THE ELLIOTT 903 EDUCATIONAL COMPUTER SYSTEM

This article describes the special computer marketed by the recently formed Educational Computing Division of Elliott-Automation, *Borehamwood, Herts. It is of medium speed, uses an 18 bit word and there are 16 basic instructions. Software will include* ALGOL *and* FORTRAN *compilers, a City and Guilds 319 Compiler, and a Symbolic Input Routine (SIR). A full range of peripherals will be available. The price of a computer system suitable for use in Educational Establishments is £14,250.*

This computer will fulfil the requirements mentioned in section 3—"Programmers" and "General" in the "Computer Training Aids" feature (June edition).

1. *Introduction*

Technological advance in computers requires an increasing number of computer programmers, operators and design engineers. Also it is important to disseminate a knowledge of computers and related techniques on a broad basis to introduce these concepts to future administrators, managers and the professional classes. With this in mind the Educational Computing Division of *Elliott-Automation* have introduced a simple computer which will enable schools and technical colleges to give basic instruction and practical computing experience. The computer has a much simplified control panel and is therefore suitable for use by schools when teaching the fundamental principles involved in the programming and operating of computers. Programming aids will include a symbolic assembly program, and the conventional but more powerful ALGOL and FORTRAN programs in a basic form. These will be well supported by a range of text books for teachers and students.

The machine has been built into a console about the size of an office desk. On the console stand the paper tape reader and punch which are included in the educational system.

A Mobile Computer Classroom

While the 903 is small and light and therefore is not really a fixed installation, when used in a school it has the limitation that students perhaps from other schools in the area have to travel to it, thus valuable time is lost. It is a logical step therefore to install the 903, in a large van of some sort. No doubt most people have seen the large vans used by public libraries everywhere, the mobile classroom will bear a strong resemblance to these. The power requirements of the computer, its associated equipment, heating, lighting and ventilation systems may be supplied by a self-contained generator mounted at the rear of the vehicle, or by a 30 ampere 250 volt a.c. mains supply point.

In 1966 one of these mobile computer classrooms is to be available for hire on a minimum half-day contract basis. There will be enough room inside for up to ten students and their teacher.

2. *Operation and Controls*

Operation of the educational computer follows normal procedure but where possible has been simplified. Its address switches are marked to give simple translate and run program starting points. Initial orders are read in from a single button.

A program trace facility is fitted to enable the teacher to follow the detailed path of a students program.

Interrupts of three levels may be given by the operator, these are used with pre-arranged sequences written into the programs, for instance one could have a program operating in level 1 which prints out answers, etc., so that when the INTERRUPT 1 button is operated an answer is automatically printed out.

Sometimes it is required to reset registers etc. without losing the contents of the store, it is for this reason that a RESET button is included.

A HALT/COMPUTE button is fitted to enable the computer to be stopped when desired.

For the reader and punch there are two controls each.

The READ and STOP buttons are used with the reader and the RUNOUT and RELOAD with the punch.

The only control not yet mentioned is POWER. This has two indicator lamps, one labelled ON, the other OFF. They serve two purposes, one is illuminated when the mains is connected but the computer is OFF, the other is illuminated when both the mains and computer are ON.

A loudspeaker is fitted to give audible indication of program running.

Program input is by the 250 c.p.s. Elliott paper tape reader.

Computer output is by punched paper tape from a 100 c.p.s. punch.

A teleprinter which can read and print, or punch at 10 c.p.s. is available. This can be used separately to prepare program tapes ready for reading into the computer, or to print out on paper information punched out on paper tape by the computer. Thus any number of teleprinters may be used with each computer.

An optional extra is a teleprinter wired directly to the computer. This has the advantage that direct communication is made to and from the computer, i.e. instructions may be typed on the keyboard, and when results are available from the computer they may be typed out by the teleprinter immediately.

3. *Technical Description*

The computer comprises three basic units, they are:

(i) the central processor
(ii) the main store
(iii) the input/output equipment

The Central Processor

The processor operates in a parallel binary mode and uses an 18 bit word. There are 16 basic instructions all of which may be modified. Instructions are of the single address type: 13 bits are used to specify the address, 4 bits specify the

function and one bit is used as a modifier. Each word of the store may be directly addressed.

In the course of a program, instructions are extracted from the store under the control of a sequence control register (S.C.R.) which holds the address of the next instruction to be obeyed and incremented automatically after each instruction.

To allow the operation of 4 programs, 4 sequence control registers are provided one for each priority level.

In addition to the above registers the central processor unit contains two other registers which can be referred to by instructions.

(1) the accumulator, which holds the result of arithmetic operations.
(2) the auxiliary register, this is used as an extension to the accumulator for holding double length numbers in shifting multiplication and division etc.

A further register accessible to the programmer is held in the store; it is the modifier register, as in the case of the S.C.R. one register is provided for each program level.

Under the system of priority interrupts programs on priority levels 1, 2 and 3 will be started in response to external operation of the appropriate buttons. If none of them is operated the program on priority level 4 will operate. Any level (except 1 of course) can be interrupted by a higher priority interrupt whatever the source.

The computing times are as follows:

Add	23 micro-seconds
Multiply	78·5 micro-seconds
Divide	81·5 micro-seconds
Transfer rate	300,000 six bit characters per second maximum

The Main Store

The minimum size available contains 4,096 words each holding 18 bits. The recommended size suitable for use with high level compilers is 8,192 words. Facilities are available for adding extra modules up to a maximum of 65,536 words.

Input/Output Equipment

Two types of basic input/output equipment are available.

The first is a separate paper tape reader having a maximum speed of 250 c.p.s. and a paper tape punch capable of punching 100 c.p.s. The reader is made by *Elliott-Automation Accessories Limited* and has proved its reliability over a

period of several years. The punch is the Teletype punch which has been used very successfully on Elliott computers for many years (one well known example is the 803B).

The second basic input/output equipment is a Teletype teleprinter which is essentially a combined tape reader and punch, and a type-writer. The maximum speed of operation of this equipment is 10 c.p.s.

A similar teleprinter can also be used off-line for preparing punched tape programs, or printing out results from punched tape output from the computer tape punch. This means, in practice, that several teleprinters may be a worthwhile proposition where computer time is rationed.

Peripherals

A full range of peripherals will be available for use with the 903. It will include:

(i) Magnetic Tape Storage Units (Industry Compatible)
(ii) Magnetic Tape Storage Units (Low Cost; Cassette Loading)
(iii) Lineprinters
(iv) Card Readers and Punches
(v) Data Disc random access stores
(vi) Enquiry Stations

Software and Supporting Services

Algol and Fortran: ALGOL and FORTRAN will be provided on the 903 as basic languages. The program is translated in two stages. The first stage consists of reading the ALGOL or FORTRAN program and producing a binary coded tape. (Once the translator program has been put in the computer, any number of ALGOL or FORTRAN programs may be translated and binary coded tapes produced.) Secondly the binary-coded tape is read into the computer, under control of a "Loader" program and run in the normal way.

Of special interest is a City and Guilds 319 Computer Personnel course compiler which will shortly be available for use with the 903.

There is a comprehensive symbolic assembly program. This program enables users to write, in effect, in machine code but with all the advantages of a symbolic routine. There is also an extensive library of sub-routines and programs available for the computer.

The computer and software will be supported by a range of text books on basic computers, operating systems and programming. A complete set of sample programs with answers is currently being compiled. These sample programs can be included in a main program as sub-routines, e.g. square root, special input/output routines etc. The emphasis is as much on commercial work—e.g. character strings, complex input/output routines, sorting etc.—as on scientific work—e.g. square roots, sin, cos, tan etc.

Also available is a computer teaching aid, the Elliott Logical Sequence Display, which demonstrates the action of adders, shift registers and other logical configurations and is intended for use in class teaching.