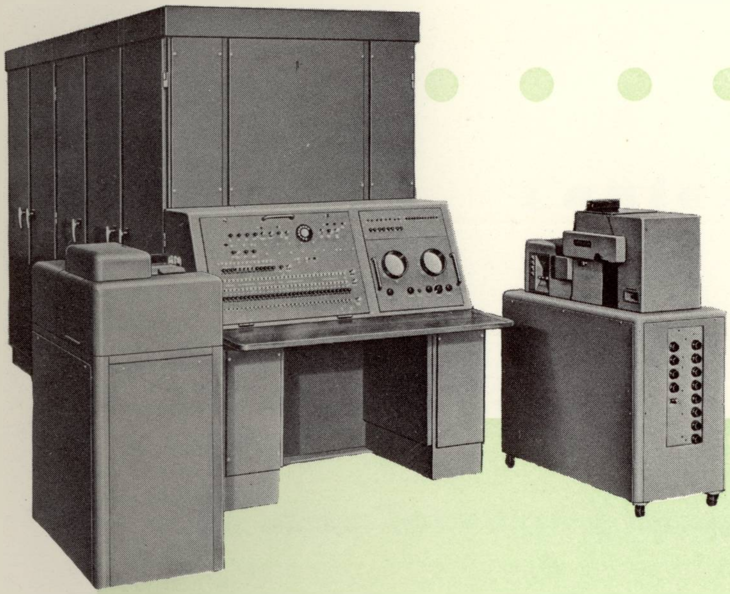

Notes on programming 'DEUCE'

'ENGLISH ELECTRIC'

Contents

Notes on Programming 'Deuce'

GENERAL

The design of the order code of the 'DEUCE' Computer was chosen principally to allow economy of electronic equipment to be achieved and also to retain a high degree of flexibility in the use of the machine. This policy places on the programmer the onus of ensuring that the full power of the computer is utilised and is justified when performance in the solution of problems of frequent occurrence is considered against the overall cost of the equipment.

The question that arises is whether the computer time saved outweighs the extended time taken by the programmer. Often, with DEUCE, the gain in performance is not fully appreciated while the extended time of programming, arising due to the order code, is confused with the fundamental difficulty of programming the solution of a problem, a difficulty which cannot be avoided simply by a choice of order code.

An answer to this question can be arrived at only after consideration of the nature of the problem to be submitted to the Computer. Clearly establishments likely to make considerable use of standard programmes would place much more weight on the saving of computer time while establishments with casual users requiring 'one-off' solutions would be seriously concerned with programming time involved.

Two vital facts which considerably enhance the utilisation of DEUCE should now be considered:

1. It is possible for programming work, once performed, to be recorded and later utilised repeatedly through an effective computer organisation.

The united efforts of all DEUCE users (the number and dates of installation of machines already in operation are relevant here) through the DEUCE USERS ASSOCIATION are expressed in the vast libraries of Sub-Routines and Programmes which have been built up and are available for immediate use. All these routines have been 'optimum coded', given maximum flexibility of application, exhaustively tested and recorded in full detail thereby enabling the Programmer to utilise them for his own needs.

Included among these are standard routines for assembly of programmes which save the programmer much effort in the preparation of programmes, numerous testing aids and also, 'floating-point' routines which ease scaling problems.

Since sub-routines usually cater for the most oft-repeated parts of a programme there will be frequently no need for the programmer to employ optimum coding techniques in the remainder of his programme. In fact a near-optimum coding procedure is quite easy to follow and often used where resultant time loss is not significant.

2. It is possible to devise systems whereby programming can be greatly simplified at the expense of efficiency of machine utilisation. Furthermore the degree of compromise can be chosen to suit the particular application. It should be noted that a machine in which fundamental speed has been sacrificed cannot achieve such compromise.

The systems presently available for DEUCE (the development of further systems is not precluded) are listed here and described separately below. They are:

a) The General Interpretative Programme.

b) The Alpha-Code Programme.

c) The Tabular Interpretative Programme.

a) provides a very efficient scheme of handling numbers with a very easy coding system which has proved of inestimable value in scientific work.

b) provides virtually another order-code which has been chosen to be as simple as a computer order code can possibly be. Naturally efficiency has been sacrificed to achieve this end.

c) provides a useful compromise between (a) and (b).

THE GENERAL INTERPRETATIVE PROGRAMME (GIP)

The GIP is designed to facilitate the 'manipulation of matrices'. This term however is capable of a very wide interpretation since a matrix is merely an ordered array of numbers and the manipulations carried out need not necessarily be those commonly associated with the 'Matrix Algebra' of Mathematics. The term should in fact be taken to mean the 'carrying out of a sequence of operations on a set of numbers in a systematic manner' which after all is the basic function of a computer.

Many sequences of operations - organisational perhaps even more than arithmetical - are of frequent occurrence and numerous programmes, termed 'bricks' have been written which are capable of operating on any sets of numbers arrayed in conventional manner. Bricks may be used independently, or successively, as normal programmes but are designed so that when stored on the Magnetic Drum their sequence of operation may be controlled by the GIP according to a sequence of simple code-words supplied on cards by the Programmer (or often by an experienced girl operator).

All operations are fully self-checking and problems of overflow do not arise owing to the 'block-floating' techniques adopted. Furthermore, the GIP, being merely a 'programme-control programme', is often used in an unconventional manner to facilitate programme construction. In general the GIP allows a very efficient utilisation of the computer's power and speed.

THE ALPHA CODE

With this system the Programmer merely specifies his problem to the computer using an extremely simple and highly flexible order code. The instructions are actually supplied in alphabetical form. As an example, a programme for evaluating the formula $(X_1 + X_2)(X_3 + X_4)$ given values of X_1, X_2, X_3 and X_4 as data might appear thus.

-	4	DATA	1		(Read 4 Data into X_1 onwards).
5	1	PLUS	2		(Make $X_5 = X_1 + X_2$)
6	3	PLUS	4		(Make $X_6 = X_3 + X_4$)
7	5	MULT	6	P	(Make $X_7 = X_5 \times X_6$ and Print it out).

where X_1, X_2 .... X_7 are storage positions within the computer some of which (x_1 .... X_4) are directly associated with the variables of the formula and others (X_5, X_6) with intermediate results.

Instructions, which might be described as 'three address plus function', are punched one per card in this alphabetical form and the cards are then processed by DEUCE in a 'compiling' run. This produces a set of cards bearing binary codewords suitable for use by Alpha Code Programme which is of an interpretative nature and which can obey alpha-instructions at a maximum rate of 33 per second - though an average rate is probably less than half this. Compared with an average DEUCE instruction rate of say 5,000 per second there is an apparent reduction in efficiency by a factor of 300. However the flexibility of the alpha instructions can reduce the number of instructions necessary by a factor of 10 thus giving an approximate overall efficiency reduction factor of 30.

The Programmer - who might well be an Engineer with one day's experience is absolved of the responsibility of studying scaling and input/output problems and results are automatically produced in a form suitable for tabulation. Single instructions can evaluate complicated functions such as 'exponentials' or 'solutions of differential equations' and 'subroutines' of alpha-instructions may be easily incorporated into a programme. Organisational, discriminatory and test facilitating instructions are provided in abundance and last minute corrections are particularly easy.

The obvious use of Alpha Code will be for personnel unfamiliar with DEUCE order code who require a quick solution to a 'one-off' problem. However, skilled DEUCE programmers will also find the Alpha Code of great value not only for 'one-off' problems but for constructing major programmes by obtaining trial results for checking purposes and, perhaps more important, for exploring the logical difficulties before the major programme is written.

THE TABULAR INTERPRETATIVE PROGRAMME

This is very similar to the GIP in operation but can be said to 'manipulate vectors rather than matrices'. The motive for this approach is that many people, used to carrying out calculations on desk machines, have formed the habit of organising their work 'by columns'. A typical code word might be a, b, c, d, meaning 'evaluate the function d (multiplication, say) of corresponding elements of column b storing the results away in column c. This scheme retains the efficiency of GIP while providing a coding scheme as easy, if not easier in many cases, than the Alpha-Code.

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