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

Vol. 8, No. 1 Editor: Albrecht J. Neumann January 1956

TABLE OF CONTENTS

* * * * * * * * * *

Approved by
The Under Secretary of the Navy
16 August 1954

COMPUTERS, U.S.A.

ABERDEEN PROVING GROUND COMPUTERS

The following statistics show the machine hours for the three high-speed computers for the "average" week for the period 0800, 12 August 1955 to 0800, 11 November 1955:

	ORDVAC	EDVAC	ENIAC*
A. Engineering Time			
1. Systems Improvements	0.00	2.41	0.22
2. Engineering Servicing	39.35	34.51	49.04
TOTAL Engineering	39.35	36.92	49.26
B. Chargeable Time			
1. Code Checking	31.56	19.36	0.38
2. Production	33.58	56.14	2.32
TOTAL Chargeable	65.14	75.50	2.70
C. Non-Chargeable Time Due To			
1. Machine Causes	10.18	3.75	0.61
2. Non-Machine Causes	25.80	24.26	0.43
TOTAL Non-Chargeable	35.98	28.01	1.04
D. Idle Time	25.97	27.65	82.13
E. Standby Time	1.64	0.00	33.00
TOTAL	168.08**	168.08**	168.13**

*ENIAC figures are given for an eight week average.
**The averages are greater than 168 hours per week because of the one hour added when the change was made back to Standard Time.

ARGONNE NATIONAL LABORATORY (GEORGE)

A new general purpose digital computer is under construction at Argonne National Laboratory and will be ready for testing near the end of 1955. It is a parallel type machine of 40-bit word length. In order to avoid the use of a contrived name, it is called simply "GEORGE," with the hope that it will be as capable and efficient as the proverbial "George."

The internal magnetic core memory which is being manufactured by the International Telemeter Corporation has 4,096 word capacity. The digit planes are arranged in a 32 x 128 rectangular matrix. Direct drive is applied to the "X" lines (32 lines) while the "Y" lines (128 lines) are driven by magnetic switches. "X" and "Y" currents are not initiated simultaneously. The X current is allowed to build up and stabilize before the Y current is applied. This increases the memory cycle time but results in a high signal to noise ratio and a low probability of random errors. The three-beat memory cycle requires 15 microseconds; however, the access time is only 7 microseconds. The remainder of the cycle is used to restore the interrogated cores.

An auxiliary memory also will be available, consisting of four magnetic tape units, expandable to eight units. The flow of information between the auxiliary memory and the computer is in a parallel mode. Each unit is capable of storing about one million words in blocks of fixed length of 128 words. Each block contains an identification number and a redundancy check. Reading and recording is not limited to integrals of block capacity.

Any number of words may be read or recorded per command. Hunting forward or backward is accomplished by counting blocks. Computation can be done while hunting takes place. Two inch wide plastic based tape is used. Its speed is 50 inches per second with a packing density of 100 words per inch. Tape reaches full speed in 5 ms and stops in about 3 ms.

Perhaps one of GEORGE's most interesting features is the structure of a command. A command is a 40-bit word composed of two parts. The first part is the order and address "A;" this corresponds to the command of a single address code machine. The second part is the tag and address "B," which is used to supplement the order. The tag is composed of two hexadecimal characters. The first character deals with the initial state of the accumulator, e.g., clear one of the accumulators to a constant, etc. The second character deals with the manner in which address B is used. These can be described as follows:

(1) Unconditionally transfer control to address B.

(2) Address B is the address of the B number or index number (this name is used by IBM). Since there are twelve bits in address B, the B box registers can be any of the internal memory. The effective address of the order is the sum of address A and B number.

(3) Add the entire content of address B to one of the accumulators after it has been properly cleared prior to the order execution.

(4) Send the result of the computation to address B or to address A. This results in a three address order where one address is used twice.

Input-output equipment will consist of paper tape with photoelectric readers, and a 60-character per second punch; also, an eight-channel narrow magnetic tape and a cathode ray tube graph plotter. Information is read into the machine from the paper tape in blocks of hexadecimal words or strings of alpha-numeric characters. A parity check is provided on the paper and magnetic tape input and output.

The console will display the state of all significant units of the machine, and also will permit manual insertion of information. Breakpoint stop and address recognition stops are provided. All manual operations will be automatically recorded by the console typewriter.

The expected performance of GEORGE is: add time of 6 microseconds, shift time 3 microseconds, and average multiplication time 180 microseconds or 90 microseconds when half precision multiplication is used. The average divide time is 240 microseconds.

The two shifting registers in GEORGE are arranged so that either may be used as an accumulator. Overflow may be detected in either of the registers. However, for division and multiplication, the register functions are not interchangeable. A logical adder is provided with a 3 microsecond carry time. This short carry time is achieved by forcing the adder in the slowest direction in parallel before addition takes place. Asymmetrical toggles are used in the shifting registers. Extensive use is made of crystal diode gating. Both DC and AC coupling are used. The method used depends on the application. Approximately 2900 tubes and 2800 semi-conductor diodes are used in the machine.

CHARACTERISTICS OF GEORGE

General:

Parallel Operation
Binary arithmetic, 2 symmetrical accumulators

Character Code:

50 binary-coded numeric digits, letters and special characters

Word Size:

40 bits

Instructions

Double address code: 2 hexadecimal digits for the order,
2 for the tag, 3 for each of the addresses
16 classes of operations

Arithmetic speed (Not including memory access)

Addition: 6 μ.s.
Multiplication: 180 μ.s. or 90 μ.s. (Half precision)
Division: 240 μ.s. or 120 μ.s. (Half precision)

Internal Memory

4096 words, individually addressed 7 μ.s. Random access time

Auxiliary Memory

8 magnetic tape units
Maximum capacity per unit = 10^6 words
Hunt forward or backward by counting blocks, 128 words per block
Reading and recording forward only by counting words
Identification mark per block provided
5 m.s. Random access time
Reading, recording or hunting speed = 5 minutes for 10^6 words
Computation can continue while hunt

Input and Output

7 Channel magnetic tape
7 Channel or 5 Channel teletype tape
Keyboard
CRT display or photograph
IBM typewriter with format

Computer Size: 2900 tubes, 2800 crystals

ARMY SIGNAL CORPS SUPPLY SYSTEM IMPROVED BY ELECTRONIC PROCESSING

As the first step in this direction, punch card data will be transmitted by electronic means between the supply depots of the Signal Corps. These cards, which can be processed by machine, have eliminated many clerical and administrative chores formerly encountered in extracting information from typewritten forms.

Sample tests made with electronic punch card communications between Tobyhanna, Pennsylvania, and Orleans, France, indicated a savings of up to 25 days in administrative handling and transmission times.

Advent of electronic computations for supply logistics of signal equipment and items became apparent when the Signal Corps installed a communication network to transmit punch card data to all Signal supply depots.

Punch card data will be sent electronically either by radio or land line and this network will interconnect the Signal Corps Supply Agency at Philadelphia with the depots at Tobyhanna, Pennsylvania; Decatur, Illinois; Lexington, Kentucky; and Sacramento, California, on a minute-to-minute logistic basis.

Communications in the United States will be established over leased long distance telephone lines which will permit conversation when the machines are not sending punch card data, while the connection with Europe will be by radio.

Cards which have been punched by electronic transmission over radio or land line between any of the connecting points may be used in standard punch card machines. Within a few hours after receipt of the punch card data, the shipping order is prepared and material is made ready for shipment, reducing the order and shipping times accordingly.

After the network is in full operation, the Signal Corps is planning tests with electronic computers which go even farther in processing data. As envisaged, electronic means would provide for immediate location of any part or equipment required as it is needed, and record proper balance figures for total available supply as each and every item changes position in the supply line.

The master electronic machine for processing this type of data will operate in the Signal Corps Supply Agency at Philadelphia where complete stock positions will be computed.

ALWAC III (LOGISTICS RESEARCH INC)

The ALWAC III series of medium-speed computers in the new model III-E, has automatic modification of addresses within instructions and the facility of picking up two instructions at once from the drum. The E register is used as a base number for address modification and for the automatic tally of repetitive sequences of operations.

The ALWAC III-E's ability to pick up a full word (two single-address instructions) in one drum revolution affords on some programs as much as 50% increase in speed. Basic operation time with optimum address for the addition of two nine-digit numbers is one millisecond. The ALWAC III-E is available with 4,096 words or 8,192 words of drum storage, in either case with 128 words of fast-access storage.

A magnetic tape buffer links the tape transport unit to the computer. Each tape unit, 16 of which may be used with one buffer, has a capacity of 320,000 words. Reading, writing, and searching speed is 100 inches per second with a bit density of 100 per inch. Information is read in or out of the buffer at 10,000 characters per second in 32-word blocks. All tape units may search simultaneously, and computation goes on while searching is in progress. Except when actual transfer of tape information is taking place, the 32 words in the tape buffer are available to the computing registers as an additional channel of fast-access storage.

Two ALWACs are available for contract computing service at the Logistics Research center in Redondo Beach, California. The Applications Division offers problem analysis, programming, coding, and machine operation on either a fixed-fee or time-charge basis. Problem routines and data may be accepted at this center on 5-hole common language tape, as was recently demonstrated on a transcontinental basis by means of a teletype hookup.

Five ALWAC III's are installed and in use for mass spectrometer computation, statistical calculations, engineering design calculation, thermodynamic studies, and data reduction. Two more will be shipped in the immediate future and production will be increased shortly after 1 January 1956.

BUREAU OF SHIPS, (APPLIED MATHEMATICS LABORATORY)

Since the end of November 1954, when two additional shifts per week were added to the routine work schedule, the Applied Mathematics Laboratory at the David Taylor Model Basin has operated 16 shifts per week, of which two are regularly assigned for preventive maintenance. Machine efficiency during the first ten months of 1955 averaged 87.36%.

In May 1955 a Benson-Lehner Electroplotter, Model G, was installed in the laboratory and put in operation.

Since the beginning of 1955 a total of 102 problems have been solved in the Applied Mathematics Laboratory. Of this number, 75 problems were either repetitions of, or variations of, problems previously coded and run.

The most significant completed problems include: (1) development and application of refined numerical techniques to the solution of a series of thermal neutron problems associated with nuclear reactor design; (2) UNIVAC processing of BuShips Electronic Failure Reports, the results appearing in five reports at regular intervals; (3) quarterly listing of electronic equipment allocated, allowed and aboard naval ships scheduled for overhaul; (4) calculation of the frictional hydrodynamic resistance of a series of bodies of revolution of prescribed shape; and (5) calculation of the critical frequencies of the torsional vibration of a planetary gear.

Since August 1955 the output of the laboratory has been supplemented by three-shift operation of a second UNIVAC, located in Philadelphia. Present plans call for the installation of this computer in the laboratory in the spring of 1956, and the subsequent conversion of each UNIVAC I into a UNIVAC II.

ELECOM 50 DIGITAL COMPUTER

Production of an improved model of the ELECOM 50 Digital-Computer Accounting Machine, first mentioned in an earlier report, was recently announced by the Underwood Corporation (Fig. 1). The new model features printed-circuit design for greater compactness and ease of maintenance. Magnetic-drum storage has been increased to 100 registers for greater internal-memory capacity. Separate program storage is provided on a previously prepared plastic control tape which is sensed electro-mechanically. Storage capacity is 31 programs of variable length.

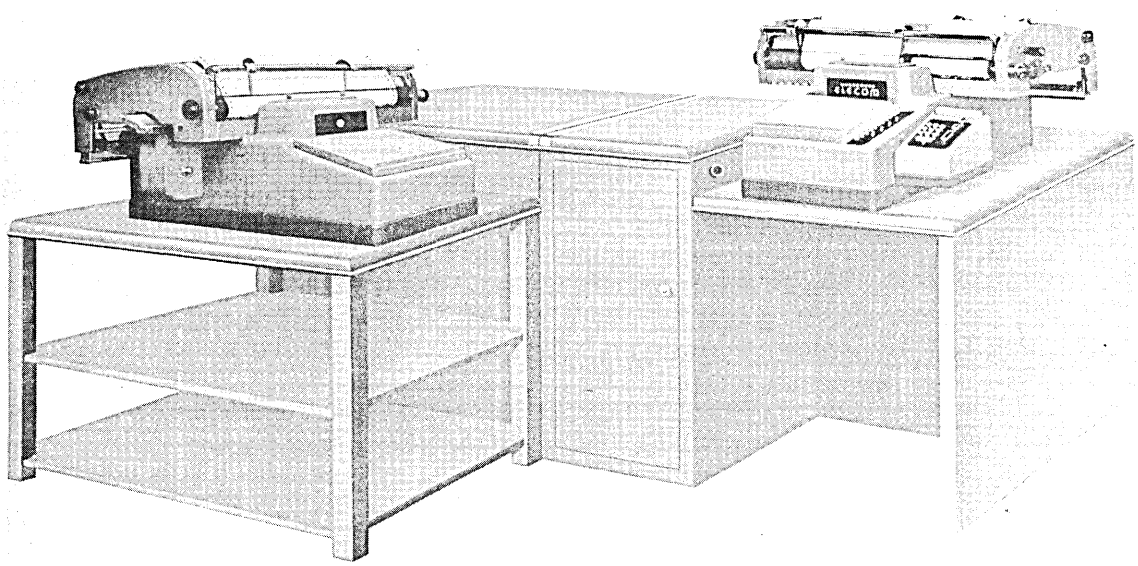


Figure 1 - The compact design of the ELECOM 50 is made possible by the extensive use of printed-circuit construction of electronic circuits

THE INSTITUTE FOR ADVANCED STUDY (ELECTRONIC COMPUTER PROJECT)

The basic control cabinet of the new input-output system for the IAS computer has been completed. The unit has been designed to permit communication between the computer and a

selected external device. It consists of a 40-stage buffering register with its necessary gates, a 14 digit word counter, and the basic control itself. One machine order (20 digits) will be used to initiate an input-output operation and specify the starting location in the Williams memory. The balance of the necessary information will be carried by a "priming" word to be in the quotient register.

At the start of the order the priming word is brought into the control cabinet and used to specify the sending unit, the receiving unit, how many words are to be transferred, and the starting address in the external device where relevant. Then a two beat cycle begins in which first the sending unit transmits to the buffer register and then the buffer register transmits to the receiving unit until the specified number of words have been transferred.

Each class of external devices will have its own special control and circuitry to enable it to transmit to or receive from the buffering register when so commanded by the basic control. Essentially the basic control will ask for an action from the external device and wait for a signal that the action has been completed. This asynchronous behavior should allow a wide range of external devices to be accommodated without difficulty.

Since this new system arose from the addition of a new, larger drum to the IAS computer, construction of special unit controls and circuitry has for the present been limited to those for the drum. It is expected that a punched card unit will be next.

LIBRASCOPE, LGP-30

Librascope, Inc. has announced a type designation (LGP-30) for its new low cost, general purpose digital computer. The machine has been described in the July 1955 issue of the "Digital Computer Newsletter," (Vol. 7, No. 3 pp 4-5).

NAVAL PROVING GROUND CALCULATORS

In October, the operation of the Naval Ordnance Research Calculator (NORC) was increased from two shifts to three shifts per day, five days per week. The machine was available for 84 percent of the 391 hours of scheduled operating time during October. Routine maintenance presently averages five hours per day. The daytime and early evening hours are usually reserved for program debugging. The remainder of the time is devoted to production runs.

In addition to the solution of problems for the Navy Bureau of Ordnance, NORC time has been made available to nine other organizations for the solution of problems sponsored by the Department of Defense and the Atomic Energy Commission.

Additional output facilities are being obtained for the NORC. Presently on order is an IBM 407 punched-card tabulator specially modified so that printing format is controlled by master cards interspersed with the data cards; information for both types of cards will be generated within the NORC by programming. Specifications are also being prepared for a high speed printer and a graphical output display.

The Aiken Dahlgren Electronic Calculator (ADEC) and the Aiken Relay Calculator (ARC) have been operated 16 and 8 hours per day, respectively.

The Programming and Coding staff and the Applied Mathematics staff are currently being expanded to meet the demands of the increased work load made possible by the capabilities of the NORC.

READIX (J. B. Rea Company)

OPERATION

The Readix is a general purpose, digital, one-address, stored program computer of the medium speed class handling alphabetic, as well as numeric data. It is available for either

fixed point operation alone, or for fixed point and floating point operation. Each of the four thousand words of internal drum storage consists of 10 decimal digits and sign, or two commands, complete with addresses. Internal operation is in the binary coded decimal number system. No conversions, manual or internal, are required with the Readix, thus making possible high speed input and output with photo-electric tape readers and punched card machines.

INPUT DEVICES

As standard equipment, the Readix is supplied with a Flexowriter electric typewriter. The keyboard of this machine, as well as its paper tape reader, may be used for computer input. The six-hole paper tape, coded especially for the Readix, can be read at a speed of 10 digits per second.

The Readix will accept the full or partial contents of IBM cards at the rate of 100 cards per minute. An IBM model 523 Reader-Punch is used to read the cards, and to transfer their data to a maximum of eight word spaces in the working storage of the computer.

The computer's magnetic tape data storage unit can also be used as an input device. Used in conjunction with a Rea-Converter analog-to-digital converter, it forms the communication link between converter and computer. It can also serve as the communicating link between two or more Readix computers.

OUTPUT DEVICES

The Flexowriter supplied with the computer can be used to produce typed copy and punched paper tapes from the computer's output at a rate of 10 characters per second. The READIX can continue to compute during the output cycle, and can be programmed for automatic output tabulation. Output can be punched into IBM cards at a rate of 100 cards per minute by an IBM Model 523 Reader-Punch. Characteristics of this operation are similar to those for IBM input, as described above. A single IBM machine can be set to either punch or read during a run. If reading and punching are desired in the same run, two IBM machines may be used.

For the preparation of plotted graphs, management report charts, and other types of graphical output representation, a digital point plotter is used. This unit consists of a Librascope plotter and a REA interim relay register. Plotting is accomplished in two simultaneous coordinates, at a rate of one plot per second. Plotting accuracy is within one-tenth of one percent, full scale. The computer is not delayed during a plot unless a new plot command is given during the execution of a previous one. The magnetic tape data storage unit may also be used as an output device, when it is desired that computed data be semi-permanently stored, or when it is necessary to communicate between two or more READIX computers.

AUXILIARY DATA STORAGE

High capacity auxiliary data storage is provided for the Readix by a magnetic tape unit with independent searching capabilities. Fifty thousand 10-digit alpha-numeric words can be stored on each 1200' reel of 5/8" tape. Words are grouped on the tape in blocks of 40, with a block address recorded permanently for each block. Eight channels are recorded on the tape: Four are used for data storage; one contains a parity check on the first four, to detect operational errors or tape defects; one contains a clock for the four data channels; and one contains the permanent block address clock. The eighth channel is a spare that may be used for special applications.

When a block search command is received from the computer, the tape unit searches in the proper direction until the desired block address is found. Then the tape unit stops and waits for the computer to give a read or write command. When this command is received, forty words are read from or written on the block that has been found in the tape search.

After the Readix issues a block search command, it can continue to compute while the search is in progress. If a read or write order is given before the search is completed, the computer will idle until the tape unit locates the desired block. If a read or write order is given without a preceding block search order, the tape unit will read from or write on the next block in order on the tape.

Tape speed is 15 inches per second for reading or writing, and 60 inches per second for searching. Average access time in a random search is 1.33 minutes. Access time can be greatly reduced in many problems by efficient programming, and in those cases where data can be stored in the order in which it will later be required, access time is reduced to the time required for the tape to advance from one block to the next. Several tape units may be used with the Readix, and all can search simultaneously.

PROGRAMMING

The arithmetic commands are addition, subtraction, multiplication, division and square root (square root is a command not a routine). Logical commands include two types of extract commands, transfer commands based on overflow decisions, and an unconditional transfer command controlled by an external switch. All of the copy commands necessary for efficient single address operation are also included.

A Readix command requires 5 decimal digits, thus allowing each word to contain two commands. The internal counter that determines the address of each succeeding command skips every other word. Optimum coding is therefore an inherent feature for about 90 percent of the Readix commands.

To gain maximum advantage from the fast access of the computer's working memory, commands are read only from a sequence of word spaces on the working channels of the memory drum. Routines stored permanently in the main memory can be copied into the working memory by a channel transfer command. Since the commands are always retained in the main memory, it is not necessary to restore the original conditions of a self-modifying routine.

A working channel may be filled one word at a time from the arithmetic registers, while a main channel is always filled completely during recording. A complete channel of data may be transferred in either direction between the main and working memories by means of a single channel transfer command.

By using the decision commands and a specific register, the programmer can obtain automatic command counting and modification. This feature enables the Readix to handle data processing table look-up and subroutines with ease. If the memory never needs to be written on during a program, an external switch will disable the write amplifier and the contents of the memory will be protected, regardless of coding or machine errors.

Fixed point or floating point operation is selected by a switch on the control console. Floating point operation is programmed in a straightforward manner, without the use of floating subroutines.

An extra register has been provided for output signals, in order that the computer will be free to compute while an output device is in operation. The output commands cause the print-out of an entire word at one time, rather than a single symbol. Fewer commands are thus required for Readix output.

CONSTRUCTION

All components are mounted on plug-in boards, readily accessible from the front of the computer. Only six types of plug-in boards are used in the logical and arithmetic sections.

As standard equipment, the Readix contains internal dynamic and static test panels. Sixteen diodes are mounted on each diode plug-in board, and all may be checked simultaneously in the static test panel. A Tektronic Oscilloscope located in the console is used for trouble-shooting and routine signal inspection. To prevent trouble before it starts, the Readix has been designed for exceptionally conservative operation. No electronic component is operated at more than 70 percent of rated power, and a deterioration of 50 percent in tube transconductance will not affect operation of the computer. Diodes are subject to no more than one-third of their rated back voltage.

MEMORY

Internal: Magnetic Drum with capacity of 4000 ten-decimal digit words on 100 channels. 4 additional channels, storing 160 words, are provided for highspeed access. 4 one-word recirculating registers are also included. Speed: 3450 RPM. Access time: 9 ms. for working storage or .4 ms. with optimum coding.

External: Magnetic tape unit, capable of block search independent of computer. Plotter tape handler with Rea logic circuitry. 1200 foot x 5/8-inch tape. 50,000 10-decimal digit words of storage.

TECHNICAL SUMMARY OF READIX

INPUTS

Type	Speed
Flexowriter Keyboard	10 characters/sec.
Flexowriter paper tape reader	10 characters/sec.
Magnetic tape unit	1000 decimal digits/sec.
IBM Card Reader and Rea Interim Register	100 cards/min.
Photo-electric Paper Tape Readers	varied

OUTPUTS

Flexowriter Keyboard	10 characters/sec.
Flexowriter Paper Tape Punch	10 characters/sec.
Magnetic Tape Unit	1000 digits/sec.
IBM Card Punch and Rea Interim Register	100 cards/min.
Librascope Point Plotter and Rea Interim Register	one plot/sec.

NUMBER OF TUBES

Flip-Flops	128
Drivers, Read and Write Amplifiers	132

NUMBER OF DIODES

Logical Gate Diodes	3040

OPERATION TIMES (Excluding Memory Access)

ADD	.44 milliseconds
MULTIPLY	25 milliseconds maximum, 16 ms. average
DIVIDE	40 milliseconds maximum, 24 ms. average
SQUARE ROOT	70 milliseconds maximum, 40 ms. average

Figures for operating times apply to both fixed point and floating point operation.

NUMBER RANGE

FIXED POINT $\pm 10^{10} - 1$

FLOATING POINT $\pm(10^{8} - 1) \times 10^{+49}$ to 1×10^{-50}

PULSE RATE 100 kilocycles

REMINGTON RAND DIVISION (SPERRY RAND CORP.)

The first high-speed low price electronic computer utilizing magnetics throughout, instead of filament tubes, has been announced by the Remington Rand Division of the Sperry Rand Corporation.

The computer employs an entirely new principle by using "micro-ferractor" magnetic amplifiers which are no larger than the rubber erasers at the end of ordinary lead pencils.

The "ferractors" will perform accurately at temperatures from 60 degrees below zero Fahrenheit to 220 degrees above zero, and are the result of five years of laboratory research. The computer opens up an era in which filament tubes and transistors will be outmoded by devices of this kind.

The prototype was completed last June, and present production plans will make the "micro-ferractors" fitted computer available early in 1957.

SWAC (UNIVERSITY OF CALIFORNIA)

A new 8192 word magnetic drum memory is being acquired for SWAC from the Librascope Company. The drum is currently being installed in the Numerical Analysis Research Laboratory and will probably be available sometime before the first of the year.

The drum circuitry will allow transfer of blocks of 8, 16, 32, or 64 words to and from the drum. In the case of a transfer of 64 words, the two 32 word halves may be permuted on transfer. The drum will also provide a parity check digit for each word, as it is stored. Each word on the drum contains a sign, 36 binary digits, and a breakpoint digit, which are transferred to and from the electrostatic memory.

The timing of drum transfers is being modified so as to reduce the amount of time lost in transfer of fractions of channels. The maximum amount of time for transfer (64 words) will be 17 milliseconds.

The drum is supplied with an outer casing for complete protection of the drum surface and edge from accidental external blows. Removal of the casing for servicing of the drum or heads is easy. The drum will operate at 3600 rpm; it is mounted horizontally and has a length of 10 inches and an approximate diameter of 8 inches.

WHIRLWIND I (JULY, AUGUST AND SEPTEMBER 1955)

Applications

During the past 3 months, the Scientific and Engineering Computation Group, in conjunction with various departments at MIT, processed 94 problems for solution on Whirlwind I. These problems are described in the Project Whirlwind Summary Reports submitted to the Office of Naval Research and cover some 22 different fields of applications. The results of 18 of the problems have been or will be included in academic theses. Of these, 12 represent doctorate theses, 1 Engineering, 4 Master's and one Bachelor's. Twenty-one of the problems have originated from research projects sponsored at MIT by the Office of Naval Research.

Academic

The Digital Computer Laboratory programming course was given once during this quarter. The course includes the following topics: Relative addresses, temporary storage, floating addresses, preset parameters, programmed arithmetic, cycle counters, buffer storage, automatic output, post mortems, and multipass conversion. The text for the course is a programmer's manual written by staff members of the S&EC Group. The 23 students enrolled during this quarter represented the following groups: Department of Nuclear Engineering, Nuclear Metals Laboratory, Meteorology Department, Physics Department, Aero Physics Laboratory,

Biology Department, Department of Civil Engineering, Harvard Business School, Lincoln Laboratory Office of Statistical Services, and the Rand Corporation.

Systems

Magnetic Drums

The interlace on the auxiliary section of the buffer drum has been changed to provide more rapid access to drum storage. The computer may now read or record blocks of information at the rate of one word every 32 microseconds. The former rate was one word every 64 microseconds.

The control systems for both drums have been modified to permit the selection of a new mode of operation. The programmer, by adding 1000 (octal) to the present drum orders, may select the drum as a consecutively addressed storage medium with no discontinuities at the end of each group. The Group Selection Register (GSR) has been made a counter which is added to by the end carry from the Storage Address Register (SAR). The SAR end carry to GSR is gated by digit 6 of the in-out switch.

Magnetic Tape

In several instances valuable information recorded on magnetic tape has been destroyed by accidental recordings over this information. A system has been installed to allow the three printout units to be locked in the read mode by means of toggle switches located on their control panels. The computer may sense an intervention bit to determine whether these switches have been thrown or whether the units are ready to record.

Power Supplies

A spare filament alternator has been obtained and the installation work necessary for connecting it into the system is in progress. The control system will be such that the alternator may be used to replace either of the two alternators now in service by operating one or two toggle switches. A system for substituting a motor-generator set for one of the d-c supplies is being developed.

Polaroid Land Camera

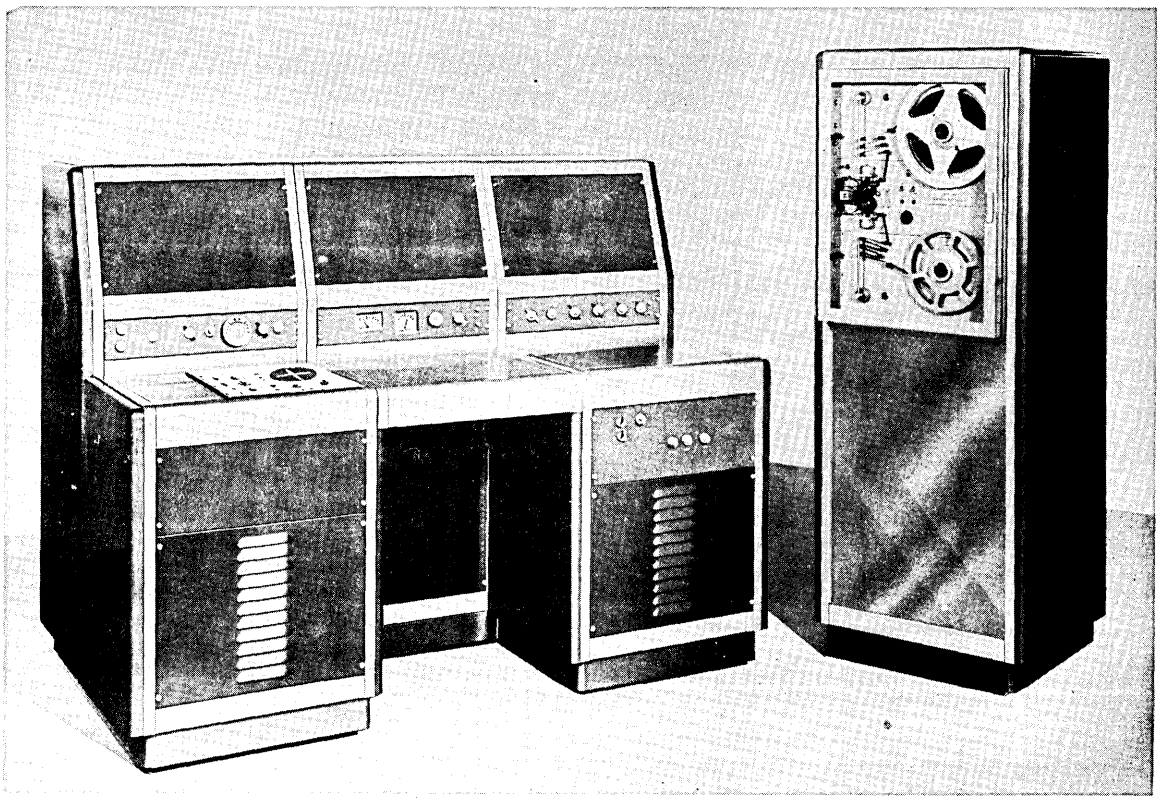
A Crown-Graphic camera with a Polaroid Land-camera back has been mounted in the control room for photographing the indicator lights. The photographs may be used in place of manual recordings of the lights. This system provides a sure, fast accurate means of gathering trouble-location information.

COMPONENTS

ANALOG-TO-DIGITAL CONVERTER (J. B. REA & CO. INC.)

An entirely new and re-packaged analog-to-digital converter, the REA-CONVERTER, is now being offered by the manufacturer, the J. B. Rea Company, Inc., Santa Monica, California (Figure 2).

The new REA-CONVERTER is a high-speed, accurate analog-to-digital converter with capacity of up to 100,000 conversions per second, 30 millivolt resolution and .1 percent guaranteed accuracy. It will accept signals from transducers, FM discriminators, FM or PWM magnetic tapes, film readers or other analog sources, and convert them to any desired digital code. Used with appropriate commutating it will sample, in sequence, data from any number



VICTOR BARNABA

Figure 2 - The REA converter

of analog sources. Digital output may be printed out, or used as input to a digital computer. Interim storage of the digital data can be accomplished, if desired, by a programmed magnetic tape unit.

A Rea high-speed input commutation switch, digital output magnetic recorders and programming circuits are among the new features offered in complete REA-CONVERTER Systems.

INTERNATIONAL TELEMETER CORPORATION

The RAND memory completed the six months acceptance test on September 30th 1955.

The equipment contains 168,960 active ferrite memory cores, 1,200 tubes, and 480 germanium diodes. There were no core or diode failures at all during the six month period. To pass the test the memory was required to provide a mean error free time of at least five hours with the sum of scheduled and unscheduled maintenance time held to less than 12% of the computing hours.

The following table lists the results during the six month test. All errors listed were caused by component failure. There were no random errors.

Month	Number of Errors	Computing Hours	Scheduled Memory Maintenance Hours	Unscheduled Memory Maintenance Hours
April	3	56.78	3.06	2.64
May	0	128.05	6.05	0.78
June	7	152.1	2.57	5.67
July	4	177.5	5.09	2.80
August	4	236.0	6.68	1.82
Sept.	0	320.0	2.58	0.88

Total Errors	18	
Total Computing Hours	1070.43	
Mean Free Time	59.5 hrs.	
Scheduled Maintenance	26.03 hrs.	2.43%
Unscheduled Maintenance	14.59 hrs.	1.363%
Total Heaters on Time	1,540 hrs.	
Total B+ on Time	1,370 hrs.	

The time not accounted for was used in engineering and maintenance on portions of the computer other than the memory.

Thirteen of the eighteen errors were caused by one tube type. On examination it was found that a batch of these tubes, representing one-eighth of the tubes of this type, were mechanically defective in a manner that could not be detected by microscopic examination. The memory made no errors after these tubes were changed in mid-August.

MECHANICAL DIGITAL CONVERTER (FISCHER AND PORTER CO.)

A new digital converter has just been introduced by the recently-formed Data Reduction and Automation Division of Fischer & Porter Co., designers and manufacturers of instrumentation systems at Hatboro, Pa.

Smaller than a desk telephone, this digital converter, called the Digi-Coder, converts the analog output of primary sensing devices—such as flow meters, thermocouples or pressure transducers, etc.—into a digital signal.

Two basic types of Digi-Coder are offered. One type converts a mechanical motion, delivered to its input shaft from a pneumatic or other receiving mechanism, into a digital output signal. Torque requirements are less than 0.20 inch-ounces. Low moment of inertia makes the converter adaptable to any servo instrument. The second type of Digi-Coder, which contains an integral self-balancing potentiometer, converts an analog voltage input into the digital signal. The voltage-input type will operate on a 0 - 1 millivolt input and up, with either a linear or nonlinear relationship maintained between input and output signals. Various models within these two basic types are available.

The Digi-Coder can deliver a variety of output signals. It can furnish (1) the decimal code output conventionally used to operate most electric typewriters; (2) a binary code useful in many computers. In addition, it may furnish teletype, binary-decimal or other special output codes.

The conversion is accomplished by purely mechanical means without relatively complex and costly components such as brush assembles, electronic circuitry or external equipment. The heart of the unit is a train of from two to ten coded drums (Fig. 3), depending on the number of digits required in the output code. Each drum has a series of circumferential hills and valleys and a set of mechanical feelers. The output signal occurs when the feelers, actuated by automatic or manual signal, come in contact with the drum surface. When the feeler encounters a hill, its associated electrical contact is closed; when it drops into a valley, the contact remains open. Any number of digits may be supplied in the code by using the required number of code drums. The motion of the input shaft in the first drum is delivered to the successive drums in the series by successive reduction gears.

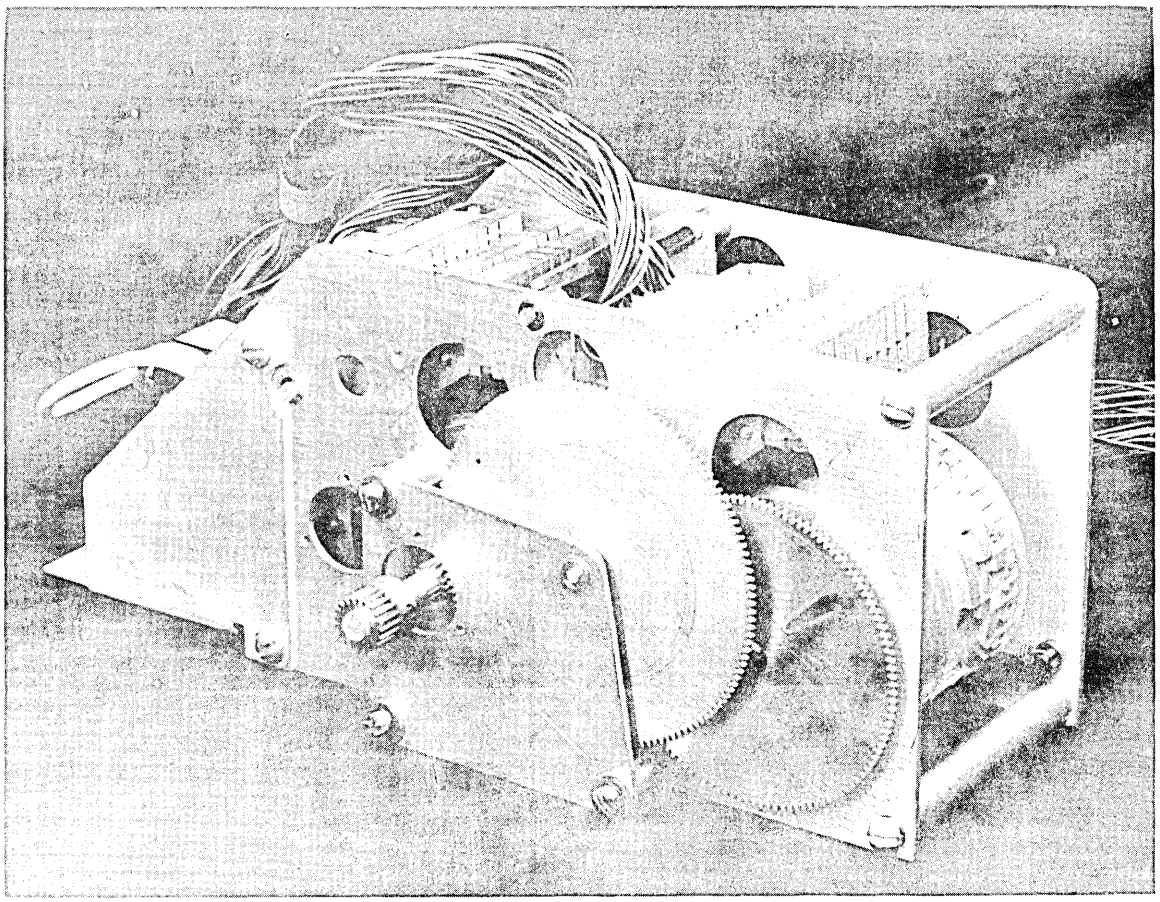


Figure 3 - One of the series of Digi-Coder digital converters containing a two-drum train. Analog input is delivered to drive shaft, which rotates coded drums. Drum feelers, upon automatic or manual signal, drop onto drum, seeking the "hills and valleys" on drum face. When feeler strikes a hill, the corresponding electrical contact is closed. The combination of closed contacts represents the output code for a specific position of the input shaft, thus converting analog input to a digital output.

Positive transfer between successive drums and sets of feelers assures unambiguous, accurate feeler positioning, even though the last drum in the train may move as little as 1 ten-billionth of a revolution. The Digi-Coder is accurate to the nearest digit, regardless of the number of digits in the output. In a 5-drum train, demonstrated accuracy is better than 1 in 34 billion parts. The Digi-Coder may be obtained with a hysteresis-free input coupler that enables the feelers to operate without interrupting the motion of the input shaft. The device can operate at speeds up to 5,000 counts per second.

NAVAL ORDNANCE LABORATORY (CORONA,CALIF.)

For the past three years the Computer Components Division has been carrying out a research program on high speed digital computer components. Specific topics studied include magnetic films prepared by evaporation, ferroelectric crystals, properties of semi-conductors, high speed phosphor response times, and high speed electronic circuit limitations. Serious study is being made of the possible application to digital computer memories of flat plate magnetic storage elements used in combination with etched circuit techniques.

AUTOMATIC TYPEWRITER (FISCHER AND PORTER CO.)

Conversion of a standard office electric typewriter to an automatic data reduction readout device has been announced by Fischer & Porter Co., Hatboro, Pa.

The F&P automatic typewriter, an electric typewriter mounted on a compact relay-operated control base, permits high-speed, remote operation of typewriter keys and typewriter controls in response to coded electrical inputs. An optional tape punch attachment provides a five-hole, punched paper tape record suitable for feeding directly into computers or high-speed data processing equipment.

Typed log sheets up to 26 inches in width can be automatically produced at speeds up to 10 characters a second.

The control base—no wider or longer than the typewriter itself and only two inches high—contains solenoid-operated tapper bars that project upward into the typewriter. When actuated, each bar trips its corresponding typewriter key. The present F&P system permits remote operation of typewriter numerals "0" through "9" and selected letters, as well as tabulator, space, carriage return and ribbon shift controls.

Since the combination does not alter the basic typewriter mechanism, the manufacturer offers its standard guarantee and low-cost service contract for repair and maintenance of the typewriter section of the device.

SLAVE TYPEWRITER (UNDERWOOD CORPORATION)

A solenoid-operated slave typewriter capable of remote or manual operation has been announced by the Underwood Corporation.

Intended primarily as an output unit for data-processing applications, the machine features an adjustable feedback switch, which acts as an automatic governor to coordinate input data with all phases of the machine's operation.

A variety of keyboards, type styles and carriage widths are available for special applications.

COMPUTERS, OVERSEAS

BARK and BESK
(Swedish Board for Computing Machinery, Stockholm, Sweden)

After more than five years' regular operation, the relay computer BARK was dismantled during October, 1955, principally because of the urgent need of space for other purposes. Although BESK is crowded by computation tasks, most of the customers have preferred waiting in the BESK queue to use BARK as a substitute.

The present state of the electronic computer BESK is as follows.

The cathode-ray tube storage has a capacity of 512 words of 40 binary digits each. A ferrite-core storage has been developed, and it is hoped to insert such a storage (capacity 1024 words) in place of the CRT storage.

The magnetic drum unit has 8192 words distributed on 256 channels, each channel corresponding to a reading head. Rotation speed is about 3000 rpm. The drum unit operates asynchronously to the rest of the machine. Blocks of words are transported between the cathode

ray and the drum storage units, with the arithmetic unit as an intermediary, each block corresponding to a channel.

The operator's console was connected to the machine in January, 1955. In addition to push-buttons, switches, meters, and indicators, it is also furnished with a special output device, called function writer. In this unit, short words (9 binary digits) can govern the deflections of a cathode-ray, thus making a graphical output possible by plotting successive points of a calculated curve. Provision is made for photographing the curve on polaroid film.

Other output equipment, directly connected with BESK, are electric typewriters, writing about 10 characters per second, and a perforator, punching with about the same speed. A high-speed perforator capable of punching 170 characters per second has been developed and is now being connected to the computer.

Input is by perforated paper tape. The tape is dielectrically read at a normal speed of 400 five-position symbols per second. Four of the positions are delivering computational information to the machine, the remaining position being used to indicate read or not read.

At present, three complete sets of equipment for punching, checking, correcting, and reperforating paper tapes are available, each set including an electric typewriter. By a separate IBM unit, data on punched cards can be translated into binary form on paper tape.

The institution has recently got a connection to the Telex network (Telex nr 1613). Investigations are to be made, how this might facilitate the data transmission to and from remote customers. A translator from Telex code to Besk code has been designed.

BESK is now in use from Monday at 08.00 to Saturday at 17.00, which means 129 hours weekly, machine time. Of these, about 30 hours are scheduled for maintenance and technical experiments with the machine, the remaining time being used for computation. In the mean, there is a loss of 14 hours weekly due to computational errors or uncertainties (including reruns).

Since 1st March, 1954, up to 30th September, 1955, the total effective computing time (in hours) spent by different kinds of customers has been as follows: Meteorology, including numerical weather forecasts: 525, Military problems: 1203, Public institutions: 19, Scientific institutions not mentioned earlier: 307, Aircraft industry: 1120; Other industries: 275, Insurance companies: 80, Internal work of the Board's personnel: 267, thus, in total: 3796 hours.

From a mathematical point of view, the effective computing time has distributed itself in the following manner, during the same period: Matrix calculations, mostly inversions of large matrices: 50%, Differential equations, ordinary and partial: 29%, Evaluation of functions: 12%, Statistics: 4%, Determination of extremum values: 2%, Number theory: 2%, Miscellaneous: 1%.

According to the increasing need for computing time, the Board has made an agreement with SAAB, Linköping, about building machines of BESK type, since the industrial production of machines is not an objective of the Board's.

Starting 1st April, 1956, Mr. Gunnar Hävermark has been appointed Director of the Working Group of the Board.

BIRKBECK COLLEGE COMPUTER LABORATORY (LONDON, ENGLAND)

The A.P.E. (X)C. has been working on problems connected with the design of electron lenses, and also on Mechanical Translation.

There have been no faults since June 5th, and no servicing has been carried out since that date. During the ensuing period the machine has been operated on the average of 4 hours per day.

A new machine of the A.P.E.(X.)C. type is the U.C.C. It has been installed in University College, London, and is now operating in acceptance trials.

The Wharf Engineering Laboratories machine, M.A.C., which is an engineered copy of A.P.E.(X.)C. in which the hot thermionic diodes have been replaced by germanium crystals, has been operating since February 1955. During the ensuing period there have been five diode failures, all of which occurred during the first six weeks of operation, and since that date there have been no machine faults and no servicing.

Machine operation has not been continuous, but has averaged about 20 hours per week. This reliability is surprising since it is our experience that machines which are left switched off for long periods of time tend to develop faults.

DANISH INSTITUTE OF COMPUTING MACHINERY (REGNECENTRALEN, COPENHAGEN, DENMARK)

Regnecentralen is a division of the Danish Academy of Technical Sciences and is supported by the Danish Government. By courtesy of the Swedish Government construction of a copy of the Swedish computer BESK has been started. This Danish version of BESK will be somewhat modified, though, compared to BESK as it is today.

The BESK cathode ray-tube storage will be replaced by a ferrite-core storage and this feature will also be incorporated in the Danish machine. This machine will furthermore have the possibility of using the accumulator and multiplicator-register as a long accumulator to a greater extent than BESK.

At present the possibility of adding a B-register is being investigated, but it is not yet possible to say for sure whether it will be done. Otherwise the data of our machine will be identical with the data of BESK. The Danish machine is expected to be ready for use in the autumn 1957.

The Institute is interested in obtaining publications and reports from American computer institutes. Communications should be addressed to:

Dr. Thøger Busk, head of the mathematical group or

Mr. Bent Scharøe Petersen, head of the technical group.

Regnecentralen
Aagade 154 tr. II,[8]
Copenhagen N, Denmark

INSTITUTO NAZIONALE PER LE APPLICAZIONI DEL CALCOLO (ROME, ITALY)

Programming is in progress on the solution of m simultaneous algebraic equations in n unknowns (m = n) by orthogonalization procedures.

The machine is used presently 8 hours per day, 4 by the engineers and 4 by the mathematicians. About 1-1/2 hours are used for training purposes.

The staff is formed by 3 engineers and 3 groups of 4 programmers each.

Courses on programming are being printed.

FUJIC (FUJI PHOTO FILM LTD., JAPAN)

This computer is a universal, stored program, automatic electronic machine, operating partly serially (at 1.1 mc rate) and partly in parallel mode (30 KC rate). It was originally designed for calculation of optical design problems.

The word length is 33 bits. One bit is used for the sign, the remaining 32 bits for the absolute value. Accordingly the range of number is $-16 < n < +16$. One order is represented by one word, which may contain three addresses.

Manual input may be in binary or decimal form. Binary numbers are converted into the hexadecimal system, while decimal numbers are represented by the binary coded decimal system. Decimal numbers have a sign, one digit to the left and eight digits to the right of the decimal point. Storage is in binary form. Addresses are represented in binary or hexadecimal form.

Signs and absolute values are treated separately in the arithmetic unit. The absolute values are calculated in a parallel system. Average multiplication time is 1.5 MS.

The memory unit is of the acoustic mercury delay line type, with a recirculation rate of 1.1 MC. The tanks are not temperature controlled. Average access time is .5 MS. Memory capacity is 255 words.

Input is achieved by cards. The punched holes are arranged in 12 rows and 57 columns. In one row 37 positions are used for contents (binary or hexadecimal) eight positions are used for address numbers, three positions are used for the designation of input operations, and the other are reserved.

There are three input operations, (1) Storage as punched, (binary number, order), (2) Storage after decimal binary conversion (decimal number), (3) Start of computation. Storage speed from input into memory is about 500 bits per second.

An electronic typewriter is used as output device. The machine is assembled in a frame 1.8 meters high and 3.8 meters wide. It has about 1600 tube envelopes, including 500 diode envelopes. Power consumption is nearly 10 KW.

NATIONAL PHYSICAL LABORATORY, (TEDDINGTON, MIDDLESEX, ENGLAND)

The DEUCE at the Mathematics Division N.P.L. is now in regular use. Recent work has included:

(a) New techniques for the evaluation of latent roots of matrices of order up to 60. For unsymmetric matrices iterated methods are used; for symmetric matrices the method of Givens has been found very powerful.

(b) A library of programmes for general matrix algebra has been completed. In particular single matrix operations can be carried out on any matrix that can be stored in the machine. An interpretive scheme has been devised for the speedy assembly of programs of mixed matrix operations.

MISCELLANEOUS

NEW COMMERCIAL COMPUTER PUBLICATION

The Electronic Computer Division of Underwood Corporation has entered the field of industrial journalism with the publication of a new external magazine called the ELECOM PULSE.

The ELECOM PULSE will appear quarterly as a news medium for illustrating and explaining the company's electronic systems and developments. Featured in the pilot issue is an

article on the use of printed circuits in the ELECOM 50 "business machine" and an operational report by an ELECOM user in the petroleum industry. A "New Products" section will appear as a standing feature.

IBM REORGANIZATION

International Business Machines Corporation has announced the formation of a Military Products Division. The new division will be a self-contained engineering, manufacturing, and administrative unit.

Charles F. McElwain, director of defense engineering and manufacturing for the past 10 months, will be general manager of the new division. He will supervise all defense contract operations, including research, engineering, manufacturing, and administration.

The administrative offices of the new division will be at IBM World Headquarters in New York City. Research engineering and manufacturing facilities will be located in two general areas in New York State. One will be the Kingston-Poughkeepsie area with the center of operation at IBM's new plant at Kingston. The principal responsibility there will be IBM's part of Project Lincoln, entered into with the government by IBM in collaboration with the Massachusetts Institute of Technology, to produce ground-based computers for the continental air warning network. The general manager of this project for IBM will be Gavin A. Cullen, now general manager of IBM's Kingston plant.

The second area of the Military Products Division's operations will be IBM's Airborne Computer Laboratory and production facilities now engaged in the production of advanced electronic bombing and navigational systems, now located at Vestal, New York. The general manager of this operation will be Curt I. Johnson, now manager of IBM's Airborne Computer Laboratory.

NEW RESEARCH ORGANIZATION

GENERAL KINETICS INCORPORATED commenced operations on June 1, 1955 as an independent organization engaged in research and development. The senior staff comprises the technical project leaders of the former Arlington Laboratory of Engineering Research Associates Division of Remington Rand. The organization is providing a mathematical analysis and computer programming service applicable to any of the available large scale digital computers. A computer repair and modification service is also active on commercial and Government orders. Digital computer research is being carried out in fields such as: storage systems, special purpose information handling systems, compilers and automatic programming techniques.

WESTERN RESERVE UNIVERSITY, (DOCUMENTATION COURSES)

Two detailed courses in specialized phases of documentation will be offered this Spring as part of the expanding program of the School of Library Science at Western Reserve University, Cleveland, Ohio.

Now offered for the first time in any library school will be classes in "Machine Literature Searching" and "Language Engineering."

According to Dr. Jesse H. Shera, dean of the WRU School of Library Science, both new courses are tailor-made for research and special library personnel concerned with handling the increasing volume of recorded information of potential value to their specific organizations.

Course instructors will be James W. Perry and Allen Kent, director and associate director, respectively, of Western Reserve's Center for Documentation and Communication Research.

"Machine Literature Searching" will be offered at WRU during the Spring semester, starting Feb. 6, 1956, and during the seven-week Summer Session which opens June 18. Course content will include recently-developed methods and equipment for analyzing, storing, correlating and retrieving recorded information; punched cards and other systems now being developed; and coordination of new techniques with conventional indexing and classifying methods.

Taught during the Spring semester only, "Language Engineering" will review the role of language in constructing indexes and classification systems; language symbols and artificial languages for use with punched cards and electronic equipment; and application of information theory and the theory of games in designing codes and machine language.

Each of the new courses carries two semester hours of academic credit toward the degree of Master of Science in Library Science. The new classes have been added to the existing schedule of WRU library school offerings, making possible full-time library study focusing on documentation work.

Complete information on WRU library school course offerings, as well as on the program of the Documentation Center, is available from the office of the Dean, School of Library Science, Western Reserve University, Cleveland 6, Ohio; Registration for Spring and Summer sessions now is open.

CONTRIBUTIONS FOR DIGITAL COMPUTER NEWSLETTER

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 response during the past year has been most gratifying and the cooperation of all concerned is appreciated. It is hoped to continuously improve the contents of this newsletter and to make it a true medium of exchange of information, between government laboratories, academic institutions and industry. It is also 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.

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.

Communications should be addressed to:

A. J. Neumann, Editor
Digital Computer Newsletter,
Office of Naval Research
Washington 25, D. C.