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# DIGITAL COMPUTER NEWSLETTER

The purpose of this newsletter is to provide a medium for the interchange, among interested persons, of information concerning recent developments in various digital computer projects



OFFICE OF NAVAL RESEARCH • MATHEMATICAL SCIENCES DIVISION

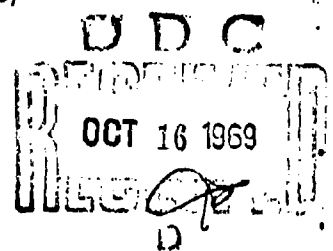
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### NRL COMPUTER (NAREC)

Under the direction of D. H. Gridley, an automatic electronic digital computer, operating in the parallel mode, has been designed at the Naval Research Laboratory. Prototypes of most of the critical components have been built and checked. A tentative completion date has been set for the summer of 1952.

Employing about 2000 vacuum tube envelopes and 6000 crystal diodes, this computer will possess 1024 words of electrostatic Williams tube memory and 2048 words of magnetic drum memory. The word length is 45 binary digits. Magnetic tape will be used for the input-output medium.

In order to check transfers and other operations, a built-in functional checking system will be employed. In the electronic circuits, in place of the standard flip-flops, a modified Schmidt-type trigger circuit is being used. Research on preliminary models of the adder indicates that, not counting memory access time, two 45 binary digit numbers can be added in approximately 3 microseconds. Access to the Williams tube memory is expected to be on the order of 10 microseconds.

The control has been designed to employ a one-address order code.

### MOORE SCHOOL AUTOMATIC COMPUTER (MSAC)

Concurrently with a research and development project on components of electronic digital computers, sponsored by the Signal Corps Engineering Laboratories, Department of the Army, the Moore School of Electrical Engineering, University of Pennsylvania, is engaged in the design and construction of an electronic digital computer. The logic of this machine, the MSAC, will be patterned after that

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of the EDVAC which was designed and constructed at the Moore School for the Ordnance Department. Work on breadboard design started in February 1950 and is scheduled to permit construction of major units beginning in the spring of 1951.

The Moore School has continued to expand its offering in the field of large scale computing devices and techniques since the first such course was presented in 1946. The following courses in this field are offered:

"Introduction to Digital Computing Machines" by Mr. Goodman; "Digital Computers - Logic" by Professor Patterson; "Digital Computers - Engineering" by Professor Rubincoff; "Continuous Variable Computers" by Professor Boghosian; "Engineering Methods for Solving Differential Equations" and "Advanced Topics in Numerical Methods for Digital Computers" by Professor Knoblauch.

#### NAVAL PROVING GROUND CALCULATORS

The Aiken Relay Calculator (Mark II) continues to run on a 24-hour day, five-day week schedule on Bureau of Ordnance work or on problems submitted by other Government activities. During the past six months only minor circuit changes have been made. These result in some simplification of coding. The operating and maintenance staff is now up to complement with six operators and eight assistant operators, who handle both operating and maintenance duties.

The Mark III Calculator has been reassembled and is undergoing tests. It is expected to be in a production status by January 1951.

#### SEAC (Formerly called NBS Interim Computer)

All of the chassis for the second memory (electrostatic) have been completed and installed, and production of the plug-in components is nearly complete. Operating tests are now under way, using the completed parts of this memory with the computer.

Magnetic recording has been successfully used in productive computation for the initial loading of the machine's memory—it is not yet ready to operate completely under the machine's control. A new magnetic tape transport has been built which moves tape at 180 inches per second with acceleration times of the order of 10 to 20 milliseconds. It uses no servos or tape reels.

During the month of October the machine was in good operating condition for 60 percent of the 76 hours per week which were allocated to computation. This 60 percent represented the 43 percent of the total time during which useful problem solutions were being obtained and the 17 percent devoted to the checking of the coding of problems.

Three different codes for the Office of the Air Comptroller have been prepared, and three models of programming were completed using these codes in about 150 hours of computation time. A problem for the Bureau of Census on the determination of optimum values for a subsampling design was completed with about 60 hours of computation time. The Monte Carlo method was applied, using both weighted and unweighted probability functions, to a two-dimensional Laplace's equation. A program for generating 500 random normal deviates was prepared and executed. A problem of tracing 1400 different electron trajectories in an electromagnetic cavity was completed with about 8 hours of computation time. Several codes have been prepared for the calculation of prime numbers and prime factors of numbers less than 1011.

A magnetic numeroscope printer was delivered to the National Bureau of Standards by Engineering Research Associates in August 1950 and demonstrated during the Association for Computing Machinery conference in September 1950. This device is an experimental high-speed printing equipment in which characters are traced sequentially on the screen of a cathode-ray tube. The electron beams which do the tracing is directed by character forming signals magnetically recorded on the surface of a rapidly rotating cylindrical drum. The printing speed for the equipment as now constructed is approximately 500 characters per second. This rate may be increased to more than 4000 characters per second by modification of the present equipment. The experimental model has provision for tracing 10 different characters and it is planned that the next model will be able to trace 40 different

characters. A photographic recording unit has been constructed utilizing a modified microfilming camera provided with a clutch for stopping film motion during idle periods. An electronic keying unit permits use of the printer for recording the output of digital computers.

#### ABERDEEN PROVING GROUND COMPUTERS

##### Coupling of IBM Relay Calculators

The storage capacity as well as the programming facilities of the IBM Relay Calculators have been enlarged recently by a simple device that effectively transforms the two identical machines into one computing device of greatly increased power. This device is a properly designed connector cable that may be connected or disengaged from the machines at will. When operating in tandem, operational control is exercised entirely by cards through the use of class selectors.

Depending on the complexity of a particular problem, the machines are now being employed either singly, as before, or jointly, in the manner indicated above.

The coupling device has already been used repeatedly, and with very satisfactory results.

##### The ENIAC

During the past two and a half years the ENIAC has been controlled by the two-digit single address Converter Code. Some 37 problems have been completed on the machine during this period with an over-all effective operating efficiency of 54 percent. The code as incorporated during this period performs the arithmetic operations with 10 decimal digit numbers at the following rates: Additions, 800/sec; subtractions, 400/sec; multiplications, 200/sec; and divisions or square roots, 35/sec. These figures are slower than the original design figures for the ENIAC because of the restrictions of the code; however, the greater ease in putting on new problems, the additional capacity of the machine, and the higher operating efficiency make the sacrifice in speed justifiable.

#### NATIONAL BUREAU OF STANDARDS WESTERN AUTOMATIC COMPUTER (SWAC)

This computer (formerly known as the Institute for Numerical Analysis Computer) was dedicated on August 17. The formal dedication was followed by a one-day symposium on applications of digital computing machines to scientific problems which are being studied by West Coast laboratories and universities at the present time.

Final plans for the SWAC include an intermediate-speed auxiliary memory consisting of a magnetic drum and a slow-speed auxiliary memory consisting of a magnetic tape unit. It is planned also to supplement the present Flexowriter input-output unit with a magnetic tape system as soon as possible. Work is proceeding on the design and construction of the chassis needed to integrate these new units into the SWAC computer system.

The computer has been used for problems originating with the research staff of the INA, such as a problem of Dr. Kac's involving the generation of random digits, and for problems originating with the United States Air Force.

#### THE INSTITUTE FOR ADVANCED STUDY COMPUTER

Since the publication of the last Newsletter the complete memory organ for the Institute for Advanced Study Computer has been given extensive life tests. These tests were satisfactory and on the basis of them the final control chassis for this organ has been built. In addition, this organ together with its control equipment has been attached to the machine itself.

During the same period various parts of the arithmetic and control organs were fabricated and put into place. With the help of these, extensive engineering and life tests were made.

## PROJECT WHIRLWIND

During August and September, each storage tube digit column was more carefully tested and adjusted than previously had been possible. Safe operating tolerances were established and marginal checking methods and facilities developed comparable to those in the other sections of the computer.

The fall term registration in the MIT Automatic Computation and Numerical Analysis courses listed in the last Newsletter averages twenty students.

The Servomechanisms Laboratory has begun study of three-dimensional high-speed storage wherein selection of a storage cell occurs at the intersection of three coordinate planes of a solid array. Storage may be in either ferromagnetic or ferroelectric cells.

Several new staff members have been added to the mathematics and coding group which is studying problems arising in MIT research projects.

## THE ACE PILOT MODEL, ENGLAND

The Electronics Section of the National Physical Laboratory, Teddington, England, was formed in 1947 to undertake, in collaboration with the Laboratory's Mathematics Division, the design and construction of the electronic digital computer known as the ACE. Because of the size and complexity of this machine it was considered desirable to build first a smaller Pilot Model, which would provide valuable experience in design and programming for the ACE itself. This Pilot Model has been virtually completed and is now working. It is a serial machine operating at a pulse repetition rate of 1 megacycle per sec and uses about 800 tubes mounted on some 40 plug-in units. The internal memory is of the supersonic delay line type. It has 8 long lines each with a delay of 1024 microseconds, and 10 short lines each with a delay of 32 microseconds, giving a total storage capacity of 264 words, each of 32 binary digits. These are either numbers or instructions in a 3 address code. Access time varies from 32 - 1000 microseconds. Experimental work is proceeding on the design of a magnetic-drum storage system which will supplement the delay line storage and greatly increase the scope of the machine. Input and output organs consist of modified Hollerith punched-card equipment.

The Pilot Model has been used for a number of simple problems, such as the evaluation of the integral of  $1/(1+x^2)$  from 0 to 1, integration of Bessel's equation for  $J_0$ , and tabulation of primes up to 128,000, using a program division routine. It has also been used to solve a problem posed by Dr. Wijngaarden of the Mathematical Centre, Amsterdam, who needed to know whether the number 150,450,047,999 was a prime. The machine found the two factors 1319 and 114,063,721, each of which is a prime. When fully completed and tested, the Pilot Model will be transferred to the Mathematics Division of the National Physical Laboratory for regular use while the ACE itself is being built.

## DATA HANDLING AND CONVERSION EQUIPMENT

### Digital Reader

Arthur D. Little, Inc., Cambridge, Massachusetts, has developed a digital reader, which will read a continuously varying voltage and convert it to digital numbers of 6 binary digits. At speeds up to 12 cycles per second, the binary numbers can be punched on standard IBM cards with the standard IBM key punch. Readings can be taken at frequencies from as low as one per few hours up to 50,000 per second. High speeds would require recording on magnetic drums or tapes or on photographic film. At low speeds accuracies of 14 binary digit numbers or at high speeds accuracies of 8 binary digit numbers are possible.

### Digital Data Recording System

The Metrotype Corporation, Chicago, Illinois, has developed a recording system, which automatically records data in tabulated digital form. The oldest installation has been in commercial operation about 2-1/2 years. The input is normally in the form of voltage and may be as low as 5 volts or as high as 200 volts for full scale. Items to be measured are selected in turn by a circuit selector and quantized into pulses by a step voltmeter which produces pulses proportional to the voltage. These pulses are counted by electronic counters, held until translated to teletype code, and printed

by a standard teletype printer. A 3 decimal digit measurement requires about 0.8 second. The printer may be remotely located. Various supplementary features such as totalizing, range shifting, multiple printers, alarms, automatically punched tape, and carbon or ditto copies, can be provided. Retransmitters are available to permit connection to self-balancing recorders or servos to provide highly accurate columnated records of multiple readings of temperature, flow, pressure, and other quantities.

A more detailed description of this system may be found in the paper "The Metrotype System of Recording and Telemetry" by G. E. Foster, Electrical Engineering, May 1950.

#### **Analog Digital Converter**

The Benson-Lehner Corporation has available an Analog Digital Converter designed to convert shaft rotations into discrete digital form and to round off the output information to within one-half of the last significant figure. For example, if the primary input to a three-decade converter unit were 355.6 revolutions, the output would be 356; if the primary input were 355.4, the output would be 355.

In accordance with the needs of the user, any number of decades can be used. A combination of mechanical gearing and electromagnetic selection is used to propagate number changes through a multidecade unit. The present unit can handle 5000 number changes per second. Driving torque required for the converter is approximately 1.6 inch-ounce.

The converter can be used to record automatically information from strain gauge output, thermocouple readings, fluid level changes, theodolite film records, and other data sources. The converter can also be used to transform digital information into analog form; for example, a number corresponding to 231° of shaft rotation can be set up in the converter circuit and the converter will drive the input shaft to this position. An arrangement such as this can be used as a form of digital servo, one unit transmitting shaft rotation in digital form and the other receiving the digital information and establishing the corresponding shaft position.

The converter can be used to operate IBM punched-card machines or electric typewriters. In the case of a typewriter, the information from each decade is sampled sequentially, e.g., by a stepping switch, while for an IBM Summary Punch it is necessary to take the data from all of the decades in parallel. The typewriter keys are operated by small solenoids installed under the regular keyboard in such a manner as not to interfere with normal typewriter use.

The Benson-Lehner Corporation has developed a variety of specialized equipment in the field of automatic data analysis, including such devices as automatically operated plotters, tabulators, and photoelectric scanning systems, as well as electronic reversible counters which will accumulate pulses and tabulate the total in the decimal system.

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