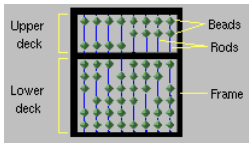
History of Computers

Origins of Digital Computers

- earliest computing devices designed to aid numeric computation
- abacus, first developed in Babylonia over 5,000 years ago



Digital vs. Analog Computers

ANALOG

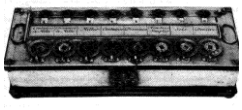
- employ analog encoding
- usually special-purpose devices

DIGITAL

- employ digital encoding
- are discrete-state devices
- can be general-purpose devices

Early Calculating Machines

- William Schickard (1592–1635), mechanical calculator
- Blaise Pascal (1623–1662), addition and subtraction using 10s complement

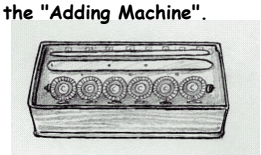


Pascaline

BLAISE PASCAL

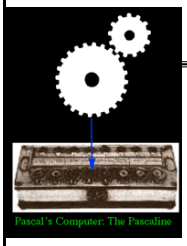
(1623 - 1662)

In 1642, the French mathematician and philosopher *Blaise Pascal* invented a calculating device that would come to be called the "Adding Machine".



BLAISE PASCAL

(1623 - 1662)



Originally called a "numerical wheel calculator" or the "Pascaline", Pascal's invention utilized a train of 8 moveable dials or cogs to add sums of up to 8 figures long. As one dial turned 10 notches - or a complete revolution - it mechanically turned the next dial.

Pascal's mechanical Adding Machine automated the process of calculation. Although slow by modern standards, this machine *did* provide a fair degree of accuracy and speed.

Early Calculating Machines

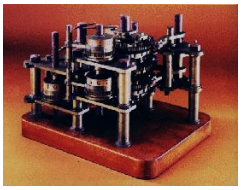
- G. W. F. Leibniz (1646–1716), "Stepped Reckoner," full-featured calculator, ("Leibniz wheel" for multiplication)

Charles Babbage (1791–1871)

- first true pioneer of modern digital computing machines
- built two prototype calculating machines
- Difference Engine
- Analytical Engine

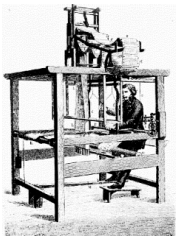
Difference Engine

- automated both the computation of tables and their printing
- employed the method of differences to calculate polynomials
- special-purpose calculating machine



Analytical Engine

- a programmable, general purpose calculating machine
- two main mechanisms: the store and the mill
- programmed by punched cards based on Jacquard loom

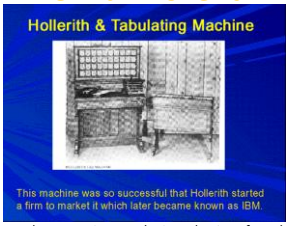


Jacquard loom

Legacy of Babbage

- designed the first, general-purpose digital computing device
- ideas and achievements were lost to his successors

Herman Hollerith



A step toward automated computation was the introduction of punched cards, which were first successfully used in connection with computing in 1890 by Herman Hollerith working for the U.S. Census Bureau. He developed a device which could automatically read census information which had been punched onto card. Surprisingly, he did not get the idea from the work of Babbage, but rather from watching a train conductor punch tickets. As a result of his invention, reading errors were consequently greatly reduced, work flow was increased, and, more important, stacks of punched cards could be used as an accessible memory store of almost unlimited capacity; furthermore, different problems could be stored on different batches of cards and worked on as needed. Hollerith's tabulator became so successful that he started his own firm to market the device; this company eventually became International Business Machines (IBM).

Konrad Zuse (1910–1995)

- designed the "Z" series of automatic general-purpose computing machines
- electro-mechanical devices
- binary internal encoding
- Z3 (1941) was programmed using punched 35mm film

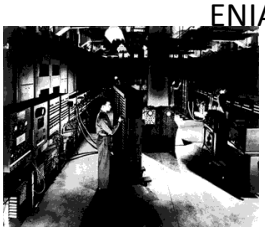
John V. Atanasoff (1903–1995)

- built the ABC machine with Clifford Berry in 1939
- first electronic digital computing machine
- special-purpose: solving simultaneous equations
- not fully automatic

Mauchly and Eckert

- John W. Mauchly (1907–1980) and J. Presper Eckert (1919–) headed the ENIAC team at the Moore School of Engineering, University of Pennsylvania
- ENIAC (Electronic Numerical Integrator And Computer), the first electronic general-purpose digital computer
- commissioned by the Army for computing ballistic firing tables

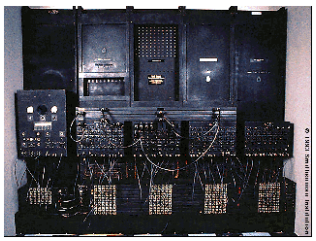
ENIAC



- noted for massive scale and redundant design
- decimal internal coding
- operational in 1946

Using 18,00-19,000 vacuum tubes, 70,000 resistors and 5 million soldered joints this massive instrument required the output of a small power station to operate it.

ENIAC



– manual programming of boards, switches, and "function table"

It could do nuclear physics calculations (in two hours) which it would have taken 100 engineers a year to do by hand.

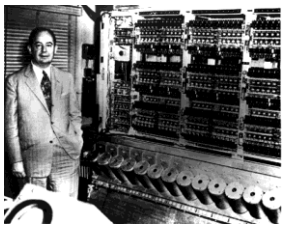
The system's program could be changed by rewiring a panel.

John Von Neumann (1903–1954)

- Von Neumann visits the Moore School in 1944
- prepares a draft for an automatic programmable device (later called EDVAC)
- "stored program" concept
- publishes ideas (with Goldstine and Burks) in 1946
- designed the IAS (Institute for Advanced Studies) machine which became operational in 1951

Von Neumann Architecture

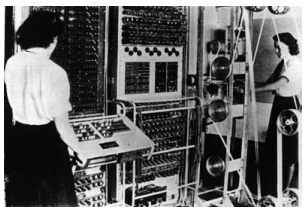
- "stored program"
- serial uniprocessor design
- binary internal encoding
- CPU–Memory–I/O orgranization
- "fetch-decode-execute" instruction cycle



Alan M. Turing (1912–1954)

- led the WWII research group that broke the code for the Enigma machine
- proposed a simple abstract universal machine model for defining computability
- devised the "Turing hypothesis" for AI

Turing and Colossus

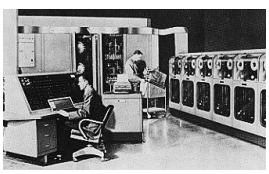


- constructed an electronic computing machine (1943) used to decrypt German coded messages

Maurice Wilkes (1913–)

- his Cambridge group constructed EDSAC in 1949
- the first stored program, general-purpose electronic digital computer
- first to use symbolic programs (assembly)

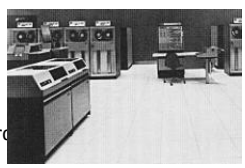
UNIVAC I



- first commercial general-purpose computer system
- successor to Mauchly-Eckert BINAC
- delivered in 1951
- used to forecast the 1952 presidential election

IBM System/360

- built using solid-state circuitry
- family of computer systems with backward compatibility
- established the standard for mainframes for decades

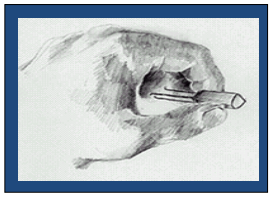


TRANSISTOR

- In the laboratories of Bell Telephone, *John Bardeen, Walter Brattain* and *William Shockley* discovered the "transfer resistor"; later labelled the transistor.
- Advantages:
  - increased reliability
  - 1/13 size of vacuum tubes
  - consumed 1/20 of the electricity of vacuum tubes
  - were a fraction of the cost

TRANSISTOR 1948

- This tiny device had a huge impact on and extensive implications for modern computers. In 1956, the transistor won its creators the Noble Peace Prize for their invention.

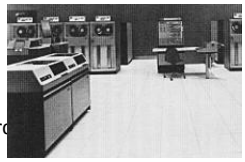


ALTAIR 1975

- The invention of the transistor made computers smaller, cheaper and more reliable. Therefore, the stage was set for the entrance of the computer into the domestic realm. In 1975, the age of personal computers commenced.
- Under the leadership of *Ed Roberts* the Micro Instrumentation and Telemetry Company (MITS) wanted to design a computer 'kit' for the home hobbyist.

IBM System/360

- built using solid-state circuitry
- family of computer systems with backward compatibility
- established the standard for mainframes for decades



IBM (PC) 1981

- On August 12, 1981 IBM announced its own personal computer.
- Using the 16 bit Intel 8088 microprocessor, allowed for increased speed and huge amounts of memory.
- Unlike the Altair that was sold as unassembled computer kits, IBM sold its "ready-made" machine through retailers and by qualified salespeople.

IBM (PC) 1981

- To satisfy consumer appetites and to increase usability, IBM gave prototype IBM PCs to a number of major software companies.
- For the first time, small companies and individuals who never would have imagined owning a "personal" computer were now opened to the computer world.

MACINTOSH (1984)

- IBM's major competitor was a company lead by *Steve Wozniak* and *Steve Jobs*; the Apple Computer Inc.
- The "Lisa" was the result of their competitive thrust.
- This system differed from its predecessors in its use of a "mouse" - then a quite foreign computer instrument - in lieu of manually typing commands.
- However, the outrageous price of the Lisa kept it out of reach for many computer buyers.

MACINTOSH (1984)

- Apple's brainchild was the Macintosh. Like the Lisa, the Macintosh too would make use of a graphical user interface.
- Introduced in January 1984 it was an immediate success.
- The GUI (Graphical User Interface) made the system easy to use.

DEC PDP series

- "minicomputers"
- offered mainframe performance at a fraction of the cost
- introduced the unibus architecture for CPU interconnections

Supercomputers

- high-performance systems used for scientific applications
- advanced designs
- Control Data Corporation, Cray Research, and others

Computer Generations

FIRST GENERATION

(1945-1956)

First generation computers were characterized by the fact that operating instructions were made-to-order for the specific task for which the computer was to be used. Each computer had a different binary-coded program called a machine language that told it how to operate. This made the computer difficult to program and limited its versatility and speed. Other distinctive features of first generation computers were the use of vacuum tubes (responsible for their breathtaking size) and magnetic drums for data storage.

SECOND GENERATION (1956-1963)

Throughout the early 1960's, there were a number of commercially successful second generation computers used in business, universities, and government from companies such as Burroughs, Control Data, Honeywell, IBM, Sperry-Rand, and others. These second generation computers were also of solid state design, and contained transistors in place of vacuum tubes.

SECOND GENERATION (1956-1963)

They also contained all the components we associate with the modern day computer: printers, tape storage, disk storage, memory, operating systems, and stored programs. One important example was the IBM 1401, which was universally accepted throughout industry, and is considered by many to be the Model T of the computer industry. By 1965, most large business routinely processed financial information using second generation computers.

THIRD GENERATION(1965-1971)

Though transistors were clearly an improvement over the vacuum tube, they still generated a great deal of heat, which damaged the computer's sensitive internal parts. The quartz rock eliminated this problem. Jack Kilby, an engineer with Texas Instruments, developed the integrated circuit (IC) in 1958. The IC combined three electronic components onto a small silicon disc, which was made from quartz. Scientists later managed to fit even more components on a single chip, called a semiconductor.

THIRD GENERATION (1965-1971)

As a result, computers became ever smaller as more components were squeezed onto the chip. Another third-generation development included the use of an operating system that allowed machines to run many different programs at once with a central program that monitored and coordinated the computer's memory.

FOURTH GENERATION (1971-Present)

In 1981, IBM introduced its personal computer (PC) for use in the home, office and schools. The 1980's saw an expansion in computer use in all three arenas as clones of the IBM PC made the personal computer even more affordable. The number of personal computers in use more than doubled from 2 million in 1981 to 5.5 million in 1982.

FOURTH GENERATION (1971-Present)

Ten years later, 65 million PCs were being used. Computers continued their trend toward a smaller size, working their way down from desktop to laptop computers (which could fit inside a briefcase) to palmtop (able to fit inside a breast pocket). In direct competition with IBM's PC was Apple's Macintosh line, introduced in 1984. Notable for its user-friendly design, the Macintosh offered an operating system that allowed users to move screen icons instead of typing instructions

FIFTH GENERATION(Future)

- Many advances in the science of computer design and technology are coming together to enable the creation of fifth-generation computers. Two such engineering advances are parallel processing, which replaces von Neumann's single central processing unit design with a system harnessing the power of many CPUs to work as one. Another advance is superconductor technology, which allows the flow of electricity with little or no resistance, greatly improving the speed of information flow.

FIFTH GENERATION(Future)

- Computers today have some attributes of fifth generation computers. For example, expert systems assist doctors in making diagnoses by applying the problem-solving steps a doctor might use in assessing a patient's needs. It will take several more years of development before expert systems are in widespread use.