An Introduction to the

FERRANTI

MERCURY COMPUTER



An outstanding feature of the Ferranti Mercury Computer is that magnetic cores are used for the store in which all computation is carried out. These cores are mounted in square arrays of 32 by 32. The typical plate illustrated above contains two such arrays, one on either side. The central coloured area in the photograph has been enlarged and used as a background on the front cover of this brochure.

Donald G. McBrien

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Ferranti Ltd. announce a new large-scale Electronic Digital Computer, to be known as MERCURY. In the design of this computer, the aim has been to produce a machine which, although completely versatile, will be principally used in performing calculations of a scientific and technical nature. The design has been evolved with the collaboration of Manchester University. The main features were established after a prolonged study of the requirements of a computing machine; the engineering techniques have resulted from intensive research and development in the Ferranti laboratories. To this has been added the wealth of experience that Ferranti engineers and mathematicians have obtained in the application and use of computers in the last eight years. The resulting machine is a truly remarkable one – immensely powerful, of enormous capacity, exceptionally fast, and providing facilities for the most advanced techniques of programming.

There are many classes of problem (large sets of partial differential equations, for example) which, although they may theoretically be solved on existing machines, are found in practice to take far too (*Continued overleaf*)



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long. It is confidently expected that many such problems will easily fall within the scope of Mercury.

Of the many interesting features of Mercury, there are three principal ones which deserve special mention. The first is the speed; arithmetical operations take on average only 180 microseconds. With a machine working at this speed, it becomes possible to perform calculations of a nature hitherto considered quite intractable.

The second special feature, and this is in some ways even more important than the first, is that all arithmetical operations are carried out on numbers represented in floating-point form. This simply means that numbers are stored in two parts: a standardized fractional part (in the range one-half to one, positive or negative), and an 'exponent' part with a sufficiently wide range to accommodate all numbers likely to occur in practical computations. This arrangement ensures that all numbers are held and handled within the machine in such a way that overflow of any register cannot occur. The range of the numbers which can be accommodated is, in practice, unlimited; in scientific problems this feature is an enormous advantage, as it is generally difficult to predict the ranges of the variables of the computation without doing subsidiary calculations.

The third main feature is the storage capacity provided in this machine. The computer embodies the principle (which is also the basis of the Ferranti Manchester Computers Mark I and Mark I*, and the Ferranti Pegasus Computer (of a high-speed store in which all the computation is done, backed by large capacity magnetic drum storage units. In Mercury the computing store is sufficient to hold large sections of a calculation, and the backing store has a capacity which experience has shown gives the user great freedom of action.

These features, and many others, combine to make the Mercury Computer an indispensable tool in any establishment where largescale calculations have to be carried out.



sound reasons why an organisation would benefit by using a Ferranti Mercury Computer

UTILITY Mercury will readily handle all kinds of lengthy and complex computing problems encountered in industry and research.

QUALITY The name Ferranti has a world-wide reputation for quality in electronic products.

ECONOMY This machine has an unusually high performance v. cost characteristic.

THE FOLLOWING SUPPLEMENTARY SERVICES ARE OFFERED TO PURCHASERS OF FERRANTI COMPUTERS

Library of Standard Routines

There will be available with every machine a comprehensive library of all the routines that are likely to be of assistance to a user in drawing up new programmes.

Customer Liaison

Ferranti Ltd. arrange for the interchange of information on computing techniques amongst the users of Ferranti machines. The opportunity exists for each user to circulate descriptions of calculations and programmes of general interest and, reciprocally, thereby benefit from the work done by other users.

Training of Operators and Engineers

From time to time, training courses are arranged for those learning to prepare programmes, and for maintenance engineers.

Instruction manuals will be available, covering the writing of programmes, the operation of the machine and its maintenance.

Performance Tests

It is normal practice for Ferranti Ltd. to put each Computer through very comprehensive performance tests, both at their factory and after installation in the customer's premises; these may be attended by representatives of the customer and also by an independent authority if required.



FERRANTI MERCUR





This artist's impression shows a typical Mercury installation. The input tape-reader is on the left of the control desk, and the output tape punch and teleprinter are to the right of the desk. The cabinets on the left contain the accumulator and multiplier units; the cabinets adjoining the desk contain the basic control circuits, part of the computing store and the B-registers. On the extreme right of the illustration are the four independent magnetic drum units for the backing store.

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The Main Features

OF THE FERRANTI MERCURY COMPUTER

Speed of Operation

The time required to add (or subtract) two floating-point numbers is only 180 microseconds, while two such numbers may be multiplied in 300 microseconds. A group of operations chiefly used for the organization of a calculation take only 60 microseconds. An important factor contributing to the high speed of operation is that there is no delay associated with obtaining any number held in the computing store.

Floating-point Representation of numbers

Magnetic Core Computing Store The Ferranti Mercury Computer is a floating-point machine. This means that all numbers within the machine automatically scale themselves as the calculation proceeds. At all times, every number is stored and handled with a precision equivalent to about nine decimal digits.

All computation is carried out in a store consisting of magnetic cores. The reliability of this form of storage is very great and will ensure long periods of trouble-free operation. The computing store has the very large capacity of 1024 words (a word being one number or two orders). The capacity of the computing store may be reduced to a half or a quarter of its standard size, should this be desired for machines intended for special or restricted applications.

Magnetic Drum Backing Store The Mercury computer has for its backing store four magnetic drums with a total capacity of over 16,000 full-length words, equivalent to over half a million binary digits. This storage is sufficient for a very large proportion of the problems which occur in science and technology, and obviates the need for such devices as punching out intermediate results for re-input to the computer at a later stage of the calculation.

Input and Output Programme material and numerical data are fed into the computer on 5-hole teleprinter tape, which is read by a Ferranti high-speed photoelectric Tape Reader (at 400 characters per second). Results are presented by means of a medium-speed Tape Punch (working at 33 characters per second), on a tape which may be printed out by means of a teleprinter. Provision is made for the addition of other input/output devices (*e.g.* magnetic tape) if these are desired. The teleprinter code for both input and output has been chosen in such a way as to make it extremely unlikely that any errors which might occur shall pass undetected.

Internal Checking Along with every group of digits inside the machine is stored an extra digit which is used for checking purposes only. If a defect in the computing store should cause any number to change, this would automatically be detected when the number was next referred to. There is a similar check on the information in the backing store.

The Order Code

The form of the instructions for the Ferranti Mercury Computer is based on the years of experience that Ferranti experts have had in introducing programming to newcomers in the programming field. The system is simple enough to be readily learnt, yet at the same time pleasing to the expert, who will find everything he could wish for. In Mercury, the instructions are obeyed in the same order as they are written (unless a specific break is called for), and the full computing speed is obtained without having to consider any special arrangement of the instructions, or the relative timing of one with another. Thus, the difficulties of 'optimum programming' do not arise. Decimal numbers are used to define the functions, and the addresses of the storage locations. There is a single accumulator, and each instruction refers implicitly to this accumulator, and to one other number, referred to through its address in the computing store. For example, 'add the number stored in address 30 into the accumulator'.

A very full range of functions has been provided (approximately 60) and their codes have been arranged in a logical manner for the benefit of the programmer, who is very soon able to remember the most important codes without having made any conscious effort to learn them.

In order to facilitate repeated operations on a series of numbers (*i.e.* where similar operations are carried out on numbers in a series of addresses), seven special registers have been provided, which are known as B-registers. Every instruction specifies one B-register, and the effect is that the contents of this B-register are added to the address-part of the instruction before the instruction is obeyed. This arrangement is simple but effective, and has been an established feature of Ferranti Computers for many years.

Of the seven B-registers, one has been selected to play a special rôle. B-register number 7 may be used as a short accumulator when it is desired to work with small integers equivalent to about three decimal digits. The instructions relating to this short accumulator may be modified by the contents of any of the B-registers; for example, numbers may be transferred to B7 from a B-modified address.

Instructions involving the B-registers require only 60 microseconds for their execution. This implies a reduction in the ratio of the time spent in carrying out 'red-tape' instructions (*i.e.* those instructions required solely for the organization of the calculation), to the useful computing time.



The backing store consists of four magnetic drums, each rotating at 3472 r.p.m., and having a storage capacity of 4096 40-digit words. Every group of 10 digits in the backing store has a check digit associated with it; this digit is referred to whenever a transfer is made to the computing store. Any error in operation will be detected and the machine will indicate this and stop.

The rectangular loop ferrite core-storage system provides a basic capacity of 1024 10-digit words for the computing store. Magnetic cores are inherently stable, and full advantages of their characteristics has been taken in the design of the system. The cores are arranged in square arrays of size 32 by 32, and 44 such arrays comprise the whole computing store. The 10 digits of any short word, and the associated check digit, are stored in the corresponding positions of a group of 11 squares. Any core is interrogated by energizing the appropriate horizontal and vertical wires, and reading the answer on a diagonal wire. The 10 digits of a short word are available to the arithmetical unit in parallel, and are converted into serial form for all operations within the computer.





Data are represented by holes punched in paper tape. The digits 0 to 9 are all represented by rows containing an odd number of holes. This allows them to be checked, for should an error have occurred and one hole be dropped or an extra one put in, the resulting character would not be a number but some other symbol. On input the check is made by the computer; on output any such error would be immediately apparent.

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Some applications of

- Dum Construction. Many problems in Civil Engineering can be handled on a computer; typical is the calculation of the stresses within a large concrete dam. This work involves the inversion of very large matrices.
- Cotton Spinning, Electronic computers have proved themselves useful in many unexpected fields. One such application arises in high speed ringspinning research in the cotton industry. The particular problem solved concerned the mathematics of a whirling thread, taking air resistance into account.
- Aircraft Design. Great use has already been made of Ferranti digital computers by the Aircraft Industry. As a design tool digital computers are becoming more and more of a necessity.
- 4. Whirling of Shafts, Digital computers are used for the determination of the whirling speeds of gas and steam turbines and other shaft-systems. The computer can determine the vibrations of large and complicated rotor systems.
- 5. Wages Computation, Computers have many applications in the fields of commerce and administration. As an example, a complete demonstration programme has been compiled which will enable gross wages to be calculated in the case of an organization where a variety of bonus schemes exist, and the resulting net wages with appropriate deductions for Income Tax, National Insurance, etc. computed.
- 6. Weather Forecasting. Experimental calculations have been made to test whether knowledge of the physical behaviour of the atmosphere is sufficient to enable tomorrow's weather map to be calculated. Encouraging results are being obtained. (The chart is reproduced by the courtesy of the Director Meteorological Office, London.)

Ferranti Computers











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