STICHTING
MATHEMATISCH CENTRUM
2e BOERHAAVESTRAAT 49
AMSTERDAM

DR 2

The EDSAC(Electronic Delay Storage Automatic Calculator).

M.V.Wilkes.

1949

Printed at the Mathematical Centre, 49, 2e Boerhaavestraat, Amsterdam.

The Mathematical Centre, founded the 11-th of February 1946, is a non-profit institution aiming at the promotion of pure mathematics and its applications. It is sponsored by the Netherlands Government through the Netherlands Organization for the Advancement of Pure Research (Z.W.O), by the Municipality of Amsterdam, by the University of Amsterdam, by the Free University at Amsterdam, and by industries.

The EDSAC (Electronic Delay Storage Automatic Calculator).

Lecture by Dr M.V. Wilkes on 22-9-1949 for the Mathematical Centre in Amsterdam.

The EDSAC is an electronic calculating machine working in the scale of two. It is serial in operation and uses ultrasonic tanks for storage. There are in all about 3000 valves and the power consumption is about 12 kw.

The principal parts of the machine are: store, arithmetical unit, input and output. A problem must first be broken down into a series of elementary arithmetical operations - additions, subtractions, and multiplications - and expressed in the order code of the machine. An extract from the order code is as follows:

A	n	add the number in storage location n into the accumulator.
S	n	subtract the number in storage location n from the accumulator.
T	n	transfer the number in the accumulator to storage location n.
E	n	if the number in the accumulator is positive or zero, execute next the order in storage location n; otherwise proceed serially.

Inside the machine, orders are represented as 17 digit binary numbers, and are contained in the same store as the numbers. The first five digits define the operation, the next the storage location referred to (the address). The store has capacity for 1024 orders or 17 digit numbers; it is possible to combine two consecutive storage locations and use them to hold a single 35 digit number. The store may thus contain a mixture of short numbers, long numbers, and orders. The most significant digit of each number is a sign digit. During operation of the machine, orders are executed serially in the order in which they stand in the store except when the sequence is broken by a conditional order.

Teleprinter punched tape is used for input, and an input operation consist in reading one row of holes and transferring the resulting 5-digit binary number to the store. Input, like the arithmetical operations, takes place under the control of orders taken from the store; the input order is

I	n	read the next row of holes on the tape and transfer the resulting 5-digit binary number to storage location n.

From this it will be seen that a programme for a problem cannot be taken in from the tape unless there are already some orders in the

store. The EDSAC has, therefore, a sequence of "initial orders", wired permanently on to a set of uniselectors; when the starting button is pressed these orders are transferred to the store. Apart from the fact that they enable the machine to start, the initial orders provide the connection between the different forms in which the orders are expressed inside and outside the machine.

Orders need to be expressed in three different ways

1) Written (when drawing up a programme)
2) Punched on the input tape
3) In the store.

The transition from 1) to 2) is made by means of a keyboard perforator which has 32 keys, each of which punches a row of holes, corresponding to a different 5-digit binary number. Some of the keys are labelled with figures as well as letters, the others with letters only. The code is so chosen that the figures are punched as the corresponding binary numbers, e.g. 5 as 00101; the code for the other keys is arbitrary. Note that it is unnecessary (and undesirable) to have different written forms for orders for use when drawing up a programme and when writing it out for the operator of the keyboard perforator.

The connection between 2) and 3) is provided by the initial orders. They cause the sucessive rows of holes representing each order to be read, the numerical part to be converted to binary form and the whole order to be assembled with the function degits and numerical digits in their correct relative positions. With the set of initial orders originally in use in the EDSAC the end of the address was indicated by an S for a short number or an L for a long number; since the 5-digit binary numbers corresponding to S and L are greater than nine, it was possible to distinguish them by means of a conditional order.

A new set of initial orders has recently been wired into the EDSAC. They contain certain additional features which facilitate the use of sub-routines. They will be explained during the lecture and will be illustrated by examples.

References:

M.V. Wilkes, The Design of a Practical High-Speed Computing Machine. The EDSAC. Proc.Roy.Soc.A, 195, p. 274-279, 1948.

M.V. Wilkes and W. Renwick, An Ultrasonic Memory Unit for the EDSAC, Electronic Engineering, July 1948.

M.V. Wilkes, Programme Design for a High-Speed Automatic Calculating Machine, 26, J.Sci.Instr., p. 217-220, 1949.

M.V. Wilkes, Progress in High-Speed Calculating Machine Design, Nature, Aug. 27, 1949.

M.V. Wilkes, Calculating Machine Development in Cambridge, Nature, (in press).

M.V. Wilkes, The EDSAC, an Electronic Calculating Machine, J.Sci.Instr., (in press).

M.V. Wilkes, A brief Description of the EDSAC, MTAC, (in press).