CSE 520
Computer Architecture II

Review: A Brief History of Computer Systems

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Computing: The Art of Abstraction

- Application
- Algorithm
- Programming Language
- Operating System/Virtual Machine
- Instruction Set Architecture (ISA)
- Microarchitecture
- Register-Transfer Level (RTL)
- Circuits
- Devices
- Physics

Computing Devices Now



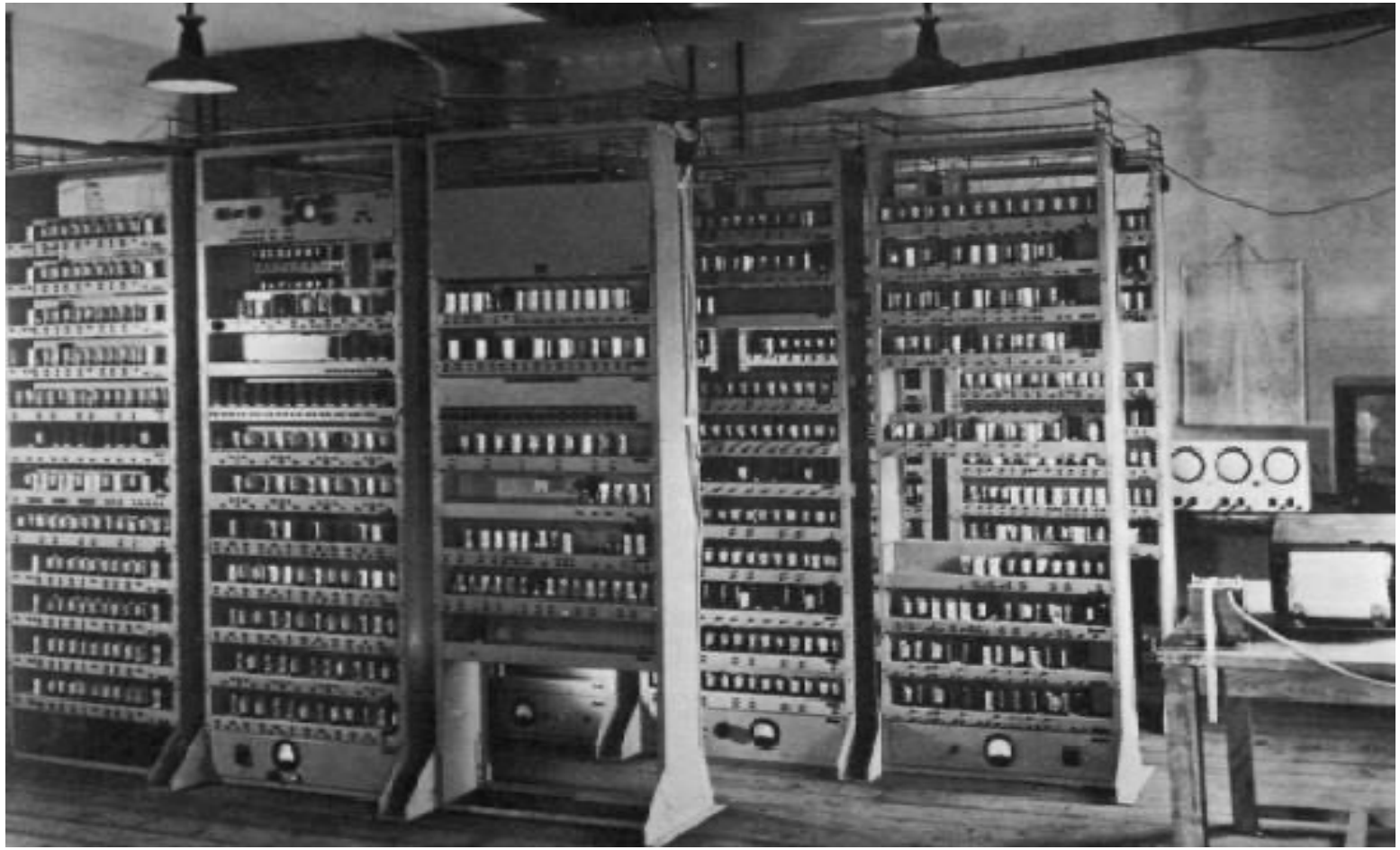









Computing Devices Then…



Importance of Technology

- New technologies not only provide greater speed, size and reliability at lower cost, but more importantly these dictate the kinds of structures that can be considered and thus come to shape our whole view of what a computer is.

Bell & Newell

Computer Design

- Technology is the dominant factor in computer design

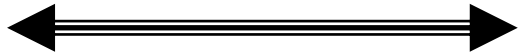
Technology
Transistors
Integrated circuits
VLSI (initially)

Computers

Technology
Core memories
Magnetic tapes
Disks

Computers

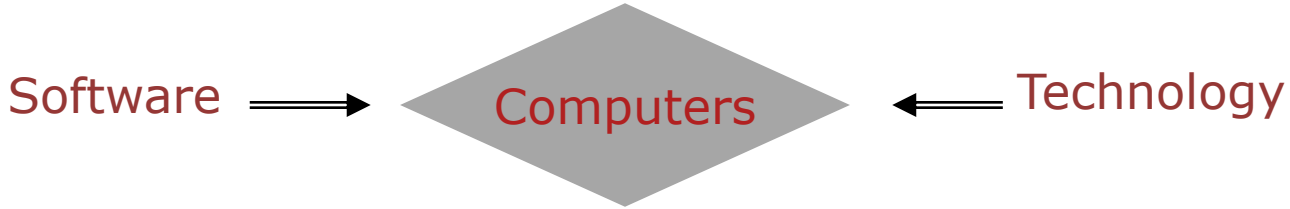
Technology
ROMs, RAMs
VLSI
Packaging
Low Power



Computers

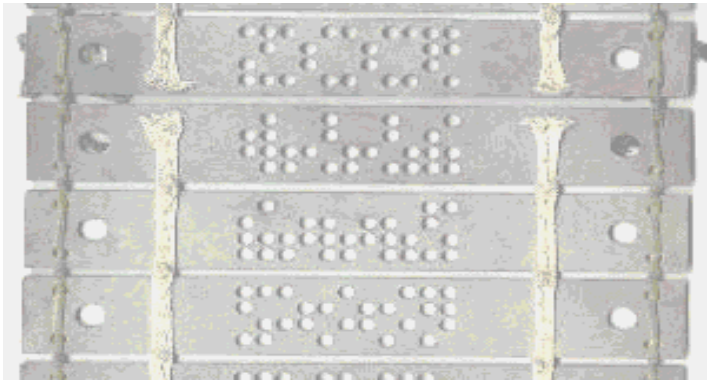
What about the Software…

- As people write programs and use computers, our understanding of programming and system behavior improve
- This has profound though slower impact on computer design
- Modern computer engineers cannot avoid paying attention to software and compilation issues.



Who invented the Computer?

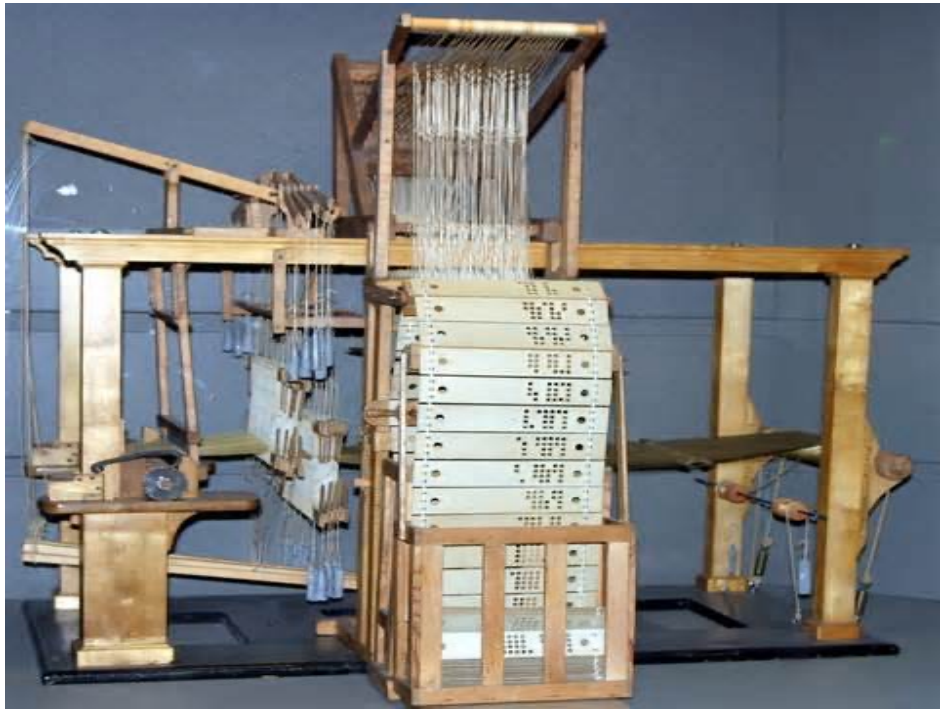
- Lot of people and it is still being invented!
  - You can be part of it too!!!



Punch Cards

Jacquard Card

1801



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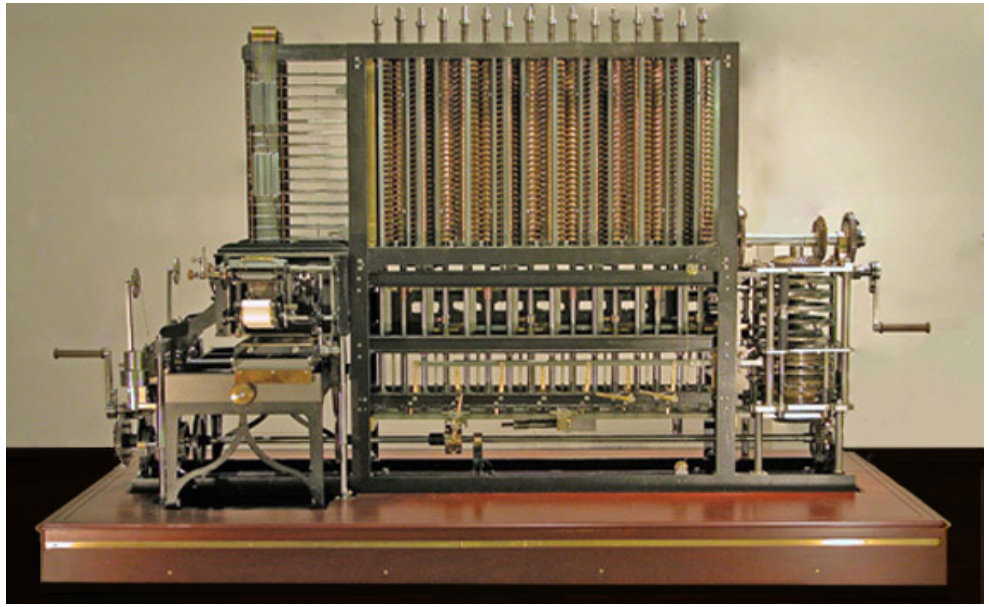
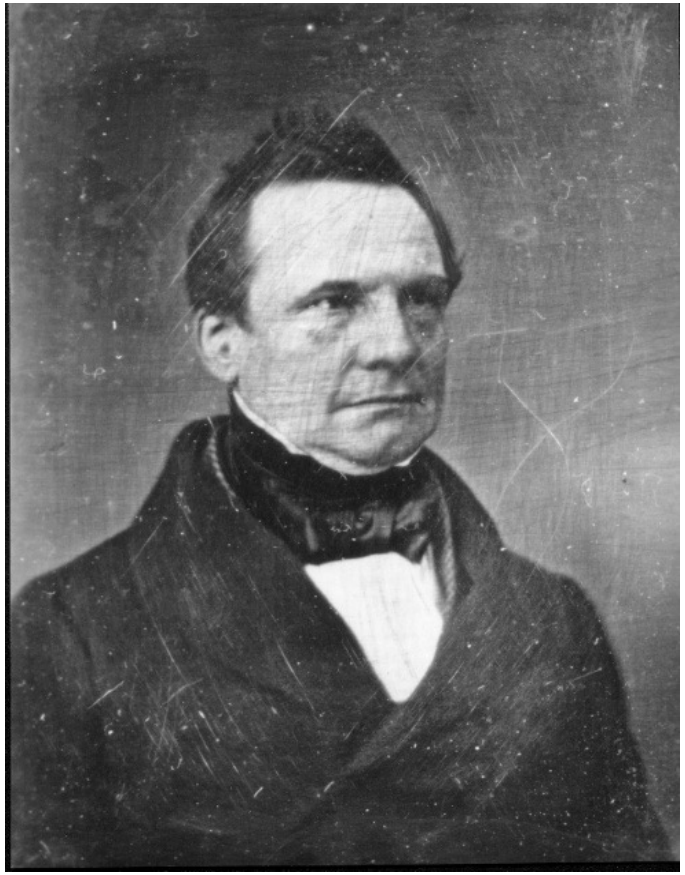
Charles Babbage



The forerunner of modern digital computer:
Difference Engine -1823

Charles Babbage 1791-1871



- Difference Engine 1823
- Analytic Engine 1833
  - The forerunner of modern digital computer!
    - Application
      - Mathematical Tables – Astronomy
      - Nautical Tables – Navy
    - Background
      - Any continuous function can be approximated by a polynomial
      - Any Polynomial can be computed from difference tables

The First Programmer

- Ada Byron aka "Lady Lovelace" 1815-52
  - Ada's tutor was Babbage himself!

More Recent: Linear Equation Solver

- 1930's:
  - Atanasoff built the Linear Equation Solver
    - It had 300 tubes!
    - Application:
      - Linear and Integral differential equations
    - Background:
      - Vannevar Bush's Differential Analyzer - an analog computer
    - Technology:
      - Tubes and Electromechanical relays

Harvard Mark I

- Built in 1944 in IBM Endicott laboratories
  - Howard Aiken – Professor of Physics at Harvard
  - Essentially mechanical but had some electro-magnetically controlled relays and gears
    - Weighed 5 tons and had 750,000 components
    - A synchronizing clock that beat every 0.015 seconds
  - Performance:
    - 0.3 seconds for addition
    - 6 seconds for multiplication
    - 1 minute for a sine calculation
  - Broke down once a week!

Electronic Numerical Integrator

- Designed and built by Eckert and Mauchly at the University of Pennsylvania during 1943-45
  - The first, completely electronic, operational, general-purpose analytical calculator!
    - 30 tons, 72 square meters, 200KW
    - Performance
      - Read in 120 cards per minute
      - Addition took 200 ms, Division 6 ms
      - 1000 times faster than Mark I
    - Also not very reliable!

Automatic Computer

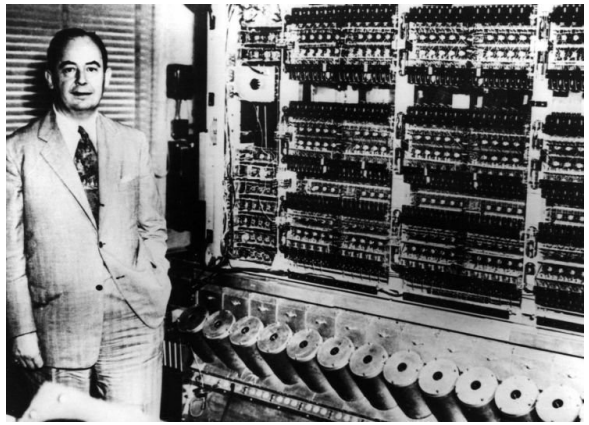
- Electronic Discrete Variable Automatic Computer
- ENIAC's programming system was external
  - Sequences of instructions were executed independently of the results of the calculation
  - Human intervention required to take instructions "out of order"
- EDVAC was designed by Eckert, Mauchly and von Neumann in 1944 to solve this problem
  - Solution was the stored program computer
  - "program can be manipulated as data"

The Big Idea in Today's Computers

- Stored Program Computer

Program = A sequence of instructions

- How to control instruction sequencing?
  - Manual control
    - Calculators
  - Automatic control external (paper tape)
    - Harvard Mark I , 1944
    - Zuse's Z1, WW2
  - Internal
    - Plug board ENIAC 1946

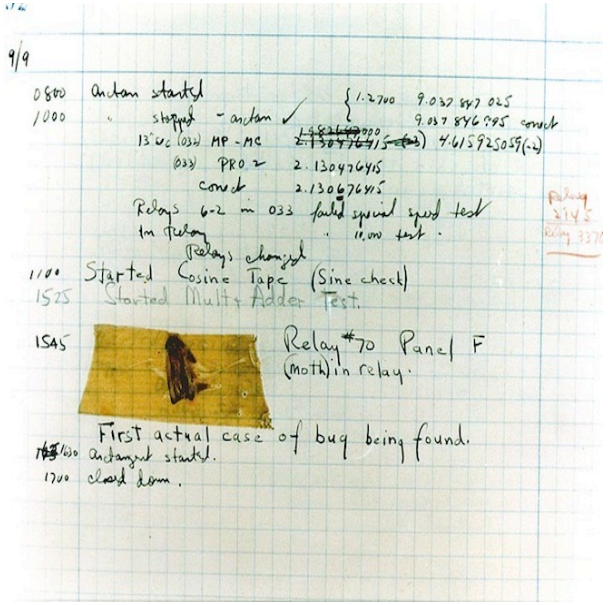


The Spread of Ideas

- ENIAC & EDVAC had immediate impact
  - Brilliant engineering: Eckert & Mauchley
  - Lucid paper: Burks, Goldstein & von Neumann
    - IAS Princeton 46-52 Bigelow
    - EDSAC Cambridge 46-50 Wilkes
    - MANIAC Los Alamos 49-52 Metropolis
    - JOHNIAC Rand 50-53
    - ILLIAC Illinois 49-52
    - Argonne 49-53
- UNIVAC - the first commercial computer, 1951

First Program Bug

- The first computer bug is a moth!
- Grace Murray Hopper found the bug while working on the Harvard Mark II computer



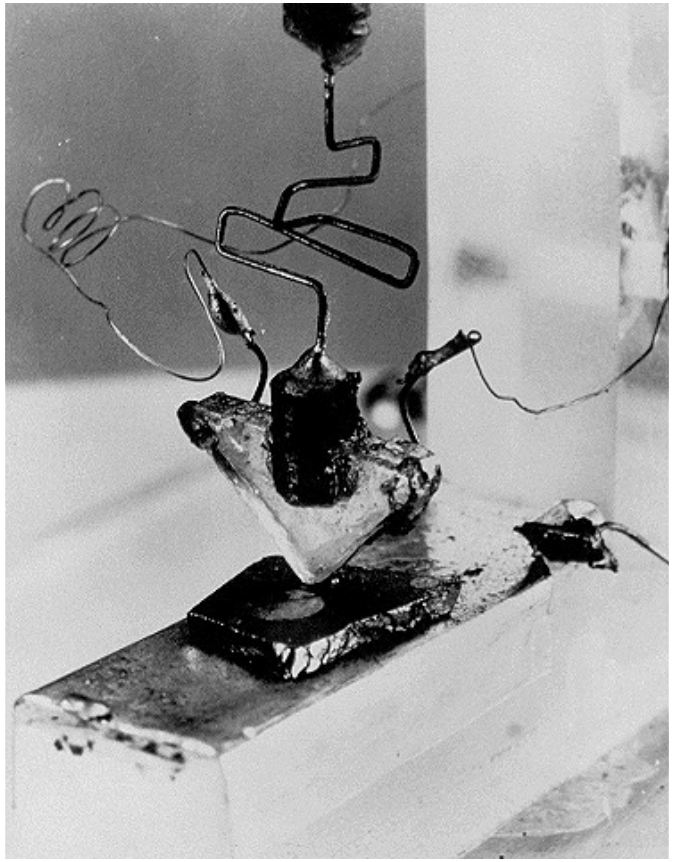
Kid, why all this excitement!!!

- But Albert, just look, look for yourself, how far we have come in just few decades!!!

- Is not this marvelous!!!

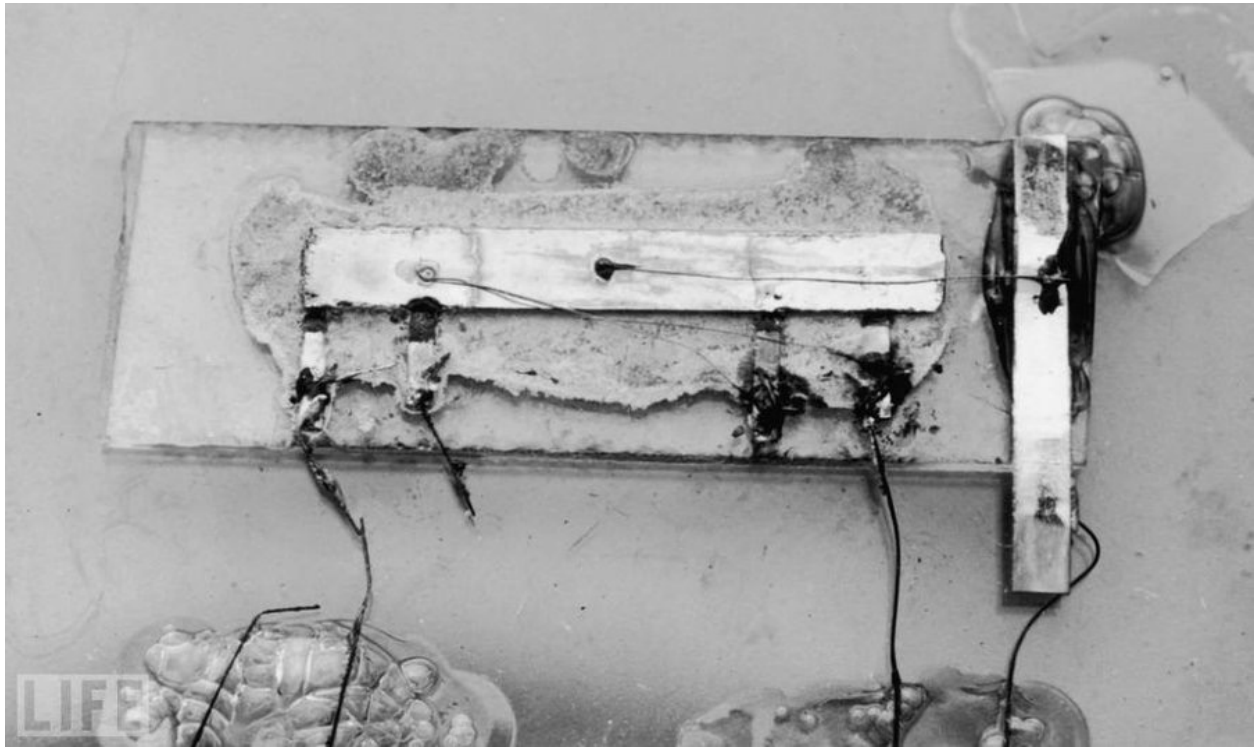
Transistor

- Uses Silicon
- Developed in 1947 in Bell Laboratories by William Shockley, John Bardeen and Walter Brattain Won a Nobel prize
- On-off switch



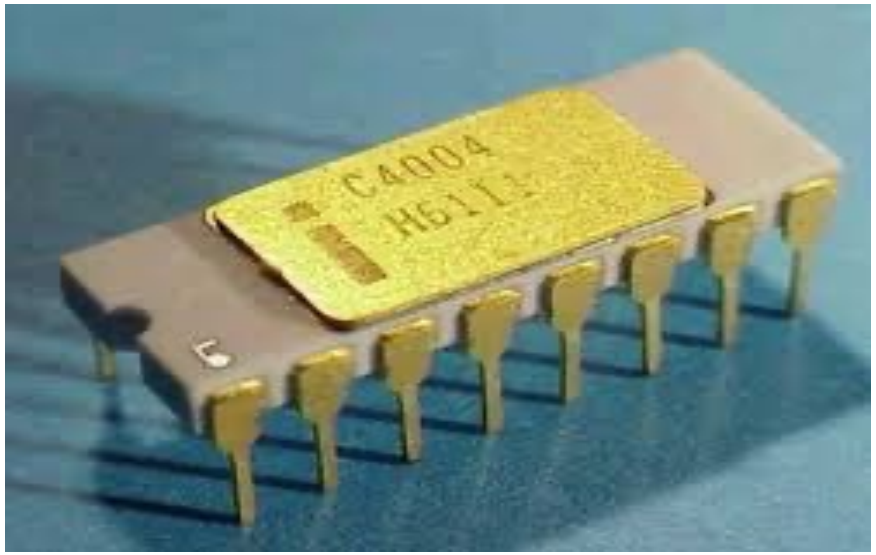
First Integrated Circuit

- Invented at Texas Instruments by Jack Kilby in 1958

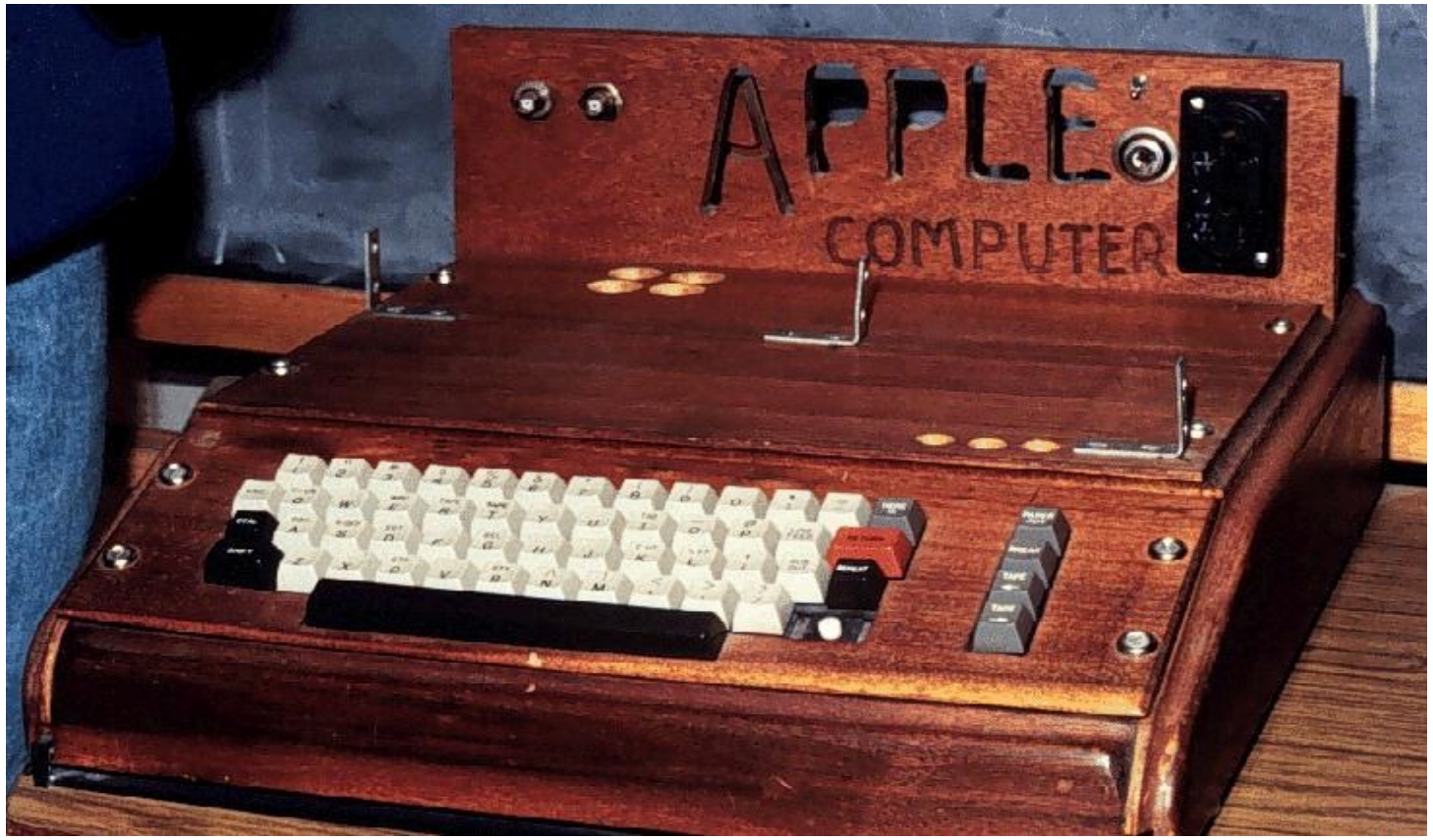


First Microprocessor

- By Intel Corporation
  - 4-bit Microprocessor 4004 in 1971
  - 8-bit microprocessor 8008 in 1972



Apple 1 Computer - 1976



IBM PC - 1981

- IBM-Intel-Microsoft joint venture
  - First wide-selling personal computer used in business
  - 8088 Microchip - 29,000 transistors
  - 4.77 Mhz processing speed
  - 256 K RAM (Random Access Memory) standard

Apple Macintosh - 1984

The Amiga 1000 1985

PowerPC 1991

Cell Phones

- One picture

Apple 2016

Next Lecture Module

- Influence of Technology and Software on Instruction Sets