

Computer History



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Technology Trends in Computing from Mobile Devices to Supercomputers

1945

1

Electronic

2

Electro-mechanical

3

Mechanical

4

Manual

Pre-Computer Generations

- Binary Numbers
Charles Babbage 1840
- Boolean Algebra and Relay Design
Shannon 1938
- Computability
Turing 1936

- Magnetic Drum
Tushek 1928

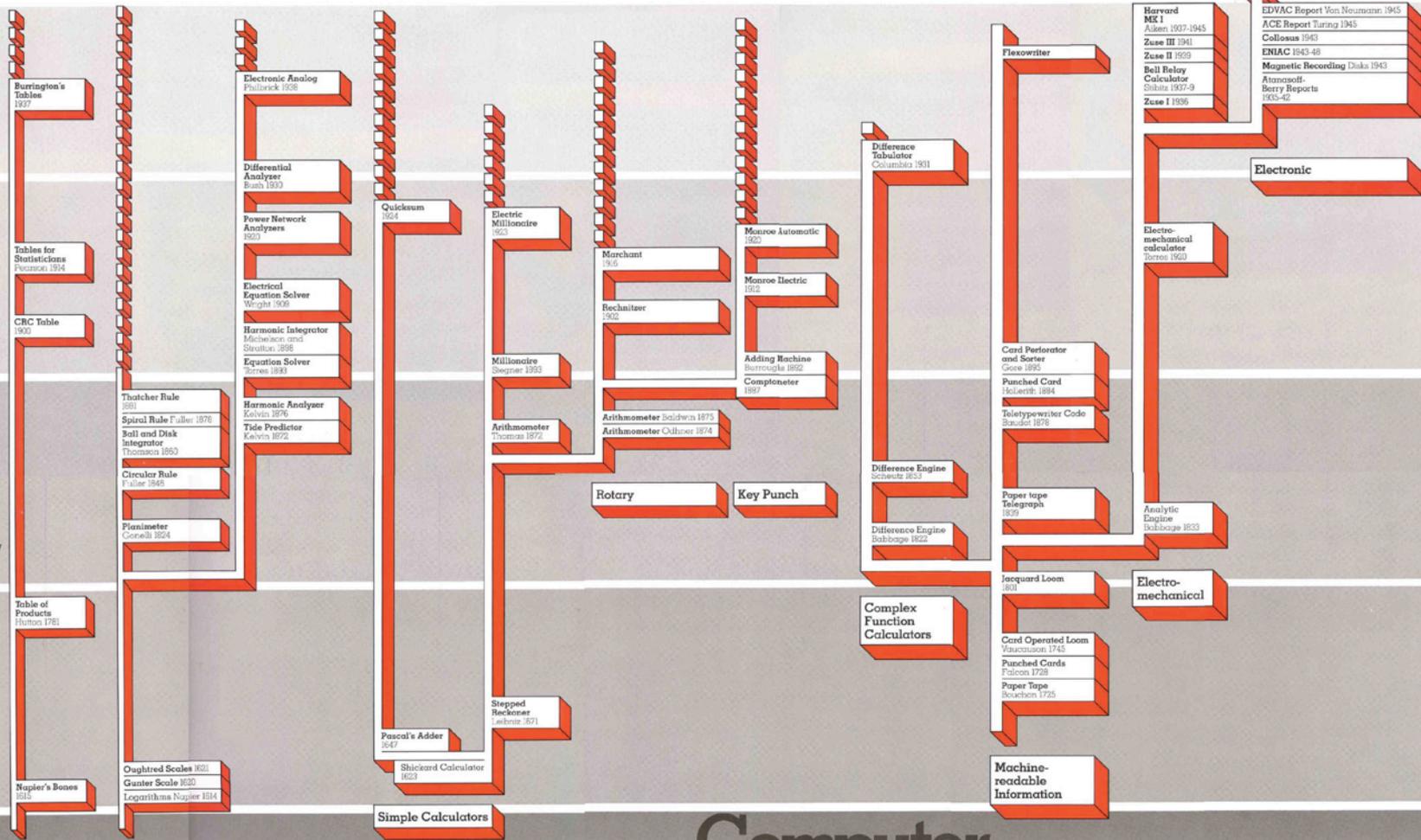
- Flip-flop
Eccles Jordan 1919
- Proportional Calculus
Whitehead and Russell 1910
- Gyroscope
Atanasoff 1908
- Triode
deForest 1906

- Incandescent Bulb
Edison 1879
- Typewriter
1817
- Electrical Current
Gauss 1873

- Maxwell's Equations
1860
- Problem Solving Logic
Boole 1854
- Gyroscope
Foucault 1852
- Telegraph
Morse 1837
- Electro-magnetic Relay
1830

- Battery
Volta 1800
- Steam Engine
Watt 1767

- Moveable Type
Gutenberg 1440
- Clock
deWick 1500s
- Block Printing
China 770
- Abacus
- Water Clock
Ktesibios 250 B.C.



Burrington's Tables 1937

Tables for Statisticians Peirson 1914

CRC Table 1900

Table of Products Hutton 1781

Napier's Bones 1617

Tables

Analog

Electronic Analog Phillips 1936

Differential Analyzer Bush 1930

Power Network Analyzers 1903

Electrical Equation Solver Wright 1908

Harmonic Integrator Meissner and Strutt 1896

Equation Solver Jones 1893

Harmonic Analyzer Kelvin 1876

Tide Predictor Kelvin 1872

Thatcher Rule 1861

Spiral Rule Fuller 1878

Ball and Disk Integrator Thross 1850

Circular Rule Fuller 1845

Planimeter Cornelli 1824

Oughtred Scales 1621

Gunter Scale 1620

Logarithms Napier 1614

Quicksam 1864

Pascal's Adder 1647

Shikard Calculator 1623

Simple Calculators

Electric Millionaire 1853

Millionaire Steiner 1833

Arithmometer Thomas 1872

Stepped Reckoner Leibniz 1671

Marchant 1916

Rechnitzer 1902

Arithmometer Baldwin 1875

Arithmometer Odlum 1874

Rotary

Key Punch

Monroe Automatic 1902

Monroe Electric 1912

Adding Machine Burroughs 1892

Comptoseter 1897

Difference Tabulator Columbia 1931

Difference Engine Scherr 1831

Difference Engine Babbage 1822

Complex Function Calculators

Flexewriter

Card Perforator and Sorter Giese 1895

Punched Card Hollerith 1894

Teletypewriter Code Branstetter 1878

Paper Tape Telegraph Giese 1895

Jacquard Loom 1801

Card Operated Loom Vaucauson 1745

Punched Cards Falson 1728

Paper Tape Babbage 1725

Machinereadable Information

Harvard MX I Aiken 1937-1945

Zuse III 1941

Zuse II 1939

Bell Relay Calculator Sholes 1907-9

Zuse I 1936

Electronic

Electro-mechanical calculator Torres 1903

Analytic Engine Babbage 1833

Electro-mechanical

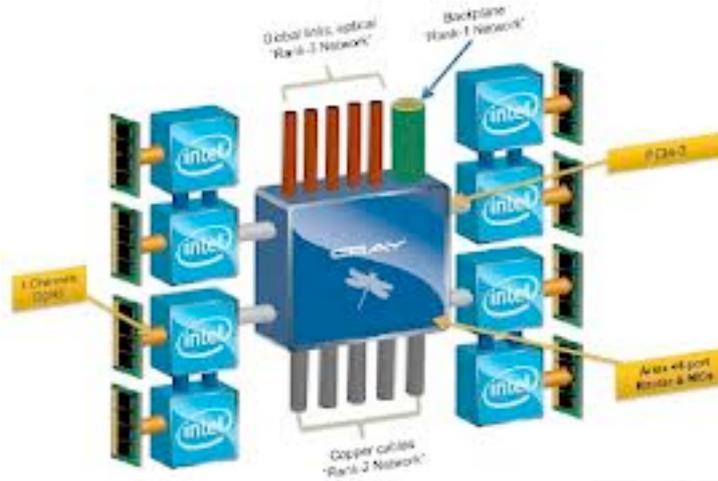
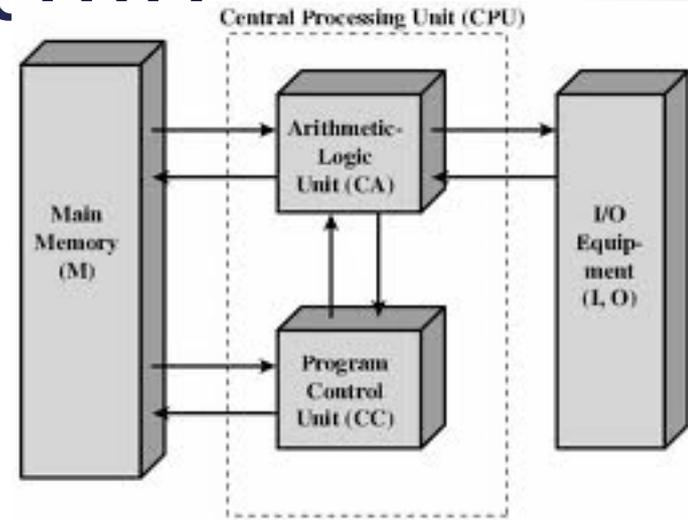
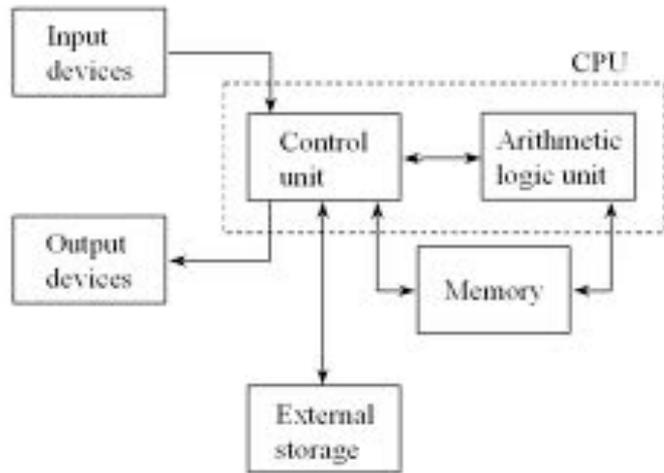
Computers

- EDVAC Report Von Neumann 1945
- ACE Report Turing 1945
- Colossus 1943
- ENIAC 1943-48
- Magnetic Recording Disks 1943
- Atanasoff-Berry Reports 1935-42

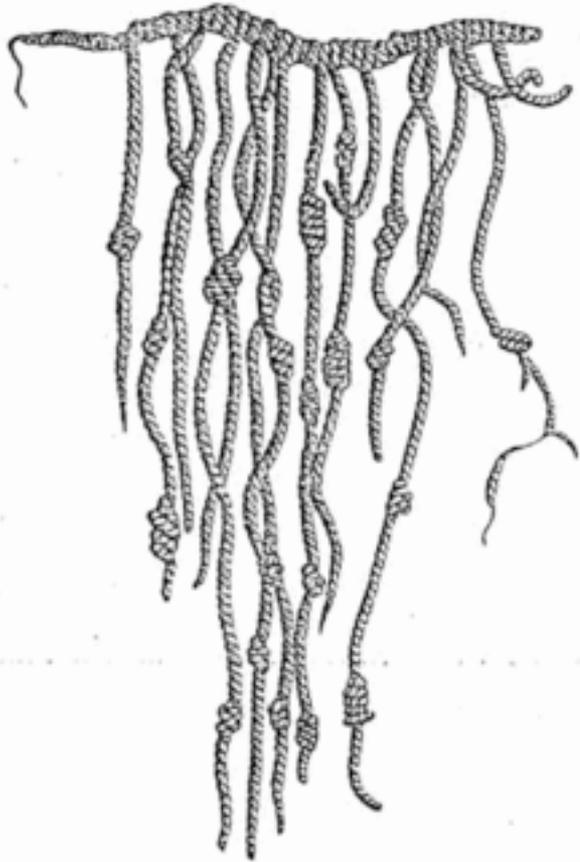
Computer Genealogy

Digital Computer Museum

Computer Architecture



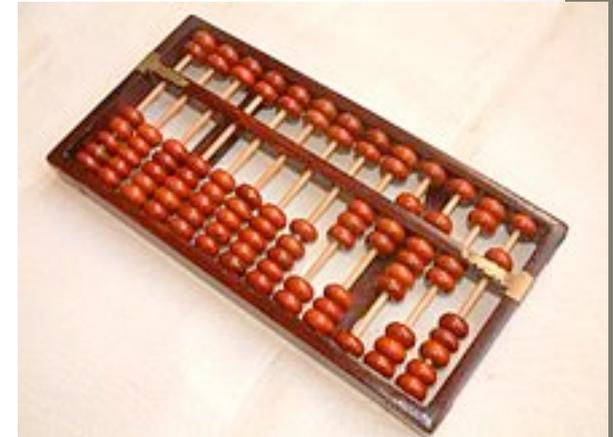
Oldest Countable Tables and Abacus



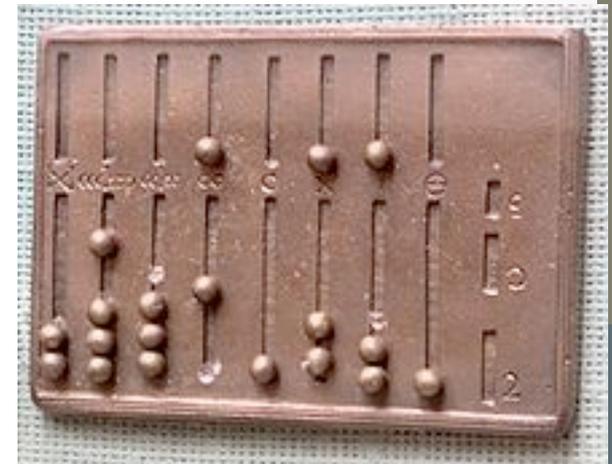
Incas



Europe 1508



Chine (2 BC)



Roman Abacus

Gerbert d'Aurillac (Pope Sylvester II)

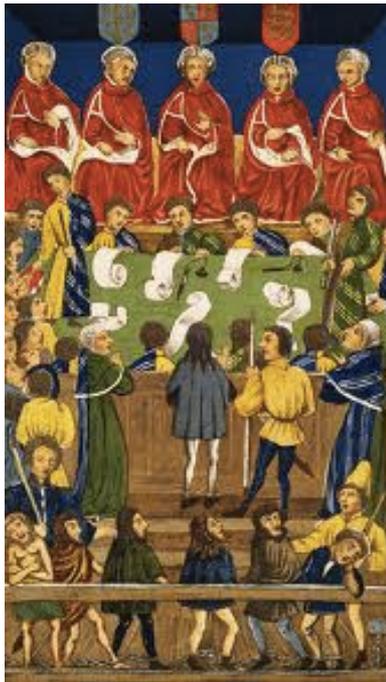
- Import the Hindu-Arabic digits machines to Europe (900 AC)
- Yes and Not Question Machine (Designed by Arabs)



Al dem gote so man salt
von gotes gedurte et
vnd emiser Do was
Sylvester ein Chobp-
der ander vnd trank ge-
lotten von welschem
lind vnd der hieß Sil-
bertus vnd staz zu ghe-
ruffen zu dem heiligen
Crux Difer heyst den

Computer

- Computer is the word used in 1613 to refer a person who carried calculations or computations.



England Court with Computers (1600)

The Breviat of the Table of 10. per Cent.

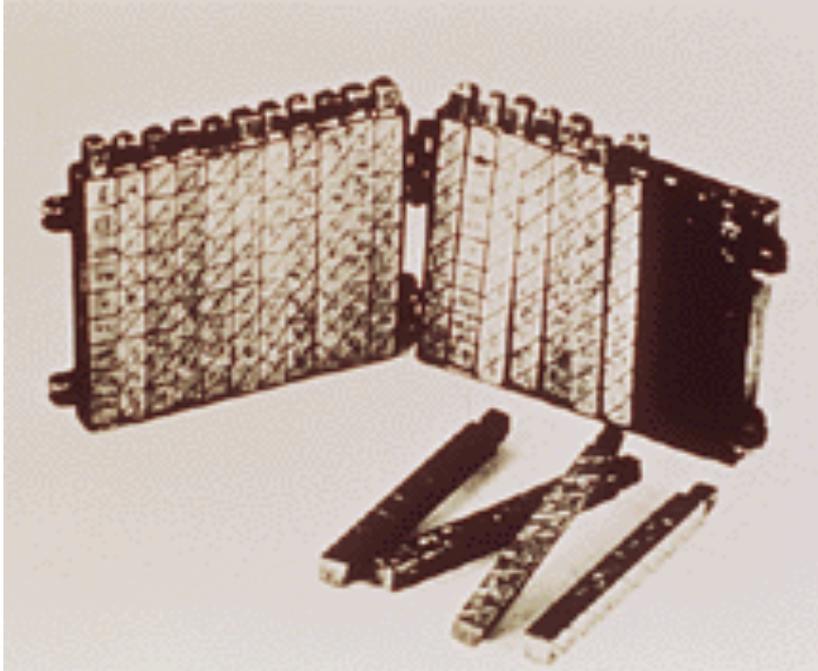
Years,		Years,	
1	11000000	16	45949729
2	12,00000	17	50544702
3	13310000	18	55599173
4	14641000	19	61159090
5	16105100	20	67274999
6	17715610	21	74002499
7	19487174	22	81402749

Image from: *Arithmeticall Questions* in 1613

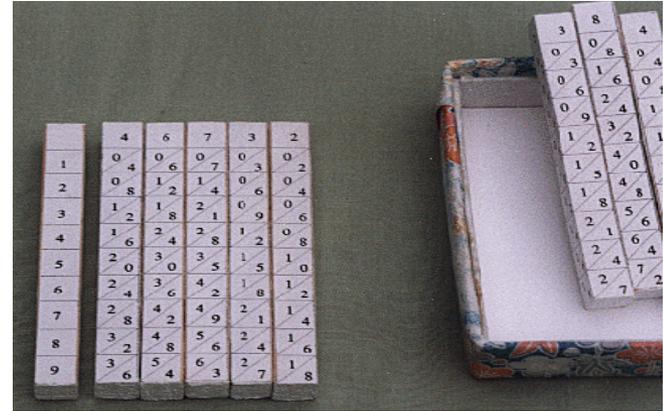


Pacioli (1500)

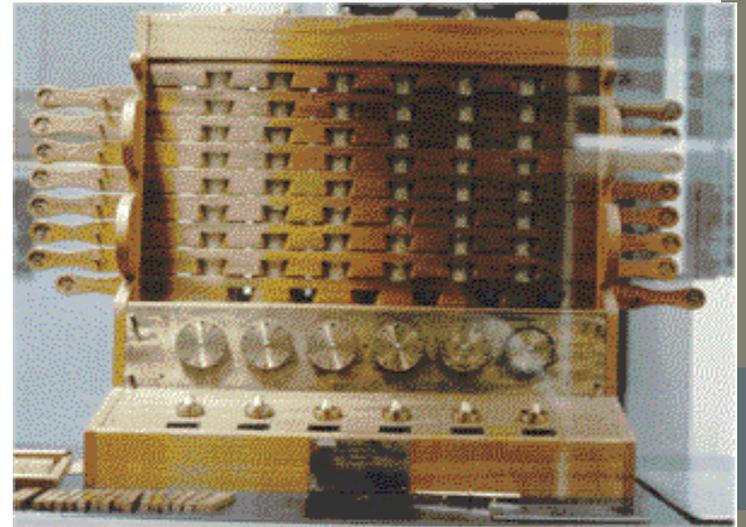
Games and Clocks



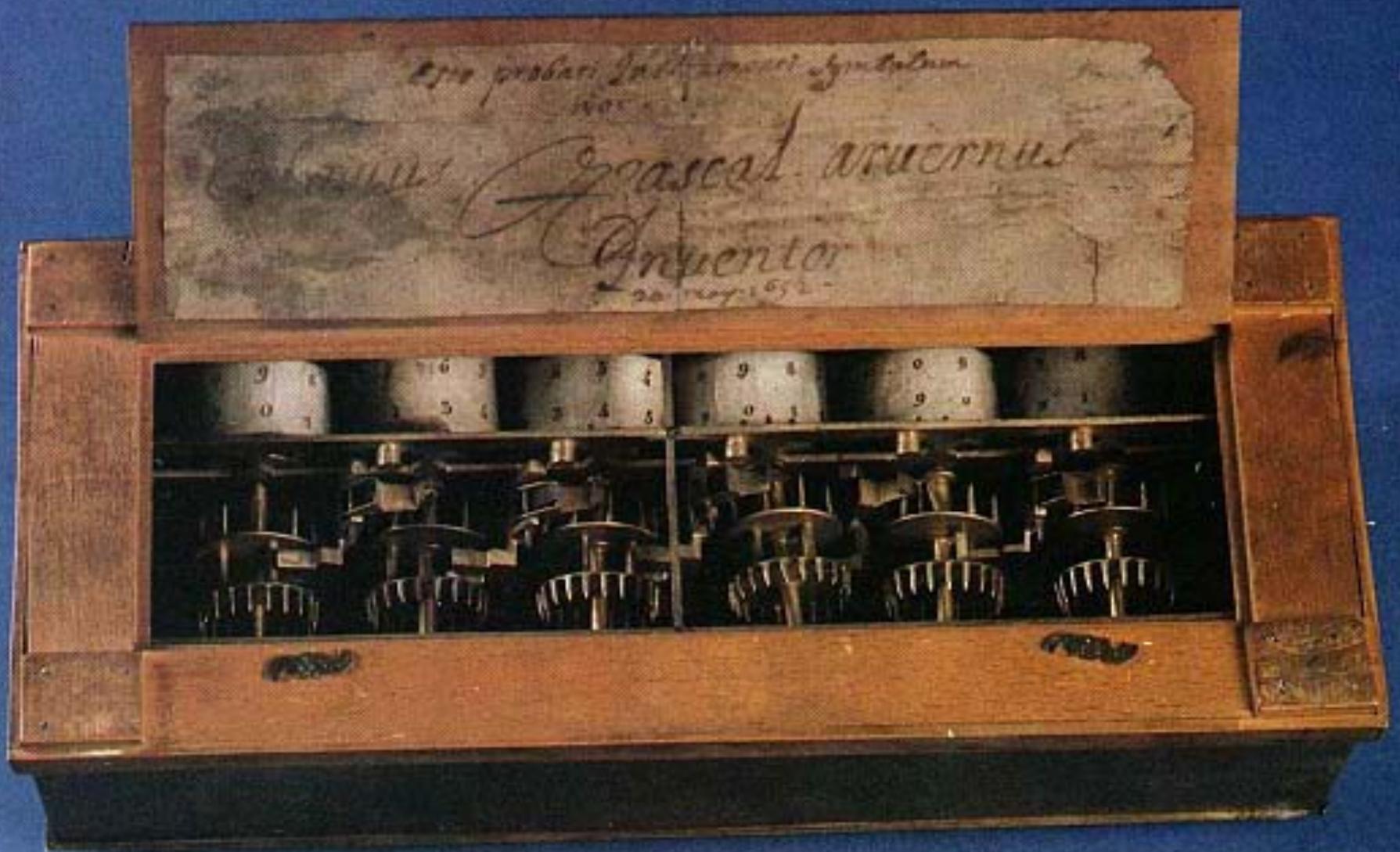
(1617) Napier's Bones



(1980) Napier's Bones



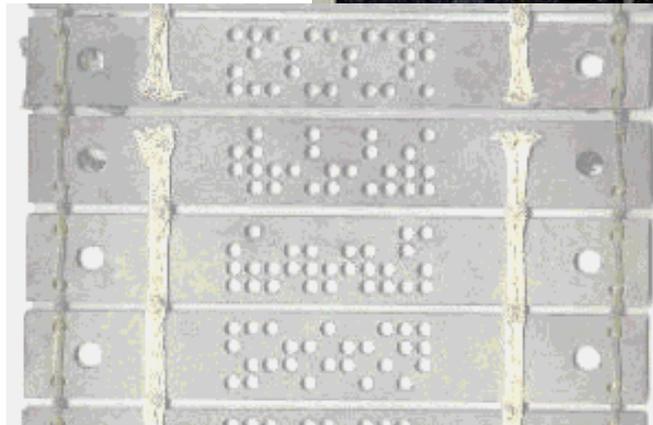
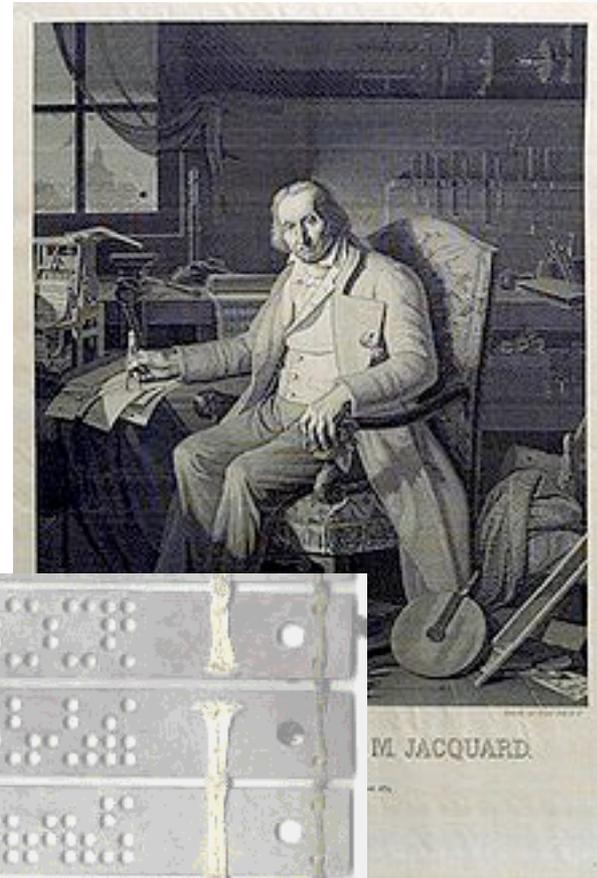
(1623) Schickard's Calculating Clock



(1642) A Pascaline opened up so you can observe the gears and cylinders which rotated to display the numerical result

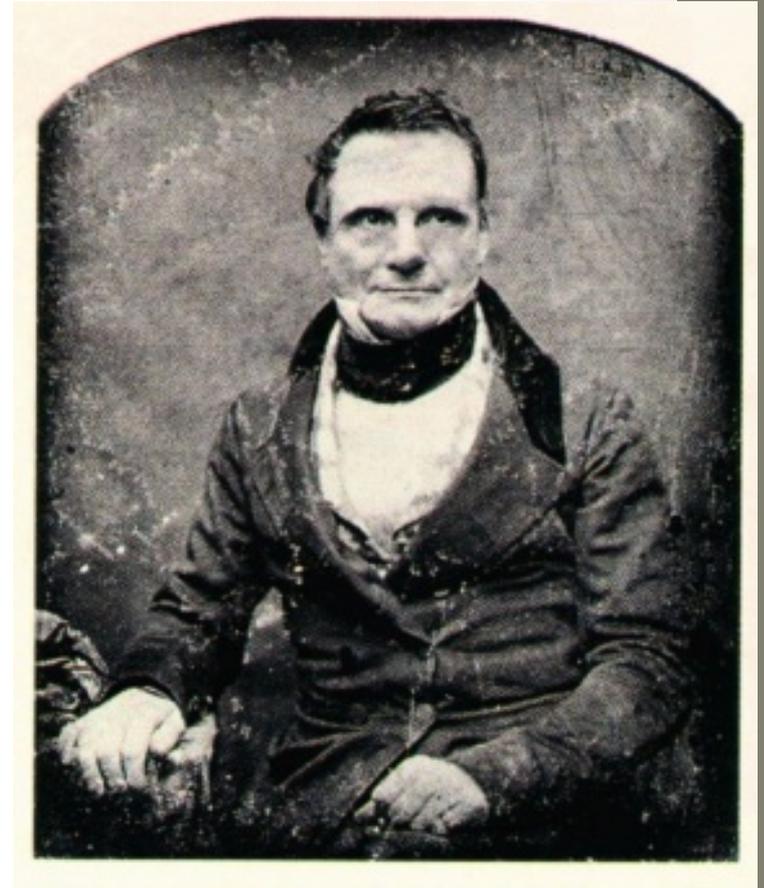
Joseph Marie Jacquard

- First pseudo- programmable Machine (1801)

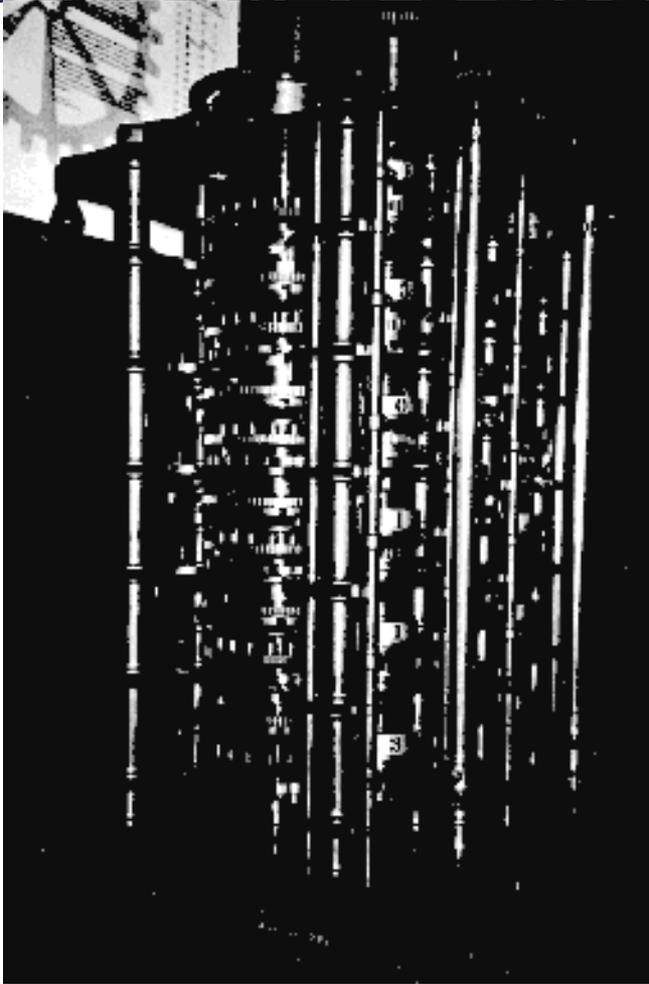


Charles Babbage

- English inventor
- 1791-1871
- taught math at Cambridge University
- invented a viable mechanical computer equivalent to modern digital computers

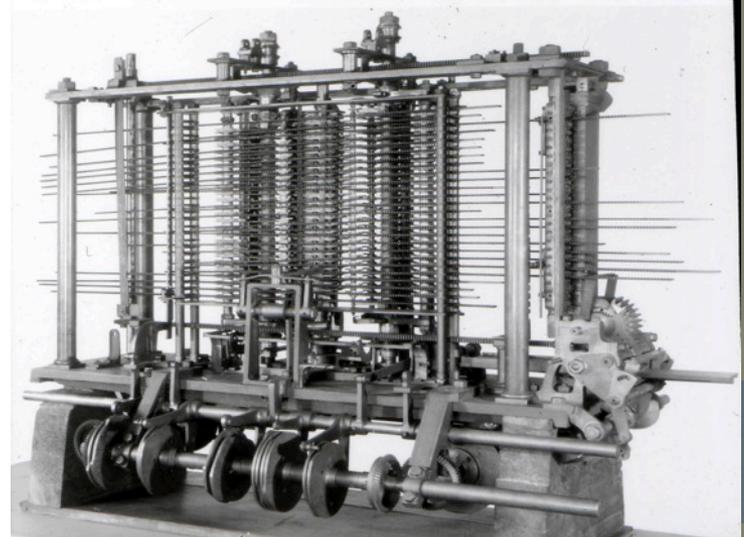


Babbage's first computer

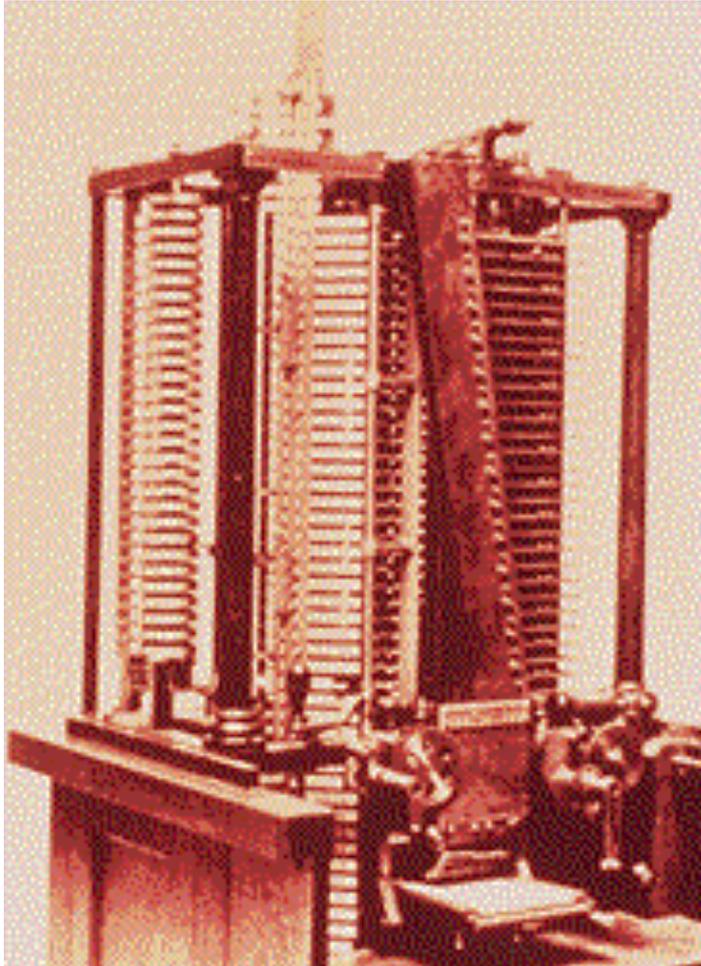


difference engine

- built in early 1800's
 - special purpose calculator
 - naval navigation charts



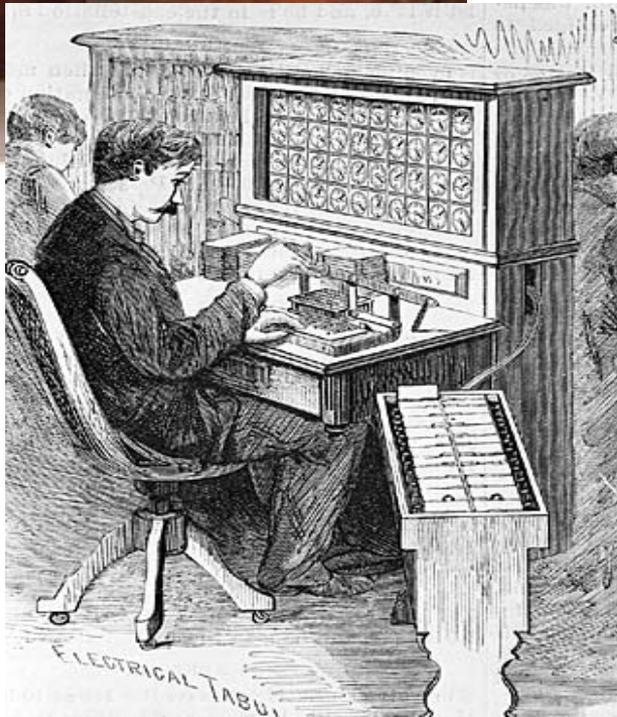
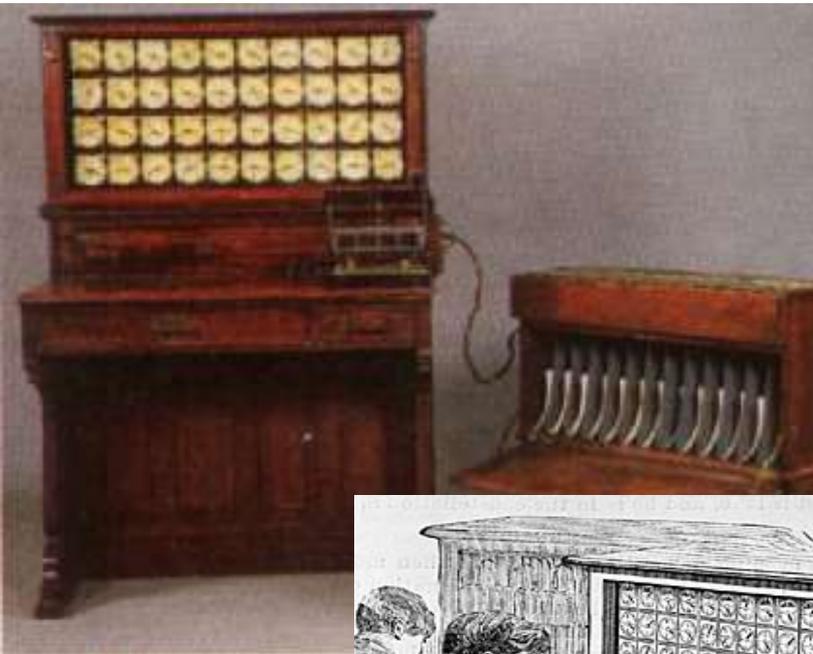
Babbage's second computer



analytical engine, 1834

- Analytical engine
 - general-purpose
 - used binary system
 - punched cards as input
 - branch on result of previous instruction
 - Ada Lovelace (first programmer)
 - machined parts not accurate enough
 - never quite completed

Hollerith Desktop



- Card Lecture (First I/O modern)
- Using in 1890 during the US Citizen Census
- Hollerith launch the International Business Machine

Invention of the light bulb, 1878

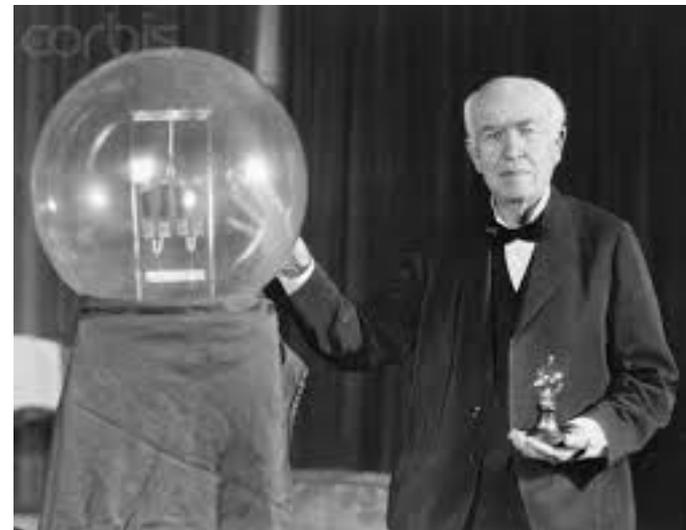
- Sir Joseph Wilson Swan
 - English physicist and electrician
 - First public exhibit of a light bulb in 1878
- Thomas Edison
 - American inventor, working independently of Swan
 - Public exhibit of a light bulb in 1879
 - had a conducting filament mounted in a glass bulb from which the air was evacuated leaving a vacuum
 - passing electricity through the filament caused it to heat up, become incandescent and radiate light
 - the vacuum prevented the filament from oxidizing and burning up



Joseph Swan
(1828-1914)

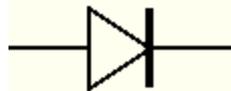
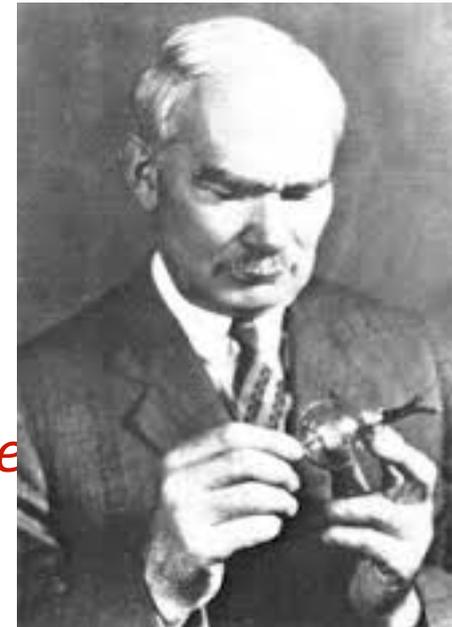
Edison's legacy

- Edison continued to experiment with light bulbs
- in 1883, he detected electrons flowing through the vacuum of a light bulb
 - from the lighted filament
 - to a metal plate mounted inside the bulb
- this became known as the *Edison Effect*
- he did not develop this any further



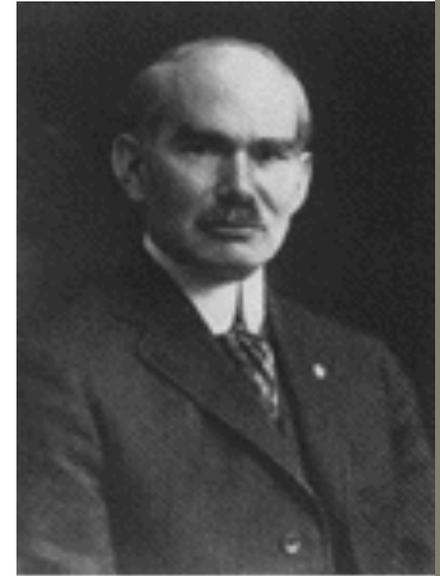
invention of the diode (late 1800's)

- John Ambrose Fleming
 - an English physicist
 - studied Edison effect
 - to detect radio waves and to convert them to electricity
- developed a two-element vacuum tube
 - known as a *diode*
- electrons flow within the tube
 - from the negatively charged *cathode*
 - to the positively charged *anode*
- today, a *diode* is used in circuits as a *rectifier*



the switching vacuum tube, 1906

- Lee de Forest introduced a third electrode into the vacuum tube
 - American inventor
- the new vacuum tube was called a *triode*
 - new electrode was called a *grid*
- this tube could be used as both an amplifier and a switch

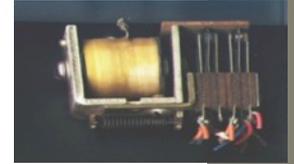


Lee De Forest

- many of the early radio transmitters were built by de Forest using triodes
- triodes revolutionized the field of broadcasting
- their ability to act as switches would later be important in digital computing

on/off switches in digital computers

- earliest:
 - electromechanical relays
 - solenoid with mechanical contact points
 - *physical switch* closes when electricity animates magnet
- 1940's:
 - vacuum tubes
 - no physical contacts to break or get dirty
 - became available in early 1900's
 - mainly used in radios at first
- 1950's to present
 - transistors
 - invented at Bell Labs in 1948
 - John Bardeen, Walter Brattain, and William Shockley
 - Nobel prize, 1956



War Computing Machines

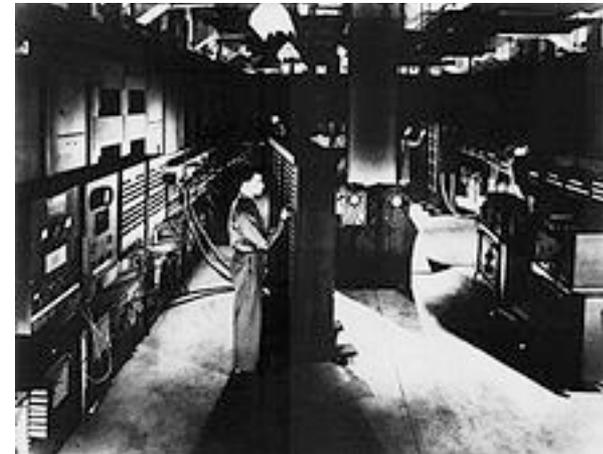
Zuse Z3 (1941)



ENIGMA(1943)

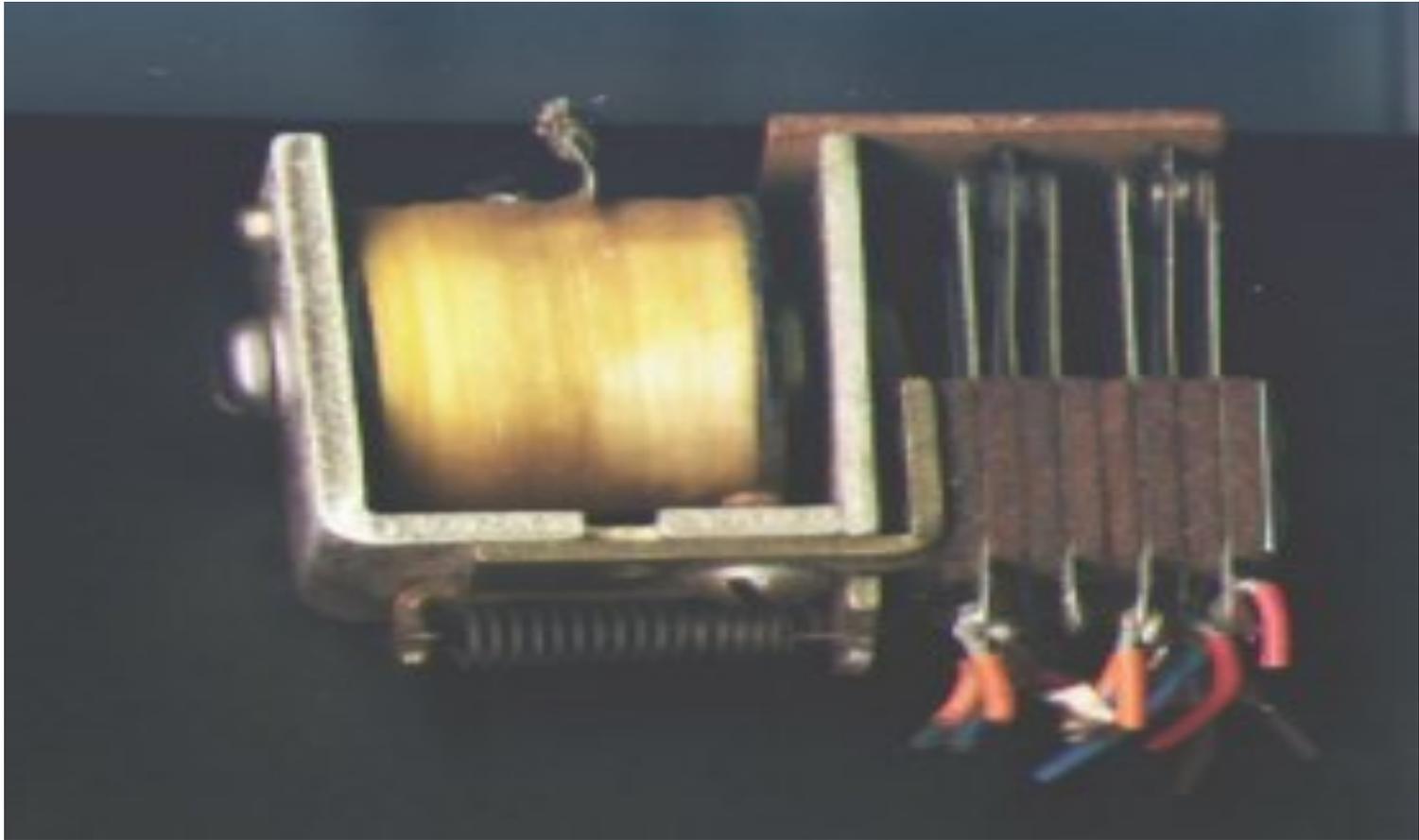


(EDSAC, 1946)



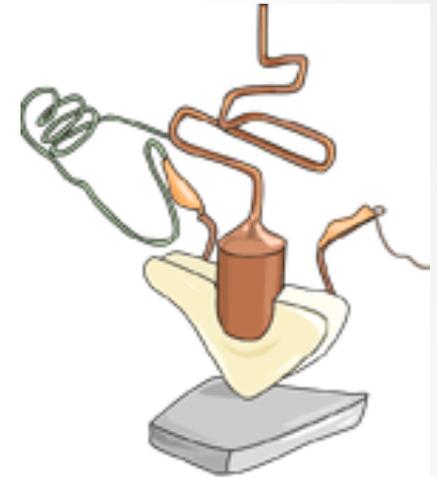
(ENIAC, 1946)

photo of an electromechanical relay



transistor evolution

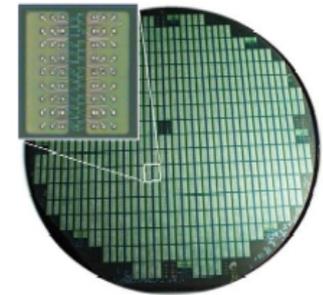
- first transistor made from materials including a paper clip and a razor blade



- later packaged in small IC's

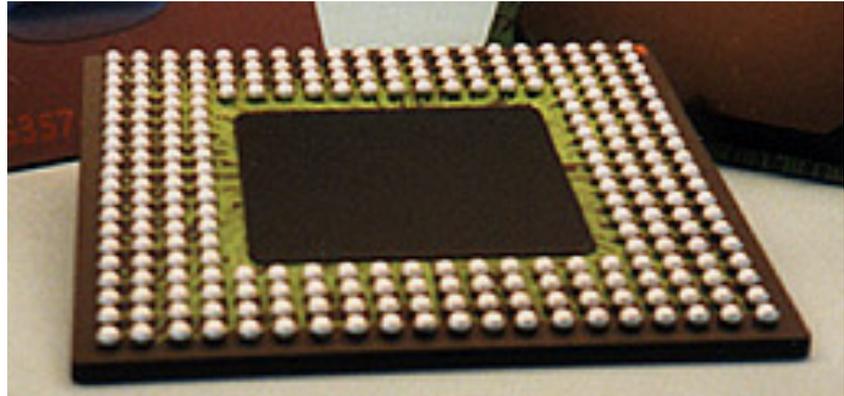
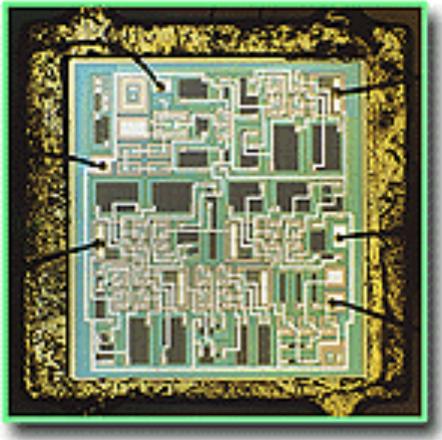


- eventually came VLSI
 - Very Large Scale Integration
 - millions of transistors per chip

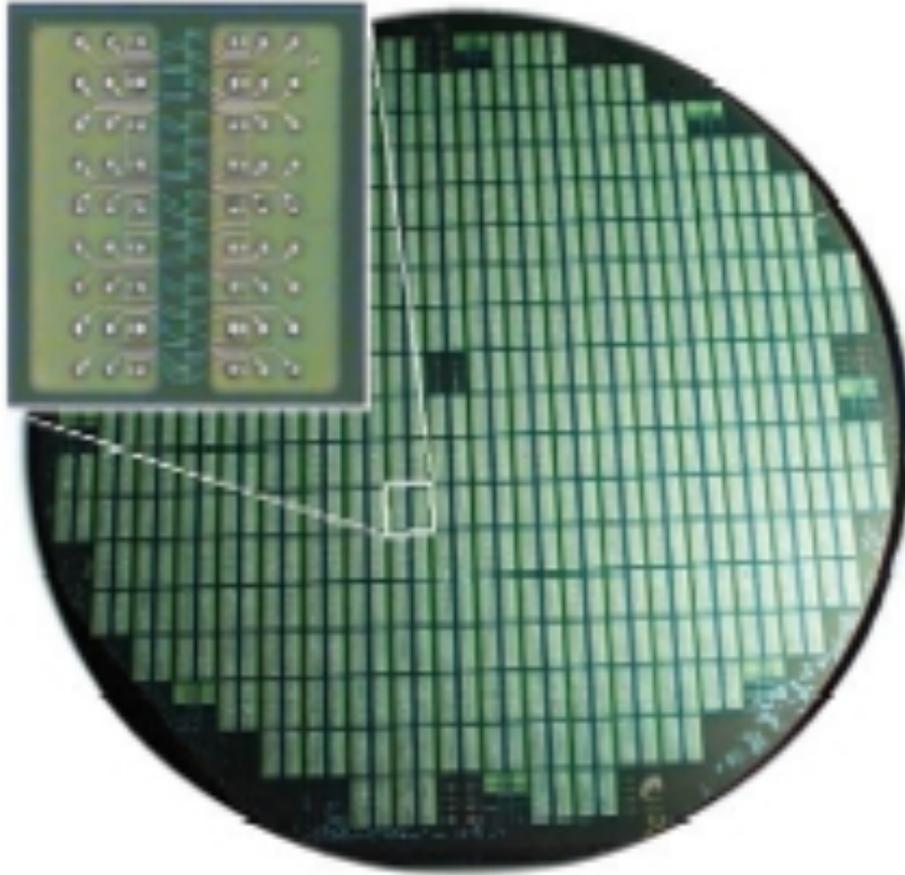


the integrated circuit (IC)

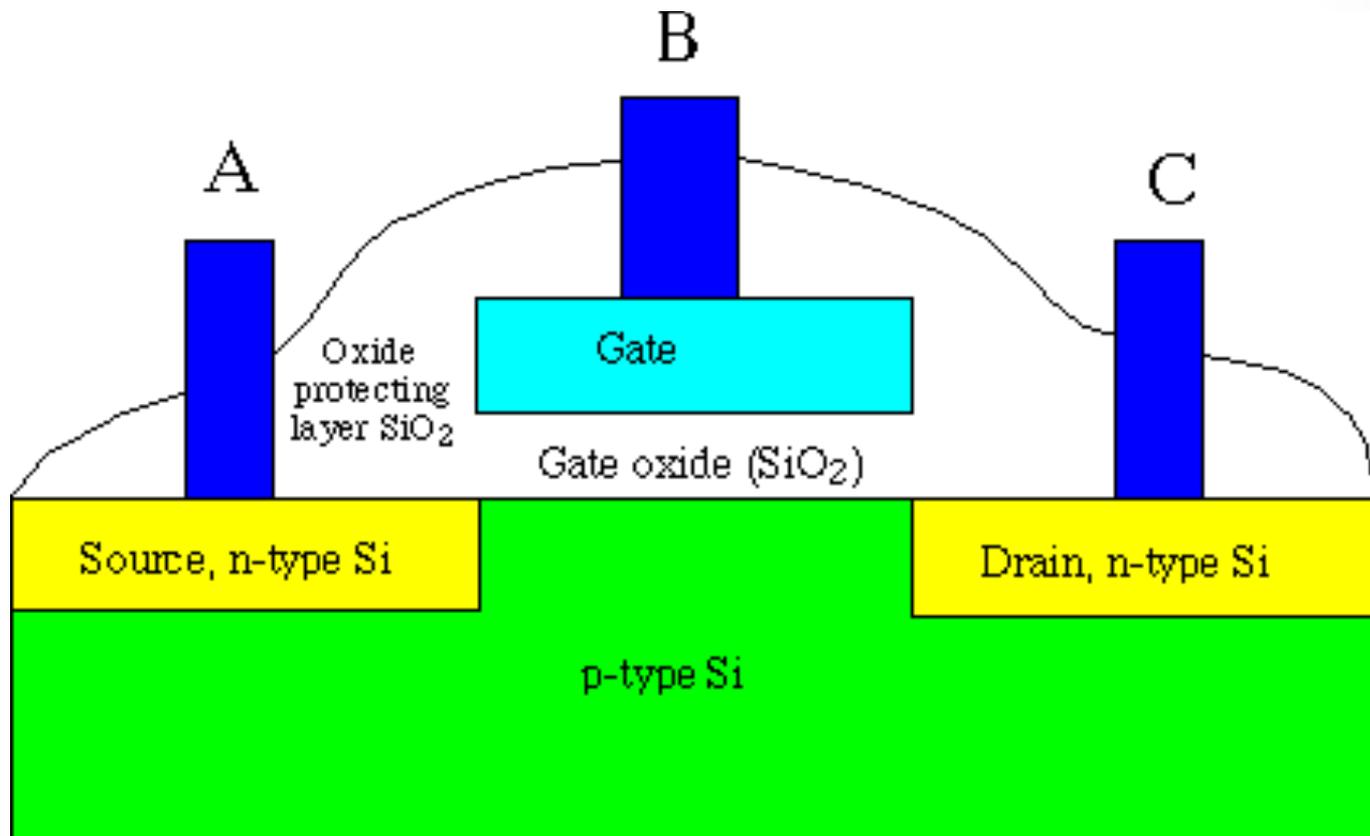
- invented separately by 2 people ~1958
 - Jack Kilby at Texas Instruments
 - Robert Noyce at Fairchild Semiconductor (1958-59)
- 1974
 - Intel introduces the 8080 processor
 - one of the first “single-chip” microprocessors



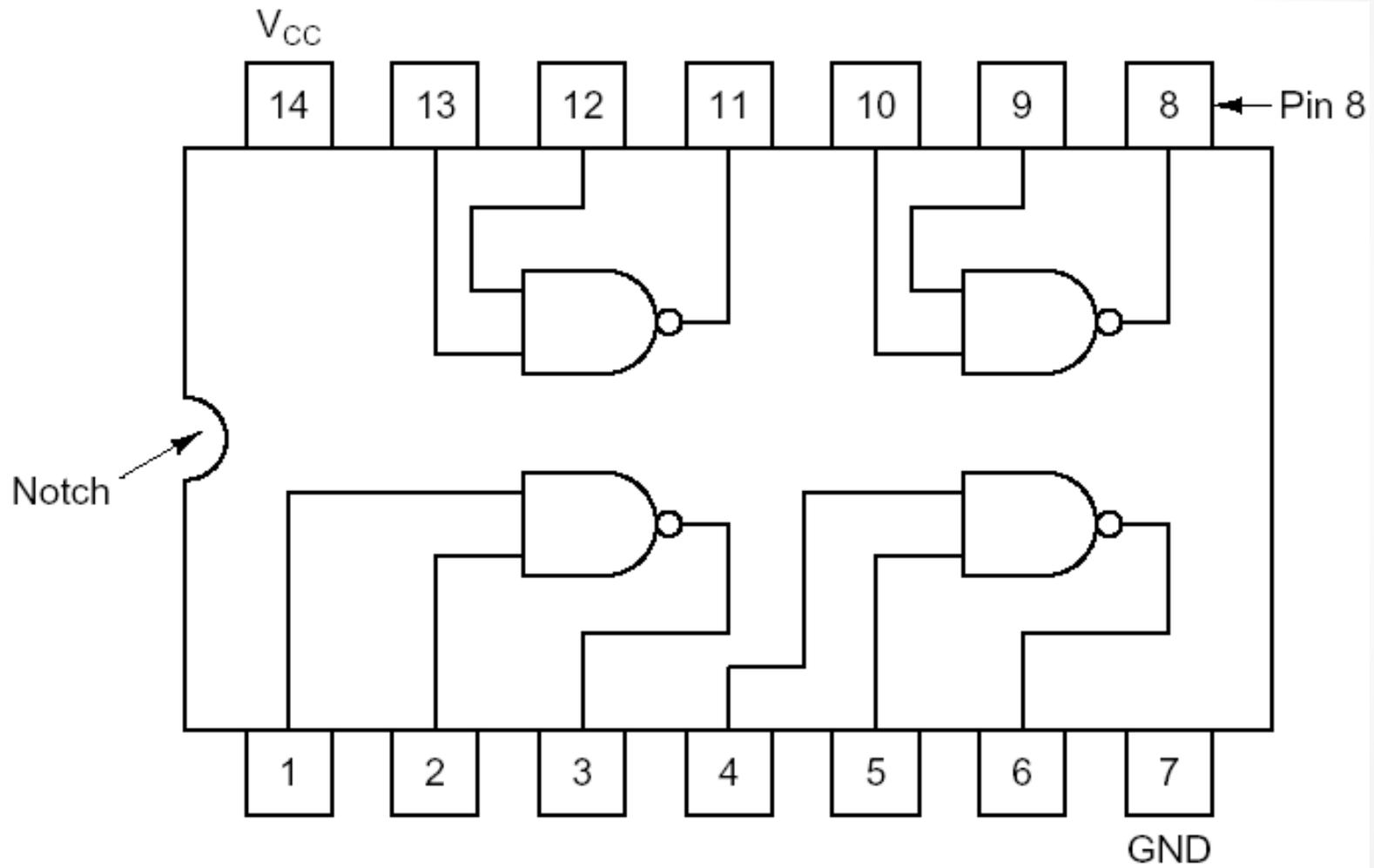
IC's are fabricated many at a time



functional view of transistor contents



a TTL chip



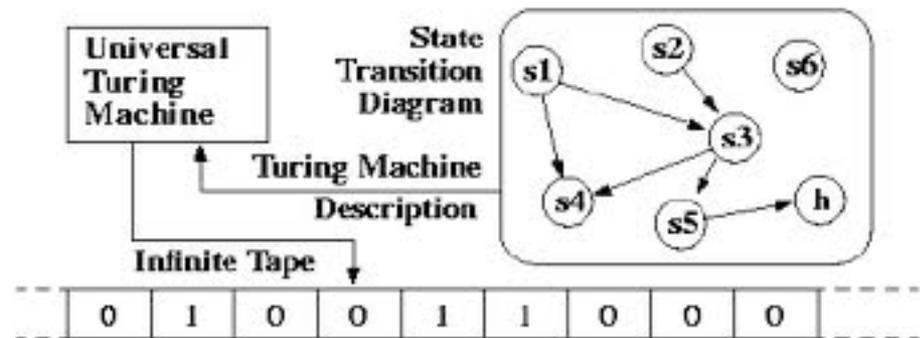
An SSI chip containing four gates.

Moore's law

- deals with steady rate of miniaturization of technology
- named for Intel co-founder Gordon Moore
- not really a *law*
 - more a “rule of thumb”
 - a practical way to think about something
- observation that chip density about doubles every 18 months
 - also, prices decline
 - first described in 1965
 - **MOORE'S LAW IS NOT APLICABLE TODAY!**
 - limited when size reaches molecular level

Alan Turing (1912 – 1954)

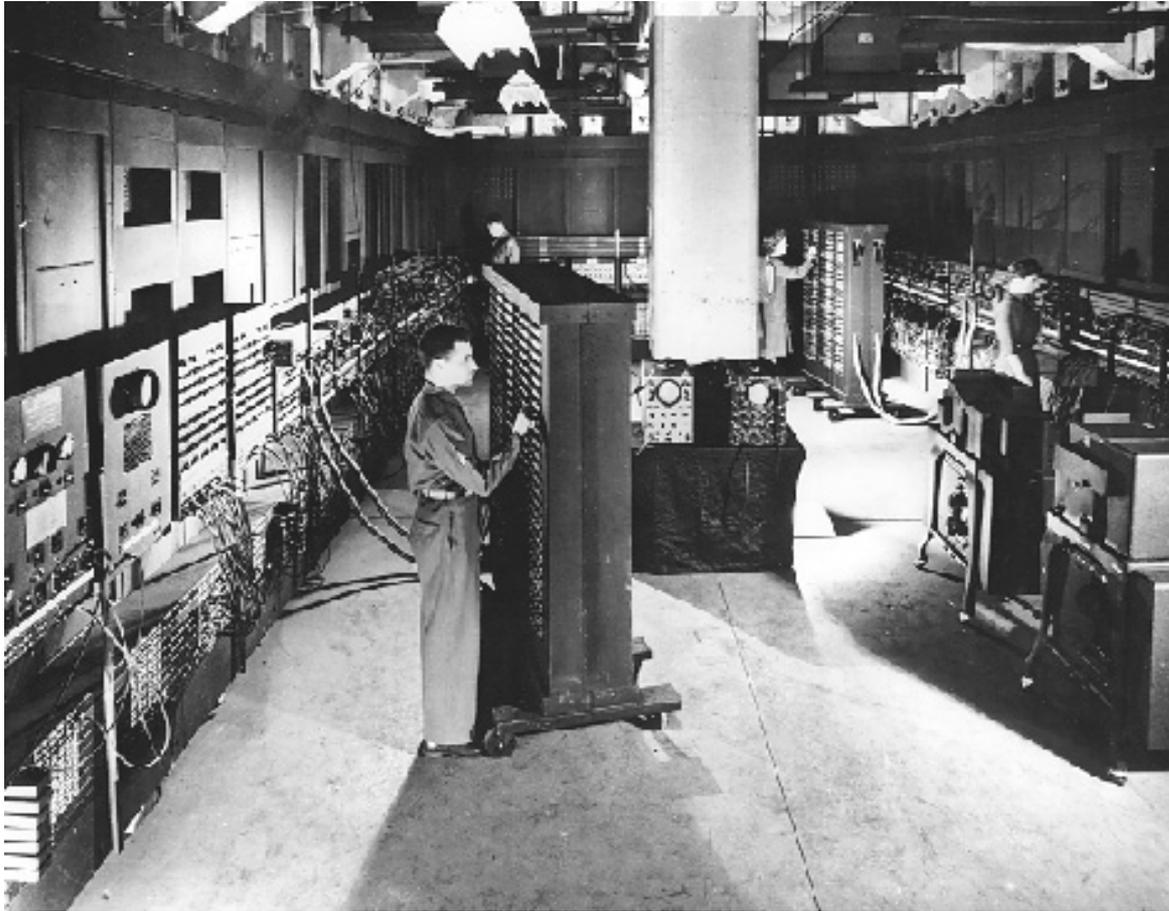
- Turing Machine
 - Model of General purpose Computer
- <http://amturing.acm.org/>



transistors - building blocks of computers

- microprocessors contain many transistors
 - **(ENIAC):** 19,500 vacuum tubes and relays
 - **Intel 8088 processor (1st PC):** 29,000 transistors
 - **Intel Pentium II processor:** 7 million transistors
 - **Intel Pentium III processor:** 28 million transistors
 - **Intel Pentium 4 processor:** 42 million transistors
- logically, each transistor acts as an on-off switch
- transistors combined to implement logic gates
 - AND, OR, NOT
- gates combined to build higher-level structures
 - adder, multiplexor, decoder, register, ...

Electrical Numerical Integrator and Computer (ENIAC), 1940's



- an early computer
- developed at UPenn
- Size: 30' x 50' room
- 18,000 vacuum tubes
- 1500 relays
- weighed 30 tons
- designers
 - John Mauchly
 - J. Presper Eckert

Intel 8088 microprocessor (single chip)

- used in first IBM personal computer
- IBM PC released in 1981
- 4.77 MHz clock
- 16 bit integers, with an 8-bit data bus
 - transfers took two steps (a byte at a time)
 - 1 Mb of physical memory address limitation
- 8-bit device-controlling chips
- 29,000 transistors
- 3-micron technology
- speed was 0.33 MIPS
- later version had 8 MHz clock
 - speed was 0.75 MIPS.

Pentium 4 chip has
42 million transistors

electrical paths now
as small as .13 micron

Relative Computing



**DEC
LSI-11,
Early 1980's**



**DEC
PDP-11,
mid 1970's**



Mobil Devices 2012

Evolution of Configurable Architecture

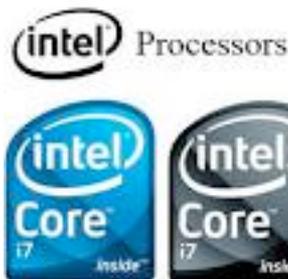
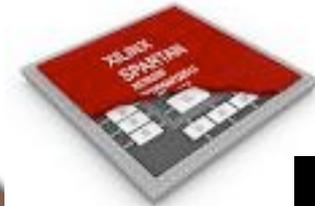
Large Scale Cores
(High Single Thread Performance)

Dual Cores
(Symmetric Multithreading)

MultiCore Arrays

Scalar + Many Cores
(Highly threaded workloads)

Manycore arrays



Processors History (Survey)



Intel 8086 / 8088 (1978)
5 – 10 MHz, 16-bit
IBM PC



Intel 80286 (1982)
6 – 12 MHz
IBM PC AT



Intel (80)386 (1985)
16 – 33 MHz, 32-bit
PC & IBM PS/2



Intel 486 (1989)
25 – 100 MHz
PC



Intel Pentium (1993)
60 – 200 MHz
PC



Motorola 68000 (19???)
4 – 8 MHz, 32-bit
Apple Macintosh,
Commodore Amiga



IBM PowerPC (19???)
4 – 8 MHz
Apple iMac

Work@class and @home

- For Classroom:
 - See the site: <http://amturing.acm.org/byyear.cfm>
 - Choice one recipient of the ACM and observe:
 - Why this person win the ACM?
 - What is the Experience, Education, Honors and Other Recognitions of them?
 - What is your impression about the selected winners and the contributions?
- For the Home:
 - See the next videos:
 - <https://www.youtube.com/watch?v=Nun1HXqBEVY>
 - <https://www.youtube.com/watch?v=vbNHCn2gHQ4>
 - <https://www.youtube.com/watch?v=1ayGJDO6PKU>
 - Open Question: ...
 - And beyond...?