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. Distribution is limited to government agencies, contractors, and contributors.

OFFICE OF NAVAL RESEARCH · PHYSICAL SCIENCES DIVISION

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Approved by
The Under Secretary of the Navy
16 August 1954

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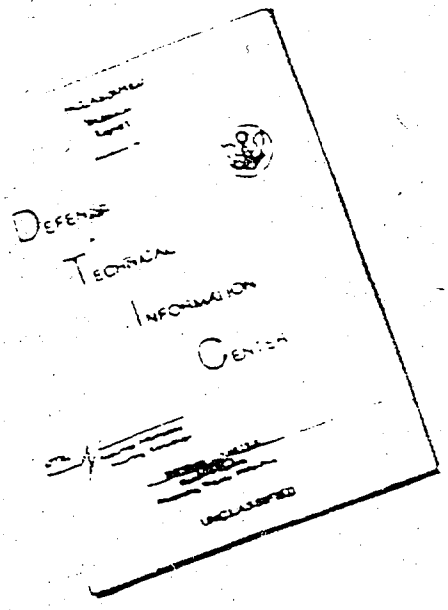

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COMPUTERS

ABERDEEN PROVING GROUND COMPUTERS

Machine hours for the three high-speed computers for the "average" week during the past summer are as follows:

	ORDVAC	EDVAC	ENIAC
Scheduled Engineering	16	9	18
Unscheduled Engineering	13	36	45
Total Engineering	29	45	63
Problem Setup and Code Checking	32	39	19
Production	81	24	84
Idle	26	60	2
Total Available	139	123	105
TOTAL	168	168	168

	ORDVAC	EDVAC	ENIAC
Number of Unscheduled Down Times	13	9	21
Average Down Time Period (hours)	0.9	3.8	2.3
Number of Problem Changes	252	119	14
Average Code Checking Period (hours)	.4	.4	1.2
Average Problem Production Period (hours)	.5	.8	5.4
Number of Different Problems	31	24	5

Many recent machine computations have been performed for the following types of problems:

1. Kill probability determination of various missiles against aircraft.
2. Supersonic flow fields about various types of axisymmetric missiles.
3. Reduction of telemetering data.
4. Units of cyclic cubic fields.
5. Determination of the flight behavior of large missiles by reduction of Dovap and cine-theodolite data.
6. Firing tables for conventional shells and other missiles.
7. Weapon effect computation to obtain parameters for maximum lethality.
8. Bombing tables for all Air Force bombs.
9. Evaluation of fire control test data.

In addition, routines are available and are being used to quickly and efficiently solve certain problems which are reducible to the following mathematical problems:

1. Determination of roots and errors in roots of polynomial and transcendental equations.
2. Solution of a system of linear algebraic equations and related matrix operations.
3. Solution of a system of first order ordinary differential equations.
4. Evaluation of integrals.

IBM TYPE 704 ELECTRONIC DATA PROCESSING MACHINE

The newly announced IBM Type 704 Electronic Data Processing Machine has an over-all effectiveness two to twenty times of the previous Type 701 because of the features listed below. Present users of the Type 701 can convert to and be provided with the advantages of the Type 704. This conversion involves the replacement of the Type 701 Analytic Control Unit with the new Type Analytic Control Unit, and the conversion of the Type 731 Magnetic Drum Reader and Recorder to a Type 731 Model 2 Magnetic Drum Reader and Recorder.

The outstanding and significant features of this Calculator are as follows:

1. Double Arithmetic Speed in Multiplication and Division

The type 704 executes multiplication and division commands at double the speed of the present Type 701. The Type 701 performs the operations of multiplication or division in 456 microseconds, or approximately 2000 operations per second. The Type 704 multiplies or divides in 240 microseconds, or approximately 4000 operations per second.

2. Automatic Floating Point Operation

The Type 704 is the first large-scale commercially available computer to employ fully automatic floating point arithmetic commands. These commands enable the machine to record automatically and keep track of the size of all numbers during thousands of computing steps. At each step the most significant digits of any given number are always used in performing arithmetic. This ability is of tremendous importance in long sequential calculations which might typically involve millions of steps with numbers and their combined results varying from extremely small to unusually large numbers on any given step. Heretofore, this has been done by interpretive programs such as the IBM 701 Speedcoding System.

The execution time for the various floating point operations are:

A. Floating Point Addition - 84 microseconds,* or 11,000 per second.
B. Floating Point Subtractions - 84 microseconds,* or 11,000 per second.
C. Floating Point Multiplication - 204 microseconds, or 4500 per second.
D. Floating Point Division - 216 microseconds, or 4500 per second.

This means floating point addition can be accomplished in approximately 1/20 of the time and multiplication can be performed in approximately 1/7 of the time presently required on the Type 701.

3. Index Registers

Three special electronic registers have been added to the machine to facilitate the writing of programs. In normal practice many programs involve the repeated application of the same sequence of steps to data located in different parts of the memory. This requires writing programs to shift the sequence of steps so as to operate on the proper data at the proper time. Such manipulation of programs is done automatically in the Type 704 by reference to index registers which control the repeated application of a programmed routine. The registers increase the logical ability of the machine and, at the same time, provide for a reduction in the number of instructions now needed to perform the proper shifting and manipulation of a given sequence.

4. High-Speed Drum Switching and Transmission

Changes in switching techniques and equipment have been made on the Type 731 Magnetic Drum unit to provide more than a twelvefold speed increase in the transfer rate between magnetic drum and electrostatic storage. In the present type 701 the magnetic drum is read at a rate of 800 words per second or the equivalent of 8000 digits per second. The Type 704 will read at 10,000 words per second or at the rate of 100,000 decimal digits per second. In addition to this, the initial access time has been reduced from an average of 50 milliseconds to an average of 12 milliseconds.

The addition of new commands enables the Type 704 to use the drum most effectively in table look-up operations. It is possible to consult tables stored on the drums without the necessity of bringing into the main memory any portion of the table other than that desired.

5. New Logical Operations

The Type 701 has a total of 32 operations available to the programmer. In the Type 704 this number has been increased to 73.

*In case the operands differ by 10 or less and normalization does not require more than 4 shifts.

Among these new commands are:

1. Logical Multiplication to Accumulator
2. Logical Multiplication to Memory
3. Logical Addition to the Accumulator
4. Logical Addition to the Memory

These commands facilitate the extraction and combination of small pieces of information within the main memory. With such commands it is possible to perform processing and arithmetic efficiently on fields smaller or larger than ten digits.

Another command, END AROUND CARRY ADD, has been added which will simplify the handling of the methods used in checking the flow of information among the various input-output units and the main memory. This will increase the over-all checking ability of the machine with a simultaneous reduction in programming requirements.

Many additional transfer and test commands have been added to increase the logical power and flexibility of the machine, as well as to reduce the memory positions necessary to effect a given program.

THE INSTITUTE FOR ADVANCED STUDY - ELECTRONIC COMPUTER PROJECT

In an attempt to improve the read-around or spill characteristics of the Williams memory (5CP1A tubes) the second anode to cathode potential was increased from 1000 volts to 1650 volts. The second to third anode potential was dropped from about 1000 volts to 400 volts. This change necessitated capacity coupling of the memory tube control grids to their beam turn-on circuitry as opposed to the direct coupling previously used. From the results obtained to date this change has had the effect of almost doubling the read-around performance.

The construction of an auxiliary oscilloscopic graphing device (mentioned in the previous issue) has been completed. It is now undergoing bench tests and it is expected to be operable in several weeks.

The capacity of the air-conditioning system has been increased to 15 tons by adding a second 7.5-ton compressor to the existing facility.

A considerable number of problems have been successfully run during the quarter and reports are now being prepared on them.

NATIONAL CASH REGISTER COMPANY - NEW DECIMAL GENERAL PURPOSE COMPUTER

To meet the growing demand for a low-cost, easy-to-operate general purpose computer, The National Cash Register Company's Electronic Division (formerly Computer Research Corporation) has developed a new electronic data processing machine, the CRC-102-D.

This computer accepts data from an electric typewriter, punched-paper type, magnetic tape or punched cards. All data is entered into the machine, operated on, and printed out in decimal form.

A new high-speed paper-tape reader, capable of reading 200 characters per second, and a new paper-tape punch with a punching speed of 60 characters per second, are available as accessories.

NAVAL PROVING GROUND CALCULATORS

The Mark III Electronic Calculator has been officially renamed the Aiken Dahlgren Electronic Calculator (ADEC).

The Aiken Relay Calculator (ARC) and the Aiken Dahlgren Electronic Calculator (ADEC) have been operating on a regular 24-hour-per-day schedule five days a week. The operating

efficiency of ARC has averaged 90 percent and that of the ADEC has averaged 77 percent during the past quarter.

The Computer Research and Development Group has completed dynamic tests on the "Brush" type magnetic heads, and it is planned to replace all the present magnetic heads in the ADEC input-output systems with "Brush" heads. In addition to this, reliability and endurance tests are being conducted on a Potter magnetic tape mechanism to ascertain its possible value as a replacement for the present ADEC magnetic tape units.

Specifications have been written for a converter to be used as auxiliary equipment for the ADEC which will provide a means of converting numbers from IBM cards to ADEC magnetic tape and vice versa. The contract to build this converter has been awarded to the Technitrol Corporation, Philadelphia, Pennsylvania.

The Computation Laboratory continues to have a heavy workload in computations for the Bureau of Ordnance. However, some time is available to perform work for contractors of the Defense Department.

UNDERWOOD CORPORATION - ELECTRONIC COMPUTER DIVISION

Installation of the ELECOM 200 or "ORDFIAC" was completed at Letterkenny Ordnance Depot, Chambersburg, Pennsylvania, on August 27, 1954.

The 10,000-word drum-memory electronic data handler previously passed its acceptance tests at the Electronic Computer Division, Underwood Corporation plant in April. The 6-foot by 16-foot computer was disassembled into eight sections, crated, and shipped from New York City to its Pennsylvania destination. It was reassembled and put back into successful operation in approximately one month. Maintenance of the ORDFIAC now is being performed by Army Ordnance personnel.

The ELECOM 120, owned by the Aviation Gas Turbine Division, Westinghouse Corporation, was moved from Philadelphia to Kansas City during August and was back in operation in its new home eight working days after being unloaded from the truck which hauled it more than 1100 miles.

RAND CORPORATION - JOHNNIAC

The JOHNNIAC was removed from operation during September, 1954, to prepare the computer for a 4096-word magnetic core memory. Prior to shutdown a modest amount of scheduled operating time (300 hours) was recorded. The mean free time between errors was 6.7 hours and the percent good time of scheduled time was 87%.

The machine is scheduled to be in operation with the new core memory and an ANelex Synchroprinter on November 13, 1954. The drum installation has been delayed until December, 1954. It is presently undergoing dynamic testing.

WHIRLWIND I

Applications

During the past 3 months, 22 problems were initiated with the Scientific and Engineering Computation (S&EC) Group in conjunction with various departments at MIT for solution on Whirlwind I, and 18 problems were completed. Of the 49 problems that remain, eight are inactive because of the academic summer recess or because future action will depend upon the processing of results already obtained.

Two simulated computers were developed and used in the special MIT summer-session course 6.531 (Digital Computers: Business Applications). One of these is a single-address computer called SAC and is a modification of the 1953 "summer session (SS)" computer. The other, called TAC, is a 3-plus-1 address computer designed to simulate a medium-speed drum computer.

Systems Engineering

In the period of slightly over a year since auxiliary magnetic-drum storage was put into use in the Whirlwind I system, significant improvements have been made in the drum-storage facilities. Two of these improvements are of particular importance to the computer-system operation and maintenance. First, the parity, (redundancy) check system, which has proved so valuable for the internal high-speed memory, has been extended to cover the drum memory. This check revealed hitherto unnoticed weaknesses in the drum systems and eliminates a large part of the computer system from suspicion when drum-memory troubles do occur. The total drum-memory capacity of about 36,000 registers is divided between two independent drums; parity checking is applied to both systems.

The second improvement is in the switching method used to select groups of heads for writing operations. One of the drum systems (containing two-thirds of the total auxiliary-storage registers) was originally designed with relays to accomplish this switching function. After several months of operation, it was found that the operate-time of these relays had increased considerably. This evidence of relay deterioration, in addition to other problems of maintenance and testing directly attributable to the relay installation, led to a decision to install electronic switching in place of relays. Although the changeover resulted in a substantial increase in the electronics in this system, it is felt that the disadvantages of such an increase are offset by a reduction in maintenance time and an increase in switching speed. Electronic switching requires about 130 microseconds as compared to the 32 milliseconds which had been allowed for the relays to operate.

Academic Program

Two summer-session courses were offered this year. Course 6.532, "Digital Computer Automatic Coding Technique," ran from the 2nd to the 26th of August; the 45 students represented business concerns which own or manufacture computers. Course 6.531 (on commercial applications of computers) covered the period 16 - 27 August; 17 of the 52 business representatives (out of an enrollment of 65) were from insurance companies.

BUREAU OF STANDARDS COMPUTERS

SEAC

In May 1954 SEAC completed its fourth year of operation at the National Bureau of Standards Electronic Computers Laboratory. During the period from October 1950 through August 1954, 20,606 productive hours had been scheduled, with 15,520 hours or 75% logged as good time (defined as time during which the computer was used for error-free problem solution and code checking or was idle-in-order). The installation will be moved from Building 83 to Building 10 on the Bureau grounds late this fall which will result in an anticipated out-of-operation period of two months.

An interesting experiment of workload time-sharing by two computers was demonstrated successfully in April when the DYSEAC and SEAC were interconnected. The preliminary results from a sorting-file merging problem prepared by SEAC were fed automatically to DYSEAC where the final merging operation was performed. The results of the problem fed into SEAC emerged from the DYSEAC Flexowriter without any manual intervention.

Interpretive programs have been developed for SEAC which enable programmers to specify complex subroutines by single orders in a machine pseudo code. This has resulted in a significant decrease in the problem preparation time and has proved valuable for use with short programs. Automatic utility routines have been developed which enable the operator to communicate with the computer in decimal notation and to perform many automatic program checks without the addition of changes in his program or the necessity for complicated switch manipulations.

DYSEAC

DYSEAC, a prototype high-speed digital computer, has been delivered to the Signal Corps and is now in operation at White Sands Signal Agency, New Mexico. It was designed by the National Bureau of Standards to serve as the experimental nucleus for a complex data-processing network for the Department of Defense. This computer is expandable and provides direct selection of up to 1024 input-output units; high-speed memory capacity of up to 4096 48-bit words; and concurrent read-in, read-out and internal computations. It has unusually flexible provisions for manual-monitor and other special operations whereby the operator or external equipment, or both, may interrupt a program in progress and redirect the DYSEAC to other tasks, but enable it to return automatically to its original program upon completion of these special tasks.

Like SEAC, DYSEAC operates at a basic repetition rate of one megacycle and employs dynamic computing circuits. In DYSEAC, this circuitry has been reduced to two types of etched-circuit plug-in packages which are adaptable to all the required computer functions by means of exterior wiring changes. These circuit modules are organized into a powerful system for controlling and responding to auxiliary external devices.

DYSEAC is intended for use as a data-processing center at various operating sites in the field and is a self-contained system with its own power supply and air-conditioning equipment permanently installed in two 40-foot trailer vans. The computer racks and acoustic memory cabinet are shock-mounted to prevent damage from vibration. Components and construction are ruggedized, and packaging and modular assembly techniques are standardized in an attempt at increased efficiency of operation and ease of maintenance.

INPUT-OUTPUT EQUIPMENT

AUTOMATIC PLOTTING BOARD

Benson-Lehner Corporation has announced the availability of their new automatic plotting board, the Electroplotter Model G accepting inputs from punched cards, punched tape and keyboard. This unit plots on a 30" x 30" surface with an accuracy of one part in 1500, or 0.02", whichever is greater.

Numerical input of ±9999 may be expanded to full scale or compressed to one-third full scale in both X and Y. Physically its origin may be placed at any desired location on the table. Roll paper may be used and a vacuum paper-hold-down system is provided for smooth, wrinkle-free hold-down.

Other features of the Electroplotter include multiple symbol printing, serial keyboard, plug-in component construction, and light-bank indication of numbers in the X and Y registers.

CARD-TO-MAGNETIC TAPE CONVERTER

A completely new Card-to-Magnetic Tape Converter, which transfers information from 80-column punched cards to Remington Rand's UNIVAC seven-channel metallic magnetic tape in a completely self-checking operation, is now available as an auxiliary input device for the UNIVAC system.

Operating at a speed of over 200 cards per minute, the card is passed under a set of brushes, read into a memory, and the information recorded as a blockette (10 twelve-digit words) on tape; the blockette of information which has just been recorded on tape is read backwards and given an odd-even pulse check and a 120-character count check; the blockette of information which has just been recorded on tape is read backwards and given an odd-even pulse check and a 120-character count check; the blockette is then read forward and given a second odd-even and 120 count check.

Simultaneously the tape information is compared with the card which by this time has been read into the memory by a second set of brushes. This checking procedure insures the

proper transcription of the card data. If any error is discovered during the above operation, the fault card is ejected into an error bin, the tape is repositioned to allow the area used by the false blockette to be reused, and the Converter stops. Neon lights on the control panel indicate the cause of the stoppage. There is also a mis-punch detector which causes a card having an erroneous punch (e.g., a 4 and a 7 punch in the same column) to be ejected into the error bin.

The Converter consists of three units: (a) a tape unit which is a clutch-operated Uniservo; (b) an electronic unit which contains the circuitry necessary to control the tape and card feeding units as well as the equipment for reading, recording, checking and storage; and (c) a card feeding unit.

One reel of tape produced by the Card-to-Magnetic Tape Converter will contain information from more than 5000 punched cards. Information is recorded on tape at a density of 120 characters per inch with the card information distributed among the 120 characters which comprise the blockette. During the conversion the columnar information on the cards may be rearranged into any format desired by the proper wiring of a plugboard unit. Blank columns on the card can be converted as either spaces or zeros depending upon the setting of a blank column selector switch.

DIGITAL PLOTTER

The Northrop Aircraft Company is currently testing a prototype high-speed, automatic, digital plotter. This plotter is a joint development project of Northrop Aircraft and the Tally Register Corporation.

The prototype is a single-symbol model, capable of plotting up to ten points a second on a vertical (Y) axis that is 10 inches long. The point spacing is .025 of an inch; consequently, up to 400 points can be plotted in the 10 inches. Plotting along the X axis is accomplished by feeding the paper past the (Y) plotting head. This permits long time-history plots or multiple plots without operator intervention. The paper may be automatically fed in either direction, thus allowing plots of loops, and other configurations. The (X) axis spacing increment is also .025 of an inch for each unit of paper spacing (ΔX) sent to the plotter. Up to 99 units (decimal digits) may be called for in one input signal.

Blank paper may be fed into the plotter and the grid can be automatically printed as the paper passes the plotting head.

In addition to its plot speed of ten points a second and the motion of the paper past the plotting head allowing continuous plots, the following features are included:

Input may be made directly from a digital computer.
Input may be made from card readers.
Input may be made from tape readers.
Multiple curves may be plotted.

A development program on the plotter is continuing and it is anticipated that a four-symbol model will be announced soon.

THE TAPE DRUM

The "Tape Drum" is a new type of magnetic storage device or memory which for many applications combines the advantages of a drum and a tape recorder. "Tape Drums" have the advantage of rapid access normally available only on drums together with the economy and large storage capacity of magnetic tape recorders. Developed by the Clevite-Brush Development Company for one of its inventory control systems, they are particularly suitable for data-handling applications such as inventory controls, processing of test data, etc.

The "Tape Drum" records on a wide, stationary, plastic tape which is wrapped around half of a rotating drum, which carries a large number of magnetic recording and playback heads. This is a reversal of the method which has heretofore been used for drum recorders which hold the heads stationary and record the information on the drum surface.

With each revolution of the drum, the rotating heads scan the information on a section of tape which covers half of the drum periphery. This can also be done with each half revolution if additional heads are provided. The section of tape so covered is referred to as a "page." Each section or "page" may contain up to 200,000 binary digits depending on the size of the drum, the width of the tape, the pulse packing, and the track widths. With conventional magnetic drums, additional drums are needed when the storage requirements exceed the drum capacity. In the "Tape Drum," the rollers advance the tape so that additional storage surface appears over the area scanned by the heads. Thus large amounts of information can be stored with only a small cost increase for the additional tape.

In this way information is accessible in terms of three parameters, namely, the "page," the column, and the angular position of the drum. This feature greatly reduces the time of access of the information stored as compared to storage on tape recorders of equal capacity.

EDUCATIONAL PROGRAM

A free Coding and Programming course is offered by ElectroData Corporation, Pasadena, California, lasting two weeks and scheduled twice a month; the course includes 80 hours of classroom and computer work.

Attended by operating personnel, mathematicians, engineers, and management, the course thoroughly explains the order code of the ElectroData Computer, operation of the quick-access memory, and subroutines. After learning to code problems in which he is interested, each student at the end of the course prepares an input tape and runs a problem on the demonstration computer at the computing center, 717 North Lake Avenue, Pasadena, California.

The first of a number of scholarships offered to leading universities by ElectroData Corporation went into operation recently. Two doctoral candidates from Purdue University are investigating digital computers and computing techniques as well as logical design and computer engineering with ElectroData mathematicians and engineers. For their training at the Pasadena plant ElectroData Corporation gave a grant to Purdue University.

MISCELLANEOUS

The Computer Research Corporation of California has become the Electronics Division of the National Cash Register Company. NCR purchased the controlling interest in Computer Research in March 1953, and made the company a wholly owned subsidiary with the purchase of the remaining stock early this year. The new NCR division will manufacture electronic computers for business applications, in addition to its present line of computers.

The Magnavox Research Laboratories has been organized as an activity of the Magnavox Company to engage in Research and Development of Digital Computers and Components. The nucleus of this group is made up of the former machine development unit of the Institute of Numerical Analysis at U.C.L.A. This group transferred to Magnavox in December and is now performing development work in the field of guidance computers, and analog-to-digital data conversion equipment. The development of a high-speed general purpose scientific computer, using the SWAC as prototype, is also under way. The group is now maintaining the SWAC at U.C.L.A. for the Institute of Numerical Analysis. Component research is being carried on in such items as magnetic memory cores, and drums.

Military and commercial contracts are being carried out in the application of digital computers to control systems, guidance systems, industrial and scientific data reduction, and business data processing.

DCN NEWS ITEMS

The Office of Naval Research welcomes contributions to the Digital Computers NEWSLETTER. Material should be received by the editor not later than 1 March, 1 June, 1 September, and 1 December, to be included in the current issue.

Short technical articles on new machines, on new developments in digital techniques and components, on new types of problems solved and generally news items which may be of potential interest to government users are desired.

Communications should be addressed to:

Editor, Digital Computer Newsletter, Code 427
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Washington 25, D. C.

NOTICE

Commencing with the January 1954 issue, this Newsletter is being republished in the Proceedings of the Association of Computing Machinery. These Proceedings may be obtained from the Association of Computing Machinery, 2 East 63rd Street, New York, New York.