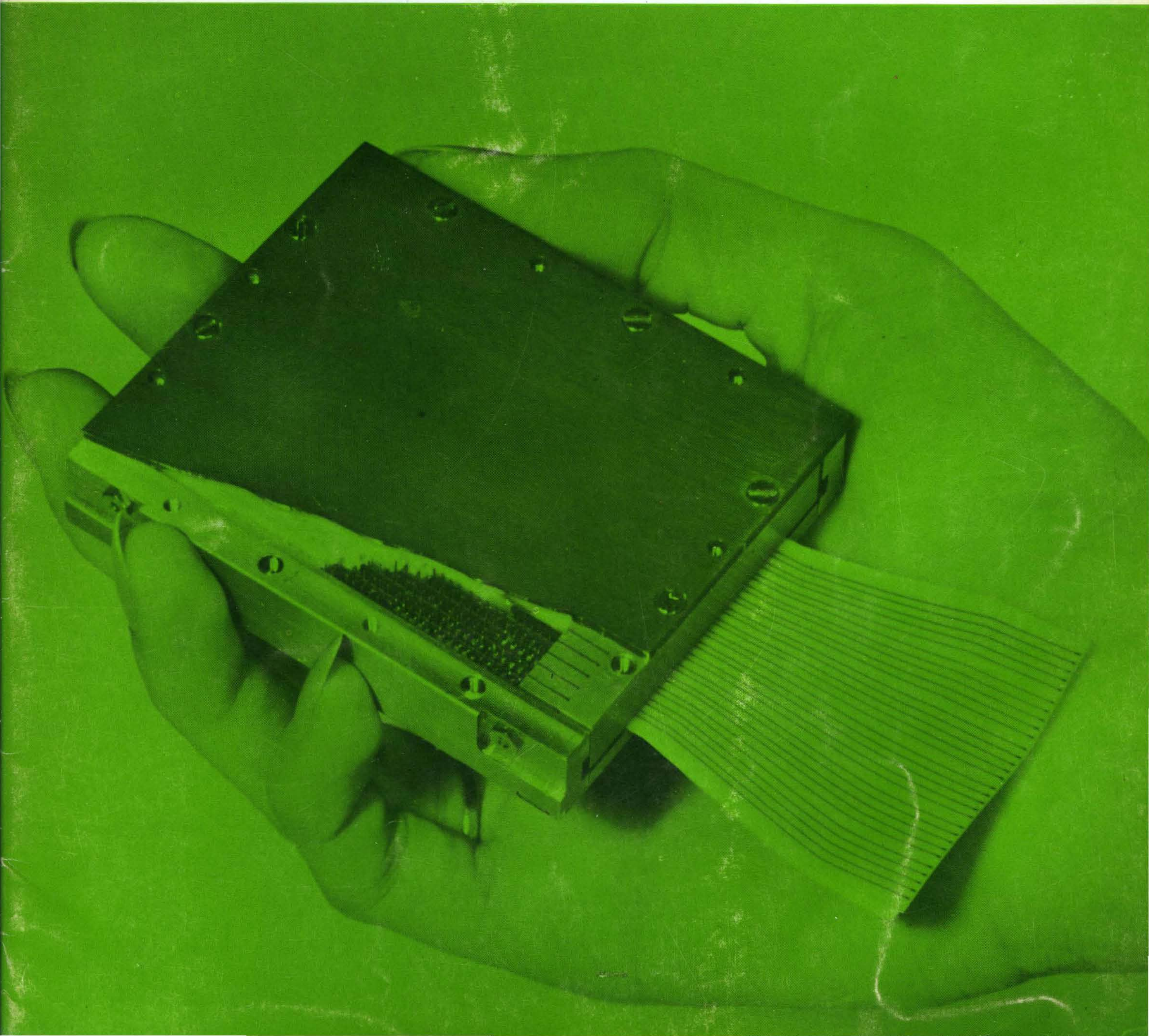
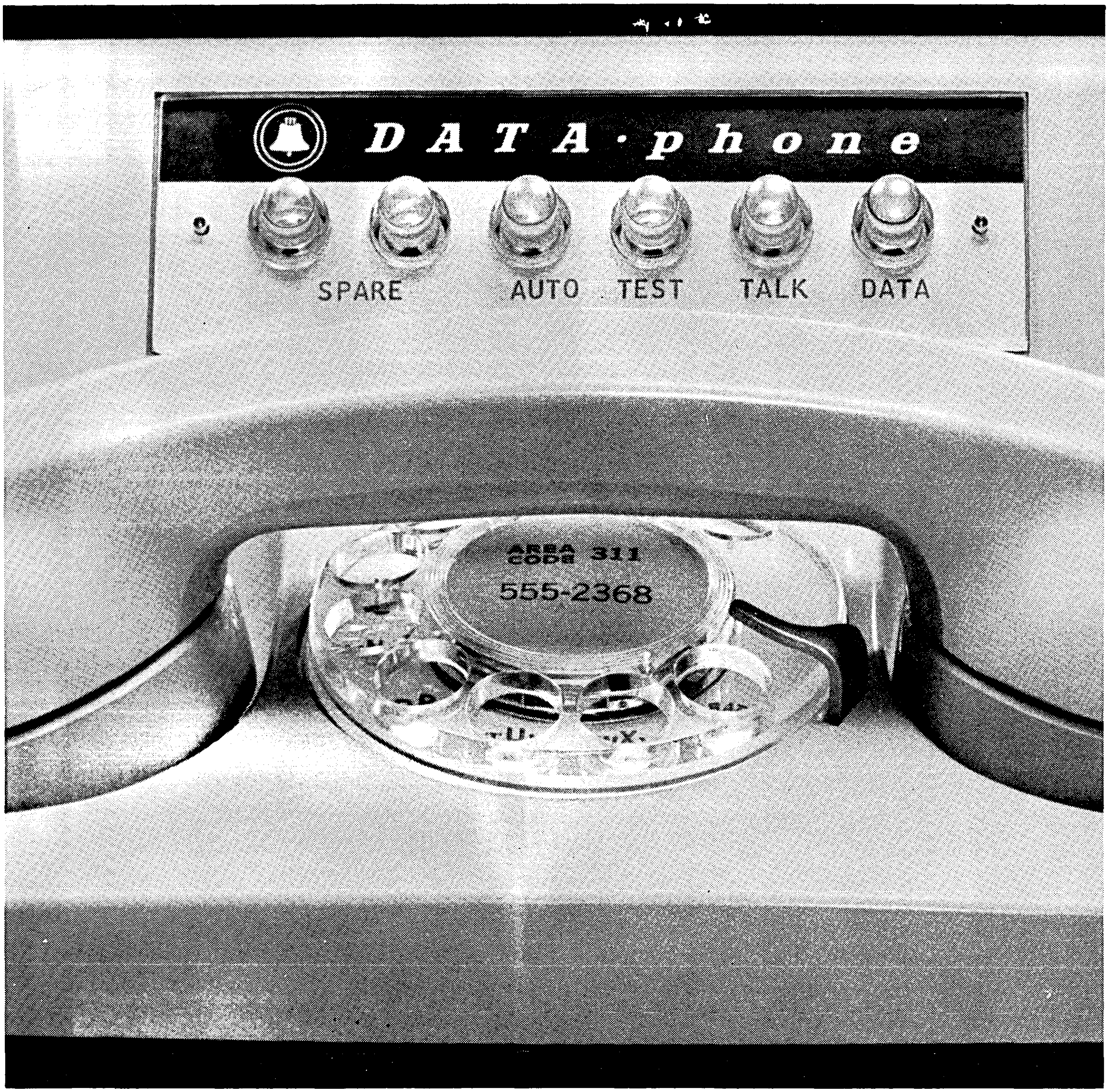
February, 1963

computers and automation

A Computer in the Hand Is Worth. . . ?





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DATA-PHONE service can save time and money for your business . . . give you tight control of operations. Talk to one of our Communications Consultants about it. Just call your Bell Telephone Business Office and ask for him.

Bell Telephone System

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.

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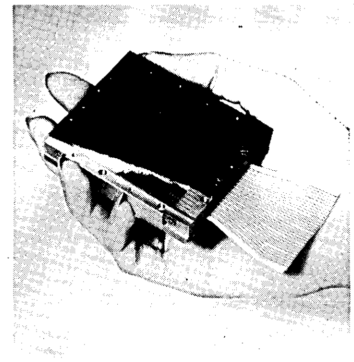

The "Computer in the Hand" this month is one of the six modules of a new thin-film, microtonic computer performing 125,000 additions per second in a space less than 0.2 cubic feet.
Story and more pictures on page 40.

computers and automation

FEBRUARY, 1963 Vol. XII, No. 2

computers and data processors: construction, applications, and implications, including automation

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COMPUTERS AND AUTOMATION IS PUBLISHED MONTHLY AT 815 WASHINGTON ST., NEWTONVILLE 60, MASS., BY BERKELEY ENTERPRISES, INC. PRINTED IN U.S.A. SUBSCRIPTION RATES: UNITED STATES, $15.00 FOR 1 YEAR, $29.00 FOR 2 YEARS, INCLUDING THE JUNE DIRECTORY ISSUE; CANADA, ADD 50c A YEAR FOR POSTAGE; FOREIGN, ADD $1.50 A YEAR FOR POSTAGE. ADDRESS ALL EDITORIAL AND SUBSCRIPTION MAIL TO BERKELEY ENTERPRISES, INC., 815 WASHINGTON ST., NEWTONVILLE 60, MASS.

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Readers' and Editor's Forum

"AMERICAN COMPUTERS—A VIEW FROM POLAND"—CORRECTION

Dr. Wladyslaw Turski
Computation Centre
Polish Academy of Sciences
Warsaw, Poland

I feel greatly honored by your publication of my comments made while I was attending the Conference of the Association for Computing Machinery in Syracuse in September, in the report which appeared on page 8 of the October issue of your widely read monthly.

I'd like to take this occasion to say that the paper I presented there was written jointly with Dr. M. Greniewski; this is not clear from the report you have published in **"Computers and Automation."**

Also, although this is far less important, the correct spelling of my name is "Turski"; and I am not related to the famous Polish mathematician and logician Professor A. Tarski.

"A HISTORY OF WRITING COMPILERS" —COMMENT

Margaret H. Harper
Drexel Hill, Pa.

Donald E. Knuth's article in your December 1962 issue titled "A History of Writing Compilers" overlooks some early history.

In early 1953 Dr. Grace M. Hopper had a mathematical compiler called "A-Zero" running on Univac I at that time.

The IBM 650 did not even exist in 1953; so it is unlikely that Dr. Perlis had written IT at that time.

ASSOCIATION FOR COMPUTING MACHINERY, 1963 ANNUAL MEETING, AUGUST 27-30, DENVER, COLORADO

(Based on information from W. H. Eichelberger, General Chairman, 1963 ACM National Conference, University of Denver, Denver 10, Colorado.)

The Association for Computing Machinery will hold its 18th National Conference August 27 to 30, 1963, at the Denver Hilton Hotel in Denver, Colorado. Continuing the policy of the past two years, there will be an International Data Processing Exhibit as a part of the conference. The University of Denver is Host Institution for this conference. Program Chairman is Fred P. Venditti.

Call for Papers

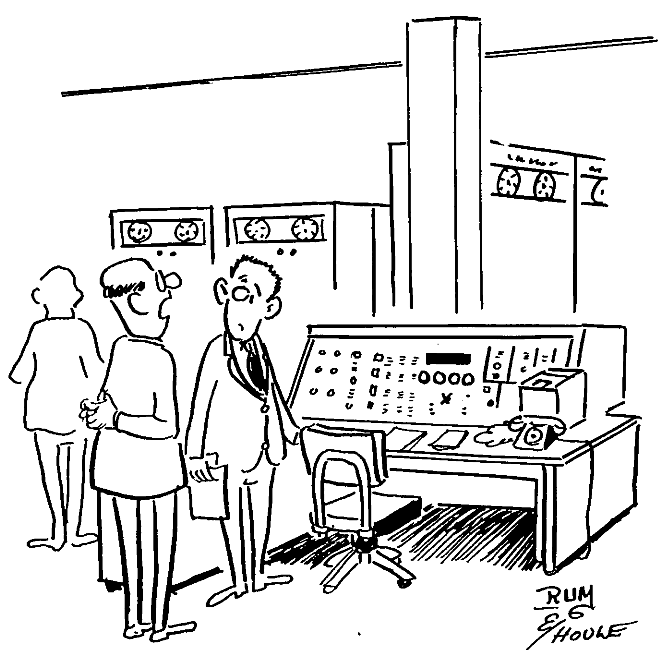
The ACM National Meeting presents each member of the computing community the opportunity to contribute to the professional growth and enlightenment of his contemporaries. The program committee recognizes that all serious endeavors are worthy of reporting. The final acceptance will, of course, be based primarily upon the content and significance of the contribution in an effort to present to the membership papers of the highest possible quality. Each member of the computing community is invited and encouraged to participate professionally in this 18th national meeting of the ACM.

Contributed papers are encouraged on any computer-related topic. Each person wishing to contribute a paper to the program must send four copies each of a 100-word abstract and an 800-word summary by April 15, 1963, to: Fred P. Venditti, Program Chairman, 1963 ACM National Conference, University of Denver, Denver 10, Colorado.

The time for presentation of each contributed paper will be 10 minutes followed by 5 minutes for discussion.

Papers must have a specific title. The author's name and affiliation must appear on each page of all copies of both abstract and summary. The abstract and summary must represent the true content of the paper. The abstract will be included in the printed program of the meeting, and will be the only information published by the conference concerning the paper.

EDP — IN 25 WORDS OR LESS



"Explain how it works — but briefly"

CALENDAR OF COMING EVENTS

Feb. 4-8, 1963: ASTM Committee Week, Queen Elizabeth Hotel, Montreal, Canada

Feb. 11-15, 1963: 5th Institute on Information Storage and Retrieval of the School of Government and Public Administration of The American University, International Inn, Washington, D. C.; contact Dr. Lowell H. Hattery, Director, Center for Technology and Administration, The American University, 1901 F St., N.W., Washington 6, D. C.

Feb. 20-22, 1963: International Solid State Circuits Conference, Sheraton Hotel and Univ. of Pennsylvania, Philadelphia, Pa.; contact S. K. Ghandi, Philco Scientific Lab., Blue Bell, Pa.

Mar. 6-7, 1963: Disc File Symposium, Hollywood Thunderbird Inn, Hollywood Calif.; contact Dr. Walter F. Bauer, Informatics Inc., 8535 Warner Dr., Culver City, Calif.

Mar. 15-16, 1963: Pacific Computer Conference, California Institute of Technology, Pasadena, Calif.; contact Dr. E. J. Schubert, Systems Division of Beckman Instruments, Inc., 2400 Harbor Blvd., Fullerton, Calif.

Mar. 19-21, 1963: Symposium on Bionics, sponsored by Aeronautical Systems Div. of the Air Force Systems Command, Wright-Patterson Air Force Base, Ohio, Biltmore Hotel, Dayton, Ohio; contact Commander, Aeronautical Systems Div., Attn.: ASRNEB-3, Lt. Col. L. M. Butsch, Jr., Wright-Patterson Air Force Base, Ohio

Mar. 23, 1963: 7th Annual Symposium on Recent Advances in Computer Technology, Battelle Memorial Institute, Columbus, Ohio; contact R. K. Kissinger, Publicity Chairman, c/o Nationwide Insurance Companies, 246 No. High St., Columbus, Ohio.

Mar. 25-28, 1963: IRE International Convention, Coliseum and Waldorf-Astoria Hotel, New York; contact Dr. D. B. Sinclair, IRE Headquarters, 1 E. 79th St., New York 21, N. Y.

Apr. 16-18, 1963: Optical Masers Symposium, United Eng. Center, New York, N. Y.; contact Jerome Fox, PIB Microwave/Res. Inst., 55 Johnson St., Brooklyn 1, N. Y.

Apr. 17-19, 1963: International Conference on Nonlinear Magnetics (INTERMAG), Shoreham Hotel, Washington, D. C.; contact J. J. Suozzi, BTL Labs., Allentown, Pa.

Apr. 17-19, 1963: Southwestern IRE Conference and Elec. Show (SWIRECO), Dallas Memorial Auditorium, Dallas, Tex.; contact Prof. A. E. Salis, E. E. Dept., Arlington State College, Arlington, Tex.

April 23-25, 1963: The Eleventh National Conference on Electromagnetic Relays, Student Union Bldg., Oklahoma State University, Stillwater, Okla.; contact Prof. Charles F. Cameron, Technical Coordinator of the NARM, Oklahoma State University School of Electrical Engineering, Stillwater, Okla.

April 24-26, 1963: Power Industry Computer Application Conference, Hotel Westward Ho, Phoenix 4, Ariz.; contact E. J. Lassen, 453 E. Lamar Rd., Phoenix 12, Ariz.

May 7-9, 1963: 1963 Electronic Components Conference, International Inn, 14th & M Sts., N.W., Washington 5, D. C.; contact J. E. Hickey, Chilton Co., Chestnut & 56th Sts., Philadelphia 39, Pa.

May 13-15, 1963: National Aerospace Electronics Conference (NAECON), Biltmore Hotel, Dayton, Ohio; contact IEEE Dayton Office, 1414 E. 3rd St., Dayton, Ohio.

May 17-18, 1963: Symposium on Artificial Control of Biology Systems, Univ. of Buffalo, School of Medicine, Buffalo, N. Y.; contact D. P. Sante, 4530 Greenbriar Rd., Williamsville 21, N. Y.

May 20-22, 1963: National Symposium on Microwave Theory and Techniques, Miramar Hotel, Santa Monica, Calif.; contact Irving Kaufman, Space Tech. Labs., Inc., 1 Space Park, Redondo Beach, Calif.

May 20-22, 1963: National Telemetering Conference, Hilton Hotel, Albuquerque, N. M.; contact T. J. Hoban, NTC Program Chairman, Sandia Corp., P. O. Box 5800, Albuquerque, N. M.

May 21-23, 1963: Spring Joint Computer Conference, Cobo Hall, Detroit, Mich.; contact Dr. E. Calvin Johnson, Bendix Aviation Corp., Detroit, Mich.

June 11-13, 1963: National Symp. on Space Electronics and Telemetry, Los Angeles, Calif.; contact John R. Kauke, Kauke & Co., 1632 Euclid St., Santa Monica, Calif.

June 19-21, 1963: Joint Automatic Control Conference, Univ. of Minn., Minneapolis, Minn.; contact Otis L. Updike, Univ. of Va., Charlottesville, Va.

June 23-28, 1963: ASTM 66th Annual Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

June 25-28, 1963: Data Processing Management Association's 12th International Data Processing Conference and Business Exposition, Cobo Hall, Detroit, Mich.; contact DPMA Headquarters, 524 Busse Highway, Park Ridge, Ill.

July 15-17, 1963: 3rd Annual Rochester Conference on Data Acquisition and Processing in Medicine and Biology, Whipple Auditorium, Univ. of Rochester Medical Center, Rochester, N. Y.; contact Kurt Enslein, 42 East Ave., Rochester 4, N. Y.

July 22-26, 1963: 5th International Conference on Medical Electronics, Liege, Belgium; contact Dr. L. E. Flory, RCA Labs., Princeton, N. J.

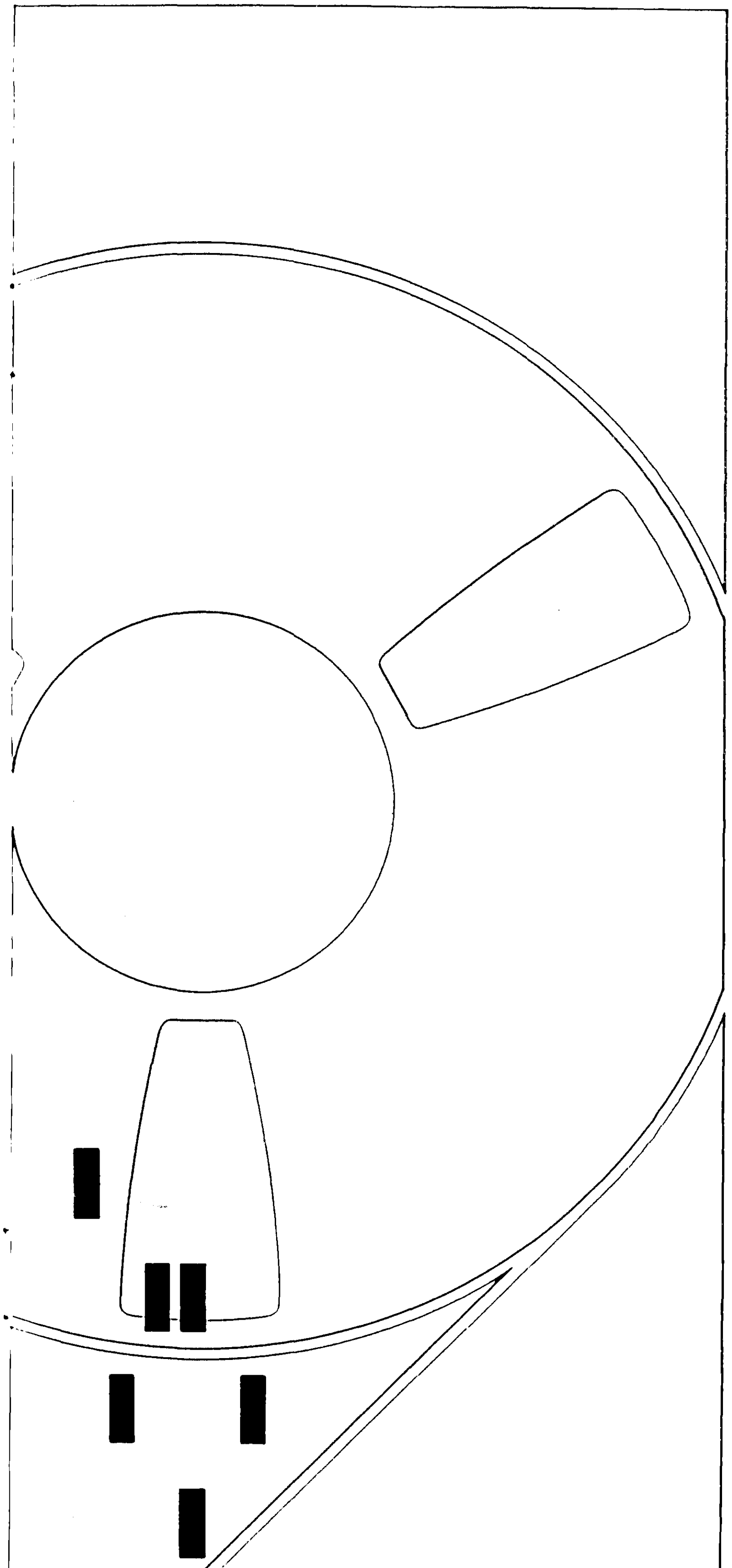
Aug. 4-9, 1963: International Conference and Exhibit on Aerospace Support, Sheraton-Park Hotel, Washington, D. C.; contact F. K. Nichols, Air Defense Div. Directorate of Operations, DSC/O Hdqs., USAF, Washington 25, D. C.

Aug. 20-23, 1963: Western Elec. Show and Conference (WESCON), Cow Palace, San Francisco, Calif.; contact WESCON, 1435 La Cienega Blvd., Los Angeles, Calif.

Aug. 27-Sept. 4, 1963: 2nd Congress, International Federation of Automatic Control, Basle, Switzerland; contact Dr. Gerald Weiss, E. E. Dept., Polytechnic Inst., 333 Jay St., Brooklyn 1, N. Y.

Sept. 9-11, 1963: 7th National Convention on Military Electronics (MIL-E-CON 7), Shoreham Hotel, Washington, D. C.; contact L. D. Whitelock, Exhibits Chairman, 5614 Greentree Road, Bethesda 14, Md.

Sept. 24-27, 1963: International Telemetering Conference, London, England; contact L. L. Rauch, Univ. of Mich., Dept. of Aero Engrg., Ann Arbor, Mich.



economy

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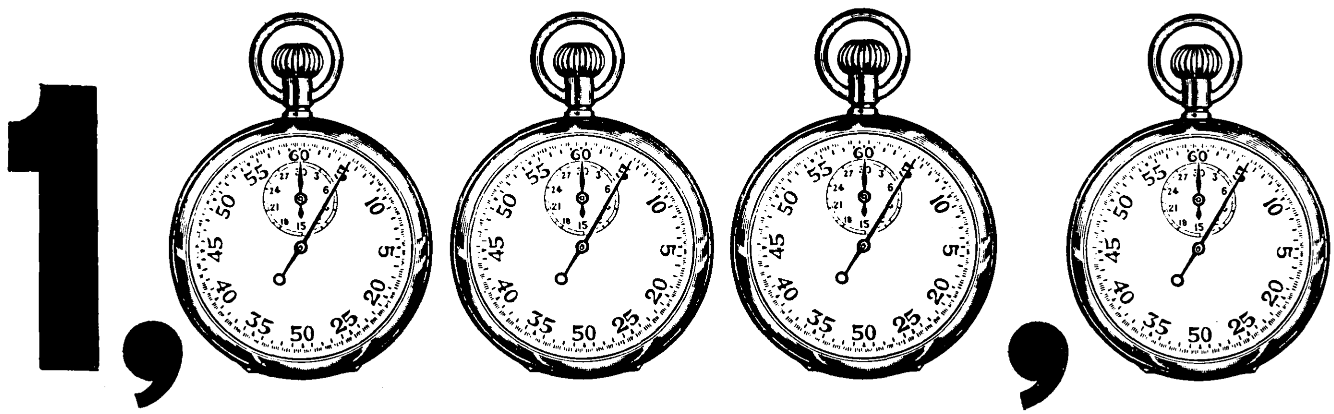
DESIGN CRITERIA

Omar S. Goode *Ohio State University*

Circuit design, input/output, and programming requirements for a computer clocking a billion cycles a second.

THE TIMING and speed of the internal electronic operations in an electronic computer are governed by an electric current oscillating at a stated frequency. This fundamental frequency, often referred to as the clocking frequency, was measured in kilo-



cycles per second (1,000 cps) in the early computers. One of the most dramatic advances in computer design has been a steady increase in the clocking frequency, since a faster clocking frequency will obviously result in faster electronic operations within the computer, if all other things remain equal. Most of the computers currently being built are governed by a clocking frequency measured in megacycles per second (1,000,000 cps). The upward trend in clock frequency shows no sign of weakening. In fact, a new term, "gigacycles" (1,000 megacycles) has been introduced by computer design engineers[1] to accommodate the frequencies of future computers.

Granted that not all the electronic techniques for such extreme speeds have been mastered, the essential consideration is that a new generation of computers is on the horizon. Perhaps it would be well to examine the criteria of computer design to determine how this new potential in speed can best be utilized.

Input-Output

Input-output operations impose a practical limit for computer operating speed. The conventional off-line readers and printers are no solution because input-output operations from magnetic tape into a gigacycle computer would require a major portion of computer time in all except the most highly involved mathematical applications. Therefore, it would be nonsense to suggest that the present-day computer be constructed with "tunnel diodes" and "molectronic" components simply to increase its speed 1,000-fold.

Dollar cost, except for a few isolated instances, is the final factor which will determine whether or not a computer may be used. Since all new developments are costly, and since many computer installations are now marginal from a cost standpoint, one can question how the new generation of computers can be introduced. Surely many new computer designs will be stillborn unless the trend toward ever increasing complexity, resulting in a higher cost, can be reversed. It does not necessarily follow that if a computer is faster it must be more complex. Therefore a natural solution to the dilemma is a re-evaluation of design criteria with a greater emphasis on simplicity. In short, if the electronic components of a computer are pared to absolute essentials, a gigacycle computer could be built to hold its own costwise.

Computer Instructions

Before proceeding with specific suggestions, it may be well to mention the "Turing Machine" which is often cited as the ultimate in simplified design. The device was proposed by an English mathematician, Mr. A. M. Turing[2], in the mid 1930's. Essentially, the system consists of two (or more) tapes, on which it is possible to indicate binary numbers by means of a series of spaces and marks, with a method of sensing and erasing the marks or spaces, and also a method of controlling the motion of the tapes. Turing and others[3] working with variations of the system have proven that any desired computation can be performed by such a machine. The principle of the Turing Machine

FOR A GIGACYCLE COMPUTER

Columbus 10, Ohio

may be restated as follows: Any desired numerical computation can be performed by a series of operations belonging to Boolean algebra slightly extended. In other words, every computer which includes the instructions "Logical And," "Logical Or," the usual "shift" and "branch" operations, and a method of complementing a number, is also a Turing Machine.

Thus it is possible to build a computer with a very limited repertoire of electronic commands. But the trend in contemporary computer design is exactly the opposite, as evidenced by the sales literature from computer manufacturers, listing a large number of commands in their machines. It is granted that the variety of available commands, (provided with much effort and expense on the part of the design engineer) is useful. Yet, unfortunately, most programmers prefer to use compilers or interpretive routines rather than the machine language, or the machine-related symbolic language. Furthermore, the trend is toward a greater use of automatic programs. This process is self-defeating. While computers are being designed with increasing command capacities, programs are being developed to evade the use of these built-in capacities. So vitally important are the programming aids, referred to as software, that the manufacturer who neglects this area is courting disaster. Unquestionably, computer operations are very complex. However, the complexity that is spared in design can be accommodated by programming techniques that have been adopted by every successful manufacturer of computers. An additional advantage of building complexity into programs rather than circuitry is the flexibility of the programming aids. A set of subroutines chosen for the specific problem to be programmed is the greatest possible programming aid.

It is obvious that the running time for a problem on a computer with a very limited number of commands will be somewhat more than for a computer with an extensive set of commands, but at 1,000 megacycles this is an academic consideration. On the other hand, if running time is important, a computer with automatic indexing, and also having a convenient reference for subroutines, but limited to the arithmetic operations of addition and subtraction could compete in running time with a computer with the most extensive repertoire of commands if the proper set of subroutines were available. For example, only one type of multiplication is usually available as an electronic operation. If, on the other hand, multiplication is performed by a set of subroutines, the exact type of multiplication needed for each particular application could be chosen, resulting in faster operation in spite of the absence of the multiply operation as a specific electronic command. In short, neither speed nor programming ease need be sacrificed in order to use a very fast computer with a limited set of electronic commands.

Parallel Operation

Most of the megacycle computers are designed to operate in parallel in order to achieve an acceptable operating speed. By parallel operation, we mean that all the binary digits of a number are operated on simultaneously by the use of parallel circuits. Therefore, most of the circuit elements are repeated many times, for example 35 repetitions are necessary in a computer designed to operate on a 36-digit binary number.

This extension of complexity should be avoided in the gigacycle computer by the use of serial operations. That is, only one circuit would be used and the digits in the binary number would be operated on in sequence. Obviously, the time required to complete an electronic command is greater in a serial machine than in a parallel machine if they have the same clock frequency; but this is one example of how we are proposing to utilize the speed potential of gigacycle system. Therefore, the circuitry of the gigacycle computer can be greatly simplified by the use of the serial mode.

Word Format

We have shown that computer design can be simplified by restricting the number of electronic commands and by performing operations serially rather than in parallel. A third and more fundamental specification which greatly affects the complexity of the computer is the word format. Generally speaking, two formats are being used: binary, and binary coded decimal. Circuitry is more complex for binary coded decimal operations because the binary integers must be set up in subgroups within the word format, and the configuration of bits in each subgroup must be checked for numeric entries for each arithmetic operation. Also, complexity is an indirect result of inefficient use of the binary integers in binary coded decimal operation. For example, 12 binary digits are required to represent the decimal numbers 00 through 99 in many computers using the binary coded decimal format. On the other hand, 12 binary digits can represent the numbers 0000 through 4095, a range of almost 41 times that for the binary coded decimal mode. The BCD mode is utilized because programming in machine language, or in symbolic language (which is machine-related), is simplified. The programming aid is especially important for input-output operations. However, as was observed in the case for a restricted set of electronic commands, complexity can just as well be accommodated, and in some instances can be better accommodated by the use of programming techniques than by circuitry. In other words, the dollars invested in the binary coded decimal components of a computer are entirely lost when automatic, that is, machine-written, programs are used.

Sign and Redundancy

Obviously, a gigacycle computer should be designed to use the binary word format. It is almost a universal practice to use one of the binary digits as a sign bit. While this practice is very convenient for the programmer using machine or symbolic language, it necessitates a considerable amount of specialized circuitry to provide for automatic sign tests, automatic complements, etc. Again, we have an instance of complexity being handled by circuitry rather than by programming. A negative number can just as well be handled as a complement, which is indicated by the presence of a "one" in the left-most position of the binary number. Incidentally, some programming would be simplified, because the illogical "minus zero" could not occur. Therefore, the word format for the gigacycle computer should simply be a specified number of bits representing an unsigned binary number. It would be well to extend the word format by one position to include a redundancy bit. The redundancy test, that is counting the number of "ones" in a binary number and checking for a pre-established odd (or even) count, would increase the complexity, but the distinction is, that in this instance the complexity could be accommodated by programming techniques in only a very superficial manner.

Generality

All design problems are matters of compromise. As noted in the preceding paragraph, simplicity in design should be compromised for the criterion of reliable operation by including redundancy checks and any other feasible self-checking system. Also, *simplicity* could become an intolerable strait jacket unless it is tempered with the companion criterion of *generality*. The importance of generality as a design criterion is implied in the fundamental concept of computer design which was enunciated by John Von Neumann, namely; a computer is essentially a means of storing numbers, each of which is addressed, and each capable of being used as an operator or an operand. A glance at the flow chart of the central processing unit in any modern computer manual, with its maze of special purpose registers and special interdependent relationships, is witness to the violation of the principle of generality. The contents of every register in the computer, with the possible exceptions of the program register[4] and the address registers which control the switch settings, should be available to the programmer as an operator or an operand. In short, the accumulator, the index registers, the location counter, and any other special purpose registers should be a part of general storage, and available to the programmer.

Buffering

In order that the speed of the gigacycle computer be utilized, it is essential that all input-output operations be buffered. This is another instance of compromising the criterion of simplicity, but this time for a very good reason. Incidentally, because of the binary word format, the input-output buffers will simply register the card image.

Facsimile Printer

A new output medium, facsimile printing, has been introduced which is very well adapted for the gigacycle computer. The printing is achieved by a series of very small dots caused by an electric discharge. The dots are spaced 100 per inch horizontally, and the vertical spacing is regulated by successive discharges in relationship to paper travel, which could be set at 100 per inch by proper programming. Several advantages of this proposal are immediately apparent. The scheme is extremely simple. The only moving parts are those concerned with paper travel. Multiple copies could be printed without the use of carbon paper by regulating the strength of the discharge. The scheme is extremely versatile. Pre-printed forms could be obviated by super-imposing the output content on a stored output form. Also, the output could be in the form of maps (a weather map with isobars superimposed on the stored geographic map) charts, curves of any type, etc. The output would be extremely fast. Gigacycle operations would allow ample programming time for paper travel at the rate of 10 inches or so per second (6,000 lines at 6 lines per inch per minute).

Photoelectric Scanner

The introduction of the facsimile printer as an output medium, suggests the inverse, a photoelectric scanner as an input device. The output form, suggested in the preceding paragraph, could be read (or scanned) and placed in computer storage. Another wide-spread use of facsimile input would be the possibility of using typewritten or printed matter as an input medium, directly into the computer. Prior scanning of a formal sample of the type font for any such printed or typed materials could be programmed to set up code relationships, achieving a very wide range of applications.

Integrated Computer

In view of the simplified card reader and facsimile printer, it would be well to consider the possibility of an integrated computer. This is a more important consideration for the gigacycle computer, because as the clock frequency is increased, the physical limit of the size, of the electronic components is decreased. Therefore, the basic integrated computer consisting of a card reader, facsimile printer, the storage medium, and the central processing unit, should be included in a single unit. Of course, provision could be made for auxiliary input-output media such as magnetic and paper tapes, card punch, a facsimile reader, and any other useful devices. Off line input-output devices which are generally associated with large scale computers are a necessary strategy to justify the very expensive computer. In contrast, multiple units of a simplified integrated computer, each capable of reading data and printing reports would be much more flexible.

Basically, nothing new has been suggested in the preceding paragraphs. On the contrary, the concept of micro-programming, which has seemingly been discarded, should be re-examined as a computer technique. The increased potential speed, resulting from the increased clock frequency, should be applied to a simplified integrative design, resulting in reduced cost and a greater reliability and flexibility than has been possible in computers presently available.

[1] Gigacycle Computer Systems, Publication S-136, published by: American Institute of Electrical Engineers, 345 East 47th Street, New York 17, N. Y.

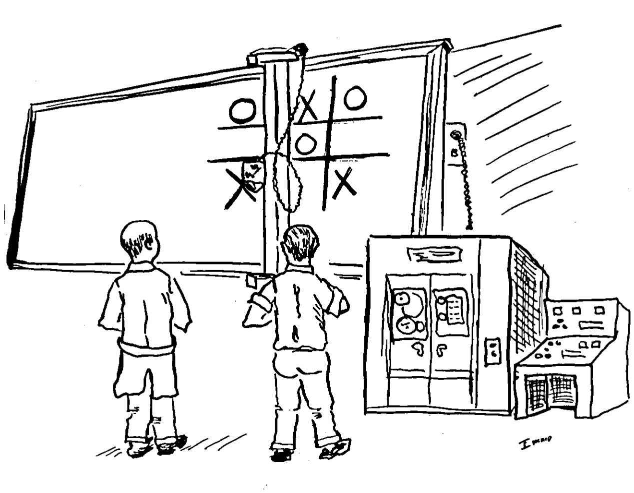
[2] A. M. Turing, "On computable numbers, with an application to the Entscheidungs-problem." Proc. London Math. Society (2), 42 (1936-7), 230-265; with a correction *Ibid.* 43 (1947), 544-546.

[3] Two articles in the October 1961 issue of the Journal of the Association for Computing Machinery, Vol. 8, No. 4: Michael Arbit, "Turing Machines, Finite Automata and Neural Nets"; Shigeru Watanabee, "5-Symbol, 8-State and 5-Symbol, 6-State Universal Turing Machines."

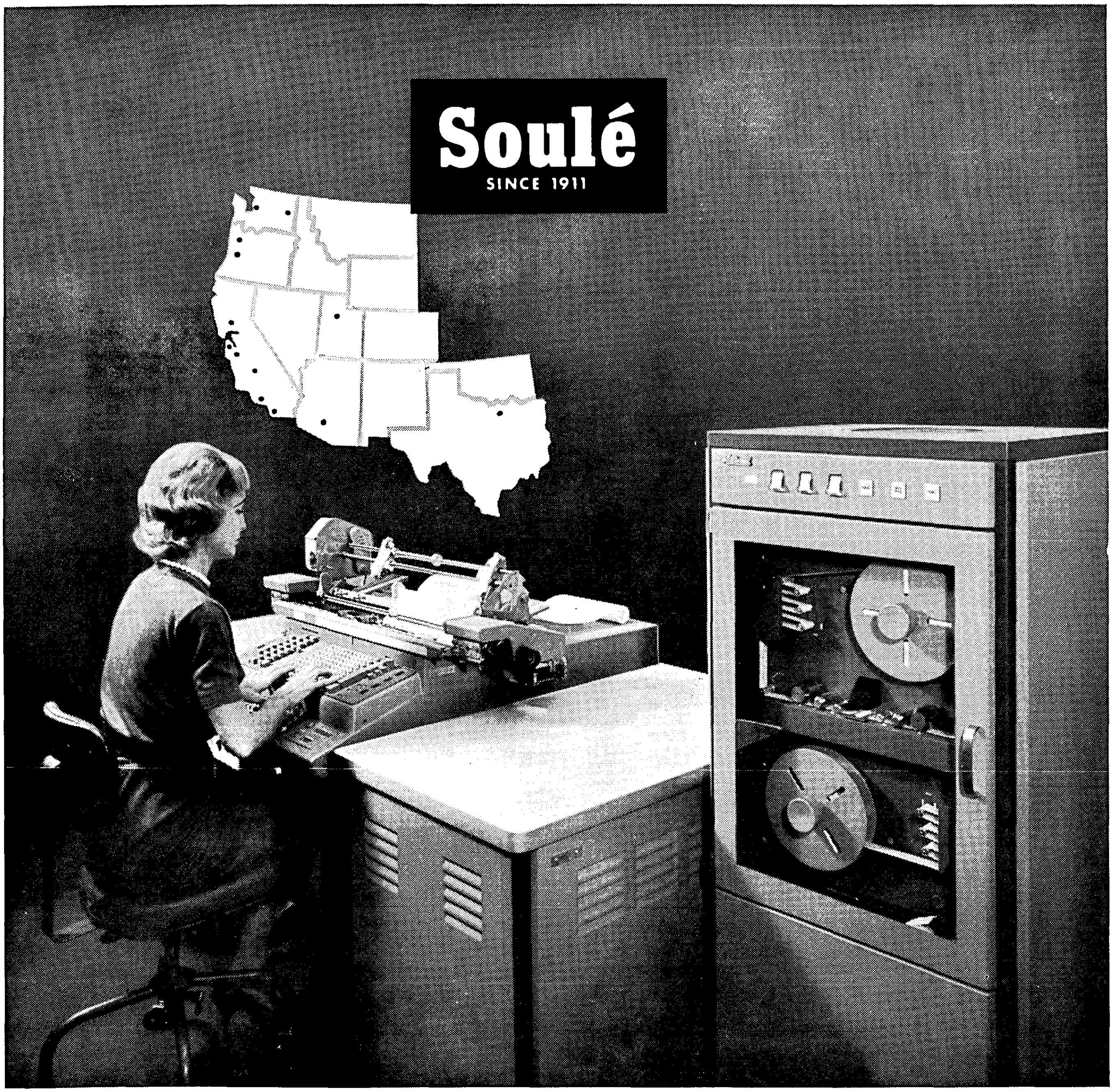
[4] Storing a number in the program register could be a possible method of indexing, illustrated by the following:

World Cycle 1: Contents of the location, addressed by the location counter, is added to the program register.
World Cycle 2: a. Address registers and operation registers are set up;
b. Program register is set to zero;
c. Location counter is stepped by one.
World Cycle 3: The operation as set up is performed. (Note that if a number is loaded into the program register as a result of the currently specified operation, the next operation is indexed.)
World Cycle 4: Repeat cycle 1, thus continuing the specific program.

COMPUTER CROSS STRATEGY

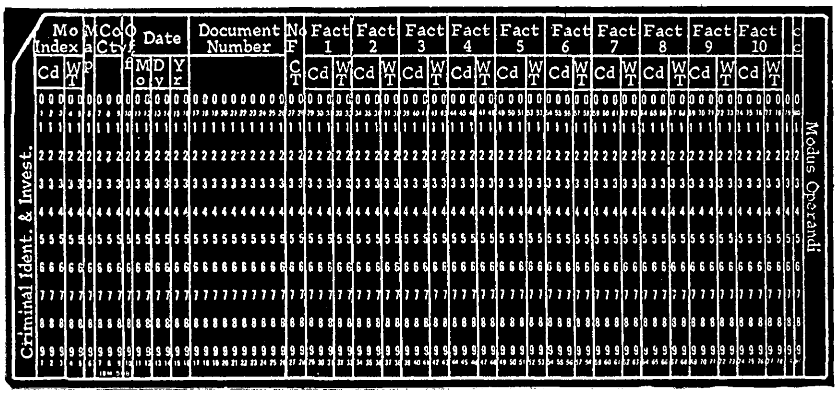


It's a special NORAD coffeebreak routine . . .



Soulé
SINCE 1911

"to catch a thief": the automatic retrieval of relevant crime reports



In the past year **Computers and Automation** *has reported how the computer is assisting the traffic cop, the tax collector and the health official. This report spotlights an interesting new public service application—the establishment of crime patterns, and the identification of the criminal.*

One of the most fascinating and complex areas of information retrieval can be found in the law enforcement field—fascinating because of the manifold techniques employed in criminal detection, and complex because of the variety of indices by which a given file may be searched.

This article deals with one of the retrieval problems faced by all law enforcement agencies, from the local police department to the Federal Bureau of Investigation. Specifically, it involves the coding, filing, and retrieval of crime reports using the long established correlation techniques of Modus Operandi. Assumptions and conclusions contained herein are based upon direct contact with the California Bureau of Criminal Identification and Investigation. Their cooperation and encouragement, especially that of Everett Chamberlin, who is the Bureau's Assistant Supervisory M. O. Analyst, is deeply appreciated.

Modus Operandi

Modus Operandi, which may be referred to as simply M. O., can be defined as the development of a pattern of behavior according to which a crime is committed. M. O. factors are those specific criminal actions whose presence, absence and relation to one another make up that pattern. M. O. procedures encompass the searching of files containing many such patterns in order to retrieve crimes whose patterns correlate to a given pattern.

The objective of an M. O. search may be: to establish a list of suspects for an unsolved crime; to determine a series of crimes which may have been committed by an individual arrested for one particular crime; or to determine a series of unsolved crimes which appear to have been committed by the same unknown criminal, thus offering further insight into the investigation of those crimes.

Through the years, M. O. operations have resulted in considerable insight into criminal behavior, which is essentially controlled by factors common to all human action. As an example, before a crime takes place there must first be an opportunity to commit it. This may be accidental, in that existing circumstances may offer the temptation for an immediate criminal act, or it may be created by a careful attempt to predetermine such factors as place and time in order to reduce the risk of discovery.

Obviously, the crime committed on the spur of the moment as a result of accidental opportunity is less apt to be attempted again in a similar pattern, than the crime committed as a result of created opportunity. Other psychological factors such as desire, motive, intent, need, knowledge, habit, and personality of the criminal are of considerable import to the analysis of a given crime and the pattern associated with that crime.

A definitive pattern to a given crime cannot be derived merely on the basis of the absence or presence of specified actions which occurred during the completion of that crime; in other words, psychological factors must also be taken into account. Such factors may in them-

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selves classify a given crime as unsuitable for M. O. analysis; for example, the crime committed as a result of accidental opportunity is unlikely to develop a pattern which can be correlated against other crimes.

The behavior of a criminal during the completion of a crime will most likely indicate an order to the factors which make up the pattern of that crime; that is, factors will be of unequal importance in the successful completion of a given crime. Consideration of these facts much be made during analysis of a given crime. Since the success of Modus Operandi techniques depends upon such an analysis, any attempt to automate M. O. should utilize the insight of the experienced crime analyst. Attempts to simplify Modus Operandi by reducing it to a completely objective state are direct contradictions to criminal behavior itself, which is subjective in nature.

Objectives of an Automated M. O. Procedure

Granting the need and value of the M. O. analyst, the basic problem is evident: How can computer techniques be employed to facilitate the work of the analyst?

Historically, M. O. procedures involved the following:

1. The establishment of a master file containing the M. O. characteristics of known criminals, usually indexed by type of crime (homicide, rape, robbery, aggravated assault, burglary, larceny, etc.) and maintained as a file drawer. Data concerning new criminals was added to the file as it became known.

2. The master file was available to department investigators as a source for obtaining suspects for unsolved crimes as they occurred.

The majority of M.O. files have become so voluminous that it is both impractical and unprofitable to search them manually. Punched card approaches have therefore been adopted and have helped to reduce search time, but important limitations remain. Any computer approach must eliminate, or at least reduce, these limitations. Thus the technique about to be described has the following objectives:

1. To establish an indexing scheme to the master file such that data contained in it can be easily retrieved on a selective basis during a single pass of the master file.

2. To design the master file in such a way that it may be easily maintained; that is, we must include the ability to make additions, deletions, and changes to data already contained in the file.

3. To include the ability to batch inquiries against the file; that is, make multiple inquiries during one pass of the master file.

4. To incorporate the analyst's experience into the search itself; that is, accomplish more than merely checking for the absence or presence of specified M. O. factors.

5. To produce an output from the search easily interpreted by the analyst, in a format which will facilitate his final analysis.

Organization of Master File

Two types of information may be stored in an M. O. file—information about a known criminal and information about an unsolved crime. It is apparent that a complete physical description of the criminal could be included with the first, but not necessarily with the second. This is of extreme significance when one begins to apply varying degrees of emphasis to the type of information. If a description of the individual committing a crime is known, then it becomes the object of greatest emphasis when searching for a possible suspect. If a description is not known, then the M. O. factors themselves become the object of greatest emphasis.

Experience has shown that this approach is not necessarily the best, especially as it applies to Modus Operandi searches. For the following reasons the author has chosen to emphasize, regardless of the type of information, the crime being committed rather than the criminal committing the crime:

1. Modus Operandi techniques were devised and have proven successful as a method of correlating crimes where the description of the criminal is unknown.

2. If his description is known, other more complete files are available for the determination of suspects.

3. Descriptions, as given by victims and witnesses, usually vary greatly from the reality; therefore, the use of such data for machine searching is limited.

4. The pattern by which a crime is committed can very often be determined, regardless of the presence of victims or witnesses.

Therefore, it is recommended that M. O. files be crime-oriented rather than criminal-oriented.

All crimes where sufficient information is known for M. O. correlation will be entered into the file as separate records. It is assumed here that the original source will be a descriptive crime report submitted to the M. O. analyst for analysis and coding by a law enforcement officer or agency. Such a document must contain an identifying number which will be entered into the master file as a reference, so that the original document may be retrieved if necessary.

When a given crime is solved, the name of the criminal and his description will be added to the record of that crime contained in the file, and will, therefore be available when that crime is retrieved. With no attempt made to consolidate multiple crimes committed by the same individual into one file record, the individuality of all crimes is maintained. This is important, because all inquiries against the file are individual crimes whose patterns of M. O. factors are best correlated against other individual crimes.

It is realized at this point that such a file will necessarily be larger than one containing consolidated information by criminal. However, the increased speeds by which computers operate are sufficient to handle such files, especially if contained on compact storage media such as magnetic tape or random access discs.

It is further recommended that the master file be subdivided by type of crime—homicide, rape, robbery, aggravated assault, burglary, larceny, etc. It is much easier to classify crimes on such a basis than criminals, and it should now be apparent that multiple crimes committed by the same criminal may be located in different subdivisions of the master file. Inquiries will be made against only that portion of the master file which is appropriate (burglaries against burglaries, etc.).

A master file of crimes, subdivided by type of crime, will have each crime stored with an identifying number of the original document by which the crime was reported, the M. O. pattern (in coded form) by which the crime was committed, and the name and description of the criminal committing the crime, if known.

BURGLARY MODUS OPERANDI

— CODING SHEET (IN PART)

Crime No.________________ DATE________________

Map Area________________________________

Country-City________________________________

Offense________________________________

TIME OF ATTACK
38-1 Sunrise to sunset (daylight)
38-2 Sunset to midnight (evening)
38-3 Midnight to sunrise (early AM)
38-4 Funeral
38-5 Vacation
38-6 Holiday
38-7 Weekend
38-12 Series Burglar (5 or more)

OBJECT OF ATTACK
39-0 Ammunition
39-1 Animals
39-2 Auto Accessories
39-3 Auto Parts
39-4 Barber & Beauty Supplies
39-5 Binoculars
39-6 Boats
39-7 Books
39-8 Building Material
39-9 Cameras
39-11 Canvas
39-12 Cash Registers
....
43-12 Blank checks or money orders

PERSON ATTACKED
44-6 Jewelry Salesman

PROPERTY ATTACKED

100-A
45-0 Airplanes
45-1 Ambulance
45-2 Armored Car
45-3 Auto
45-4 Boat
....

100-B
45-11 Church
45-12 School

100-C
46-0 Brewery, Distillery, Winery, Food processing, bakery, cannery, frozen food, meat plant
46-1 Machine shop or foundry
46-2 Manufacturing plant

100-D
46-3 Aircraft Hanger
46-4 Auto Accessories & Parts
46-5 Auto Wash
....

100-E
47-1 Distributor (beer, food, etc.)
47-2 Freight lines
47-3 Misc. sheds or storehouses
47-4 Produce sheds
47-5 Tool sheds
....

100-F
47-7 Cafe
47-8 Hot Dog or Food Stands
47-9 Ice Cream Stands
47-11 Night Club
47-12 Tavern

100-G
48-0 Boarding or Rooming House
48-1 Dormitory
48-2 Fraternity or Sorority
48-3 Hospital or Sanitarium
48-4 Hotel
....

100-H
48-9 Apartment or Flat
....

100-S
57-3 Building Supplies (Lumber, roofing, etc.)
57-4 Construction Co.

100-X
57-5 Government Reservations
57-6 National Guard Armories

100-Z
57-8 Unclassified

ENTRY
57-9 Attic or Ceiling
57-11 Concealment
57-12 Door Front
....
58-9 Adjacent Building
58-11 Transom

HOW ATTACKED
58-12 Bores Holes
59-0 Breaks Glass
59-1 Cuts Glass
59-2 Attacks moulding (cuts, pries, removes, etc.)
....

MEANS
60-8 Axe, Hatchet or Hammer
60-9 Bodily Force
....
62-2 Rope, Garden Hose, Cable, Wire, etc.
....

TRADEMARK
62-4 Alarm Conscious, disconnects or bypasses
62-5 Alibi
62-6 Assaults Victim
62-7 Ate or Drank on Premises
62-8 Barefoot
....
65-1 Exit prepared
65-2 Suspect wounded or injured

VEHICLE USED
65-4 License seen
65-5 Rents Car
65-6 Stolen Auto taken before or after burglary
....

NOTE: This is a partial listing of the code sheet. For a copy of the full coding sheet, please write to the author.

Coding of M. O. Factors

Within each subdivision of the master file, there is a definite number of possible M. O. factors. These have been developed through experience; no attempt is made here to justify those presently being used or to establish a list which should be used. The only assumptions made by the author are that the number of possible M. O. factors for a given type of crime will be less than 1,000 and, in fact, should be less than 400; and each type of crime (subdivision of the master file) will have its own set of possible M. O. factors. Therefore, a three-digit code is sufficient to define each possible M. O. factor.

In most punched-card procedures the column binary techniques is employed; that is, each hole punched in a card refers to a specific M. O. factor. (Several holes may be punched in one column.) Each hole punched indicates the presence of that particular M. O. factor during the completion of a given crime.

In a computer approach it would be of significant value if, in addition to the indication of the presence or absence of a particular M. O. factor, the importance of each factor to the successful completion of a given crime could also be indicated. Therefore, a weighting scheme was devised in order to establish both an order of importance to factors within a crime, and a level of importance as compared to an absolute scale.

Thus, each coded factor would be tagged with a weight. Arbitrarily, the range of weights was chosen to vary from zero to fifteen. A zero weight indicates that the M. O. code to which it is tagged must not appear in a correlated crime; a weight of fifteen indicates that the M. O. code to which it is tagged must appear in a correlated crime; and a weight from one through fourteen indicates the relative importance of the M. O. code to which it is tagged.

In order to incorporate this approach, the column binary technique must be discarded, as no method is evident for applying weights to single holes in a card. However, no change in the coding itself is necessary, for the card column and digit within that column (as previously employed) can be combined to form a three-digit code for computer use. Any three-digit coding scheme is sufficient.

Thus, five digits are necessary to define completely any given M. O. factor; three for the coded factor and two for the attached weight. For example: (code) 64-3, (weight) 14. This indicates that the fact that the criminal "rented the adjacent room" (code) was of "extreme importance" (weight) to the completion of this crime.

The analyst now has a greater degree of flexibility, which he can incorporate into his coded description of a given crime. He can indicate specifically which factors are most likely to recur in another crime committed by the same individual. At the same time he can indicate factors which could not possibly be a part of a crime pattern pertaining to that individual.

The most significant value of such an approach is achieved by the computer itself. Through a mathematical analysis of the weights which are attached to matching factors, the computer can retrieve correlated crimes on a selective basis. That is, the crime contained in the master file which best matches the inquiry can be retrieved first, the second best second, etc.

I admit that some subjectivity is necessarily a product of any weighting scheme. I further realize that the same factor in the same crime may not be given the same weight by two independent analysts, or even by the same analyst on two different occasions. It is important to note, however, that these two facts in no way jeopardize the results of a computer M. O. search. The correlation required to match two crimes is determined by the presence or absence of the coded M. O. factors independent of the attached weights; the weights only offer a degree of correlation which determines the selective basis upon which crimes are retrieved from the master file.

In any M. O. procedure, whether manual or automated, this selectivity is performed, usually by the analyst himself. Thus, the analyst is employing the computer to perform this selectivity.

Indexing to the Master File

Included in any information retrieval system is the problem of determining a method of indexing to the desired area of the file from which data is to be retrieved. The three objectives previously stated are critically affected by whatever indexing technique is employed. With this in mind, the following technique is recommended:

1. Sequence the master file in numerical ascending order by M. O. factor code. Each crime added to the file will be inserted in its proper place.

SAMPLE OUTPUT FOR MODUS OPERANDI CORRELATIONS

MODUS OPERANDI CORRELATION

INQUIRY	MATCH #1	MATCH #2	MATCH #3	MATCH #4	MATCH #5	MATCH #6	MATCH #7	MATCH #8	MATCH #9
REPORT #8	62-450727	51695	A-75276	62-461748	747097	62-442-3444	47781	A-75276	
7	7 411 P	7 019 P	3 637 P	7 411 P	4 670 P	7 411 P	7 411 C	3 637 P	
05-03-62	04-07-62	05-03-62	05-02-62	04-30-62	03-25-62	03-22-62	04-01-62	05-01-62	
40-0 13	40-0 12	40-0 13	40-0 15	64-5 15	40-0 14	54-6 14	40-0 10	54-6 13	
60-5 11	54-6 12	54-6 12	54-6 14	40-0 14	54-6 13	40-0 13	46-2 08	40-0 10	
54-6 10	58-7 12	58-7 08	57-& 11	54-6 14	38-7 09	59-0 11	57-& 08	57-& 08	
59-0 08	60-5 12	59-0 08	59-0 10	64-- 10	58-7 08	61-9 09	58-7 08	59-0 08	
58-7 07	59-0 10			38-7 09	61-5 08		59-0 08	61-5 08	
59-- 06				58-7 09	41-7 07				
				60-8 08					
				63-6 05					

2. The M. O. factors which collectively make up the pattern for a given crime have been ordered by their respective weights. The factor defined as the most important will be selected as the index to the file for all inquiries. This most important factor will hereafter be referred to as the M. O. index code.

3. It is now assumed that, in order for a crime contained in the master file to correlate with an inquiry, the M. O. factor defined as the most important to the inquiry must be found in the master file crime as either first, second, third or fourth most important. (This assumption has proven valid for all studies thus far undertaken.) Each crime contained in the master file will, therefore, be filed in four different locations—most important M. O. factor, second most important, third most important, fourth most important.

Therefore, within each M. O. code classification of the master file, the file will contain, in order, all crimes where that particular M. O. factor was most important first, second most important second, third most important third, and fourth most important last. Consider the following example:

Crime A Factor	Wt.	*Crime B* Factor	Wt.	*Crime C* Factor	Wt.	*Crime D* Factor	Wt.	*Crime E* Factor	Wt.
41-7	13	47-5	14	47-8	10	47-6	14	41-7	12
64-8	12	57-9	14	56-1	10	41-7	12	57-9	05
62-7	11	59-6	13	41-7	09	58-7	12	52-3	04
61-5	10	41-7	10	61-5	06	64-8	12	59-9	04
58-7	08	38-3	08	62-7	05	59-3	11	61-5	03
60-2	06	64-8	08	64-8	05	38-2	10	64-8	03
54-1	02	61-5	05			38-3	10		
		65-7	02			60-9	05		

The above five crimes have been coded as described earlier. They are listed vertically from top to bottom in descending order by weights (order of importance) for ease of reading. Notice that all five crimes have a code of 41-7 (money stolen) as either the most, second most, third most, or fourth most important M. O. factor (among those factors above the dotted line). Therefore, all five crimes would be located in the 41-7 (money stolen) subdivision of the master file. Within that subdivision, they would be ordered A, E, D, C, B. Crime A would also be located in the master file under 64-8 (second most important), 62-7 (third most important), and 61-5 (fourth most important).

Even though the master file is now four times as large as it would be if each crime were placed in the file only once, it is estimated that 35,000 crimes (140,000 records) can be contained on one 2,400 foot reel of magnetic tape. There are also indications that crimes in the master file need only be placed in three locations (neglecting the fourth most important factor), but as of this writing, such a file has not been tested.

4. All inquiries will be sorted by the most important M. O. factor, and will be run as a batch against the master file, with detailed correlations being made only against crimes contained in that portion of the master file which is defined by the most important M. O. factor of the inquiry.

5. A separate run on the computer can convert single card inquiries to four-card master file additions, the first card having as its index to the file the most important M. O. factor, the second card the second most important factor, etc. These cards can then be sorted to M. O. factor sequence, and inserted into the master file through the usual methods of file updating.

Detailed Correlation

For each inquiry which is correlated against the master file, all crimes contained in that portion of the file designated by the M. O. index code of the inquiry must be checked for a possible correlation. This is accomplished simply by comparing all factors on the inquiry to all factors on each record contained in that subdivision of the master file. This comparing process is facilitated by keeping all factors within each inquiry and within each master file record in ascending numerical sequence. Rearrange the sequence of M. O. factors in Crime A and Crime B to:

Crime A		*Crime B*	
41-7	13	38-3	08
54-1	02	41-7	10
58-7	08	47-5	14
60-2	06	57-9	14
61-5	10	59-6	13
62-7	11	61-5	05
64-8	12	64-8	08
		65-7	02

Notice that the attached weights still define the order of importance, even though the M. O. factors themselves are numerically in sequence. However, with the factors of both crimes now in numerical sequence, each factor of Crime A can be compared sequentially to those factors in Crime B, without the need to compare each factor in Crime A to all factors in Crime B. If factor A compares low to factor B, then factor A is not a part of Crime B; if factor A compares equal to factor B, then factor A is a part of Crime B; and if factor A compares high to factor B, then factor B is not a part of Crime A. By indexing down both crimes, depending upon a high, low or equal comparison, until all factors of one or the other crime have been considered, the number of M. O. factors which appear in both crimes can be determined. In this case, three factors appear in both Crime A and Crime B (41-7, 61-5 and 64-8).

For ease of coding, coding sheets should be designed with all possible M. O. factors listed numerically in sequence. The coder would then merely circle those factors which apply and assign weights to them. Ease in keypunching would also require the same format. As stated above, M. O. factors one through ten would be keypunched numerically in sequence by M. O. factor, rather than by weight. Thus, the coding sheet is in the same sequence as the keypunched card and is used as the document from which the card is punched.

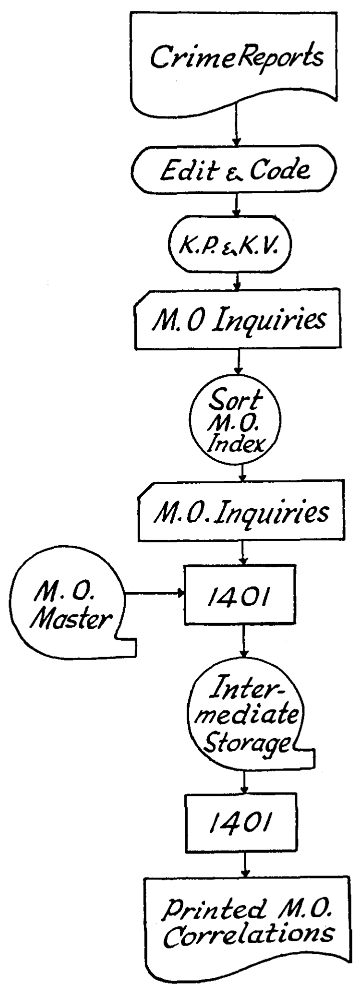
Once the number of M. O. factors which are common to both of two crimes has been determined, it can be compared to a required number of common factors for a minimum correlation. This minimum requirement may be a constant factor; for example, three M. O. factors must be common to both the inquiry and the master file crime: or it may be variable; for example, two factors must be common if the inquiry contains a total of four or less factors, three factors must be common if the inquiry contains eight or less factors, four factors must be common if the inquiry contains sixteen or less factors, etc. If the resulting comparison meets the minimum requirements, then a degree of correlation can be determined based upon the weights attached to those M. O. factors which were common to both crimes.

Several mathematical manipulations could be performed upon these weights in order to determine a degree of correlation. It is possible to limit the output of a computer search to a desired number of retrieved crimes. For example, for each inquiry submitted to a computer correlation against a Modus Operandi master file, one may state, through programming, that no more than ten crimes shall be retrieved, and still be assured that the ten (or less) crimes retrieved are the ten (or less) crimes contained in that master file which best correlate to the inquiry. Should the ten crimes retrieved establish a significant series of criminal patterns, then additional crimes may be retrieved from the file for further analysis using the same technique.

IBM 1401 Exploratory Program

In order to incorporate the techniques derived above, an exploratory program was written for an IBM 1401 tape system with 4K storage, hi, lo, equal compare, advanced programming, 1402 Card/Read Punch, 1403 Printer, two 7330 Magnetic Tape Units. Five hundred burglary crime reports were edited and coded, against which 50 inquiries were to be correlated. In order to assure that the inquiries would, in fact, correlate with crimes in the master file, 50 of the 500 crime reports were later re-coded to serve as inquiries.

MODUS OPERANDI 1401 FLOW CHART



The 500 coded crime reports designated as the master file were keypunched and written onto magnetic tape as variable length records with a maximum block length of 600 characters (variable blocking factor). On the average, nine crimes were contained in each block. The 50 re-coded crime reports designated as inquiries were keypunched and sorted to M. O. index code sequence before being used as input to the correlation run. In addition to the M. O. master file, another magnetic tape was used as intermediate storage onto which all crimes from the master file which correlated to each inquiry were written.

During the running of the M. O. correlation program, each inquiry was correlated against that portion of the master file where possible correlations might be located. In cases where more than one inquiry contained the same M. O. index code, it was necessary to backspace the master file in order to search the same portion of the file for all such inquiries. As each inqury was correlated against the master file, those crimes which met the criteria for minimum correlation were written onto the intermediate storage tape (along with the inquiry itself) and were tagged with their calculated degrees of correlation.

At the conclusion of processing for all 50 inquiries, this magnetic tape, containing the results of the correlation run, was immediately read back into the 1401 (through the use of an execute command). At this time, the correlated crimes for each inquiry were arranged in order by degree of correlation. For ease of interpretation and further analysis by the M. O. analysts, the entire record of each crime was printed out, vertically, with heading information such as "Crime Report Number," "Map Area" and "County-City" where the crime was committed, the "Type of Offense," and the "Date" on which the crime was committed appearing at the top, and the coded M. O. factors appearing immediately beneath in sequence by weight. This was accomplished through an internal distribution of the correlated crimes themselves and through a "sifting" by weight of the M. O. factors into the desired sequence.

This program ran in a total time of five minutes, including both the correlation and printing run. To extend these results to a larger scale, it would be safe to assume that as many as 200 inquiries could be correlated against a master file of 100,000 crimes in less than two hours. A single inquiry would require only enough time to pass the appropriate tape reel to the designated subdivision, make the required correlations, and to print them out; which, on the average, would require less than seven minutes.

Summary of Feasibility

It becomes clear, therefore, that an indexing scheme can be devised for computer procedures for Modus Operandi which, when employed, can selectively retrieve crimes from a master file contained on magnetic tape storage. The master file can be designed in such a manner that the normal procedures of file maintenance can be employed. Inquiries can be batched; that is, multiple inquiries can be processed during one pass of the master file.

The M. O. analysts' experience can be incorporated into an automated M. O. procedure through the use of a weighting scheme which allows him to define more completely a crime in coded form. The output from such an automated crime retrieval program can be arranged in a format which offers an immediate source of further analysis to the M. O. analyst or department investigator. Through computer techniques, large scale Modus Operandi operations can be undertaken on a production basis by law enforcement agencies. With the many 1401 tape systems installed throughout the country, it is entirely conceivable that law enforcement agencies could economically rent sufficient time from local 1401 users for the purpose of Modus Operandi processing.

COMPUTER ART CONTEST

In January the front cover of "Computers and Automation" displayed an example of "computer art," an esthetic form created by the wedding of a computer to other electronic devices. To encourage explorations in this new artistic domain, "Computers and Automation" will hold an informal contest for similar examples of visual creativity in which a computer plays a dominant role. We invite any reader to submit to us examples — which we shall consider for publication in "Computers and Automation." To the best example in the judgment of the editors, we plan to devote the front cover of our August issue.

Entries close on June 30, 1963. For ideas, see the picture on the front cover of the January issue, and the account of it. For more information, please write to Computer Art Contest Editor, Computers and Automation.

INSTRUMENTATION AND THE INFORMATION SYSTEMS REVOLUTION

Gilbert W. King

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There is a great deal of talk nowadays about the Information Systems Revolution, but whether it will really come about depends on two factors. Is there really a demand and "customer acceptance," and are current ideas and technology advanced enough to make it feasible?

Let us first examine briefly the question of who are the customers. There is no question that the librarians are flooded with material, and they have a natural interest in having better ways to cope with it. But why? Information is not generated for librarians, but for people who need it. Who are they? They are research workers, project engineers, directors of research. These people already have plenty to read, and have no trouble in finding more. True, the selection of material for them to read could be made more efficient, but we cannot expect these people to sit at a desk being force fed like laying hens. A little stroll to the library is not entirely wasted. More impotrant, however, is the grave question whether all these people are intelligent enough to appreciate the extra facts and ideas provided by a system, even if it were very efficient in selectivity. Certainly they do not want stacks of books and papers to read, but even when we know how to distill and organize the information for them, a man can only absorb so many ideas a day. Fred Hoyle in his novel "Black Cloud" ends with the question whether today's humans could withstand exposure to a higher intelligence.

In an economy such as ours, surely an information system could be provided if there were a real demand. As far as I know, no real user has ever described what he really wants. I doubt whether the failure of the Information Revolution to come about is due to lack of instrumentation.

On the other hand, instrumentation could make life easier for the present readers of information, if it were cheap enough. This, however, is a secondary issue. The question facing civilization is whether the generation of information can be handled in such a way that ordinary people can be exposed to it so that they create and perform beyond their present standards.

The Basic Problem

First rate mentalities are those who have managed to absorb the current literature so well that anything new can be fitted into their private intellectual structures. The really basic problem is not one of instrumentation per se. It is how can information be processed in volume to a form that can be readily read and absorbed by the ordinary human being? This involves the understanding of teaching and presentation far beyond that which exists today.

However, it is not too soon to try to see a glimmer of the kinds of instruments that will be required. And it is perhaps important and instructive to define some of these characteristics so that our younger generation can think about them and give us in the next decades the technology necessary to provide them in an efficient or improved way.

The principal characteristic of what we are talking about, the Information Revolution, is

(Based upon "The 1962 FIER Distinguished Lecture," given before the Foundation for Instrumentation and Education Research, New York 17, N. Y., October, 1962; reprinted with permission)

the volume of material, at least in its crude form. It is quite evident that no person or group of persons can handle this data by hand methods. If then we assume automatic processing, we face, as a prime requisite, the mechanical record of the bulky material.

To orient ourselves we quote, without feeling the need to be justified, the following detail:

System	Capacity in Bits (30 bits per word)
Contents of Library of Congress	10^{14}
Discipline	10^{11}
Human mind	10^{11}
Well-defined body of knowledge, e.g., Shelf of basic books	10^{10}
1000 graduate books	10^{9}
A good compendium	10^{6}
Document	10^{5}
A page	10^{4}
Sentence	10^{3}
Word	$.3 \times 10^{2}$
Character	$.6 \times 10$

A very important and difficult characteristic, but rarely appreciated, is the fact that a corpus, or body of knowledge, is impossible to delineate (because it always overlaps other bodies), and in any case is large, $10^9 - 10^{11}$ bits. Thus, even the most rudimentary information processors have to provide storage of 10^{11} bits before anything can be demonstrated. Typically, the Library of Congress creates 10^{11} new bits of indexing information a year. Consequently, no experimentation or demonstration of an information retrieval system can be convincing unless it handles 10^{11} bits. To substantiate this, there are many instances of human beings having a grasp of 10^4 documents, or 10^9 bits. A system must demonstrate it can do better than a man, i.e., handle 10^{11} bits.

A capacity of 10^{11} bits is no problem per se. This amount of information has been handled in books, for instance, or could be handled with a hundred million punched cards, or a thousand reels of magnetic tape.

There is, however, a fundamental figure of merit for storage devices, roughly that if capacity is C and rate of access is w, then $Cw^2 = k$. Only a radical change in technology can increase the constant k. This rule says that as capacity increases the rate of access decreases, and much faster. Clearly having the Library of Congress on punched cards is technically feasible, but access is too slow. Capacity by itself is not enough. Reasonable access is also needed, but what is reasonable?

Two Extremes in Search

In considering access to a storage, it much be appreciated that there are two extremes in objectives—the search for a fact and the search for a suggestion. The former is simpler to understand, although really as difficult as the second. This is not at all understood by librarians. As an example, one might be interested in knowing the boiling point of mercury, and many people think this is a fact to be found in an information storage. In practice, it is a complicated question —what pressure, what isotropic composition, etc.?

The search for suggestions may be illustrated by the question, "What is the boiling point of element 110?" The questioner knows no one has measured it, but nevertheless this is not an unreasonable question. The questioner does not expect a "fact" but a suggestion — the boiling point of other elements in the same group and a method of extrapolation, such as Trouton's rule.

There is, in reality, only the second type of question, and this requires all the resources of our civilization to answer. This fact implies there will be many look-ups, not just one, to answer every query. Hence, the access time must be made shorter and shorter and answers become more and more sophisticated.

The specifications of high capacity and rapid access are not sufficient, because even when these are met well enough for experimentation we are still at a loss of how to execute a search. At the present time, there are extremes in the possibilities of mechanical retrieval. On the one hand there is the mechanical storage of a conventional card catalog, and at the other the storage of the full raw text. The former is limited because the information contained in the document (10^6-10^7 bits of it) is mapped onto a few highly stylized items on the catalog card (10^3 bits). Catalog cards, and even abstracts, are rejection filters, and it is almost always the information rejected which is desired.

The other extreme, of full text, is not at present subject to search by mechanical devices. Perhaps the best way to state the difficulty is to say it is a problem of matching — of matching the words and structure of a query with the texts of the recorded literature. Evidently, the technique of matching a query with an author file or a subject file involves a complicated transformation which we do not yet understand intellectually, and hence one in which the desirable form of instrumentation cannot yet be expressed in engineering terms.

The Console Concept

For a long time to come, we can expect a man-machine interface. At present we live with a spectrum—from a man standing at a card catalog to recently a man sitting at one of the designed consoles. The consoles which are beginning to emerge for information retrieval allow the operator to view printed material on a high resolution screen (e.g., cathode-ray tube), and allow him to call for a wide variety of material as he executes a search trail through the recorded information. To this extent, these consoles do nothing more than make it easier for the search to be carried on — there is no lugging of catalog trays to a crowded table, reaching for books and turning pages, etc.

There is more to the concept of a console than this. The user-operator can be guided by the central machine in following a search trail. An elementary example would be the automatic translation of his natural language into the more rigid language of indexers. Another example, is a display of how many items there are in response to his query—often embarrassingly large —and recommendations of how to be more specific in his query. Over the years, the machine itself will become very much wiser in its guidance.

This aspect of console use is largely a matter of programming and does not affect the console instrument itself. It calls for a methodology of exploiting the memory function and traversing complex paths within the memory through heterogeneous types of material. Thus, an organization of the memory must be developed to accommodate these needs.

Engineering the Information

There is one more requirement for instrumentation. An information system must contain information, and very little attention has been given to engineering this part. Let us first take a reasonably well-defined corpus that should be in a mechanical system, the National Union Catalog developed and maintained by the Library of Congress. This has some 14 million cards of descriptive cataloging of books, monographs, serials, etc., representing 10^{10} bits of information. It could be instructive for an engineer to take a look at these 14 million cards as they exist now, for the task of conversion is impressive. It is all very well to talk glibly about automatic character readers, but it must be remembered that all existing readers only read fonts more or less designed for the particular instrument. A machine which can read the multiple and mixed fonts of a Library of Congress catalog card has not yet been built. Moreover, practical conversion involves other factors. Most files are not clean, freshly printed Library of Congress cards. There is a wide variety of fonts — typewritten and hectographed, with manual insertions. It is doubtful whether human beings at the conversion station can be eliminated for many years, and this results in high cost and slow speed of conversion of files.

One approach is the development of mixed machine and clerical processing. A scheme, which is relatively attractive, is to use operators keying the information on a Stenotype keyboard, with the output of the Stenotype machine being immediately translated into English. The principal advantage is the high speed of stenotyping. A secondary advantage is the fact a good deal of proofreading can be accomplished as the typing is done. All the input is processed, and most errors in stenocoding will be detected during the process of translating with immediate feedback to the operator.

Nevertheless new systems with less and less human operators are needed to increase speed and reduce costs.

Some Conclusions

The major instrumentation for information handling is beginning to be defined. The principal features are:

1) Very large capacity memories
2) Fast random access
3) Organization of memories to facilitate search trails
4) Versatile consoles for users
5) Input conversion systems

Technology is at a stage to provide practical solutions to all of these, although development of instruments to the specific requirements of textual information is necessary. There is plenty of room to make fantastic improvements over present designs.

A SURVEY AND STUDY OF THE COMPUTER FIELD

PART 2

Industrial Securities Committee
Investment Bankers Association of America
Washington 4, D.C.

(Continued from the January issue)

A. *Company Position by Value of Installations*—the computer industry, as mentioned previously, is very close with its so-called proprietary information, so that installation and backlog figures are the result of educated guesses by industry spokesmen, consultants, trade and technical publications, and computer users. A combination of these sources has been used in the compilation of a computer census.[3] This chart shows the total number of computers installed to date by each manufacturer, including vacuum tube and solid state machines, the estimated value of these installations, the number of computers on order and the estimated value of these orders. As it would be impossible to know the sales value of each installation, an average system price was used. Since the introduction of the first Univac until September 1962, it has been deduced that there have been 16,187 computers installed, with an installation value of $4.5 billion when new. The exhibit clearly indicates the dominance of IBM in the computer industry. The company has installed 78.3% of the total number of machines with its 12,743 installations, the cumulative estimated value of which is $3.5 billion (see Table 2). A trend is the rapid decline in use and production of vacuum tube computers. IBM and Sperry Rand, the two major contenders in the industry initially, have had the greatest number of vacuum tube computer installations. Although many of these computers are still in use, production of nearly all has been phased out. If these machines were excluded from consideration when discussing market share, Table 3 indicates that IBM's position would be relatively unchanged. Sperry Rand would only have 5.4% of the market under this assumption, but the newer companies like RCA, Control Data, Minneapolis-Honeywell and General Electric would benefit significantly. As solid-state computers have just about completely replaced vacuum tube machines, Table 3 indicates which companies are improving their relative standings in terms of present market share and machines on order. Viewed in this light, Sperry Rand, National Cash and Burroughs all appear to be in a position to improve their relative standings.

Table 2

Present Market Share *

Company	Percent of Market based on Number of Machine Installations	Percent of Market based on $ Value of Machine Installations	Percent of $ Value of Machines on Order
IBM	78.3	79.2	77.9
Sperry Rand	4.8	8.5	7.8
RCA	1.2	2.3	3.1
Control Data	1.5	2.0	1.5
Minneapolis-Honeywell	0.5	1.9	1.8
General Electric	0.7	1.2	1.3
National Cash	1.9	1.2	2.3
Burroughs	1.9	1.0	2.6
Philco, Bendix, General Precision, Monroe, Packard Bell, Autonetics, Clary, Advanced Scientific Instruments	9.2 combined	2.7 combined	1.7 combined

* Based on the total number of machine installations (16,187) and on the total dollar value of these machines, using a typical sales price ($4,517,950,000).

B. *Company Position by Machine Size*—there are many ways of classifying computers by size, but the two most common methods are rental cost per month, and average selling price per system. The latter method will be used in this study, and machine sizes will be classified as follows: extra large, $5 billion and up; large, $1-5 billion; medium, $500,000-$1,000,000; small, $50,000-$500,000; and desk-size, under $50,000. This is an arbitrary classification, and could possibly place a computer or two in a wrong category if the average price is not a representative figure. Using this classification, it is apparent from Exhibit 4 and Table 4 that IBM is particularly strong in the large and medium size fields. IBM has 85.5% of the large-scale market, with 193 installations of the 7090 series and 340 installations of the 7070 series, accounting for installation values of $579 million and $360 million, respectively. Minneapolis-Honeywell has 5.5% of the total value of the large computer market, primarily due to its 800 computer. Control Data has 5.3% of this market, with 41 installations of its 1604.

IBM has dominated the medium-scale field, due to the success of its 1401. The company has installed 94.3% of the computers in this area, with an estimated value of $1.2 billion. No other computer manufacturer has as much as 5% of this market. RCA has 4.5% of the market, based on 78 installations of its 501, valued at $62.4 million. GE occupies third place with a market share of 2.9%, on 50 installations of its 210 machine, valued at $40 million. Burroughs' share of this market is 2.2%, which is the result of 55 installations of its vacuum tube B-220 computer. The ability to retain this position will depend on the marketing success of the solid-state B-5000, which currently has an excellent backlog of orders.

Table 3

Present Market Share *

Company	Percent of Market Based on Number of Machine Installations	Percent of Market Based on $ Value of Machine Installations	Percent of $ Value of Machines on Order	Percent of Number on Order
IBM	79.1	77.8	77.9	72.8
Sperry Rand	4.7	5.4	7.8	13.0
RCA	1.5	3.3	3.1	2.9
Control Data	1.9	3.0	1.5	1.0
Minneapolis-Honeywell	0.5	2.6	1.8	.8
General Electric	0.7	1.8	1.3	1.3
National Cash	2.4	1.5	2.3	4.2
Burroughs	1.6	1.3	2.6	3.0
Philco	0.1	1.2	1.1	.3
Bendix	2.7	1.1	0.3	.1
General Precision, Monroe, Packard Bell, Autonetics, Clary, Advanced Scientific Instruments	4.8 combined	1.0 combined	Less than 1.0% combined	

* Based on the number of computer installations (12,928) and their market value ($2,990,347,000), with the exclusion of vacuum tube computers which are no longer in production.

Sperry Rand emerges as the leader in the small-scale market, with 524 installations valued at $133.7 million. This accounts for 39.1% of this market. IBM is second with 16.7% of the market, based on 600 installations valued at $57 million. RCA (10.6%), Bendix (7.3%), and Control Data (8.5%), also have significant shares of this market.

The classification of IBM's 632 computer as a desk-size machine, gives this company 81.8% of the desk-size market. Among the non-major companies, Packard Bell and Monroe have a respectable share of this market with a 7.2% and 5.4% participation, respectively.

In the extra-large category, there are only two companies with installations today, namely IBM and Sperry Rand. Long production time, and specialized engineering and programming requirements have kept many manufacturers out of this area. However, even the top two producers are not going to stay in this field with their present machines. IBM has two installations of its STRETCH, and Sperry Rand has two installations of its LARC. Both companies have indicated that these machines will no longer be produced. This could leave the whole extra-large field open to Control Data, which will deliver its first 6600 super computer in 1964.

C. *Computer Backlog*—at present, the computer industry has a backlog of 8,496 computers with an estimated installation value of $3.0 billion. As indicated in Exhibit 4 and Table 4, IBM has 6,176 orders for machines valued at $2.36 billion. IBM's backlog accounts for 72.8% of the total backlog number and 77.9% of the backlog dollar value. Sperry Rand (13.0%), National Cash (4.2%), and Burroughs (3.0%) have greater potential percentages of the market in terms of the number of machines on backlog, rather than the dollar value of these machines, indicating a trend toward lower-priced computers. RCA, Control Data, Minneapolis-Honeywell and Philco backlog figures indicate a trend to the higher-priced machines. As a measure of growth, the total backlog of machines today is greater than the total number of machines installed between 1951 and 1960.

Table 4

Computer Manufacturers' Market Share by Machine Types *

Company	Number of Machines	Percent of Total Number	Machine Value	Percent of Total Value
I. Extra Large Computers				
IBM	2	50.0%	18,000,000	47.0%
Sperry Rand	2	50.0	20,000,000	53.0
Total	4	100.0	38,000,000	100.0
II. Large				
IBM	559	83.8%	999,720,000	85.5%
Sperry Rand	4	.7	6,500,000	.6
Control Data	41	6.1	61,500,000	5.3
Minneapolis-Honeywell	43	6.4	64,500,000	5.5
Philco	20	3.0	36,800,000	3.1
Total	667	100.0	1,169,020,000	100.0
III. Medium				
IBM	4,185	94.3%	1,190,875,000	86.9%
RCA	78	1.8	62,400,000	4.5
Minneapolis-Honeywell	24	.5	12,000,000	.9
GE	50	1.1	40,000,000	2.9
National Cash	30	.7	25,500,000	1.8
Burroughs	55	1.2	30,800,000	2.2
Bendix	14	.4	8,162,000	.8
Total	4,436	100.0	1,369,737,000	100.0
IV. Small				
IBM	600	25.2%	57,000,000	16.7%
Sperry Rand	524	22.0	133,705,000	39.1
RCA	121	5.1	36,300,000	10.6
Control Data	205	8.6	29,035,000	8.5
GE	555	2.3	13,750,000	4.0
National Cash	285	11.9	18,750,000	5.5
Burroughs	22	.9	6,600,000	1.9
Bendix	358	15.0	25,060,000	7.3
General Precision	80	3.3	8,800,000	2.6
Adv. Scien. Inst.	3	.4	360,000	.2
Autonetics	125	5.3	12,500,000	3.6
Total	2,378	100.0	341,860,000	100.0
V. Desk-Size				
IBM	4,950	89.4%	59,400,000	81.8%
Burroughs	140	2.6	2,800,000	3.9
Monroe	251	4.5	3,950,000	5.4
Packard Bell	130	2.3	5,200,000	7.2
Clary	64	1.2	1,280,000	1.7
Total	5,535	100.0	72,630,000	100.0

* Excluding vacuum tube computers.

Potential Market

The previous section on computer applications shed some light on the future prospects of the industry. The problem of forecasting in the computer industry is that market estimates by experts in the field have always been on the low side. Looking ahead to 1966, it has been estimated that sales of business-scientific computers could be 75% ahead of 1961, with industrial computers 200% ahead, and process control equipment 400% ahead. In terms of dollar value, shipments are expected to reach $2.2 billion for business and scientific computers, and $2.0 billion for special military computers. The usual method of projecting the future market potential of the computer industry has been to analyze the government, business, scientific and military fields, or to estimate industry and area applications.

One other method which might receive a little more attention is the market for computers which results from cost savings in such areas as clerical personnel and inventory. For example, the clerical force in the U.S. could reach 12.25 million by 1970, assuming a 25% increase in ten years. With salaries increasing at an average rate of 3% a year, the average wage could reach $99.35 a week. Under these assumptions, the annual clerical bill could reach $632.8 billion. If it is assumed that companies employing personnel equivalent to 5% of these total clerical costs could take advantage of cost savings through computers, then clerical personnel earning $31.5 billion would be exposed to replacement by computers. As cited previously, it is not uncommon for computers to save 10-25% in clerical costs, so that a potential computer market in this area alone is on the order of $3.1-7.8 billion by 1970.

The situation with inventory presents somewhat the same picture. During the past decade, manufacturers' inventories increased from $44.4 billion to $55.2 billion, or 25%. If a similar increase can be assumed by 1970, then these inventories could reach $69 billion. Assuming firms carrying one-tenth of this inventory are in a position to employ computers, and if savings under this assumption are 10-20% in each case, then savings of $690 million to $1.4 billion are possible. In other words, savings from clerical and inventory costs could channel as much as $3.8-9.2 billion into computers by 1970.

A. *Military Market*—one area which cannot be overlooked is the military market, which is growing faster than the electronic data processing market as a whole. Electronics industry sources indicate that as much as one-sixth of all defense electronics expenditures go for some type of computer. An estimated $8.0 billion will be spent for military electronics in 1962, with $1.3 billion spent on data processing equipment. If expenditures for defense electronics continue at the present rate, they could reach $15.0 billion in 1970, creating a $2.5 billion military computer market.

B. *Foreign Market*—the future potential of the computer industry is further enhanced by foreign market prospects. There are approximately 2,800 computer systems installed and on order in Western Europe, plus 389 installations in Great Britain. By 1970, there will probably be more than 14,000 installations in Western Europe, and 700 installations in Great Britain. West Germany leads in overseas computing installations with 472 systems, Great Britain is second with 389, and France is third with 342. The biggest market for computers in the future will be in these three countries followed by Italy, the Benelux countries, Scandinavia, Austria, and Switzerland. Of the 14,000 estimated installations by 1970, 10,000 or more are estimated to be small systems, 3,000-4,000 medium-size computers, and 150-250 large-scale computers. The total value of this market should be in the neighborhood of $5 billion. Domestic companies are considered to have a decided advantage in this market, since U.S. technology, sales techniques, programming and computer applications for specific jobs are years ahead of the West Europeans. According to a recently published estimate, the foreign computer market is shared as follows: IBM—70%; Sperry Rand—8%; and two foreign companies, BULL (8%), and International Computers & Tabulators (6%), sharing the rest of the market along with other local firms. In France, there is a sales battle between IBM and Compagnie des Machines BULL, which share almost all of the market in France. BULL is an aggressive firm with excellent government connections. The company has signed a marketing agreement to sell RCA's 301, and in return gets full access to all RCA present and future technical developments. In West Germany, IBM is well in the lead with over 400 installations. Univac and BULL run a distant second, while the major German firms (Siemens, Telefunken, and Zuse), although selling some systems, lack the sales organization needed for market dominance. The Benelux countries have mainly installed IBM and BULL equipment, with some sales going to NCR (through its Elliot Automation affiliate), and Univac. In Italy, most of the 250 computer installations belong to IBM, with BULL and Olivetti sharing the rest of the market. In Great Britain, International Computers & Tabulators (53 installations), and Ferranti (50 installations) are proving excellent competition for IBM (56 installations). A tight labor supply and rapidly increasing wages will lead European industries to push toward more automation. Automation means computers, and computers are what U.S. manufacturers have and know how to sell.

C. *Digital Computer Market in 1970*—industry experts are projecting shipments of $3.0 billion in business and scientific computers in 1970, and $2.5 billion in special military computers. The prospects for a $4-7 billion market in 1970 does not appear overly optimistic in view of growth rates exhibited to date. On this basis, it is estimated that the total cumulative market will grow by 350% in the next eight years, or will increase from $4.5 billion to approximately $20 billion. In view of current machine installations, backlogs, areas of concentration, marketing ability, finances, etc., Table 5 is a prognostication of computer company standings in 1970. IBM should still be the acknowledged leader in the industry, but its share of the market will be less than the 78% which it now commands. This will be the result of a number of factors. As the reliability of machines increases, the offering of service, which has been IBM's strongest selling point, becomes less of an asset. In addition, companies like GE, Philco and Minneapolis-Honeywell, which are large computer users, will start supplying their own company with their respective machines. For example, next to the government, GE has been the largest customer for IBM, employing over 100 computers. Future marketing strategies will become more sophisticated on the part of manufacturers, and since machines will have approximately the same capabilities, the company which can offer the best package and working relationship to a customer should have an advantage over competition. This is one reason why National Cash and Burroughs should do well in their total systems approach. It is a tossup for the number two spot by 1970, but based on present progress and the potential of its electronics capabilities, RCA appears to have a slight edge over GE. RCA's backlog is rapidly approaching that of Sperry Rand, so that the number two position could be decided in a few years. GE faces a more difficult task, but should make its big move late in 1964 or 1965, when it introduces its new line of third generation computers, employing advanced technological concepts.

Table 5

Projected Market Share Through 1970 *

Company	Est. Market Share	Cumulative $ Value of Machine Installations ($ million)
IBM	60-70%	$ 9,000-14,000
RCA	8-10	1,200- 2,000
General Electric	7-10	1,050- 2,000
Sperry Rand	7-10	1,050- 2,000
Control Data	4- 6	600- 1,200
National Cash	4- 6	600- 1,200
Burroughs	3- 5	450- 1,000
Minn.-Honeywell	3- 5	450- 1,000
Philco	2- 3	300- 600
Others	1- 2	150- 400
		$15,000-20,000

* Based on a potential cumulative dollar value of machine installations approximating $15-20 billion.

D. *Potential Analog Computer Market*—the total value of general-purpose analog computers, process control computers and hybrid digital-analog computers is estimated to reach $180 million by 1966, representing a compound growth rate of 15% a year since 1962. This rate is likely to continue through 1970, so that the total value of analog computers could be $300 million by that date. Electronic Associates accounts for approximately two-thirds to three-fourths of the total general-purpose analog computer market, with the remaining sales divided among Beckman Instruments, Systron-Donner and Applied Dynamics.

The Future

As remarkable as the progress has been in computer technology over the past decade, industry experts regard computers at the same stage of development that automobiles were when they began to be generally accepted by the public. Advances in the state of the art will bring third generation computers employing thin films, cryogenics, micro-miniaturization and tunnel diodes. These components will not only lower costs, but permit operating speeds measured in nanoseconds, or billionths of a second. Looking further to the future, operating speeds some day may be measured in terms of the speed of light. Today's computers perform 200,000 operations a second. MIT has developed a working model for a new generation of machines which will perform over 2,000,000 computations per second. Future computers will be reduced in size to extend their use to smaller organizations, and reduced in prices and rental charges to increase their markets. Advances made in the peripheral equipment area, such as optical scanners, data communication equipment, and data display systems, will open up new multi-million dollar industries.

Extension of computer applications will come with increased emphasis on real-time systems. In the next decade, direct communications with computers from a point of sale will not only result in order filling, data recording, and inventory control, but could also extend further down the line into bank credits and debits. Credit cards could become inputs to computers through data communications equipment. Commercial banks will have inter-connecting systems which will lead to up-to-the-minute information on bank and customer balances, eliminating a great deal of the float in the banking system. Total management information systems will be possible by communications links between industrial control computers and data processing computers, transforming the industrial complex into one continuous loop of synchronized data flow.

Electronic computers will be a great impetus to technological development, as it broadens man's capabilities and intellect. The day of trial-by-error will soon be history, as the analytical approach provided by simulation techniques will channel efforts to decisions providing the greatest payoff and return. Increased automation and productivity will not only lead to increased profits on the part of over-all industry, but will be a vital factor in meeting the serious challenge facing our country in international trade competition.

[3] See Exhibit 4 (which is very voluminous) in the full report of the committee.

Appendix 1

List of Computer Manufacturers

*Advanced Scientific Instruments, 5249 Hanson Court, Minneapolis 22, Minn.

Autonetics, North American Aviation Co., 3584 Wilshire Blvd., Los Angeles 5, Calif.

*Bendix Corporation, 5630 Arbor Vitae St., Los Angeles 45, Calif.

*Burroughs Corporation, 6071 Second Ave., Detroit 32, Mich.

Clary Corporation, 408 Junipero St., San Gabriel, Calif.

*Computer Control Corporation, 2251 Barry Ave., Los Angeles 64, Calif.

*Control Data Corporation, 501 Park Ave., Minneapolis, Minn.

*Digital Equipment Corporation, Main St., Maynard, Mass.

El-Tronics, 13040 S. Cerise Ave., Hawthorne, Calif.

*General Electric Corporation, 13430 N. Black Canyon Highway, Phoenix, Ariz.

*General Precision, Inc., 101 W. Alameda Ave., Burbank, Calif.

*IBM Corporation, 590 Madison Ave., New York, N. Y.

*Minneapolis-Honeywell Regulator Co., 60 Walnut St., Wellesley Hills 81, Mass.

*Monroe Calculating Machine Co., 555 Mitchell St., Orange, N. J.

*National Cash Register Company, Dayton 9, Ohio

Packard Bell Company, 1905 Armacost Ave., Los Angeles 25, Calif.

*Philco Corporation, 3900 Welsh Rd., Willow Grove, Pa.
*Radio Corporation of America, Camden, N. J.
Ramo-Wooldridge Corporation, 8433 Fallbrook Ave., Canoga Park, Calif.
*Remington Rand Corporation, 315 Park Ave. So., New York 10, N.Y.
*Scientific Data Systems, 1542 Fifteenth St., Santa Monica, Calif.

* The authors are indebted to these companies for their cooperation and assistance in the project.

Appendix 2

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Appendix 3

Members of the Industrial Securities Committee

Blancke Noyes, Chairman; Frederick G. Braun, Jr., Gerald F. Brush, John F. Bryan, William E. Fay, Jr., Edward K. Hardy, David W. Hunter, Herbert D. Hunter, James F. Keresey, Thomas A. Larkin, J. Victor Loewi, L. Gordon Miller, Jr., Allen J. Nix, Frank B. Reid, Philip O. Rogers, Jesse A. Sanders, H. Virgil Sherrill, Julian A. Space, Carl Stolle

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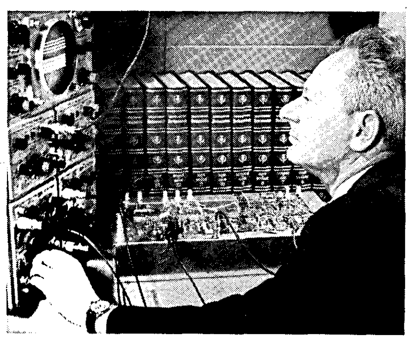
NEW APPLICATIONS

20 MILLION BITS PER SECOND OVER 40-MILE LINK

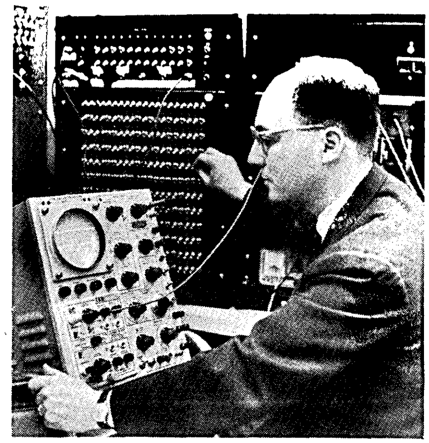
Computer data has been flashed at 20 million bits of information a second (33 million words per minute) over a 40-mile experimental high-quality television link between Yorktown Heights and Harriman, New York, by IBM Corp. engineers. This is equivalent to transmitting more than 1,500,000 words in a typical encyclopedia volume in just three seconds.



-- Dr. Emil Hopner, computer communications manager of IBM Advanced Systems Development Division, is shown above with the experimental system. The system uses a binary feedback technique, and simple and flexible signal detection equipment. Modulation of computer signals for transmission is not required.

Most "long-distance" communication of data in business systems today is by common carrier telegraph (up to 75 bits per second) and telephone lines (up to 2400 bits per second). Dr. Hopner said the TV channel offers possibilities for higher speed computer communications not only because it is far broader in bandwidth than the telephone line, but also because it is designed for transmission of pulses that are similar to the binary signals of computer language. For this reason, simple equipment can be used to translate signals between computers and television channels.

The speed of data communication over voice lines has been limited up to now by "delay" distortion affecting computer signals but not noticeable to the human ear, and the great variety of lines. A solution to this problem has also been demonstrated by another IBM system operating at the highest rate of transmission reported to date over telephone lines. In this test, data was transmitted over an experimental high quality telephone channel at 8000 bits per second between the IBM laboratory in Yorktown Heights and the American Telephone and Telegraph Company station at Harriman, New York. The system, shown in the picture at the upper right, being operated by IBM Engineer H.L. Funk, makes high transmission speeds possible by compensating for telephone line distortion. Sample signals are sent over the line at the beginning of transmission so that the transmitter can produce a pre-distorted wave form automatically, which compensates for



the phase and amplitude distortion of the line. In addition to the automatic compensation for line distortion, higher transmission rates are obtained by the use of a simple vestigial sideband phase modulation system which almost doubles the capacity of the voice channel. Further increases in transmission rate are made possible by carrying the information in both polarity (positive or negative to ground) and amplitude (two possible values) of the data signal.

COMPUTER WILL "WRITE" DATA INTO NAVY "ORBITING ALMANAC"

A satellite navigational system (which will be operational in the near future) is expected to make navigation many times more accurate than it now is using conventional equipment. Earth satellites traveling in precisely known orbits are used in conjunction with radio equipment and high-speed electronic computers to calculate a ship's exact position to an accuracy of a few hundred feet.

A TRW-130 (AN/UYK-1) digital computer has been delivered to the Navy at Point Mugu, Calif., by the RW Division of Thompson Ramo Wooldridge Inc. The computer will automatically "write" almanac-type data into the memories of orbiting Navy navigational satellites as they pass over Point Mugu. The satellites, continuing in their polar orbits, will transmit the data to specially equipped ships at sea for use in locating their positions on the globe.

In the system, four tracking stations in the United States will continuously monitor the changing orbital paths of the satellites and feed this information into a computing center at Point Mugu. A large digital computer at the center will calculate the present orbit of each satellite and predict exactly where it will be during the next twenty-four hours. This information will then be given to the smaller TRW-130 computers for later transmission to the satellites via a 60-foot antenna located on Laguna Peak. After receiving the information from the larger computer, the TRW-130 makes the necessary format conversions and codings, locks onto the satellite signal, and then clocks out the latest orbital information. The computer operates so fast that there is time during one pass of the satellite to ask it to repeat what it was just told, in order to be sure that no errors were made. If any errors are detected, it is possible to transmit a complete set of data as many as three times during the few minutes a satellite is within range of the transmitting equipment.

As the globe rotates on its axis, every point on it will be underneath a satellite at least once every two hours. A ship at sea can "sight" these satellites with radio equipment (a doppler radio system) and the "navigator" (a ship-borne computer) on the ship calculates the ship's exact position from the data stored in the satellite memories.

DETECTING FAILURES BEFORE THEY HAPPEN IN THE TITAN

At Martin Company's Denver Division in Colorado, a computer-armed "detective" squad is a key factor in the successful flight testing program of the Air Force-Martin TITAN ICBM. Martin-Denver systems engineers and a group of failure-reporting experts have compiled a 200-mile-long paper history of the TITAN. During the past five years more than two million punched cards have been used to create a case history on every part in every missile built at Martin-Denver. These cards have been converted onto several small reels of magnetic tape for quick computer reference.

Once a month, the manager of systems engineering, J. L. Burridge, receives a book prepared by the IBM 7090 which shows the performance of the TITAN over an eight-month period. The performance curve drawn by the computer indicates potential trouble areas. The staff of engineers then is able to correct or redesign a part which has started to drop in reliability. Recognizing trouble before it happens prevents failures in flight. The term "failure" doesn't necessarily mean that the missile failed to attain its flight objectives. It might just be a loose wire, a plugged hole or a minor drop in voltage recorded by radio signals as the missile flew to its target as planned.

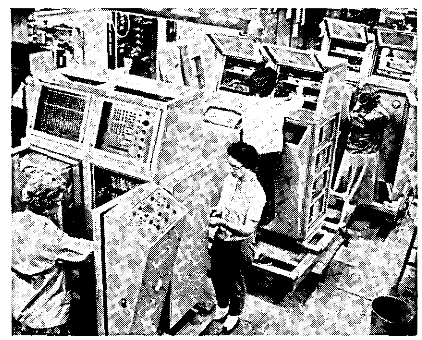
When a failure occurs, Martin scientists and engineers call on their IBM computer to sift millions of clues to pinpoint the cause. Once this has been established, the 7090 looks into the history of every past missile to see if there's a pattern of failure. If so, the computer alerts the engineering staff and corrections are made. Trouble areas have been traced from such things as a loose wire on a diode, up to problems requiring changes in manufacturing processes of a missile part in a factory thousands of miles away.

The IBM 7090 spends twelve hours a month keeping the TITAN history up to date and preparing the monthly engineering parts profile. It would take the working lifetimes of seven men to prepare just one of these reports. The computer reporting system now in use in the TITAN II program will play a key role in insuring success when the TITAN II is used to boost a team of Project GEMINI astronauts into a low earth orbit.

NEW CONTRACTS

MACHINE TOOL MODIFICATION WITH NUMERICAL CONTROL

Thompson Ramo Wooldridge will undertake a $178,000 machine tool modification program for Lockheed-Georgia Company as part of the modernization of equipment in the U.S. Air Force. The TRW order will be handled by the Michigan City, Indiana, plant of TRW and consists of: 1) three TRW-3000 all-solid state numerical control systems to replace existing controls on three Cincinnati profile milling machines; 2) modification of the machine tools themselves to accommodate the TRW-3000 numerical control systems; and 3) extensive equipment testing.



-- Three numerical control systems for machine tools - the major part of a $178,000 order from Lockheed-Georgia Company - are shown here in various stages of assembly at the Thompson Ramo Wooldridge plant in Michigan City, Indiana.

Lockheed-Georgia will use the newly equipped machine tools (scheduled to be ready in the fall) in production of Air Force aircraft such as the prop-jet C-130 Hercules, the C-140 Jetstar, and the new Turbofan C-141 Starlifter.

DATATROL AWARDED $78,000

Datatrol Corporation has been awarded a $78,000 contract by the National Science Foundation. The firm will compile a dictionary of equivalents for the indexing vocabularies of three major federal scientific and technical information centers: the Atomic Energy Commission; the Defense Department's Armed Services Technical Information Agency; and the National Aeronautics and Space Agency. Accompanying each term from one agency in the indexing vocabulary will be the closest indexing equivalent used by the other two agencies.

The new dictionary will make it easier for the nation's research and development community to exchange needed information.

GENERAL PRECISION RECEIVES CONTRACT FOR COMPUTERS FOR GEMINI TRAINERS

Link Division, Simulation & Control Group, General Precision, Inc., Binghamton, N.Y., is the recipient of a letter contract for more than one million dollars from McDonnell Aircraft Corporation for two computers to be used on two Gemini space-mission trainers. The trainers are being built to train astronauts for two-man orbital flights. The contract also calls for the development of computer programs which will accurately and completely simulate the various phases of space flight. The specially designed Link Mark I Digital Computers will provide real-time simulation computations for all phases of a normal mission.

DUKE POWER COMPANY ORDERS G. E. COMPUTER SYSTEM

Duke Power Company, Charlotte, North Carolina, has purchased a GE 412M computer system and associated control equipment from General Electric. Installation will be made at Plant "Marshall", now under construction near Charlotte.

Two 35-mw turbine-generators will go on-line at the new plant in 1965. The system represents the first computer application for startup and shutdown of two turbines with sequence monitoring of boiler and auxiliaries in a coal-fired plant.

MULTIMILLION CONTRACT TO ELECTRO-MECHANICAL RESEARCH

The National Aeronautics and Space Administration has announced the award of a $7,376,379 contract to Electro-Mechanical Research, Inc., Sarasota, Fla., for the manufacture, test, and installation of telemetry PCM ground stations for the NASA World Wide Range. The EMR Sarasota Products Division will supply ground data processing stations to be installed at NASA manned spacecraft tracking stations throughout the world. Each of the stations to be supplied consists of 15 racks of electronics designed specifically to acquire PCM telemetry signals rapidly, and to convert the signals into various forms suitable for transmission, display, and further computation.

In addition to system design and installation, EMR will perform site surveys at each of the NASA world wide range stations; will conduct training courses for NASA personnel; and will provide technical assistance in running simulated missions to familiarize NASA personnel with the operation of the new universal PCM ground stations.

TWO RCA 301 COMPUTERS LEASED BY OHIO UNEMPLOYMENT COMPENSATION BUREAU

The Ohio Bureau of Unemployment Compensation, Columbus, Ohio, has signed a contract for the leasing of two RCA 301 EDP systems to speed up the handling of claims and printing of checks and expand the Bureau's research and reporting services. The RCA 301 systems have been specially tailored to meet the Bureau's precisely defined needs for computer equipment. A training program has been started for the selected bureau personnel who will operate the system after it is installed next July.

NEW INSTALLATIONS

COMPUTER WILL BE INSTALLED FOR HIGH SCHOOL EDP EDUCATION

Des Moines Technical High School, Des Moines, Iowa, will have a Burroughs Corp. B260 for use in a comprehensive data processing education program for a high school. The new solid-state system is scheduled for delivery next summer. It will be the heart of a new course designed to develop computer operating personnel from among the city's 5000 high school business students.

The data processing curriculum will include courses in computer programming, system development and design, and business simulation. Training in operation of keypunch and tabulating equipment is also included. Students from the city's four other high schools may enroll in specified data processing classes without transfer. In addition to classroom use, the computer will be used for school administrative tasks.

FIRST BANK COMPUTER IN ALASKA

The First National Bank of Anchorage has Alaska's first bank computer in operation -- a Burroughs Corporation B251 which is being used initially for demand deposit accounting. The Alaskan bank, which doubled its deposits between 1952 and 1962, has been involved in a concentrated MICR encoding program for nearly a year. It maintains a correspondent relationship with 23 other banks and operates 11 branch offices in Alaska.

ESQUIRE ORDERS NEW ELECTRONIC COMPUTER

Esquire, Inc., New York, N.Y., will use a UNIVAC III this year to speed copies of 18 national publications to the homes of subscribers. Esquire's Data Processing Center is used by fifteen national magazines (including Popular Science, Vogue, Outdoor

Life, etc.) plus the company's own publications. The UNIVAC III will replace three older UNIVAC computers in use at the Esquire Center for the past five years. Delivery of the new system is scheduled for July.

BANK EXPANDING EDP EQUIPMENT

The Colonial Bank and Trust Co., Waterbury, Conn., is planning to install a Burroughs Corp. B270 system this spring to succeed the B251 which has been in operation about a year. With the B251, Colonial automated its high-volume check collection and redistribution job. The installation of the larger B270 system means that Colonial will now extend its EDP to include savings accounts, installment loans, Christmas and vacation clubs, Ready Credit, dividend check preparation, trust, check reconciliation and others, as well as checking accounts. The new system will include a high-capacity, solid-state central processor, an electronic sorter-reader, high-speed card reader, card punch, four magnetic-tape transports and a high-speed, wide-line printer.

COMPUTER WILL MONITOR BOILER AND TURBO-GENERATOR SET FOR BELGIAN POWER STATION

An Argus 108 Computer has been ordered by Electrobel (Belgium) for installation in the extension to the Monceau Power Station near Charleroi of the Societe Intercommunale Electricite Belge. The computer, made by Ferranti Electric, Inc., will monitor and compute data to achieve optimum operation of a Sultzer once-through boiler. The computer will also monitor remaining items of the plant including an Escher Wyess 125 MW turbo-generator set. A new use of the computer is the direct control of the blade angle of one of the circulating water pumps to enable condenser conditions to be maintained at their optimum.

Another Argus computer from the Ferranti 100 series is to be used on-line for the guidance and control of a new radio telescope to be installed at Jodrell Bank during 1963. It will also log astronomical data obtained with the telescope, which will then be passed by data link to the Atlas computer at Manchester University for interpretation.

WEIZMANN INSTITUTE TO INSTALL COMPUTER SYSTEM

The Weizmann Institute of Science in Rehovoth, Israel, has contracted for the installation this month, of a Control Data 1604-A and 160-A computer system. Either computer will command and control a wide range of peripheral equipment also to be installed -- including twelve new Control Data 606 magnetic tape units, a 1000-line-a-minute printer, a card-reader and card-punch system, and additional magnetic core memory and arithmetic units.

The Control Data 1604-A/160-A Computer complex is expected to be useful to most research departments of the Weizmann Institute.

FIRST TEST UNITS FOR MOON PROJECT SHIPPED TO NASA

The Pacific division of The Bendix Corporation, North Hollywood, Calif., has delivered the first units of 20 telemetry transmitting systems for use in the research and development phases of Project Apollo to the National Aeronautics and Space Administration, Houston, Texas. These will be installed on test models of the Apollo spacecraft -- designed to carry astronauts to the moon and back to earth. The transistorized systems will transmit to tracking stations on earth more than 100 individual types of data concerning environmental conditions, including structural measurements, temperatures and pressures. Bendix engineers described the system as a pulse amplitude modulated FM/FM system using 16 subcarrier channels.

FIRST NEW HAVEN NATIONAL BANK INSTALLS TWO B270 SYSTEMS

The First New Haven National Bank, New Haven, Conn., has completed installation of the first of two Burroughs Corporation B270 financial data processing systems for the full range of bookkeeping and accounting functions. The remaining units will be installed by March.

The bank plans initially to transfer its transit operations to computer processing. Other applications scheduled for computer processing include savings, installment loans, payroll and trust accounting.

The system installed includes a central processor, two MICR sorter-readers, two magnetic tape units, punched card reader, and a six-tape lister. The second system will include four tape transports, line printer, central processor, two card readers and one card punch.

WESTINGHOUSE STARTS COMPUTER-CONTROLLED TELETYPE NETWORK

Westinghouse Electric Corporation, last month, began operating what is said to be the world's first computer-controlled Teletype system. A recently-installed UNIVAC 490 Real-Time Computing System has taken over the automatic routing of Teletype messages from one company location to another. The company has a communications system serving almost 300 locations throughout the United States. A semi-automatic switching center which was formerly used, handled about 20,000 messages a day. Robert C. Cheek, Director of the Tele-computer Center, being completed outside Pittsburgh, predicts a 100 per cent increase in volume by 1965.

The computer is able to "read" the message destination by certain characters at the beginning of the Teletype. Incoming information is automatically switched to the proper location. If the Teletype lines to that location are in use when the message comes in, the computer will store the message until a line is free. It will then send the Teletype to the proper plant or office.

NEW UNIVAC BANK PROCESSOR SYSTEM ORDERED BY FEDERAL RESERVE BANK, SAN FRANCISCO

The Federal Reserve Bank of San Francisco will replace its two UNIVAC-NDP Bank Processor System prototypes with a new UNIVAC Bank Processor I system. A major improvement in the new system is its ability to sort finally the San Francisco bank's documents in 1.7 passes compared to 2.9 passes in the prototype system. This makes it possible for the San Francisco bank to handle its work load with the one Bank Processor I instead of two.

Specifically designed for high-speed processing of the proof and/or transit operation, the Bank Processor I is capable of inproofing, establishing controls for further processing, and outproofing with cash letter preparation. The system consists of a Document Sorter, System Controller, and Audit Lister.

DEERE AND COMPANY INSTALLS CONTROL DATA 160-A

The Tractor Engineering Center of Deere and Company, Waterloo, Iowa, has replaced an electron tube computer with a solid-state 160-A. Installation of this high-speed computer is expected to provide faster service for design engineers and permit new programs to be written, tested, and added to the library. The Control Data 160-A will handle problems in transmission design, camshaft deflections, oil line bending as well as other engineering and scientific calculations.

DETROIT BANK INSTALLS COMPUTER

Public Bank, Detroit, Mich., has installed a Burroughs Corp. B251 EDP system to keep equipment capacity ahead of its growth. The Detroit bank's assets have climbed from $9 to $65 million in five years operation. The B251 system is being assigned to process checks and records for demand deposit (checking account) customers. The computer has also been programmed to provide account reconciliation as an additional service for commercial accounts.

ORGANIZATION NEWS

SCIENTIFIC COMPUTERS, INC. BUYS COMPUTER CENTER

Scientific Computers, Inc., of Minneapolis, Minn. has purchased, for an undisclosed amount of S.C.I. stock, the computer center operated by Channing Corporation at 85 Broad Street, New York, N.Y. Mr. James E. Peterson, President of S.C.I., indicated the New York Center would be equipped initially with an IBM 1401 four-tape computer system, a complete punched card tabulating system, and programming and systems personnel able to offer services in the application of digital computers in the fields of business, engineering and scientific data processing. S.C.I. will also offer management services in systems analysis and operations research.

Acquired with The Channing Center were personnel and programs to provide complete service to managers, investment counselors, and custodians of mutual funds, as well as brokerage houses and other financial institutions. Programs developed and presently being used by S.C.I. in the fields of banking, brokerage accounting, student grade reporting and scheduling and other computer applications will also be offered.

CUBE ELECTS OFFICERS

The newly merged and expanded computer users group, Cooperating Users of Burroughs Equipment (CUBE), has chosen a slate of officers for its first year of operation. They are: President -- Victor Whittier, Dow Chemical Co., computer specialist; Vice President -- F. E. Langenfield, Northern Natural Gas Co., vice president; Secretary-Treasurer -- Richard Frick of Abbott Laboratories; Dr. Alan Batson, Univ. of Virginia, and Irving Werner, Dept. of the Interior, directors; and A. P. Jensen, Georgia Institute of Technology, editor of quarterly newsletter.

R. E. Menick, Allstate Insurance Company, and Joseph Perrett, First Pennsylvania Banking and Trust Company, were elected to two-year terms as CUBE directors.

CUBE membership includes representatives of Burroughs 205 and 220 computer users and is open to present and future users of the company's B200 and B5000 systems.

SYSTEM SCIENCES DIVISION FORMED

A separate Systems Sciences Division has been formed by the Auerbach Corporation, Philadelphia, Pa. This new division will provide all the services required in complex systems work, from system synthesis and mathematical analysis to the design of all system logic, hardware, and software.

NCA HAS NEW BANKING CLIENT

Princeton Bank and Trust Co. of Princeton, N.J. has entered into an agreement with National Computer Analysts Inc. Princeton, N.J., to perform its demand deposit accounting at the new NCA Princeton Datacenter, which is scheduled to begin operations in March. Princeton Bank and Trust becomes the third banking client of NCA. The new Datacenter will be equipped with one of the largest of the RCA 301 systems.

AUERBACH AND BASIC SYSTEMS ANNOUNCE AGREEMENT

The Auerbach Corporation, Philadelphia, Pa. and Basic Systems, Inc., New York, N.Y., have announced an agreement that gives Basic Systems full commercial marketing rights to the Required COBOL-1961 Self-Teacher. This programmed instruction text was developed by the Auerbach Corporation on the Common Business Oriented Language for computer programming.

Basic Systems, Inc., has offices in Los Angeles, Cambridge, Mass., and Berkeley, Calif. It specializes in the design and application of programmed instruction material for industrial and government training, as well as academic education.

PEOPLE OF NOTE

DIRECTOR OF GENERAL PRECISION RESEARCH CENTER

Robert A. Dietrich has been appointed director of the Research Center of General Precision's newly formed Information Systems Group. The Research Center conducts research and development programs in basic and applied areas of computer and information-systems technology. Dietrich was formerly director of technical planning for General Precision's Librascope Division, which is now a unit of the Information Systems Group.

RCA EDP APPOINTS R. G. DEE

Robert George Dee has been appointed Manager, Product and Market Planning, Radio Corporation of America Electronic Data Processing. Mr. Dee will have responsibility for product planning and pricing analysis for RCA Electronic Data Processing. Prior to his appointment, Mr. Dee served as Manager, Industry Marketing Operations in the RCA data processing organization.

PACKARD BELL ELECTRONICS NAMES EXECUTIVE VICE PRESIDENT

Dr. Wendell B. Sell, group vice president and member of the board of directors of Packard Bell Electronics, has been named to the newly created post of executive vice president, according to an announcement by Robert S. Bell, president.

Dr. Sell has directed three divisions of the company as group vice president. In his new position he will be the chief operating executive supervising all line and staff managers of the company. The position of group vice president will be eliminated, Mr. Bell said.

ITT PROMOTES TWO EXECUTIVES

Dr. William M. Duke has been elevated to general manager - defense operations for ITT. In his new capacity he will serve as deputy to C. M. Mooney who heads the U.S. Defense Group. He also will continue as president of ITT Federal Laboratories, Nutley, N.J., a position he has held since February, 1962.

George A. Banino was appointed executive vice president of ITT Federal Laboratories. He also continues as division president of ITT Kellogg Communications Systems, a post he has held since August, 1962.

R. W. O'KEEFE PROMOTED AT IBM

Robert W. O'Keefe has been promoted to controller of the General Products Division of the IBM Corp.

This division operates four plants and three laboratories for the company and is charged with developing and manufacturing intermediate-sized data processing systems, which include the IBM 1401 and IBM 1440 computers. Mr. O'Keefe was formerly manager of financial planning and controls for the Data Systems Division of the company.

EXECUTIVE VICE PRESIDENT AT COMPUTER DYNAMICS CORP.

Computer Dynamics Corp. has announced the appointment of John S. MacKay

as Projects Director of the Programming and Applications Division. In this position, Mr. MacKay is responsible for management and development of complex government and industrial data processing applications on a wide range of computers. He is a specialist in multi-computer problems requiring extensive systems analysis and design planning.

PERSONNEL APPOINTMENTS AT data products corporation

W. Edwin Boyette has been appointed Director of Manufacturing, Midwest Operations, data products corporation, St. Paul, Minn. This facility manufactures the DISCfILE, a mass random-access memory.

William F. Winget has been appointed as Director of Contracts, also Midwest Operations.

I. S. S. NAMES PAUL MARGOLIN VICE-PRESIDENT, DIGITAL SYSTEMS

Paul Margolin has been named to the post of Vice-President of Digital Systems by Information Storage Systems. Mr. Margolin will be directly responsible for all activities relating to systems analysis, logical design, circuit design and coordination of all study, research and development, and corporate-sponsored programs on digital computer systems. Before joining I.S.S., he was Project Engineer at A. B. DuMont Laboratories.

GROUP EXECUTIVE NAMED

Dr. Irven Travis, president of Burroughs Labs and corporate vice president, has been named as group executive of the new Burroughs integrated corporate-wide Defense and Space Group. The new group includes Burroughs Labs, Defense and Space Systems Management Division, Military Electronic Computer Division, Military Field Service Division, Control Instrument, Defense and Space Systems Marketing, and Contract Administration.

GD/E ANNOUNCES APPOINTMENT

General Dynamics/Electronics-San Diego has announced the appointment of O. F. Hamann as design specialist for data products. In this position, Mr. Hamann will do advanced product planning and development for GD/E's high speed printers, cathode ray tubes, and various systems and devices which display and record information from computers or communications links. During his seven years with General Dynamics, he has held several research and engineering positions and assisted in the design of the CHARACTRON® Shaped Beam Tube and associated components which are used in the SAGE air defense system.

NEW GENERAL MANAGER, VP FOR TELECOMPUTING

Telecomputing Corporation has named Monson Hayes, Jr., corporate vice president and general manager of its Electronic Systems and Data Instruments Divisions.

Mr. Hayes was manager of the Computer Division, Ground Systems Group, Hughes Aircraft, prior to his appointment. Mr. Hayes has applied for 12 patents in the field of analog and digital computing techniques and is a senior member of the Institute of Radio Engineers.

COMPUTING CENTERS

UCLA COMPUTER "TALKS" OVER LONG DISTANCE

An educational computer center, linking six western schools by telephone and auxiliary transmission devices, is now operating. The center's machine is an IBM 7090 in the Western Data Processing Center (WDPC) of the Univ. of California at Los Angeles. The six institutions that can "talk" directly with the 7090 in Los Angeles are: the Air Force Academy (Colorado Springs, Colo.); California Institute of Technology; University of California, San Diego; Stanford University, University of Southern California, and University of Utah (Salt Lake City). Some of these schools have computers of their own, which can be linked directly with the 7090 at WDPC.

-- Arnold Somkin, off-campus program consultant in UCLA's Western Data Processing Center, takes final information before turning on Teleprocessing machine which will receive data from computer on one of six other campuses in telephone computer network.

The WDPC at present serves 77 other colleges and universities in twelve western states by mail, but plans to expand its telephone network to a total of a dozen participants during the year. WDPC is oriented toward business research, but the cooperating schools use the computer network for teaching and research problems. The center's IBM teleprocessing unit is able to record on tape immediately a problem received over a line, and hold it for available time on the machine. Answers are usually returned within a few hours in contrast to the several days required by mail.

MEDICAL COMMUNITY SERVED BY COMPUTER CENTER

A computer facility adapted to a medical school is being built by Control Data Corp. of Minneapolis, Minn., in the Johnson Foundation of the University of Pennsylvania School of Medicine, Philadelphia, Pa. The facility will analyze such problems as (1) variables in a mathematical model of a cancer cell, and (2) the flow of energy through an animal system from plant to ultimate predators. The medical community of the Philadelphia area will have access to the facility.

The equipment consists of a desk-sized central computer, four magnetic tape units, and a large variety of other equipment to receive, store, and transmit information. The equipment will be designed and programmed to "talk" the language of medicine and chemistry, rather than accounting, insurance, or other fields.

VA RESEARCH SUPPORT CENTER

The Veterans Administration Hospital at Sepulveda, Calif., last month inaugurated a VA Research Support Center, the culmination of a pilot project carried on at System Development Corp., Santa Monica, Calif. Under the direction of Dr. Reed Boswell, a VA experimental psychologist, the new center will help research workers from universities, industry, and other places working in the VA Department of Medicine and Surgery. The center will give information and assistance in non-medical aspects of research projects. The help will include experimental design, mathematical and statistical advice, data handling and computation, electronic instrumentation consultation, and a variety of other specialized services.

NEW PRODUCTS

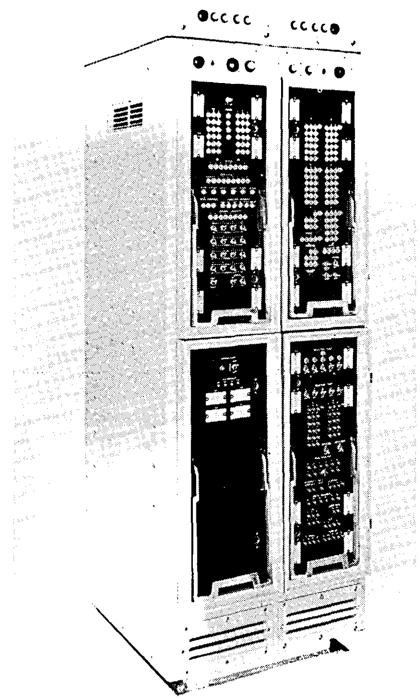
Digital

UNIVAC ANNOUNCES A NEW MILITARY COMPUTER

UNIVAC Div. of Sperry Rand Corp.
315 Park Avenue South
New York 10, N.Y.

The UNIVAC 1218 Military Computer, developed by this company, has an extremely wide range of military applications. It is a stored-program, medium-scale, general-purpose digital computer. It has an 18-bit-word ferrite-core memory, a 4 microsecond cycle time, and a memory capacity of 4000 to 16,000 words. The basic 4096-word memory is expanded by simply adding memory modules; electronic or mechanical modifications are not required.

The computer may be used with a wide variety of on-site or remote standard peripheral devices or as an independent complete general-purpose system. Also, it will operate as a satellite computer with larger systems, to supply off-line processing or associated on-line operations.



-- UNIVAC 1218 computer occupies slightly more floor space than a filing cabinet.

Rapid input and output is provided with eight input and eight output channels. Arithmetic and input-output operations may be performed on single-length 18-bit words or on double-length 36-bit words. The channels may be linked in pairs to provide 36-bit parallel input or output.

Internal high speeds and a repertoire of 98 instructions permit rapid processing of large amounts of complex data. An average multiply instruction takes 38 microseconds; an add instruction is executed in 8 microseconds.

The computer includes an extensive software or programming package consisting of a mnemonic (abbreviated English) assembler, floating point arithmetic, table manipulation, and utility and debugging routines.

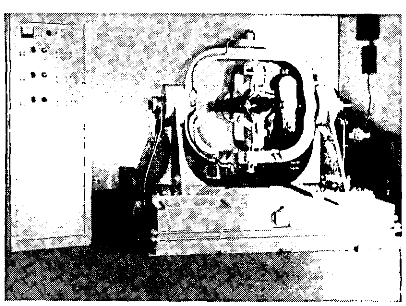
Analog

NEW FLIGHT SIMULATOR

Carco Electronics
1180 O'Brien Drive
Menlo Park, Calif.

A three-axis flight simulator has been developed by this company, to provide extended low-velocity operation, dynamic range, and large load capabilities. It is available with space or earth coordinates.

The flight simulator, called Model S 450A, is programmed by an analog computer, or a function generator, to duplicate the angular rotational motions of an actual missile, space capsule, or aircraft. The equipment has a controlled dynamic velocity ratio of over 1,750,000 to 1, with maximum rates in excess of 700 degrees per second and minimum rates of less than one-tenth the earth's rotational rate. High angular controlled accelerations exceed 50,000 degrees per second squared, with a frequency response over 27 cycles per second with rated load.



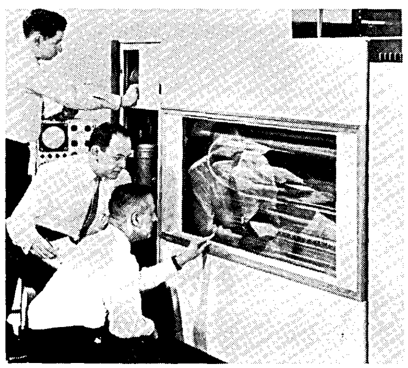
-- The equipment shown in the photograph above is installed at McDonnell Aircraft Corp. for use on their Gemini spacecraft program.

Memories

MASS DATA STORAGE IN NEW COMPUTER SUBSYSTEM

UNIVAC Div. of Sperry Rand Corp.
315 Park Avenue South
New York 10, N.Y.

This company has developed an electronic device for the storage of large masses of business data, which can be retrieved by an electronic computer in 92 thousandths of a second. The device is known as the UNIVAC 490 Fastrand Mass Storage Subsystem. These units have a storage capacity of 64 million characters of information each. Theoretically, as many as 96 of the units may be used at one time with the company's UNIVAC 490 Real-Time Computing System.



-- Engineers give final check-out to a UNIVAC 490 Fastrand Mass Storage Subsystem.

Each unit consists of two drums revolving at 870 revolutions per minute. 64 flying heads mounted on flexure springs are used to search the rotating drums for desired facts. Only one moving part is used to position all 64 heads in each unit. Positioning is accomplished through the use of a linear transducer directly coupled to the positioning carriage on which the heads are mounted. Only nine bearing surfaces are used in each Fastrand unit. Two motors, one integrally mounted to each drum, are used to drive the system, which is completely self-contained with its own power supply.

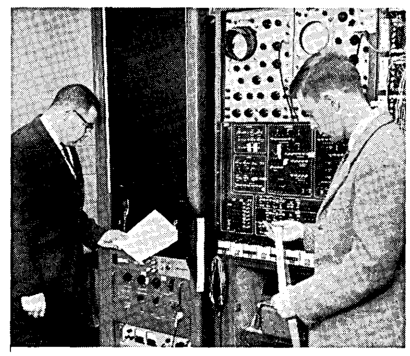
Company officials stated that the new sub-system is specifically designed for use by companies that require up-to-the-minute information on large ammounts of data, in order to keep on top of rapidly changing business conditions. Existing programming packages for the UNIVAC 490 Real-Time Computer will operate the subsystem.

Input - Output

ELECTRONIC READER OF TYPE OF MANY FONTS

Sylvania Electric Products, Inc.
Applied Research Laboratory
Waltham, Mass.

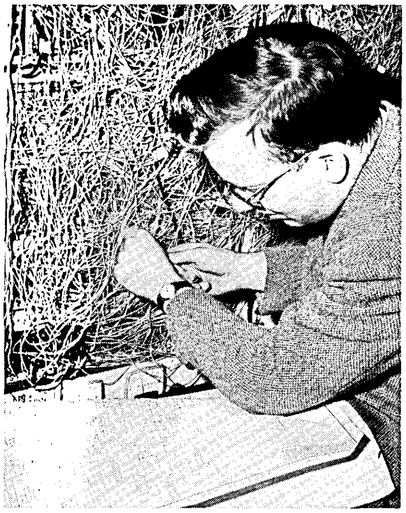
An electronic multi-font print "reader", which converts what it "sees" into data on punched cards or tape at the rate of 700 characters per second, has been developed by this company. Speeds up to 20,000 character conversions per second are feasible, based on principles established during development work on the current model.



-- At the left a page of typewritten copy is removed from the reader's scanning unit, which starts the reading process. At the right the punched tape output is being scanned; it can be fed into a computer for processing or a flexowriter for display.

The machine reads up to 20 different type faces from 1/12-inch to 1/2-inch in height, and reads either printed or typewritten documents. Modifications can be made to accommodate additional type fonts. The reading of many fonts is done through the use of a light spot generated by a cathode ray tube, similar to those used in television sets. The reflection of the spot moving along the surface of the printed page is converted to electrical signals for character recognition. The electrical signals are matched against a large number of coded reference characters compactly stored in a recognition unit. Recognition is achieved by obtaining the best match between the character being read and the character stored in the machine.

The reader has a number of military uses including machine translation of foreign language



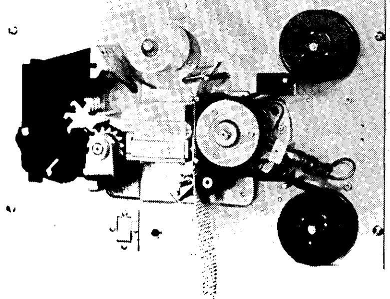
-- Above, the digital control logic unit is being checked; it matches electrical signals given off by printed characters against the stored coded referenced characters. The over-all recognition process requires less than 50 millionths of a second.

documents, proofreading, accounting and optical-pattern recognition. With modifications, the machine could be used for photo interpretations and for map reading.

NEW DIGITAL PRINTER

Monroe Calculating Machine Co., Inc.
Electronics Components Div.
San Francisco 5, Calif.

This company has announced its Monroe DATA/LOG MC 10-40 digital printer. This printer is a solid state, 4 line, coded input strip printer. It prints at the rate of 1040 lines per minute. Impressions are made by permanently timed hammers, cam driven, striking through a ribbon and against a constantly revolving character drum.



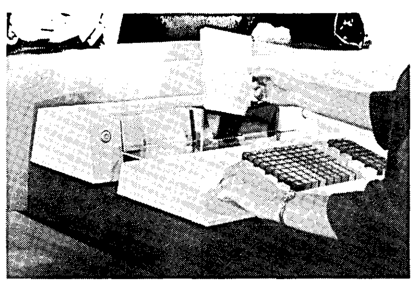
The printer may have 4, 8, 12, or 16 printing positions. Each position is capable of printing 0 through 9 in addition to 5 symbols, plus, minus, decimal, A and B (standard). The printer is of modular construction with a self-contained regulated power supply, timing circuitry, and a conversion matrix for the acceptance of 4 line codes.

BANK TELLER TERMINAL

IBM Corporation
Data Processing Division
White Plains, N.Y.

A communications terminal which places financial information about customer accounts at the fingertips of a bank teller has been developed by this company. The new IBM 1062 terminal enables a teller to relay a transaction to a central computer for processing and have the new balance printed out at his station in seconds.

The 1062 terminal, which can be shared by two tellers, has a keyboard for manually entering data; an insertion chute for passbooks, checks, money orders and receipts; and a printing unit that records all transactions in printed form for audit purposes. It also posts replies from the computer on a passbook or other document.



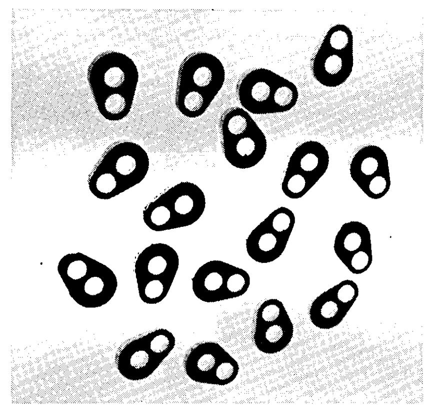
Data from a terminal is transmitted over communications lines to the computer through the IBM 1061 control unit and the IBM 1448 transmission control unit.

Components

"SHMOO" SHAPED TRANSFLUXOR

Electronic Memories, Inc.
9430 Bellanca Ave.
Los Angeles 45, Calif.

A new two-hole "shmoo"-shaped transfluxor, for application in coincident-current non-destructive memories, has been developed by this company.



The "shmoo" shape of the transfluxor gives electrical characteristics, such that in the saturated state for "Read" or "Write" the unsaturated area of the transfluxor is very small. This shape also gives simplified orientation of "Read" and "Write" holes during automatic grading. The physical and electrical characteristics of the "Read" hole of the "shmoo" transfluxor can be matched with those of a standard 50 mil toroid; this enables construction of both a non-destructive coincident-current memory and a destructive-read "scratch pad" memory, using the same design of drive circuits.

NEW CATHODE RAY TUBE FOR ALPHANUMERIC SYMBOLS

Litton Industries
Electron Tube Division
San Carlos, Calif.

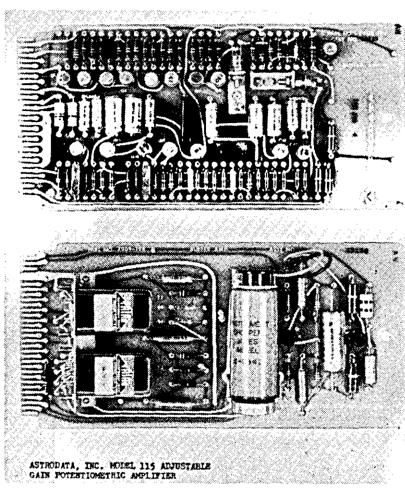
A new cathode-ray tube is being produced by this company with dual deflection, high resolution and high light output. It is denoted C21C4. A special gun design provides high-resolution capabilities of magnetic focus, and a set of high-speed electrostatic-deflection plates with equal deflection sensitivity on both axes. This enables character generation. Symbol positioning and conventional line-scan operation are provided by magnetic deflection. The electrostatic deflection system may be used to scan a small raster for character formation. Appropriate wave forms fed to the plates will also generate alpha-numeric and other symbols. The display tube has a 21" rectangular screen. It is useful for computer read-out, traffic control, message display, and monitor operations.

ASTRODATA EXPANDS LINE OF MODULAR COMPUTER AMPLIFIERS

Astrodata, Inc.
240 East Palais Rd.
Anaheim, Calif.

A new series of modular amplifiers, Models 113 through 116, constructed on plug-in etched circuit cards, has been announced by this company.

The new models all have 100 megohms input impedance, and are chopper-stabilized. Models 113 and 114 are unity gain amplifiers with a bandwidth from dc to 1 megacycle (3 db point). These models have a power supply isolator system which seeks to provide true floating amplification in multi-channel operations. Model 115 has a bandwidth from dc to 150 kc with gain adjustable from 1 to 200. Model 116 is a narrow-band, fixed-gain amplifier.



This new series is for use in data systems, analòg-to-digital converters, analog computers, and control systems.

FERRITE MEMORY CORES

Electronic Memories, Inc.
9430 Bellanca Ave.
Los Angeles 45, Calif.

This company has developed a range of square-loop ferrite memory cores in 30 mil sizes for use in coincident-current memories. The cores have a switching time of less than 0.4 microsecond obtainable with a drive of less than 600 milliamperes, making them useful in 1.5 to 3 microsecond coincident-current memories.

FRONT COVER STORY

NEW AEROSPACE COMPUTER FEATURES CIRCUIT "CHIPS" AND THIN-FILM MEMORY

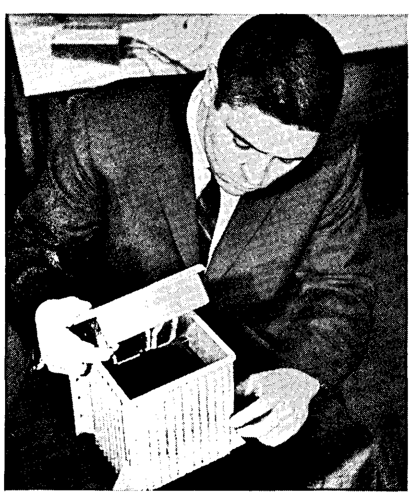
UNIVAC Div. of Sperry Rand Corp.
2121 Wisconsin Ave. N.W.
Washington, D.C.

What is called the "biggest little computer" on the market was recently demonstrated to officials of the Department of Defense and the National Aeronautics and Space Administration.

Designed for aerospace applications, the computer is six inches square, seven inches high and weighs less than 17 pounds. It dissipates only 53 watts of electrical power, less than that consumed by a small table radio.

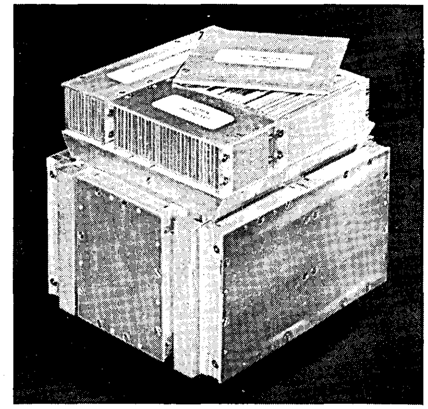
UNIVAC says the Microtronic Aerospace Computer, Model 1824, is "the fastest aerospace computer available today." In a single second, the computer can perform 125,000 additions or subtractions, multiply 30,000 times, divide 15,000 times, or compute 8000 square roots on 24-bit data words.

UNIVAC claims the 1824 is the only microtronic, thin-film computer in operation ... the first to advance beyond the research and development phase. It represents the first successful "marriage" of magnetic thin films and semi-conductor integrated (microtronic) circuits to produce a working computer. Fabrication techniques allow UNIVAC to produce the computer using a batch production method at the rate of three per week in their St. Paul, Minnesota plants. The 1824 costs about $100,000 per unit in orders of 12 or more.



-- Ted Sammis, microtronic project engineer at UNIVAC, examines the 1824 computer, which weighs less than 17 pounds and occupies less than 0.2 cubic feet.

The computer consists of four basic sections: the central computer (arithmetic and control section), 2½ x 2½ x 1½ inches high; the memory, 4 x 4 x 4 inches; power supply, and input-output section.



-- The six modules which comprise the central processor and the input/output section mounted around the thin-film memory.

It contains a total of 1952 parts, including 1243 integrated circuits, plus the memory stack. Integrated circuits are solid state circuit semiconductor networks that integrate all of the computer's 18,000 transistors, diodes, capacitors and resistors -- and their associated interconnections -- into tiny semiconductor wafers. One integrated circuit may include up to 18 transistors.

The memory section contains 74,000 bits of information which are deposited in the form of miniature magnetic dots on glass substrates. Switching time between the dots is measured in nanoseconds. The 1824 requires three microseconds to gain access to a stored bit of information.

The input-output section, consisting of five input and eleven output channels, may be expanded to as many as 156 channels in situations requiring that much computer capability. This modular or "building block" design technique applies also to other sections of the computer, where either the memory or logic circuit modules may be expanded as easily.

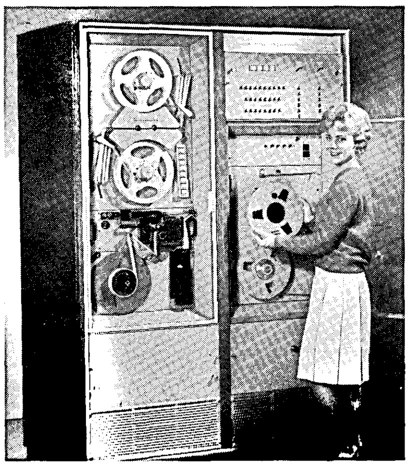
A reliability of at least 20,000 hours is forecast for the 1824. By January 20th, the first 1824 had accumulated over 275 hours of operational air time.

Data Transmitters and A/D Converters

BI-DIRECTIONAL DATA CONVERTER

General Dynamics/Electronics
1400 North Goodman St.
Rochester 1, N.Y.

A new bi-directional data converter has been developed by this company, the SC-332. It is a "translator" that converts one kind of "computer talk" to a different "language" at high speeds. Data is converted from magnetic tape to punched paper tape, from punched paper tape to magnetic tape, and from punched paper tape in one code to punched paper tape in a different code.



The device has a speed of 500 characters per second when operating in the magnetic tape mode. When converting data to paper tape, it has a speed of 250 characters per second. Five, six, seven, or eight-level paper tape codes can be accommodated, with or without parity. On the magnetic tape application, the converter operates with either the IBM 729 II/IV binary, or binary coded decimal low density format. Code translation, formating, and error-checking are performed automatically.

HIGH AND LOW SPEED DATA TRANSMISSION WITH NEW COMMUNICATIONS UNIT

IBM Corporation
Data Processing Division
White Plains, N.Y.

This company has announced a data transmission device which makes it possible for computers to exhange information over long distances at either high or low speeds.

This data communication device, called the IBM 7710, transmits information between the magnetic core memories of two IBM 1401 computers at all speeds for which broad-band common carrier equipment is available -- up to 5100 characters a second. At lower speeds -- 150, 250 or 300 characters a second -- the new device uses standard, voice-grade, telephone lines, making possible low cost communication with card and magnetic tape transmission units, as well as computer memories.

A 7710 can operate at either high or low speeds under switch control. Data collected over telephone lines at low speed can be retransmitted by the same 7710 at high speed over broad-band facilities. The 7710 operates under control of the 1401 to which it is linked. Data to be transmitted is transferred from the computer to the communication unit where each character is converted from a seven-bit computer code to a four-for-eight code for serial transmission. At the receiving end each character is checked for accuracy by the 7710, reconverted to computer code and transferred to the 1401's core storage for processing.

High-speed 7710's can be used for load-sharing between remote data processing installations in such activities as the aerospace industry, manufacturing, petro-chemicals and in government.

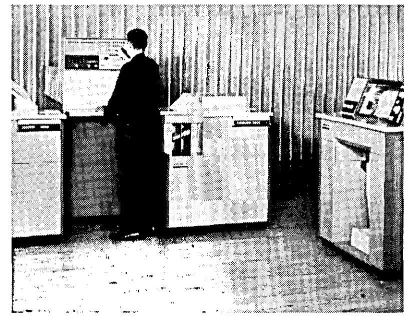
UNIVAC 1050 — NEW SUBSYSTEM

UNIVAC Div. of Sperry Rand Corp.
315 Park Avenue South
New York 10, N.Y.

A new subsystem, the UNIVAC 1050, that performs off-line data processing functions has been announced by this company. This solid-state, character-addressable computing subsystem has a basic magnetic core memory of 8192 six-bit alphanumeric characters that can be expanded in modules of 4096 characters to a maximum capacity of 32,768 characters. Memory cycle time is 4.5 microseconds.

A program-interrupt technique permits the UNIVAC 1050 to handle both a card-to-tape operation and a tape-to-printer operation concurrently.

This device gives additional off-line capacity to users of parallel-processing, large-scale UNIVAC systems; the capacity includes conversion of data from punched cards to magnetic tape and from magnetic tape to punched cards or printed hard copy.

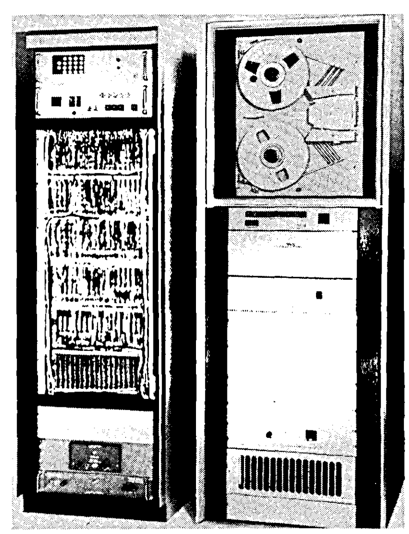


-- Operator checks console on Central Processor of UNIVAC 1050 during concurrent operation of this new subsystem for UNIVAC large-scale computers. High-speed reader (left) senses cards at a rate of 1000 per minute. Card punch unit (to right of operator) punches cards at a 300 per minute rate. Buffered solid-state printer (extreme right) produces 922 one hundred and twenty-eight character lines per minute.

NEW HIGH-SPEED DATA SYSTEM FOR A/D CONVERSION

Non-Linear Systems, Inc.
Del Mar, Calif.

This company has developed a new data system which automatically measures DC voltages to 0.01% precision, at rates of up to 1000 readings per second, and records the measurement in digital form on magnetic tape. The data system is designated NLS 24216. The Model 24216 has a transistorized analog-to-digital converter with a digitizing time of 67 microseconds for a four-digit conversion (decimal system).



The data system can rapidly convert electrical measurements or physical quantities, such as temperature, stress, strain, flow rate, pressure or vibration, into a form suitable for digital computers, digital printers or automatic control or testing systems. The standard tape format is fully compatible for direct use with the IBM 7090 computer using a standard six character word in binary coded decimal form. The format includes addressing, labeling, record gap, vertical and longitudinal parity, and end of file instructions. Formats for other computers, tape readers and tape to card converters are also available.

DP SYSTEM FOR BANK OPERATIONS

IBM Corporation
Data Processing Division
White Plains, N.Y.

A data processing system has been designed by this company, exclusively for high-speed handling of bank transit operations. It is called the IBM 1420 bank transit system; it was developed specifically for Federal Reserve banks and commercial banks where check handling of unusually high volume is a problem.

The system consists of three solid-state, interconnected units: a bank transit processing unit, a card read-punch, and a printer with selective tape listing.

The processor combines the reading-sorting features of a magnetic character reader with the instruction and storage control features of a general purpose computer. It has 4000 to 16,000 positions of internal information storage. Core storage cycle time is six microseconds. Processing can take place at the same time checks are being read.

The system can sort MICR-encoded checks and documents at a rate of up to 1600 checks per minute and can also read 51-column cards, such as postal money orders, at speeds up to 1900 a minute. A special endorsing feature imprints the bank's endorsement during processing with no reduction in speed.

The printer prints either eight detail tapes or a master (control) tape and six detail tapes. Maximum output of the printer is 1285 lines per minute. Both numeric dollar listings and alphabetic cash letters can be printed at 600 lines per minute.

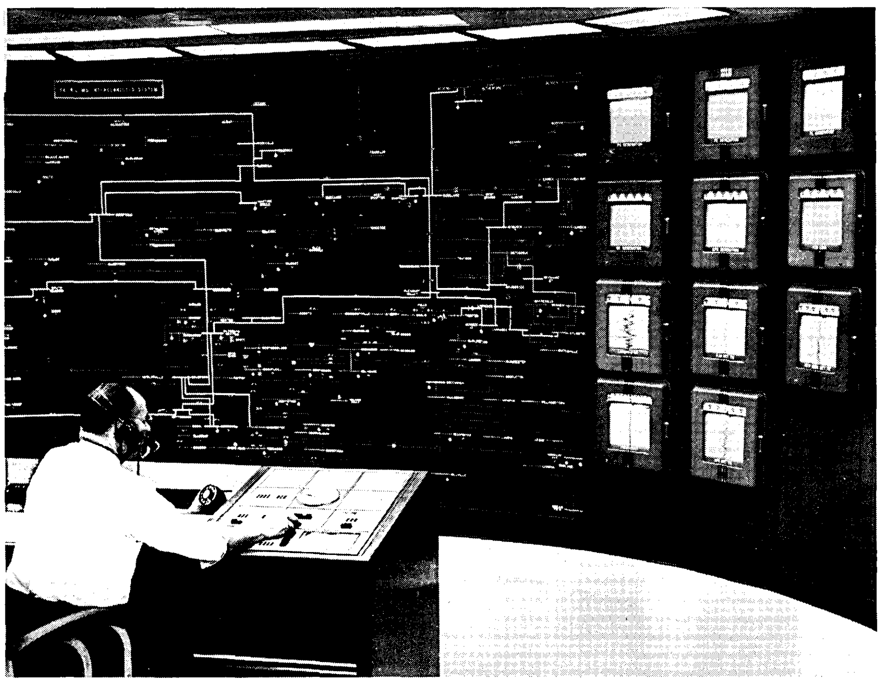
AUTOMATION

AUTOMATICALLY CONTROLLED POWER-LINKING OF UTILITY GROUPS

A new automatic control system is the nerve center for operations linking the utilities of the Pennsylvania-New Jersey-Maryland Interconnected System (PJM) and two other groups of utilities: Alleghany Power System (APS) and CANUSE (Canada-U.S.-Eastern Interconnection). These utilities are involved in the recently announced 350 million dollar expansion plan for construction of additional high voltage lines and generating plants.

Information on generating costs of the neighboring systems is received by the interconnection dispatcher to enable him to compare them with those of his own system. As a result, he may decide to receive from or deliver power to the other systems, which he does by altering his schedule controlling the amount of power flowing on the interconnecting lines.

The interconnected systems provide the means for: speedy



-- Power flows of the net amount of electricity on five tie lines to CANUSE and seven tie lines to the APS are shown on the recording meters of L&N's automatic control system in PJM's headquarters.

The system, manufactured by Leeds & Northrup Company, Philadelphia, is located at PJM's headquarters in the Philadelphia Electric Company building in Philadelphia. The L&N control system receives data, displayed on a recorder board showing the quantity of power flowing from five tie line connections to CANUSE and seven to the members of the PJM.

transfer of electricity from surplus areas to those in need due to sudden, unexpected demands; provide increased reliability for all the participating utilities; and improve voltage and frequency regulation. Interconnection is spreading rapidly in all sections of the United States; it is expected that the country will be tied together from coast-to-coast in the not-too-distant future.

BUSINESS NEWS

RCA ANNOUNCES RECORD SALES AND EARNINGS IN 1962; OPERATING PROFIT UP 40% OVER 1961

RCA achieved record sales and profits in 1962 for the best twelve-month period in its 43-year history, Chairman David Sarnoff announced recently.

RCA's 1962 sales will approach $1,700.000,000 and its operating profit after taxes will exceed $50,000,000, representing gains of at least 10 per cent and 40 per cent, respectively, over the 1961 levels, he pointed out.

General Sarnoff called RCA's 1962 performance that of an "industrial pacesetter" in relation to the movement of the national economy as a whole. He cited as two principal elements contributing to the company's success in 1962:

1: Growing strength in RCA's electronic data processing operations, reflected in the more than doubling during 1962 of revenue from domestic and international sale and rental of commercial systems, and the continued substantial reduction of related costs;

2: Continued advances in space and defense electronics, dramatized by the unprecedented 100 per cent effectiveness of the six RCA-developed TIROS weather satellites that have so far been launced and operated by the National Aeronautics and Space Administration.

General Sarnoff said that RCA's EDP program "is proceeding toward the development of a profitable growth business". He added that the company has shipped more than 280 electronic data processing systems to government and commercial users in this country and overseas, and that foreign orders for RCA systems rose to 158, a 125 per cent increase over the 1961 year-end total. He disclosed also that the first RCA 601, a large computer for industrial and scientific use, was placed in operation in December at the New Jersey Bell Telephone Company.

IBM SALES UP 15%

IBM has announced its preliminary results for the year 1962. Thomas J. Watson Jr., chairman of the board, reported that IBM's gross income for the year 1962 from the sale, service and rental of its products in the United States amounted to $1,925,221,857, compared with $1,694,295,547 in the year 1961.

Net earnings for the year ended December 31, 1962, after U.S. federal income taxes amounted to $241,387,268. This compares with net earnings after taxes for the year 1961 of $207,227,597.

BENDIX REPORTS PEAK PEACETIME SALES VOLUME

The Bendix Corporation for the fiscal 1962 year had the highest peacetime sales in its history.

Sales volume amounted to $788,100,000 for the year ended September 30, 1962, an increase of 4.7 per cent over the total of $752,800,000 in 1961. Net income for the fiscal year amounted to $22,545,524. Earnings from operations in fiscal 1962 were 9½ per cent higher than the preceding year, Bendix reported.

Bendix sales during the fiscal year were divided 72 per cent military and 28 per cent commercial products, virtually unchanged from last year in this respect. Dollar volume in the space and missile field rose to $227,574,000, up from $197,160,000 a year ago, and space projects accounted for more than $60,000,000 in 1962.

55% SALES INCREASE, PROFITABILITY IMPROVEMENT SEEN BY C-E-I-R

An increase in sales of C-E-I-R, Inc., from $10,940,358 in fiscal 1961 to a record high of $16,989,878 in its ninth fiscal year ending September 30, 1962, were announced by Dr. Herbert W. Robinson, president and chairman of the board.

Sales were 55% higher in fiscal 1962 than in fiscal 1961, Dr. Robinson said; and sales in the second half were 63% higher than in the second half of fiscal 1961.

Dr. Robinson pointed out that expenses of the company's expansion program had continued for much of the year at the high levels reached during the last quarter of fiscal 1961. While the pattern of development of sales, earnings, and cash flow over the year conformed generally to expectations, sales from "seasoned" operations at the C-E-I-R Centers lagged somewhat behind, and this caused a continuation of losses into the second half of the fiscal year, Dr. Robinson said. The expansion program will have increased C-E-I-R's total computer capability six and a half times between Fall 1960 and Spring 1963.

Losses on operations for the fiscal year were $1,149,996, compared with $967,862 for fiscal 1961.

C-E-I-R has undergone a comprehensive reorganization, and has initiated a widespread profit improvement program, with the aid of Cresap, McCormick and Paget, management consultants. Due for completion this month, these measures have already yielded results which should accelerate the profitability improvement of the second half in fiscal 1963.

C-E-I-R is an international organization devoted to problem solving, analytical and computer services, with corporate headquarters in Washington. Regional Centers are located in Washington, New York, and Los Angeles, and Centers are operated in Boston, Houston, San Francisco, Mexico City, London, and Paris.

RCA AND PHILCO ANNOUNCE AGREEMENT

RCA and the Philco Corporation, a subsidiary of Ford Motor Company, announced jointly, an agreement which resolves their long-standing dispute in the patent license field. The agreement provides that RCA will receive non-exclusive licenses under all present Philco and Ford United States patents and patent applications relating to radio purpose apparatus (including color television), transistors, and data processing equipment. These licenses will run for the full lives of the patents.

In addition, for the next five years, RCA will be free to use any domestic color TV patent issuing to Philco on an application filed after the date of the agreement.

For the rights received under this agreement, RCA has paid $9 million to Philco.

MONTHLY COMPUTER CENSUS

The number of electronic computers installed, or in production at any one time has been increasing at a bewildering pace in the past several years. New vendors have come into the computer market, and familiar machines have gone out of production. Some new machines have been received with open arms by users -- others have been given the cold shoulder.

To aid our readers in keeping up with this mushrooming activity, the editors of COMPUTERS AND AUTOMATION present this monthly report on the number of American-made general purpose computers installed or on order as of the preceding month. We update this computer census monthly, so that it will serve as a "box-score" of progress for readers interested in following the growth of the American computer industry.

Most of the figures are verified by the respective manufacturers. In cases where this is not so, estimates are made based upon information in the reference files of COMPUTERS AND AUTOMATION. The figures are then reviewed by a group of computer industry cognoscenti.

Any additions, or corrections, from informed readers will be welcomed.

AS OF JANUARY 20, 1963

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Addressograph-Multigraph Corporation	EDP 900 system	Y	$7500	2/61	10	12
Advanced Scientific Instruments	ASI 210	Y	$2850	4/62	5	4
	ASI 420	Y	$12,500	1/63	1	1
Autonetics	RECOMP II	Y	$2495	11/58	135	8
	RECOMP III	Y	$1495	6/61	30	20
Bendix	G-15	N	$1700	7/55	360	5
	G-20	Y	$15,500	4/61	18	6
Burroughs	205	N	$4600	1/54	83	X
	220	N	$14,000	10/58	58	X
	E101-103	N	$875	1/56	170	X
	B250	Y	$4200	11/61	40	35
	B260	Y	$3750	11/62	15	45
	B270	Y	$7000	7/62	10	28
	B280	Y	$6500	7/62	6	16
	B5000	Y	$16,200	2/63	0	9
Clary	DE-60/DE-60M	Y	$675	2/60	82	3
Computer Control Co.	DDP-19	Y	$3500	6/61	1	2
	DDP-24	Y	$3000	-	0	1
	SPEC	Y	$800	5/60	10	2
Control Data Corporation	160/160A	Y	$2000/$3500	5/60 & 7/61	215	55
	924	Y	$10,000	9/61	4	3
	1604	Y	$35,000	1/60	40	15
	3600	Y	$52,000	4/63	0	2
	6600	Y	$120,000	-	0	1
Digital Equipment Corp.	PDP-1	Y	Sold only about $175,000	12/59	35	10
	PDP-4	Y	Sold only about $75,000	8/62	6	7
El-tronics, Inc.	ALWAC IIIE	N	$2500	2/54	32	X
General Electric	210	Y	$16,000	7/59	65	10
	225	Y	$7000	1/61	104	88
General Precision	LGP-21	Y	$725	12/62	4	32
	LGP-30	semi	$1300	9/56	400	20
	RPC-4000	Y	$1875	1/61	67	18
Honeywell Electronic Data Processing	H-290	Y	$3000	6/60	11	3
	H-400	Y	$5000	12/60	34	65

NAME OF MANUFACTURER	NAME OF COMPUTER	SOLID STATE?	AVERAGE MONTHLY RENTAL	DATE OF FIRST INSTALLATION	NUMBER OF INSTALLATIONS	NUMBER OF UNFILLED ORDERS
Honeywell EDP (cont'd.)	H-800	Y	$22,000	12/60	49	9
	H-1800	Y	$30,000 up	-/63	0	2
	DATAmatic 1000	N	-	12/57	5	X
H-W Electronics, Inc.	HW-15K	Y	$500	3/63	0	2
HRB Singer, Inc.	SEMA 2000	Y	$700	1/62	18	20
IBM	305	N	$3600	3/62	925	X
	650-card	N	$4000	11/54	735	X
	650-RAMAC	N	$9000	11/54	262	X
	1401	Y	$2500	9/60	4390	4200
	1410	Y	$10,000	11/61	140	400
	1440	Y	$1800	4/64	0	550
	1620	Y	$2000	9/60	1350	320
	701	N	$5000	4/53	4	X
	702	N	$6900	2/55	5	X
	7030	Y	$300,000	5/61	8	1
	704	N	$32,000	12/55	89	X
	7040	Y	$14,000	6/63	0	37
	7044	Y	$26,000	6/63	0	8
	705	N	$30,000	11/55	160	X
	7070, 2, 4	Y	$24,000	3/60	320	250
	7080	Y	$55,000	8/61	38	28
	709	N	$40,000	8/58	45	X
	7090	Y	$64,000	11/59	213	144
	7094	Y	$70,000	12/62	1	5
Information Systems, Inc.	ISI-609	Y	$4000	2/58	22	1
ITT	7300 ADX	Y	$35,000	7/62	6	4
Monroe Calculating Machine Co.	Monrobot IX	N	Sold only-$5800	3/58	165	7
	Monrobot XI	Y	$700	6/60	210	150
National Cash Register Co.	NCR - 102	N	-	-	30	X
	- 304	Y	$14,000	1/60	30	0
	- 310	Y	$2000	5/61	32	42
	- 315	Y	$8500	5/62	40	128
	- 390	Y	$1850	5/61	295	225
Packard Bell	PB 250	Y	$1200	12/60	133	24
Philco	1000	Y	$7010	-/63	0	12
	2000-212	Y	$68,000	1/63	1	12
	-210, 211	Y	$40,000	10/58	23	25
	4000	Y	$6000	-/63	0	10
Radio Corp. of America	Bizmac	N	-	-/56	4	X
	RCA 301	Y	$6000	2/61	180	320
	RCA 501	Y	$15,000	6/59	90	12
	RCA 601	Y	$35,000	11/62	1	7
Scientific Data Systems Inc.	SDS-910	Y	$2190	8/62	10	11
	SDS-920	Y	$2690	9/62	3	5
TRW Computer Co.	RW530	Y	$2500	8/61	15	7
UNIVAC	Solid-state 80, 90, & Step	Y	$8000	8/58	529	154
	Solid-state II	Y	$8500	9/62	2	34
	490	Y	$26,000	12/61	4	12
	1107	Y	$45,000	10/62	1	16
	III	Y	$20,000	8/62	4	68
	LARC	Y	$135,000	5/60	2	X
	1100 Series (except 1107)	N	$35,000	12/50	32	X
	I & II	N	$25,000	3/51 & 11/57	62	X
	File Computers	N	$15,000	8/56	77	1
	60 & 120	N	$1200	-/53	907	19
	1004	Y	$1500	2/63	0	1200
X -- no longer in production				TOTALS	13,718	9,008

BOOKS AND OTHER PUBLICATIONS

Moses M. Berlin
Allston, Mass.

We publish here citations and brief reviews of books and other publications which have a significant relation to computers, data processing, and automation, and which have come to our attention. We shall be glad to report other information in future lists if a review copy is sent to us. The plan of each entry is: author or editor / title / publisher or issuer / date, publication process, number of pages, price or its equivalent / comments. If you write to a publisher or issuer, we would appreciate your mentioning **Computers and Automation.**

Chu, Yaohan / Digital Computer Design Fundamentals / McGraw Hill Book Co., 330 West 42 St., New York 36, N. Y. / 1962, printed, 481 pp, $15.00.

This useful and informative book is an outgrowth of a course given since 1953 for seniors and graduate students in engineering and science who are interested in the logic and circuit aspects of electronic digital computers. No previous acquaintance with the subject is needed, but knowledge of college mathematics and a general understanding of electronics is essential. The first four chapters deal with digital arithmetic & Boolean algebra. Chapters 5 to 9 cover various types of logic circuits. Chapters 10 to 12 deal with digital computer logic and design. Additional sources of information are found in the references at the end of each chapter. Problems accompany most chapters. An index is included.

Saxon, James A., and William S. Plette / Programming the IBM 1401: A Self-Instructional Programmed Manual / Prentice-Hall, Inc., Englewood Cliffs, N. J. / 1962, printed, 208 pp, $9.00.

Although this useful work is entitled a "self-instructional programmed manual," the book does not contain material of the usual Skinnerian type of programmed learning organized as a succession of steps: item-frame, immediate response, immediate reenforcement. What it does contain is information very carefully organized and presented in small lessons, followed by several questions or quizzes for which the answers have to be constructed, followed by the statement of the answers on the back side of the page. The author says, "There is nothing to keep the student from cheating by looking at the correct answer before attempting to work the problem except the realization that he will not learn to program if he does this."

The book looks as if it can be effectively used by beginners for programming of the IBM 1401. There are 42 lessons (each titled) gathered into 10 units (not titled). Some of the lessons are "Machine Storage," "Symbolic Programming," "Special Features of Tape Processing," etc. Index. Erratum: on page 3, line 4 from bottom, under the letter "F" in the outlined box "FINAL," replace small "406" by small "906."

Coulson, John E., editor, and 29 authors / Programmed Learned and Computer-Based Instruction / John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. / 1962, printed, 291 pp, $6.75.

Based on the proceedings of the Conference on Application of Digital Computers to Automated Instruction, held in Washington, D. C., Oct. 10-12, 1961, this book presents 21 papers expressing the current findings and forecasts of future developments in computer-related instruction by scientists and educators in the field. Part I, "Theory and Experimentation in Programmed Learning," represents a state-of-the-art summary of knowledge regarding the basic variables and methods of auto-instruction. Part II, "Computer-Based Instructional Systems," describes current attempts to apply computing machinery to automated instruction. Part III, "Computer Technology in Automated Teaching," presents discussions on problems and opportunities in the application of computers to instruction. Many references are given at the ends of papers. Index, pp. 289-291.

Hollitch, Robert S., and Benjamin Mittman, editors, and 18 contributors / Computer Application—1961 / The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. / 1962, printed, 198 pp, $8.95.

This book is based on the Proceedings of the 1961 Computer Applications Symposium, October 25-26, 1961, sponsored by Armour Research Foundation of Illinois Inst. of Tech. It reports new developments in the application and expanding uses of digital computers in management, business, engineering and scientific research. Among the papers included are the following: "Management of Records in a Large-Scale Collaborative Research Program (Honeywell 800)," "Automation of Library Operations," "Description of the Mercury Real-Time Computing System," and "Scientific Applications for the UNIVAC LARC." Also included are two panel discussions: "Business and Management Applications" and "Engineering and Scientific Applications."

Berge, Claude, translated from the French by Alison Doig / The Theory of Graphs and its Applications / John Wiley & Sons, Inc., 440 Park Ave. South, New York 16, N. Y. / 1962, printed in Great Britain, 247 pp, $6.50.

This book is a study of the theory of graphs, in the sense of groups of points joined by lines or arrows. The book aims to provide a mathematical tool useable in the behavioral sciences, cybernetics, games, transport networks, etc. The first chapter includes "General Definitions," and some general mathematical rules. The remaining twenty chapters include: "The Ordinal Function and the Grundy Function on an Infinite Graph," "Games on a Graph," "The Matrix Associated with a Graph," "Trees and Arborescences," "Euler's Problem," "Semi-Factors," and "Planar Graphs." Two appendices include notes on the general theory of games and on transport problems. List of symbols, index of terms used, and a bibliography.

National Radio Institute, Staff of / Radio-Television-Electronics Dictionary / John F. Rider, Publisher, Inc., 116 West 14 St., New York 11, N. Y. / 1962, printed, 168 pp, $3.50.

This dictionary defines briefly and directly more than 5,000 terms and expressions in electricity, electronics, radio, computers, and allied fields. Phrases are listed alphabetically by the first word in the phrase. There are five appendices, including charts of "Vacuum Tube Symbols," and "Transistor Symbols."

Clarke, Emerson / How to Prepare Effective Engineering Proposals / TW Publishers, River Forest, Illinois / 1962, printed, 212 pp, $?.

This book tells how to prepare effective engineering proposals, based on the thesis, "The engineering proposal is the key to a $10 billion annual market." It describes the form and content of typical proposals, and suggests many procedures for increasing the efficiency with which proposals are prepared. Part One is entitled "The Form and Content of the Proposal," Part Two "Methods for the Efficient Production of Proposals," and Part Three "Topics for Review." The book also provides a number of topic lists to ensure that topics vital to persuasion are not overlooked. Cartoons by James Curnock. No bibliography.

Lytel, Allan / ABC's of Computer Programming / Howard W. Sams & Co., Inc., 4300 West 62 St., Indianapolis 6, Indiana / 1962, printed (paperbound), 128 pp, $1.95.

Presents the fundamentals of digital computer programming with actual examples of programming methods. Actual computer-instruction repertoires are listed showing their use in solution of problems. The six chapters include: "What Is Programming?", "Fundamentals of Programming," "Program Instructions," "Programming for the Computer," "Programming for the Problem," and "Programming Algebra." Glossary and index included. Erratum: page 110, line 4, word 5, correct to read "acronym."

Hall, J. A. P., editor, and 21 contributors / Computers in Education / a Pergamon Press Book, The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. / 1962, printed, 122 pp, $7.50.

This book is based on papers presented at the Proceedings of a Conference on "The Computing Laboratory in the Technical College" held at Hatfield College of Technology, England, May 27-28, 1960. The aim was to exchange ideas on the purpose, equipment, and use of a computing laboratory in a technical college, with particular reference to the effect of computing machines on mathematics today. Some of the papers included are: "Applied Mathematics and Computing Machines," "The New Significance of Computation in Technological Education," and "Industrial Requirements for Computer Staff." A concluding statement by the editor, two appendices, and an index are included.

La Salle, Joseph P., and Solomon Lefschetz, editors, and 12 contributors / Recent Soviet Contributions to Mathematics / The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. / 1962, printed, 324 pp, $8.75.

A panel of mathematicians make a very important report of their 1959 study of recent Soviet contributions to the following fields: algebra, control and stability theory, functional analysis, numerical analysis, partial differential equations, probability and statistics, and topology. The first part "A General Appraisal of Mathematics in the U.S.S.R." expresses views on the state and status of Soviet mathematics. The next eight parts are devoted to surveys of individual mathematical fields by panel members. The final part is a survey and checklist of Russian journals which publish mathematical papers, and also includes a limited Russian-English glossary for understanding their names. References are listed at the end of each section. A thorough index (six pages long) is included.

Hamilton, Norman, and Joseph Landin / Set-Theory and the Structure of Arithmetic / Allyn and Bacon, Inc., 150 Tremont St., Boston, Mass. / second printing, May 1962, printed, 264 pp, $7.75.

Evolved from lecture notes for a course at the Univ. of Illinois intended for high school mathematics teachers, this book aims first to answer the question "What is a number?" Secondly, and of greater importance, is the authors' wish to provide a foundation for the study of abstract algebra, elementary Euclidean geometry and analysis. **The book is the first in a series of three volumes.** Chapter 1, "The Elements of the Theory of Sets," presents the rudiments of set theory in an intuitive rather than logical manner. The rest of the text concerns the construction of the natural number system, and ends with a construc-

MANUSCRIPTS

WE ARE interested in articles, papers, reference information, and discussion relating to computers and automation. To be considered for any particular issue, the manuscript should be in our hands by the first of the preceding month.

ARTICLES: We desire to publish articles that are factual, useful, understandable, and interesting to many kinds of people engaged in one part or another of the field of computers and automation. In this audience are many people who have expert knowledge of some part of the field, but who are laymen in other parts of it.

Consequently, a writer should seek to explain his subject, and show its context and significance. He should define unfamiliar terms, or use them in a way that makes their meaning unmistakable. He should identify unfamiliar persons with a few words. He should use examples, details, comparisons, analogies, etc., whenever they may help readers to understand a difficult point. He should give data supporting his argument and evidence for his assertions.

We look particularly for articles that explore ideas in the field of computers and automation, and their applications and implications. An article may certainly be controversial if the subject is discussed reasonably. Ordinarily, the length should be 1000 to 3000 words. A suggestion for an article should be submitted to us before too much work is done.

TECHNICAL PAPERS: Many of the foregoing requirements for articles do not necessarily apply to technical papers. Undefined technical terms, unfamiliar assumptions, mathematics, circuit diagrams, etc., may be entirely appropriate. Topics interesting probably to only a few people are acceptable.

REFERENCE INFORMATION: We desire to print or reprint reference information: lists, rosters, abstracts, bibliographies, etc., of use to computer people. We are interested in making arrangements for systematic publication from time to time of such information, with other people besides our own staff. Anyone who would like to take the responsibility for a type of reference information should write us.

NEWS AND DISCUSSION: We desire to print news, brief discussions, arguments, announcements, letters, etc., anything, in fact, if it is likely to be of substantial interest to computer people.

PAYMENTS: In many cases, we make small token payments for articles, if the author wishes to be paid. The rate is ordinarily ½¢ a word, the maximum is $15, and both depend on length in words, whether printed before, etc.

All suggestions, manuscripts, and inquiries about editorial material should be addressed to: *The Editor,* COMPUTERS *and* AUTOMATION, *815 Washington Street, Newtonville 60, Mass.*

tion of the real numbers. The remaining four chapters are: "The Natural Numbers," "The Integers and the Rational Numbers," "The Real Numbers," and "The Deeper Study of the Real Numbers." An index is included.

Salzer, Herbert E., and Norman Levine / Table of Sines and Cosines to Ten Decimal Places at Thousandths of a Degree / a Pergamon Press book, The Macmillan Co., 60 Fifth Ave., New York 11, N. Y. / 1962, printed (in Poland), approx. 930 pp, $10.00.

This present table is intended to be the most extensive of all existing tables of the sine and cosine using decimal subdivisions of the degree. The table offers improvements over existing tables in that it is a ten-decimal table with degrees subdivided by thousandths. Furthermore, the sine and cosine are tabulated side by side, each entry has all digits, and, finally, it is somewhat easier to use a table where all entries run vertically instead of horizontally. A useful discussion of accuracy in interpolation and direct and inverse interpolation with illustrations, is given on pages v to xiv.

NEW PATENTS

RAYMOND R. SKOLNICK
Reg. Patent Agent
Ford Inst. Co., Div. of Sperry Rand Corp., Long Island City 1, New York

The following is a compilation of patents pertaining to computer and associated equipment from the "Official Gazette of the U. S. Patent Office," dates of issue as indicated. Each entry consists of patent number / inventor(s) / assignee / invention. Printed copies of patents may be obtained from the U. S. Commissioner of Patents, Washington 25, D. C., at a cost of 25 cents each.

December 4, 1962

3,066,865 / Martin Ziserman, Hartsdale, and Frank S. Preston, Tarrytown, N. Y. / United Aircraft Corp., East Hartford, Conn., a corp. of Delaware / Arbitrary Function Analogue-To-Digital Converter.

3,066,866 / Hermann Kittel and Willy Schellig, Villingen, Black Forest, Germany / Firma Kienzle Apparate G.m.b.H., Villingen, Black Forest, Germany / Adding Apparatus.

3,066,867 / Charles A. Krause, Gardena, and Marvin R. Emerson, Rolling Hills, Calif. / United Aircraft Corp., East Hartford, Conn., a corp. of Delaware / Digital Comparator and Digital-To-Analogue Converter.

3,067,408 / William A. Barrett, Jr., Madison, N. J. / Bell Telephone Labs., Inc., New York, N. Y., a corp. of New York / Magnetic Memory Circuits.

December 11, 1962

3,068,451 / Warren W. Bolander, Scotia, N. Y., and Burnette Paul Chausse, Roanoke, Va. / General Electric Co., a corp. of New York / Data Storage Register and Control System.

3,068,452 / George P. Sarrafian, Dallas, Texas / Texas Instruments Inc., Dallas, Texas, a corp. of Delaware / Memory Matrix System.
3,068,455 / Cebern B. Trimble, Dayton, Ohio / National Cash Register Co., Dayton, Ohio, a corp. of Maryland / Magnetic Drum Storage Systems.
3,068,462 / Joseph L. Medoff, Newton, Mass. / Avco Manufacturing Corp., Cincinnati, Ohio, a corp. of Delaware / Analog-To-Digital Converter.
3,068,464 / Hidetoshi Takahashi and Hiroshi Yamada, Tokyo, Japan / Fuji Tsushiniki Seizo Kabushiki Kaisha, Kawasaki, Japan, a company of Japan / Code Conversion Circuitry.

December 18, 1962

3,069,077 / Mario Rosati, Milan, Italy / Lagomarsino F.A.I., Milan, Italy / Repeat Storing Device for Computing Machines.
3,069,079 / Karl Wilhelm Steinbuch, Fellbach, Wurttemberg, and Hermann Endres, Stuttgart-Muhlhausen, Germany / International Standard Electric Corp., New York, N. Y., a corp. of Delaware / Automatic Character Recognition Method.
3,069,085 / Roderick A. Coopper, Hyde Park, and Joseph J. Moyer, Wappingers Falls, N. Y. / I.B.M. Corp., New York, N. Y., a corp. of New York / Binary Digital Multiplier.
3,069,086 / Maurice Papo, Paris, France / I.B.M. Corp., New York, N. Y., a corp. of New York / Matrix Switching and Computing Systems.
3,069,566 / Roy W. Reach, Jr., Sudbury, Mass. / Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., a corp. of Delaware / Synchronous Logical Circuit.
3,069,658 / Charles Mark Kramskoy, Ealing, London, England / Electric & Musical Industries Limited, Middlesex, England, a company of Great Britain / Matrix Storage Devices.
3,069,659 / Harry A. Skovmand and Kenneth R. Skovmand, San Jose, Calif. / I.B.M. Corp., New York, N. Y., a corp. of New York / Data Processing Systems.
3,069,660 / Esmond Philip Goodwin Wright, Desmond Sydney Ridler, and Alexander Douglas Odell, all of London, England / International Standard Elec. Corp., New York, N. Y. / Storage of Electrical Information.
3,069,661 / Umberto F. Gianola, Florham Park, N. J. / Bell Telephone Labs., Inc., New York, N. Y., a corp. of New York / Magnetic Memory Devices.
3,069,662 / Harold K. Kaiser, Los Altos, Calif. / Lockheed Aircraft Corp., Burbank, Calif. / Low Power Magnetic Core Shift Register.
3,069,663 / Anthony Galopin, Arlington, and Joseph L. Medoff, Cambridge, Mass. / Radio Corp. of America, a corp. of Delaware / Magnetic Memory System.
3,069,664 / Robert T. Adams, Short Hills, N. J., and Barry M. Mindes, New York, N. Y. / International Telephone and Telegraph Corp., Nutley, N. J., a corp. of Maryland / Magnetic Storage Systems.
3,069,665 / Andrew H. Bobeck, Chatham, N. J. /Bell Telephone Labs., Inc., New York, N. Y., a corp. of New York / Magnetic Memory Circuits.
3,069,666 / Kenneth L. Austin, Grapevine, Tex. / Burroughs Corp., Detroit, Mich., a corp. of Michigan / Magnetic Tape Storage System.

ADVERTISING INDEX

Following is the index of advertisements. Each item contains: Name and address of the advertiser / page number where the advertisement appears / name of agency if any.

MEETS SPECIAL-INTEREST NEEDS...PRODUCES TOTAL-ORGANIZATION RESULTS

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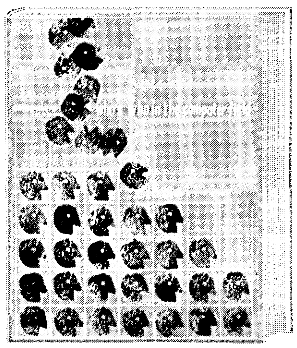

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Where did he get his degree?
How do you spell his name?
What is his home address?
Where is he working?
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