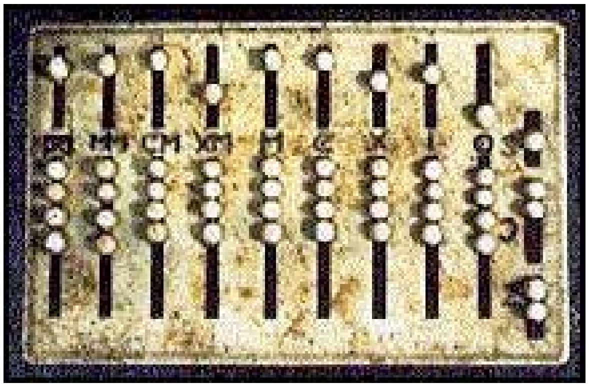
Key Events in the History of Computing

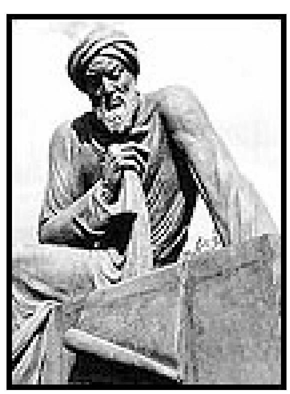
The Early Years



Calculation was a need from the early days when it was necessary to account to others for individual or group actions, particularly in relation to maintaining inventories (of flocks of sheep) or reconciling (adjusting) finances. Early man counted by means of matching one set of objects with another set (stones and sheep). The operations of addition and subtraction were simply the operations of adding or subtracting groups of objects to the sack of counting stones or pebbles. Early counting tables, named abaci, not only formalized this counting method but also introduced the concept of positional notation that we use today. The next logical step was to produce the first "personal calculator" -- the abacus -- which used the same concepts of one set of objects standing in for objects in another set, but also the concept of a single object standing for a collection of objects -- positional notation. This one-for-one correspondence continued for many centuries even up through the many years when early calculators used the placement of holes in a dial to signify a count -- such as in a rotary dial telephone. Although these machines often had the number symbol engraved alongside the dial holes, the user did not have to know the relationship between the symbols and their numeric value.

Only when the process of counting and arithmetic became a more abstract process and different sizes of groups were given a symbolic representation so that the results could be written on a "storage medium" such as papyrus or clay did the process of calculation become a process of symbol manipulation.

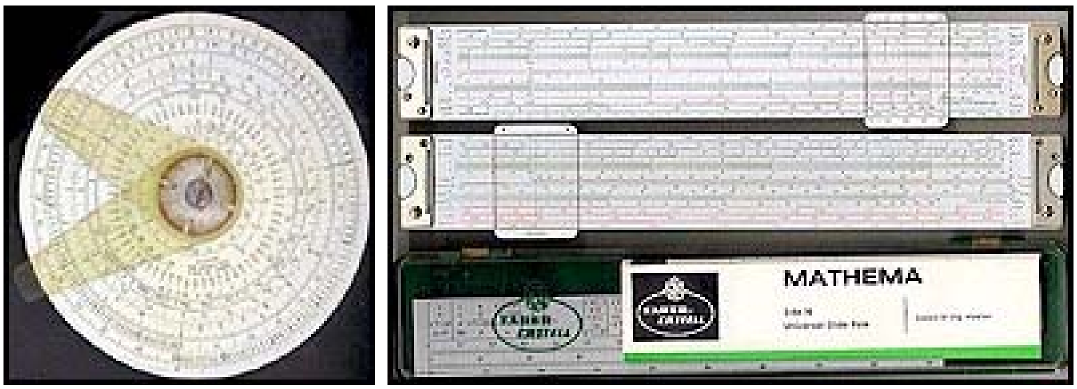
The bits and pieces of a computer (including the software) came together over many centuries, many people each adding a small contribution. One of those that was not recognized for many years was that of Muhammad ibn Musa Al'Khowarizmi, a Tashkent cleric who in the twelfth century developed the concept of a written process to be followed to achieve some goal, and published a book on the subject that gave it is modern name -- algorithm.



Muhammad ibn Musa Al'Khowarizmi

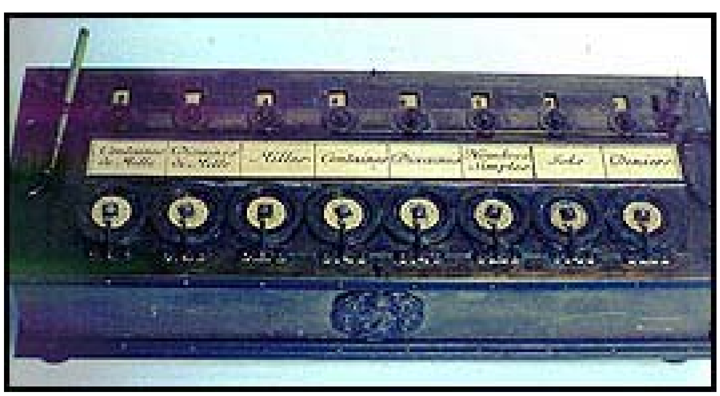
History of Computing - 1600's

1612 John Napier made the first printed use of the decimal point (after it had been invented in the Netherlands, and invents logarithms, and several machines for multiplication. Best known of his machines was the "bones" that was an aid to multiplication, though perhaps the chessboard calculator was the most ingenious and least known!
1622 William Oughtred created the slide rule (originally circular) based on Napier's logarithms that was to be the primary calculator of engineers through the 19th and early 20th centuries. With an common accuracy of only three digits, the slide rule, an analog device, provided sufficient precision for most works, but was not suited to situations where accuracy was needed such as in accounting.



Slide rules

1623 William Schickard described a machine that combined the concept of Napier's bones (in a cylindrical form) with a simple adder that allowed the user to more easily complete the multiplication of multi-digit numbers. However no original copies of Schickard's machine have been found, and thus the credit for the first adder with automatic carry often is given to Blaise Pascal.
1642 Blaise Pascal created an adding machine with automatic carries from one position to the next. The son of a merchant, Pascal devised a machine that contained several dials that could be turned with the aid of a stylus. Addition was achieved by the underlying gears turning as each digit was dialed in, the cumulative total being displayed in a window above the "keyboard". While several models were completed, Pascal's machine (often called the "Pascalene") was more likely to be found in the living rooms of their owners as a conversation piece rather than in the work room.

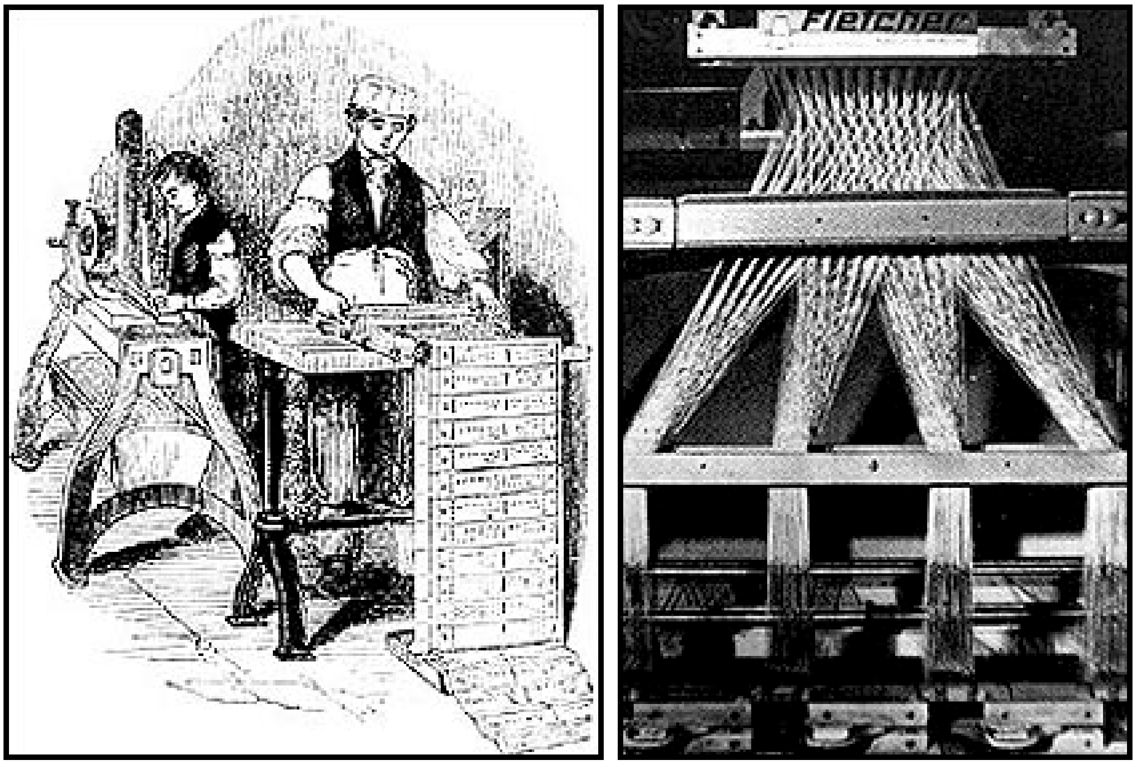


Adding machine

1673 Using a stepped cylindrical gear, Gottfried Leibniz built a calculator capable of multiplication in which a number was repeatedly, and automatically added into an accumulator.

1800s

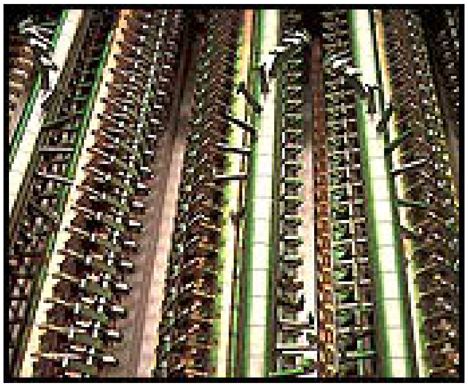
1801 In France, Joseph-Marie Jacquard invented an automatic loom using punched cards for the control of the patterns in the fabrics. The introduction of these looms caused the riots against the replacement of people by machines.

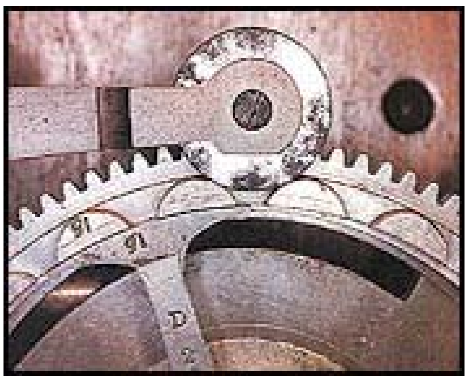


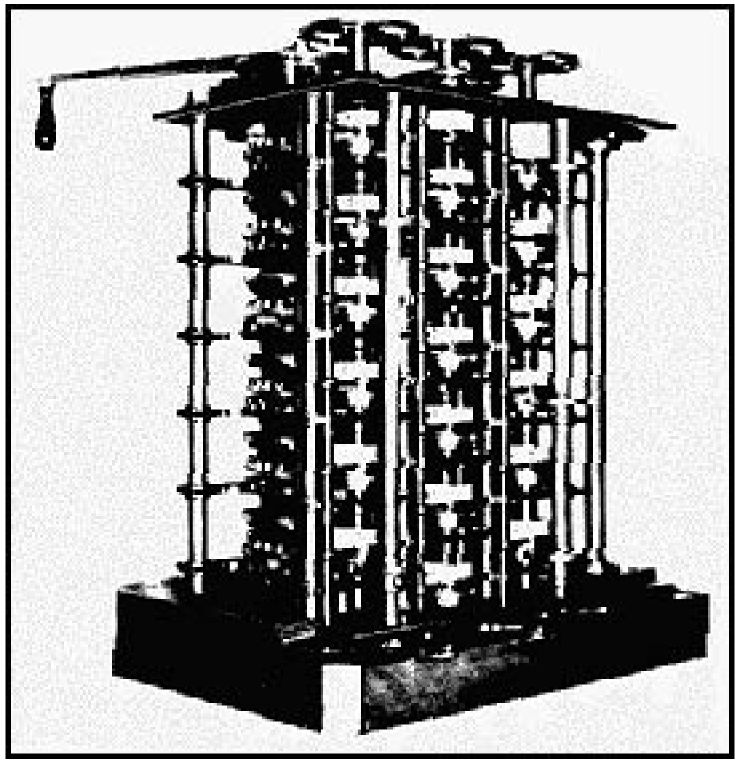
Jacquard's automatic loom

1822 Charles Babbage recognized that among the most common of calculating devices -- the mathematical, celestial, and navigation tables -- are full of errors and leading to the loss of ships. While studying at Cambridge University he suggests that it ought to be possible to compute the table entries using a steam engine. This desire becomes the theme of his life and he begins to design the Difference Engine for the purposes of computing the entries in navigation and other tables. Later he applies to the British Government for assistance, and receives what may have been the first government grant for computer research -- an event that is repeated a hundred years later in the US to help build the ENIAC at the University of Pennsylvania.

1833 Ten years later Charles Babbage had second thoughts about the Difference Engine, realizing that it was a special-purpose machine capable of only a single operation. Abandoning this line of work temporarily, he designed the Analytical Engine that had the basic components of a modern computer, and has led to Babbage being described as the "Father of the Computer". Like so many programmers of today, Babbage did not do a good job of documentation and his ideas were not widely accepted for the simple lack of communication.







1842 Ada Augusta King, Countess of Lovelace, translates Menabrea's pamphlet on the Analytical Engine, adding her own notes, and becomes the world's first programmer.
1847-49 Charles Babbage returned to his plans for the Difference Engine and completed 21 drawings for the construction of the second version, but still did not complete the manufacture himself. In 1991, on the occasion of the bicentenary of Babbage's birth, the Science Museum in Kensington, England, built a copy from those drawings, only finding a small number of very obvious errors. To overcome the suggestion that Babbage was unable to complete his machine because the technology of the era was insufficient, the Museum carefully used only techniques available in the mid-1800's and built a copy that operated correctly. After Babbage's death his son, Henry Prevost, built several copies of the simple arithmetic unit of the Difference Engine and sent them to various places around the world, including Harvard University, to ensure their preservation. In October 1995 one of those copies was sold by Christie's, auctioneers, in London, on behalf of descendants of Charles Babbage in New Zealand to the Powerhouse Museum in Sydney, Australia for approximately $200,000.
1854 George Boole describes his system for symbolic and logical reasoning that becomes later the basis for computer design.
1884 The American Institute for Electrical Engineering (AIEE) was founded; the first of the organizations that would eventually merge to form the IEEE (Institute of Electrical and Electronics Engineers) in 1963.
1890 The increasing population in the US, and the demands of Congress to ask more questions in each census, was making the processing of the data a longer and longer process. It was anticipated that the 1890 census data would not be processed before the 1900 census was due unless something was done to improve the processing methodology. Herman Hollerith won the competition for the delivery of data processing equipment to assist

in the processing of the data from the 1890 US Census, and went on to assist in the census processing for many countries around the world. The company he founded, Hollerith Tabulating Company, eventually became one of the three that composed the Calculating-Tabulating-Recording (C-T-R) company in 1914, and eventually was renamed IBM in 1924. The Hollerith machines were the first to appear on a magazine cover.

19 th South Africa's oldest computer - and an even older slide rule

Judging by its size, it's more closely related to your wardrobe than to your Pentium computer. But then again, with its hundreds of knobs and lights and power points it would not be much use as a wardrobe either. We are talking about Africa's first computer - a crudely built box

with switches and wires, once regarded as the ultimate in electronic wizardry. In fact, way back in 1948 when it was built by Stellenbosch engineering professor Carl Olen, it was so highly regarded that it was put on show.

Ph.D. student in Electronic Engineering Robert van Zyl says that compared with today's computers, Professor Olen's model is worthless. The best it can do is calculate the trajectories of moving objects with a fairly regular path, such as a pendulum or ballistic missile. Today a scientific pocket calculator can do more than that. Mr. van Zyl said that the old computer was thrown out about three years ago and left outside in the rain before someone realized its historic value; it was then decided to give it a place of honor in the newly established Explorarium at the Department of Electronic Engineering.

Mr van Zyl said that although the Explorarium was still in its infancy, it was hoped that it would eventually be possible to track the development of everyday electronic equipment through interactive displays. Other valuable exhibits include a slide rule from 1879, which was used as a calculating aid. This one is special as it is in cylindrical form, enabling it to store much more information than the conventional flat slide rule.

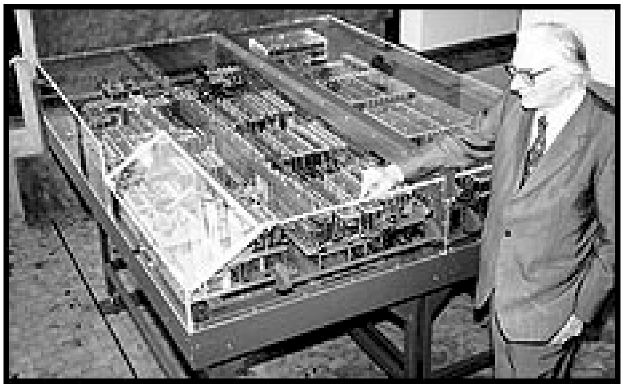
1900s

1912 The Institute of Radio Engineers was founded -- the second organization that would eventually merge to found the IEEE in 1963.

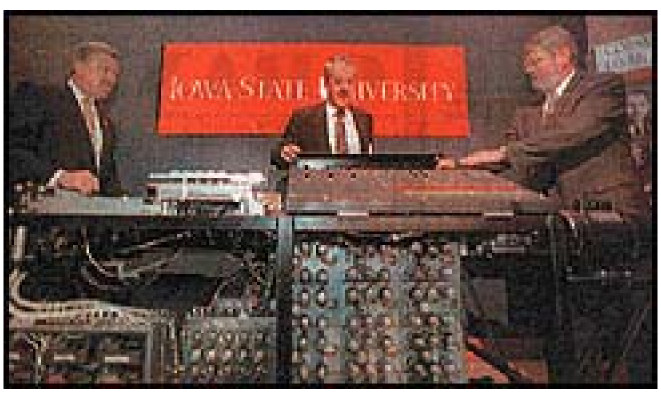
1925 Babbage's and Hollerith's digital computing methods were rarely used in scientific computation, though analog devices such as the slide rule were in wide use, especially in engineering calculations. Vannevar Bush, MIT, built a large-scale differential analyzer with the additional capabilities of integration and differentiation. Funded by the Rockefeller Foundation, the differential analyzer was perhaps the largest computational device in the world in 1930.

Digital computing came to the fore again in the 1930's when a number of scientists recognized that the technology had reached the stage where the necessary components of a computer were available. Each, in his turn, had to conceive (or perhaps "reconceive" not being aware of the prior work of Babbage) of the structure of a computer. While we can identify the discrete precise dates during which at least four pioneers recognized the capabilities of the technology, a hundred years from now our ancestors will see this as a single instance in time and that simultaneously independent researchers brought forth the computer.

1935-38 Konrad Zuse, in Berlin, Germany, developed his Z-1 computer in his parent's living room, a relay computer, using binary arithmetic. He continued with the Z-2 in 1938 with the help of Helmut Schreyer. During World War II he applied to the German Government for assistance in building his machines, but he was turned down on the basis that it would take longer to complete his work than the government expected the war to last. Eventually he fled to Hinterstein at the end of the war and then to Switzerland where he reconstructed his Z-4 machine at the University of Zurich and founded a computer company that was eventually absorbed into the Siemens Corporation. Recently the Deutsches Museum in Munich, Germany, reconstructed the Z-1 machine as the central core of their computer exhibition. Zuse's machines were unknown outside Germany until well after the war, and while they may have precedence chronologically, they had little impact on the overall industry development.



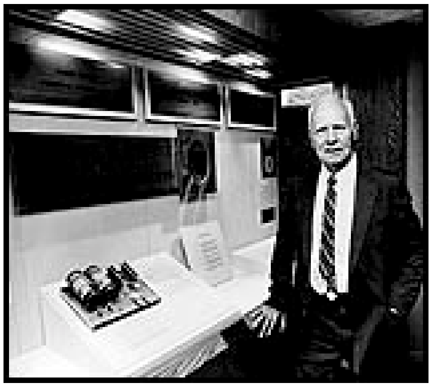
1936-39 John Vincent Atanasoff, with John Berry, developed the machine we now call the ABC -- the Atanasoff-Berry Computer -- at the University of Iowa, USA as a special purpose machine for the solution of sets of linear equations in Physics. Perhaps the earliest example of an electronic calculator, the ABC did develop primary concepts that would appear later in "modern computers" -- the electronic arithmetic unit and the regenerative, cyclic memory.



Martin Jischke, president of Iowa State, John Atanasoff II and David Berry, right, unveil a rebuilt copy of America's first electronic computer, which was originally built in the late 1930s, at a press conference at the national Press Club in Washington, D.C. Wednesday.

1937 While not using the practical technology of the era, Alan Turing developed the idea of a "Universal Machine" capable of executing any describable algorithm, and forming the basis for the concept of "computability". Perhaps more importantly Turing's ideas differed from those of others who were solving arithmetic problems by introducing the concept of "symbol processing".

Also in the US two other people were considering the problems of computation: Howard Aiken at Harvard University, whose work would come to fruition in 1944, and George Stibitz at Bell Telephone Laboratories who was looking at the use of telephone relays in doing arithmetic. He first constructed a relay driven arithmetic unit in 1937 (which he later called the Model-K since it was built on the Kitchen table) and from that small start built a number of relay machines that were in use during World War II.



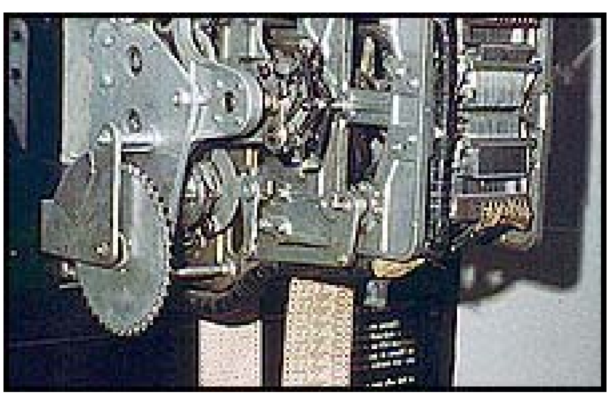
George Stibitz and his relay driven arithmetic unit called Model-K

1939 One of the major computational problems at Bell Telephone Laboratories was in the domain of complex numbers. Stibitz' first full-scale electromagnetic relay calculator solved this problem and was named the Complex Number Calculator (later the Bell Labs Model 1). A year later this machine was the first to be used remotely over telephone lines, setting the stage for the linking of computers and communication systems, time-sharing, and eventually networking. A teletype was installed in a hallway outside the meeting rooms for the annual American Mathematical Society conference at Dartmouth College, and connected to the Complex Calculator in New York. Among the people who took the opportunity to try out the system were Norbert Wiener and John Mauchly.

World War II

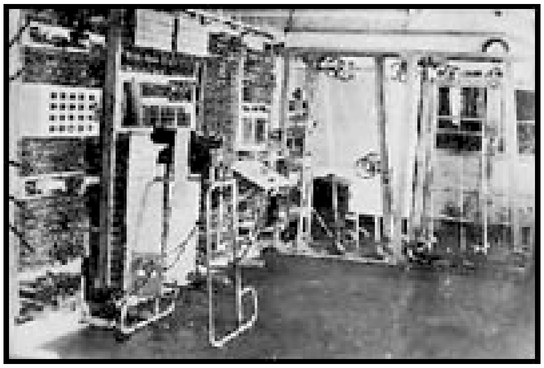
The need of computation during World War II was exacerbated by the sudden enhanced development of a number of ordnance (military materiel, such as weapons, ammunition, combat vehicles, and equipment) devices to counter the increased technology of attack devices such as the aircraft. Stibitz extended his relay machines to include tracking and aiming devices to be attached to anti-aircraft guns, but the major deficiency was the availability of "firing tables" for field and naval artillery. Thus the early US calculating devices were, like Babbage's Difference Engine, designed to produce tables, not to complete on-time computations for the solution of scientific (or military) problems.

1944 The first large scale, automatic, general purpose, electromechanical calculator was the Harvard Mark I (AKA IBM Automatic Sequence Control Calculator [ASCC]) conceived by Howard Aiken in the late 1930's and implemented by Messrs. (Plural of Mr.) Hamilton, Lake, Durfee of IBM. The machine, sponsored by the US Navy, was intended to compute the elements of mathematical and navigation tables -- the same purpose as intended by Babbage for the Difference Engine. Aiken dedicated his early reports to Babbage, having been made aware of the piece of the Difference Engine at Harvard in 1937 The ASCC was not a stored program machine but instead was driven by a paper tape containing the instructions. Grace Murray Hopper went to work for Aiken at Harvard in June 1944 and became the third programmer on the Mark I. The two who preceded her, then called "coders", were Ensigns Robert Campbell and Richard Bloch.

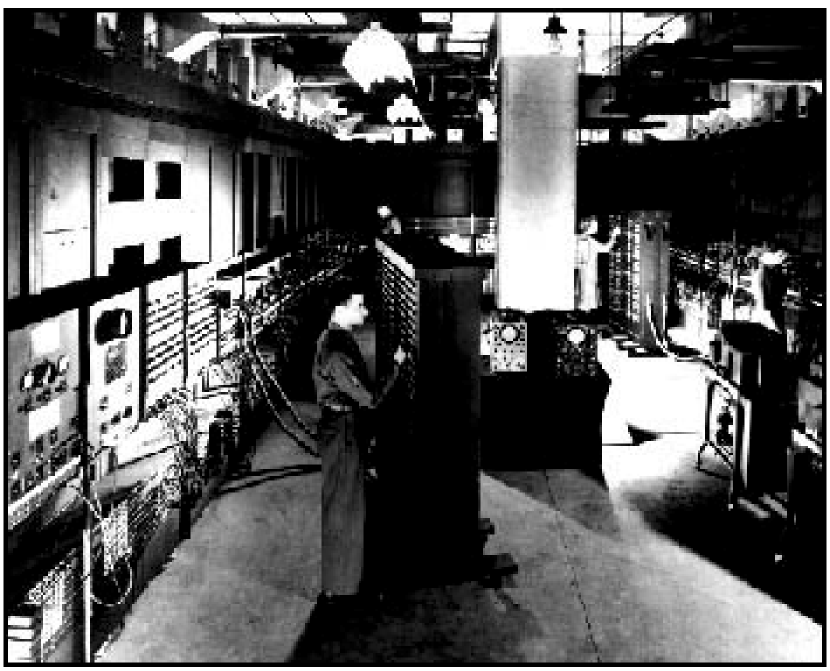


Automatic Sequence Control Calculator (ASCC) reader

1940-44 Across the Atlantic a major need for supporting the war effort was to decrypt the intercepted messages of the German forces. Encrypted in the early years using the US designed ENIGMA, a team at Bletchley Park, halfway between Oxford and Cambridge Universities, including Alan Turing, built a series of machines culminating in 1943 with Colossus. The Colossus Mark I was delivered by the



Telephone Research Establishment, under the leadership of Tommy Flowers (seen on the right here with Sir. Harry Hinsley, also a leader in the Bletchley Park activities, and more recently a documenter of their activities), in December 1943 and became operational in 1944, decrypting messages to assist in the planning for D-Day later that year. Further machines were delivered in time for the landings in Normandy and played a significant part in the defeat of Nazi Germany. The existence of Colossus was a secret until 1970 and the algorithms of decryption are still a secret today. Turing and others had only a small influence on the British computer development after the war. A copy of Colossus is being reconstructed at the Museum that now exists at Bletchley Park in England. In the US a similar program using the technology transferred from Bletchley Park was undertaken at the United States Naval Computing Machine Laboratory (USNCML) in Dayton, Ohio, and later at the Wisconsin Avenue headquarters of what is now known as the National Security Agency (NSA). Besides adding to the code breaking of German Codes the USNCML also worked on Japanese codes. After the war members of this group of engineers founded the Electronic Research Associates (ERA) in Minneapolis.



1943 Work on ENIAC was started in 1943 under the guidance of John Brainerd, Dean of the Moore School of Electrical Engineering at the University of Pennsylvania, with John Mauchly and J. Presper Eckert responsible for its implementation. The US Army liaison, on behalf of the Aberdeen Proving Ground (Ballistic Research Laboratory), was Herman Goldstine.

30 June 1945 John von Neumann wrote the "First Draft of a Report on the EDVAC" that set the stage for the architectural design of several generations of computers; the report never got past the draft stage, and his co-authors (though obviously not his co-writers) never got properly named. The architectural style became as the "von Neumann architecture" and this source of the concept of the "stored program" becomes a matter of controversy. Eckert and Mauchly claimed that they had those thoughts before von Neumann joined the work in progress at the University of Pennsylvania. Konrad Zuse claimed in later years that he had those thoughts too in the 1930's.