

# History of Computer Science

Also, a History of Computing

E. Braden Hendricks

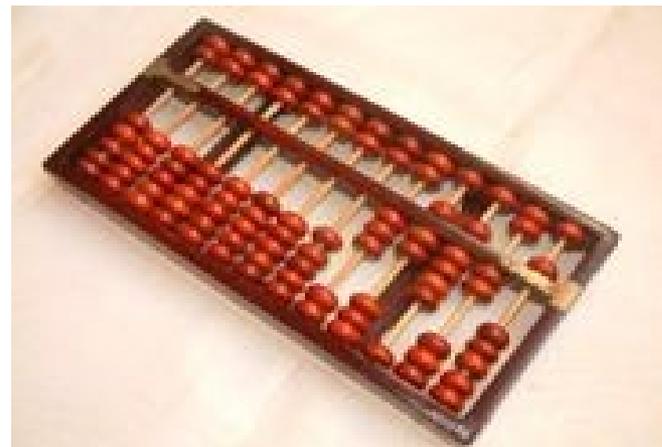
# Early Computation

- The abacus “the first automatic computer” is the earliest known tool of computing
- It was thought to have been invented in Babylon, circa 2400 BCE.
- The abacus generally features a table or tablet with beaded strings.
- The abacus is still in use today in China and Japan. It was only very recently (the 1990’s) that the availability and sophistication of the hand-held calculator supplanted the abacus.
- In 1115 BCE the Chinese invented the South Pointing Chariot, a device which was the first to use the differential gear, which is believed to have given rise to the first analog computers.

# Examples of Abaci



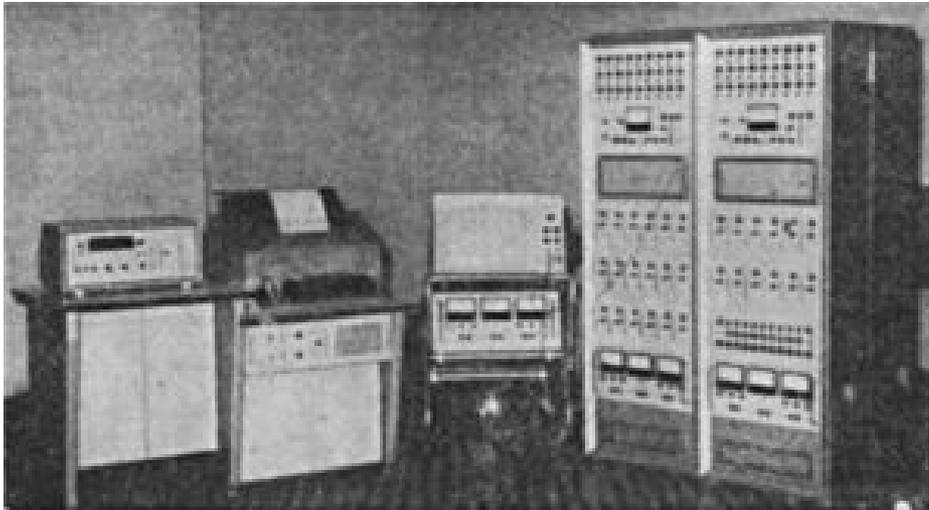
Left: Russian abacus. Above:  
Roman abacus. Below: Chinese  
abacus.



# Analog Computers

- According to Wikipedia- Analog computers are a form of computer that use electrical, mechanical, or hydraulic means to model the problem being solved (simulation).
- Analog computers are believed to have been first developed by the Greeks with the Antikythera mechanism, which was used for astronomy. The Antikythera mechanism was discovered 1901 and was dated back to circa 100 BCE.
- Analog computers are not like today's computers. Modern computers are digital in nature and are immensely more sophisticated.
- There are still analog computers in use, such as the ones for research at the University of Indiana and the Harvard Robotics Laboratory.

# Examples of Analog Computers



Upper Left: the Polish analog computer ELWAT. Bottom Left: a typical student slide rule. Bottom Right: the Norden bombsight, used by the US military during World War II, the Korean War, and the Vietnam War. Its usage includes the dropping of the atomic bombs on Japan.



# History of Algorithms

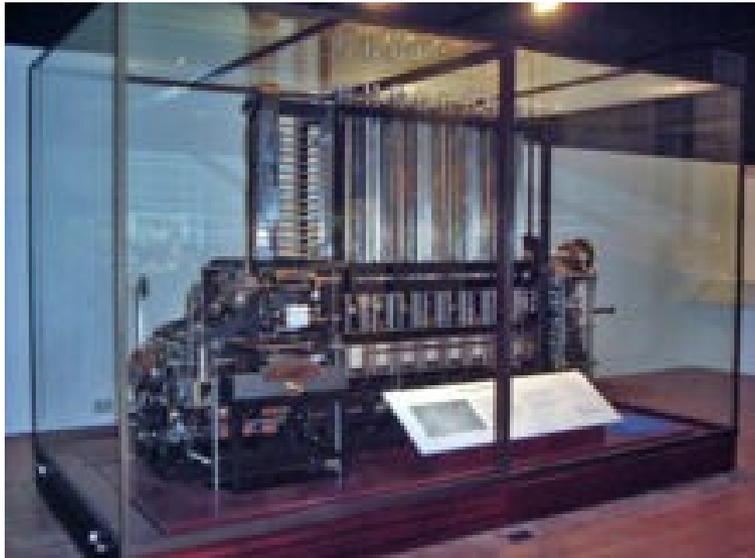
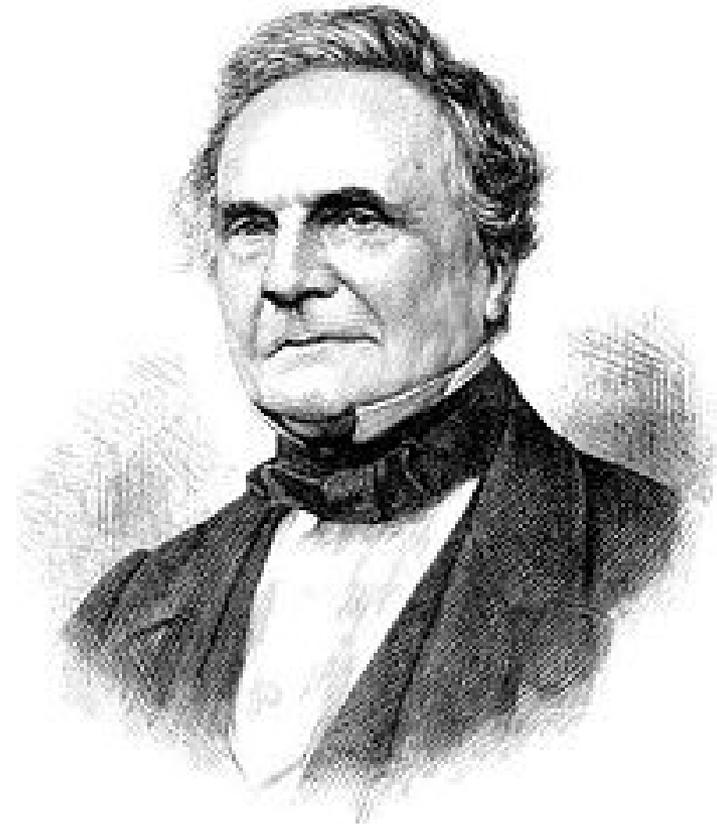
- Algorithms are in etymology are derived from algebra, which was developed in the seventh century by an Indian mathematician, Brahmagupta. He introduced zero as a place holder and decimal digits.
- In 825, a Persian mathematician, Al-Kwarizmi wrote *On the Calculation with Hindu Numerals*. This book helped the diffusion of Hindu-Arabic numerals into Europe.
- In the 12<sup>th</sup> century, the book was translated into Latin, *Algoritmi de Numero Indorum*, and with the new processes of problem solving came the formation of the concept of an algorithm.
- In today's computers, it is algorithms in essence that runs the system and computation. Programs are the manifestation of algorithms in machine language.

# The Development of Binary Logic

- As in the case of algorithms, computers rely on something else that originated in ancient times-binary logic.
- The binary system was invented by the Indian mathematician Pingala in the 3<sup>rd</sup> century BCE. In this system any number can be represented with just zeroes and ones.
- It was not until the 1700's however, that binary logic was formally developed from the binary system by German mathematician Gottfried Leibniz. Leibniz is also known for having invented Calculus independently of Newton. In binary logic, the zeroes and ones take on the values of false and true, respectively, or off and on.
- More than a century later, George Boole refined the process in his publication of *Boolean Algebra*.

# Charles Babbage and Ada Lovelace; Founders of Modern Computing

- Charles Babbage and Ada Lovelace together are often thought of as the founders of modern computing.
- Babbage invented the Difference Engine, and, more importantly, the Analytical Engine. The latter is often recognized as a key step towards the formation of the modern computer.
- Of note, Babbage was obsessed with fire-he once baked himself in an oven for four minutes at 265 degrees Fahrenheit just to see what would happen. He reported “No great discomfort”.
- Ada Lovelace, daughter of famous poet Lord Byron, is known for describing-in algorithms- the processes the Analytical Engine was intended for. In this sense she is considered a pioneer in computer programming.



Above: Charles Babbage. Top Left: Ada Lovelace. Left: a replica of the Difference Engine.

# The Analytical Engine

- The analytical engine is a key step in the formation of the modern computer. It was designed by Charles Babbage starting in 1837, but he worked on it until his death in 1871. Because of legal, political and monetary issues the machine was never built.
- The analytical engine is best described as a mechanical general purpose computer that would run off a steam engine. The steam engine would have been huge, a full 30 meters long and 10 meters wide.
- Although it was never built, in logical design it anticipated modern general purpose computers by about a century.
- Howard Hathaway Aiken, designer of the first large scale digital computer in the USA, the Harvard Mark I, claimed that Babbage's writings on the A.E. were his primary education.

# Computer Science: Beginnings

- We now think of computers as machines, but before the 1920's the term "computer" denoted an occupation. Computers in those days were people whose job it was to calculate various equations. Many thousands were employed by the government and businesses.
- Analog computers and the very first digital computers were being developed by the 20's and 30's were known as "computing machines", but this phrase had passed out by the 40's. By that time "computer" meant a machine that performed calculations.
- Analog computers relied on physical substances to perform calculations, such as the turning of a shaft, while digital computers could process information and render a numeric value and store it as an individual digit.

# Alan Turing

- Charles Babbage laid the foundations of Computer Science, but it was Alan Turing of England who is regarded as the “Father of Computer Science”.
- He provided a new concept of both algorithms and the process of calculations with the invention of his Turing Machine.
- The Turing Machine is a basic abstract symbol manipulating device that can be used to simulate the logic of any computer that could possibly be constructed. It was not actually constructed, but its theory yielded many insights.
- The Turing Test is Turing’s idea of how to determine a machine’s capability as far as thought is concerned.
- Of note, Alan Turing was a world class marathon runner.



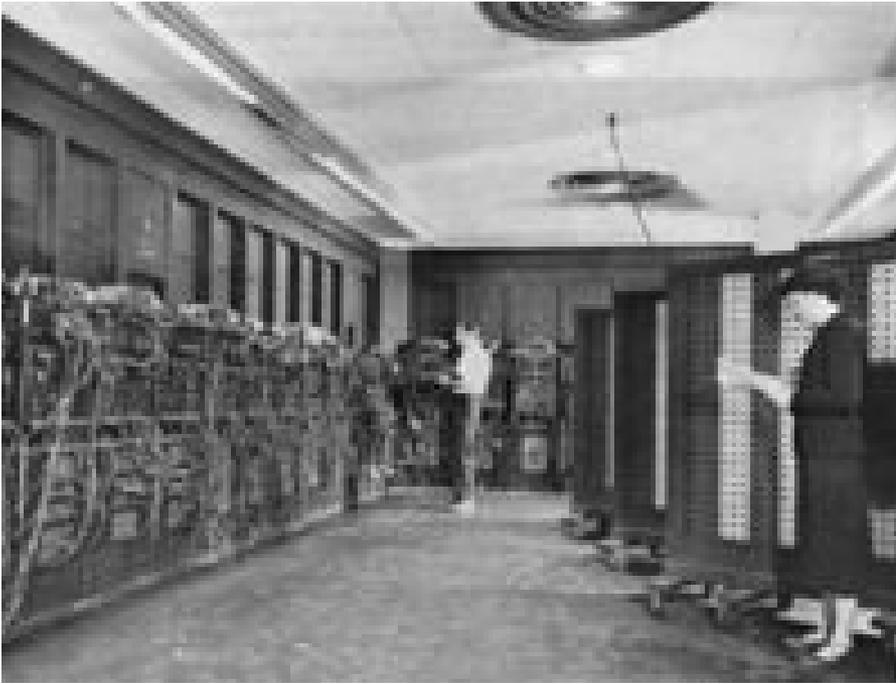
Alan Turing. He described the Turing Machine and the Turing Test, and is known as the Father of Computer Science. As a runner, his best marathon time was only eleven minutes behind the winner of the 1948 Olympics.

# History of Modern Computer Hardware (Pre- 1960's)

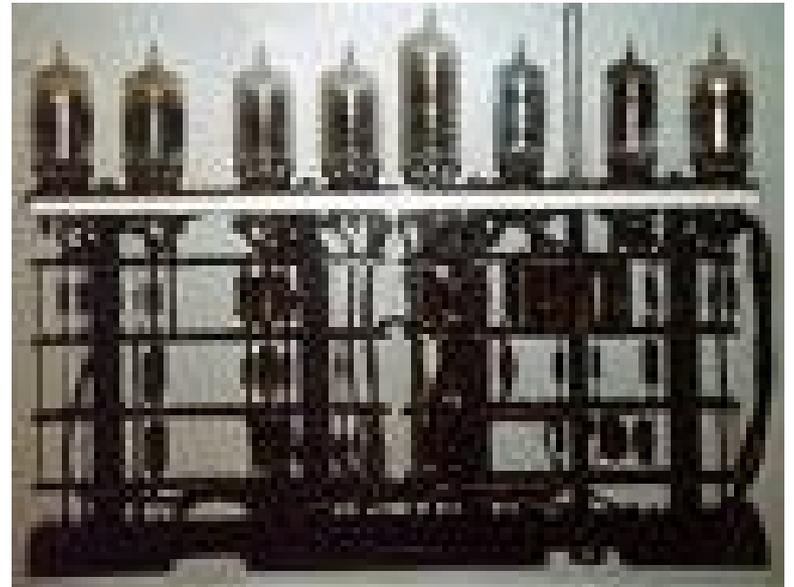
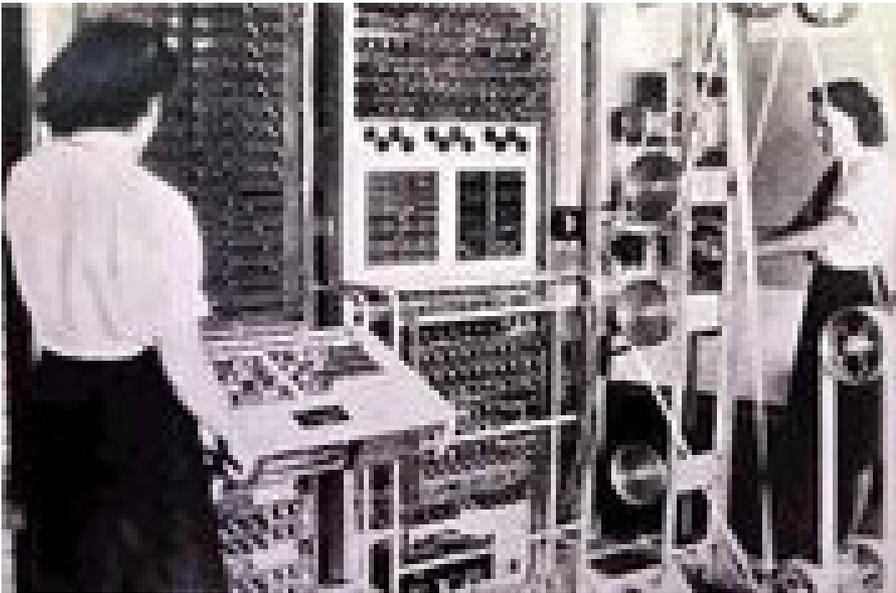
- Ever since the abacus was developed humans had been using devices to aid in the act of computation.
- Throughout 1500 to 1800's many breakthroughs in computational hardware technology were developed, including mechanical calculators and punch card technology (used to this day).
- In the late 1800's the first "programmable" computers appeared using punch card technology. To be programmable, a machine had to be able to simulate the computations of any other machine by altering its computational process.
- From the 1930's to the 1960's "desktop calculators" were developed, making the transition from mechanical to electronic.
- By the 1940's the age of analog computers was about to become the age of digital computers.

# Computers: The Transition from Analog to Digital

- The advent of World War Two prompted the transition from analog computers to digital.
- Electronic circuits, relays, capacitors and vacuum tubes replaced mechanical gears and analog calculations became digital ones.
- Examples of new digital computers were Atanasoff-Berry Computer, the Z3, the Colossus and ENIAC (which was 1000 times faster than its contemporaries).
- These computers were hand built and relied on vacuum tube technology. For input assimilation they relied on punched cards or punched paper tape.
- These computers represented many advances in the field, although it is hard to pinpoint which in the series is the first “true” modern computer as we know them today.



Top Left: U.S. built ENIAC (completed 1945). Bottom Left: Colossus, a British computer used in breaking German codes during WWII. These computers featured thousands of delicate vacuum tubes (pictured below).



# History of Computer Hardware

## (Post 1960's)

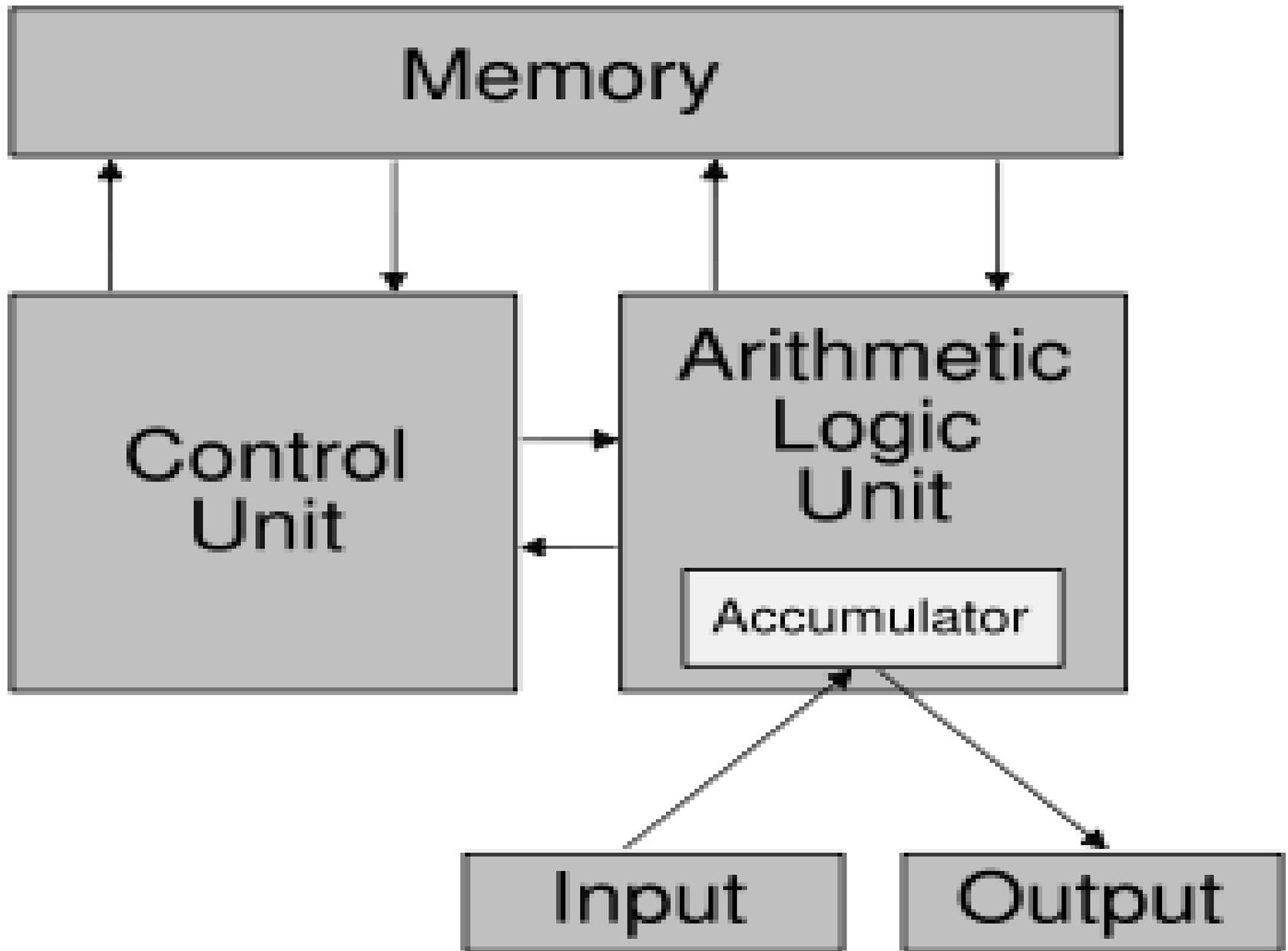
- There were several developments that occurred in the 1960's that forever changed the course of modern computing.
- The first of these was the transition from vacuum tube to transistor. The transistor was developed in the 1940's and 50's, and applied to computers in the 60's. By the 1970's transistors had almost completely supplanted vacuum tubes as the main active components of computers.
- Transistors hold several advantages over vacuum tubes, not the least of which is their small size and small price. With transistor technology, electronic equipment gradually became smaller and smaller.
- This decrease in size was also made possible by the invention of the microprocessor, developed in the 1960's.

# Post 1960's Continued

- The microprocessor, in conjunction with another invention of the 1960's, the integrated circuit, led to microcomputers.
- This was a huge step towards making computers more available to the general public.
- Generally, the number of transistors on a integrated circuit has doubled every 2 years since the 1970's, in accordance with Moore's Law.
- With amount of progress being made, the speed and quality of computers advances very quickly.
- Nano-technology developed during the 1980's and 90's and allowed for even faster and smaller computers.
- Currently the smallest transistor chips in the world are about 30 to 45 nm (most are 65 to 90).
- A nanometer (nm) is  $10^{-9}$  meters.

# The Von Neumann Machine

- Every modern computer has the same five basic components: memory, control unit, arithmetic logic unit, input and output.
- This was designed by noted mathematician John von Neumann in the 1940's. It has been very influential in the design, evolution, and continued architectural setup of the modern computer.



# The Advent of the Home Computer

- From the beginnings of the modern computing age until about 1970 the home computer did not exist. All that changed as processors grew smaller and the number of transistors in them grew.
- In 1975, the first commercially successful home computer, the MITS Altair 8800 (the same computer that Microsoft was founded to provide programming for), was released. Shortly thereafter the Apple I, Apple II, Commodore PET, and TRS-80 were released. Of these computers the Apple II was by far the most successful.
- Seeing Apple's success, IBM released the original IBM PC model. Soon afterwards a number of "IBM PC" clones were released, such as computers from Compaq. This continues to this day. Microsoft successfully negotiated a deal to provide the operating system of all IBM's and IBM compatible machines. This, coupled with later blunders by Apple, led to Microsoft's assumption of a near monopoly in the computer market.



Clockwise from the top:  
Commodore Pet, IBM  
PC, Macintosh I, iMac,  
TRS-80, Apple II



# Implications

- Three and a half decades later, the home computer revolution is still occurring. Microsoft still dominates the market, but Apple, with the introduction of the new iMac, as well as branches of other innovating technology (the iPod) has made some ground, as have independent free source operating systems like Linux and Solaris.
- The modern world in industrialized countries revolves around computers. The computer industry itself generates billions upon billions of dollars in revenue annually between software, hardware, games, etc.
- Modern militaries and nearly every other commercial industry in the world now relies upon computers. Never before has one thing changed the world so fundamentally and quickly as the modern computer.

# References

- [www.wikipedia.org](http://www.wikipedia.org)
  - Multiple articles touching on every subject in the lecture
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