COURSE: Fundamentals of Information Technology

TOPIC: Generations of computers

Lecture 1

The Five Generations of Computers

The history of computer development is often referred to in reference to the different generations of computing devices. Each generation of computer is characterized by a major technological development that fundamentally changed the way computers operate, resulting in increasingly smaller, cheaper, more powerful, more efficient and reliable devices.
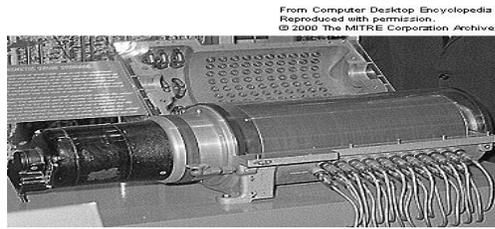
First Generation (1940-1956) Vacuum Tubes

The first computers used vacuum tubes for circuitry and magnetic drums for memory, and were often enormous, taking up entire rooms. They were very expensive to operate and in addition to using a great deal of electricity, generated a lot of heat, which was often the cause of malfunctions.

First generation computers relied on machine language, the lowest-level programming language understood by computers, to perform operations, and they could only solve one problem at a time. Input was based on punched cards and paper tape, and output was displayed on printouts.

The UNIVAC and ENIAC computers are examples of first-generation computing devices. The UNIVAC was the first commercial computer delivered to a business client, the U.S. Census Bureau in 1951.
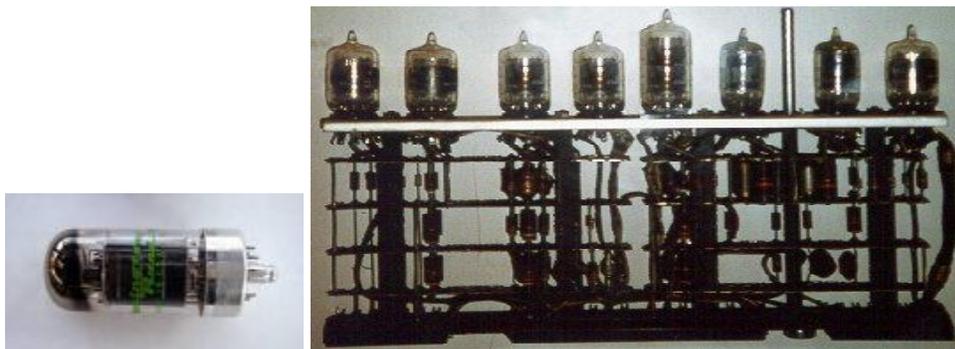

Vacuum Tubes

Magnetic Drum

Second Generation (1956-1963) Transistors
Transistors replaced vacuum tubes and ushered in the second generation of computers. The transistor was invented in 1947 but did not see widespread use in computers until the late 1950s. The transistor was far superior to the vacuum tube, allowing computers to become smaller, faster, cheaper, more energy-efficient and more reliable than their first-generation predecessors. Though the transistor still generated a great deal of heat that subjected the computer to damage, it was a vast improvement over the vacuum tube. Second-generation computers still relied on punched cards for input and printouts for output.
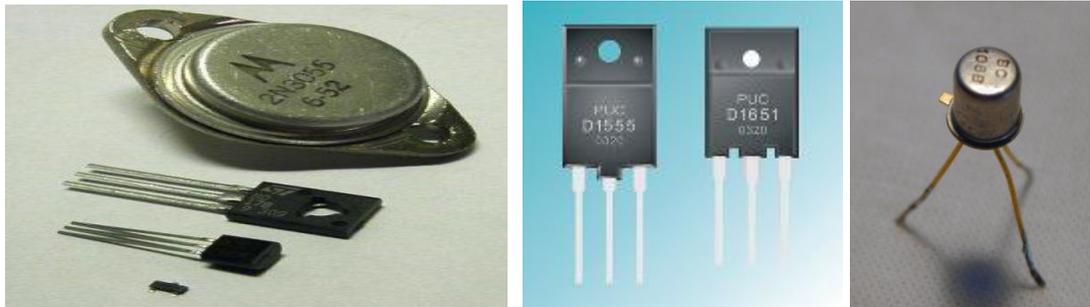

Transistors

Second-generation computers moved from *cryptic binary machine language* to symbolic, or assembly, languages, which allowed programmers to specify instructions in words. High-level programming languages were also being developed at this time, such as early versions of COBOL and FORTRAN. These were also the first computers that stored their instructions in their memory, which moved from a magnetic drum to magnetic core technology.

The first computers of this generation were developed for the atomic energy industry.

Third Generation (1964-1971) Integrated Circuits
The development of the integrated circuit was the hallmark of the third generation of computers. Transistors were miniaturized and placed on silicon chips, called semiconductors, which drastically increased the speed and efficiency of computers.

Instead of punched cards and printouts, users interacted with third generation computers through keyboards and monitors and interfaced with an operating system, which allowed the device to run many different applications at one time with a central program that monitored the memory. Computers for the first time became accessible to a mass audience because they were smaller and cheaper than their predecessors.
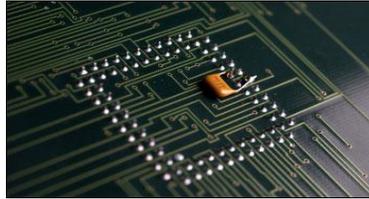

Integrated Circuits

Fourth Generation (1971-Present) Microprocessors
The microprocessor brought the fourth generation of computers, as thousands of integrated circuits were built onto a single silicon chip. What in the first generation filled an entire room could now fit in the palm of the hand. The Intel 4004 chip, developed in 1971, located all the components of the computer—from the central processing unit and memory to input/output controls—on a single chip.

In 1981 IBM introduced its first computer for the home user, and in 1984 Apple introduced the Macintosh. Microprocessors also moved out of the realm of desktop computers and into many areas of life as more and more everyday products began to use microprocessors.

As these small computers became more powerful, they could be linked together to form networks, which eventually led to the development of the Internet. Fourth generation computers also saw the development of GUIs, the mouse and handheld devices.
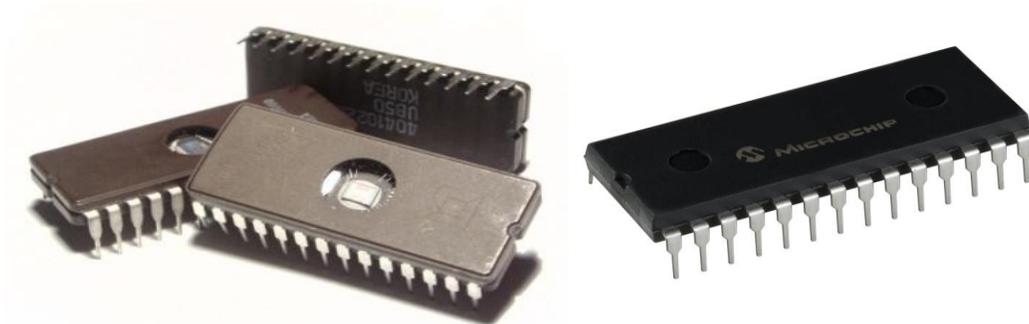
Microcircuits

Fifth Generation (Present and Beyond) Artificial Intelligence
Fifth generation computing devices, based on artificial intelligence, are still in development,

though there are some applications, such as voice recognition, that are being used today. The use of parallel processing and superconductors is helping to make artificial intelligence a reality. Quantum computation and molecular and nanotechnology will radically change the face of computers in years to come. The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization.

History of Computers

1. 1623: Mechanical calculator

   - o Wilhelm Schickard invented first known mechanical calculator, capable of simple arithmetic.
   - o Similar mechanical adding machine made in 1640's by Blaise **Pascal**. Still on display in Paris.
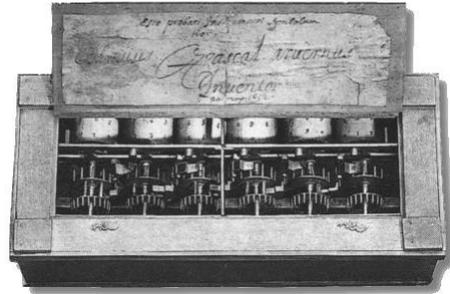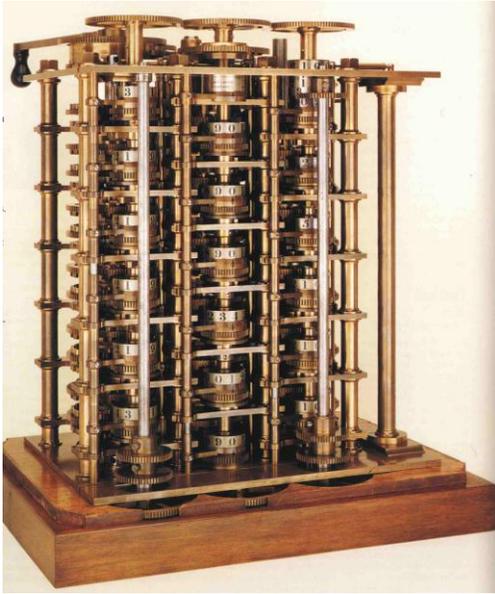

The "Pascaline," from The History of Computing Project

2. 1673: More advanced mechanical calculator

   - o 1673 by German mathematician Gottfried Leibniz
   - o Capable of multiplication and division
   - o Purely mechanical with no source of power.

The "Step Reckoner," from maxmon.com

3. 1823: **Charles Babbage** begins work on Difference Engine

- o He designed, but it was completed by a Swedish inventor in 1854.
- o Image of the Difference Engine from Niagara College

- 1833: Charles Babbage begins **Analytical Engine**

  - o Never completed.
  - o Important concept: a general-purpose machine capable of performing difference functions based on programming.

4. 1834: **Ada Byron**, Lady Lovelace impressed with the concept of the Analytical Engine at a dinner party.
   - o Daughter of poet Lord Byran
   - o Created plans for how the machine could calculate Bernoulli numbers. This is regarded as the first "computer program," and she is the first "programmer."
   - o The Department of Defense named a language "Ada" in her honor in 1979.

5. 1890: punched cards used by Herman Hollerith to automate Census

   - o Concept of programming the machine to perform different tasks with punched cards was from Babbage.
   - o Punch cards based on Josph Marie Jacquard's device to automate weaving looms.
   - o Hollerith founded a company that became International Business Machines (**IBM**) to market the technology.
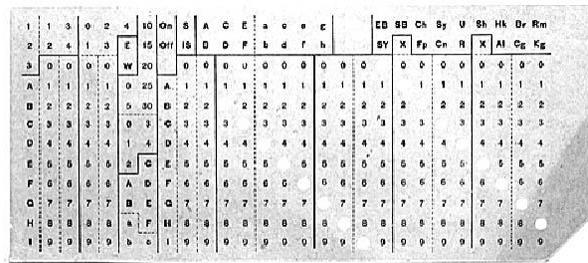

Sample Punch Card, from About.com

6. 1939: prototype of the first electronic computer
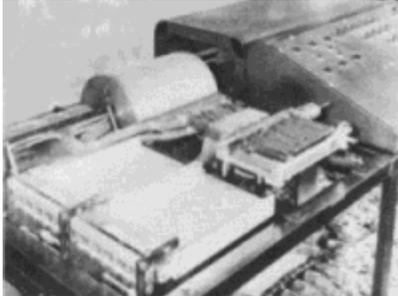
- o   Assembled by John Atansoff and Cliford Barry.
- o   John Atansoff came up with the concept of using binary numbers.
- o   Completed in 1942 using 300 vacuum tubes.
- o   Could solve small systems of linear equations
- o   Image from The History of Computing Project

7. 1946: **ENIAC** completed

- o Electronic Numerical Integrator and Computer
- o By Presper **Eckert** and John **Mauchly**
- o 18,000 vacuum tubes.
- o Occupied a 30 by 50 foot room
- o Programming by plugging wires into a patch panel. Very difficult to do, because this style programming requires intimate knowlege of the computer.
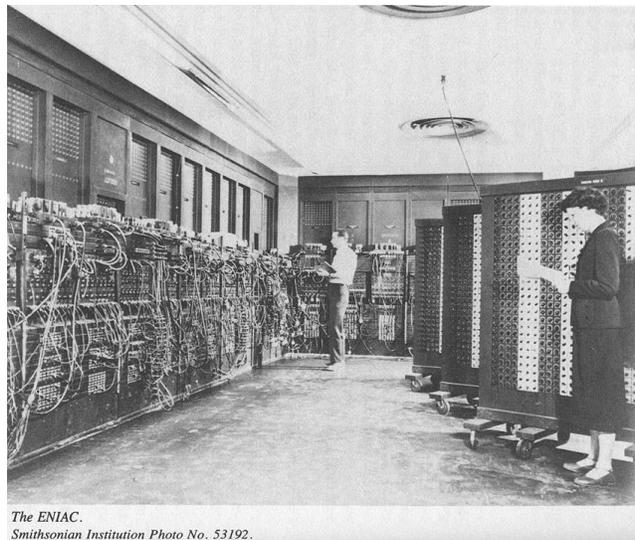
The ENIAC.
Smithsonian Institution Photo No. 53192.

ENIAC, from ftp.arl.mil

8. 1946: **John van Neumann Architecture stored-programming concept**
   - o He suggested that programs and data could be represented in a similar way and stored in the same internal memory.
   - o All modern computers store programs in internal memory.

Summary - Generebations of computers

1. **Vacuum tube** (1939)
2. **Transistor** (invented in 1947, used in IBM 7090 in 1958)
3. **Integrated circuit** or chip (invented in 1959, used in IBM 360 in 1964)
    - A small wafer of silicon that has been photographically imprinted to contain a large number of transistors together.
4. Large-scale integration: **microprocessor** (1975)
    - Entire processing unit on a single chip of silicon
5. **Fifth Generation (Present and Beyond) Artificial intelligence**
    some applications, such as voice recognition, use of parallel processing and superconductors, The goal of fifth-generation computing is to develop devices that respond to natural language input and are capable of learning and self-organization.

Vacuum tube, from computermuseum.li
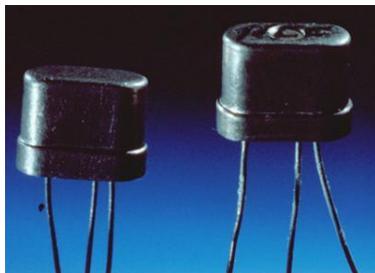
Transistors, from Texas Instruments
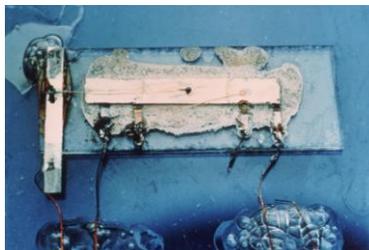
Circuit, from IEEE Virtual Museum

Old CPU's, from Wikipedia

Robert Noyce, one of the inventors of the integrated circuit and founder of Intel speaking of a modern computer chip compared to the Eniac: "It is 20 times faster, has a larger memory, is thousands of times more reliable, consumes the power of a light bulb rather than that of a locomotive, occupies 1/30,000 the volume and costs 1/10,000 as much."

Source: Robers, Eric S. *The Art and Science of C.* Addison-Wesley Publishing Company. Reading: 1995.