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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NAVAL PROVING GROUND CALCULATORS

The Aiken Relay Calculator (Mark II) continues to average 85 per cent operating efficiency with some recent trends toward 90 per cent. On 20 October 1952, it was placed back on a twenty-four hour per day schedule on exterior ballistics computation. During 1951 Mark II operated twenty-four hours per day, six days per week, with the following record:

Total Number of Scheduled Hours for 12-month period	Average Efficiency for 12-month period	Number of Good Hours According to Shifts		
		0000 0800	0800 1600	1600 2400
7248	78.5%	1875.43	1861.35	1959.79

The Mark III Calculator was also placed on a twenty-four per day schedule on 20 October 1952. During the past three months, the operating efficiency has been about 60%. Several preventive-maintenance techniques are being investigated to minimize intermittent failures, which are the source of the majority of the down time on Mark III.

To supplement the operating staff of Mark II and Mark III, a computer research section, consisting of a small number of engineers and technicians, has been organized to keep abreast of recent computer developments, to design new equipment, and to modify existing equipment on both the Mark II and Mark III for more speed, flexibility, and reliability.

WHIRLWIND I

During the past quarter, Whirlwind I has given approximately 80% useful time. In the period 1 October - 1 December 1952, 375 programs were operated (exclusive of military applications).

To facilitate programming for outside users, a comprehensive new system of service routines is essentially complete, although development and improvement will continue. These routines include provision for a system of floating addresses (permitting the location of any given word or group of words to be designated by any unique letter-number combination), with the final assignment to storage location being made by the computer itself. Interpretive subroutines for extra-precision and floating-point arithmetic place on the machine the responsibility for choice of the appropriate subroutine; the program for such subroutines is written in accordance with a special instruction code in much the usual way. Instructions contained in the interpretive subroutines, instead of being performed directly by the control element, are picked out of storage one at a time by the subroutine and interpreted as desired. The conversion program is so arranged that decimal numbers may be written with a sign followed by as many or as few digits as necessary; the decimal point may be placed anywhere within the number; and integer powers of 2 or 10 may be introduced explicitly into the number as factors. These are then converted to binary numbers in any desired fixed-or floating-point system.

At the present time, installation of auxiliary magnetic-drum storage facilities is nearing completion. The drum will provide storage in 12 groups of 2048 registers each and will allow single word or block transfer to and from electrostatic storage. Average access time to single words or blocks is 8.5 milliseconds within a group or 16 milliseconds to select a new group. The block transfer rate is 64 microseconds per word.

MOORE SCHOOL AUTOMATIC COMPUTER (MSAC)

Construction of the order-type selector and the major portion of the control chassis has been completed. Design work has continued on the mercury acoustic memory amplifier, and the power supply requirements have been investigated, with regard to the quiescent states, the maximum peak loads, and the maximum transients.

THE SWAC

Work on the magnetic drum memory for the SWAC has been resumed. Power supply units, voltage regulators, and the necessary control circuitry for a tie-in with the SWAC have been built. Work continues on selection systems of reading and writing heads.

During the last quarter, computations were performed on the following tasks:

Problem	Task Number
Associated Legendre Functions	1101-50-5131/52-48
Eigenvalues of Symmetric Matrices	1101-50-5131/53-6
Simultaneous Non-linear Equations	1101-50-5131/53-12
Simultaneous Linear Equations	1101-50-5131/53-13
Statistical Smoothing	1101-50-5131/51-19
Roots of Riemann Zeta Function	1101-50-1111/49-1a
Distribution Sampling	1101-50-1111/49-1a
Magic Sets of Latin Squares	1101-50-5131/53-3
Flow Past Body of Revolution	1101-50-5131/51-33
Recurrent Differential Equations	1101-50-5131/52-35

Information on any of these computations may be found under the appropriate task numbers in "Projects and Publications of the National Applied Mathematics Laboratories," National Bureau of Standards.

ABERDEEN PROVING GROUND COMPUTERS

The average number of hours per week of productive machine operation, based on the experience of the past 6 months, is given below. (Productive machine operation is defined as the successful use of the machine in problem set up, code checking, and the correct solution of problems.) This figure does not include available time when the machine is known to be in good operating condition, but is not being used.

ORDVAC

(76 hours). The ORDVAC continues to give excellent service, and has been operable for more than sufficient time to accomplish all work that has been prepared for it.

EDVAC

(37 hours) This comparatively low figure for the EDVAC is partially explained by the time required to incorporate engineering modifications in the past few months. These changes should ultimately result in increased operating efficiency of the machine.

ENIAC

(87 hours) Plans are being completed to incorporate a 100-word static magnetic memory in early 1953.

BELL

(71 hours - average per machine) Usage of the Bell Computer continues to decline.

IBM - CPC

(35 hours) The CPC is being used for the solution of several important data reduction problems in addition to its other assigned work. The IBM Relay Computers are to be returned to the IBM Corporation in the near future.

THE CIRCLE COMPUTER

The Circle Computer is now in production at Hogan Laboratories, Inc. (155 Perry Street, New York 13, New York), with the first machine due for completion in early 1953. The machine features ease of operation and maintenance with interchangeable-chassis construction for many of its circuits. A library of subroutines is being prepared for use with most problems.

THE JACOBS INSTRUMENT COMPANY COMPUTER (JAINCOMP)

Logical design has been completed and construction is well advanced on the JAINCOMP-C computer, which is intended for use in a control system. The JAINCOMP-C is a 24-digit machine which performs 200 three-address operations (about one-half of them multiplications) in 0.1 sec. It has 13 instrument input channels and 3 output channels. Some 70 constants can be inserted on punched cards. This machine has very flexible general-purpose programming facilities and is applicable to a variety of uses.

Preliminary studies have been made of a very compact general-purpose computer capable of extremely high speed and possessing very unusual flexibility. This, too, is a 3-address machine, capable of 4-address operation.

Computer components that have been developed are as follows: (1) A magnetic storage register, comprising 24 magnetic storage elements plus their associated gates. It is capable of storing a 24-digit number in 0.8 microsecond, and the entire number can be read out in 1/2 microsecond or less. Its volume, complete, is 2-1/2 cu. in., and its weight is 2-1/4 oz. (2) An all-magnetic frequency divider, using minute magnetic amplifiers for carry purposes. Four stages can be mounted on a subassembly panel measuring 1-7/16 x 5/8 x 2-1/8 in. and weighing less than 2 oz. (3) A semi-magnetic counter, which can count at rates in excess of 135 kc. Three stages can be mounted on a subassembly of the dimensions given above. (4) A potted pulse transformer weighing 1/100 oz. This is made in the form of a cylinder 5/16" in diameter and 1/8" high.

THE ELECOM COMPUTERS

Electronic Computer Corporation, 265 Butler Street, Brooklyn 17, New York, manufacturers of the ELECOM computers, has been acquired by the Underwood Corporation, 160 Avenue of the Americas, New York 13, New York, and now operates as the Electronic Computer Division of that company. Activities are being continued at the same locations and under the same management.

ELECOM 100

The first ELECOM 100 successfully completed its acceptance test for the Development and Proof Service of the Aberdeen Proving Grounds during the period of 22 November to 25 November 1952. The test required 40 hours of operation, of which 16 hours were to be continuous and error free. Actually the test was run 53 hours, with the last 34 hours entirely error free.

The test comprised two different eight-hour cycles, which were run alternately to make up the 40-hour total. The first cycle was a "leap-frog" test, in which the program moved itself from one part of the memory to another, modifying itself to operate in the new location, and continued this by a precession process which resulted in every part of the memory being used for every part of the program.

In the second test cycle, a program was read from tape, re-recorded, re-read, and compared to check tape operation, after which a sequence of arithmetic operations was repeated 1000 times. The entire program was repeated after advancing the tape, and the process continued for eight hours.

ELECOM 120

To meet the demand for a low-cost decimal computer, the ELECOM 100 design has recently been modified for decimal operation, and memory capacity has been increased to 1000 words. The new model has been designated as the ELECOM 120.

The ELECOM 120 word length is 8 decimal digits and sign, with provision for handling alphabetic data. Up to ten tape units and one or more typewriters are under control of the computer. Data, including complete programs, may be introduced by means of keyboard or punched paper tape, and output data may be punched directly into paper tape for latter reproduction on a special typewriter.

Instructions are of the two-address type, and available operations include alphabetic comparisons. A tape search operation permits movement of the tape, a specified number of blocks in either direction in parallel with computation.

UNIVERSITY OF ILLINOIS COMPUTER (ILLIAC)

The ILLIAC, a computer very similar to the ORDVAC, has been completed and was put into operation in September 1952 at the University of Illinois. It differs from the ORDVAC in the following two ways:

(1) Its input from a photoelectric reader operates at a speed of 240 sexadecimal characters per second and its output from a punch operates at a speed of 25 sexadecimal characters per second (as compared to the 6.3 characters per second for both input and output on the original ORDVAC), and

(2) the details of and the code for some orders differ between the two machines.

A library of about 30 routines has been prepared. The machine is being used by staff members of the University on problems the programs for which are obtained in part from the library.

HUGHES AIRCRAFT COMPANY COMPUTER

A digital computer has been developed for use in airborne control systems by a team of thirty engineers, mathematicians, and physicists at the Hughes Aircraft Company, Culver City, California. This application presents many problems. The computer must be small, lightweight, and very reliable. It receives its input signals from analogue instruments in the rest of the system, converting them to the binary digital representation. The computer performs in real time the computations corresponding to the mathematical representation of the control problem. These output numbers are converted into the analogue-type signals used in the control operations.

The computer is of the serial binary type. It is general-purpose since even the simplest special-purpose digital computer for a non-trivial problem has the characteristics of a general-purpose computer. The special character of the application is reflected principally in the input-output unit.

The arithmetic unit consists of three one-word circulating registers and a binary adder.

The magnetic-drum memory provides storage space for over 1500 nineteen-digit words. Sixteen of the nineteen digits are available for number digits, one for sign digit, and two for switching operations. On the drum, which is four inches in diameter and rotates at 8000 rpm, the density of storage is approximately 100 binary digits per inch. In order to reduce the access time, an eight word circulating register is provided.

The code which has provision for twenty-two operations, is of the relative-address type*. Each instruction pertains to an operation on only one number. The logical structure was designed with the aid of a computer algebra based on Boolean algebra.

In order to achieve small size, sub-miniaturization techniques are employed throughout. Subminiature tubes, germanium crystal diodes, and etched-circuit construction are all used. The requirement of operability under conditions of vibration and shock is met by a rugged mechanical design, and the temperature requirements are met by circuits designed to operate even though the components--diodes, resistors, etc. --deteriorate appreciably from their rated values. Cooling is by forced air.

Accessibility of components and ease of check-out and maintenance are obtained from a unitized type of construction. A standard flip-flop, which is used throughout the computer as well as the diode network associated with each flip-flop is constructed as a plug-in unit.

Analogue-to-digital input conversion devices have been developed for d-c voltage, a-c voltage, and shaft position inputs. Each of these devices converts the analogue quantity into a time interval from which the digital number is obtained by counting timing pulses from the computer, thus permitting the use of a single counter which is switched in succession to each conversion device. A similar set of conversion devices converts the digital numbers into voltages and shaft positions. The accuracy of the conversion appears to be limited principally by the problems in the accurate measurement of physical quantities and not by the digital output.

In one application of the computer there are ten analogue inputs and four analogue outputs, which in this system are sampled at one-tenth second intervals. The complete computer system, including conversion devices, has approximately 250 tubes and 2000 germanium crystal diodes. Its volume is four cubic feet.

DATA PROCESSING AND CONVERSION EQUIPMENT

FLYING TYPEWRITER

Of the 1, 200 tubes originally in the "Flying Typewriter" 900 have now been eliminated through the use of a small drum instead of the counter type storage. Its printing speed has been increased to 600 lines per minute by a simple rearrangement of the type.

THE CHARACTRON

Since the last report of the CHARACTRON (in the January 1952 issue of the Newsletter) considerable progress has been made in the refinement and standardization of several forms of the tube, code conversion and tube control circuitry have been developed, and printing means have been studied. Adequate light intensities are available from the screen of the tube to energize reproducing media at speeds in excess of 10, 000 characters per second with photographic or dry printing techniques.

The Company plans to make available CHARACTRON equipment, comprising the tube and its control circuitry, a code converter adapted to the characteristics of various input signals, and a printer attachment. Demonstrable engineering models for converting analogue, binary, and Morse code information into CHARACTRON images are scheduled for completion in early 1953.

Applications of the equipment include telemeter monitoring and recording, analogue-to-digital data display, high-speed communications read-out and printer, computer display, business machine and dick-strip printing, etc.

* A. Zurkin, "Automatic Program Control Utilizing a Variable Reference for Addressing," Proceedings of the Electronic Computer Symposium, April 30 - May 1, 1952, at The University of California at Los Angeles.

AVAILABILITY OF DIGITAL COMPUTING SERVICES

Key: (a) Name and Address of Contact
(b) Facilities and their Location
(c) Coding and Mathematical Services
(d) To Whom Available

(1) Raytheon Manufacturing Company

(a) R. F. Clippinger, Computing Services Section, Raytheon Manufacturing Company, Waltham 54, Massachusetts.

(b) Large scale, high-speed, general-purpose digital computer, drum and electrostatic memory, paper tape input-output.

(c) Available.

(d) No restriction.

(2) Northrop Aircraft, Inc.

(a) L. A. Ohlinger, Director of Computing, Northrop Aircraft, Inc., Hawthorne, California.

(b) Three Card Programmed Calculators (CPCs); One SuperC, a computer having more electronic storage and output capacity than conventional C-P-C's; Other auxiliary IBM equipment; Magnetic Drum Digital Differential Analyzer (MADDIDA); An Automatically Sequenced Computer (BINAC). A new improved computer, not yet named, will be available in midyear 1953. Northrop Aircraft, Inc.

(c) Available.

(d) Primarily available to government agencies and their contractors, limited availability to academic and industrial agencies.

(3) University of Wisconsin

(a) P. C. Hammer, University of Wisconsin, 306 North Hall, Madison 6, Wisconsin.

(b) Desk Calculators and IBM equipment including Model 1 C. P. E. C. (Numerical Analysis Lab., Room 206, North Hall), and fifty-two linear Philbrick operational amplifiers, four multipliers, two function generators, and other nonlinear computing devices (Electrical Engineering Department, New Engineering Building). University of Wisconsin.

(c) Available (Research mathematicians also available for consultation.)

(d) No restrictions. Preference is given to proposals of a research nature.

PLANNED FACILITIES

(1) Computer Research Corporation

(a) R. E. Sprague, Computer Research Corporation, 3348 W. El Segundo Boulevard, Hawthorne, California.

(b) CADAC 102-A, by approximately August 1953 and other equipment later. Computer Research Corporation.

(c) The computer will be operated by the Applications Department under the direction of Mr. Sprague.

(d) No restriction.

Note: The Report of the Symposium on Commercially Available General-Purpose Electronic Digital Computers of Moderate Price, sponsored by the Navy Mathematical Computing Advisory Panel, 14 May 1952, has been turned over to the Office of Technical Services for reproduction. It can be purchased under Catalogue No. PB 111 043 at $1.25 per copy. Requests should be sent to the Office of Technical Services, Department of Commerce, Washington 25, D. C., with checks made payable to the Treasurer of the United States.

SPECIAL NOTICE

Because of the increased demand for the Digital Computer Newsletter, the Office of Naval Research is obliged to arrange for its publication through another agency on a subscription basis. As soon as the necessary arrangements can be made, information will be sent to the present mailing list concerning the procedure for subscribing.

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