

# CSE 520

## Computer Architecture II

Review: A Brief History of Computer Systems

Prof. Michel A. Kinsy

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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

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# Computing Devices Now

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### Computing Devices Then...

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### 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

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### 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

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### 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.

Software → **Computers** ← Technology

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### 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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### Who invented the Computer?

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

Charles Babbage  
The forerunner of modern digital computer:  
Difference Engine -1823

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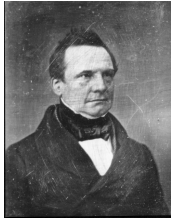
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### Charles Babbage 1791-1871



- 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

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### The First Programmer

- Ada Byron aka “Lady Lovelace” 1815-52
  - Ada’s tutor was Babbage himself!



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### 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

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### 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!

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### 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!

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### 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"

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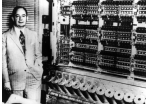
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### The Big Idea in Today's Computers

- 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



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### 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

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### First Program Bug

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




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### 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!!!

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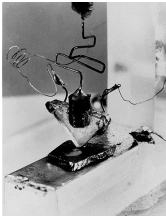
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### Transistor

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



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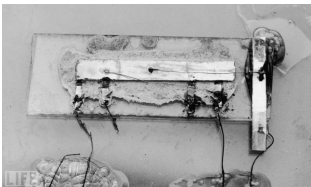
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### First Integrated Circuit

- Invented at Texas Instruments by Jack Kilby in 1958



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### First Microprocessor

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



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### Apple 1 Computer - 1976



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### 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



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Apple Macintosh - 1984



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The Amiga 1000 1985



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PowerPC 1991



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### Cell Phones

- One picture



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### Apple 2016



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### Next Lecture Module

- Influence of Technology and Software on Instruction Sets

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