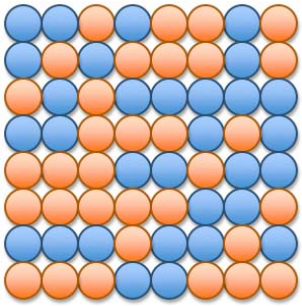


UNIT 1B
A Brief History Of Computing

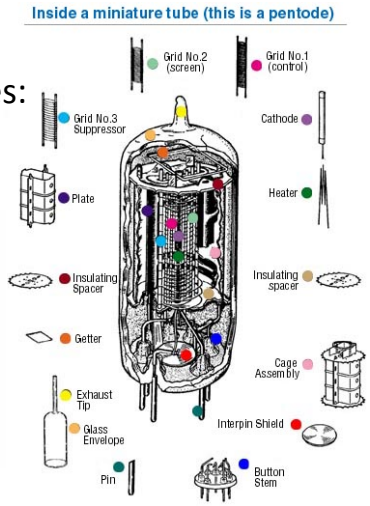
Electronic Computing (1940's to the Present)

Generations of Computing Devices

- Purely mechanical (Leibniz, Babbage)
- Electro-mechanical (Aiken's Harvard Mark I)
- Purely electronic (vacuum tubes)
  - 1000 times faster than electro-mechanical
- Stored-program digital computers
- Integrated circuits
- Microprocessors
- Quantum computers (in development)

Vacuum Tubes: Like Light Bulbs But With Extra Wires

- Before the transistor was invented, we used vacuum tubes: 2-3 inches tall; equivalent to 1-3 transistors



ENIAC

Electronic Numerical Integrator and Computer

- Collaboration between Moore School of Electrical Engineering at the University of Pennsylvania and the Ballistic Research Laboratory in Aberdeen, MD
  - Designed by John W. Mauchley and J. Presper Eckert

from www.computer.org

- In 1943, the Ordinance Dept. signs a contract for UPenn to develop an electronic computer to solve differential equations for ballistic trajectories
- Constructed completed in the fall of 1945 after WWII ends, and dedicated in February 1946.

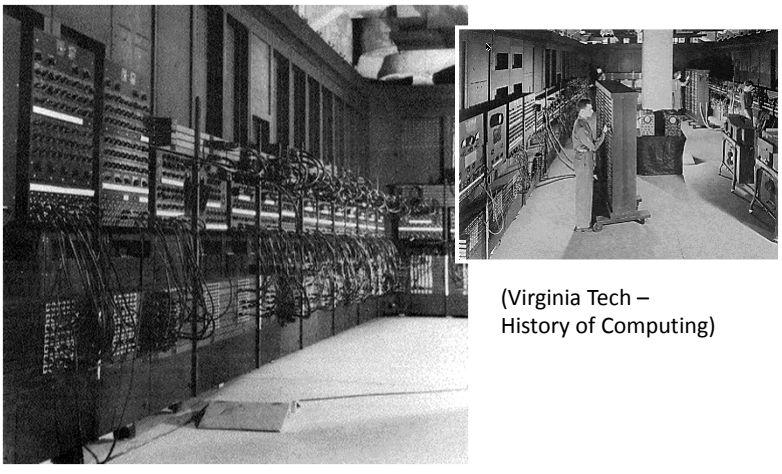
ENIAC

Electronic Numerical Integrator and Computer

- Filled an entire room
  - 42 panels, each 9’ X 2’ X 1’, three on wheels
  - organized in a U shaped around the perimeter of a room with forced air cooling
- Weighed 27 tons
- Reportedly consumed 150-200 kW of power
- Contained a huge amount of parts:
  - 17,468 vacuum tubes and 1,500 relays
  - over 100,000 resistors, capacitors and inductors
- Memory: 20 ten-digit numbers
- Input and output via an IBM card reader and card punch

ENIAC

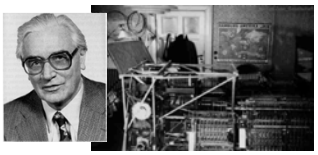
Electronic Numerical Integrator and Computer



(Virginia Tech –
History of Computing)

The first electronic computer?

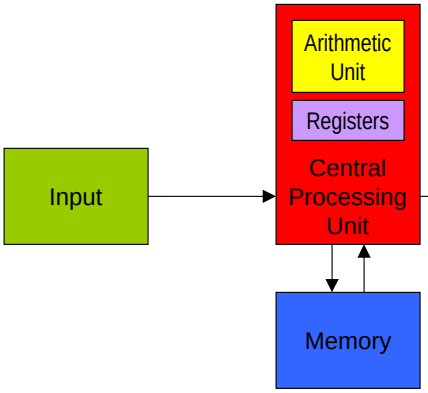
- Patent filed for ENIAC in 1947 as first electronic computer
- In 1973, patent is ruled invalid
  - The inventor of the first electronic computer is John Atanasoff for the Atanasoff-Berry Computer
  - Outside of the U.S., Konrad Zuse of Germany is considered the inventor of the modern-day computer
    - Also designed the first programming language, Plankalkül (Plan Calculus) in 1945



Stored Program Concept

- Stored-program concept is the fundamental principle of the ENIAC's successor, the EDVAC (Electronic Discrete Variable Automatic Computer)
- Instructions were stored in memory sequentially with their data
- Instructions were executed sequentially except where a conditional instruction would cause a jump to an instruction someplace other than the next instruction.

Stored Program Concept



"fetch-decode-execute"

Address	Contents	
200	1000 0001	(ADDI to R1)
201	0110 0110	(data value 100)
202	1001 0001	(ADD to R1)
203	0110 0110	(data at address 100)
204	1111 0111	(JUMP 7 bytes)

Stored Program Concept

- Mauchly and Eckert are generally credited with the idea of the stored-program
- BUT: John von Neumann publishes a draft report that describes the concept and earns the recognition as the inventor of the concept
  - "von Neumann architecture"
  - *A First Draft of a Report of the EDVAC* published in 1945
  - http://www.wps.com/projects/EDVAC/

von Neumann, Member of the Navy Bureau of Ordinance 1941-1955

Alan Turing

- Considered the "father" of modern computer science.
- Presented formalisms for the notions of computation and computability in the 1930's.
- Worked at Bletchley Park in Great Britain during WWII to develop Collossus to help break the German Enigma Code.
- Developed the notion in 1950 of a test for machine intelligence now called the Turing Test.
- The Turing Award, the highest award in computing, is named in honor of Alan Turing.

UNIVAC and the First Compiled Programming Language

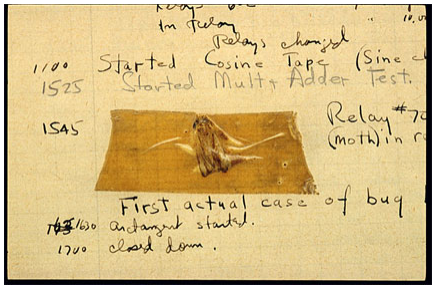
J. Presper Eckert and Walter Cronkite next to the UNIVAC in 1952
(Center for the Study of Technology and Society)

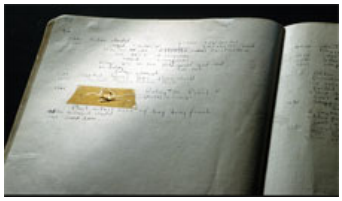
- UNIVAC I
  - Built by Remington Rand to compute 1950 U.S. census but completed in 1951
  - Used to predict the winner of the 1952 U.S. Presidential Election based on ~3.4M votes
- A-0 is a programming language for the UNIVAC I or II, using three-address code instructions for solving mathematical problems.
  - Example: ADD R1, R2, R3
    (Add the contents of R2 and R3 and put result in R1.)
- A-0 was the first language for which a compiler was developed, produced by a team led by Admiral Grace Hopper.

Admiral Grace Hopper

The First Debugger

- Grace Hopper, working on the Harvard Mark II computer in 1947, found the first actual computer "bug" and coined the term "debugging".
- The "Grace Hopper Celebration of Women in Computing" is an annual conference named in her honor.



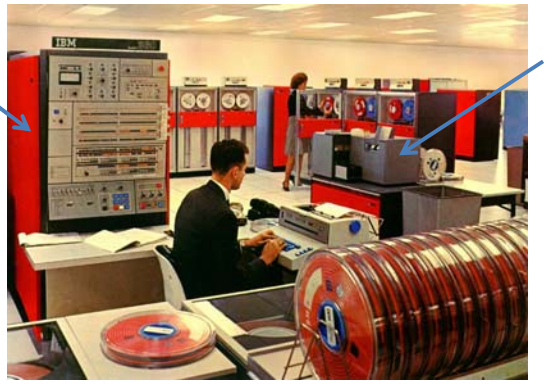


The Integrated Circuit

- Robert Noyce and Jack Kilby are credited with the invention of the integrated circuit (IC) or microchip.
  - Robert Noyce co-founded Intel in 1968.
  - Kilby won the Nobel Prize in Physics in 2000.
- By the mid 1970s, ICs contained tens of thousands of transistors per chip.
  - In 1970, Intel created the 1103--the first generally available DRAM (memory) chip.
  - Today, you would need more than 65,000 of them to put 8 MB of memory into a PC.

Mainframes

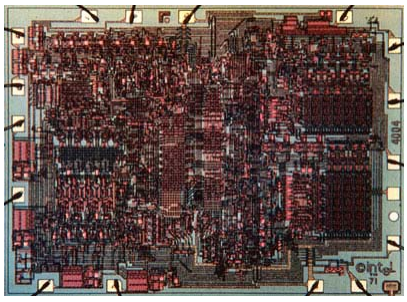
- In the 1960s and 1970s, large computers called "mainframes" became widespread in businesses and universities. IBM was the largest computer maker.

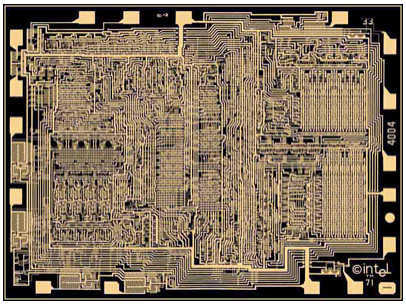


IBM System/360

The Microprocessor

- In 1971 Intel released the first microprocessor: the 4004, shown below.
- A microprocessor is an entire CPU on a chip.
- The personal computer revolution began shortly thereafter.





Units of Memory

- Byte B 8 bits (8b)
- Kilobyte KB 1024 B = 2^{10} bytes ≈ 10^3 bytes
- Megabyte MB 1024 KB = 2^{20} bytes ≈ 10^6 bytes
- Gigabyte GB 1024 MB = 2^{30} bytes ≈ 10^9 bytes
- Terabyte TB 1024 GB = 2^{40} bytes ≈ 10^{12} bytes
- Petabyte PB 1024 TB = 2^{50} bytes ≈ 10^{15} bytes
- How many bytes can be stored in a 4GB flash drive?
- How many bytes/second is a 16Mbps cable modem connection?

Really?

- In 1981, Bill Gates is supposedly quoted as saying that how much computer memory "ought to be enough for anyone"?

How Time Flies…

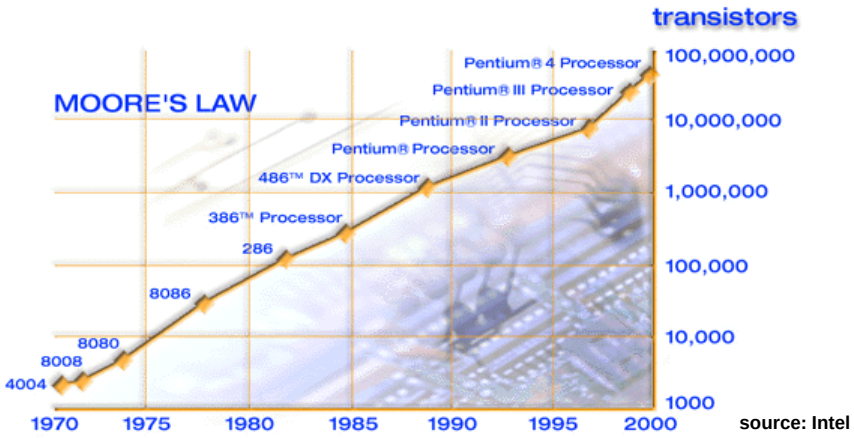
Commodore 64 (1982)
40cm X 22 cm X 8 cm
64KB of IC memory
$595

Apple iShuffle (2008)
3cm X 3cm X 1cm
2GB of flash memory
$49

Moore's Law

- Gordon Moore co-founded Intel Corporation in 1968.
- Famous for his prediction on the growth of the semiconductor industry: Moore's Law
  - **`ftp://download.intel.com/research/silicon/moorespaper.pdf`**
  - An empirical observation stating in effect that the complexity of integrated circuits doubles every 18 months. ("complexity" generally means number of transistors on a chip)

Moore's Law

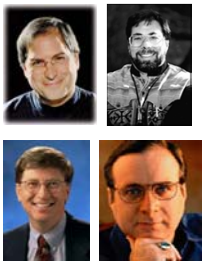


source: Intel

The GUI

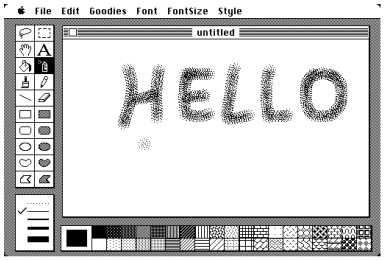
Graphical User Interface

- Concept born at SRI in the early 1960s
- Major development at Xerox PARC in late 70s
- Apple Macintosh, founded by Steve Jobs and his friend Steve Wozniak, introduced in 1984 with full GUI operating system
- Microsoft is founded by Bill Gates and Paul G. Allen with sales of Microsoft BASIC
  - develops its own window-based operating system soon afterwards based on Apple's design… many lawsuits follow
- Even IBM jumps into the fray with OS/2

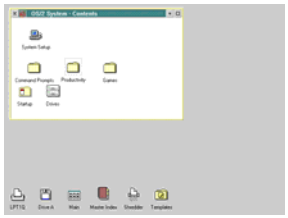


The GUI

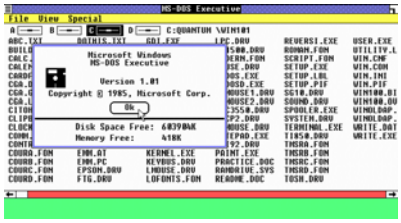
Graphical User Interface



Macintosh OS



IBM OS/2



Microsoft Windows 1.0

Input Devices

- The mouse was invented by Douglas Engelbart of Stanford Research Institute in 1963 after extensive usability testing.
  - He received a patent in Nov. 1970 for the "X-Y Position Indicator For A Display System".
  - He was the recipient of the 1997 ACM Turing Award. (http://www.acm.org/awards/taward.html)

- Apple was the first company to offer the mouse as a commercial product (on the Macintosh, in 1984).
- The scroll wheel mouse first appeared in the late 1990s.

Networking

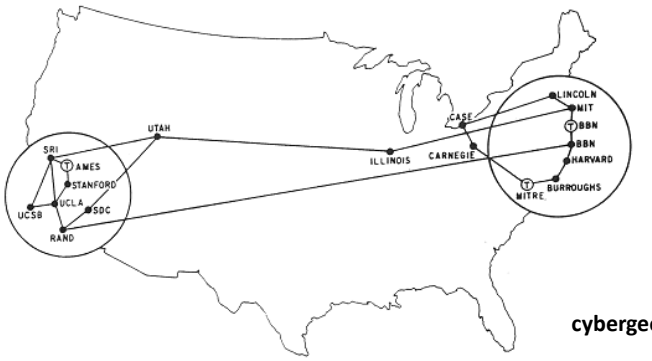
- Ethernet was originally developed as one of the many pioneering projects at Xerox PARC.
  - Invented between 1973-1976 by Robert Metcalfe and David Boggs
  - Metcalfe left Xerox in 1979 to found 3Com.
  - Ethernet first appeared as a commercial product in 1981.

- Wi-Fi (wireless networking) began in the mid-1980s but didn't really take off until the 1990s.
  - Initially required special circuit boards or USB dongles.
  - Today Wi-Fi is built in to most laptops and portable devices.

The Birth of the Internet

- The earliest ideas of a global computer network were formulated by J.C.R. Licklider at MIT in 1962 in a series of memos discussing the "Galactic Network" concept.
- The Advanced Research Projects Agency Network (ARPANET) of the U.S. DoD was the world's first operational packet switching network.
  - Much of the work in computer development in the 1960s was spurred by the Space Race and the Cold War.
- In 1971, Ray Tomlinson of Bolt, Beranek, and Newman (BBN) wrote the first email program
- By the late 1980s, the DoD transferred operation of the network to NSF, and what is known as the "Internet" emerges.

ARPANET 1971



MAP 4 September 1971

cybergeography.org

The World Wide Web

- Developed by Tim Berners-Lee of CERN (European Organization for Nuclear Research) - 1990
  - Used hypertext to mark up text documents so they could be searched and displayed by other users on the Internet
- Mosaic (1993): First Internet browser developed by a team at the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign (NCSA-UIUC)
- Yahoo (1994): Yet Another Hierarchical Officious Oracle. A catalog of interesting web sites created by Jerry Yang and David Filo at Stanford.

The World Wide Web

- Lycos (1994): The first "spider" and search engine, created by Michael "Fuzzy" Mauldin at Carnegie Mellon.
  - Automatically "crawled" web pages and indexed their content.
- Google (1998): World's most popular search engine company on the web launches from a pair of graduate students at Stanford University (Larry Page and Sergey Brin)
- Wikipedia (2001), Facebook (2004), YouTube (2005), Twitter (2006)

The Next Technological Revolution

- Microprocessors (1971)
  - Personal computer industry, video games, iPhones, etc.
  - Bill Gates becomes the world's richest man (now #2)
  - Apple has the highest valuation of any corporation ever
- The World Wide Web (1993)
  - Google, FaceBook, Amazon, eBay
- Robotics (2012?)
  - Bill Gates in Scientific American: "A robot in every home"
  - You might catch this wave!

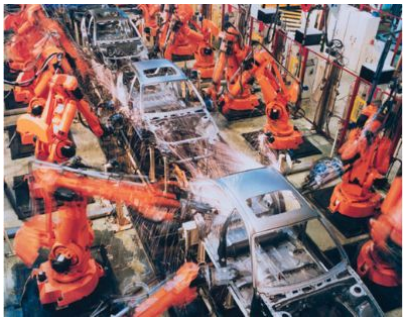
1970s Mainframes

IBM System/370

1970s Early PCs

The Radio Shack TRS-80 stored programs on cassette tape.

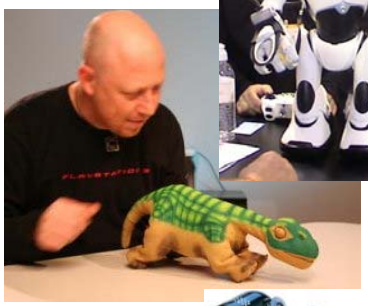
2012 Industrial Robots



Welding robots on an automobile assembly line.

2012 Consumer Robots

Wowee's Robosapien



Pleo baby dinosaur

Sony AIBO

Consumer robots in 2012 are like home computers in 1975: mostly useless. But that is about to change!