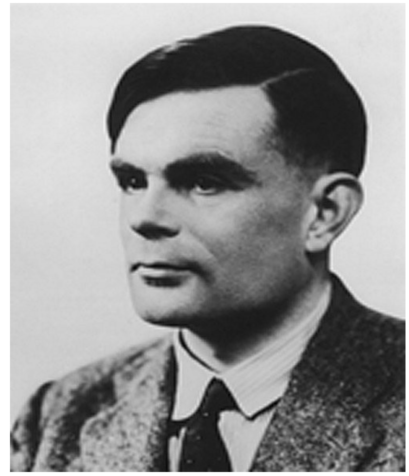
Alan Turing

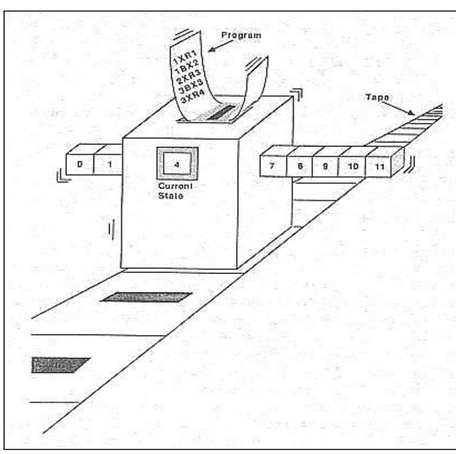


English mathematician and philosopher **Alan Mathison Turing** (June 23, 1912 – June 7, 1954) was a brilliant original thinker and the theoretical founder of the computer revolution. As a code breaker he helped win WWII, as a searcher for the relationship between mind and matter he became a pioneer in the field of computer science. His research into the relationships between machines and nature led to the creation of the field of artificial intelligence. In a seminal paper "On Computable Numbers," (1936) he proved that there cannot exist any general algorithmic means of determining truth in mathematics, and that mathematics will always contain undecidable, as opposed to unknown, propositions.

Turing was born in Paddington, London. His father was a British member of the Indian Civil Service and his mother was the daughter of the chief engineer of the Madras railways. When Alan was one year old his mother returned to India to be with her husband, leaving Alan and his older brother John in England with friends of the family. From 1926 to 1931, Turing attended Sherborne School, where he excelled at mathematics and the sciences, but did not care much for other subjects. Even in mathematics he was more interested in his own ideas than those of his teachers. Early in life Turing developed a healthy skepticism, a distrust of authority, and a lack of interest in worldly values. He was considered eccentric, particularly because of his mood swings from depression to high-spirits. He also was aware that he was gay and did not wish to hide the fact.

In 1931, Turing entered King's College, Cambridge to study mathematics. There he had more freedom to explore his own ideas. He read John von Neumann's text on quantum mechanics, a subject that he hoped would help him answer his questions about mind and matter. By the time he earned an M.A. in 1935, Turing had turned his attention to mathematical logic, making history by solving one of its most outstanding problems. The challenge was to determine if it were possible to devise a systematic procedure that infallibly could recognize undecidable propositions. In 1928, David Hilbert raised the question as to whether mathematics was *complete*, *consistent*, and *decidable*. Turing sought a useful definition of computation and the means of knowing if a computation could actually be performed. He invented a theoretical concept, later called a universal "Turing Machine," capable of carrying out all possible computations. His results were contained in "On Computable Numbers, with an Application to the Entscheidungsproblem*"* (1936). The Entscheidungsproblem was the mathematical problem of *decidability.*

Turing envisaged a theoretical "machine" that would be designed to sort propositions into decidable and undecidable. He believed such a device would be capable of deciding the truth of mathematical



statements automatically without human involvement. The machine would be something like a typewriter, designed to mark symbols on a page, but also designed to read or scan other given symbols, and to erase them if necessary. He imagined a tape of infinite length, divided into squares, with each square containing a single symbol. The instrument would move the tape one square at a time, read the symbol, and then either remain in the same state, or move to a new state, depending on what it read. In each case the response would be purely automatic. The machine would either leave the symbol alone, or erase it and type another, and then it would move the tape one square and continue. If it actually existed, the so-called Turing machine would transform one series of symbols into another series in accordance with some predetermined set of rules. These rules could, if necessary, be tabulated, and the behavior of the machine at each step could be read from the table.

Turing defined a number to be "computable" if in using a finite set of instructions, the number could be generated to unlimited accuracy, even if the complete answer would be infinitely long. He imagined an infinitely long list of all computable numbers. Now the question became, "does this infinite list of all the computable numbers contain every conceivable number." Turing discovered the answer was "No!" He showed how such a list could be used to create other numbers that were not anywhere on the list. As the list includes all computable numbers, it follows that the new numbers must be uncomputable. Getting Turing's paper accepted was complicated by the fact that American logician Alonzo Church had published an unsolvable problem in elementary number theory that also proved there is no decision procedure for arithmetic, but by a totally different approach. Early in 1936, Turing went to Princeton in the United States to study with Church, who directed his 1938 Ph.D. thesis. While at Princeton, Turing gave some thought to constructing a computer, but it wasn't until he returned to Cambridge that he began in earnest to build an analogue mechanical device with which he hoped to investigate the Riemann hypothesis.

When Britain declared war on Germany in 1939, Turing was asked by the Government Code and Cypher School to join the effort to break the German Enigma codes. During the next few years, working at Bletchley Park, the cryptanalytic headquarters, Turing contributed many mathematical insights, both for breaking the Enigma code and the "Fish" teletype cyphers, as well as the development of the special purpose digital computer *Colossus*, developed by Max Newman. In addition, Turing designed advanced versions of the Polish "bombe," which was used to find keys for Enigma messages. There is no way to calculate precisely the number of lives saved by Turing and his Bletchley Park colleagues' efforts, but the number must have been very large.

After the war, the National Physical Laboratory of London recruited Turing to design and develop an electronic computer – an actual version of the universal Turing machine. His conception of the Automatic Computing Engine (ACE) was the first relatively complete specification of an electronic stored-program general-purpose digital computer. In 1948 he joined the University of Manchester where he created the programming system of the Ferranti Mark I, the world's first commercially available electronic digital computer. Two years later, Turing published *Computing Machinery and Intelligence in Mind.* With it, he became the leading early exponent of the hypothesis that the human brain is in large part a digital computing machine. He theorized that at birth the cortex is an "unorganized machine" which through "training" becomes organized "into a universal machine or something like it."

By 1952, the Cold War made democracies mistrust their own people. Governments on both sides of the ocean were fearful of what their brilliant scientists might do with the secret knowledge gained during the war. One night Turing called the police to report a burglary. Their investigation led them to discover that the thief was a man with whom Turing was sexually involved and who was now trying to blackmail him. Turing was arrested under the Criminal Law Amendment Act of 1885 that defined a male homosexual act as a *gross indecency*. He was tried on March 31, 1952, offering no defense other than he saw nothing wrong with his actions. No one in the government, which he served so brilliantly during the war, came to his support. It is likely that they believed his homosexuality made him a security risk. He was convicted and was given the alternatives of prison or submission to psychoanalysis and oestrogen [hormones produced by the ovaries of vertebrates or synthetic hormones that mimic there effects] injections for a year in an effort to "cure" his disease. He chose the latter and returned to a wide range of academic pursuits.

Turing died of potassium cyanide poisoning while conducting electrolysis experiments. The cyanide was found in a half-eaten apple beside his body. Medical examiners concluded that his death was a suicide "while in a moment of mental imbalance." Some believed that his trial and the subsequent treatment unbalanced him and he killed himself in the throes of depression. His mother had another explanation, claiming that he had been experimenting with household chemicals, trying to create new substances and became careless. Whatever, the truth, Turing deserves consideration as the "father of the computer" and a major contributor to the war effort. As Peter J. Hilton reports in "Cryptanalysis in World War II – and Mathematics Education, *The Mathematics Teacher*, October 1984:

> "L.J. Good, a wartime colleague and a friend, has aptly remarked that it is fortunate that the authorities did not know during the war that Turing was a homosexual; otherwise, the Allies might have lost the war."

Quotation of the Day: "Machines take me by surprise with great frequency." – Alan M. Turing