This Day In Tech
Events That Shaped the Wired World

March 8, 1955: The Mother of All Operating Systems

By Priya Ganapati ✉ March 8, 2010 | 12:00 am | Categories: 20th century, Computers and IT, Inventions

1955: Computer pioneer Doug Ross demonstrates the Director tape for MIT's Whirlwind machine. It's a new idea: a permanent set of instructions on how the computer should operate.

Six years in the making, MIT's Whirlwind computer was the first digital computer that could display real-time text and graphics on a video terminal, which was then just a large oscilloscope screen. Whirlwind used 4,500 vacuum tubes to process data.

The Whirlwind occupied 3,300 square feet and was the fastest digital computer of its time. It also pioneered a number of new technologies, including magnetic core memory for RAM.

Another one of its contributions was Director, a set of programming instructions on paper tape that is regarded as the predecessor of operating systems in computers. The Director was designed to issue commands to the 4-year-old Whirlwind machine.

The idea was to eliminate the need for manual intervention (.pdf) in reading the tapes for different problems during a computing session.

The Director tape would communicate with the computer through a separate input reader. That means different tapes with various problems to be computed would be recognized and appropriately processed. A Director tape would make a complete run possible by pushing a single button.

Programmers John Frankovich and Frank Helwig wrote the first Director tape program. The software concept was to connect a Flexowriter – a mechanical, heavy-duty tape reader – to a newer, faster photoelectric tape reader.

This allowed the team to feed the spliced-together paper tapes directly to Whirlwind, without having a separate human operator.

Lead programmer Doug Ross finally demonstrated it in 1955.

The Director tape was also probably the first example of a Job Control Language–driven operating system. JCL is a scripting language used on mainframe operating systems to instruct them how to run a batch job or start a subsystem.

The Whirlwind is credited with leading to development of the SAGE, or Semi-Automatic Ground Environment, system used by the U.S. Air Force. It's also said to have influenced most of the computers of the 1960s.

Source: Wikipedia, MIT Computer Science and Artificial Intelligence Laboratory

Photo: Stephen Dodd, Jay Forrester, Robert Everett and Ramona Ferenz test Whirlwind in 1950.
Courtesy Mitre Corp.

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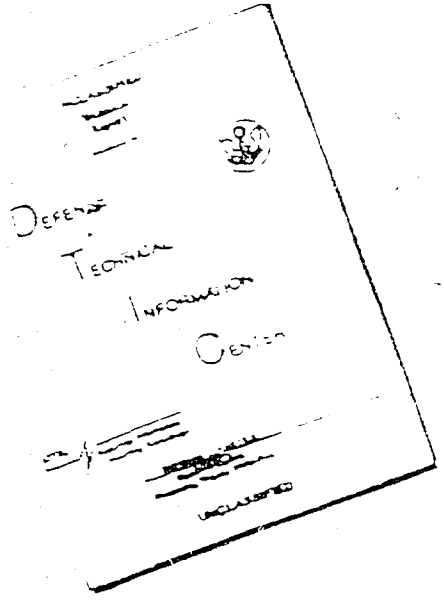

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DIGITAL COMPUTER NEWSLETTER

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. 7, No. 1 — January 1955

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Approved by
The Under Secretary of the Navy
16 August 1954

COMPUTERS

ABERDEEN PROVING GROUND COMPUTERS

Machine hours for the three high-speed computers for the "average" week for the period 0800 1 January 1954 through 0800 26 November 1954 are as follows:

	ORDVAC	EDVAC	ENIAC
Scheduled Engineering	19.2	20.6	39.8
Unscheduled Engineering	27.5	34.1	48.9
Total Engineering	46.7	54.7	78.1
Code Check	30.4	26.3	10.0
Production	78.0	42.8	62.6
Idle	12.2	41.8	18.6
Total Available	120.6	110.9	91.2
Standby Unavailable	0.7	2.4	0.7
TOTAL	168.0	168.0	168.0

Contracts for a 10,000 word magnetic drum and a 4,096 word static magnetic memory for the ORDVAC have been let and delivery of the equipment is expected in the spring of 1955.

A new order type selector has been built and installed in the EDVAC, removing a source of frequent breakdowns.

The CRC-105 Digital Differential Analyzer has passed its acceptance tests.

NAVAL PROVING GROUND COMPUTERS

During the past quarter the Aiken Dahlgren Electronic Calculator and the Aiken Relay Calculator have been used to solve urgent ballistic problems on a twenty-four hour, six day a week schedule.

Considerable emphasis has been placed on testing the new Naval Ordnance Research Calculator (NORC) and on planning for its installation. The calculator is now in New York, and will be installed at the Naval Proving Ground, Dahlgren, Virginia early in 1955.

During the design of the NORC the Bureau of Ordnance appointed a technical committee consisting of machine experts from the Bureau of Ordnance, the Naval Ordnance Laboratory, and the Naval Proving Ground to participate in the formulation of a detailed design characteristics of the machine.

Salient characteristics of the machine are as follows:

General

Decimal number system used throughout.

Serial digit-by-digit operation.

Automatic fixed and floating decimal point operation.

Word Size

10-place decimal numbers plus sign and 2-digit number designating power of 10.

A word is represented by 64 bits plus two check bits.

Instructions

Three-address instructions, including automatic modification of each address by three stored modifiers.

63 different operations.

A single instruction controls the complete process of reading or writing a block of words on magnetic tape.

Computing Speed

More than 14,000 three-address addition or multiplication operations per second - each operation including automatic floating or fixed decimal point computing; automatic address modification; and automatic checking of arithmetic, storage and transmission of numbers and instructions.

Electrostatic Storage

Capacity: 2,000 words of 10 decimal digits.

Speed: One word every 8 microseconds for use or regeneration (125,000 per second).

Arithmetic Unit

Two universal electronic registers.

Speed: 1,000,000 decimal digits per second.

Addition time: 15 microseconds, excluding memory access, checking, etc.

Multiply time: 31 microseconds, excluding memory access, checking, etc.

Division time: 227 microseconds, excluding memory access, checking, etc.

Serial multiplication table.

Operations checked by casting out nines.

Magnetic Tape Storage and Input-Output

Eight high-speed magnetic tape units.

Tape may be read in either direction, written on in forward direction.

Reading may include searching for a specified block.

With certain limitations, blocks can be rewritten within a tape.

Recording in four parallel channels at a density of 510 characters per inch.

Capacity of one reel: 350,000-450,000 words depending upon the average block length.

Distance between blocks: 1.5 inches.

Time of acceleration of writing or reading speed: 10 milliseconds.

Rate of reading or writing a block: 71,500 characters per second (3965 words per second).

Checking

Tape reading is checked by a bit count (modulo 4) accompanying each word and by end-of-word and end-of-block characters.

Electrostatic storage is checked continuously by bit-count verification and a greater-than-nine check on the digits every time a word is read in, read out, or regenerated. Transmission of number and instructions is checked by the bit count.

The arithmetic section is checked by an auxiliary computer operating on the basis of casting out nines.

The registers are checked by the bit count and serve as a transition point between bit count and the casting-out-nines arithmetic check.

Console

Decimal display of contents of the two arithmetic registers, instruction register, control and address modifier registers.

Controls for manual operation.

Indicator lights showing problem and calculator status.

Page Printing

Two printers: Speed 150 lines per minute, with 112 digits or 7 words per line. Only one of the printers can be operating at any given time.

Printing interrupts computing program (other than input-output operations) for only 10 milliseconds of the 400-millisecond print cycle.

Printing is checked by verification of the bit count accompanying each word via the echo contacts of the printer.

RAYDAC

The contract of the Computer Control Company, Inc. with the Navy for the operation, maintenance, and mathematical and programming services for the Raydac has been renewed.

The computer is operating on a one-shift basis. The Raydac is now "available and productive" 75 percent of the time. Programming and machine time is available to Bureau of Aeronautics contractors, Navy agencies and contractors, and other government agencies and contractors. The charge for machine time is $40.00 per hour. Arrangements for time may be made with:

Bureau of Aeronautics (EL 4251)
Department of the Navy
Washington 25, D. C.

ILLIAC

University of Illinois

The demand for Illiac time for university work has increased so that it became necessary to operate the machine on a 24-hour basis, five days a week, starting in the summer of 1954. About four hours of each day are devoted to scheduled maintenance and about one more hour each day is devoted to unscheduled maintenance. Thus, about 19 hours per day are available as useful time from the machine. Approximately four of the 19 hours each day are set aside for government sponsored research, leaving about 15 hours per day available for unsponsored work. The machine continues to be used on a very wide variety of problems with about 100 different persons making use of the machine during an academic semester.

An important addition to the Illiac during the last summer was the incorporation of a cathode-ray tube unit which makes it possible to plot a single point from a single output order, rather than punching paper tape as was the usual case. The raster provided on the cathode-ray tube has a resolution of 28 spots in both the x and y axes. Work is continuing on the incorporation of a magnetic drum memory into the Illiac.

Analytical results as well as a set of circuit values have resulted from a study of certain direct-coupled transistor computer circuits. The analysis has taken into account the tolerances

on all of the parts of the circuits. The flip-flop circuits comprising point contact transistors are the weakest part of the circuit group. Most point contact transistors cannot be kept within the tolerance band required for safe operation for this particular class of circuits.

Work has continued on the program library for the Illiac which is intended for general use by the faculty and students of the University. Each program is written up in detail and punched on heavy teletype tape which is then filed in an open file. All library routines are used with the same input and assembly routine. Copies of individual programs within the library are sent outside to interested laboratories where some usefulness can be derived from them. At present the library is divided into two parts, an active library and an auxiliary library.

The active library, containing the most-used and most important programs, now has 78 programs in it. The auxiliary library contains 27 less-used programs formerly in the active library as well as a considerable number of special programs written for their own use by individuals in the University and placed on file for reference. All users of the machine must assume their own programing responsibilities.

THE INSTITUTE FOR ADVANCED STUDY - ELECTRONIC COMPUTER PROJECT

The changes in the operating voltage levels of the Williams memory mentioned in the last Newsletter were completed. As a result of this changeover a new maintenance test was devised. Since the read-around characteristics of a machine can be improved at the cost of dash storage, the new code is used to find the optimal read-around ratio subject to the requirements of reliable dash storage.

A large hydrodynamical calculation is now in progress. It is concerned with the mixing of two fluids which at the start of the problem are in equilibrium with the heavier above the lighter one. The equilibrium is under the action of gravity and the motion is started by a small perturbation of the common interface between the two fluids. In addition to this a number of other problems are in the process of solution and reports are being prepared on them.

An extensive calculation was undertaken of successive partial quotients of the continued fraction expansion of roots of a given polynomial with integer coefficients. It is desired to determine distribution functions of these partial quotients for comparison with known theorems about the corresponding distributions for random numbers. A brief note on this work has been submitted to "Mathematical Tables and Other Aids to Computation." An extensive analysis is now being undertaken of the data and it is expected that a more detailed paper will be submitted to an appropriate journal in the near future.

THE MANIAC

Los Alamos Scientific Laboratory
Los Alamos, New Mexico

Some time ago the MANIAC completed 10,000 hours of successful operation. The efficiency (determined as the ratio of successful operation to the sum of "a.c. on" time plus "down" time) was 77 % over that period.

Design and development of a new "Maniac" has started. It is planned to have approximately 10,000 words of random access electrostatic storage. Both floating binary point and fixed point operation are included. The former is not of the usual form where the exponent is interpreted as the power to the base 2. Instead, it is intended to use a very large base, say 2^{16}. The fractional part of the number is represented by a sign and 43 bits and the exponent by, say, a signed 3-bit number. The advantage of such a large radix is that most of the arithmetical operations are effectively done in fixed point and only occasionally is shifting necessary. Hence, one obtains the high speeds of arithmetical operations without much pain and at the same time has the flexibility provided by floating point operation.

The vocabulary contains about fifty orders; almost all are half-word. It is also planned to include orders that effect the Ferranti B-mode of operation. Restricted use of magnetic tape is intended, similar to that in the present computer but faster in operation. Use of a square root order is contemplated.

WHIRLWIND I

Applications

During the past 3 months, the Scientific and Engineering Computation Group, in conjunction with various departments at MIT, processed 62 problems for solution on Whirlwind I. These problems are described in the Project Whirlwind Summary Reports submitted to the Office of Naval Research.

A procedure has been developed to eliminate most of the need for manual intervention in "reading in" the tapes for different problems during a computing period. The procedure makes use of a specially prepared "director" tape which communicates with the computer through a separate input reader. The various problem tapes, together with suitable post-mortem-request tapes, are spliced together in the proper sequence. The complete run is then effected under the control of the director tape by a single push on the read-in button.

Systems Engineering

A newly written program locates and identifies troubles in WWI terminal equipment. The diagnosis printed out by the computer includes the nature of the trouble and its location and, sometimes, identifies by number the tube in the offending circuit. (This program is applicable only to terminal equipment, and it does not appear that its use can be further extended.)

In a recent test, a tube previously removed from the computer because of low emission was placed in socket V08 of the plug-in unit in Bay 2, Jack 10, of the drum system; in a few seconds the direct typewriter printed:

d 0-7 fail g O ck write gate ampV08b2j10

In plain English, digits 0 through 7 failed in Group O, the cause being the write-gate amplifier tube V08 in Bay 2, Jack 10.

The program works on the assumption that each trouble has a unique set of symptoms. If the program ever runs into a set of symptoms which is not in its catalogue, it gives an indication of these symptoms. Later, when the trouble is found by "old fashioned" means, it, too, can be included in the catalogue of troubles.

Academic Program

The principal course on machine computation being offered at MIT in the fall of 1954 was 6.25, Machine-Aided Analysis, a survey of computing techniques intended largely for seniors in Electrical Engineering. This subject, first offered in the spring of 1954, had a fall-term enrollment of about 55 seniors and graduate students. Practice problems were planned to allow each student to use both a REAC and the Whirlwind I computer (simulating the hypothetical Three-Address Computer developed for the 1954 Summer Session). Exercises using desk calculators and a card-programmed calculator which were included in the first presentation of the course were eliminated in this second presentation to permit more time for studying techniques of problem and error analysis.

READIX (J. B. Rea Company)

The Readix General-Purpose Digital Computer is a serial, binary-coded decimal, single-address machine with a magnetic drum storage capacity of 4,000 words. Each word consists of 10 decimal digits with sign, or two commands complete with addresses.

The machine uses the decimal system for all internal operations, and has standardized plug-in units and a large magnetic drum memory.

Standard input-output equipment is an electric typewriter with associated punched paper tape equipment attached. Magnetic tape, punched card, and point plotter equipment can also be supplied to operate with the READIX.

ELECOM

The Electronic Computer Division of Underwood Corporation has announced the ELECOM model 120-A computer. A development of the ELECOM model 120, the 120-A computer features:

1. A ten (decimal) digit word length;
2. Memory capacity of from 1,000 to 10,000 words;
3. Base Registers available as optional features;
4. Automatic Floating Decimal operation as an optional feature.

The first two ELECOM model 120-A computers are scheduled for delivery to the Sandia Corporation, Albuquerque, New Mexico, early in the summer of 1955. The Sandia ELECOMS will have 4,000 word memories, and one of the computers will contain Automatic Floating Decimal operation.

The final ELECOM 120 is scheduled for delivery to Redstone Arsenal, Huntsville, Alabama, early in 1955. Deliveries of ELECOM 120s to Griffiss Air Force Base, Rome, New York, and Republic Aviation Corporation, Farmingdale, Long Island, New York were made during October and November, 1954.

The first ELECOM model 125 Electronic Business System will be installed at Mallory Air Force Depot, Memphis, Tennessee, in the spring of 1955. Mallory Depot will use the ELECOM 125 for Inventory Control. The ELECOM 125 system includes an electronic sorting and collating unit, called the ELECOM File Processor. The File Processor operates as an independent unit, and features an acoustic, quartz line memory operating at microsecond speed. The Underwood-ELECOM Tapewriter, a device for preparing printed paper tape to be used as one of the inputs to the ELECOM 125 System, was exhibited at the recent Joint Computer Conference in Philadelphia, December 8, 9, and 10, 1954.

UNIVAC FILE COMPUTER

A high speed random access magnetic file computer, operated electronically and designed to meet the demand for an intermediate alphabetical and numerical data processing system, named the "Univac File Computer," has been announced by Remington Rand, Inc.

This computer will be available for sale or on a monthly rental basis. Flexibility of operation and speed is attained by means of a magnetic buffer store and by a magnetic drum. A "multiplexing unit" permits simultaneous handling of as many as 24 input channels simultaneously. Thus several unrelated types of transactions may be processed simultaneously, such as inventory control, cost distribution, payroll computations, labor distribution and similar data.

Working from a variety of input-output equipment, such as paper or magnetic tape, or 80 or 90 column cards, and programmed through conventional control panels or through a high speed magnetic drum, or a combination of both, the computer can accommodate in its random access drum storage from 180,000 to 1,800,000 alphabetical or numerical characters. Also available is a high speed storage drum with a capacity of 1000 ten character words for data storage and additional capacity for high speed instruction storage with an average access time of 2-1/2 milliseconds.

Input-output devices include card sensing and punching units with card speeds of 150 cards a minute, 10 key entry keyboards with input-output printers, conventional key punches, tape handling equipment for punched-paper and magnetic metal tape, and the high speed printer, which prints 130 characters per line at the rate of 600 lines a minute.

The Computer was designed to handle operations not large enough to warrant installation of the large scale Univac system, but it can be used to supplement the larger system through common use of interchangeable input-output equipment.

THE SPEEDAC

The Sperry electronic digital automatic computer (SPEEDAC) is a general purpose computer designed by the Sperry Gyroscope Company. The design of the computer was undertaken several years ago and its full scale operation as a computer facility for Sperry's Engineering Division will start sometime in the spring of 1955.

In the design of the computer emphasis was placed on utmost simplicity of programming and operation. It is intended that users of the computer will program their own problems.

The computer was completely designed at Sperry. It occupies a space nine feet long, seven feet high, and one and one half feet deep. Plug-in type construction is used throughout. There are a total of 260 plug-in packages made up of eight standard designs. Plug-in connections are used between all panels to permit easy servicing and replacement.

Some of the general characteristics of the computer are:

Arithmetic Unit type	Serial, Binary, Fixed Radix point
Word Length	18 bits plus sign (19 total)
Clock Frequency	180 kcps
Average # of Arithmetic Operations per second	130
Storage Unit	Magnetic Drum, 4096 words capacity
Type of Input	Punched paper tape
Type of Output	Flexowriter
Number of Vacuum Tubes	700
Number of Germanium Diodes	2,000
Address System	Single Address
Number of Instructions	23
Volume	95 Cubic Feet
Power Requirements	6 kw

Although the computer will operate in the straight binary system, input and output can be in the decimal system, including the use of alphabetical characters if desired. Conversion from decimal to binary and from binary to decimal data will be accomplished with a permanently stored program.

The speed of the computer given above (130 operations per second) represents the average speed during normal operation. Except for a few special cases, the computer will require the same length of time to execute any one of the orders. Under special circumstances it will be possible to have the computer operate in special high-speed modes, with a result that the computer will operate at either twice or four times the normal speed.

Plans are underway to devise a fairly extensive library of subroutines for the computer. A special subroutine transfer order is incorporated in the order code to facilitate the use of subroutines by the programmer.

Considerable effort is being expended toward developing checking techniques. Both special checking and marginal checking equipment is being incorporated in the computer.

COMPONENTS

REMINGTON RAND, ERA DIVISION - TWO NEW MAGNETIC DRUMS ANNOUNCED

The line of magnetic storage drums offered to computer builders by Remington Rand's Engineering Research Associates Division has been augmented by two new drums of medium size. The smaller new drum, model ERA1119, has a rotor 4-3/8 inches in diameter by 8 inches long and has a basic storage capacity of over 100,000 bits of information on 100 tracks. Twenty extra tracks are available for control patterns, etc.

Special features include all-steel construction, broad range of speeds up to 15,000 rpm, average access time as low as two milliseconds, and one miniature ferrite magnetic read-write head per track. On special orders the drum can be provided with more than one head per track. The larger of the two new drums, model ERA 1120, is identical in all respects except that it is 15 inches long and stores over 200,000 bits of information on 200 tracks. Forty extra track spaces are provided.

EUROPEAN NOTES

BIRKBECK COLLEGE, UNIVERSITY OF LONDON

Two electronic computing machines are now operating in this Laboratory. One, the H.E.C., which has punched card input and output, and a storage capacity of 512 words; the other, the A.P.E.(X).C., is at present running test acceptance programs.

The work of the Laboratory is now concentrating on the use of computing machines, and current projects include mechanical translation, and a program for the conversion of standard English text into contracted Braille for use by the blind.

AUTOMATIC CONTROL AND COMPUTING AT THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON

The formation of a new Division for Control Mechanisms and Electronics has been announced at The National Physical Laboratory, Teddington, England. This new Division will cover the field of automatic control of industrial, administrative and experimental operations, and the development of techniques and equipment for data processing and computation. Mr. R. H. Tizard of the Metrology Division of N.P.L. has been appointed Head of the new Division.

NEW PUBLICATION

This office has received copies of a new publication, MT (Mechanical Translation). The first three issues of Volume I, issued in 1954 are being distributed without charge to those interested. This first year of publication has been financed by The Massachusetts Institute of Technology. Future issues will be available on a subscription basis.

Number 1 of March 1954 contains a 41 item bibliography. Number 2 contains "News," a report on the first conference on Mechanical Translation, "Research in progress" and a continuation of the Bibliography.

The magazine is published at The Massachusetts Institute of Technology and subscription correspondence should be addressed to W. N. Locke, Room 14N-307. Editorial correspondence should be addressed to the above or to V. H. Yngve, Room 20B-101B, Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge 39, Massachusetts.

DCN NEWS ITEMS

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

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

Communications should be addressed to:

Editor, Digital Computer Newsletter, Code 427
Office of Naval Research
Navy Department
Washington 25, D. C.

NOTICE

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