Modern computers

Concept of modern computer

The principle of the modern computer was proposed by Alan Turing in his seminal 1936 paper,[] *On Computable Numbers*. Turing proposed a simple device that he called "Universal Computing machine" and that is now known as a universal Turing machine. He proved that such a machine is capable of computing anything that is computable by executing instructions (program) stored on tape, allowing the machine to be programmable. The fundamental concept of Turing's design is the stored program, where all the instructions for computing are stored in memory. Von Neumann acknowledged that the central concept of the modern computer was due to this paper.[58] Turing machines are to this day a central object of study in theory of computation. Except for the limitations imposed by their finite memory stores, modern computers are said to be Turing-complete, which is to say, they have algorithm execution capability equivalent to a universal Turing machine.

Stored programs
Main article: Stored-program computer


A section of the reconstructed Manchester Baby, the first electronic stored-program computer

Early computing machines had fixed programs. Changing its function required the re-wiring and re-structuring of the machine.[] With the proposal of the stored-program computer this changed. A stored-program computer includes by design an instruction set and can store in memory a set of instructions (a program) that details the computation. The theoretical basis for the stored-program computer was laid out by Alan Turing in his 1936 paper. In 1945, Turing joined the National Physical Laboratory and began work on developing an electronic stored-program digital computer. His 1945 report "Proposed Electronic Calculator" was the first specification for such a device. John von Neumann at

the University of Pennsylvania also circulated his *First Draft of a Report on the EDVAC* in 1945.[]

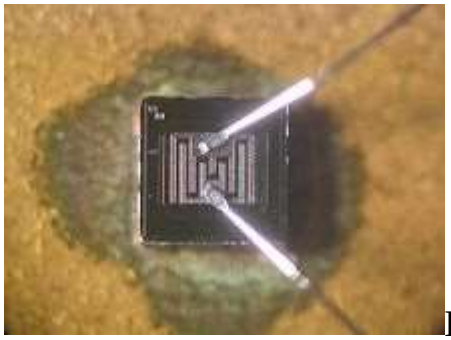
The Manchester Baby was the world's first stored-program computer. It was built at the University of Manchester in England by Frederic C. Williams, Tom Kilburn and Geoff Tootill, and ran its first program on 21 June 1948.[] It was designed as a testbed for the Williams tube, the first random-access digital storage device.[] Although the computer was described as "small and primitive" by a 1998 retrospective, it was the first working machine to contain all of the elements essential to a modern electronic computer.[] As soon as the Baby had demonstrated the feasibility of its design, a project began at the university to develop it into a practically useful computer, the Manchester Mark 1.

The Mark 1 in turn quickly became the prototype for the Ferranti Mark 1, the world's first commercially available general-purpose computer.[] Built by Ferranti, it was delivered to the University of Manchester in February 1951. At least seven of these later machines were delivered between 1953 and 1957, one of them to Shell labs in Amsterdam.[] In October 1947 the directors of British catering company J. Lyons & Company decided to take an active role in promoting the commercial development of computers. Lyons's LEO I computer, modelled closely on the Cambridge EDSAC of 1949, became operational in April 1951[64] and ran the world's first routine office computer job.

Grace Hopper was the first to develop a compiler for a programming language.[

Transistors
Main articles: Transistor and History of the transistor

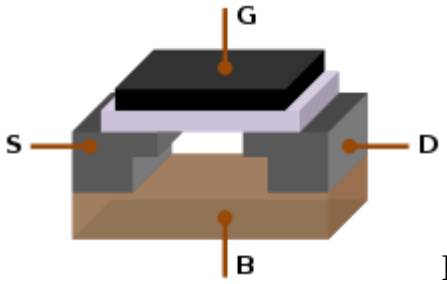
Further information: Transistor computer and MOSFET


Bipolar junction transistor (BJT)

The concept of a field-effect transistor was proposed by Julius Edgar Lilienfeld in 1925. John Bardeen and Walter Brattain, while working under William Shockley at Bell Labs, built the first working transistor, the point-contact transistor, in 1947, which was followed by Shockley's bipolar junction transistor in 1948. From 1955 onwards,

transistors replaced vacuum tubes in computer designs, giving rise to the "second generation" of computers. Compared to vacuum tubes, transistors have many advantages: they are smaller, and require less power than vacuum tubes, so give off less heat. Junction transistors were much more reliable than vacuum tubes and had longer, indefinite, service life. Transistorized computers could contain tens of thousands of binary logic circuits in a relatively compact space. However, early junction transistors were relatively bulky devices that were difficult to manufacture on a mass-production basis, which limited them to a number of specialized applications.[]

At the University of Manchester, a team under the leadership of Tom Kilburn designed and built a machine using the newly developed transistors instead of valves.[] Their first transistorized computer and the first in the world, was operational by 1953, and a second version was completed there in April 1955. However, the machine did make use of valves to generate its 125 kHz clock waveforms and in the circuitry to read and write on its magnetic drum memory, so it was not the first completely transistorized computer. That distinction goes to the Harwell CADET of 1955,[] built by the electronics division of the Atomic Energy Research Establishment at Harwell.



MOSFET (MOS transistor), showing gate (G), body (B), source (S) and drain (D) terminals. The gate is separated from the body by an insulating layer (pink).

The metal–oxide–silicon field-effect transistor (MOSFET), also known as the MOS transistor, was invented by Mohamed M. Atalla and Dawon Kahng at Bell Labs in 1959.[] It was the first truly compact transistor that could be miniaturized and mass-produced for a wide range of uses.[] With its high scalability,[] and much lower power consumption and higher density than bipolar junction transistors,[] the MOSFET made it possible to build high-density integrated circuits. In addition to data processing, it also enabled the practical use of MOS transistors as memory cell storage elements, leading to the development of MOS semiconductor memory, which replaced earlier magnetic-core memory in computers. The MOSFET led to the microcomputer revolution,[] and became the driving force behind the computer revolution. The MOSFET is the most widely

used transistor in computers, and is the fundamental building block of digital electronics.[1]