

History of Computers

Taken from Chapter 3 A Brief History of Computer Technology retrieved from:
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http://www.ipp.mpg.de/de/for/bereiche/stellarator/Comp_sci/CompScience/csep/csep1.phy.ornl.gov/ov/node8.html
- This online text support an introductory course in Computational Science
- Thus, the material is skewed to scientific large-scale computing, as opposed to personal computers

Non-Electronic Computing Devices

- Chinese abacus (ancient)
- Jacquard loom (1805)
- Charles Babbage's analytical engine (1834)
- Mechanical devices for computation
 - Marchant calculator (1960s) used in science and engineering
 - Slide rule (<http://www.sliderule.ca/>)

Electronic Computing Devices

- Analog (<http://dcoward.best.vwh.net/analog/>)
 - performs many calculations at the same time
 - **operates using continuous variables**
 - uses numbers that change not in steps, but in a smooth continuous manner
- Digital (<http://www.cs.iastate.edu/jva/jva-archive.shtml>)
 - performs sequential (one at a time) operations
 - operates on discrete (noncontinuous) numbers

Digital Architecture Won

- o through power, economics and scalability advantages
- o Could handle large scale computations
- o Digital computers now dominate
 - ▶ Included: hand calculator
 - ▶ Included: PCs
 - ▶ Included: supercomputer

In TECH 1313...



Our content focus is on digital electronic computers

Generations of Digital Computing

- o A *generation* is characterized by dramatic improvements in the technology over the previous generation
- o Technologies include those used to build computers, how computer system components are organized and linked together, and programming languages

Parallel Developments in Algorithms

- o There has been a steady improvement in algorithms
- o Algorithm: a step by step procedure or instruction for solving a problem (http://www.comphist.org/computing_history/new_page_2.htm)
- o Computer programs often implement algorithms

Generations

- o Mechanical (1623 - 1945)
- o First generation electronic (1937 - 1953)
- o Second generation (1954 - 1962)
- o Third generation (1963 - 1972)
- o Fourth generation (1972 - 1984)
- o Fifth generation (1984 - 1990)
- o Sixth generation (1990 - present)

The Mechanical Era



1623-1945

Use Machines to do Math

o Mathematicians who designed and built calculators that could

- ▶ Add
- ▶ Subtract
- ▶ Multiply
- ▶ Divide

o Included: Wilhelm Schickhard, Blaise Pascal, and Gottfried Leibnitz

Charles Babbage's Engines

o Difference Engine

- ▶ The first multi-purpose computing device
 - It was multi-purpose because it was *programmable*
 - You could give it a set of instructions
- ▶ Begun in 1823 but never completed (technology was not yet sufficient)

o Analytical Engine

- ▶ Designed in 1842, also only partially completed

Ada Lovelace

- o Ada, Countess of Lovelace
- o A colleague of Babbage
- o recognized important programming techniques
 - ▶ conditional branches
 - If this Then (1) Or Else (2)
 - ▶ iterative loops
 - Repeat this step n times
 - Repeat this step until a certain condition holds
 - ▶ index variables
 - A variable that counts the iterations through a loop

Pseudocode with Looping, Branching, Index Variable

```
Let j = 1
Let k = 8
Repeat the indented lines that follow until j > 12
  write "The count is", j
  j = j + 1 'increment the value of j by 1
End of Loop
If k/2 has a remainder Then
  k = k - 1
End of If
Write "The algorithm is finished. The value is:", k/2
```

A Realized Mechanical Computer

- o One inspired by Babbage's design
- o George Scheutz and his son Edvard Scheutz, constructed a machine that could process 15-digit numbers and calculate fourth-order differences
 - ▶ 1853 after twenty years of work
 - ▶ Won a gold medal at the Exhibition of Paris in 1855
 - ▶ Dudley Observatory in Albany, NY, used it to calculate the orbit of Mars

First Commercial Use of a Mechanical Computer

- o US Census Bureau used punch-card equipment designed by Herman Hollerith to tabulate data for the 1890 census
- o In 1911 Hollerith's company merged with a competitor to found the corporation which in 1924 became International Business Machines (IBM)

First Generation Electronic Computers



1937 - 1953

How Were FG Electronics Different from Electromechanical Devices?

- o Used electronic switches in the form of vacuum tubes
- o In principle electronic switches would be more reliable than the previous technology (electromechanical)
 - ▶ no moving parts that would wear out
 - ▶ Did not prove true since vacuum tube technology was new and unreliable
- o Major benefit: they could "open" and "close" about 1,000 times faster than mechanical switches

Three Possibilities for First

- o 1941 J. V. Atanasoff, professor of physics and mathematics at Iowa State and graduate student Clifford Berry
- o Built a machine that could solve 29 simultaneous equations with 29 variables
- o Was not programmable, thus more closely resembles a calculator

Colossus

- o 1943 Alan Turing designed it for the British military
- o Helped break codes used by the German army in World War II
- o Colossus' existence was secret until long after the end of WWII

ENIAC (Electronic Numerical Integrator and Computer)

- o First general purpose programmable
- o J. Presper Eckert and John V. Mauchly at the University of Pennsylvania
- o Completed in 1945 funded by the army
- o Did calculations for the design of hydrogen bomb
- o Used until 1955 for many projects
 - ▶ design of wind tunnels
 - ▶ random number generators
 - ▶ weather prediction

EDVAC

- o Same ENIAC guys plus Jon Von Neumann
- o Included the idea of a *stored program*
- o Memory that could hold both instructions and data
- o Use the program stored in memory to control the order of arithmetic operations
- o Ran jobs many times faster than ENIAC

Power of Collaboration

- o EDVAC project an example of the power of interdisciplinary projects
- o Von Neumann, a logician, combined with Eckert and Mauchly's electrical engineering skills, formed a very powerful interdisciplinary team

Primitive Software

- o First programs were written out in machine code
- o 1950s - programmers used symbols, assembly language
- o Programmers then hand-translating the symbols into machine code
- o Later programs known as assemblers performed the translation task

First Electronic Machines were Useful

- o Applied science
- o Engineering
- o First problem run on ENIAC was a simulation used in the design of the hydrogen bomb
- o Required 20 seconds
- o Required 40 hours using mechanical calculators

UNIVAC

- o 1952 first commercially successful computer
- o Eckert and Mauchly again
- o UNIVAC predicted Eisenhower would defeat Stevenson with 438 electoral votes (he ended up with 442) 45 minutes after the polls closed in 1952

Second Generation



1954 - 1962

Important Developments

- o Technology used to build basic circuits
 - ▶ Electronic switches based on discrete diode and transistor technology
 - ▶ Faster
- o Memory Technology
- o Computer Architectures
- o Programming languages used to write scientific applications

Memory Technology

- o Based on magnetic cores
- o Could be accessed in random order instead of sequentially

Computer Architectures

- o Index registers for controlling loops
- o Floating point hardware units for calculations based on real numbers

Programming Languages

- o Multiple high level programming languages
- o FORTRAN (1956)
- o ALGOL (1958)
- o COBOL (1959)

First Supercomputers

- o designed specifically for numeric processing in scientific applications
- o More powerful than other machines of its era
- o Livermore Atomic Research Computer (LARC)
- o IBM 7030 (aka Stretch)

Third Generation



1963 - 1972

More Power Through ...

- o integrated circuits ICs (semiconductor devices with several transistors built into one physical component)
- o Use of semiconductor memories instead of magnetic cores
- o microprogramming as a technique for efficiently designing complex processor
- o pipelining and other forms of parallel processing
- o introduction of operating systems and time-sharing

Bottom Line

- o Faster
- o Faster
- o Faster
- o Means ...
- o Solve bigger and bigger and bigger mathematical problems

Fourth Generation



1972 - 1984

Very Large Scale Integration (LSI and VLSI)

- o Lots of devices per chip
- o An entire processor on a chip
- o An entire simple computer on a chip

Memory

- o Semiconductor memories replaced core memories
- o Large main memory

Parallel Architectures

- o Parallel computing efforts were mostly experimental

Microcomputers

- o Saw wide use as alternatives to time-shared mainframe computers

Software

- o Compilers for established languages started to use sophisticated optimization techniques to improve code
- o Development of the C programming language and the UNIX operating system
 - ▶ Both at Bell Labs
 - ▶ UNIX was written in C and ported to many different computers
 - ▶ User did not have to learn a new operating system each time they changed computer hardware

Publication of the Lax Report

- o 1982
- o Pointed out aggressive and focused foreign initiatives in high performance computing, especially in Japan
- o Compare to nothing comparable in the US
- o Establishment of the NSF supercomputing centers followed

Fifth Generation



1984 - 1990

Parallel Processing

- o Hundreds of processors could all be working on different parts of a single program

Scale of Integration

- o Chips with a million components
- o Semiconductor memories became standard

New Developments

- o Widespread use of computer networks
- o Increasing use of single-user workstations

Sixth Generation



1990 - ?

Smaller, more powerful,
cheaper, more storage, faster

Other Developments Likely to Have Significant Impacts

- o Network speeds
- o Massively parallel architectures
- o Workstation technology improvements
- o Heterogeneous computing
 - ▶ a program started on one workstation can find idle workstations elsewhere in the local network to run parallel subtasks
- o Network growth
- o Wireless networks

Questions for You to Ponder



And discuss on the discussion board in WebCT

Impact of Computers on Society?



Did the invention of mechanical computers change the way we live, eat, work? Did they have a large impact on society? How about first generation electronic computers? What aspect of computer technology has had the largest impact?

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TECH 1313 Impact of Modern

Technology on Society
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