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 · MATHEMATICAL SCIENCES DIVISION

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NAVEXOS P-645

COMPUTERS AND DATA PROCESSORS, NORTH AMERICA

DATATRON-MILLISADIC SYSTEM—ELECTRODATA DIVISION OF BURROUGHS CORP.—PASADENA, CALIF.

One answer to the growing data reduction problem has been announced by the ElectroData Division of Burroughs Corporation. Their technique links the Millisadic analog-to-digital data converter to the Datatron electronic computer.

Modifications permit the computer to read and process test data directly from the Millisadic system's magnetic tape. Card punching and subsequent input operation which made overall reduction times unnecessarily large are bypassed. The new bridge between the Millisadic and Datatron is the computer's ability to read the Millisadic's magnetic tape output, eliminating any in-between operations. Input to the Millisadic system is determined by the particular application. In a typical case, the analog signal is recorded on magnetic tape and the tape then is run through a play-back unit. This device reads the information to the analog-to-digital converter which records the data (in digitized form) on another magnetic tape.

This tape reel is then manually removed from the Millisadic and the reel is inserted into an ElectroData magnetic tape transport. The information is read into the computer. This action is the only human intervention in the entire system.

The final compatible magnetic tape has six channels. Numbers 1, 2, 3, and 4 are used for the standard binary-coded representation of the decimal digits of the samples. Channel 5 is unused for compatible operation, and channel 6 is used as an indicator which separates groups of samples. 1200 test samples per second can be digitized and recorded on magnetic tape for insertion into a Datatron tape unit by the Millisadic.

Formerly, in the Millisadic operation each group of samples was punched into a card, together with a time indication. Each group on the tape was separated by a "card marker" recorded in the sixth channel. In the compatible system the card marker is used by the computer to signal the start of a 20-word record.

There are six digits in each data sample. The first two digits are zero, the next three indicate the value of the variable being recorded, and the last one is either a time digit or zero. The standard Datatron tape format consists of 10 digits, a sign, and one space for each computer-word. Thus, two Millisadic data sample (12 digits) fit into one word.

Data samples recorded on the Millisadic output tape are divided into groups of 10, 15 or 20 samples. The beginning of each group of samples is indicated by the "card mark." In the case of 10 or 20 samples, the computer interprets every fourth or second mark as a block marker. In the case of 15 samples per group, extra card marks are added by the modified Millisadic so that a card mark appears over the last digit of every set of five samples. The computer reading circuits are modified to interpret every eighth card marker as a block marker.

The Millisadic accumulates time pulses in a time accumulator (6 digit capacity) and each time a card marker is written on the tape (or every third time in the 15 samples per card case), the contents of the time accumulator is read into a time buffer. The time interval to be counted can be selected as 0.1, 0.01 or 0.001 seconds. The time information digits are read from the time buffer and recorded on magnetic tape by interlacing a single digit between each of the first six data samples of each group.

Other operational flags the Millisadic tape contains, to be compatible with the Datatron magnetic tape system, include overscale and calibration data, end-of-record indicator, and manual tape control.

After the digitized tape has been placed in the Datatron's tape transport, the data is transferred from the tape to the computer's magnetic drum (40,800 digit capacity). The words are examined for a negative sign, indicating overscaling, calibration points or end-of-record flags which direct the computer to an "exception" routine.

Second step in processing data is the extraction of the time digits. The computer separates the word containing two samples into individual data points, and each point then becomes a separate word.

Samples on Millisadic tape consist of numbers indicating the strength of the analog signal. This sample does not represent the true units of the physical property being measured until specific computation translates the indicated number into its true value. For example, pressures ranging from 1000 psi to 2000 psi were to be measured. The corresponding range for the test was arbitrarily set at 100 and 900. The results, on magnetic tape, are read into computer. The first Millisadic reading, 700, is converted to a true pressure of 1750 psi by following an equation of ratios. The other readings are similarly converted.

Once the sample reflects its true value it may be used in several different ways. It may be punched into paper tape or cards for further external processing or curve plotting. It may be printed out by an electric typewriter or by a line printer for visual study, or it may be retained on the drum for further processing.

In a process such as the example above, the computer takes 50 milliseconds to examine the words, extract the time digits, separate the samples and determine the true pressure.

Five major features in the compatible system are:

1. Reduction of computer input preparation time. 1200 test samples per second can be digitized and recorded on magnetic tape by the Millisadic.

2. Increase of input speed. At an input rate of 200 cards per minute it would require 18 seconds to read in 60 cards containing 1200 samples. The time required to read the 1200 samples from magnetic tape, store them in computer memory and begin computations is 1.4 seconds.

3. Minimization of storage space. One 2400-foot reel of tape will store 200,000 computer words, or 400,000 data samples.

4. Computer control of input media. By reading tape into the Datatron the samples may be scanned for specific pieces of data at relatively high speeds, a difficult and time-consuming operation with cards.

5. Multiplicity of input channels. Information can be read into the computer from separate tape units in the desired order, eliminating collating and card preparation.

NAREC - NAVAL RESEARCH LABORATORY - WASHINGTON, D. C.

Progress in the operation and development of the U. S. Naval Research Laboratory's electronic digital computer was previously reported in the July 1955 issue of the Digital Computer Newsletter. On 1 July 1956, the responsibility for operation and maintenance of the NAREC was transferred from the Operational Research Branch of the Laboratory to the Applied Mathematics Branch, the former having completed all the contemplated development work which included:

1. Installation of an 8192-word drum storage system.

2. Addition of two new branching orders based upon a comparison between the main arithmetic registers, and two new transfer orders for transferring blocks of 16 K words ($0 < K \leq 255$) within the storage.

3. Installation of a new operating console.

The "Programming Manual for the NAREC" has been revised and published as NRL Report 4652, dated 17 November 1955.

Since 1 July 1956, the monthly operating efficiency has varied from 60 to 90%, based on usable computing time as the percentage of the total available computing time. The efficiency has been improving steadily as the new staff acquires operating experience and as the quality of replaced components (tubes, diodes, resistors) improve.

Long term plans include:

1. Acquisition of a core memory of at least 4096 words.
2. Additional orders for extraction and programmed output-format control.
3. Acquisition of magnetic-tape auxiliary storage.
4. Acquisition of a high-speed printer.

ORACLE - OAK RIDGE NATIONAL LABORATORY - OAK RIDGE, TENNESSEE

The New ORACLE Input-Output System. A new input-output system has been installed which is superior to the old system in versatility, reliability, and speed. This has been accomplished by replacing some of the old equipment, adding some new devices, and adding circuitry which permits the ORACLE to accept alphanumeric characters and which also allows more complete checking.

The console has been completely redesigned. Additional indicator lights have been added and all lights regrouped to facilitate visual monitoring of the ORACLE. The numerous toggle switches used in the old console to insert instructions and data manually (on a binary bit-by-bit basis) have been replaced with a compact keyboard. The keyboard, consisting of a control key panel and an information key panel, reduces by a factor of four the number of operator manipulations required to perform a specific operation. A console typewriter acts as keyboard monitor by printing a character or symbol which is associated with each key each time that key is depressed. When used in this function the console typewriter produces a record of all information and instructions inserted into the ORACLE by the operator.

While automatic input is still performed by a 200 character per second Ferranti photoelectric reader, new output equipment has been added. The old 20 character per second paper tape punch has been replaced with a 60 character per second unit, and high-speed output is now possible by means of a magnetic tape recorder which operates at a speed of approximately 900 characters per second. In addition, the console typewriter can be used as an output device for small quantities of data.

The curve-plotter is the same as in the previous system with the exception of a few minor alterations. A cathode-ray tube designed for this specific function replaces the old, smaller tube, and a camera with greater film capacity is now used. Curve-plotter monitoring is accomplished by paralleling the display tube with a Hughes Memotron which has been installed in the console.

New off-line equipment has been added to complement the new input-output system. Paper-tape preparation units operating in either the hex-decimal or alphanumeric mode provide facilities for preparing, verifying, and reproducing tapes for ORACLE input. Output from the ORACLE can be printed on typewriters from either the paper tape or magnetic tape media.

The ORACLE Magnetic Tape Auxiliary Memory. The reliability of the ORACLE two inch, 42 channel, Magnetic Tape Auxiliary Memory has been improved by some recent electronic changes. "Drop-outs" have been virtually eliminated by the incorporation of a redundant recording scheme. Although this necessitated a reduction in word rate from 8.4 kc/s to 4.2 kc/s, the reduced error rate obtained was considered more important than the higher speed.

After incorporation of the above system, the remaining errors encountered were almost exclusively "pick-ups." These "pick-ups" have been dramatically reduced by substituting transistorized front-ends in the play-back amplifiers. Although only 12 of the 42 amplifiers have thus far been altered in this manner, the results show great promise.

Below is a breakdown of the error rate before and after the above modifications. The figures shown represent the number of 42 digit words read per error for each of the four drives.

	6 month average before modifications	2 month average since modifications
Drive # 0	4.3×10^6	12.2×10^6
Drive # 1	4.5×10^6	13.0×10^6
Drive # 2	11.6×10^6	13.7×10^6
Drive # 3	4.6×10^6	32.5×10^6

Accurate error data records were not kept before the above eight month period. The average number of words read per month per drive was approximately 50×10^6.

Other improvements to the Magnetic Tape Auxiliary Memory are:

1. Plug-in add-subtract counters for the continuous monitoring of tape position by "blocks" of 128 words.

2. Addition of automatic rewind facility by means of internal machine orders.

3. Optional interlock to prevent accidental recording on valuable tapes.

TRICE AND MULTIVERTER - PACKARD-BELL COMPUTER CORPORATION - LOS ANGELES, CALIF.

The TRICE is an incremental computer that in many areas is the first digital device fast enough to operate in real time. It performs 100,000 iterations per second and, as opposed to most other digital computers, this rate does not change with the complexity of the problem that is to be solved. The iteration rate is constant because the TRICE is constructed like an analog computer: it consists of an expandable number of computing elements operating in parallel. Each element is transistorized and, during periods of actual computation, is independent of the remainder of the computer except for clocking information. The first application of the TRICE is in conjunction with a d.c. analog computer to perform essentially non-linear operations. It is contemplated that the TRICE will also be employed independently as a real time digital simulator, and that elements of the computer will be used as portions of other computing systems to perform real time open loop integrations, to provide high accuracy control, and to supply other operations that require speeds beyond the capabilities of presently available digital equipment and accuracies beyond the capabilities of analog equipment.

The MULTIVERTER is a completely transistorized conversion system that operates at accuracies of better than .01% and speeds in excess of 15,000 whole number voltage-to-digital and 300,000 digital-to-voltage conversions per second. In addition to performing conversions, the MULTIVERTER can generate products or quotients, depending upon the direction of conversion: when used to convert a number n to a voltage, the product nx may be formed by supplying the variable voltage, x; when used to convert a voltage a to digital form, the quotient a/v may be generated by supplying a second voltage v. Other expressions can be formed by appropriately interconnecting the component parts of the MULTIVERTER system.

The MULTIVERTER can also be supplied as an incremental converter with a counting rate in excess of 300,000 per second. A switch permits the interchange of speed and accuracy by shifting the "units" position in the counter. This interchange, furthermore, may be made a function of the rate of change of the incoming voltage so that the relationship between accuracy and speed is automatically optimized.

FLAC I AND II - RCA SERVICE COMPANY, INC. - PATRICK AIR FORCE BASE, FLORIDA

FLAC I operating record, 20 July 1957 through 20 August 1957.

Category	No. of Hours	Percent of Manned Hrs.
Data Processing	246.4	45.36
Code Checking	115.9	21.31
Analysis	2.7	.49
Routine Library Maintenance	7.7	1.46
External Power Failures	10.9	2.04
Scheduled Maintenance Incl. Scheduled Engineering	103.4	19.01
Unscheduled Maintenance	56.2	10.33
Idle Time	0.0	0.0
Total	543.2	100.00%
Unscheduled Computer Time	200.1	
Total Available Hours For Period	743.3	

FLAC I is currently in operation 24 hours each day, 5 days each week for data processing and related work. Engineering time is scheduled periodically or on weekends to accomplish logical modifications and make preparations for improvements in input-output now programmed.

The major components of FLAC II have now been delivered and are currently being installed. Engineering evaluation of the basic system is scheduled to be initiated in October 1957.

NAVAL ORDNANCE COMPUTATION CENTER - U. S. NAVAL PROVING GROUND - DAHLGREN, VIRGINIA

Operating 120 hours per week during the first half of 1957, the Naval Ordnance Research Calculator (NORC), was available 89% of the scheduled time, or 74% of total working hours. These figures compare with 86% and 71%, respectively, for 1956.

Further design work on the Universal Data Transcriber (UDT) has indicated that this flexible, stored program device will be capable of transcribing from punched cards at rates exceeding 500 cards per minute. With suitable input-output mechanisms, it will be able to transcribe between almost any two media of digital data representation.

FIRE CONTROL COMPUTER - NAVY BUREAU OF ORDNANCE (ReU4b) - WASHINGTON, D.C.

Librascope, Incorporated of Glendale, California, is at present in the final stages of design of a Fire Control Computer. This computer is to be part of a Bureau of Ordnance anti-submarine weapons system.

The computer is a magnetic drum transistorized digital computer. It contains approximately 5,000 Silicon Transistors and 25,000 Silicon Diodes. Modular construction has been used wherever practical within the computer. The transistorized circuits are packaged using etched circuit techniques on 4 x 11-inch Epon glass boards. These boards were designed for ease of manufacture and maintenance. The computer contains approximately 450 printed circuit boards.

The transistorized circuits have been designed to operate over a temperature range of -20° C to +100° C.

The digital computer is in reality three separate computers. Two of the machines are Incremental Digital Computers and one is a General Purpose Computer. These two types of computers were included in the system because of the suitability of each type to handle certain aspects of the problem to be solved. These three computers have the ability to communicate with each other. The General Purpose Computer acts as the main control for the system.

The computer memory is a magnetic drum. This drum revolves at 6000 rpm. Each full track on the drum contains 128 eighteen binary bit words. The drum has a capacity of approximately 8,000 words. The memory drum stores information at a density of 98 bits per inch. The basic clock rate is 230 KC.

The Incremental Digital Computers (IDC's) are both identical. These computers are designed to solve algebraic equations by difference methods. They operate at a rate of 100 iterations per second. Each IDC can perform two operations per word time and 256 operations per iteration cycle. The IDC performs Integration, Retracable Sine-Cosine, Input-Output and Servo type operations.

The General Purpose Computer is a serial binary machine. It has a workable word length of 15 binary bits plus sign. Its command list includes Addition, Subtraction, Multiplication, Division, Square Root, Shift Left, Shift Right and several transfer type commands, both conditional and non-conditional. The computer can perform one operation per word time except for Multiplication and Shift Left which require two word times, Shift Right three word times, Division 18 word times and Square Root 16 word times. The need to wait to read the next command has been eliminated by reading the command while the preceding one is being performed. This places a heavy responsibility on the programmer in placing the commands on the drum, but as one program will suffice for all produced machines, the savings in electronics and running time will well offset this initial cost. The entire computing system is under control of the GPC. It has the ability to modify the problem being performed by changing initial conditions and scaling factors in the incremental computers which solve the ballistic equations.

The present model of the computer uses converter disks for all operational inputs and outputs. The two IDC's have 64 disks which they can share. Some can be used as inputs, some outputs and some for both. The GPC has 16 disks which act as inputs only. The GPC also has an Input-Output Register. This register is used in conjunction with a paper tape reader to initially fill the magnetic drum memory. The initial fill is a factory operation and requires approximately 30 minutes. Although the present system does not require it, the Input-Output register is flexible enough in design to be used with other input-output media, such as magnetic tape, telemetering equipment, and even another Fire Control Computer.

In addition to the Fire Control Computer, Librascope is developing a Digital Stabilization Computer, which performs gun mount and sonar stabilization. It uses the same transistorized electronic plug-in units used in the Fire Control Computer. Approximately 80 printed circuit cards are used. The Stabilization Computer is a separate computer and has its own housing, magnetic drum and power supplies.

OFFICE OF RESEARCH AND DEVELOPMENT - U.S. PATENT OFFICE - WASHINGTON, D.C.

HAYSTAQ. The Office of Research and Development of the U. S. Patent Office, working cooperatively with the Data Processing Systems Division of the National Bureau of Standards, is developing a comprehensive mechanized literature searching system. This system, known as HAYSTAQ, is being coded for SEAC. The documents being encoded for the experimental library to be searched are in the field of chemistry and include disclosures of compounds, compositions (mixtures of ingredients) and chemical processes. The system includes four main sections: a data preparation routine for the library, a data preparation routine for questions, the search routine and a checkout routine for evaluating apparent answers. The question preparation routine will generate control words, screening and housekeeping information, extractor constants, and variable connectors and will assemble the question data. The search

routine uses a 3 address code and employs the full 2048 word memor[illegible]he 8 high speed Ampex tape units now being added to the computer will be use[illegible] levels of organization of information must be dealt with and since many non-p[illegible]res are encountered, the encoded data is ordered in terms of ascending num[illegible]e codes at each of the levels. This will increase the searching speed by early [illegible]bject matter which does not contain the sought codes. Another device used ex[illegible]y for speeding up the search is screening. Screens are general or summary information about subject matter encoded in each block of information presented to the computer. Subroutines for searching empirical formulas and descriptions of compounds in terms of chemical properties are provided. Chemical structures are searched on an atom by atom basis by means of a topological search routine which permits searching in terms of structural fragments. Many logical relationships are provided, such as combinations, alternativeness, equivalence, negative teachings and the absence of specified information. Processes are searched for in terms of temporal relationships, starting materials and products produced, reactions, reaction conditions or any combination of these factors. At the present time only the searching portion of the HAYSTAQ system has been coded and debugged.

Mechanized Searching for Steroids. Effective August 23, the Patent Office established a new division known as Mechanized Examining Division A. Personnel in this group will examine applications for patents directed to steroid compounds. Searching of the patent literature will be performed on a multi-column punched card sorter rather than manually, as has been traditional in the Office since early in the 19th century. The system developed in the OR and D, uses one card per document, each card containing encoded information dealing with generic and specific aspects of all steroid compounds disclosed in the document. This constitutes the first time that mechanization is being used on a productive scale by the Patent Office in conducting its daily search operations and represents the first step in embodying a long range plan for mechanizing the searching operations of the entire Office.

ILAS. An experimental punched card sorting machine, designed by OR and D, and built by the Bureau of Census, represents a new mechanized searching tool. Designated as ILAS (Interrelated Logic Accumulating Scanner), the machine includes two units, a console and a multicolumn sorter. The console contains the power supply, most of the electronic circuitry, a large array of rotary switches and a small plug board. Codes are punched horizontally across the 80 positions of each row of the card and cards are scanned at the rate of 450 per minute.

The code patterns corresponding to a question are set up by indexing the required number of horizontal series of rotary switches on the console. A large number of logical relationships between codes may be indicated by the use of grouping signals (indicating, e.g. that several codes describe a single chemical compound) and interfixes (indicating cross relationships between codes in different groups) and those are each indicated by plug board wiring. Codes can be interrelated in as many as 12 different levels of organization. Relationships among the various logical code levels are reflected in the pyramidal logic of banks of IBM relays which are energized by 1D21 thyratrons. The multicolumn sorter scans the punched cards and performs a progressive sorting operation. Initially all cards go into the reject pocket. However, when the first answer to a question is found, cards are sorted into the next adjacent pocket, and as each successive answer is found, sorting to the next pocket occurs. The bottom card in each pocket thus represents an answer. The original order of the deck may be easily maintained by restacking the cards from each pocket in sequence. Matching of codes may be done in either of two modes: exact pattern matching (both 0 and 1 bits are compared) or on a set-subset basis (only 1 bits are compared). Experimental work is now in progress to develop suitable coding schemes (for both chemical and mechanical subject matter) which can take advantage of the flexible facilities of ILAS.

OFFICE OF CLIMATOLOGY - U. S. WEATHER BUREAU - WASHINGTON, D. C.

Prototype equipment has been built for the United States Weather Bureau's Office of Climatology, to prepare and utilize the microfilm of punched cards as a permanent, compact digital data storage and processing medium.

FOSDIC FILMER, built by the Census Bureau's Machine Development Lab, is a special camera which microfilms 420 punched cards per minute, placing 13,000 card images on a 100 ft. roll of 16 mm. film; this represents a data density of 860 characters per inch, and a space reduction from punched cards of 180:1. One of the several unique features of the camera is its anamorphic filming, reducing the long dimension of the punched card (across the film) by 24:1, and the short dimension (along the film) by 44:1. FOSDIC FILMER is now in active use at the National Weather Records Center, Asheville, N. C.

FOSDIC PC-1 (Film Optical Sensing Device for Input to Computers - Punched Card Model 1) was built by the Electronics Section, National Bureau of Standards, and reads the punched card microfilm via the flying spot of a CRT focused through the film onto a photocell.

FOSDIC PC-1 has been designed with two basic functions - data search, and full read out. In the data search mode, the flying spot is programmed to scan any preselected ten columns of information in the 80-column card image, and test for coincidence with criteria set up in an externally pluggable control panel. The search (or 10 column scan) is done with the film in motion, at the rate of 4300 card images per minute. When a "hit" is found (i.e., the search criteria are satisfied), the film is stopped, and the read out mode takes over; i.e., the card image is read out, row by row, to an attached IBM Type 523 Card Punch machine which operates at the rate of 100 cards per minute.

FOSDIC PC-1 is now undergoing extensive testing for reliability under hard use at the Bureau of Standards; when the tests are complete, the machine will be shipped to the National Weather Records Center at Asheville.

COMPUTING CENTERS

APPLIED MATHEMATICS LABORATORY - DAVID TAYLOR MODEL BASIN - WASHINGTON, D.C.

On 2 August 1957 AML - DTMB transmitted a total of twenty-nine Federal Public Works Projects Reports to the White House Staff. This constituted the successful completion, almost one full month ahead of schedule, of one of the most challenging management data analysis projects carried out within the Applied Mathematics Laboratory. The development of the program for this series of reports and their preparation, in record time, on a large scale calculator demonstrates most effectively the great potential inherent in the use of electronic calculators for automatic data processing in the management field. Especially gratifying was the successful application of "FRAMEWORK," developed at DTMB, to substantially reduce the programming effort.

SIMULATION AND COMPUTATION DIVISION - HOLLOMAN AIR DEVELOPMENT CENTER - NEW MEXICO

In April 1957, the Digital Computer Branch at Holloman Air Force Base received a Remington Rand Univac Scientific 1103-A. The system includes six Uniservos and punched card equipment. Most of the work to date has been in developing a procedure to translate and assemble symbolic programs, writing and checking out a service library, and preparing a library of mathematical subroutines. Several scientific problems are now being run and others are in preparation. A second 1103-A computer is scheduled for delivery in September 1957. These two computers will be combined in a Real-Time Missile Performance Analysis System for use in testing of guided missiles.

The Branch also has two CRC 102-A digital computers, however the work that has previously been done on them is gradually being shifted to the 1103-A.

NAVY BUREAU OF SHIPS (CODE 280) - WASHINGTON, D. C.

Ship Profile Design. Dr. Feodor Theilheimer, head of the Theory Division, Applied Mathematics Laboratory at the David Taylor Model Basin, is developing a method for mathematically determining ship profiles when a preliminary design is given. Research to date indicates that such a technique is feasible.

Nuclear Reactor Computation. Production computing for the Nuclear Power Division of the Bureau of Ships, other than that performed at Contractors' Plants, is now being run on the NORC at Dahlgren. Recently completed by the Nuclear Reactors Branch, David Taylor Model Basin, under Dr. Elizabeth Cuthill, is a two-dimensional, two-group burnout code for the NORC which includes additional editing of results to assist engineers in the use of the computations. The Nuclear Reactors Branch is also in the process of planning a three-dimensional burnout code for the UNIVAC LARC, which is scheduled for delivery to the Applied Mathematics Laboratory in December 1958. Essentially no nuclear reactor computing is being done on the UNIVACs.

Statistical Regression Analysis. A UNIVAC code for performing a statistical regression analysis was recently completed where there is one dependent v riable and up to twenty independent variables. Thus the analysis finds the best relation, in the sense of least squares, of the form

$$y = a_0 + a_1 x_1 + a_2 x_2 + \ldots + a_j x_j \quad j \leq 20$$

and tests whether the a_i are significantly different from zero. Here y is the variable considered as depending in a linear fashion on the other variables $x_1, \ldots, x_j$. The a_i are determined so that the resulting equation represents the best linear relation between the variables and "best" means that the sum of the squares of the differences between the observed y values and the ones resulting from the linear relation, is a minimum. The inverse matrix of the original set of normal equations is also available.

Electronic Failure Data Program. Since November 1956 a "Report by Exception" has been produced in connection with the Bureau's Electronic Failure Data program. Some 40,000 reports of failures, essentially of tubes, resistors, and capacitors, are received each month and are listed by the UNIVAC in various orders. One of these listings provides the data for a test of the hypothesis, for example, that the rate of failure in a particular socket per set per month is excessive, on a .05 level of significance. In this way the original listing comprising three large binders, each about three inches thick, is reduced to a list of "excessive" failures approximately 3/4 of an inch thick. Engineering attention is thereby directed to the major sources of poor performance of electronic equipment.

Computers. The Bureau of Ships' program for digital computers in its shipyards and laboratories is progressing smoothly. Portsmouth and Puget Sound Naval Shipyards have been operating IBM 650 card computers for over a year. Approval has been granted for delivery of an IBM 650 tape RAMAC to Norfolk and an IBM 650 card computer to New York by the end of 1957, and a UNIVAC II to Philadelphia in early 1958. Still subject to approval but planned for early 1958 are an IBM 705 for Mare Island, a Datatron for Boston, and an IBM 305 RAMAC for Charleston Naval Shipyard. As for the laboratories, a Datatron was delivered to the Mine Defense Laboratory in August; present plans call for the installation of an intermediate computer at the Naval Electronics Laboratory in September 1957, and at Naval Radiological Defense and Underwater Sound Laboratories in late 1957 or early 1958.

AEC COMPUTING AND APPLIED MATHEMATICS CENTER - NEW YORK UNIVERSITY - NEW YORK, N. Y.

IBM 704. The 704 system has been in operation since early July and includes 8192 words of core memory, 4 logical drums of 2048 words each, 9 tape units, an on-line card punch, card-reader and printer, and an off-line printer and card-to-tape unit. The standard SHARE assembly program (SAP) and the FORTRAN automatic coding system are in use.

Machine time and assistance is offered to U. S. Government Agencies and their Contractors as well as AEC users at cost. Large requests for time, up to or exceeding one shift can be accommodated. Requests for time and information concerning rates, etc. should be made to the AEC New York Operations Office, 70 Columbus Avenue, New York 23, N.Y., c/o Mr. S. Zirin, (Telephone PLaza 7-3600). Technical questions should be addressed to Mr. Max Goldstein, AEC Computing and Applied Mathematics Center, 4 Washington Place, New York 3, New York.

UNIVAC I SYSTEM. Several additions and modifications have been made to the circuitry of our Univac Central Computer. The more important of these are:

The Control Counter, a one word register, has been modified to store, in its previously unused left hand half, the memory location of the most recently executed instruction pair containing an instruction for transfer of control (but only if transfer takes place). As the right hand half of the Control Counter sequences, the left hand half remains unchanged until another instruction for transfer of control is executed. This modification will aid in debugging a "loop."

Three instructions have been added to the Univac Instruction Code: an N-digit "greater-than" selection instruction ψ (see Digital Computer Newsletter July 1957), an N-digit "identity" selection instruction, $\bigcirc$, and an N-digit "less than" selection instruction, $\odot$. These instructions will select, from memory location xy0 (modulo 10) through and including Z99 (Z = any number 0 through 9) the "largest," "identical," or "smallest" word larger, identical to, or smaller than a reference word placed in the L register. The "largest," "identical," or "smallest" word is chosen by comparison of only those N digits which are specified by a monitor word in the F register, the rule for specification being the same as in the extract order. Selection means that upon conclusion of the instruction, the selected word replaces the reference word initially placed in the L register while its memory location is stored in the three least significant digit positions of the X register. The time required to execute these instructions will vary with the number of memory locations to be searched. For ten words, the time will vary between 640 and 1000 microseconds, depending upon latency time. Additional ten word groups require 480 microseconds per group. To search half the memory (five hundred words) requires about 25 milliseconds. For purposes of comparison, the Univac PMC circuitry requires 560 microseconds per ten word group. These new instructions will find use in rapid sorting routines, table look up, etc.

The basic four cycle operation of the Univac computer has been reduced to three; i.e., β, γ, and δ time. α time has been deleted with a resultant savings in time of two minor cycles (80 microseconds) per instruction pair executed. There are five exceptions: overflow, empty, fill, PMC, and manual operations that clear to α time (i.e., Clear C and General Clear). Each of these will result in the inclusion of α time in the subsequent cycle of operation. With programs tested to date, the average savings in computing time is approximately 10 percent.

PRINCETON COMPUTER - PRINCETON UNIVERSITY - PRINCETON, N. J.

The transfer of the Princeton University Digital Computer, (formerly Electronic Computer Project, Institute for Advanced Study) to Princeton University, as outlined in the last issue of this Newsletter, has become effective as of July 1, 1957. The staff totals 12 employees, viz. 6 for maintenance of the machine, 5 for numerical analysis and coding, and one secretary. All problem coding must be done by the users, while the staff will supply general purpose routines.

Engineering in July, August, and September, has concentrated on replacing the forty 5" cathode ray tubes by 3" tubes (RCA 6571) and improving our magnetic drum amplifiers which were marginal and hence unreliable.

COMPUTATION CENTER - STANFORD RESEARCH INSTITUTE - MENLO PARK, CALIF.

A second computer system has been installed and is now in operation. These two systems, used jointly by Stanford and SRI, comprise an IBM 650 operated by the University's applied mathematics and statistics laboratory and a Datatron operated by the Institute's mathematics

group. Both computer systems are used for non-sponsored research as well as for specific projects sponsored by government and industry. They are also used in the educational program of the University.

Prof. J. G. Herriot directs the activities of the Stanford University Computation Center and Dr. C. L. Perry directs the activities of the Stanford Research Institute Computation Center.

ALWAC 800 - U. S. ARMY BIOLOGICAL WARFARE LABORATORIES - FORT DETRICK, FREDERICK, MARYLAND

Delivery on 1 February 1958 of an ALWAC 800 Computer (See Digital Computer Newsletter July 1957) is expected at the Army's Chemical Corps Biological Warfare Laboratories, Fort Detrick, Maryland. The System will employ Remington Rand 90-column input and output to be compatible with the government owned equipment currently being used to calculate analysis of variance, quality control, bioassay using probits or logits, multivariate analysis, and other statistical calculations arising in a research and development program. The machine will also be used to supplement the data handling resources of other elements of the post.

The machine was chosen by comparison with performance specifications developed from the specific application at Fort Detrick, which has employed machine methods in statistical calculations since 1950. The services of the Data Processing Systems Division and Applied Mathematics Division of the National Bureau of Standards were utilized under a collaborative program for the study, evaluation, and acquisition of a suitable computer.

RAYDAC - U. S. NAVAL AIR MISSILE TEST CENTER - POINT MUGU, CALIF.

In conjunction with the check-out of the new input system for RAYDAC, programming of service routines for direct entry of programs and data has been initiated. For example, a new reassembly program with input IBM cards in symbolic form is being prepared. The output of the reassembler will be a deck of packed binary cards as well as a deck of compressed symbolic cards. The compressed symbolic deck will be used to make additions and to correct the program by reassembly. In addition, a listing of the symbolic instructions versus octal instructions will be made on the directly connected IBM 407 printer.

COMPUTERS, OVERSEAS

EMIDEC 2400 AND 1000 - E.M.I. ELECTRONICS LTD. - HAYS, MIDDLESEX, ENGLAND

EMIDEC 2400.

E.M.I. Electronics Limited., sponsored by the National Research and Development Corporation, is developing a transistor data processing system. Assembly of the machinery will be taking place shortly and it is expected that the first units will be operating early in 1958.

A number of standard processing units will be available; the set used in a given machine will be determined by an analysis of the customers requirements.

Components Used. Transistor diode logic with germanium junction transistors and point contact or gold bonded diodes form the main circuit elements. The components are assembled on "plug in" printed circuit panels. Three forms of storage are used: magnetic tape, ferrite core storage, and diode capacity storage.

Low cost bulk storage is obtained on 4-inch wide magnetic tape; these tape units are of a simple design without fast stop-start facilities.

One-inch fast stop-start tape is used as the input and output medium of the various processing units of the machine. The system is essentially batch processing, the one inch tape being used as intermediate storage.

Ferrite cores form working storage in each unit and diode capacity elements the rapid access storage in the computing unit.

Tape Unit Characteristics.

Tape length	2400 feet.
Transport speed	200 inches per second.
Read write frequency	20 Kc/sec.
Packing density	100 bits per inch longitudinally, 25 bits per inch laterally.

Four Inch Tape

9 tracks per channel - 6 data, 1 parity, 2 timing tracks.
10 channels across the tape.
30,000,000 alphanumeric characters per reel.
Tape reversal time - 3 to 5 seconds.

One Inch Tape

12 tracks per channel - 6 data, 1 parity, 2 timing tracks.
3 extra to give single bit error correction.

2 channels per tape.
6,000,000 alphanumeric characters per reel.
Less than 5 milliseconds stop or start time.

Data Format. Both alphanumeric and pure binary data are used in the machine. The fundamental word is either six alphanumeric characters or a 36 bit binary number. Alphanumeric data is variable word length allowing any number of six character units up to 15.

Machine Units. Four independently controlled processing units will be available. These are an input unit, printing unit, search unit or file control unit, and the computing unit. The latter is a program controlled device while the others are specialized fixed purpose units. The equipment is integrated in an electromechanical telephone-exchange arrangement which can either be controlled from a manual control desk or by program from the computing unit. Manual interchange of one-inch tape reels is not usually required.

Input Unit

Function	To check and record on magnetic tape, data entered from a large number of input devices.
Input Devices	Direct keyboard, paper tape, punched cards or land line.
Capacity	Up to 112 keyboards or at least that equivalent from other devices.
Checking	Incoming code numbers are checked as entered and errors indicated to the input operator.
Storage	A core store buffer of 4096 x 14 bits is used.

Search Unit

Function	Selects records or sections of records from a four-inch tape file. The unit can be electrically switched to one of a number of such files.

Input	A one-inch tape gives an ordered list of record numbers and parts of records to be selected.
Output	A second one-inch tape takes the selected data and any notifications of "errors" occurring during the selection procedure.
Buffer	A core store of 512 x 14 bits is used.

Printing Unit

Input	This is supplied, usually by the computing unit, on one-inch tape. A certain amount of control data will be included to help in arranging the information for printing.
Printer	A Xerographic printer is being developed. The capacity of one printer should be sufficient for most applications.
Buffer	A core store buffer is used for editing the data and supplying it to the printer.

Computing Unit

Input and Output	Usually one-inch magnetic tape, up to four channels in parallel. Twelve character diode capacity storage is used as buffer with each input/output channel.
Storage	(1) Core store 4096 x 37 bits. Read/rewrite - 15 microseconds. Use: data and instruction storage. (2) Diode capacity store 64 x 37 bits. Read/rewrite 3 microseconds. Use: Modifying numbers. Input/output control data. Arithmetic operating store.
Arithmetic	Thirty-six bit parallel asynchronous adder. Average addition time about 0.6 microsecond. Adding frequency 1 Mc/s.
Instructions	Function 6 bits Modifier address 6 bits Core store address 12 bits (includes diode capacity store) Diode capacity store address 6 bits Spare 6 bits Setting up time about 15 microseconds.
Speed	A two phase one megacycle clock is being used to time synchronous operations. With the flip-flop circuit used counting rates up to two megacycles are possible. Short instruction (e.g. addition) 20 microseconds Multiply and divide 50 to 60 microseconds

Both input and output of data from magnetic tape proceeds in parallel to computation. Optional buffer storage is available allowing input or output of up to four magnetic tapes in parallel with computing.

On Line Machine - EMIDEC 1000. In a full data processing system the computing unit will be used off line as indicated above. For an installation which does not require the capacity obtained with any of the various off line units the computing unit will work on line to perform these processes. Such an on line machine will be known as the EMIDEC 1000 series.

COMPONENTS

OSCARETTE - BENSON-LEHNER CORPORATION - LOS ANGELES, CALIF.

The OSCARette is the latest addition to the Benson-Lehner Corporation spectrum of semi-automatic record analyzers and readers. This new machine is at one end of an ascending scale of data readers whose other units include the OSCAR Models E, J, and N.

In data reduction situations where a limited number of points are to be read over a long trace record, the reader is suitable because of its speed, simplicity, and low price. Similarly, where much computing is to be done, the unit is applicable as it reads out on a fixed numeric scale.

The flexible design permits its use with the Benson-Lehner Viewpak (oscillograph editor and reader) and also with a translucent screen and projector for film record analysis. This single-axis amplitude-measuring machine, with its motor-assisted cursor drive, has a 9999 count full "Y" scale and a 15" by 15" viewing area. The zero or origin can be set anywhere on the record. The output is to either an IBM Summary Punch or to a Benson-Lehner Electrotyper.

NCR MAGNETIC CORES - THE NATIONAL CASH REGISTER CO. - DAYTON, OHIO

A new type of magnetic core for transistorized electronic computers has been developed by research physicists at The National Cash Register Company. The N400-080 ferrite core offers improved stability over a wide range of temperatures, currents and other disturbing influences.

For example, in maintaining a ratio of 3 to 1 or better between a read 1 and a read 0, the drive current used with one of the new cores can vary plus or minus 7-1/2% in the 300 to 400 milliampere range, over a temperature range of 50 to 100 degrees Fahrenheit. In the 100 percent testing procedure applied to the new cores, more than 600 half pulses are applied in checking the above-mentioned 3 to 1 ratio.

The new core is the result of three years' research by NCR and was developed for their forthcoming 304 electronic business data processing system. The 304 system uses transistors throughout instead of vacuum tubes.

In addition to using the new cores in its own electronic computers and similar circuits, NCR will make them available to other manufacturers. Marketing will be handled through the company's Special Products Department.

STORAGE DRUM - REMINGTON RAND DIVISION OF SPERRY RAND - NEW YORK, N. Y.

A new magnetic information storage drum capable of storing 1,350,000 binary digits (based on return-to-zero recording) has been announced by the St. Paul laboratory of Remington Rand Univac Division of Sperry Rand Corporation. The drum, Model 1123, is an integral part of the Univac File Computer and the Univac Scientific Computer.

The drum features large storage capacity and intermediate access time at nominal cost (about one cent per bit). It has an integral 1740 rpm drive motor and provision for up to 320 information tracks. A larger version, storing 1,740,000 bits, and 410 tracks is available. A new style read-write head employed in the drum lends itself to transistorized circuitry.

MISCELLANEOUS

DIGITRONICS CORP. - ALBERTSON, NEW YORK

Digitronics Corporation is now installed in its new home, located in Albertson, Long Island, New York. Occupying 18,000 square feet of air-conditioned buildings, the new organization consists of approximately 100 people, including an engineering staff with digital computer experience.

The firm was organized when Underwood Corporation closed its former Elecom Division. President of Digitronics is Albert A. Auerbach, former Elecom Chief Engineer. Robert Shaw and Eugene Leonard are vice presidents, and Norman Grieser is secretary-treasurer.

Digitronics manufactures lumped parameter delay lines, a line of mechanical clutches, brakes and amplifiers, and magnetic tape units and high speed paper tape readers. The organization designs and builds special purpose computer equipment and systems, including tape to tape converters, high speed line printer systems, special purpose computers, and other peripheral and input-output equipment.

10 SPEED TAPE TRANSPORT - ELECTRODATA DIVISION OF BURROUGHS CORP. - PASADENA, CALIF.

A 10-speed magnetic tape transport for electronic data processing systems has been announced by the ElectroData Division of Burroughs Corporation.

A speed ratio of 60:1 is available with this ElectroData Model 546-53368 Digital Magnetic Tape Transport. The unit selects any one of the 10 closely regulated tape speeds by remote or local control. The speeds, in inches per second, are 1.5, 2.25, 3, 4.5, 9, 15, 22.5, 30, 45, and 90.

Three-quarter inch tape is used, wound on two 10-1/2-inch reels. Start-stop time is 6 milliseconds. The oxide surface of the tape touches only three stationary members, one of which is the magnetic head. During the rewind operation, the tape is automatically removed from the head.

The tape drive system consists of a single pinch-roller assembly, controlled by a high-speed moving coil actuator. Two five-speed motors are used to drive the capstan. The pinch roller is moved 6 to 8 thousandths of an inch to press the tape against the capstan for any of the speeds.

The vacuum controlled tape reeling system is operationally independent of the tape drive system. Each reel is driven by a separate motor through a reduction gear. Vacuum sensing switches are associated with each motor, varying the speed of the motors to prevent the accumulation of tape in either of the columns adjacent to the read/write head.

Exact end-of-tape sensing is accomplished by passing the tape over two vacuum manifolds, which detect the arrival of perforated leaders and trailers on the tape.

To provide dust-free operation, the transport is mounted in a vertical frame equipped with a glass door, which covers the reel-tape mechanism. Power supply, control circuitry, and both forward and reverse high-speed rewinding units are contained in the unit.

UNIVAC USERS CONFERENCE ORGANIZATION

Since late in 1954, several industrial users of Univac I have been meeting informally to discuss a variety of problems dealing with operational procedures, maintenance, programming, business systems and computer applications, equipment modifications and evaluation of new equipments, administration of computer activity, etc.

The informal group grew to include a large number of business installations and one government installation, and to concern itself with the Univac II also. During this time, it maintained its independence of the manufacturer.

Finally, in sessions in Cleveland on May 2 and 3, it was decided to establish a formal organization, Univac Users Conference, and to extend privileges of membership more widely. Any establishment which has contracted for, and is actively programming for the installation of a Univac I or II is eligible. Communications concerning membership should be addressed to Mr. R. M. Petersen, General Electric Company, Appliance Park, Louisville, Kentucky.

At the Cleveland meeting, the following officers of the Univac Users Conference were elected:

Dr. H. N. Laden	The Chesapeake and Ohio Railway Company	President
Mr. L. P. Chvany	John Hancock Mutual Life Insurance Company	Vice President
Mr. R. M. Petersen	General Electric Company	Secretary

The Executive Board consists of

Mr. L. W. Calkins	United States Steel Corporation	Pittsburgh, Pa.
Mr. O. D. Seely	Metropolitan Life Insurance Co.	New York, N. Y.
Mr. T. H. New	Westinghouse Electric Corp.	East Pittsburgh, Pa.
Mr. K. A. Foster	Sylvania Electric Products, Inc.	Camillus, N. Y.

The next meeting of the Univac Users Conference was scheduled to be held at Franklin Life Insurance Company in Springfield, Illinois on September 19 and 20. Members of the Arrangements Committee were:

Mr. J. M. Cranwill (Chairman)	Franklin Life Insurance Company
Mr. K. T. Garrison	Pacific Mutual Insurance Company
Dr. H. N. Laden	The Chesapeake and Ohio Railway Company
Mr. R. L. VanWinkle	Franklin Life Insurance Company

The Univac Users Conference for some time included all the pioneer computer installations for large-scale, business data-processing. While former policy restricted other representation to the Applied Mathematics Laboratory, David Taylor Model Basin, applications for membership from several government, university and research installations are now awaiting action.

WESTERN RESERVE UNIVERSITY SEARCHING SELECTOR - WESTERN RESERVE UNIVERSITY - CLEVELAND, OHIO

The Center for Documentation and Communication Research Western Reserve University, has produced a 16 mm sound film on the WRU Searching Selector. The film is 15 minutes long and is in color. It was produced for the American Society for Metals, and is available for showings after November 15, 1957. The title is "The Metals Information Center of Tomorrow."

CONTRIBUTIONS FOR DIGITAL COMPUTER NEWSLETTER

The Office of Naval Research welcomes contributions to the NEWSLETTER. It is hoped to continuously improve the contents of this newsletter and to make it an even better medium of exchange of information, between government laboratories, academic institutions, and industry. It is hoped that the readers will participate to an even greater extent than in the past in

transmitting suggestions and technical material to this Office for inclusion in future issues. Because of limited time and personnel, it is often impossible for the editor to acknowledge individually all material which has been sent to this Office for publication.

The NEWSLETTER is published four times a year on the first of January, April, July, and October and material should be in the hands of the editor at least one month before the publication date in order to be included in that issue.

The NEWSLETTER is circulated to all interested military and government agencies, and the contractors of the Federal Government. In addition, it is being reprinted in the Journal of the Association for Computing Machinery.

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