Programming and software for the Elliott 400 Series computers.

Very little system software was provided by computer manufacturers for their hardware in the 1950s. It was assumed that each customer-site would train its own mathematicians to develop machine-code programs appropriate for particular applications. Of the few British computer manufacturers selling machines in this period, Elliott Brothers (London) Ltd. were amongst the slowest to provide systems software such as Autocodes.

The Elliott 401.

In Tables 1 and 2 below we give an example of the *square root* library subroutine, as used on the Elliott 401 computer at Rothamsted. The descriptions come from an original typewritten manual at Rothamsted, where the author/date of this particular subroutine is given as M J R Healy, 7th October 1954. Table 1 gives the formal description of the subroutine and Table 2 gives the machine code.

Sub-routine
Square root

$y = \sqrt{x}, \quad 0 \leq x < 1$

Addresses occupied: V.64 - V.82

Registers used: All.

Enter at V64, link in R1, x in R4

Result: y in R1 (0 in R4)

Time: 0.1 - 1 sec. approx, longest for small numbers.

Accuracy: The result has two fewer significant (binary) figures than
the original number.

Method: see EDSAC sub-routine S2

$a_{n+1} = a_n (1 - \frac{1}{2} c_n)$ $a_0 = x$ $a_n \rightarrow \sqrt{x}$
$c_{n+1} = \frac{1}{4} c_n^2 (c_n - 3)$ $c_0 = x - 1$ $c_n \rightarrow 0.$

M.J.R.Healy
7 October 1954

Table 1. The formal description of the square root library subroutine.

The notation in Table 2 is as follows, where <SFDC> are the four octal digits giving the {acc. source, op. code, acc. destination and control}:

<addr. of instr.> <addr.of next instr.> <SFDC> <addr. of operand>
Addresses are given as decimal numbers preceded by V.

Programme

Square root

```
   V.64   V.82   4460   V.65
   V.82   V.81   0002   V.71    If x = 0, jump to end of
programme.
   V.81   V.72   6000   V.70    c0
┌->V.72   V.75   0330   V.73    ¼cn;  cn to R3
│  V.75   V.77   6600   V.76    ¼cn – ¾
│  V.77   V.79   4456   V.78
│  V.79   V.66   0110   V.35    ancn
│  V.66   V.68   0300   V.67    ½ancn
│  V.68   V.73   4440   V.69
│  V.73   V.78   4600   V.74    an+1
│  V.78   V.80   5446   V.79
│  V.80   V.67   0110   V.36
│  V.67   V.74   0006   V.68
│  V.74   V.69   0110   V.38    cn+1
└─ V.69   V.72   0002   V.71
   V.71   V.65   4440   V.72

   V.70   4.00   0000   0.00 ‖  -1
   V.76   3.00   0000   0.00 ‖  ¾
   V.65   0.12   3456   7.89 ‖  link space.
```

Table 2. The code for the square root library subroutine.

The Elliott 402.
The programming conventions for this computer were much the same as for the 401. In addition, there is some evidence that by 1958 Elliott's Borehamwood Laboratory had developed what was known as a *Simple Autocode* system for the 402. The Autocode simplified the written form of arithmetic expressions by permitting the programmer to use standard teleprinter symbols to stand for commonly-used operations. Thus for example:

- `*` is used for 'multiply'
- `/` is used for 'divide'
- `)` is used for 'greater than'

(is used for ‘less than’

A small example Autocode program is given in:
http://www.ourcomputerheritage.org/ccs-e2xtra1.pdf

The Elliott 403.
A small example program, taken from an original WREDAC specification dated 1962, is given in http://www.ourcomputerheritage.org/ccs-e2xtra1.pdf

The Elliott 405.
Three sample programs are given in:
http://www.ourcomputerheritage.org/ccs-e2xtra1.pdf These consist of an automatic timing routine and two standard paper tape input routines.

The timing routine has been provided by the original author, D J Pentecost, and is very informative. In http://www.ourcomputerheritage.org/ccs-e2xtra1.pdf will be found the original 1961 documentation, the hand-written programming sheets, the corresponding machine code and some helpful modern explanations. The explanation includes a close-up image of a length of punched paper tape containing the original 405 routine.

Input/output codes for the Elliott 400 series computers.
Input/output for the Elliott 400 series was in the first instance via 5-track paper tape, based historically on Creed teleprinter equipment. The complete Elliott coding of alphanumeric characters, called Elliott Telecode, is given in Table 1 for the Elliott 402, 403 and 405 computers. It may be seen that the numerals all have odd parity for the 402 and 405 conventions. Aside from the desirability of maintaining a conveniently-ordered collating sequence for letters and numbers, Table 1 indicates that there is some choice in assigning visible characters to bit-patterns.

Telecode character	***Letter shift***	***Figure shift, 402***	***Figure shift, 403***	***Figure shift, 405***
00000	blank	blank	blank	blank
00001	A	1	.	1
00010	B	2	*	2
00011	C	*	1	*
00100	D	4	=	4
00101	E	$	2	$ or “
00110	F	=	3	= or £
00111	G	7	;	7
01000	H	8	.	8
01001	I	‘	4	‘
01010	J	,	5	,
01011	K	+	:	+ or 11
01100	L	:	6	:

01101	M	-	%	-
01110	N	.	;	.
01111	O	%	(	%
10000	P	0	-	0
10001	Q	(	7	(
10010	R	)	8	)
10011	S	3	?	3
10100	T	?	9	?
10101	U	5	/	5
10110	V	6	+	6
10111	W	/	)	/
11000	X	@	0	@ or &
11001	Y	9	£	9
11010	Z	£	@	£ or 10
11011	figure shift	figure shift	figure shift	figure shift
11100	space	space	space	space
11101	carriage return	carriage return	carriage return	carriage return
11110	line feed	line feed	line feed	line feed
11111	letter shift	letter shift	letter shift	letter shift

Table 1. Teleprinter codes for various Elliott 400 series computers. The 1's in a telecode character indicate holes in paper tape and the 0's no holes.

For 400 series computers, the size of an *internal* character was defined according to the programming context, values of 4 bits, 5 bits and 6 bits occurring at various points in the Elliott technical literature.

Punched card equipment for input/output was subsequently introduced for the 402 and 405 computers. A Table of Elliott 405 punched card character codes and lineprinter codes is given in http://www.ourcomputerheritage.org/ccs-e2xtra4.pdf