DIGITAL COMPUTER
NEWSLETTER

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GENERAL PURPOSE COMPUTERS

Burroughs Laboratory Computer

Since February 21, 1951, the Burroughs Adding Machine Company has been operating, in the Philadelphia laboratories of its Research Division, an electronic digital computer of unique construction.

This machine, which has a magnetic-drum memory and teletype input-output facilities, was assembled entirely from general-purpose electronic building blocks. Almost all of these general-purpose units belong to the line of equipment known as Pulse-Control Units, for which a descriptive brochure is available on request.

Each Pulse-Control Unit is a standard logical component, such as a flip-flop, gate or pulse-delay circuit, and is equipped with input and output buffers. Waveforms on the coaxial cables which interconnect units are restricted to two standard types: 0.1-microsecond pulses and two-valued d-c control voltages having 0.2-microsecond switching time.

Use of Pulse-Control Units permitted assembly of the computer directly from logical diagrams without the usual intermediate engineering steps. Only nine months elapsed from inception to completion. After assembly and interconnection of approximately 500 units, the computer was made to

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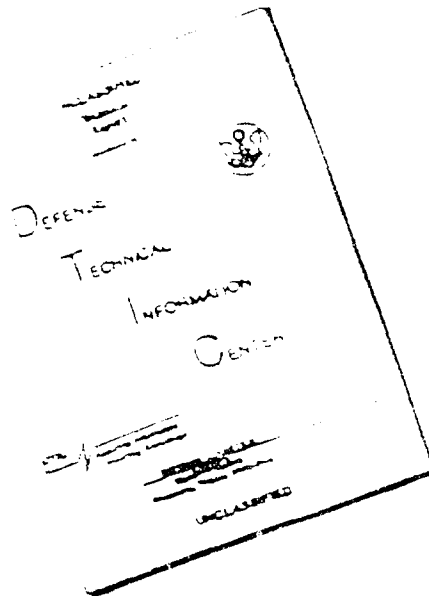
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work in its entirety within 48 hours total accumulated time on the d-c supplies. This time included check-out of the power system.

The machine's present repertoire includes 12 instructions, which are sufficient to make it a general-purpose computer. Until now multiplication and division have been programmed, but modifications in progress will make them single instructions. A single-address code is normally used, but a recent change permits a programmed choice between single- and double-address operation. Most single-address operations require one magnetic drum revolution, i.e., 16 milliseconds for completion. The program is normally stored on the drum.

Number representation is binary-coded decimal (excess three). Storage is serial-serial on the drum, but serial-parallel in the magnetic shift-register accumulator. A word check is employed (weighted modulo-3 count of bits).

The form of unitized construction employed here affords an additional degree of freedom which makes this machine unique; not only can it be programmed, both the internal workings of the machine can be and have been modified readily by easily accomplished changes in plug-in connections without great concern over electronic details.

This computer has been operating during normal working hours since February 21 with about 85% trouble-free availability.

UNIVAC Dedication

On June 14, 1951 the formal dedication ceremonies were held in Philadelphia by the Bureau of the Census, National Bureau of Standards, and the Eckert-Mauchly division of Remington Rand, Inc. at which time the Secretary of Commerce, Charles Sawyer, accepted the first UNIVAC system for the Census Bureau. Dr. Roy V. Peel, Director of the Census, Dr. Edward U. Condon, Director of the Bureau of Standards, Mr. James H. Rand, President of Remington Rand, Lt. Gen. Leslie R. Groves, V. Pres. of Remington Rand and Mr. Albert M. Greenfield, President of Greater Philadelphia Chamber of Commerce took part in the ceremonies, as did Dr. S. N. Alexander of the Bureau of Standards, J. A. McPherson of the Bureau of the Census and J. P. Eckert, Jr., of the Eckert-Mauchly division of Remington Rand. The first UNIVAC system passed government acceptance tests in March and has been in almost continuous use by Census personnel since the first of April. It is operated twenty-four (24) hours a day, seven (7) days a week.

The second UNIVAC system is now nearing its final test and the third UNIVAC system is going through its initial test. All of these systems are identical in design and construction differing only in the amount of auxiliary equipment which varies according to the needs of the user. The self-checking facilities of the UNIVAC system have shown themselves to be highly important and desirable. This is the first large digital computer system to be manufactured on a production basis.

The Raytheon Digital Computer

The clock, central control, main memory, and the hunt rack are now in the system testing phase. The external memory rack and the problem preparation data transfer unit have been unit tested, and are now undergoing rack tests. Twenty-six chassis, not yet included in rack tests, have been unit tested, while seven chassis are undergoing unit test. Eleven chassis have been fabricated awaiting unit test; thirty-nine chassis are in fabrication, with the last one scheduled to be delivered early in August. Optimization of the circuitry of the remaining twelve chassis of the computer is now being completed and the fabrication of these chassis is scheduled for completion in August.

Magnetic tape defects have been reduced considerably by tape manufacturers. These defects, where not removable, will be positioned in dead spaces between blocks on the magnetic tape.

A pulse transformer, capable of passing a 10-microsecond pulse with 5% droop and having a 0.02 microsecond rise time, has been developed and is utilized in certain circuits of the arithmetic unit.

Present plans call for operational testing of the complete machine to be underway in October.

The National Bureau of Standards Eastern Automatic Computer

A large variety of problems have been run successfully on the SEAC. Total operating time devoted to problem solution exceeded 1000 hours during the months January through March 1951.

The Williams tube memory has been operated successfully with 256 spots for several 8-hour sessions on a supersonic nozzle problem. Engineering tests show that the system can be adjusted so that the Maximum machine-call-rate of one word every 48 microseconds does not interfere with stored information. The Williams memory has also been used successfully with 512 spots on a problem in dynamics (involving two degrees of freedom) which concerns the construction of sensitive apparatus related to airplane safety. It is now being tried out (with 512 spots) in conjunction with the acoustic memory on a problem requiring the full capacity of both memories.

A punched-card-to-magnetic tape converter has been built and used successfully for the SCOOP problem.

Whirlwind I (M.I.T.)

During April, May, and June the Whirlwind computer has been assigned to computation on schedule for 35 hours a week. Of this assigned time, 89 per cent has been trouble-free. The Whirlwind staff is using 348 registers of electrostatic storage and computing at a speed of 20,000 single address operations per second. A photoelectric reader provides paper tape input at a speed of fifty 16-digit words per second.

A group of 15 mathematicians and engineers are engaged in planning the operation of the machine and in preparing and operating programs for scientific and engineering computation. A feature of the organization of the group is the development of techniques, similar to those used by the EDSAC people, by which all general applications programs are performed on the computer and the results or symptoms recorded by an operator without any knowledge of the given programs.

In addition to the above group, there is another group of 16 mathematicians and engineers doing analysis and preparing programs for government applications.

The ORDVAC (Univ. of Ill.)

The arithmetic unit and the controls for the arithmetic orders for the ORDVAC have been completed. The electrostatic memory containing forty 3KP1 tubes has, in test runs, stored patterns for 24 hour periods without error but no read around ratio test of the entire forty tubes has as yet been carried out. The memory has been installed recently on the arithmetic unit and has operated error free for short periods of several hours in that location. The standard teletype input-output equipment has been completed.

The group is now engaged in testing the memory and constructing the memory control components which will be necessary for the combined operation of the memory and arithmetic unit.

Moore School Automatic Computer (MSAC)

The development of the basic circuits are being completed and final design memoranda are being written. These will appear in future issues of the MSAC progress reports.

A survey of the timing tolerance was carried out and a decision made as to the number of clock pulse phases required.

The physical and electrical layout of the logical elements of the machine has been started as well as the packaging of the plug-in diode assemblies.

The construction of racks and chassis is now underway along with the assembly of portions of the memory system.

The Institute for Advanced Study Computer

As this account is being written the control organ of the Institute for Advanced Study Computer is undergoing its final tests in the machine.

The only remaining parts are the divider, the teledeltos unit which is now being fabricated, and a few minor "cleanups" of various chassis now in place.

SPECIAL PURPOSE COMPUTERS

The CRC 101 Digital Differential Analyzer

A CRC 101 Digital Differential Analyzer was completed recently by the Computer Research Corporation of Torrance, California. This machine is a mobile unit, weighing about 330 pounds including power supply and occupying approximately the space of an office desk.

It is applicable to a wide range of computation, test and control problems and can solve any problem that can be put in the form of ordinary differential equations (linear or non-linear). It has 50 integrators and each of them can integrate the algebraic sum of up to 15 variables with respect to any other variable.

Control of CRC 101 is from a remote operating panel which may be placed at any desired distance from the machine. The control panel is the size of an adding machine.

Input data may also be read into the machine from external sensory devices or graph followers and the output may be in the form of a plotted graph, typed numbers or control over some type of effector. Connections are provided for these purposes.

The computing section of the machine contains 102 vacuum tubes and 1743 germanium diodes. The memory uses 21 tubes.

Power requirements are nominal.

The machine is filled by means of "typing" in initial conditions and integrator connection codes with two adding machine type buttons. Integrators and channels are selected by control knobs. While the machine functions in the binary system, read out at the remote control panel is in the octal notation.

The memory for CRC 101 is a magnetic drum which can store in excess of 7000 digits, with drum speed 3600 RPM. Computation speed is 3900 increments of the independent variable per minute.

The MADDIDA

Copies of the 44-integrator, MADDIDA, called the MADDIDA 44A, whose development was mentioned in the 1 August 1950 Newsletter, have been completed and are now in operation. This computer employs a magnetic-drum memory combined with a computer unit. Although the fundamental operation is numerical integration, integrators can be so operated as to perform other operations such as addition, comparison, and multiplication.

Essentially, integration of the equation $z = \int ydx$ is performed by repeated addition. However, the block diagram of the solution of a differential equation or system of equations on the MADDIDA is similar to that on an analogue differential analyzer.

During computation, information is transmitted between integrators in the form of incremental changes in variables. Each integrator has a dx input through which it receives incremental changes in an independent variable x; a dy input through which it receives changes is a dependent variable y; a dz output through which it delivers incremental changes in the integral z. The source of dx may be the output of any one of 42 other integrators, or its own output, or any one of 12 empirical input channels. The source of dy may consist of the algebraic sum of from one to seven of the above

sources in any combination. The dy input may also be omitted when using the integrator as a constant multiplier. In cases where the equation is such that dx must also consist of the sum of several channels, an additional integrator is used, coded as a simple adder.

Computation within the computer is done in the binary number system, since this leads to more compact and reliable circuitry. This means that initial conditions must be typed into the computer as binary or octal numbers; however, output devices are available which will tabulate the results of MADDIDA computations directly in the decimal system.

The desired interconnections between integrators are easily expressed as a binary code, and this code is typed into the computer along with initial conditions. The actual interconnection of integrators is done fully automatically in the machine's electronic circuits.

While many functions can be generated within the computer by solving auxiliary differential equations, it is at times convenient to insert purely arbitrary or empirical data into the computation. For this reason 12 empirical input channels are provided in the machine. These input channels may be fed from various input devices. One such arrangement is now being made available as a graph follower with which graphical data are semi-automatically placed on perforated tape. A number of tapes may then be simultaneously fed into the computer through these input channels while computation proceeds. The independent variable (or speed of tape advance) is under the control of the computer. Step functions may also be inserted at pre-set intervals with such apparatus.

Also provided in MADDIDA are 12 output channels. A tabulating printer which will accumulate and print results decimally, and an automatic plotter to present results graphically are available for operation from these channels. There are many other devices which can be developed that will operate from these channels.

The integrating device consists of two registers "Y" and "R" and a transfer device, "T." When a dx pulse is applied to T, Y is added to R and the dz outputs are pulses representing overflows from R. Hence the rate of dz pulses overflowing out of R is proportional jointly to y and to dx; dz = ky dx. Of course at any time $y = y_0 + \Sigma_i dy_i$.

The memory drum uses six channels. One of these is a permanently recorded clock channel which keeps the machine in synchronization. Two channels hold the Y and R information, corresponding to the two registers already discussed. Two more channels, which are referred to as "L"$_1$ and "L"$_2$, contain hook-up information and specify what problem is being solved. A sixth channel, referred to as the "Z line," is used for intercommunication between integrators and transmits this information in accordance with the data contained in the L channels.

AUXILIARY AND CONVERSION EQUIPMENT

Flying Typewriter

Potter Instrument Company, Inc., 115 Cutter Mill Road, Great Neck, N. Y. announces the development of a new high-speed, line-at-a-time printer. Driven by a flexible electronic shift register, the "Flying Typewriter" will print over 300 lines per minute. Each line consists of 80 columns of alphanumeric characters. Forty-seven different alphanumeric and special characters are used. Printing is on standard 17-ounce teletype paper and several carbon copies can be made.

The vacuum tube shift register, in addition to being used as a loading device for the printer, can also be used as an 80-column arithmetic accumulator for calculations. Although primarily designed for coded pulse and magnetic tape input, it can be adapted to print from punch cards, perforated paper tape, keyboard, and other means.

Conversion and Display Equipment

Recent contributions to the computer field by the Benson-Lehner Corporation, 2340 Sawtelle Boulevard, Los Angeles 64, California, include the following:

1) A D.C.-to-decimal converter for feeding from strain gauges, potentiometers, etc., directly to tape, punch cards, typewriters. The system has no electronic counters; it involves the Analog Digital Converter (see Newsletter of December, 1950), and is accurate to one part in a thousand.

2) Benson-Lehner Dactylograph: an x-y plotter for desk use with 11 x 17 inch paper, having independent x and y scale and origin adjustment. A variety of inputs may be used according to model type, including the following: hand-operated keyboard, D.C. voltages, IBM output, MADDIDA output, and others.

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Comments, letters to the editor, and additional contributions for inclusion in the Newsletter should be addressed to:

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