ABC of Computing

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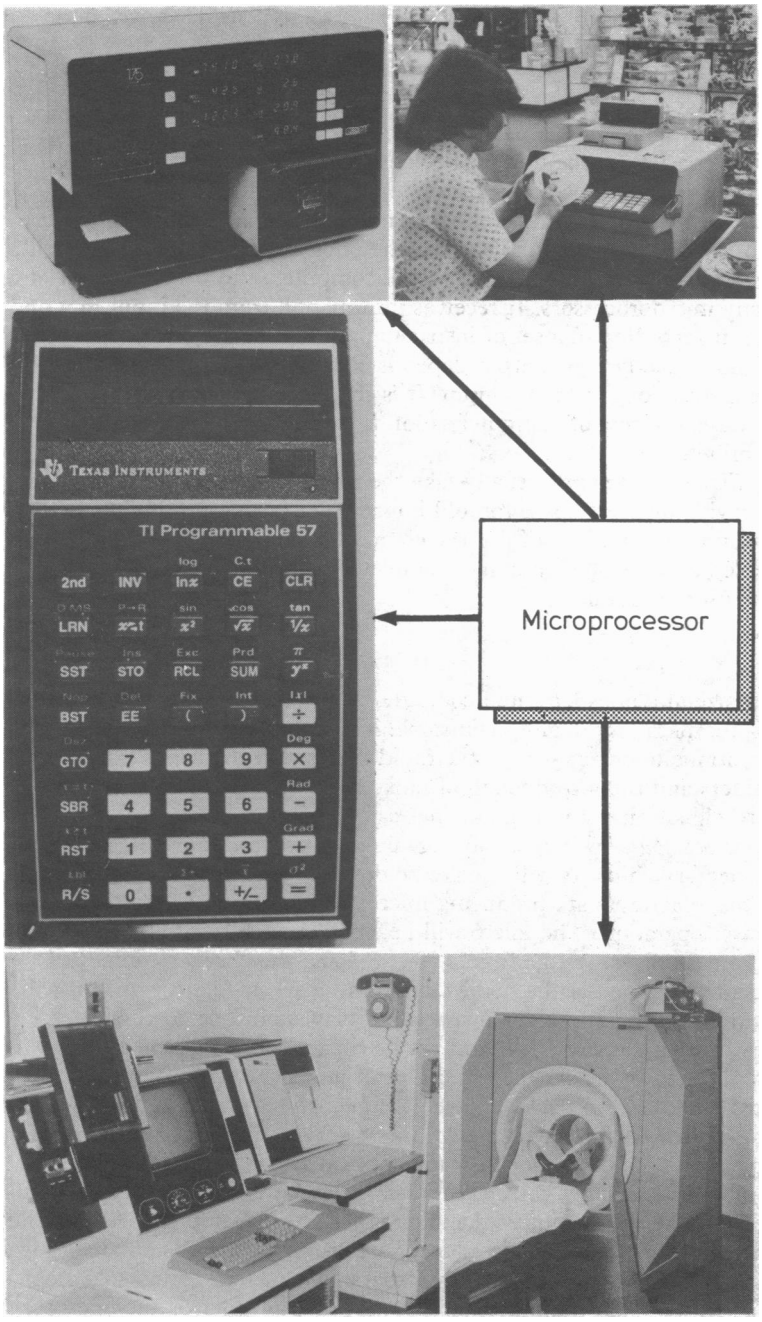
WHAT IS A DIGITAL COMPUTER?



Computers have a bad image as the mindless machines that send six figure gas bills to old age pensioners. But they also form the basis of many other, seemingly unrelated, activities: the automatic supermarket till that "reads" the price label on purchases; the computed tomography scanner; the pocket calculator; and the automatic blood gas analyser, which does all the measurements, prints the results, and automatically cleans itself.

It is easier to define the computing process than to describe how to recognise a computer. The principle is that incoming information is entered in a predetermined form and manipulated according to a set of rules (added, divided, sorted, etc) and the resulting information is then either presented directly to the user or used to control another piece of apparatus. The basic unit in all these activities is the microprocessor—the component that has caused the revolution in computing in the past 20 years. The first computers were designed only for mathematical calculation, were large, had a limited capability, and consumed as much power as a village. The modern microprocessor, which contains thousands of transistors on a minute chip of silicon (typically 5 mm square), can be used in many different ways and can run off batteries. Modern techniques for producing transistors allow complex microprocessor circuits to be mass produced, and the development of these methods has caused prices to fall dramatically.

Perhaps the most striking growth is in memory size. Five years ago few people could afford computers with large memory banks to run programs. Most of the large computing power resided in universities and industry. Now the silicon chip has made computer memory so cheap that even a small business can afford a powerful computer, for accounts, VAT, payroll, stock taking, etc. The market for more memory in a smaller volume (packing density) seems insatiable, and already manufacturers are developing laser techniques for memory modules which will hold the equivalent of 10 novels in the space of a credit card. One could foresee a patient's whole case file condensed to the size of a credit card, with immediate access to all parts and no loss of information.

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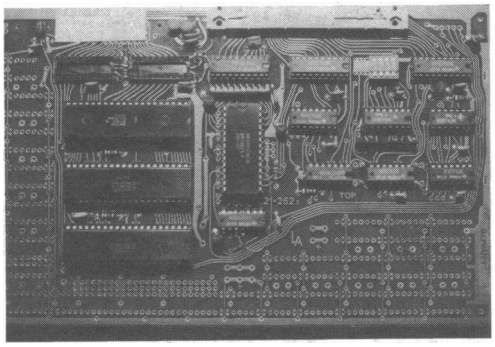
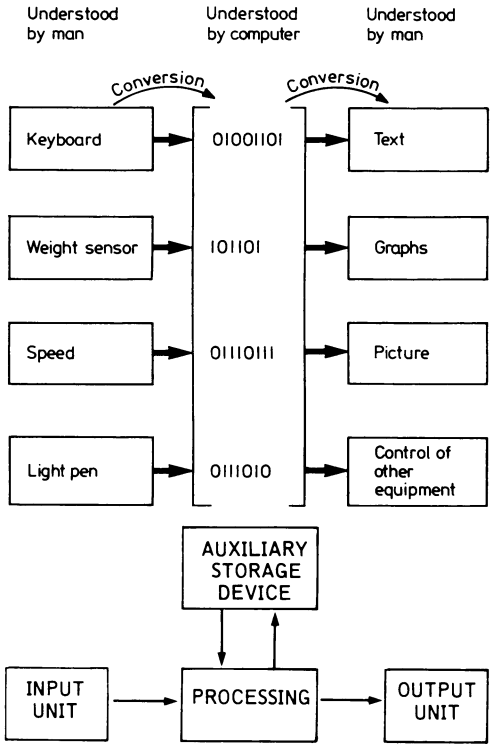


A computer may take many forms. Some, such as the desk top computer, are flexible in their design and can be used for a wide variety of tasks, according to the way the user chooses to program them (non-dedicated computer application). Others, such as the supermarket till, are designed to perform only one function (a dedicated application). Both, nevertheless, contain microprocessors.

The shape of a computer



Dedicated or non-dedicated, nearly all computers conform to the same plan and include four basic parts.

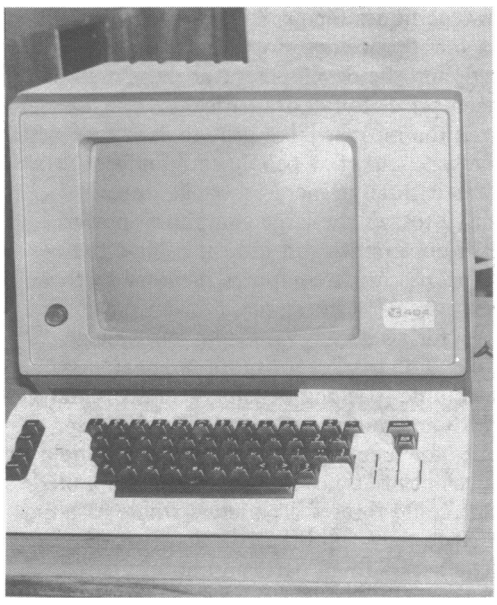
The input unit converts information from a form understandable to the user to a form understandable by the computer. The information may come from the electrodes in a blood gas analyser, the typists' keyboard in an automatic text processor, or the keys on the supermarket till.

The output unit converts the stream of information from the processing unit into a form that the user can use: a television display of patient data on a surgery computer; a precise graph for the statistician; a statement of banking disaster for the unwary businessman. The computer may send its signals to a more powerful computer or control the function of complicated machinery (as in modern military aircraft, where computers do most of the flight control because the pilot cannot be precise enough).

The processing unit is the heart of the computer, and it may consist of one or many microprocessors. It receives information from the input unit and acts on it according to a set of instructions (the user program), which it will follow exactly. The output depends entirely on the sense or otherwise of the instructions in the program. It is therefore not surprising that in many cases the cost of computerisation is mainly the cost of employing good programmers.

Auxiliary storage units usually take the form of magnetic discs or tapes and provide memory space to hold information during processing. The information is stored in a form the computer can understand (computer readable), and the storage unit is completely controlled by the processor and its user program.

Micro to mainframe



The size of a non-dedicated computer is commonly described by three concepts: micro, mini, and mainframe. The definitions have changed—and continue to change—with the rapid increase in the complexity of computers and the introduction of inexpensive microprocessors. Nevertheless, some simple guidelines can be given.

A microcomputer will probably contain one or two microprocessors with some memory chips. It will usually be designed for a single user, though some manufacturers are producing micros which can be linked for multiuser operation. The micro will be small enough to sit comfortably on top of a desk. Prices range from £50 to £4000, the cheaper computers tending to be aimed at the home computing market. As little as £50 will buy a micro which has enough storage to play sophisticated computer games, using a domestic TV, and yet be capable of useful computation though limited by its slowness and lack of memory. Such computers are already being used to teach children the elements of computing. A micro costing nearer £4000 may come with its own visual display unit, auxiliary storage device, and would have a memory capacity some 50 times greater than that of its cheaper cousin. More commercially produced software is available for microcomputers than any other size of computer. At one end of the scale games and simple educational programs may be obtained for as little as £10. At the other, business programs, which are often sold along with a series of staff training tutorials, may cost as much as the micro itself.

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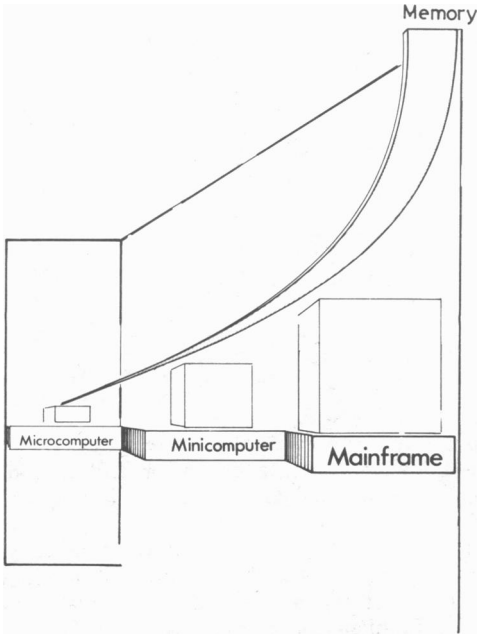


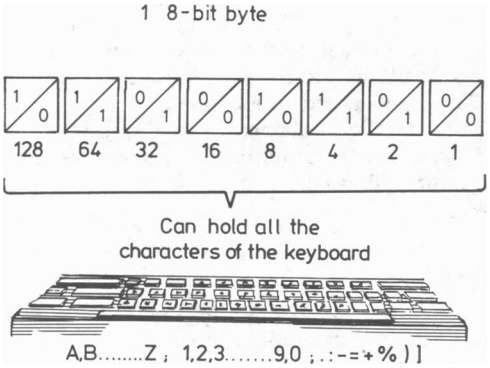
A minicomputer will contain many microprocessor chips and can handle the tasks of many users with such speed that it seems to be doing them simultaneously. In volume the mini is usually a roomful and may cost from £4000 to £100 000. If for example the minicomputer is to be used in industry, one would add the cost of terminals. There might be 20 terminals sighted in offices, on the shop floor, etc, each costing £300. The commercially produced programs for minicomputers could easily cost from £500 to £10 000, depending on facilities and on the need for modifications. One might well find micros and minis in industry, the mini managing the purchasing, stock control, accounting, and wages while micros were used for desk top calculations on the shop floor.

The mainframe computer is at the top of the scale of computer size and may occupy several rooms. It costs well over £100 000 and will support many users. The mainframe may be connected to many minis and would support calculation techniques which cannot be undertaken on smaller computers. Typically mainframes are maintained at universities and large research establishments. Most university mainframe computers are interlinked by land lines to form a network so that a user in Sheffield can use facilities supported in London, or even abroad.

Usually when a mainframe is bought a suite of programs, worth many thousands of pounds, is provided, and these are subsequently modified by the purchaser.

Unfortunately these definitions of computer size are fluid as manufacturers increasingly manage to pack more computing power into smaller and smaller space.

Memories

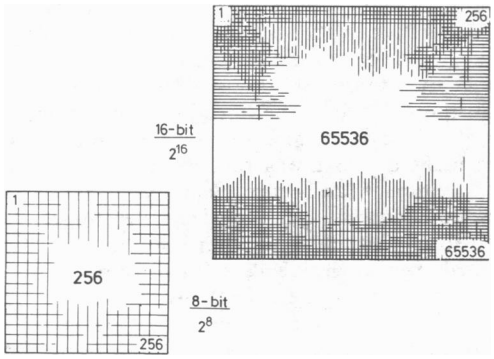


One important and hitherto bulky part of the computer is the memory, which usually forms an integral part of the microprocessor unit. This integral memory may be sufficient to hold a program, but may not be able to hold the data as well. In this case an auxiliary storage device can be used to hold the data ready to be brought into the integral memory. Commonly the programs, data, and eventually the results are all held on the auxiliary storage device.

Computer memory is usually described in terms of bytes. A byte is the smallest functional unit of computer memory; a bit is the binary subunit of the byte, and usually there are eight bits to the byte. The byte can hold one character. A six figure number may be stored in several bytes, which are then treated as a single unit for calculation. For most purposes the byte as a unit is too small and most people tend to think in terms of kilobytes, each of which is just over 1000 bytes (1024 in fact), and megabytes, each of which is just over a million bytes. In terms of text storage a page of A4 typing, double spaced, might occupy about one kilobyte.

Typically a modern microcomputer may have up to 64 kilobytes of memory with another megabyte available on auxiliary storage devices. A mini may start with a megabyte of memory and have access to another 300 on the auxiliary storage devices. A mainframe computer may have many megabytes integral memory on thousands of chips and thousands of megabytes of storage on auxiliary storage devices.

Eight and 16 bit processors



There is an increasing trend in computing to use microprocessors which have 16 bits to the byte rather than eight. This trend has come about because the memory chips are now so cheap that computer development is less hindered by the price of chips. 16 Bit computers offer an increased range of simple commands, more rapid transfer of data, access to a greater range of data, and more precision in calculation. This is undoubtedly an important revolution in computing and it will inevitably influence medical computing in the future.

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