluntary basis.

In this country, there is a standardization society for most all widely known product areas, such as textiles, paper, leather, ceramics, plastics, electrical equipment, rubber, cement, etc. These completely autonomous societies operate from paid memberships and without Government interference. The membership of a society usually consists of persons whose daily activities are concerned with the product area covered by the society, and of representatives of firms doing business in that commodity area. They also attract students, young technologists, and others who seek to enhance their professional stature by being abreast and a part of the standardization work in the area of their choosing.

Meetings are held regularly and subjects for proposed standards are accepted for assignment to committees for consideration. Within a committee there is a free and thorough exchange of ideas, experiences, data, and other information which is educational and broadening to the participants. Thus each person has the benefit of the knowledge of his colleagues.

Standardization does not alone treat with the quality of products although this is frequently of prime importance. It also extends to other fields where it is intended to pursue or adopt a uniform material, method, technique, size, nomenclature, service, etc. Anything or any practice, abstract or concrete, concerning which it is expected to limit, regulate, specify, control — to the degree that it is intended to be habitually compounded, performed, mentioned, observed in an orthodox manner — is a standard even though it may not be documented. This definition suggests the enormous breadth and scope of standardization and the limitless fields in which it may be practiced or undertaken.

Standards are not static. As the rudiments of technological aspects of problems become commonplace, as greater knowledge of the chemical and physical characterstics of products are more widely known and accepted, a committee may again be activated to reconsider and modernize or improve a previously issued standard. Such improvements are regular, frequent, almost routine. There are relatively few documented standards that have never been revised. Thus, standardization agencies find themselves engrossed in the problems of revising standards as well as developing new standards, and to about the same degree. Standardization is dynamic. It must necessarily follow closely upon the heels of science, research, invention, and creation if it is to serve its intended purpose.

Standardization activities of the members of the technical societies are carried forward on an extracurricular basis. Each of the persons in a society who contributes to the development of standards is usually a scientist or technician who is otherwise employed full time. His contributions are frequently made at the expense of his leisure. Accordingly, under this voluntary system, standards development and production are not as great or speedy as one might expect.

Because of the wide latitude in the overall responsibility which the Congress has entrusted to the Bureau, its daily work encompasses many scientific fields. Some of its activities are suggested by the organizational area into which its work is divided: Electricity and Electronics, Optics and Metrology, Heat, Atomic and Radiation Physics, Chemistry, Mechanics, Organic and Fibrous Materials, Metallurgy, Mineral Products, Building Technology, Applied Mathematics, Data Processing Systems, and Radio Propagation. ■

order what you need

A BIBLIOGRAPHY OF GLOSSARIES

A Brief Glossary of Data Processing Terms, by G. D. Roth, 1959, IBM Data Processing Div., White Plains, N. Y.

ACM Committee on Nomenclature, 1957, Association for Computing Machinery, New York, N. Y.

A Dictionary of Documentation Terms, by Frank S. Wagner, Jr., 1960, American Documentation

ADP Glossary, 1961, Interagency Automatic Data Processing Committee, Washington, D. C.

AIEE Subcommittee on Logic and Switching Circuit Theory, 1960, American Institute of Electrical Engineers, New York, N. Y.

Basic IBM Applied Programming Teaching Glossary, by L. Ellsworth, 1960, IBM Data Systems Div., Applied Programming, New York, N. Y.

Bell Telephone Laboratories, Murray Hill, N. J.

Bendix Computer Div., The Bendix Corp., Los Angeles, Calif.

Business Equipment Manufacturers Association, New York, N. Y.

Communications Dictionary, by James F. Holmes, 1962, John F. Rider Publisher, Inc., New York, N. Y.

Computer Applications in the Behaviorial Sciences, Harold Borko, editor, 1962, Prentice-Hall, Inc., Englewood Cliffs, N. J.

Computer Programming Handbook, by Robert Nathan and Elizabeth Hanes, 1962, Prentice-Hall, Inc., Englewood Cliffs, N. J.

Dictionary of Automatic Control, by Robert J. Bibbero, 1960, Reinhold Publishing Co., New York, N. Y.

Electronic Computers: Fundamentals, by Paul von Handel, editor, 1962, Prentice-Hall, Inc., Englewood Cliffs, N. J.

Fundamentals of Digital Computers, by Matthew Mandl, 1958, Prentice-Hall, Inc., Englewood Cliffs, N. J.

Glossary for Data Processing Machines, 1959, IBM Washington Education Center, Washington, D. C.

Glossary for Data Transmission Study Group, by D. E. Hannum, Northrup Aviation, Downey, Calif.

Glossary for Information Processing, IBM Corp., 1962, White Plains, N. Y.

Glossary of Computer and Programming Terminology, by Mandalay Grems, 1960, IBM Corp., Corporate Div., White Plains, N. Y.

Glossary of Computer and Programming Terms, by O. W. Perry, 1959, IBM Corp., Poughkeepsie, N. Y.

Glossary of Computer Engineering and Programming Terminology, by Martin H. Weik, 1957, Ballistic Research Labs., Aberdeen Proving Ground, Md.

Glossary of Computer Terminology, Computer Department, General Electric Co., Phoenix, Arizona.

Glossary of Programming and Computer Technology, by D. L. Mordy, 1960, IBM Data Systems Div., Applied Programming, New York, N. Y.

Glossary of Programming Terms, by M. Bolsky, 1961, System Development Corp., Santa Monica, Calif.

Glossary of Terms, By R. M. Herron, 1960, IBM ASD Div., White Plains, N. Y.

Glossary of Terms in Computers and Data Processing, by Edmund C. Berkeley and Linda L. Lovett, 1960, Berkeley Enterprises, Inc., Newtonville, Mass.

Glossary-Terms Used in Computer Programming and Engineering, by W. O. Bormann, 1960, IBM Data Systems Div., Poughkeepsie, N. Y.

Guide to IBM 1401 Programming, by Daniel D. McCracken, 1962, John Wiley & Sons, Inc., New York, N. Y.

Handbook of Automation, Computation, and Control, Vol. 2, 1959, John Wiley & Sons, Inc., New York, N.Y.

Installing Electronic Data Processing Systems, by Richard G. Canning, 1957, John Wiley & Sons, Inc., New York, N. Y.

IRE Standards on Electronic Computers—Definitions of Terms, 1956, Institute of Radio Engineers, New York, N. Y.

The Language and Symbology of Digital Computer Systems, 1959, RCA Service Co., Camden, N. J.

NOMA Glossary of Automation Terms, 1961, National Office Management Association, Willow Grove, Pa.

Operating System Description Standard Definitions, by Doris Rhine and D. Brandon, 1961, System Development Corp., Santa Monica, Calif.

Pocket Dictionary of Computer Terms, 1962, Howard W. Sams & Co., Indianapolis, Ind.

Programming Business Computers, by D. D. McCracken, H. Weiss, and T. Lee, 1961, John Wiley & Sons, Inc., New York, N. Y.

Programming for Digital Computers, by J. Jeenel, 1959, McGraw-Hill Book Co., New York, N. Y.

Programming for Digital Computers, by M. H. Wrubel, 1959, McGraw-Hill Book Co., New York, N. Y.

Sandia Corporation, Albuquerque, New Mexico.

Share Glossary of Terms, by D. E. Eastwood, 1960, Bell Telephone Laboratories, Murray Hill, N. J.

Systems Design and Programming Terminology, 1960, UNIVAC Div., Sperry Rand Corp., Philadelphia, Pa.

Understanding Digital Computers, by Paul Siegel, 1961, John Wiley & Sons, Inc., New York, N. Y. ■

do you have a watch?

HOW MUCH OF WHAT KIND OF TIME

by E. H. COUGHRAN, Executive Vice President, Advance Data Systems Corp., Los Angeles, Calif.

The 10th Anniversary meeting of the Digital Computers Association was held recently. This event in itself is not likely to change the course of history. It is probably not even necessary for you, if you missed the gala affair, to begin to think up excuses to give your grandchildren for not having attended. The significance of this event lies in the fact that ten years ago it was possible to gather most of the world's supply of those men and women knowledgeable in the use and application of computers into one medium-sized dining room. As everyone is aware, the computer and data processing business has proliferated at a rabbit-dizzying rate. That there are N new jobs in an industry that barely existed ten years ago, or that there are current needs for M new mathematicians and programmers are well publicized, if poorly understood, numbers.

I would like to direct my attention to a smaller group of men who will have a profound effect on the next five years of data processing. I am addressing the executives who have top-level responsibility for information and data processing.

It should be fairly obvious that the 30 or so people who made up the early DCA could not possibly fill a hundred times that many executive positions even if they were all so inclined. Most of the executives charged with responsibility for data processing have a sincere interest in learning what kind of bear is on the other end of the tail. Since data processing is primarily a service, it is measured in hours — but what kind of hours and what do they mean.

To gain some perspective and back away from the "microsecond mumbo-jumbo" that frequently surrounds computing or data processing systems, let us consider the system as a piece of productive machinery. (Ignoring for purposes of this article whether it is appropriately or profitably employed).

First, it should be recognized that the data processing system is probably its own best customer. Just as an electric generating plant uses 25 - 30 per cent of the power generated to run its own boiler-water feed pumps, forced and induced draft fans, and other auxiliary equipment, about 25% of the usable time of a data processing system is consumed by assembling, compiling, debugging, and program checkout necessary to support the system and keep it running smoothly. This is not necessarily bad or a symbol of poor performance; it is frequently a very healthy symptom, but should be evaluated in each installation and over a period of time.

An even more difficult task is to measure the actual productive use of the system. In one fairly exhaustive study, an average of only 75% of the elapsed time between pressing the start button and the end-of-job-halt was the system or any of its components actually in operation. Twenty-five percent of the supposed production time was spent in manual intervention: manual input, card or tape handling, readying units or error analysis. This area of actual operational techniques and the efficiency of use of an expensive piece of equipment may well be a fertile area for cost cutting.

Almost all EDP installations operate on a "service center" principle. That is to say they charge their customers for services rendered at some appropriate rate. The usual basis for charges is equipment hours required to perform a given job at a rate that will amortize the expenses of the service center. With the exception of the independent service bureaus who strive to make a profit, most installations establish charges that will wash out expenses. Under the service center concept, it is important that charges be consistent between different customers and different runs of the same job.

Since systems hours form a basis for charges (and, incidentally, for equipment rental payments), the need for accurate time recording should be obvious. This is especially true since system hours may cost up to $450 each for equipment rental alone. Other costs will approximately equal the rental.

It should come as no great shock that time records kept manually are subject to error. In this case, the errors that are most expensive are not the occasional mistakes of incorrect logging, but those of correct logging done too late!

The actual system use time terminates with the end-of-job-halt and not at the time the operator completes removing tapes or returns from his coffee break. The job time and accumulated usage records should reflect this fact. I am not suggesting that the operator be prohibited from a cup of coffee, a trip to the rest room, operating several pieces of equipment simultaneously, or any other activity that might preclude his being in front of a particular machine, job card in hand, at the precise millisecond that the machine reaches an end-of-job-halt. In fact, this is not the operator's primary responsibility. He is charged with production of the jobs scheduled to be done on his shift.

Time totalizers of several types are available which will automatically accumulate usage time. On the more sophisticated end of the scale are real time clocks that keep time in milliseconds, can be addressed by the computer, and can be used as interval timers either by repeated access or by initiating a trap.

These time totalizers normally appear to the system as a data channel or tape drive. The computer can then keep job time statistics. One other interesting use for this type of totalizer is on iterative calculations. The programmer is requested to estimate the time to a solution. The monitor keeps track of the elapsed time and where the actual time exceeds the estimate, non-convergence is assumed and the job stopped. This procedure encourages more accurate and honest estimates of solution time, hence better data for use in scheduling.

Less sophisticated and considerably less expensive are totalizers that can sense whether the computer is in operation, and accumulate such time. These can be as simple as a one display totalizer which accumulates system usage time. Other versions have one totalizing dial for each piece of equipment in a system to record usage on individual components. A five display totalizer could record usage on main frame, reader-punch, printer and each of two tape units on an IBM 1401. Another version of a simple totalizer has three displays, one each for System Time, Job Time and Elapsed Time. The System Time display records cumulative system usage time. The Job Time display records system usage time and has a reset knob so that system use time for an individual can be read directly. The Elapsed Time display runs at all times and is also equipped with a reset knob so that total elapsed time for a particular job is directly available.

In between these extremes are several printing or strip chart recording types of time totalizers.

The simplest types of totalizers in most cases pay for themselves in a few weeks. The major source of savings stems from the fact that the totalizer does not start accumulating time until the start button is pressed, and stops accumulating time automatically when the end-of-job-halt occurs. Automatic accumulation of usage time in hours and hundredths cannot help but be more accurate than reading the clock on the wall. And inaccuracy can cost money! One minute lost between the end-of-job-halt and the operator's returning to log out, plus one minute error in reading the clock on the wall due to parallax, occurring three times a day, could cost a customer as much as $900 in payment for apparent computer usage or enough to rent an additional tape drive. Just as in any other business activity, good records are a prerequisite to good and effective management control.

One final subject needs to be mentioned. This is the definition of what constitutes "usage" time. The significance of this definition may well be expressed in terms of a thousand dollars per month or more. The basic monthly rental paid to the manufacturer supplies you, the customer, with some number of hours worth of "usage" which shall be made available to you (normally 176). This obviously excludes maintenance, both scheduled and unscheduled, since during maintenance the equipment is not available for your use.

There is a sometimes emotionally charged situation where the system is defined to be "in use," but is not actually in operation. The definition of the several circumstances vary as widely within the several manufacturers as between them. It would be well to examine and specify what type of time is defined as use or non-use, by your people and by your manufacturer. Because of the wide variation in definition, there is frequently some manual switch manipulation necessary to record time that is used as a basis for rental payments. For guidance in your installation, check with your manufacturer and your fellow users.

To the original members of DCA these questions of how much of what kind of time should be used, charged or paid for, are much as they were ten years ago. There are simply more installations of more expensive computing systems and, hence, more executives charged with evaluation. The encouragement I would give you today is that things are better and easier today than in the good old days — mistakes are just more expensive. ■

A KLUDGE KOMPUTER LEXIKON

by KARROL KORLUTH, Kludge Komputer Korporation

With the advent of the large scale Kludge Komputer and recognizing the need for all of the personnel working with the Kludge to be able to understand each other, the Kludge Komputer Korporation, at great time and expense, has compiled a lexikon of komputer and komputer programming terms for those who feel the need for it. The following are selected excerpts:

ACCESS TIME — The years between 1936 and 1945 in Germany and Italy.

BIT — (1) Part of a horse's bridle. (2) 12½ cents. (3) Past tense of bite.

BOOTSTRAP — A leather thong. If put into a machine, BOOM.

CHECK — Used if you have no credit cards.

CIRCULATING MEMORY — A visiting professor.

CODE — A sickness for which, at the present time, there is no cure.

CONDITIONAL JUMP — A suicide pact.

CONSOLIDATION — Making two programs do the work of two programs.

D.C. DUMP — The garbage disposal location in the city of Washington.

FEEDBACK — What is gotten if you sneeze while eating soup.

FIVE DIGIT MULTIPLIER — One hand.

FLOW CHART — A liquid graph.

HEAD — Upper part of the body. Used occasionally by programmers.

JUSTIFICATIONS — Blaming errors on the keypunch operators.

LOGICIAN — One who meditates on the facts and arrives at conclusions already self-evident.

MANAGEMENT CONSULTANTS — Former owner of a bankrupt business who now advises others how to succeed in the same line of business and charges exorbitant fees.

METHODS ANALYST — One who makes plans for installing a computer which will be replaced in two years by one bigger and faster.

OPERATIONS RESEARCHER — One who does the least work in the longest time in order to figure out how to do the most work in the shortest time.

PARITY CHECK — Money given to farmers by agriculture dept.

VERSATILITY — The ability of a programmer to recite Shakespeare while drawing flow charts. ■

match and merge

GENERALIZED INFORMATION RETRIEVAL AND LISTING SYSTEM

by JOHN A. POSTLEY[a] and T. DWIGHT BUETELL[b]

The ability of modern data processing equipment to maintain a number of different files of information on magnetic tape has been widely exploited and currently represents one of the major contributions of this equipment to engineering and business information systems. A variety of tens or perhaps hundreds of such files in a single company is the rule rather than the exception.

Such files might encompass the areas of engineering, personnel, inventory, and accounting. Since the requirement for these files arises in such a variety of areas of company operation, to require that the files be of identical format and form is likely to be inefficient both from the standpoint of the functional requirements of the files and the programming effort involved in creating and maintaining them. In most cases, different people and even different computer programming organizations are responsible for the creation of files and so the administrative problem of coordinating these activities to produce a single compatible format may be substantial.[4]

At the same time, the requirement to retrieve information and produce reports from this variety of files is an important one. Typically, this problem has been approached by writing a separate computer program for each required report. This is adequate though costly for periodic reports, but woefully inadequate for the large number of one-time working lists which are needed on a timely basis. Report generators have been applied to the problem, but in general they show serious shortcomings in their capabilities for reading tapes of uncontrolled format and for selection by complex criteria of information for the desired reports.[3]

In recognition of this problem, a Generalized Information Retrieval and Listing System (GIRLS) has been developed and is now operational. The System has the capability to prepare reports in a wide range of formats according to any request criteria from any file. A large number of reports can be produced in a single pass of a given master file, each based on different request criteria and each in a different report format. The value of the System in terms of eliminating the requirement for special retrieval and reporting routines is increasingly evident as it is operated in computer installations containing a variety of such magnetic tape files.[1]

In an article published in the Journal of the ACM[2], W. C. McGee has recognized that the technique of *generalization* is the key to reducing costs in such situations. He notes that the related operations of *file maintenance* and report *generation* are especially important in this regard. But while such systems as McGee's were a major step toward generalization, the techniques described in this paper represent a significant further improvement.

Specifically, GIRLS contains the means to identify and describe *types* of existing fields of any length which might be contained (any number of times) in a *type* of record, rather than a description of existing records in terms of the number of characters in a field; and it enables the processor to locate these fields by providing the means to find the relative location of the initial such occurrence, rather than the actual location of the field in the record.

Thus, since GIRLS identifies and locates fields and records entirely independently of the format and con-

[a]Executive Vice President, Advanced Information Systems, Inc., 3002 Midvale Avenue, Los Angeles 34, California.
[b]Group Engineer, Missiles Computing Engineering Section, Missiles and Space Systems Division, Douglas Aircraft Co., Inc., Santa Monica, California.

tent of the file itself, it can be employed with existing files of format variable not only among types but within a given type as well.

There are three basic requirements for the operation of the System. The first is that the requests of managers, engineers, or accountants be described in the prescribed request format; these requests identify the criteria for selection of information from file records and identify the content and form of each report desired. The second requirement is a magnetic tape dictionary for each file, defining the structure, format, and size of the records in that file. The final requirement is the computer program.

The *request form* is prepared by the person desiring the printed report. It contains two kinds of information; the search criteria necessary to identify the records required, and the report specifications which describe the content and format of the desired printed report. Either the search criteria or the report specifications or both may deal with any of the data fields in the files. The System checks this information for consistency and completeness before processing is carried out.

Figure 1

INFORMATION RETRIEVAL REQUEST MEMO, PAGE 1

DO NOT WRITE IN THIS BOX
REQUEST # 1 (GANG)

TO: MISSILES COMPUTING ENGINEERING SECTION, A2-260

A FROM: I. M. CASANOVA, PERSONNEL MANAGER

B SUBJECT: CLASSIFIED PERSONAL PERSONNEL REPORT

C

D PLEASE SELECT, FROM THE PERSONMASTER FILE, ALL ITEMS THAT MEET THE FOLLOWING REQUIREMENTS:

	SECTION	ROW	COLUMN	THE FIELD NAMED -	FIRST X DIGITS	IS - - - -	ONE OF THESE VALUES.
E	1	1	1	SEX		EQ	F
AND							
E	1	1	2	AGE		GT	18
AND							
E	1	1	3	AGE		LE	26
AND							
E	1	1	4	WEIGHT		LT	140
AND							
E	1	1	5	MARITAL STATUS		EQ	SINGLE) DIVORCED
AND —							
E	2	1	1	HAIR		EQ	BLONDE) YELLOW) PLATINUM
AND							
E	2	1	2	EYES		EQ	BLUE) GREEN
AND							
E	2	1	3	BUST		GE	36

INFORMATION RETRIEVAL REQUEST MEMO, PAGE 1 — *Continued*

DO NOT WRITE IN THIS BOX
REQUEST # 1 (GANG)

TO: MISSILES COMPUTING ENGINEERING SECTION, A2-260

A FROM:

B SUBJECT:

C

D PLEASE SELECT, FROM THE FILE, ALL ITEMS THAT MEET THE FOLLOWING REQUIREMENTS:

	SECTION	ROW	COLUMN	THE FIELD NAMED -	FIRST X DIGITS	IS - - - -	ONE OF THESE VALUES.
E	2	1	4	WAIST		LE	24
AND							
E	2	1	5	HIPS		EQ	35) 36) 37) 38
- OR -							
E	2	2	1	HAIR		EQ	BRUNETTE) BLACK
AND							
E	2	2	2	EYES		EQ	BROWN
AND							
E	2	2	3	HEIGHT		LT	5-7
AND							
E	2	2	4	JOB CLASSIFICATION	3	NE	ENG) PRO) DES) ANA) RES
AND							
E	2	2	5	BANK BALANCE		GE	50000
- OR -							
E	2	3	1	HAIR		EQ	RED

The search criteria are provided by the requestor in a portion of the memo request format, Fig. 1. For each such request the requestor designates the name of the particular data fields to be examined, the specific values or ranges of values of those fields for which a report is required, and the logic which relates these values to those of other fields in the same record. In addition to four levels of "and/or" logic, the desired values are further defined by the specific operators: "greater than," "greater than or equal to," "less than," "less than or equal to," "equal to," and "not equal to." The System processes this information ultimately to select from the master file the appropriate items for the report.[5]

The report prepared by GIRLS is completely specified by the requestor in the remaining portion of the same request memorandum, Fig. 2. Here, the requestor designates the proper information to retrieve for the report and the format of the report itself. The report format is automatically composed by the System according to the framework specified by the requestor. In those cases where the information which must be printed exceeds the width of a single page, the report columns are automatically "folded" to accommodate any required number of columns of information.

The System sorts information for each report in the specified reporting order without regard to the original sequence of the file. Any appropriate data may be designated for summarization during the report preparation operation in terms of major, intermediate, or minor total levels. The system has the capability to print or suppress the printing of indicative data. It automatically provides standard column headings for each data field which may appear on a report; such headings will appear at the top of appropriate columns without the need for their identification by the requestor.

In the event that a report requires non-standard column

Figure 2

INFORMATION RETRIEVAL REQUEST MEMO, PAGE 2

DO NOT WRITE IN THIS BOX
REQUEST # 1 REPORT # 1 (GANG)

F REPORT SUBTITLE: ALPHABETIC LIST

G

CHECK BELOW ONLY IF OPTIONAL FEATURES ARE DESIRED:

H ☐ ELIMINATE DUPLICATES ☐ COUNT DETAIL ITEMS ☐ PRINT SUMMARIES ONLY 2 ✓ DOUBLE SPACE 3 TRIPLE SPACE M MULTIPLE ENTRIES ON ONE LINE ☐ PUNCH CARDS 0 14 WIDE 11 1 11 WIDE 8½ 2 ✓ 8½ WIDE 11 0 VELLUM 1 SINGLE COPYBOND 2 2 COPIES 3 4 COPIES

ENTER BELOW THE DETAIL LINE FORMAT FOR THIS REPORT

	SEQUENCE LEFT-TO-RIGHT	FIELD NAME	NON-STANDARD COLUMN HEADING LINE 1	LINE 2	PART OF SORT KEY	NEW PAGE ON CHANGE	SUPPRESS PRINTING ON NO CHANGE	CONTROL TOTAL LEVEL	SUMMARIZE THIS FIELD	OCTAL PRINTOUT	INSERT EXTRA BLANKS AFTER THIS FIELD	DECODE FROM K-TABLE *
J	1	NAME			✓							
J	2	DEPT										
J	3	PHONE NUMBER										
J	4	HAIR COLOR										
J												
J												
J												
J												
J												

INFORMATION RETRIEVAL REQUEST MEMO, PAGE 2

DO NOT WRITE IN THIS BOX
REQUEST # 1 REPORT # 2 (GANG)

F REPORT SUBTITLE: ARRAY BY BANK BALANCE,

G WITH TOTAL BANK BALANCE FOR EACH HAIR COLOR

CHECK BELOW ONLY IF OPTIONAL FEATURES ARE DESIRED:

H ☐ ELIMINATE DUPLICATES ✓ COUNT DETAIL ITEMS ☐ PRINT SUMMARIES ONLY 2 ✓ DOUBLE SPACE 3 TRIPLE SPACE M MULTIPLE ENTRIES ON ONE LINE ☐ PUNCH CARDS 0 14 WIDE 11 1 11 WIDE 8½ 2 ✓ 8½ WIDE 11 0 VELLUM 1 SINGLE COPYBOND 2 2 COPIES 3 4 COPIES

ENTER BELOW THE DETAIL LINE FORMAT FOR THIS REPORT

	SEQUENCE LEFT-TO-RIGHT	FIELD NAME	NON-STANDARD COLUMN HEADING LINE 1	LINE 2	PART OF SORT KEY	NEW PAGE ON CHANGE	SUPPRESS PRINTING ON NO CHANGE	CONTROL TOTAL LEVEL	SUMMARIZE THIS FIELD	OCTAL PRINTOUT	INSERT EXTRA BLANKS AFTER THIS FIELD	DECODE FROM K-TABLE *
J	1	HAIR			✓		✓	✓				
J	2	BANK BALANCE			✓				✓		12	
J	3	NAME			✓							
J	4	BUST	MEAS									
J	5	WAIST	UREM									
J	6	HIPS	ENTS									
J												
J												
J												

headings, these may be specified by the requestor and they will automatically be substituted for the standard headings in this report. Several report formats may be specified simultaneously for any particular retrieval request.

The *dictionary* maintained on magnetic tape contains an entry for each file with which the system deals. The entry for each file is divided into three sections: the file section, the record section, and the symbol section. The file section of the dictionary describes the physical records on tape with respect to: tape labelling, whether they are fixed or variable in length, whether the data is grouped or ungrouped, whether the data is packed or unpacked, and the actual length of the physical record, if fixed, or an upper bound on it, if variable.

The record section of the dictionary contains information about each type of logical record in the file; e.g., the means of identification of the logical record type, and the length, if fixed, or the parameters necessary to compute the length, if variable, of the record type. The symbol section of the dictionary contains information about the data fields (symbols) in each record type: that is, the standard column headings for the report, the length of the fields, the form of the data in each symbol (binary, decimal, etc.), justification (right or left), the relative address in the logical record, and the record types in which each field appears.

Figure 3

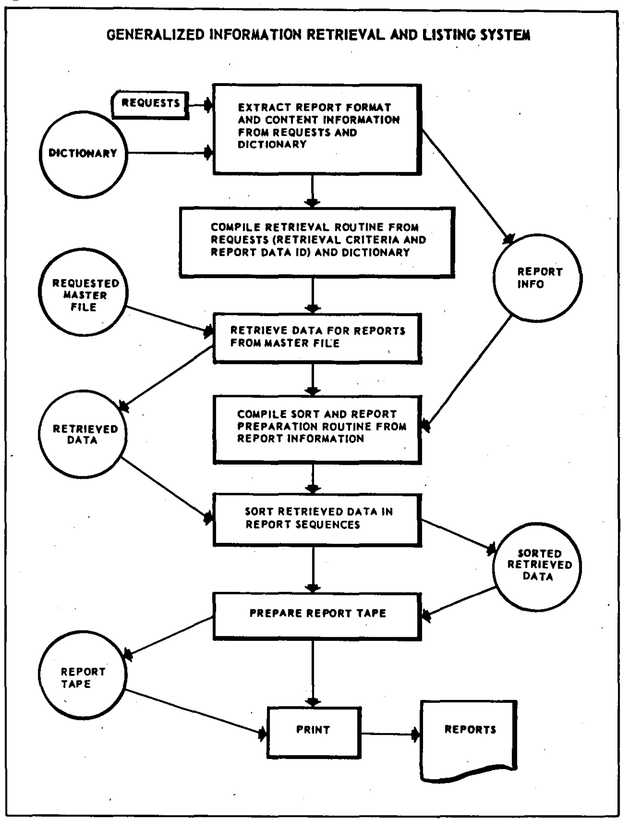


Figure 3 depicts the basic functions of the *GIRLS program*. In operation, the System reads the dictionary and the request specification into the computer and compiles a separate retrieval routine for each request. The master file to be searched is read, one record at a time, and each routine compares the search criteria of its request with the record. When the criteria of a request are satisfied, the routine extracts the data fields required for preparing the report and writes them on a report tape, one record per report. When all of the retrieval routines have been executed, the program proceeds to the next record. The complete file is examined in this fashion. Then the System compiles the sort and report preparation routines according to the report criteria.

Next, the retrieval data are sorted to separate the several reports and to sequence each one as specified in the corresponding request. One or more reports for each request are then listed according to the remaining report specifications. Minimum running time, including compiling, for this "load and go" system, is given by the sum of the times required to pass the master file, sort the report tape, and print. In many applications, this time is reduced to the time to pass the master file from which information is sought, since sort and print times are negligible.

The contents of the master files upon which the System can operate cover a broad range of information. Engineering files might include a file of drawing number data, a part number cross reference file, a bill of materials file, a next assembly file, a file of weights and centers of gravity for each part number, and many more. Personnel files might include a file of labor hours expended for each shop order, a labor accounting file, a file of labor projection data, etc.

Inventory files might include a file of inventory balances, a file of inventory requirements and the procurement status of items, a file of item cost in various quantities, a file of vendor names and data for each part number, and so forth. Accounting files might include any number of journals, a general ledger file, a payroll file, a file of budget information reflecting actual vs. programmed costs, and a variety of subsidiary records.

Use of the program can be illustrated by an example, although it should be realized that a single example does not demonstrate all of the capabilities of the program.

This is the case of I. M. Casanova, a young personnel manager who wants to search the personnel file to select suitable feminine companionship. In general, he is looking for records that describe a person who must be 1) a girl, and either 2a) a shapely blond, or 2b) a wealthy brunette, or 2c) any redhead. His exact requirements are shown on the sample load sheets, Figures 1 and 2, and are explained below.

Mr. Casanova benefits from the fact that the extra cost of preparing these personal reports will be insignificant because it is to be expected that the System will be simultaneously used to prepare other reports such as a skills survey, a plant telephone directory, and the biographies of all PhD's in the research department for use in a contract proposal.

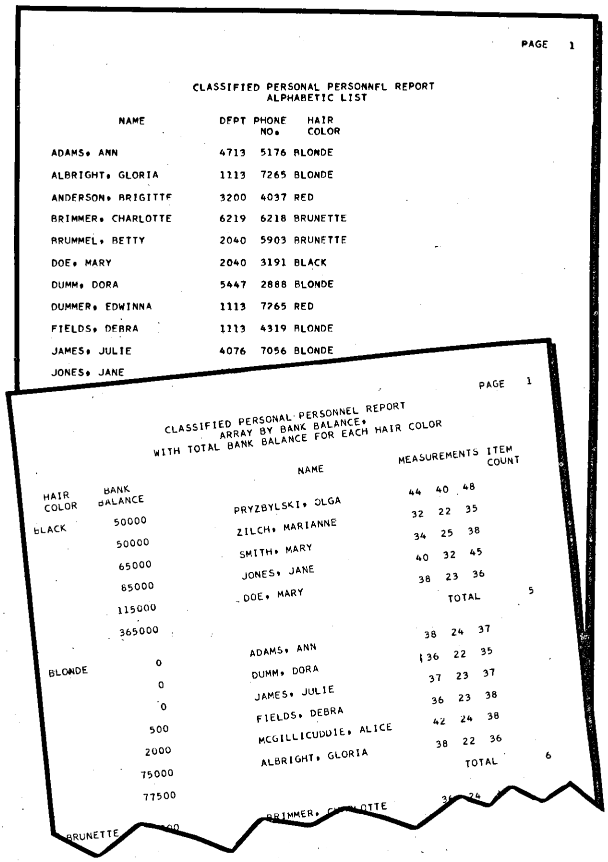
Casanova has no experience with computing or load sheets. All he knows about the System is that its title suggests that it might be useful to his present purpose. He is guided by a User's Manual which is written in layman's language. It describes the magnetic tape file he will use, in terms of file identification, and the field names and their contents. It also gives simple instructions for filling out the load sheets. By following the instructions, Mr. Casanova will find that his search can be accomplished using the four-level logic described below, see Figure 1.

1. Highest level
   Groups of entries with different "section" numbers (first column on the page) will govern selection on an "and" basis, e.g., selected records must meet the requirements for sex, age, etc., *and* also for hair, eyes, etc.
2. Second level
   Sets of entries with the same "section" number but different "row" numbers (second column on the page) will govern selection on an "or" basis, e.g., all requirements for blue eyed blondes must be met, *or* all requirements for brown eyed brunettes must be met, *or* the single requirement for redheads must be met.
3. Third level
   Entries with the same "section" and "row" numbers but different "column" numbers (third column on the page) will govern selection on an "and" basis, within the higher level limitations, e.g., hair must be blonde or yellow or platinum *and* eyes must be blue or green, etc.
4. Lowest level
   All of the values of a particular field that have

the same "section-row-column" number will govern selection from that field on an "or" basis, e.g., hair must be blonde *or* yellow *or* platinum.

To facilitate his use of the retrieved data, Casanova has requested two reports, as specified in the load sheet memo, Figure 2. The entries on each report will be a list of the records selected. The fields that are printed are not necessarily those used for selection. Parts of the printed reports are shown in Figure 4.

Figure 4



PAGE 1

CLASSIFIED PERSONAL PERSONNFL REPORT
ALPHABETIC LIST

NAME	DFPT	PHONE NO.	HAIR COLOR
ADAMS, ANN	4713	5176	BLONDE
ALBRIGHT, GLORIA	1113	7265	BLONDE
ANDERSON, BRIGITTE	3200	4037	RED
BRIMMER, CHARLOTTE	6219	6218	BRUNETTE
BRUMMEL, BETTY	2040	5903	BRUNETTE
DOE, MARY	2040	3191	BLACK
DUMM, DORA	5447	2888	BLONDE
DUMMER, EDWINNA	1113	7265	RED
FIELDS, DEBRA	1113	4319	BLONDE
JAMES, JULIE	4076	7056	BLONDE
JONES, JANE			

PAGE 1

CLASSIFIED PERSONAL PERSONNEL REPORT
ARRAY BY BANK BALANCE,
WITH TOTAL BANK BALANCE FOR EACH HAIR COLOR

HAIR COLOR	BANK BALANCE	NAME	MEASUREMENTS	ITEM COUNT
BLACK	50000	PRYZBYLSKI, OLGA	44 40 48	
	50000	ZILCH, MARIANNE	32 22 35	
	65000	SMITH, MARY	34 25 38	
	85000	JONES, JANE	40 32 45	
	115000	DOE, MARY	38 23 36	
	365000		TOTAL	5
BLONDE	0	ADAMS, ANN	38 24 37	
	0	DUMM, DORA	36 22 35	
	0	JAMES, JULIE	37 23 37	
	500	FIELDS, DEBRA	36 23 38	
	2000	MCGILLICUDDIE, ALICE	42 24 38	
	75000	ALBRIGHT, GLORIA	38 22 36	
	77500		TOTAL	6
BRUNETTE		BRIMMER, CHARLOTTE		

The specific computer program described herein is presently considered to be a proprietary item, but the system concept has been utilized to produce an essentially similar operating program for a different computer system.

The System's ability to prepare reports from any magnetic tape file removes the requirements for special routines to produce the variety of reports which are the essential outputs of engineering and business information systems. The applicability of the logic of this system to any magnetic tape, magnetic disc, magnetic card, film, or similar file, suggests that further development will produce a completely general solution to this type of information storage and retieval problem. ■

REFERENCES

1. R. M. Hayes: *Information System Design: Tools, Elements, Theories,* John Wiley, to be published.
2. W. C. McGee: "Generalization: Key to Successful Electronic Data Processing," JACM, January, 1959.
3. J. S. Morison: "Information Retrieval Experience," presented at IBM Aircraft & Missile Information Retrieval Seminar, March 8, 1961.
4. J. A. Postley: *Computers and People,* McGraw-Hill Book Co., N.Y., 1960.
5. L. Wheaton Smith: "Information and Transformations on General Arrays," presented at 16th Annual Meeting of ACM, Sept. 5-8, 1961.

NEW COMPUTERS FOR AEROSPACE OPERATIONS

Four new pieces of computer hardware for aerospace applications were displayed at the American Rocket Society's 17th Annual Meeting and Space Flight Exposition, held at the Pan Pacific Auditorium, Los Angeles, in November.

Ranging in weight from 19 to 88 pounds, the subminiature computers shown were: the Burroughs D210; Honeywell's "Pico;" the Librascope L-90; and the UNIVAC ADD-1000 thin-film computer. In addition, Burroughs also displayed, in scale-model form, its military-oriented, modular D800 series.

Main feature of the Burroughs D210 is its variable clock, which permits a clock rate of from 1 KC to 100 KC. Representing the first model of a class of subminiature machines, the D210 weighs in at about 19 pounds, and has a volume of .25 cubic foot. The storage consists of 256, 24-bit words of destructive data memory, and 4096, 16-bit words of non-destructive program memory.

At the clock rate of 100 KC, add and subtract time is 30 microseconds; multiply, 570 microseconds, and divide, 640 microseconds. Advertised MTBF is 47,000 hours.

Storage capacity of the Honeywell Pico can be expanded from a basic 3,072 words (24 bits) to 8,192 words, by stacking additional memory planes vertically. The memory planes are enclosed in a separate sealed case which plugs into the computer.

Add cycle of the Pico, including access time, is 12 microseconds. Multiply time is 242 microseconds, and division 606 microseconds. Weighing 20 pounds, the computer has a volume of 700 cubic inches. Operating power required is 46 watts.

The Librascope L-90 utilizes semiconductor microcircuits, resulting in a part count reduction of from 6800 components to less than 1200, and allowing the computer to be built on a modular "building-block" concept. Basic add time to the L-90 is 7 microseconds; multiply time is 105 microseconds and division time 203 microseconds.

The memory unit contains 8192, 28-bit words, with allowance for expansion using any number of individual 512-word modules. Scratch pad and I/0 data storage section consists of 260, 28-bit words on eight glass delay lines. This capacity may be doubled. The L-90 operates at a 20-megacycle clock rate, weighs 20 pounds, and occupies 0.3 cubic foot.

Utilizing a thin-film memory, UNIVAC's ADD-1000 contains 6656, 24-bit words of permanent and 256, 24-bit words of variable storage. Typical instruction times are 12 microseconds for an add and 9 microseconds for a transfer. Extended sequence commands such as multiply and divide are programmed.

The ADD-1000 computer, including case, I/0, and power supply weighs 88 pounds, occupies 1.3 cubic feet and dissipates 262 watts peak. Reliability is estimated at 10,000 hours. Other computers in the 1000 family are the ADD-1020, with extended logic and twice the computational capacity of the ADD-1000, and the ADD-2000, for central system processing in surveillance, instrumentation, guidance, and display. All ADD computers feature thin-film memories.

In addition to military Command and Control functions, Burroughs stated that its D800 may be used for real-time simulation, air traffic control, communication switching and data processing, and general purpose scientific computing.

with remarks on future developments

A SURVEY OF COMPUTER MEMORIES

by JAN A. RAJCHMAN, RCA Laboratories, Princeton, N.J.

The standard internal memory of present computers is a random access ferrite core memory.[1] Storage capacity and speed of access determine its usefulness. The largest typical commercial memory has about two million bits, the fastest has a cycle time of about .8 microseconds. Considerable work is in progress throughout the world to increase speed and some to increase capacity.

This paper considers what are reasonable limits in speed and capacity which can be attained with ferrite, thin magnetic films or any magnetic technology. It also considers superconductive and tunnel diode memories which show promise to exceed these limits.

limits of speed

Let us consider the maximum speed attainable in magnetic memories. We shall consider the cycle time T required to address, to read, and to write or to rewrite the information and to leave the memory ready for another such access. This cycle time is thus the reciprocal of the maximum possible repetition rate. In a memory of N words of m bits each, the speed is independent of m (in all cases of practical importance when $N >> m$), so that we confine ourselves to the consideration of a single bit N word memory. The cycle time T can be expressed as the sum of times required for each of various functions:

$$T = \underbrace{2\frac{S_W d}{I}}_{t_s} + \underbrace{\frac{N\,d}{K\,c}}_{t_t} + \underbrace{\frac{r\,N}{B}}_{t_g} + \underbrace{t_a}_{} + \underbrace{t_n}_{} \qquad (1)$$

Switching Transmission Amplification Addressing Preread Delay

Each of these times can be derived as follows:

(a) The switching time t_s of a core or other magnetic element can be written as

$$t_s\,(H - H_c) = S_w \qquad (2)$$

In a current coincident mode the mmf H can be at most twice the coercive force H_c, – and should be optimally $H = 1.5\,H_c$ – for otherwise the half selected cores will switch. In general this limits the speed with respect to a word organized mode in which H can be many times H_c, so that $t_s \approx S_w / H$. The mmf H depends on the drive current I and the length of the magnetic path. This length, in turn, is related to the element spacing, d, when the elements are packed as tight as possible. Approximating geometrical factors which are slightly different for flat and circular elements, the following single relation can be assumed:

$$t_s \cong \frac{S_W d}{I} \quad [S_w \text{ in Oe sec, d in cm, I in amp, } t_s \text{ in sec.}]$$

A memory cycle necessarily involves two switchings of the core. This explains the factor 2 in relation (1).

Let us consider possible minimum times t_s for ferrites and thin magnetic films. In either case a drive current of $I = 1$ ampere is about the maximum to be expected from the best transistor and about the maximum tolerable in small wires. In the case of ferrites a value of $S_w = \frac{1}{2}\,10^{-6}$ Oe sec is the lowest reported, so that with $d = 1$ mm $t_s = 100$ ns and with $d = .1$ mm $t_s = 10$ ns. In the case of films, values as low as $\frac{1}{2}\,10^{-7}$ Oe sec have been consistently observed. But here the spacing cannot be arbitrarily small because the ratio of length-to-thickness of 10^3 to 10^4 is necessary to prevent deleterious demagnetizing effects. Spacings in the range of $d = 1$ cm, used in an early experiment, yield $t = 100$ ns and spacings in the range of $d = 1$ mm found possible in more recent experiments yield $t = 10$ ns.

(b) The transmission time t_t along the digit write and read windings which link all N elements is made of N times the delay at each element. If the spacing between elements is d cm and the electrical disturbance travels at K times the speed of light C, the time $t_t = Nd_{KC}$. We will assume $K \simeq \frac{1}{3}$, not an unreasonable value for the transmission line type of windings encountered in ferrite cores, ferrite plates, or thin film memories. There is delay along both write and sense windings, but if these are grounded on opposite ends the variations in write and read delay will compensate and have a sum of t_t. Typically $t_t = N.10^{-10}$, $N.10^{-11}$ or $N.10^{-12}$ for a spacing d of 1 cm, 1 mm, or .1 mm.

(c) The voltage V obtained from the sense winding must be amplified sufficiently to set an output register, and then further to provide voltage for the digit winding which inhibits (or partially drives) the whole plane. This voltage is made up of N times the voltage produced at each unselected element which in turn is the sum of the elastic voltages unavoidably present in real non-ideal rectangular hysteresis loop material and the voltage due to the inductance of the windings between elements. Let us call r the ratio of these elastic voltages to inelastic voltage due to the switching of the selected core. The required voltage on the digit winding is thus

$$r\,V\,N + V = r\,V\,N$$

In general $r\,N >> 1$, so that the useful voltage V can be neglected in comparison with the sum of elastic voltages. The total voltage gain G required to amplify the sense voltage is therefore rN. Amplification necessarily entails time : a certain frequency bandwidth is necessary and a certain delay is encountered in the amplifier. We will make the simplifying assumption that in the best amplifier, with cascaded stages if necessary, the ratio of the gain G to the time t_g required to obtain it is a constant $B = G/t$. This constant B is characteristic of the amplifying element used; tube, transistor or tunnel diode. Also we assume, optimistically, that the current gain which is required in addition to voltage gain, is obtained without further loss of time. Therefore the minimum time t_g required for amplification is $t_g = {}^{rN}/B$.

A typical value of r is .1 for good hysteresis squareness and reasonably tight spacing of the elements. Values of B vary a great deal with transistors. Not uncommon are amplifiers for which $B = 10^9\ sec^{-1}$. Advanced experimental types show as much as $B = 10^{10}\ sec^{-1}$. Tunnel diode amplifiers with an equivalent B of $10^{11}\ sec^{-1}$ have been made. The corrresponding delays t_g are thus $t_g = 10^{-10}\ N,\ 10^{-11}\ N$, or $10^{-12} N$.

In general, the input write signal must be amplified, and this takes time. However, usually the input signals are at reasonably high level, so that this time can be neglected in comparison to that required to amplify the sense signals.

(d) The time t_a to "address" is defined as the time required for decoding the address. In general, if the inputs to the memory are at sufficient high level they need not be amplified before decoding. Consequently this operation can proceed in a time t_a short with respect to t_g and will be neglected for simplicity.

(e) The time t_n "preread delay" is in practice a dominating factor. In general the digit write (inhibit) is coupled to the sense winding so that a large signal appears in the read circuits during writing. This signal can be orders of magnitude greater than the desired read signal. Cancellation systems balanced circuits, etc., are generally used to keep this pick-up at a minimum, but it still produces a signal considerably greater than the sense signal. Cancellation cannot in general be perfect due to delta effects, i.e. due to the fact that elastic couplings are dependent on the remanent state of the core. Clamps can be used on the sense amplifier to prevent it from being paralyzed by this large signal. In practice most of these remedies do not avoid the necessity for allowing a certain time to elapse for the decay of the transients due to writing at one address before it is possible to sense at this or another address. This is the time t_n. In typical 5 μsec memories, t_n is about 1 μsec.

To gain an idea of the highest attainable speeds, let us consider only the switching time of the element, the delay through the array and the time required for amplication. These are times dependent on basic properties of the magnetic material, the size of the memory and the limits of the associated electronics. We neglect the practically very important "preread" delay time on the optimistic assumption that further ingenuity in balancing, clamping, etc., will render this delay negligible. Similarly we neglect the decoding time t_a.

On Figure 1 are plotted a number of curves relating the cycle time T to the number of words N. The curves are for three switching times, 10^{-6}, 10^{-7}, 10^{-8} seconds respectively. For a one bit word the cycle time is simply twice the switching time. As the number N of words increases a term proportional to N is added, since both t_t and t_g are proportional to N. The curves are drawn for $t_t = t_g$. This is a convenience, and is justified since the efforts in the last few years in microminiaturization to reduce t_t and in semi-conductor amplifier to reduce t_g seem to have roughly resulted in a draw between the importance of these two factors. In any case it is easy to see on the curves the effect of having one of the times dominating the other.

In the case of ferrite cores, OD's of 18 mils and 1D of 13 are at the forefront of advanced memories. These cores switch in about 10^{-7} seconds (100 nanoseconds) for a current of roughly one ampere. Spacings of $d = 1$ cm are commonly used. Present transistor circuitry is characterized by roughly $B = 10^9\ sec^{-1}$. Therefore the curve corresponding to $t_t + t_g = 2.10^{-10}N$ represents about the best state of the art. A memory of 1024 words has a minimum cycle time of .4 to .5 μsec and one of 4096 words a cycle of 1 μsec. Assuming an easily achievable spacing of $d = 1$ mm and somewhat more difficult but possible circuitry of $B = 10^{10}\ sec^1$, the curve for $t_t + t_g = 2 \times 10^{-11}N$ shows that a cycle time of 200 ns for 1024 words and 300 ns 4096 words are limiting. The next substantial improvement must result from a decrease in switching time. This can be obtained simply by reducing

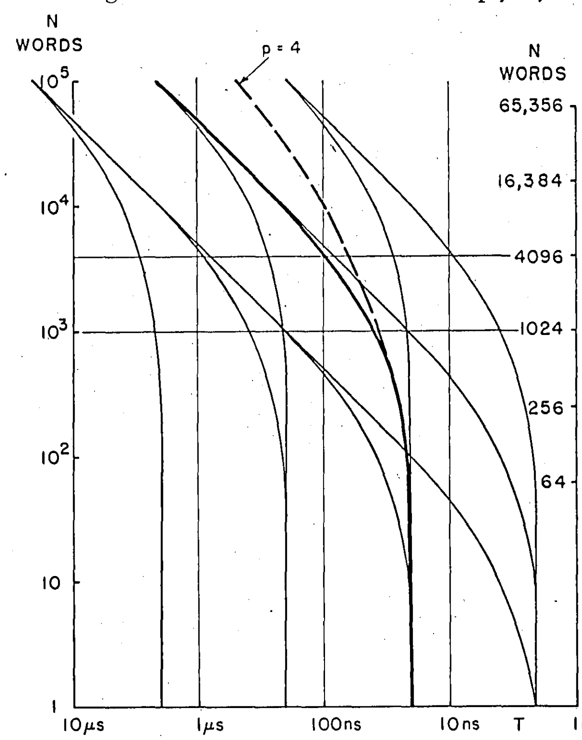


FIG. 1 RELATION BETWEEN NUMBER OF WORDS N AND CYCLE TIME T. CURVES ARE FOR t_s = 1, 10, 100 AND 1000 ns AND FOR $t_t = t_g = N.10^{-10}, N.10^{-11}, N.10^{-12}$

the size of the core. The degree of reduction depends on the skill of technology. It is unreasonable to assume a reduction below 2 or 3 mils. A slight improvement in the switching coefficient S_w, perhaps by 50% can be assumed. This would then lead to a switching time of 10 nanoseconds, which with $t_t + t_g = 2 \times 10^{-11}N$, corresponds to the heavy curve in the figure. Typically a memory with 4096 words could then be cycled at the limit in 100 nanoseconds.

The outstanding virtue of thin magnetic films is fast switching. [2] [3] However, because elements smaller than about 1 mm would entail deleterious demagnetizing effects and practical limits of drive current are about 1 ampere, the fastest usable elements still take about 10 nanoseconds to switch. Optimistically, with some reduction in size and a considerable improvement of S_w a limiting switching time of 1 nanosecond could be assumed. Because a drastic reduction of size is not possible, the transmission time is at best $t_t = 10^{-11}N$ sec. The best transistor circuitry can perhaps yield a $B = 10^{10}$ sec^{-1}, as was assumed for ferrite, but here there are practical difficulties with dealing with a much smaller signal, so that it may be more difficult to achieve it. In any case the heavy line

$$(t_s = 10\text{ns},\ t_t + t_g = 2 \times 10^{-11}N)$$

of the figure seem to be about the ultimate limit for both thin films and microferrites.

In the foregoing analysis we have assumed a "pure" magnetic memory in which all the N magnetic elements of a given bit of the words are coupled through a single sense and through single digit winding. Considerable speed-up is possible by splitting these windings into p parts each. The delay time t_t, and the required gain and consequently the amplification time t_g are both proportional to N/p in such a "compound" memory. Furthermore in the case of a current coincident memory, the disturbs are reduced by the factor p. Of course, such partitioning requires more electronics. The number of required digit drivers and sense amplifiers is increased by p. In present commercial practice, the largest "pure" planes have 4096 cores. Planes with 16,384 are usually partitioned at least four times.

One could believe that, with sufficient partitioning the effects of t_t and t_g could be reduced at will but this is not possible because wiring requirements never make t_t zero and there is definite minimum time for amplification required for current gain and losses. A reasonable reduction of $t_t + t_g$ of about 4 can be expected. The result of such

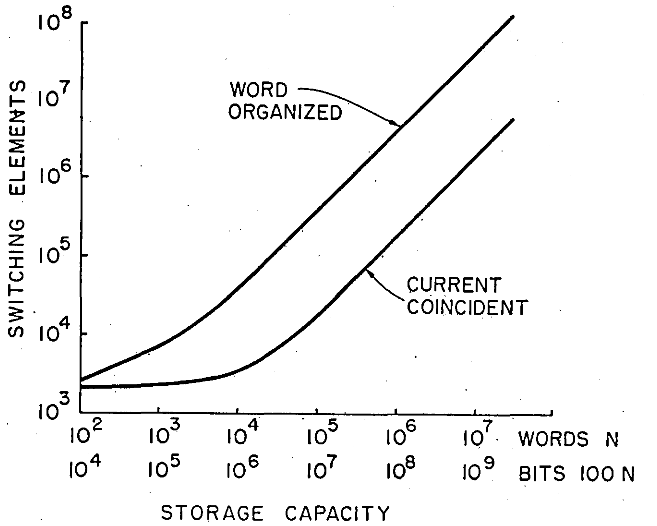


FIG. 2 NUMBER OF SWITCHING ELEMENTS AS A FUNCTION OF MEMORY CAPACITY.

a reduction is plotted on the figure for the case $t_s = 10$ ns and $t_t + t_g = \frac{1}{4}(2 \times 10^{-11}N)$ showing this improvement with respect to the heavy limiting curve.

With such partitioning a memory with 16,384 words could by cycled in principle in 100 ns.

tunnel diode memories

What are the prospects of an increase of speed by an order of magnitude with respect to these magnetic memories?

A 10 ns cycle time could be obtained with an element switching in 1 ns. The capacity would be 4096 for elements spaced .1 mm apart, provided of course that the amplifiers would work at the right speed. (See Figure 1.) These severe requirements can be met by using tunnel diodes for the storage element as well as for the amplifier and drivers. The bistable character of the device and its sharp non-linearities permit operation of an array in voltage or current coincidence. Faster speed is obtained in a word organized mode where coincidence is used only for writing, as in magnetic memories. Special "backward" tunnel diodes having practically a flat region in place of the usual peak-valley region, can be used to couple the storing diodes to the sense amplifiers. This reduces considerably the otherwise severe attenuation of the signal and thereby permits obtaining the output read signal in only 1 to 3 nanoseconds when tunnel diode circuitry is used.[4]

Tunnel diode memories with cycle times of 10 to 25 ns and capacities of about 1024 words are in an experimental state of development. Their probable region of utility is shown on Figure 3.

limits of capacity

Let us consider the largest storage capacity attainable in magnetic memories. One could think of the question simply in economic terms. For example, one could contemplate obtaining a billion bit memory by buying a thousand conventional memories of one million bits each. If one had the required billion dollars this might be a solution. However, the delivery time would likely be very

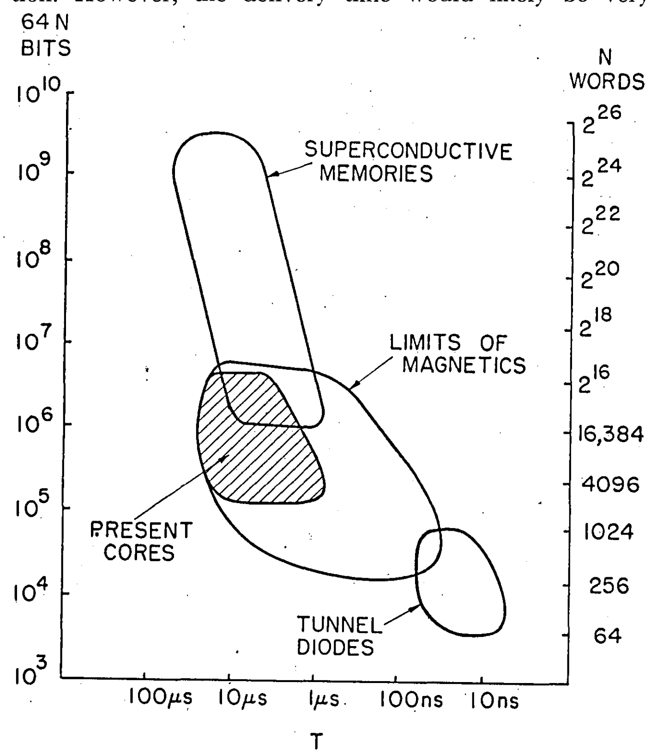


FIG. 3 PROBABLE FUTURE MEMORY DEVELOPMENTS.

long. This can be appreciated by considering that automatic machines making and wiring elements at the rate of one per second would take 30 years to complete a billion bit memory! Higher fabrication speeds, parallel operations, etc. still would make a bit-by-bit construction too lengthy to be acceptable. Clearly then, means must be found to speed up construction by a batch fabrication technique. Also obviously the cost must be reduced.

There is probably no fundamental limit to attainable storage capacity if the consequent loss of speed is accepted. A meaningful question is therefore to ask what is entailed in a given significant increase in capacity, let us say from today's million bits to a billion bits.

Considerable progress was made with certain batch fabrication techniques. For example, as long as five years ago an apertured ferrite plate with 256 bits and with printed windings was developed.[5] More recently some of the work proceeding in various laboratories with thin magnetic films is aimed primarily at batch fabrication[6] rather than or in addition to speed. Of significance are recently announced[7] etched permalloy sheets with many elements and their necessary windings fabricated by photo-etching techniques. Notable are also efforts to make arrays by electroplating wires[8] or meshes. Various degrees of success have been achieved but thus far no method has speeded up fabrication or reduced cost with respect to bit-by-bit fabrication by the sought factor of a thousand. It is likely, however, that further vigorous development along the lines already proposed or others will yield this factor within the next few years.

Unfortunately this is not sufficient. Magnetic materials, even with the best hysteresis squareness, just do not have sufficient non-linearity and other properties to provide all the required switching without the aid of considerable electronics. To appreciate the amount of electronics necessary, let us estimate the number C of single semi-conductor switches, transistors or diodes, required for a memory of N words of m bits each.

Addressing requires $2\sqrt{N}$ driving channels in current coincident mode and N channels in a word organized mode. Each channel must be dual to provide the two polarities. Furthermore, address decoding requires multiplying these numbers by at least 2. Therefore, about $8\sqrt{N}$ elements for current coincident mode and 4 N for word organized mode are fair estimates.

Magnetic switches can be used for addressing. Most practical is an xy dc biased switch, in which the X drive overcomes the bias and the y drive provides the switching and useful output of the selected core. A large switch of this sort would of course have to be made by integration techniques similar to those used for the memory. The number of address drivers would be $2\sqrt{N}$, but here the number used need not be doubled since both polarities are obtained due to the restoring effect of the dc bias. On the other hand, the inefficiency of the switch requires more power in the drivers, so that the estimate of $8\sqrt{N}$ semi-conductor for current coincident addressing will still be approximately valid in this case.

For writing and reading, a single channel for each of the m bits would be sufficient if the magnetic elements were ideal, but for large number of words N the writing and sensings windings must be partitioned. For writing, the maximum number of N_w of elements per windings is $V_d/r\,VN_w$, where V_d is the maximum voltage of the driving transistor. Typically if $V_d = 10$ volts, and $V = 10$ mv and $r = .1$, then $N_w = 10^4$.

For reading, in a word organized mode, the maximum number N_R of elements per sense winding is determined by the attenuation produced by the large series impedance of the winding. An estimate of $N_R = 10^4$ is not too unreasonable. In a current coincident mode the $2\sqrt{N}$ half select disturbs add each a fraction f of the sense voltage V. This fraction depends on the squareness of the cores, on their uniformity since cancellation effects are used, and on the delta effect at strobing time. For extremely good cores f attains barely 400, so that if a 2-to-1 signal to disturbs is tolerated, $N = 10^4$ at the limit.

It is thus evident that when N exceeds $N_R = N_w = 10^4$ the sense and digit write windings must be partitioned. The partitioning factor p is N/N_w. We will assume that the sense amplifier and that the write amplifier with its logic rewrite, require 10 semi-conductor elements each. Consequently the total number of elements for sensing and writing is $20\,m\,\dfrac{N}{N_w}$, assuming $N_R = N_w$.

The total number of semi-conductor devices for addressing, writing into and sensing from a memory of N words of m bits each is thus approximately, for $N > N_w$:

$$C = 8\sqrt{N} + 20\,m\,\frac{N}{N_w} \text{ current coincident mode} \qquad (4)$$

$$C = 4\,N + 20\,m\,\frac{N}{N_n} \text{ word organized mode} \qquad (5)$$

For $N < N_w$ the additive terms are 20 m when partitioning is not necessary. These relations are plotted on Figure 2 for $m = 100$ and $N_w = N_R = 10^4$.

It is apparent that a billion bit memory requires about twenty million semi-conductor devices if operated in current coincidence and 400 million if operated word organized. In any case it is clear that batch fabrication of the semi-conductor devices is indispensable. A great deal has been done, and even more has been said, about batch fabrication of semi-conductors together with the necessary circuit elements i.e., integrated circuits. To date, batch fabrication of about ten elements is a modest reality, but a number of experimental approaches for much greater integration show good promise.

What is then the overall prospect for a billion bit magnetic memory? Great strides in magnetic and semi-conductor batch fabrication are necessary. At the moment, there is more progress in this respect in magnetics (where it is perhaps easier) than in semi-conductors. It seems therefore that a current coincident mode which taxes magnetics more severely for squarer and more uniform elements but requires less electronics will come into being before a word organized mode more lenient in magnetics but requiring order of magnitude more electronics. In any case, the development is likely to be gradual unless spectacular success in material improvement or a brilliant invention, or more likely both, should permit a sudden jump. More likely this evolution may be stopped through the success of superconductive memories.

superconductive memories

Superconductive phenomena are essentially ideal for memory applications: persistent supercurrents are a natural form of storage and sharply defined thresholds between the superconductive and normal states permit switching. Moreover, thin superconductive film technology offers the unique possibility of simultaneous miniature batch fabrication of storage elements, addressing switches and all connections.

A short description of a superconductive continuous sheet memory may be in order since it has been reported only recently.[9] Two perpendicular sets of parallel suitably insulated lead strips are evaporated on top of a continuous film of tin. When an X and a Y strip carry a current I, the magnetic field pattern at their intersection is at 45° with respect to the strips. The intensity of the field is maximum at the intersection and diminishes gradually with distance. Consequently, there is a region limited by a definite boundary within which the field in the tin sheet exceeds a critical value and renders the sheet normal and outside of which it does not. Within that region it is possible to induce persistent currents and change the polarity of existing persistent currents. The final polarity obtained depends on the polarity of the primary currents and determines whether a one or a zero is stored. An element is switched only if the primary excitation is opposite to that which previously established its state, and only if it exceeds a certain definite threshold. The situation is thus quite analogous to a hysteretic magnetic element with a perfect square loop. A voltage is induced in a sense winding on the opposite side of the memory plane due to the local magnetic field leaking through the plane at the selected position. No field leaks elsewhere through the superconductive sheet because it is a perfect magnetic shield, so that there are no disturb signals due to half excitations. Addressing is done by a decoding tree of cryotrons feeding the selected lines. These cryotrons are fabricated at the same time as the memory and are made of the same materials: lead and tin.

The superconductive memory can be used in connection with a conventional semi-conductor computer. The drivers for the cryotrons, the sense circuits, and the write and rewrite circuits are of the conventional transistor type. However here, in contrast to magnetic memories, the number of circuits increases only very moderately with capacity. For addressing, drivers are necessary only for the binary bits of the address. The writing and sensing circuits need not be partitioned.

The technique thus seems to offer all the prerequisites for making a large capacity memory—integral miniature batch fabrication techniques and very small requirements of auxiliary circuits. Capacities of billions of bits may be achieved and thus furnish the computer art, for the first time, the large capacities available today only in electromechanical memories. The accesses at electronic speeds will be measured in microseconds rather than in seconds or minutes.

The large capacity possible with superconductive memories justifies the use of liquid helium. Today, such use is a laboratory inconvenience, but tomorrow closed cycle refrigeration units will be no less objectionable than air cooling or air conditioning systems.

While the superconductive memory offers a unique solution to large capacity memories, it promises also to be fast. Its speed is chiefly limited by the time required to address it through the cryotron tree. Cycle times of about a microsecond may be expected with conventional cryotron designs for capacities of millions of words.

conclusions

The estimates and speculations described above can be summarized by the diagram of Figure 3 with the following remarks:

1. Present ferrite core technology has achieved capacities of about two million bits and cycle times as short as .8 microseconds.

2. Extension of magnetic technology to faster memories is likely to be limited. The limit depends on the number of words and is about 100 ns for 4096 words or possibly for 16,384 words. Ferrite and thin film technologies may be pushed to this limit. Both present serious engineering difficulties, which are perhaps more severe with thin films.

3. Tunnel diode memories may extend speed beyond the limit of magnetic memories by a factor of 5 to 10, for capacities of about 1024 words.

4. Extension of magnetic memories to large capacities depends on economic factors. Substantial extension requires batch fabrication techniques for both the magnetic elements and the semi-conductor circuitry. Progress in semi-conductor batch fabrication needs to be far more advanced to make this a real possibility.

5. Superconductive thin film technology—and particularly the continuous sheet superconductive memory—offers the possibility of a very large capacity memory because of its ideal storage and switching characteristics combined with its integrated miniature batch fabrication possibilities.

Foretelling limits for any part of the explosively advancing art of electronics is perhaps foolhardy. Brilliant inventions or breakthroughs in materials, or both, may render reasonable limits of today completely meaningless tomorrow. This may well be the case for the estimates given here. Nevertheless, a reasonable attempt at circumscribing possible gains with given approaches helps to set the field in perspective. This is the only purpose of this paper.

A possible course of events may be the development of other types of memories. The backbones of computers are memories. The advent of random access memories was essential to the coming into being of the modern stored program computer as we know it. Memories with a more general type of access may well dictate new forms of computers. In these, there may be less emphasis on speed as more direct solution methods may become possible. For example, it may be possible to address a memory through the content of part of the stored information itself and retrieve the remaining part associated with it. Such content addressable or associative memories could make searching for information very simple and could either simplify or make unnecessary such tasks as ordering merging, sorting and collating of information which require so much time as in today's serial processing. Content addressability entails mixing logic functions with storage functions. This is precisely what was necessary to achieve really large capacities in random access memories, so that all the considerations on integrated batch fabrication are valid here. Superconductive techniques are thus a prime candidate for content addressable memories and have already been used in small scale experiments for that purpose.[10] Magnetic techniques with a judicious use of semi-conductors may well provide the first prototypes.[11] The real solution could be through the use of integrated semiconductor techniques such as thin film transistors.[12] At this time it is too early to formulate a sensible judgment on the technique best suited to content addressable memories, but it is already clear that memories of that type will be very important in the future.

REFERENCES

(1) J. A. Rajchman — "Computer Memories: A Survey of the State of the Art," Proc. IRE January 1961, pp. 104-127.

(2) A. V. Pohm and E. N. Mitchell — "Magnetic Film Memories — A Survey," IRE Trans. on Electronic Computers, vol. EC-9, Sept. 1960, pp. 308-314.

(3) J. I. Raffel — "Operating Characteristics of a Thin Film Memory," J. Appl. Phys., vol. 30, April 1959, pp. 605-625.

(4) M. M. Kaufman — "A Tunnel Diode — Tunnel Rectifier, 15 Nanosecond Memory," Solid/State/Design, Feb. 1962, pp. 23-28.

(5) J. A. Rajchman — "Ferrite Apertured Plate for Random Access Memory," Proc. IRE, vol. 45, March 1957, pp. 325-344.

(6) E. M. Bradley — "Making Reproducible Magnetic Film Memories," Electronics, vol. 33, Sept. 1960, pp. 78-81.

(7) G. R. Briggs and J. W. Tuska — "Permalloy — Sheet Transfluxor Array Memory" — Magnetism and Magnetic Materials 7th Conference, Phoenix, Arizona, Nov. 13-16, 1961.

(8) T. R. Long — "Electrodeposited Memory Elements for a Nondestructive Memory," J. Appl. Phys., vol. 31, May 1960, pp. 123-124.

(9) L. L. Burns, Jr., G. W. Alphonse, G. W. Leck — "Coincident — Current Superconductive Memory," IRE Trans. Electronic Computers, vol. EC-10, No. 3, Sept. 1961, pp. 438-446.

(10) A. E. Slade and C. R. Smallman — "Thin Film Cryotron Catalog Memory," Symposium on Superconductive Techniques for Computing Systems, May 1960.

(11) J. R. Kiseda, H. E. Petersen, W. C. Seelbach, M. Teig — "Magnetic Associative Memory System", IBM Journal, Jan. 1961.

(12) P. P. Weimer — "Evaporated Circuits Incorporating a Thin Film Transistor," 1962 International Solid-State Circuits Conference, Phila., Feb. 1962.

Make sure your new computer does both

Don't settle for data processing alone. If your company is planning to buy or replace a computer, get one that can also handle today's increasingly complex scientific, engineering and management problems. A good medium priced machine should be able to meet *all* of your computer needs.

What should you look for? First, it must have *both* binary and decimal capabilities. It should have a full-scale scientific language *and* a competent business-oriented language. It should have high speed arithmetic, a large and effective memory, and built-in floating point. It should be able to handle a number of input-output devices at the same time. And, of course, it should be designed to grow . . . as your organization grows.

It should, in short, be just like the GE-225.

When the question of a new computer comes up, investigate the GE-225. We think you'll be impressed. It's a lot of computer for the money. General Electric Computer Department, Section J12, Phoenix, Arizona.

Progress Is Our Most Important Product

CIRCLE 14 ON READER CARD

GENERAL ELECTRIC

dual memory and stored logic

THE PB 440

The latest issue from Packard Bell Computer, the PB 440, was announced last month.

The dual memory stored logic system features a new approach of the stored logic concept (DATAMATION, May '61, pg. 33) to provide a flexible repertoire of "instructions" which may be designed with a specific application in mind. The basic word length of the machine is 24 bits. The main memory cycle time is 5 microseconds.

The basic machines contain 4096 words of memory, which can be expanded in 4K blocks to a maximum of 32K. This memory can be read non-destructively to give an effective "cycle" time of 1 microsecond.

The instruction set consists of basic orders called micro-steps. The usual mode of operation will be to use a simple interpreter to decode (by programming) a chosen instruction set. After the decoding operation, a subroutine will be entered to perform the desired function. These subroutines, called macro-instructions, are written in micro-steps.

It is theoretically possible to use such a scheme to simulate other existing computers so that investments in programming libraries can be protected. On the other hand, it is possible to exploit the flexibility of the equipment and devise other instruction sets which are "tuned" to the application at hand.

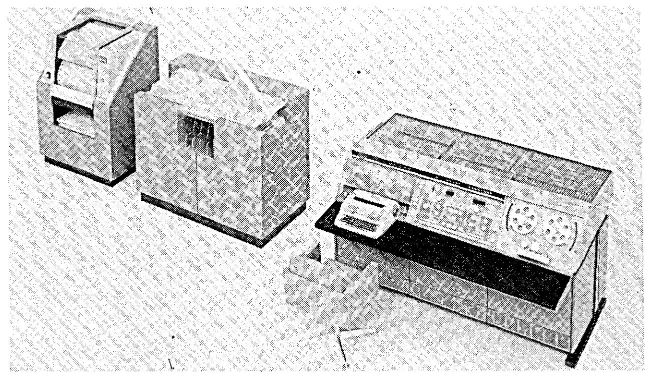
The 24-bit word length of the machine allows two micro-steps to be stored in a single word. The programmer loads is with the frequently-used macro-instructions. However, once fast memory is loaded the effective "cycle" time is 1 microsecond per word.

One area of application is in process control or real-time situations. A small configuration which consists of processor with 4K memory, a Selectric typewriter, and punched paper tape in and out rents for $3,500 monthly and is suitable for engineering/scientific calculation. The configuration pictured also has 800 cards per minute input, 250 cards per minute output, and a 1000 lines per minute printer. Monthly rental for this configuration has not been established. A mag tape option is also available.

Software centers around a recommended command list for systems applications and engineering/scientific computing. Also provided will be FORTRAN, an assembler, and a basic library.

First delivery is scheduled for September, 1963. ■

CIRCLE 108 ON READER CARD



and fortran II

RW 230

The RW Division of Thompson Ramo Wooldridge Inc. announced this month its new RW 230, a general purpose scientific/engineering computer developed from RW's earlier TRW 130, designated for the military as the AN/UYK-1.

Falling in the medium-scale computer range, the basic 230 features 8K, 15-bit words of core memory, which may be expanded to 32K. The indirectly-addressed machine has a 6 usec cycle time and an add time of 12 usec.

Also featured are eleven interrupt lines, which allows the computer to interleave computations simultaneously with input/output functions.

Currently being prepared for the 230 is FORTRAN II, which may be implemented with a minimal configuration, and is capable of a paper tape output directly from an 8K main frame memory.

The stored logic design of the 230 is similar to that of the TRW 130 (see DATAMATION, May, 1961, pg. 33). Programs for the 130, it was pointed out, are compatible with the 230. Extrapolation, curve-fitting, simultaneous equations, test data reduction, and telemetry data processing are among the typical routines available from RW.

Peripheral equipment (also compatible with the 130) available for the 230 includes a standard peripheral group, consisting of paper tape reader, reeler, and punch; input/output typewriter, and controller; the magnetic tape system consists of up to four mag tape drives and a controller. Individually-required devices are also available, such as a medium-speed line printer; Flexowriter; card reader; digital plotter; extended 32K memory; and a data line synchronizer, which permits data transmission using telephone lines.

A basic 230 with 8K memory will lease for $1800 monthly. First delivery is expected by this summer.

Other computers in the RW line are the TRW 330 and the TRW 340, both process control computers, the former with drum memory, the latter with core storage. Both may be combined to function as a drum/core system. The TRW 530 is a general purpose, stored logic, 18-bit computer, for business data processing and scientific applications. ■

CIRCLE 109 ON READER CARD

THE CALIFORNIA COMPUTER CIRCUIT

November was an active month on the California compiler circuit. Of special note was the one-day technical symposium held in San Francisco on November 9. The theme itself is unique: "Problem Oriented Systems: a Report of User Experience." The emphasis was on users rather than developers who sometimes "become burdened with the enormous beauty and perfection of it all."

Dan Teichroew, program chairman, summarized the sessions on business compilers for DATAMATION: "Compilers are in fact in operation and production runs are being made; training and experience is just as necessary with the use of compilers as it was before; the amount of systems analysis that is required is not reduced; the documentation problem is eased; the compiled programs use more memory and require more computing time than those prepared directly by experienced programmers; the use of compilers reduces the time required for program debugging."

The discussions of languages for Command and Control (1, 2, 3, 4, 5,) were continued with a session on NELIAC by W. H. Wattenberg and a session on JOVIAL by Jerry L. Koory. The touted debate did not materialize as the speakers did not address each other directly. The two speakers described the two systems and indicated that two different design concepts were involved. One was essentially a "programmer's language" while the other was quite suitable for a mathematically oriented, non-computer person. In addition, the size of the programs for which JOVIAL was designed "require" sophisticated tools for handling a large common data base.

meanwhile

On the 14th of November the discussion was to be continued at the San Fernando Valley ACM meeting. The participants were changed; the subject was the same. After drinks and dinner, Tom Steel and Ed Meyers discussed two different topics in the same room. Meyers described NELIAC for the Valleyites and Steel treated JOVIAL. Again no debate ensued. The question session probed for a debatable topic, but the subject is so complex that positive stands, challenges and defenses seem to be difficult. One wonders if the subject is reducible to good or bad, black or white, standard or not.

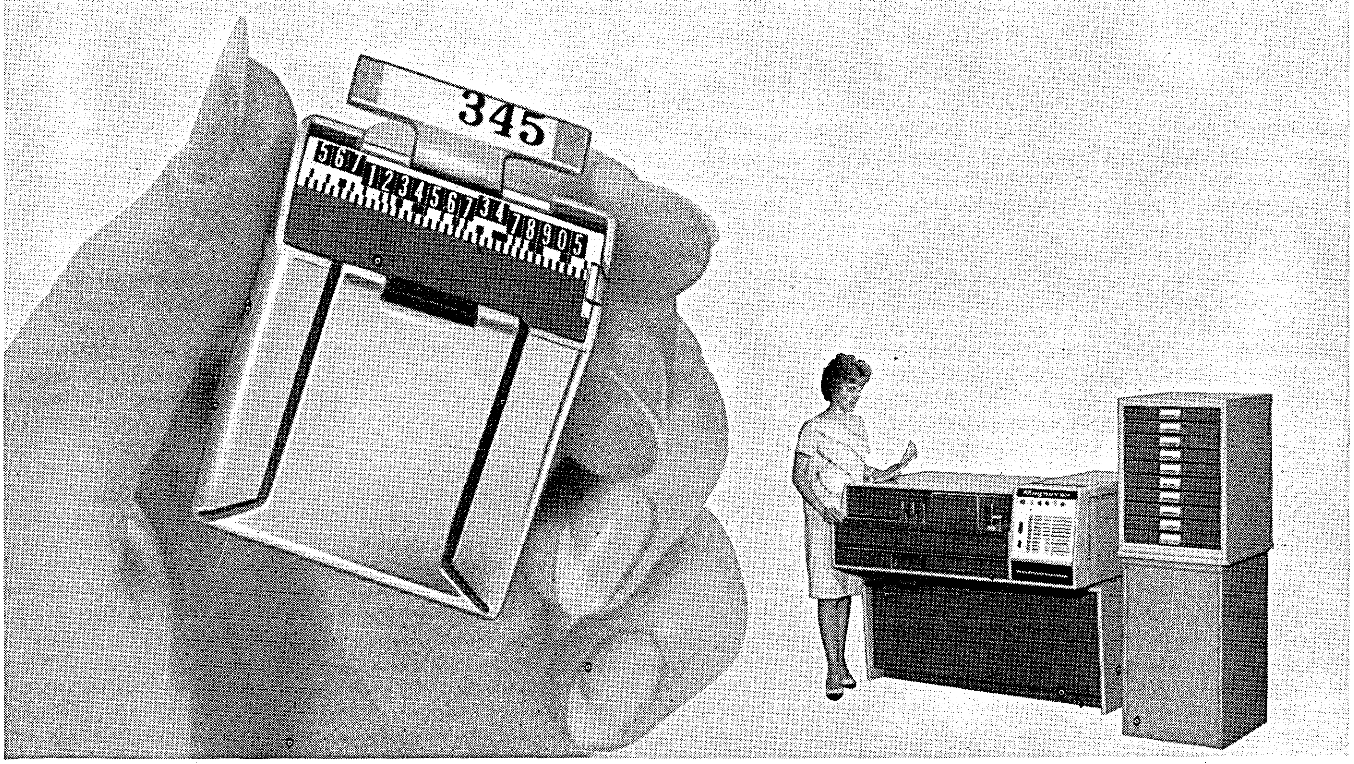
while out in county orange

Also on the 14th of November, the Orange County chapter of ACM heard Dr. Maurice Halstead (of NELIAC fame) speak on NELIAC (what else). Dr. Halstead noted that measures of programming efficiency were few and far between, but that indications could be found that NELIAC increased a programmer's output. He cited "Before" and "After" (NELIAC) figures which, among other things, showed a decrease in the number of debugging runs to have a program checked out. Bob Strahl, chapter secretary, reports that Dr. Halstead also emphasized "that being written in its own language, (the compiler) is easily suited to correction and modification. This also allows individual users to put in special modifications and improvements whenever they desire." ■

REFERENCES

1. Lee S. Christie, Marlin G. Kroger, *Information Processing for Military Command,* DATAMATION, June 1962, pp. 58-61.
2. W. H. Wattenberg, *The Programming Problem In Command & Control,* DATAMATION, September 1962, pp. 43-44.
3. "Business And Science," DATAMATION, October 1962, pp. 17-18.
4. *RAND Symposium,* DATAMATION, October 1962, pp. 25-32.
5. *RAND Symposium,* DATAMATION, November 1962, pp. 23-30.

MEDIA™ *another first from* **Magnavox**



Just 60 seconds to retrieve and make hard copy of any one of 30,000,000 documents

This new, high speed, electronically controlled filing system provides an entirely new concept in document storage and retrieval.

Called **MEDIA** (Magnavox Electronic Data Image Apparatus) it locates and produces a full size black and white hard copy of any page in a file of 30,000,000 pages or more, in less than a minute. As a result, you can realize substantial savings in time, floor space and office overhead.

Material is filed in an absolute minimum of space since each tiny metal capsule holds up to 600 pages. Documents are never removed from the system which consequently assures you of a completely inviolate file, and entirely eliminates the problem of lost documents and refiling errors.

Automatic purging of obsolete documents, random updating, and low cost duplicate files are some of the many additional advantages offered by **MEDIA**

For complete information on equipment and prices, please fill out and mail coupon below.

Magnavox

Half a century of excellence in electronics

The Magnavox Company, Dept. 31122
MEDIA Sales Department • Fort Wayne, Indiana

Send me complete information and prices on **MEDIA**. My requirements will involve the filing of approximately______ documents, averaging________pages per document. These pages are a maximum of________inches in size and are printed on the front only ☐ front and back ☐

*Name*________________________

*Title*________________________

*Firm*________________________

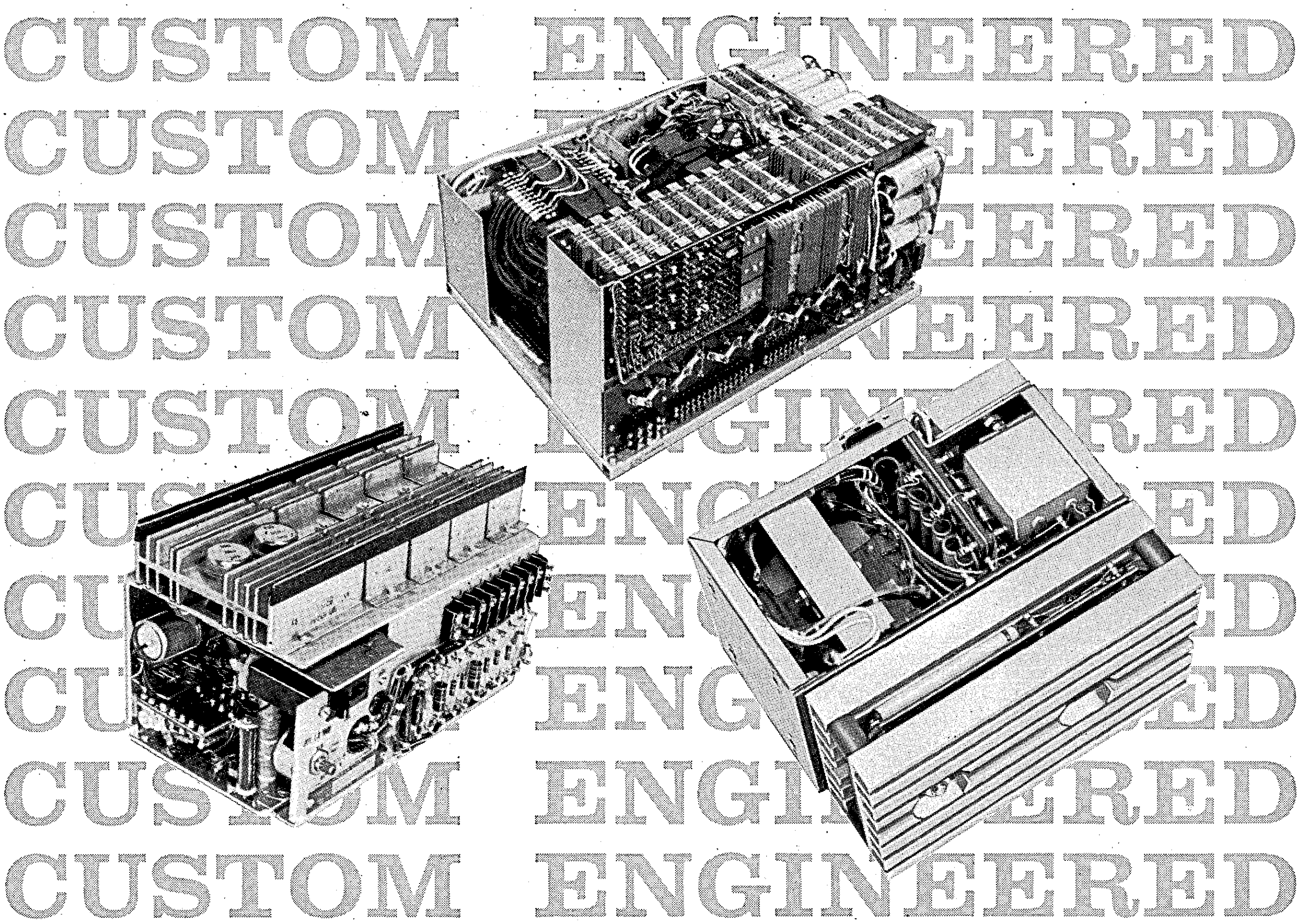
*Address*________________________

*City*________________*Zone*____*State*________

CIRCLE 16 ON READER CARD

NORTH ELECTRIC

VISIONEERING ACHIEVEMENT
SINCE 1884 . . . INTO THE FUTURE



POWER SUPPLY SYSTEMS

...an expression of basic philosophy at Power Equipment Company

Leading manufacturers of computer, communications and automatic control systems have discovered it is more economical to order reliable PECO power supplies custom engineered to their rigid requirements than to modify off-the-shelf catalog units.

The reason is obvious. When you order a power supply designed for your special application, you are assured of optimum performance characteristics, utilization of minimum space, fastest delivery and utmost economy.

PECO development, prototype and production facilities since 1935 have been devoted exclusively to the manufacture of power supplies for commercial, industrial and military systems applications. Today, PECO is the largest custom manufacturer of power supplies in the country.

It is to your advantage to call on the most experienced and capable power supply system manufacturer... PECO. We'll be glad to tell you more... write for our brochure "Custom Engineered Systems."

OTHER DIVISIONS:
DEFENSE SYSTEMS—*Electronics • Command and Control Systems*
ELECTRONETICS—*Switching • Controls • Computers • Components*
TELECOM—*Public Telephone Exchanges • Associated Equipment*

NORTH ELECTRIC
POWER EQUIPMENT DIVISION • GALION, OHIO

CIRCLE 17 ON READER CARD

A GUIDE TO TESTMANSHIP

how to accept a computer without really crying

by R. W. RECTOR, System Development Corp., Santa Monica, Calif.

To all computer users there comes an exciting day — *the* day on which the computer is to be demonstrated and accepted. This is the day that you have been waiting for, since you first began to think about the stimulating applications of a computer in your business. Months of preparation have preceded this day. The salesmen have spent weeks describing the machine (sometimes called a system). The System Analysts have spent months describing the system (sometimes called a machine). You have pondered and weighed the decision. The lawyers have agreed on contract terms. The construction people have torn up the old washroom, built the necessary raised floors and put in air conditioning. The computer has been installed and now it's going to be *yours!* Inefficiency is on its way out.

However, just prior to completing this giant stride, the computer manufacturer wants to put on one last demonstration, to prove that you have purchased a good thing — not only a good thing, but the best of a good thing. This is his final effort to show you your own astuteness. Tomorrow he knows that you will be calling him with Problems, but today you are his captive audience. He will demonstrate the capability and versatility of his product on your premises.

The following discussion is an acceptor's primer for all phases of the acceptance procedure, intended for those who actually do the accepting. Top management can have confidence in those who follow the precepts of testmanship as explained here.

the two facts about acceptance testing

To begin with, there is one elementary and inexorable fact which must be stressed before any general discussion of acceptance procedures can proceed. This first fact is:

THE MACHINE WILL BE ACCEPTED

The decision to accept the machine has already been made and no matter what happens during the acceptance test — the computer breaks down, the acceptance program fails to work, the power supply fails — nothing, but nothing is going to stop the inevitable, the successful completion of the test. You can imagine the catastrophic effects of an unacceptable acceptance test.

The people running the test are therefore chosen very carefully by the manufacturer. They are schooled at detecting errors while the tests are in progress and, without showing any emotion whatever, can calmly put in emergency procedures. They do this very suavely and smoothly. If the acceptance test shows any signs of not succeeding during its operation, a manufacturer's representative can, and will, (1) short out failed machine components, (2) remove malfunctioning subprograms from the acceptance program, (3) use batteries to light up the neons, (4) use hand cranks on visible rotating parts and, (5) in general, improvise.

You must understand that the maneuvers above are performed in such an unobtrusive way that no one will know that anything has gone wrong. This is not done maliciously but is performed as part of the ritual which is the successful demonstration of the equipment.

The second fact is:

THE ACCEPTOR WON'T KNOW AS MUCH ABOUT THE SYSTEM AS THOSE RUNNING THE ACCEPTANCE TESTS

This is not only a truism but is true by several orders of magnitude. The people who operate the acceptance tests are in many cases the same ones who designed the machine. In most cases they helped to build the machine. They have a long background in its operation, programming and repair (not just any machine, but *this machine*). Of course the people who operate the acceptance tests are also the ones who wrote the acceptance programs.

Consequently, to be successful the acceptor must have no illusions about who is going to know the most about the tests. He must also have the right mental attitude about their succesful completion. Forewarned is forearmed in testmanship.

carrying on and muddling through

Knowing that it is hopeless to really understand the test, the acceptor must carry on as if he understood it completely, for this is his cardinal rule of action. If this impression is correctly conveyed, both top management and the computer manufacturer will be pleased. If it is not conveyed, it reflects directly on the acceptor's ability and skill, thereby reflecting on his employer's ability and skill. The following discussion will show how to appear knowledgeable about acceptance without suffering inside from a complete sense of helplessness.

Before the acceptance tests begin, the acceptor will be given a brochure purporting to describe and explain the testing procedure. He should become thoroughly familiar with this document. It will contain many obtuse and esoteric remarks, such as "The tape drive unit controller is given a rigorous test to determine its capability under program control. The following printout appearing on the line printer signals a successful completion of the test:"

> "THE TAPE DRIVES HAVE BEEN PROVED SUCCESSFUL ON RUN 37 XXX #37421 TEST 7. THE TAPE ADAPTOR UNIT HAS CHECKED OUT SUCCESSFULLY ON 20 x 30 MATRIX INVERSION EQUATIONS OPERATED IN THE DUAL CYCLE MODE WHILE RUNNING. THIS TEST CAN ONLY BE PERFORMED WHILE MEMORY IS IN TEST AND THE TAPE DRIVES ARE IN THE DUAL MODE OPERATED WHILE ALL TAPE DRIVES ARE IN DOUBLE CHECKING ACCURACY."

The acceptor is asked to believe that the tape drive controller is O.K. if the printout appears. What is really proved by this success is that the program can successfully produce the printout (this capability may indeed be extremely valuable). Whether the tape controller works or not, or even if it has been tested or not, is really unknown (except by the programmer of the acceptance program). The astute acceptor will not question the veracity of the acceptance program.

The acceptor must become as familiar as possible with the acceptance document without really trying to understand it. Although he doesn't understand it he should become familiar with the pages on which certain tests are discussed so that during the actual running of the acceptance test he can refer to these pages and cite phrases more or less at random from them.

how to carry on and muddle through

Three major areas will be covered in detail.

I. The Equipment Area. The acceptor must have an adequate supply of equipment on hand for the successful test. The following items are considered musts:

(1) paper punch (three are preferable — one each for one, two, and three hole punching)
(2) a card punch, (a small desk model or one of the hand-held types is best)
(3) several waste baskets
(4) several printout binders
(5) a clock (preferably this should be a time stamp, but if unavailable an actual clock will do)
(6) two or three loose-leaf notebooks (filled)
(7) a grease pencil
(8) several "Day-Glo" signs
(9) if possible the tester should be talked into providing a copy of the expected outputs for use of the acceptor (these may be present in the acceptance brochure — but ask anyway)

This equipment should be placed in the computer room prior to the day of acceptance. No slip-ups of missing equipment should be allowed to occur. Appearing to be completely equipped will put both computer manufacturer and top management in the right frame of mind for the acceptance tests.

The following use should be made of the above equipment. The signs (#8) should be of two types:

(1) ACCEPTANCE TESTS IN PROGRESS NO ADMITTANCE. Every door that leads to the

computer area should have one of these signs on it, conspicuously.

(2) ACCEPTANCE TESTS IN PROGRESS PLEASE LEAVE. These signs should be placed at all exits from the computer room on the opposite side of the doors from the "No Admittance" signs. These signs, of course, do the reverse from the signs leading into the computer room. Making the signs in "Day-Glo" adds style as well as authority to the signs. Signs should be very official looking but not flashy.

The grease pencil (#7) and the clock (#5) are used together. On all printouts, cards, and other pieces of paper given to you by the tester, you should mark in large bold letters some unintelligible message, your initials, and the time. As mentioned previously, it is probably better to use a time stamp, but if this is not available you can use a grease pencil. These two items can also be used during the actual progress of specific tests.

You should walk over to the line printer from time to time, glance at it to see if it is printing; if it is printing then you should look at it, nod your head, mark something unintelligible on the printout, initial it, and mark the time. Timing is critical. This should be done almost at random though with apparent good reason; therefore, it will take some intuition on the part of the acceptor to know exactly the moment when this should be done. It should appear that you have noticed some particularly important phase of the testing procedure and want to remember it for further reference. There should be no trepidation on the part of the acceptor in doing this. The manufacturer's representative will be amused but not inquisitive about your marking up the printouts. They will never ask what you are doing because they don't care. *They know* what is happening.

The waste baskets (#3) should be used to discard all of the extraneous material to be used during the acceptance tests. This includes carbons, ripped up and bent cards (do not ask the manufacturer's representatives about these) and other trash which will be manufactured during the test. Having several waste baskets, rather than one or two, will give a general air of work being done, of efficiency, and will lend a ring of authority to the proceedings.

The paper punches (#1) and the printout binders (#4) are also used in conjunction with each other. As mentioned previously, the acceptor will be given vast amounts of printouts during the acceptance tests. These are described in the brochure. All of these printouts should be kept in printout binders and the handpunches can be used to prepare these for the printout binders. Every scrap of paper which is given to the acceptor should be scrupulously saved and put into one of the printout binders. The trash referred to previously, which goes into the waste baskets, can only be separated from the truly meaningful material by the shrewd and intuitive acceptor. They may become mixed now and then, but don't fret about it — carry on.

There may be some questions about what the notebooks (#6) should contain. This is up to the individual acceptor. In all cases they should be *filled.* It is also suggested that before the acceptance tests begin, the acceptor write down several phrases to be used during the test. The following phrases are suggested for use and can be used casually. Some intuitive feeling is needed for the use of these phrases, but even a modicum of sophistication will provide knowledge of the proper time for use: (1) "You certainly have built a reputation with this machine." (2) "These tests certainly prove out the worth of your machine." (3) "These tests prove that we made a right decision in choosing your equipment." (4) "Well, that seems ok." (5) "Oh never mind about that part of the test." (6) "Performs those operations much better than our old computer." (This last phrase should be used only if the machine does not smoke during some phase of the test.) Incidentally, if the machine begins to smoke during the test go to the washroom immediately. There is nothing you can do.

II. Personal Actions. There is no rigid code of conduct for the acceptor during the acceptance tests. However there is a code by which the acceptor can guide his actions to give the best overall impression during the tests.

The acceptor and the tester must act as if everything is going according to plan. Furthermore, the acceptor must act as if he understands the plan; and since things never go according to plan, the acceptor must possess a high degree of flexibility. The intelligent acceptor will, indeed, anticipate the ploys that the tester is likely to use in any given situation. For example, when the printer goes down at a critical moment, the experienced acceptor will be already waiting for the delayed output at the nearest magnetic tape drive.

The acceptor must appear at all times as if he expected the tests to come to a successful conclusion (as of course *they* will). He must appear as if he anticipates this result but is not anxious for it. This calls for careful preparation and determined self-discipline. At the successful completion of the test, the acceptor must graciously shake hands with all those who participated in the test, thank them profusely for their sincere application to the job that was done and give a small congratulatory speech about the successful completion of the test. All this can be rehearsed well ahead of time because the true acceptor is prepared for the successful conclusion.

III. Reporting the Tests. Any good top management will want a complete report of the successful operation of the test. The acceptor should be prepared to provide this report immediately upon the completion of the test. The following form for the report has been successful in the past.

The first page should have a clear and concise statement of the time of the tests, the equipment tested, and other pertinent facts. As all of these facts are known several days in advance, the form can be completed well ahead of time. The rest of the report should consist of all of the printout items that have been given to the acceptor by the testers. Just take all of the paper that has been produced by the tests and bind them with the first page of the report. These printout items, of course, are completely unintelligible to top management or anyone else, but they have an official look about them. The grease pencil notations which have been made previously, of course, will be very impressive and will show that the acceptor was on hand during the actual operation of the test. The first page of the report should have spaces for the testers' signatures as well as the acceptor's signature. The acceptor should expect that the manufacturer's representative will present him with a similar document after the tests have been run.

Accepting a computer is a difficult job. It requires an intelligent, sensitive person who possesses a great level of intuition. There is one last fact that an acceptor should remember during the operation of the test: **someone in top management was responsible for the original decision to buy this particular machine. The acceptor must remember that if the acceptance tests do not prove successful, that the original decision by someone in top management to purchase the machine was wrong.** ■

Why so many Programmers prefer the Control Data 1604/1604-A

The 1604/1604-A is not only a powerful, reliable, efficient computer, providing more computations per dollar expended, it is a computer that's "programmer designed" . . . one that together with its software will simply and quickly serve the needs of the programming personnel who use it. Consider these software packages.

FORTRAN 62 Fortran 62 for the 1604/1604-A has all the ease and efficiency of older Fortran systems, plus featuring rapid compile times. Most significant in this new Fortran system, however, are the input/output statements which allow the programmer to take advantage of the buffering capabilities of a modern computer. For example, the statement BUFFER IN (5,0) (A,B) initiates a transfer of information from peripheral equipment #5, recorded in even parity to a region of common memory, starting with variable A and ending with variable B. Meanwhile, computation can continue. At a later time, this statement may be executed IF (UNIT, 5) N1, N2, N3, N4, causing transfer of control to statement N1 if the information transfer is satisfactorily completed, to N2 if the transfer is not completed, to N3 if an end-of-file mark is encountered and to N4 if an error is apparent after the transfer is completed. Companion statements, ENCODE and DECODE, may be used in conjunction with the buffering statements to provide format control over conversion of variables.

FORTRAN 63 Control Data's Fortran 63 will be available early in 1963 and will include all Fortran 62 statements. It will provide even further extensions to the Fortran language. With Fortran 63 it will be possible to declare variables by type . . . integer, real, double precision, complex and logical. Conditional transfers will be effected on logical as well as arithmetic expressions. Memory allocation at run-time will be accomplished through array dimensions expressed as parameters of subprograms. Compile time will be just as fast. Extensive Do-loop examination during compiling will ensure optimum use of index registers. The result will be an object program comparable in efficiency to a hand-coded object program. Storage allocation and buffering capabilities of Fortran 63 make it applicable to a new class of programs previously restricted to machine language.

1604/1604-A COBOL Statements in Control Data's Common Business Oriented Language will closely resemble an English language statement, and will yield a program which serves as its own documentation. Control Data's Cobal will be ready in early 1963.

ALGOL Control Data will also have an Algol compiler early in 1963. Compiling speed will be fast and it will feature load-and-go operation. It will compile an efficient object code while retaining most of the features of Algol 60.

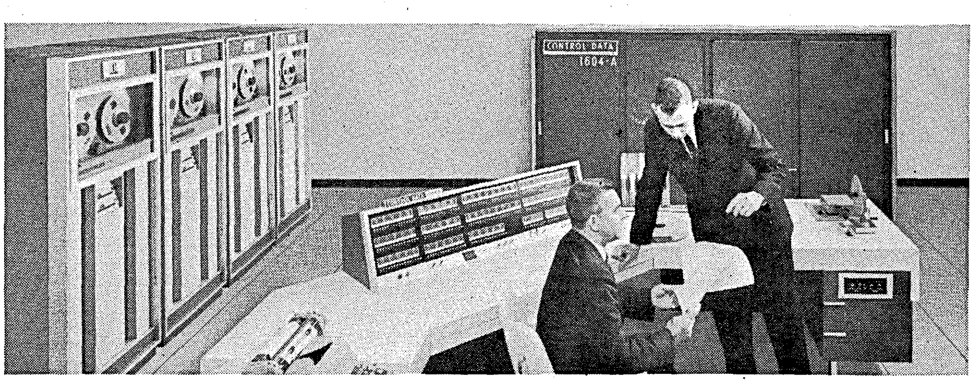
CODAP Control Data's assembler for the 1604/1604-A is CODAP. It provides a convenient symbolic machine language and enables automatic conversion of decimal and octal constants as they occur within a program.

CO-OP MONITOR CO-OP MONITOR is a master system which controls input/output, program interrupt and the use of a real-time clock without sacrificing flexibility. All Control Data compilers and assemblers operate within this system and object programs can be linked together by the loader in the CO-OP MONITOR system.

PERT Control Data's Program Evaluation and Review Technique provides management with an orderly and rapid planning and evaluation method, having print-out capabilities which keep the user easily in touch with the progress of his project.

CDM2 Control Data's linear programming system is written in Fortran and uses the Revised Simplex Method. It includes a master control system with maximum flexibility. Operating in single precision, it is considerably faster than competitive linear programming techniques. This is possible because of the 1604/1604-A 48-bit word length and the use of checking features which assure the preservation of significance.

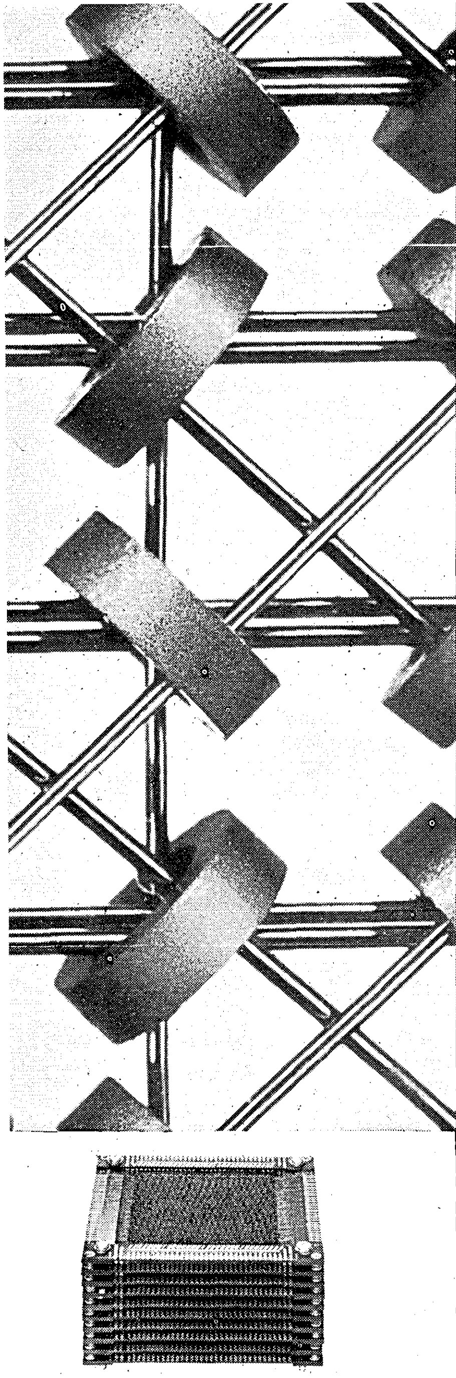
UPWARDS COMPATIBILITY Software systems compatible with the above are being implemented on the Control Data 3600 Computer, so that programming done for the 1604/1604-A can be used on the 3600 Computer. Additional, proven programming systems (including JOVIAL) are available through the CO-OP users organization.

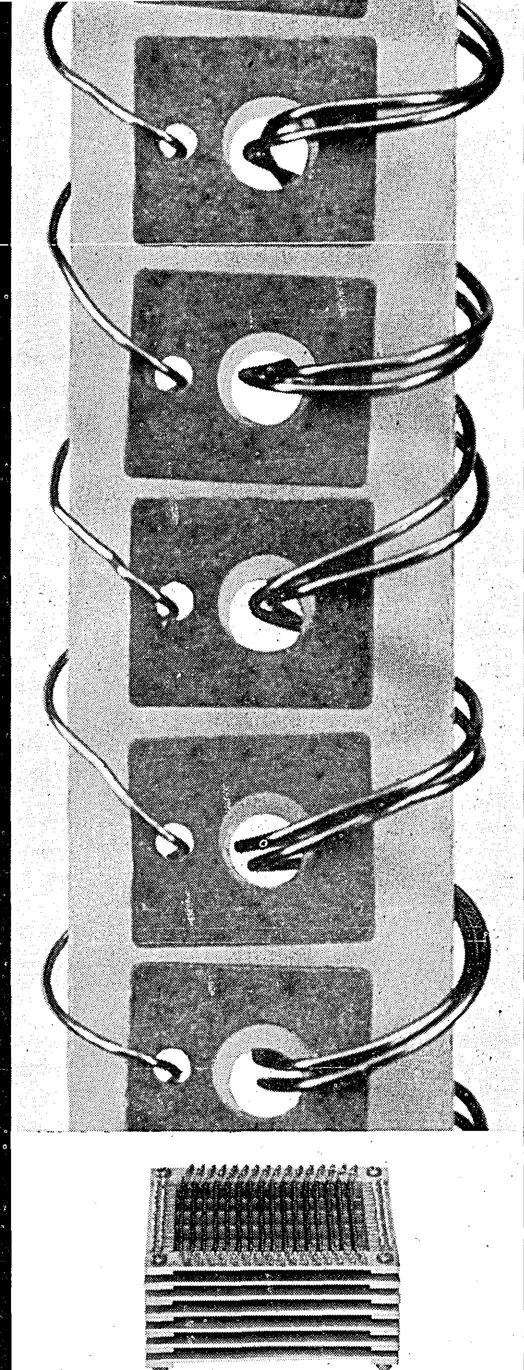


Offices: Albuquerque • Beverly Hills • Birmingham • Boston • Chicago • Cleveland • Dallas • Dayton • Denver • Detroit • Honolulu • Houston • Ithaca • Kansas City • Minneapolis • Newark • Norfolk • Orlando • Palo Alto • Philadelphia • San Diego • San Francisco • Washington, D.C.

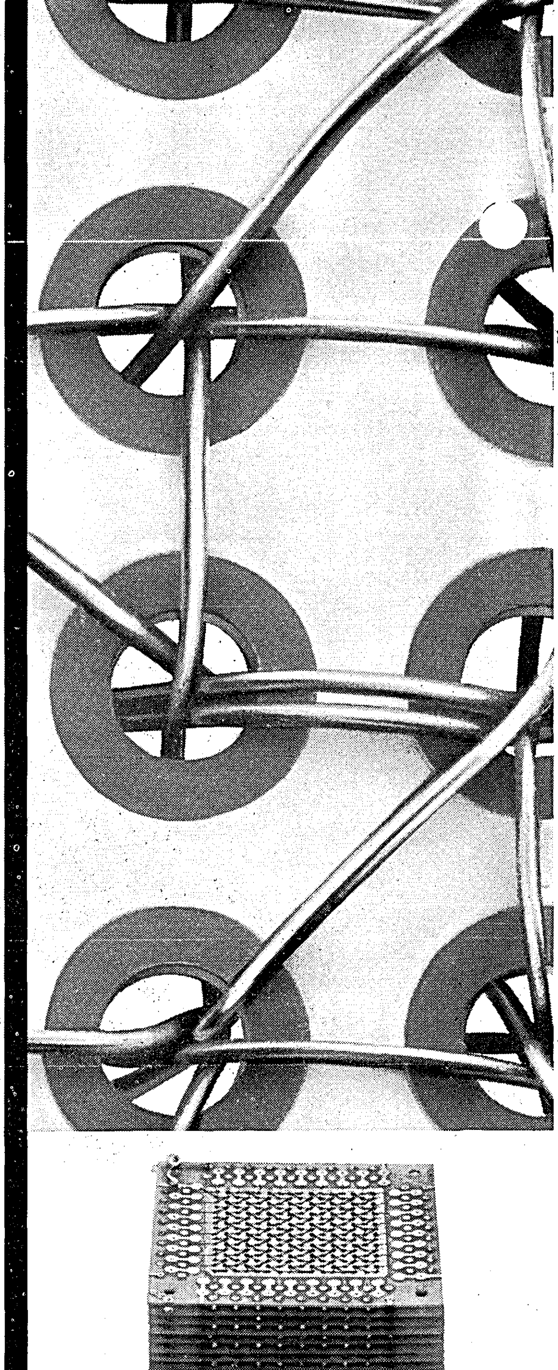
CONTROL DATA
CORPORATION

8100 34th AVENUE SO. • MINNEAPOLIS 20, MINN.





2.



3.

PRODUCTS PHOTOMACROGRAPHED APPROXIMATELY 30 TIMES ACTUAL SIZE

close-up of maximum reliability

ockheed Electronics' in-house capability produces ferrite ores, multi-aperture devices, printed circuit boards, memory lanes and stacks, plug-in circuit modules, and fabricated netal casings. Every step from design through test is under ne management to assure maximum quality control and ninimum cost.

he enlarged photos above show three of the many types of nemory plane assemblies produced by Lockheed Electronics.

. Standard commercial open frame ferrite core memory lane utilizing either coincident current or linear select wiring.

. Lockheed designed memory array using multi-aperture cores to provide non-destructive readout. This unique method of mounting and wiring provides the necessary rigidity for severe environmental applications.

3. Memory plane with conventional ferrite cores using imbedded assembly and wiring techniques to meet exceptionally high environmental shock and vibration requirements of military specifications.

For further information on Lockheed cores, memory planes and stacks, or printed circuitry to fill your particular requirements, write: Lockheed Electronics Company, 6201 East Randolph Street, Los Angeles 22, California.

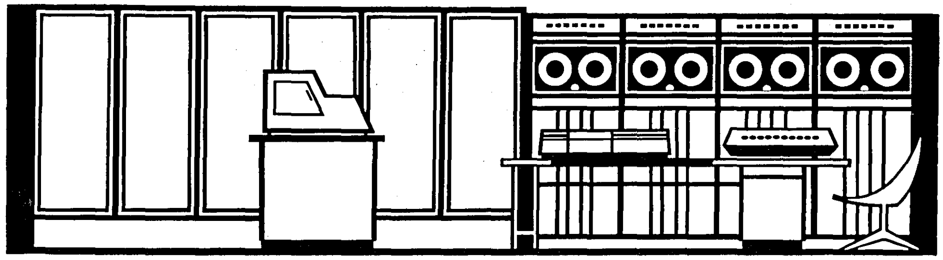
LOCKHEED ELECTRONICS COMPANY

A DIVISION OF THE LOCKHEED AIRCRAFT CORPORATION

CIRCLE 20 ON READER CARD

Don't shove. There's room for everybody.

Heavens. All these nice people (and others too shy to be mentioned) have installed one or more Honeywell computers so far: Massachusetts Institute of Technology; A. C. Nielsen Company; SRDS Data, Inc.; National Aeronautics & Space Administration (NASA) Michoud Operations; Chrysler Corporation (Engineering Division); General Motors Corporation; Batten, Barton, Durstine and Osborn, Inc.; Public Health Service of Cincinnati; U. S. Treasury Dept.; General Mills, Inc.; Book-of-the-Month Club, Inc.; New Hampshire Insurance Company; Savings Bank Life Insurance Council of Massachusetts; Amerotron Company; Army Finance Center; Military Assistance Program Logistics Agency; The First National Bank of Boston; Texas Eastern Transmission Corporation; Tennessee Gas Transmission Company; Minnesota Hospital Service; Gold Bond Stamp Company; Philadelphia Electric Company; Standard Pressed Steel Company; Associated Hospital Service of New York; Beech Aircraft Corporation; University of Southern California; Virginia Hospital Service Association; National Institutes of Health; National Weather Records Center; Hospital Service Corporation (Chicago); Australian Department of Defence; Equitable Life Assurance Society of the U.S.; Robert Hall Clothes, Inc.; American Angus Association; Defense Construction Supply Center; Army Map Service; Commission on Professional and Hospital Activities; Southern California Edison Company; Cannon Electric Company; If you write us right now at Wellesley Hills, Mass., we'll find a way to squeeze you in.



Honeywell

Electronic Data Processing

CIRCLE 21 ON READER CARD

NEWS BRIEFS

EDP AND CONSUMER FEEDBACK

Honeywell and Gift Stars, Inc., Minneapolis, have developed a merchandising program to provide information on product distribution, in-house inventories, buying habits, and marketing delays back to the sponsoring organization.

Gift Stars are coded coupons which are placed on consumer products. The name of the product, place of manufacture, how it was distributed and its approximate selling price can be encoded on the coupon. A frugal housewife saves these coupons, looks in a "wish" book, and eventually mail orders her "free" gift.

The mail order house (Gift Stars) has a special-purpose scanning device called an "Orthoscanner," made by Honeywell. The Orthoscanner is an optical scanner which has an off-connection to an H 400. The encoding technique has limited redundancy which will allow both the detection and the correction of some types of scanning errors. A 99.9 percent document acceptance rate is claimed.

NCR CONDUCTS DP COURSE FOR H.S. SENIORS

National Cash Register Co. is conducting a ten-week course in data processing which is attended by 53 high school seniors from 16 Dayton, Ohio, area schools. The course is designed to acquaint students with data processing as a profession and to encourage interest in developing skills at a university level.

Subjects include an introduction to data processing, instruction on flow charting and programming, and computer operation. Two courses are offered, one in scientific and the other in business applications.

The students were selected from 290 applicants on the basis of aptitude tests. The classes meet Saturday mornings, and are under the supervision of Harold M. Jarrett, director of training, and staff members Fred Pohl and Robert J. Brown.

FIFTH ANNUAL L.A. TECHNICAL SYMPOSIUM

The Fifth Annual One-Day Technical Symposium, sponsored by four Southern California ACM Chapters, was held at the Statler-Hilton Hotel, Los Angeles, on October 29. The day will probably go down as the smoggiest in the memory of many of the attendees.

The sessions were originally conceived to allow the younger members of the profession to present some of their work to a sympathetic local audience. This theme, however, was not followed for the fifth meeting.

The surprise of the day, though, was a paper presented by Gary Carlson, of Advanced Information Systems, concerning the errors made by operators of bank check sorting and totaling equipment. Carlson cataloged the errors, and was able to come up with meaningful statistics of their probability of occurrence. His work further indicated that operators were prone to the same type of errors regardless of experience.

The luncheon speaker, Dr. Willis Ware, chairman of the governing board of AFIPS, exhorted the computer industry to be concerned about its public image. He further admonished those in the industry to think about the goals of its professional societies, and to further consider what those goals should be.

RCA REPORTS 50% INCREASE IN FOREIGN EDP ORDERS

Orders for an additional 51 301s have been received by RCA for delivery to Compagnie des Machines Bull, France, and International Computers and Tabulators Ltd., England. The two firms had originally ordered 100 301s.

Machines Bull also placed an order for about $5 million worth of 301 components and peripheral equipment. The firm plans to produce RCA-designed computers in France.

RCA also announced that Hitachi, Ltd., Japan, may order $7 million worth of equipment and components in 1963. Initially, Hitachi contracted for ten 301s to be delivered this year.

U.S. WEATHER BUREAU INSTALLS STRETCH

The U. S. Weather Bureau's General Circulation Research Laboratory has installed an IBM STRETCH which will be used to simulate global weather. Ultimately, the computer is expected to simulate day-to-day weather changes at 10,000 points around the world, and will analyze surface weather patterns plus those at nine levels above the surface.

According to Dr. Joseph Smagorinsky, chief of the laboratory, computer simulation will be accomplished in this manner: a mathematical model will be constructed that embodies the complex equations that are believed to govern weather changes; a program will be written which will make a prediction when it is supplied with information on pressure, temperature, and other weather factors at the 10,000 points.

Finally, the results of the first prediction will be used to make a second prediction, the second for a third, and so on, until a sufficient series of predictions has been made for final analysis.

Initial study with the STRETCH system will be devoted to the refinement of known weather equations. Once a set of equations is developed that can closely approximate natural weather throughout long simulation experiments, then the equations can be adapted for long-range forecasts.

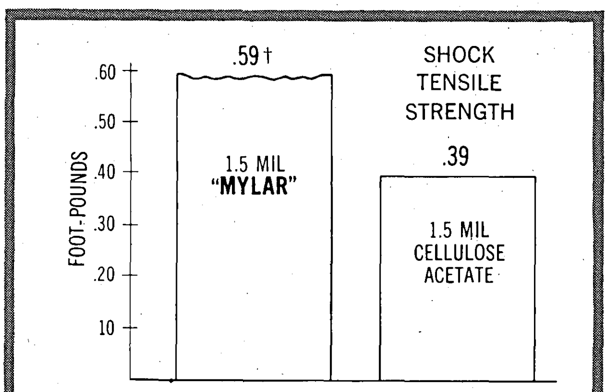
Memory capacity includes core storage of 65K words and disk storage of more than two million words.

COMMAND AND CONTROL IN THE SPACE AGE

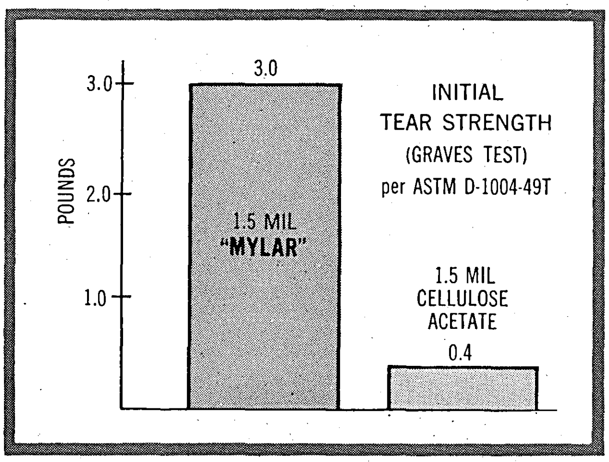
Command and control operations in a space environment will be basically similar to the systems employed in an "aero" environment, with current computer technology capable of meeting the requirements that would be imposed on system planners.

Speaking at the Air Force Association's 16th National Conference, Major General C. H. Terhune, Jr., commander of the Electronic Systems Division, Air Force Systems Command, said that while space C & C operations will be akin to those pres-

GUARD AGAINST DOWNTIME WITH RELIABLE TAPES OF MYLAR®



†Strength of "Mylar" exceeds potential energy of measuring device.



Every minute of downtime costs you dollars. That's why the reliability of your magnetic tape is so important. Tapes of Mylar*, resist breaking from sudden starts and stops since they have high shock-tensile strength . . . and they have 7 times the initial tear strength of acetate tapes.

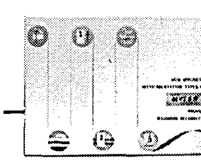
"Mylar" adds to the reliability of playback. It resists the cupping, swelling and shrinking which can reduce intimate head contact and cause read/write errors. Age, storage conditions and repeated playbacks won't affect "Mylar" either.

The cost of the data . . . the cost of the equipment . . . the cost of time *all* demand reliability. Get it with tapes of "Mylar". Send coupon for free booklet of comparative test data and judge for yourself. Du Pont Company, Film Department, Wilmington 98, Delaware.

*Du Pont's registered trademark for its polyester film.

DU PONT
REG. U. S. PAT. OFF.
Better Things for Better Living . . . through Chemistry

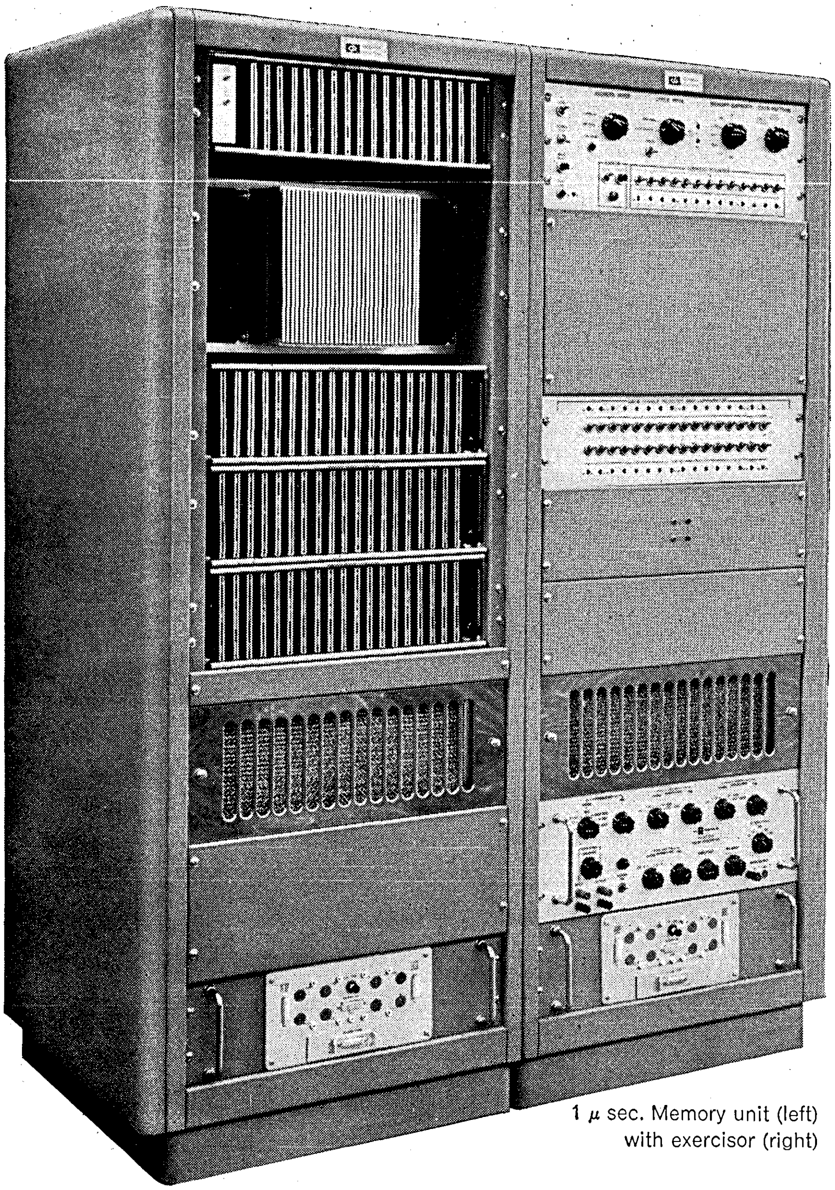
DU PONT **MYLAR®** POLYESTER FILM



E. I. du Pont de Nemours & Co. (Inc.)
Film Department, Room #12, Wilmington 98, Delaware
Please send free, 12-page booklet of comparative test data to help me evaluate magnetic-tape reliability.

Name________ Position________
Company________
Address________
City________ Zone____ State________

CIRCLE 22 ON READER CARD

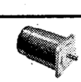
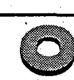
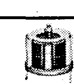


1 μ sec. Memory unit (left) with exercisor (right)

1 µ sec. word organized Memory System

. . . joins the broad line of Indiana General memory systems. "Terminal" switching — a new, more efficient switching technique developed by IGC engineers — offers you high read/write speed plus the time-proved reliability of FERRAMIC® core memory elements. ■ Sense windings and increment windings are wound to cancel increment noise pickup in the sense windings. ■ Drive currents are derived from a constant current source and switched to drive lines on command to eliminate problems of high current pulsing. ■ One-volt noise rejection built into all circuits. ■ All Logic Circuits utilize the Norlogic technique. ■ Sense amplifier has a wide band pass with a high signal-to-noise rejection ratio. ■ System is furnished with capacities in multiples of 2,048 words in all standard access modes — with shortest possible delivery. ■ Wide range of optional equipment available. ■ **Magnetic storage systems are our business.** We offer a wide range of main and buffer memory systems with virtually unlimited capacities and bit lengths, wide range of cycle speeds. **Write today for engineering data file on our new 1 μ sec. memory system to** Indiana General Corporation, Electronics Division, Keasbey, New Jersey.

INDIANA GENERAL

				
FERRITES	MICRO-STACKS®	MINIATURE MOTORS	PERMANENT MAGNETS	TC CORE ASSEMBLIES

CIRCLE 23 ON READER CARD

ently functioning, another generation of electronic developments will be needed. Some requirements have already been met, he said, naming microminiaturized components and coherent energy generators as two examples.

"What space operations will do is to raise the level of intensity of the problems of command," Gen. Terhune said, "and hence, the level of responsibility for the system designers. Decision-making time will be reduced still further. New and exotic weapons will challenge, if not bypass existing defense techniques . . ."

X3.4.4 TO DISCUSS COBOL STANDARDS

The ASA subcommittee on programming languages X3.4 has established a working group, X3.4.4, to give immediate attention to COBOL standards. X3.4 recognizes the CODASYL COBOL Maintenance Committee as the development and maintenance authority for COBOL.

X3.4.4 will have its organizational meeting on Jan. 15 and 16 at BEMA headquarters, 235 E. 42 St., N.Y.C. For information contact Howard Bromberg, Chairman, X3.4.4, RCA-EDP, Bldg. 204-2, Cherry Hill, N.J.

SUB-NANOSECOND DIODE OPERATED BY IBM

The Thomas J. Watson Research Center has operated experimentally a new semi-conductor diode which may allow switching in picoseconds (trillionths of a second). The calculated storage or recovery time of the diode is about one picosecond, but available equipment has not yet been possible to measure such a short storage time.

The new device is one of the first to successfully exploit the potential of heterojunctions — junctions between different semiconductors. It is made by the vapor growth which permits n-type germanium to "grow" on n-type gallium arsenide and assume the same crystal lattice structure.

An important characteristic of the diode is that its switching time is independent of the current to be switched, and may provide high speed switching at relatively high current levels (40-50 milliamperes) for the first time.

UNIVAC FORMS OEM DEPARTMENT

The UNIVAC division of Sperry Rand Corp. will market a wide range of equipment to computer, communications, and control equipment manufacturers. At first, standard equipment utilized in the full line of UNIVAC computers will be offered, to include card readers, card punches, printers, memory drums, and mag tape units.

Also planned are full engineering, manufacturing, and marketing of special equipment and devices as required by the original equipment manufacturers. Named to head the department was George A. Hagerty, who will report directly to UNIVAC president Louis T. Radar.

● The University of Alabama will install a UNIVAC 1107 at its Research Institute in Huntsville. The 1107 will be used to assist the national space and missile effort through research in the aerospace physical sciences. The computer will be operated by both university and UNIVAC personnel. Delivery was scheduled for the fall of 1963.

● An EAI HYDAC computer has been ordered by McDonnell Aircraft Corporation's Automation Center, St. Louis. The hybrid computer is made by Electronic Associates, Inc., Long Branch, N. J.

CIRCLE 100 ON READER CARD

● The First National Bank of Wilkes-Barre, Pa., is operating a B251 for demand deposit accounting, plus proof and transit operations. The system can be programmed to select, update and re-file account ledgers during processing without operator intervention.

● An RCA 301 with a fast access Bryant disc file, MICR reader and sorter, card and paper tape I/O, printer, and mag tape units, has been ordered by National Computer Analysts, Inc., Princeton, N. J. The system, scheduled for delivery early next year, will provide services in the banking field, including demand deposit accounting, savings accounting, mortgage loan accounting, etc.

CIRCLE 101 ON READER CARD

● A General Dynamics/Electronics S-C 4020 computer recording system has been leased to the Data Reduction Branch of NASA's Computation Center at Huntsville, Ala. The 4020 will be used with two 7090s to convert data from spacecraft instrumentation into graph form.

CIRCLE 102 ON READER CARD

● The U. S. Army Electronics Research and Development Laboratories, Fort Monmouth, N. J., has successfully completed "torture" and operation acceptance of Philco's Basicpac, a medium-sized military computer. The computer is in the Fieldata line of data processors.

● S. Himmelstein and Co., Chicago engineering firm, will conduct a research and engineering program in mag tape recording technology for the Naval Research Laboratory. The program will consist of design, construction and test of readout transducers, plus R & D efforts in tape dynamics, tape guidance, signal circuitry and "media conservation."

○ The first UNIVAC III for the overseas market was shipped to CIBA Ltd., Basel, Switzerland, recently. The system, including eight UNISERVO III mag tape units, printer, card reader and card punch, will be used for production control, sales statistics, payroll, scientific calculations and "codeless scanning."
CIRCLE 103 ON READER CARD

○ The Management Systems Division of Operations Research Incorporated, Santa Monica, has been awarded a $242,000 contract by the U.S. Navy for further implementation of the Reliability Maturity Index (RMI) throughout the Polaris program.

○ RCA is building a computer test set for the U. S. Navy Electronics Laboratory, San Diego, Calif., to monitor transmission within large data communications and processing systems. The device, said to be smaller than a shoe box, uses 94 micromodules incorporating 143 digital circuits, and will accomodate one output and 32 input signals, with a total of five distinct operating functions.

○ AC Spark Plug, El Segundo, Calif., has announced a 24 bit, 4K airborne digital computer named MAGIC for missiles and aircraft. The device is made of solid-state "micrologic" elements packaged in a magnesium heat sink. To date, 500 MAGIC hours of operation have been accumulated.
CIRCLE 104 ON READER CARD

○ A workshop on Programming Langauges for Automatic Checkout of hardware is being sponsored by the Computer Programming Subcommittee of the Computing Devices of the AIEE. For more information, contact Burton H. Went, Battelle Memorial Institute, 505 King Avenue, Columbus 1, Ohio.

○ Eastern Air Lines has ordered an ITT 7300 ADX Automatic Data Exchange System which will coordinate and expedite information flow, including aircraft movement, flight and crew schedules, weather forecasts, interline sales and management analysis. The system will be directly connected with Eastern's reservations center in Charlotte, N. C. (where a UNIVAC 490 is installed) and data processing operations at Miami, Fla.
CIRCLE 105 ON READER CARD

○ An automatic program interrupt feature for use with UNIVAC SS 80 and 90 computers has been made available by UNIVAC. The feature can be installed within 90 days in the factory or field. Monthly rental is $60; purchase price, $3,000.

○ General Electric will supply digital computer equipment to the U. S. Military Academy's new Academic Computer Center. One computer will be installed during the current term, and the system will be expanded to include three computers of the same type prior to the start of the next academic year. The computer type was not specified.

○ Computer Control Co., Inc., Framingham, Mass., has delivered a random-sequential core memory system to Haskins Laboratories to be used in studies in speech simulation and analysis. The unit is capable of

NEWS BRIEFS . . .

generating addresses internally in binary counters of adjustable length and perform logic functions by using S-PAC digital logic modules.

● Informatics, Inc., Culver City, has been awarded a contract by Bendix Computer Div. to assist in adapting the G-20 SPACE programming system from mag tape to disc file operation. The Socony Mobil Research Center, Paulsboro, N. J., will be one of the first users to utilize a G-20 with only disc for external memory.

● Vanderbilt University, Nashville, Tenn., has placed an order for an IBM 7072 and 1401, with delivery scheduled for early 1963. A new building to house the Computer Center is currently under construction. Director of the Center is Howard Rolf.

● A compiler language called CORC (CORnell Computing language) has been prepared by the Department of Industrial Engineering and Administration at Cornell University. The language, to be taught to all sophomores in the sciences and engineering, has been implemented for both the Burroughs 220 and CDC 1604. Programs can be compiled and run on either machine, without modification.

● A UNIVAC 490 Real-Time System will be installed at Westinghouse Electric Corporation's new Tele-Computer Center in Pittsburgh. When in operation, the 490 will maintain real-time communication with all Westinghouse offices, factories, warehouses, and sales branches in the U. S. and Canada.

CIRCLE 106 ON READER CARD

● The Digital Equipment Computer Users Society (DECUS) held its second annual meeting in October, hosted by the AF Cambridge Research Laboratories, Hanscom Field, Bedford, Mass. One of the papers presented described the uses of a PDP-1 as peripheral equipment for Lawrence Radiation Laboratory's STRETCH, LARC, and 7090s.

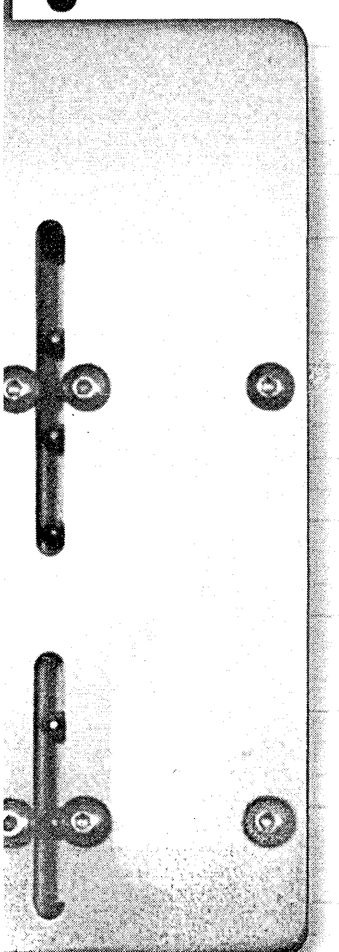
● Iowa State University, Ames, has installed a 7074-1401 system, replacing a 650, according to Ralph W. Klopfenstein, director of the Computation Center. Time on the system will fall into three categories: block-time on a contractual basis; unit-time at an hourly rental rate for sponsored research, and free time for unsponsored research by graduate students and staff.

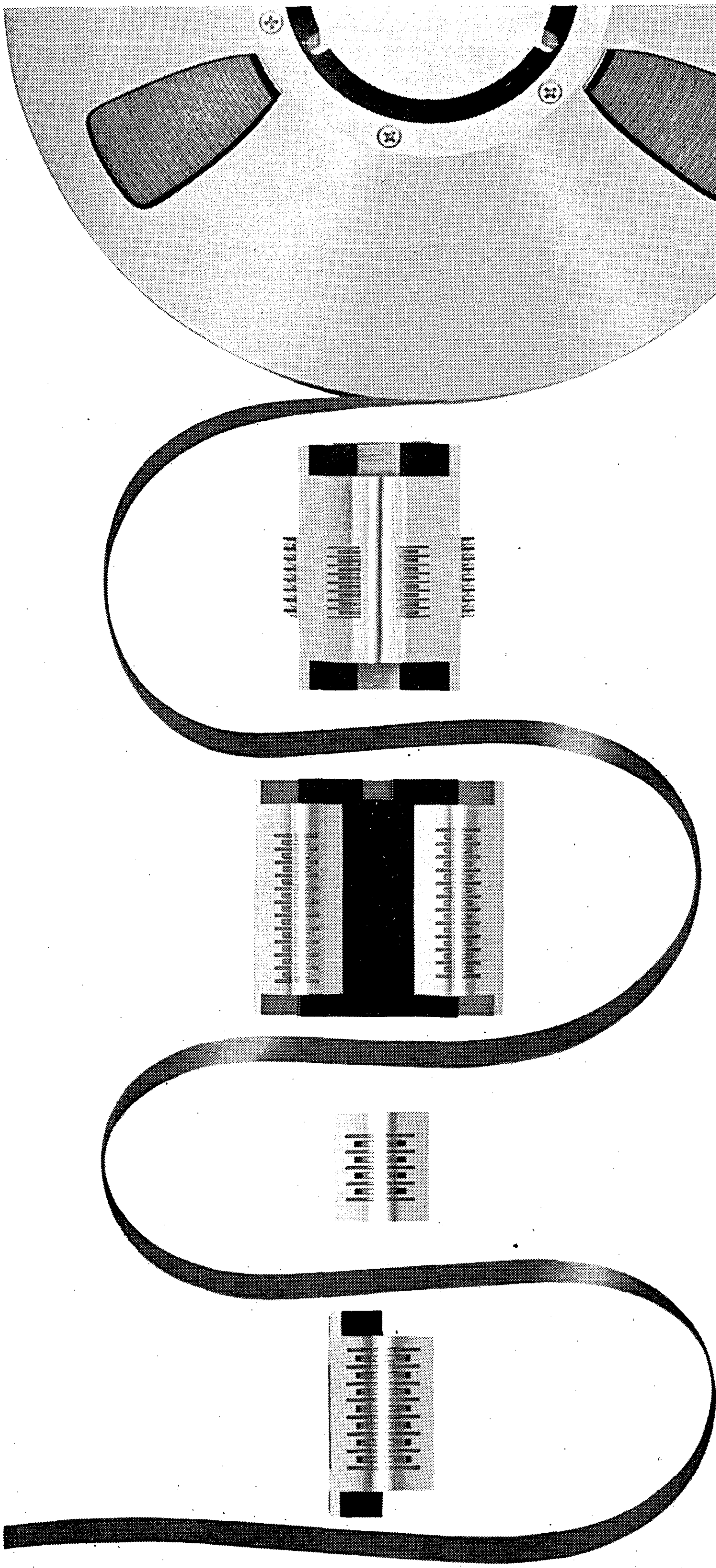
● A Digitronics data converter is being used at Spiegel, Inc., a leading mail order company, to gather sales data derived from 25,000 to 55,000 orders daily in catalog sales. The device converts sales information from punched paper tape to mag tape for computer input.

● Development of a program for collecting and analyzing statistics on the characteristics of U. S. letter mail will be carried out by C-E-I-R, Inc., under a contract awarded by the Post Office Department. Some ten cities will be surveyed, as to the size of envelopes, color of ink, typed or handwritten addresses, and the class of mail. Study of the information will lead to development of machines which will be capable of reading the address and sorting letters for delivery to destinations throughout the world.

CIRCLE 107 ON READER CARD

```
C     ATTENTION—SCIENTIFIC PROGRAMMERS
      DIMENSION AREA (5)
      AC SPARK PLUG =
     1 THE ELECTRONICS DIVISION OF GENERAL MOTORS
      CHALLENGING OPPORTUNITIES = LOS ANGELES + MILWAUKEE

      PROJECTS = APOLLO + TITAN II + TITAN III

      DO 1 I = 1,5

      YOU = AREA (I)

      IF (INTERESTED) 1, 1, 2

    1 CONTINUE

      GO TO 4

C     POSITIONS AVAILABLE ARE CONCERNED WITH SIMULATION

C     OF GUIDANCE AND CONTROL SYSTEMS, SATELLITE AND TRAJECTORY

C     STUDIES, LOGICAL DESIGN, NUMERICAL ANALYSIS, STATISTICAL

C     ANALYSIS, ELECTRONIC SYSTEM DESIGN AND SYSTEMS CALIBRATION

      AREA(1) = FLIGHT DATA REDUCTION

      AREA(2) = MISSILE TRAJECTORY SIMULATIONS AND TARGETING

      AREA(3) = SYSTEMS ANALYSIS AND DESIGN

      AREA(4) = NUMERICAL CONTROL

      AREA(5) = NUMERICAL METHODS

    2 PRINT 3, RESUME

    3 FORMAT (110H AC SPARK PLUG, G. F. RAASCH, DIRECTOR OF SCIENTIFIC
     1 AND PROFESSIONAL EMPLOYMENT,
     2 DEPT 57-53, MILWAUKEE 1, WISCONSIN, 110)

      RESUME = DEGREE + FIELD + EXPERIENCE

C     DEGREE IS B.S. OR M.S. IN THE FIELDS OF

C     MATHEMATICS, PHYSICS OR ENGINEERING WITH TWO YEARS

C     704-7090 EXPERIENCE

C

C     AN EQUAL OPPORTUNITY EMPLOYER

    4 STOP

      END
```





P. S. Computape doesn't really talk, of course. But in a computer, Computape *reliability* will deliver its own message. New COMPUTAPE, the premium quality computer and instrumentation tape, is the product of the only company devoted exclusively to the manufacture of quality tapes for data processing and instrumentation. *Investigate new Computape today. Better still, immediately.*

Send today for your free magnetic tape booklet.

COMPUTRON INC.
122 Calvary Street, Waltham, Massachusetts

CIRCLE 26 ON READER CARD

NEW PRODUCTS

line printer

The H207 features a speed of 300 lines per minute when 64 characters are printed and has a print ribbon with three times former life, it is claimed. Also featured are inter-

changeable print drums, permanently timed hammers and a swing-up drum arm. HOLLEY COMPUTER PRODUCTS CO., 11955 E. Nine Mile Road, Warren, Mich. For information:

CIRCLE 200 ON READER CARD

photoelectric tape reader

The 7109 is bi-directional and operates synchronously or asynchronously at speeds up to 100 frames per second. It is available in eight or 16-channel configurations. The reader operates at temperatures from −40° F. to 160° F. SEATTLE DEVELOPMENT LAB., HONEYWELL ORDNANCE DIV., 5303 Shilsole Ave., N. W., Seattle 7, Wash. For information:

CIRCLE 201 ON READER CARD

air conditioning

The Site Environmental System is a specially designed air conditioning unit which meets the specifications of all major computer manufacturers for temperature, humidity and filtration control, it is claimed. FLOATING FLOORS INC., 22 E. 42nd St., New York 17, N. Y. For information:

CIRCLE 202 ON READER CARD

microfilm printer

The TD-943 is able to read digital data from computers or mag tapes, print information, and plot both curves and lines on cathode ray tubes to produce both microfilm and hard copy. Input is accepted at speeds up to 62,500 characters per second and the system has a peak printing speed of over 29,000 lines per minute. TRANS-DATA, INC., 1000 N. Johnson Ave., El Cajon, Calif. For information:

CIRCLE 203 ON READER CARD

punched tape verifier

In addition to handling paper tape, the ADS-04 is able to operate with oiled paper, Mylar, or aluminum-Mylar laminate in lengths up to 1000 feet, spooled or fanfold, in any combination at speeds up to 60 characters per second. ADVANCED DATA SYSTEMS CORP., 2037 Granville Ave., Los Angeles 25, Calif. For information:

CIRCLE 204 ON READER CARD

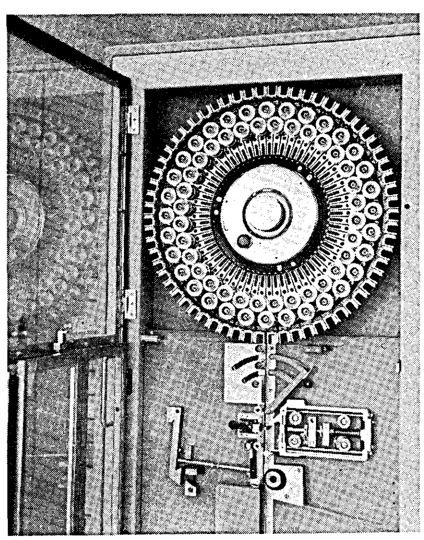
instrumentation recorder

This recorder features seven bi-directional tape speeds of 1⅞, 3¾, 7½, 15, 30, 60 and 120 ips, which are electrically selectable. Capstan speed is held accurate to within .02% by phase lock to a crystal-controlled reference frequency. PRECISION INSTRUMENT CO., 1011 Commercial St., San Carlos, Calif. For information:

CIRCLE 205 ON READER CARD

random-access tape transport

The Facitape ECM 64 Carousel features a platter which holds 64 tape reels, each containing 29½ feet of ⅝″, eight-track mag tape. Average access time of this random-access device is approximately two seconds. Packing density is approximately 200



bits/inch; tape speed is 16.4 feet/sec. Price will be in the $25,000 range, with delivery scheduled for six to eight months. AUTONETICS INDUSTRIAL PRODUCTS, 3400 E. 70th St., Long Beach 5, Calif. For information:

CIRCLE 206 ON READER CARD

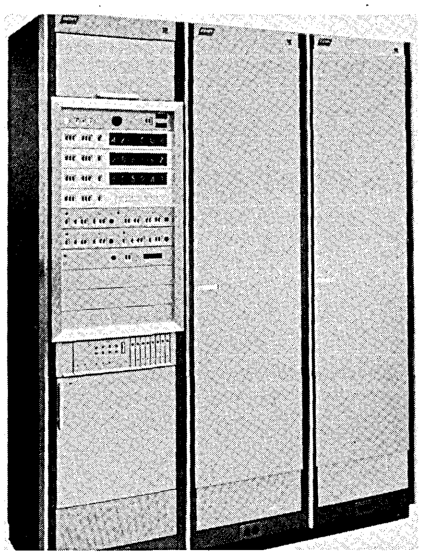
mag tape unit

The D2020 is fully IBM compatible for tape formats of 200 and 556 bits per inch and has a 30 inches per second bi-directional drive with a five ms start time and 1.5 ms stop time. DATAMEC CORP., 345 Middlefield Rd., Mountain View, Calif. For information:

CIRCLE 207 ON READER CARD

pcm telemetry data processor

Model 285 is able to accept variable word-length data within a frame in any word pattern, has a range of one bit per second to one million bits per second and has remote or manual format selection. Data outputs avail-



able include BCD, truncated (four to fourteen bits) or untruncated (four to sixty-four bits) broadside or serial . . . parallel recording output. ELECTRO-MECHANICAL RESEARCH, INC., Sarasota, Fla. For information:

CIRCLE 208 ON READER CARD

photovoltaic readout cell

The HTA 121 is especially suited for reading punched tape and punched cards. The cell is self-generating and has a response time of less than 10 microseconds. HELIOTEK, 12500 Gladstone Ave., Sylmar, Calif. For information:

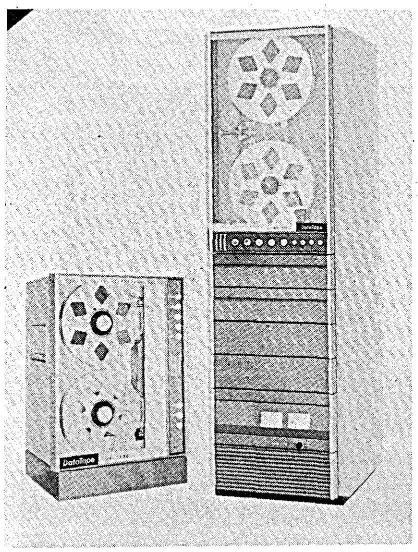
CIRCLE 209 ON READER CARD

gp 6144 bit buffer

The 2000 has been specially designed to provide the needed speed conver-

sion between I/O devices and voice frequency data transmission systems in the communications field. Both input and output proceed asynchronously at speeds up to 3000 words per second and are able to operate simultaneously. DATA SYSTEMS, INC., 20535 Mack Ave., Grosse Pointe Woods 36, Mich. For information:
CIRCLE 210 ON READER CARD

mag tape recorder/reproducer
The VR-2800 and VR-3300 are two wide-band mag tape recorder/reproducer systems, each with a frequency range from 0 cps to 200 kc. The former is a laboratory-type instrument which uses either ½″ or 1″ width

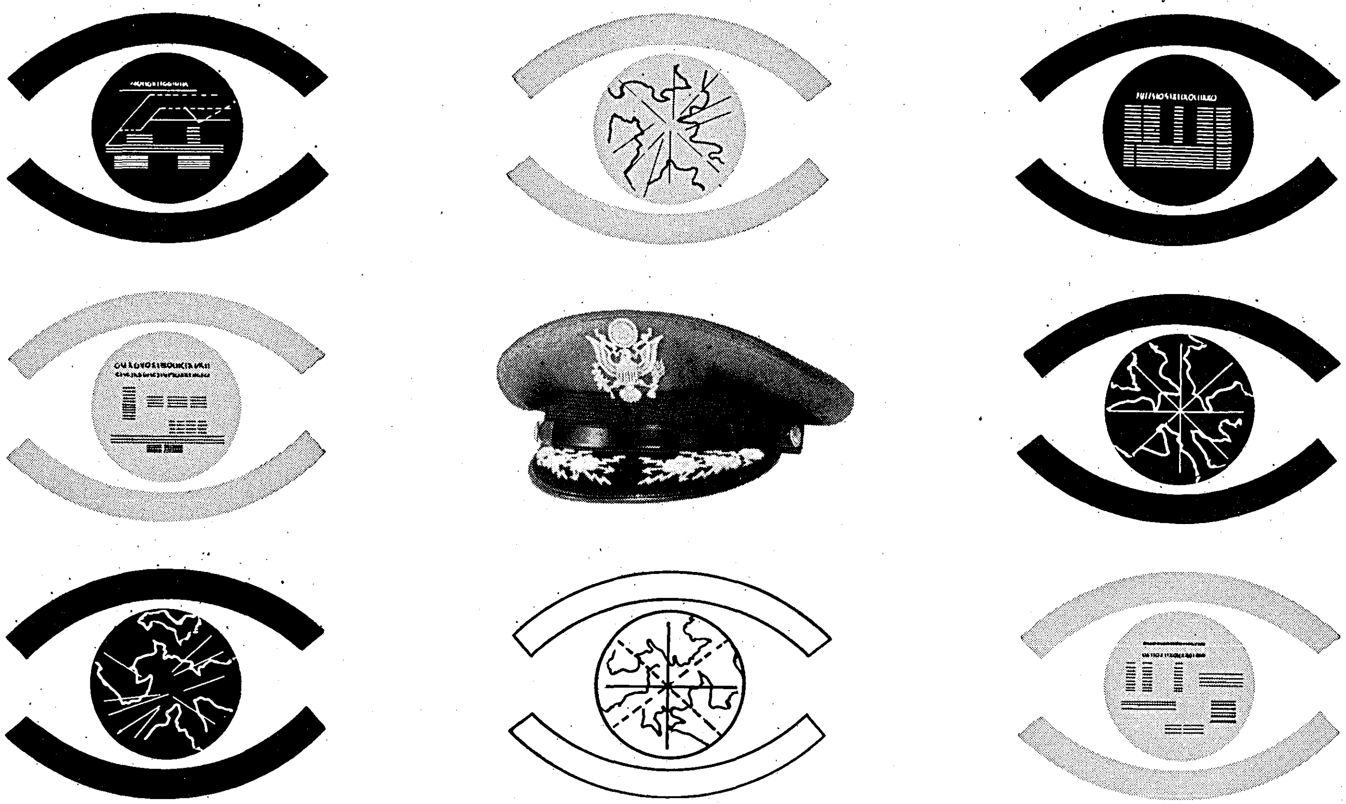


tape. The VR-3300 is a portable system. CONSOLIDATED ELECTRODYNAMICS CORP., 360 Sierra Madre Villa, Pasadena, Calif. For information:
CIRCLE 211 ON READER CARD

display driver modules
The QX 12, for incandescent displays and the QX 14, for Nixie displays, operate at temperatures from 0 - 100°C and allow direct decoding of any of the following codes: (8,4,2,1), (2,4,2,1), (5,4,2,1), (4,2,2,1), (Excess 3) or (Gray). Price for the QX 12 is $120 and $165 for the QX 14. SCIENTIFIC DATA SYSTEMS, 1542 15th St., Santa Monica, Calif. For information:
CIRCLE 212 ON READER CARD

photoelectric code converter
Model 190 is able to convert at speeds of 20 characters per second, any five to eight bit code to any five to eight bit code by interchanging code discs. Model 190 is priced at $500. Model 190E is also available, with complete circuitry for full conversion and buffering, for $2000. INVAC CORP., 26 Fox Rd., Waltham 54, Mass. For information:
CIRCLE 213 ON READER CARD

CRUCIAL SYSTEMS CHALLENGES OF THE '60's



Combating Information Saturation

Today's decisions at the highest level of military command require a range, precision and speed of communication and information processing beyond virtually anything conceivable in the past. Further, optimization of the electronic portion of a command control system cannot be considered independently of the capabilities of the ultimate, human decision-maker in the chair of command.

A good case in point is the SAC global command and control system 465-L, for which ITT International Electric Corporation carries systems development, design and management responsibilities. In order to further multiply the effectiveness of the military commander, faced with the crucial task of assimilating vast quantities of information projected on the screens before him, ITT engineers and scientists recently added a remarkable new capability to 465-L: **data presentation in color.**

Operating at speeds that appeared incredible only a short time ago, the system enables computer outputs to be converted to alpha-numeric form . . . photographed . . . developed and projected on control center screens in as many as 7 colors in a matter of seconds.

This new capability opens up a whole new field of data format techniques to be explored. An obvious and immediate value is the enhancement of human perception through color changes denoting differing degrees of situation criticality.

OPPORTUNITIES IN MANY COMMAND AND CONTROL AREAS NOW OPEN TO SYSTEMS ENGINEERS AND SENIOR PROGRAMMERS

Many of these positions are on 465-L. Other opportunities relate to large-scale commercial digital communication systems, oceanic systems, and satellite control. Your inquiry about any of the positions listed below will receive immediate attention.

PROGRAMMERS/ANALYSTS. For real-time programming analysis and development. Broad activities encompass advanced programming systems, including special color display routines; diagnostic programs; automatic recovery; problem-oriented language; artificial intelligence.

OPERATIONS ANALYSTS. To establish systems requirements in satellite control, air traffic control, ASW and command/control. Also, assignments in man/machine communications and information retrieval.

SYSTEMS IMPLEMENTATION ENGINEERS. Electronic engineers to develop tests for stressing and evaluating communication-display-computer systems. Recommend improvement and refinements. Also, field positions for installation and integration of digital command/control systems.

INFORMATION SYSTEMS ENGINEERS. For design of command/control and advanced communications systems. Experience in traffic, antenna and propagation theory, and mathematics as applied to communications and space technology.

DIGITAL SYSTEMS ENGINEERS. Engineers with management ability to direct sub-systems engineering effort on a global command/control system. Experience is desired in message traffic control, data processing systems, data display and multi-sequencing techniques.

Write fully in strict confidence to Mr. E. A. Smith, Manager of Employment, Box 35-C, ITT-International Electric Corporation, Route 17 and Garden State Parkway, Paramus, New Jersey.

An Equal Opportunity Employer

ITT

INTERNATIONAL ELECTRIC CORPORATION

CIRCLE 88 ON READER CARD

people IN DATAMATION

■ New director of the Princeton Computation Center of Electronic Associates, Inc., is Walter Brunner, who was previously a senior applications engineer with EAI. The center, one of four which EAI operates, conducts analog computer studies in all areas of scientific research, rents computer time and conducts primary and advanced courses in analog computer techniques.

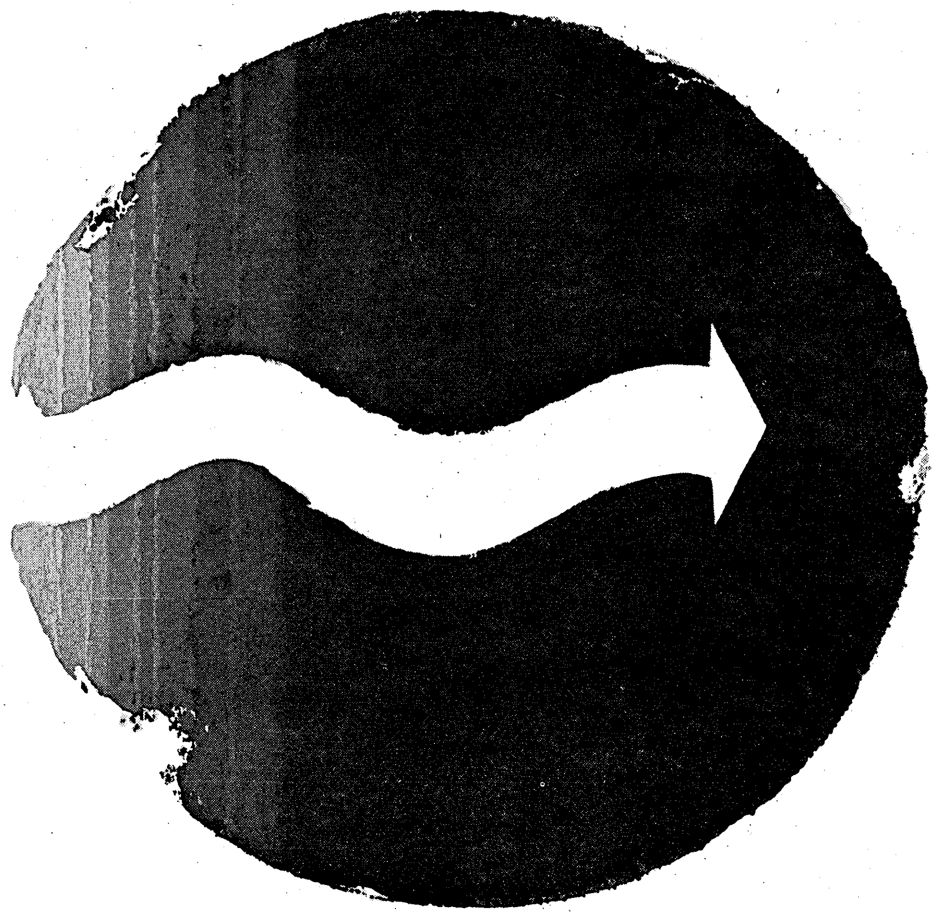
■ The RCA EDP division has announced the promotions of Arnold K. Weber to division VP and general manager, and Edwin S. McCollister to division VP, business planning and marketing. Weber will still be responsible for the overall direction of RCA dp activities, while McCollister will continue to be responsible for all marketing activities, including sales and product planning.

■ Jack D. Little has joined Planning Research Corporation, Los Angeles, as a senior associate in the firm's Information Sciences Division. Little, formerly with THE RAND Corp., will be deputy director of the Information Sciences Department.

■ William W. Eaton, a director and vice president of C-E-I-R, Inc., has resumed private consulting practice. Eaton, one of the original co-founders of C-E-I-R, will be available to the company on a part-time basis as required, and will contiue as VP and director.

■ New general manager of Packard Bell Computer is J. J. McDonald, who will direct engineering, manufacturing, and marketing of computers and other digital systems, equipment and components. McDonald was formerly vice president in charge of engineering and research at Consolidated Systems Corp.

■ The Electrada Corporation, Los Angeles, has announced the appointment of Paul S. Collins as vice president, corporate planning and product development. Collins was previously director, special projects, Hughes Aircraft Co.



NEW LITERATURE

OSCILLOGRAPH: Type 5-119 recording oscillograph is described in this 16-page bulletin. Features, capabilities, and specifications are offered. CONSOLIDATED ELECTRODYNAMICS CORP., 360 Sierra Madre Villa, Pasadena, Calif. For copy:
CIRCLE 130 ON READER CARD

WATT CONVERTER: This technical bulletin includes features and specifications of the T357 computer module. AVTRON MANUFACTURING, INC., 10409 Meech Avenue, Cleveland 5, Ohio. For copy:
CIRCLE 131 ON READER CARD

G-15 CPM/PERT: Features of the G-15 Critical Path Method and PERT program are noted in this four-page brochure. BENDIX COMPUTER DIV., 5630 Arbor Vitae St., Los Angeles 45, Calif. For copy:
CIRCLE 132 ON READER CARD

MEMORY SYSTEM: This brochure explains selections of operating modes, options and systems capacities of a five-usec memory system. RCA SEMICONDUCTOR & MATERIALS DIV., COMMERCIAL ENGINEERING, Somerville, N. J. For copy:
CIRCLE 133 ON READER CARD

AUTOMATOR MODULE: A technical bulletin describes this self-powered relay-type programmer. Characteristics, relay ratings, construction, compatibility and specifications are offered. TRIO LABORATORIES, INC., Plainview, L. I., N. Y. For copy:
CIRCLE 134 ON READER CARD

LOGIC CIRCUITS: A six-page bulletin describes the DMC 100 Digital Micro Circuit and its ratings, gives worst-case design considerations and analyzes test and evaluation results. RCA, COMMERCIAL ENGINEERING DEPT., Somerville, N. J. For copy:
CIRCLE 135 ON READER CARD

REDUCTION EQUIPMENT: This four-page booklet describes a new line of acquisition and reduction equipment for track and range data. Information on a high speed velocity plotter, space-time receiver, space-time quantizer and data display unit is included. RESDEL ENGINEERING CORP., 990 S. Fair Oaks Ave., Pasadena, Calif. For copy:
CIRCLE 136 ON READER CARD

DATAFINDER: An illustrated brochure features a device for assisting keypunchers in preparing complex forms. Its operational features are listed. TAB PRODUCTS, CO., 550 Montgomery St., San Francisco 11, Calif. For copy:
CIRCLE 137 ON READER CARD

SENIOR PROGRAMMERS

"Help solve the Common Language Problem"

Packard Bell's new PB-440 Dual Memory Stored Logic, "Common Language" Computer has created unusual opportunities for the Senior Programmer interested in Micro-Programming the PB-440 so that it will be capable of utilizing machine language programs of other computers. To assist in the Micro-Programming of command sets optimized for specific application areas.

If your background includes creation of assemblers, interpreters, compilers or function evaluation routines on conventional computers, please send resume to Mr. G. G. Feijoo.

PACKARD BELL COMPUTER

1905 Armacost Ave.
Los Angeles 5, Calif.

An equal opportunity employer.

CIRCLE 92 ON READER CARD

NCR

EDP OPPORTUNITIES

Present and planned expansion has created new opportunities for qualified personnel:

- **SYSTEMS ANALYSTS**
  Background in manufacturing systems of inventory and production control using punched card techniques. Programming aptitude or experience desirable. Willing to relocate. Future assignments in South, East, and Mid-west.
- **PRODUCT PLANNER**
  Sufficient technical and systems knowledge to assist in definition of equipment for proposed lines. Some marketing knowledge desirable.
- **SYSTEMS ENGINEER**
  EDP experience plus equipment engineering background. Work in Product Planning relating design needs to customer needs from marketing viewpoint.
- **CUSTOMER INSTALLATION REPRESENTATIVES**
  2-5 years' experience in computer programming, college background and systems analysis work in commercial or scientific areas. Locations vary.

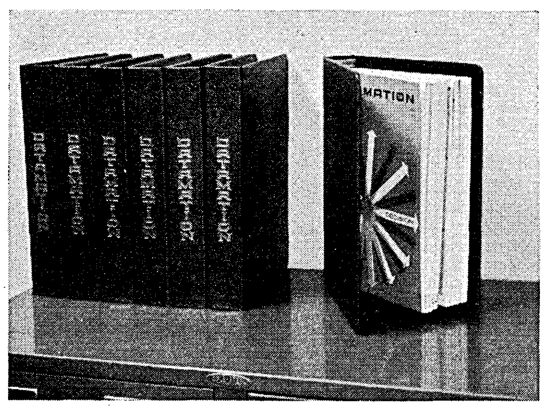
REPLY IN CONFIDENCE TO:

T. F. Wade, Technical Placement
The National Cash Register Co.
Dayton 9, Ohio

An Equal Opportunity Employer

CIRCLE 93 ON READER CARD

DATAMATION



BINDERS

5.95 FOR SET OF TWO

POSTPAID

Here is the easy way to protect your back copies of DATAMATION. Each of these attractive, durable binders, made of washable, simulated Morocco, will accommodate six copies of DATAMATION. The binders are the answer to fast, easily-obtainable reference material.

Complete coupon at right indicating number of sets desired and amount of check enclosed.

DATAMATION
141 East 44th Street, New York 17, N. Y.

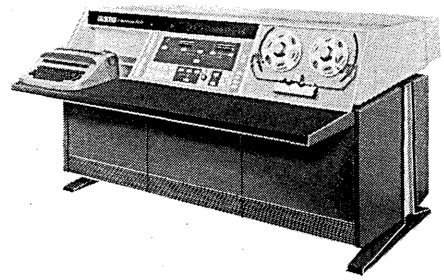
Please Send Me ______ Sets of Datamation Binders; $______ enclosed

NAME ______ ADDRESS ______

CITY ______ ZONE ______ STATE ______

ADVERTISERS' INDEX

Get full details on the PB440 at the FJCC: BOOTHS 145-148



PB 440

"THE COMMON-LANGUAGE COMPUTER"

PACKARD BELL BREAKS THE COMPUTER LANGUAGE BARRIER

NOW—a small computer designed so that your programmer can **create a command list to fit his particular problem.** A program written with his commands will require less memory and take less machine time than one he would write if restricted to the single command list of conventional computers. Example: Our programmers created a command list especially for use in writing a scientific compiler. Object programs produced by the resultant FORTRAN II compiler require about half the memory and run far faster than corresponding programs for conventional computers.

INTERCHANGEABLE PROGRAMS—You can use your existing FORTRAN library on the latest high-speed hardware without reprogramming... run PB440 FORTRAN programs on other computers... even program the PB440 to utilize your existing machine language library.

The PB440 is a product of a new technology we call Dual Memory-Stored Logic. Its tremendous power can be applied to realtime systems, scientific/engineering problems, business data processing...wherever computers have an application.

The PB440 has an outstanding display console, can add in one microsecond, input-output at speeds to 800 kc, has program interrupt and many other brilliant features. Call or write today for complete data on the computer which is establishing a new plateau in the technology.

Condensed Specifications

DUAL MEMORY

Main Memory:	Size	4096 words expandable to 28,672
	Speed	5 microseconds cycle time
	Word Length	24 bits single precision 36 bits expanded precision 48 bits double precision
Logic Memory:	Size	256 words expandable to 4,096
	Speed	1 microsecond read time

INPUT-OUTPUT—Typewriter, and choice of paper tape, cards, line printer, magnetic tape.

System input-output transfer rates 140,000 words per second. 400,000 characters per second (optional 800,000 characters per second).

EXECUTION TIMES (24 bit fixed point operands)

add	1 to 11 microseconds
subtract	3 to 13 microseconds
multiply	25 to 33 microseconds
divide	47 to 57 microseconds

FOR FULL INFORMATION ON THE PB440 WRITE:

pb Packard Bell Computer

1931 ARMACOST AVENUE, LOS ANGELES 25, CALIFORNIA
A Division of Packard Bell Electronics

CIRCLE 2 ON READER CARD

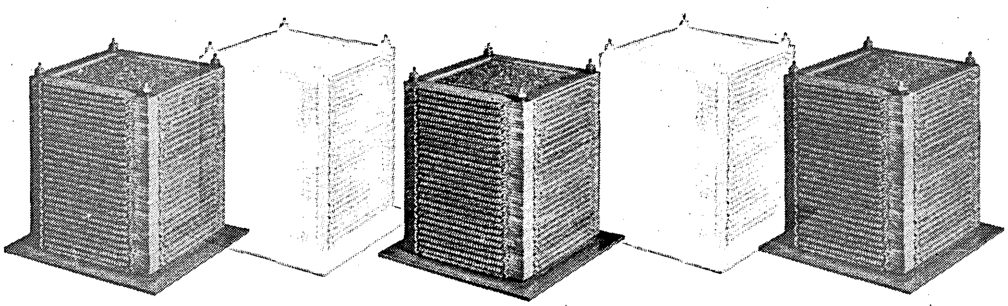
FIRST FAST NON-DESTRUCTIVE READOUT IN FERRITE MEMORIES

Now, all the stability and dependability of ferrite memories with non-destructive read-outs for repeat functions. Ferroxcube Biax memory units are available in element, plane, or stack configurations for use in digital, general data processing or data reduction systems. The Biax memory core has two orthogonal holes, with related flux fields running at 90° to each other. Data storage is accomplished by saturating the ferrite material around one hole in the desired polarity direction. Upon command, an interrogating pulse is fed through the other hole, sensing the polarity, but not destroying the field, permitting an infinite number of read-outs without rewrites.

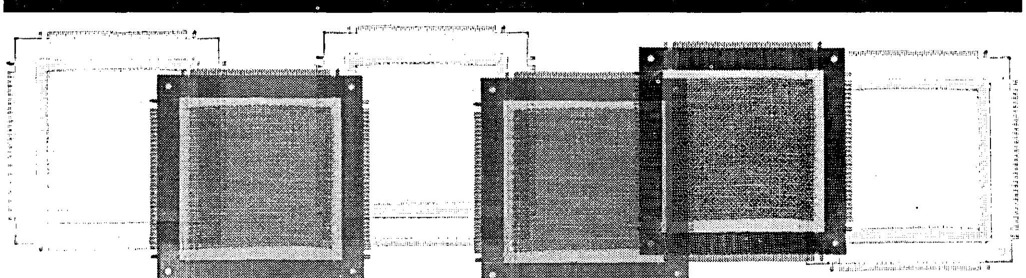
AVAILABLE RIGHT NOW!

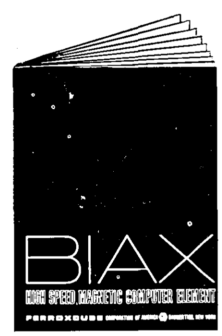
BIAX

...IN ELEMENTS, PLANES OR STACKS



READ AS FAST AS .05 USEC/WRITE AS FAST AS 2 USEC WITH 100 mA DRIVE





WRITE
for your copy of complete theory and engineering data on **BIAX MEMORIES**

FIRST IN FERRITES

FERROXCUBE CORPORATION OF AMERICA/SAUGERTIES, N.Y.

CIRCLE 3 ON READER CARD