CS 102 / ECE 206
Introduction to Computing
with Robots

1

Note!

- This purpose of this class is to teach you how to program, in particular, using the C++ programming language.

- It is a course intended for those who want to know about programming in some depth (e.g., computer scientists, computer engineers, electrical engineers; to a lesser extent: math., physics, etc.).

- Nevertheless, there are no prerequisites for CS 102 / ECE 206. You do not need prior programming experience!

- If you are looking for an overview of computers, especially from a users' perspective, as a way of satisfying your Quantitative Reasoning requirement, then:

  You probably should take CS 100 instead of CS 102!

- Otherwise, welcome to CS 102 / ECE 206!

2011-01-13

For the next class read:

How to Think Like a Computer Scientist,

chapter 1

(I will abbreviate this book "TCS" or "thinkCScpp."
I will abbreviate *Learning Computing with Robots*
"LCR.")

Vital Information

- me: Bruce MacLennan maclennan@eecs.utk.edu
- Course website:
  web.eecs.utk.edu/~mclennan/Classes/102
  (or go to web.eecs.utk.edu/~mclennan and look under "Teaching")
- The course website includes the Syllabus, Schedule, and much more.
  - Make sure you read policies etc.!
- Your Teaching Assistants (provisional list):
  - Nick Overfield
  - Joshua Strange
  - Jia Jia Luo
  - more (TBD)
- First Lab meeting: Jan. 24 (Mon. lab) or Jan. 26 (Wed. labs)

Textbooks

- The textbooks are online (for free!) on the course website.

- You can read them online, download them to your laptop, or print them out, as you like.

  - I've also put kindle-friendly versions online

- There will be printed copies available from Graphic Creations:

  - How to Think Like a Computer Scientist in C++: about $20

  - Learning Computing with Robots in C++: about $30

  - How many of you think you will want hardcopy?

Grading

- Exams (60% of course grade)
  - Two "mid-terms" (20% each)
  - Final Exam (20%)
- Labs and Homework (40% of course grade)
  - Approximately weekly homework
    - assigned in lecture, due in lab
  - Weekly labs, mostly working with robots
    - attendance required
    - usually due in one week
    - labs begin Jan. 24/26

Attendance

- Attendance at lectures is <u>expected</u>.

- You are unlikely to be able to pass the exams or do the labs unless you attend the lectures (and pay attention!)

- I probably won't take attendance, but I might give pop quizzes

- Ask questions!

- Attendance at the labs (during their scheduled times) is required

- In addition to the labs, the lab assistants will have office hours (TBA)

Personal Computers

- You do not need a C++ compiler on your personal computer (PC) for this course

- In fact, you don't need a PC at all for this course!

- All of your lab assignments can be done on the workstations in the EECS labs in Claxton Complex

- These workstations use the Ubuntu (linux) operating system, which is used in most computer science courses

- Nevertheless, you can use your PC for:
  - Testing C++ programs
  - Remotely logging into the lab workstations
  - Controlling your robot

- The lab assistants can help you get your PC set up to control the robots and run C++ programs (if you want to)

2011-01-13

8

Why Robots?

Scribbler with Fluke

MECHANIZED THOUGHT

(A Short History of Computing)

Slides (with modifications) from:
Institute for Personal Robots in Education (IPRE)

2011-01-13

CS 102 / ECE 206 with Robots

Jacques de Vaucanson 1709-1782

- Gifted French artist and inventor
- Son of a glove-maker, aspired to be a clock-maker
- 1727-1743 – Created a series of mechanical automatons that simulated life.
- Best remembered is the "Digesting Duck", which had over 400 parts.
- Also worked to automate looms, creating the first automated loom in 1745.

2011-01-13
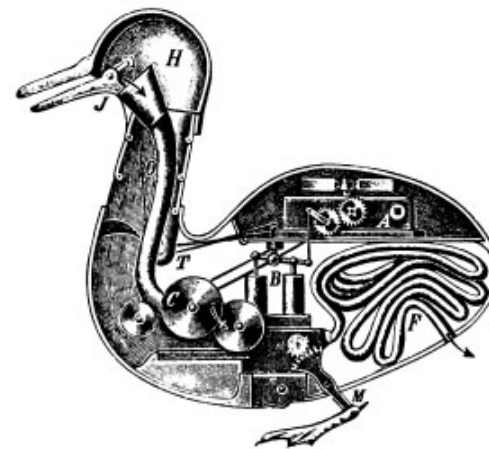
1805 - Jacquard Loom

- First fully automated and programmable loom

- Used punch cards to "program" the pattern to be woven into cloth

Charles Babbage 1791-1871

- English mathematician, engineer, philosopher and inventor.

- Originated the concept of the programmable computer, and designed one.

- Could also be a jerk.
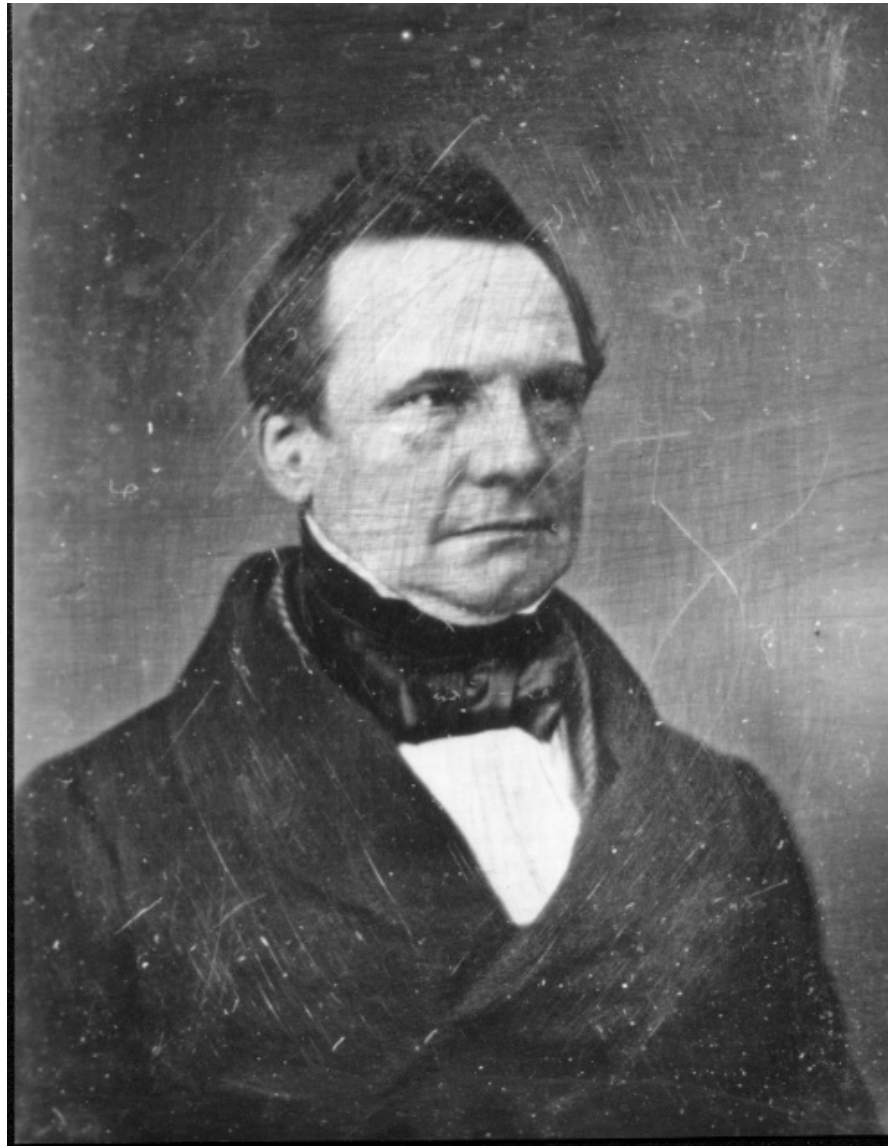
1822 – Difference Engine

Numerical tables were constructed by hand using large numbers of human "computers" (one who computes).

Annoyed by the many human errors this produced, Charles Babbage designed a "difference engine" that could calculate values of polynomial functions.

It was never completed, although much work was done and money spent.

Book Recommendation:

The Difference Engine: Charles Babbage and the Quest to Build the First Computer

by Doron Swade

1837 – Analytical Engine

Charles Babbage first described a general purpose analytical engine in 1837, but worked on the design until his death in 1871. It was never built.

As designed, it would have been programmed using punch-cards and would have included features such as sequential control, loops, conditionals and branching. If constructed, it would have been the first "computer" as we think of them today.

Augusta Ada Byron King, Countess of Lovelace 1815-1852

The Right Honourable Augusta Ada, Countess of Lovelace

Created a program for the (theoretical) Babbage analytical engine which would have calculated Bernoulli numbers.

Widely recognized as the first programmer.

Kurt Gödel 1906-1978

- Famous for his incompleteness theorem (1930s)

- This theorem implies that not all mathematical questions are computable (can be solved).
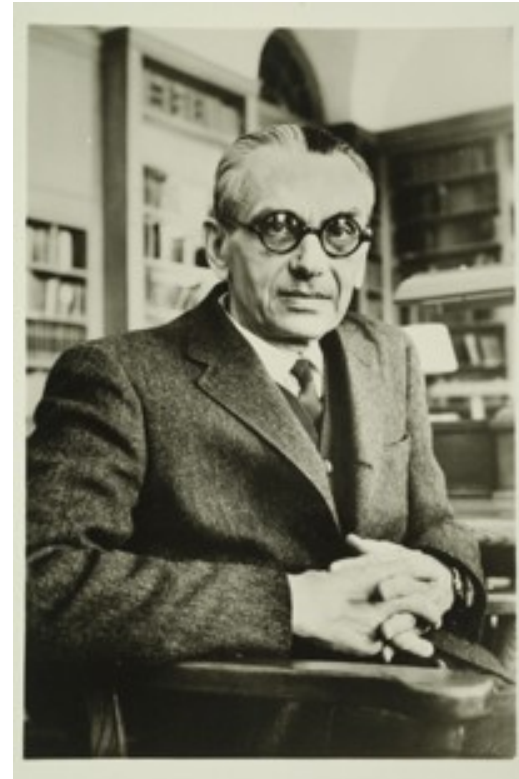
Alonzo Church 1903-1995

- American mathematician and logician.

- Developed *lambda calculus*, directly implemented by LISP and other functional programming languages.

- Showed the existence of an undecidable problem.

- Lambda calculus was proved to be equivalent to a Turing Machine by Church and Turing working together.

Alan Turing 1912-1954

- British mathematician and cryptographer.
- Father of theoretical computer science.
- Contributions include:
  - Turing machine
  - Turing Test (for AI)
  - First detailed design of a stored program computer (never built)
- The Turing Machine is a simpler version of Kurt Gödel's formal languages.
- Halting problem is undecidable.

2011-01-13

20

1936 – Konrad Zuse – Z1 Computer

First freely programmable computer, electro-mechanical punch tape control.
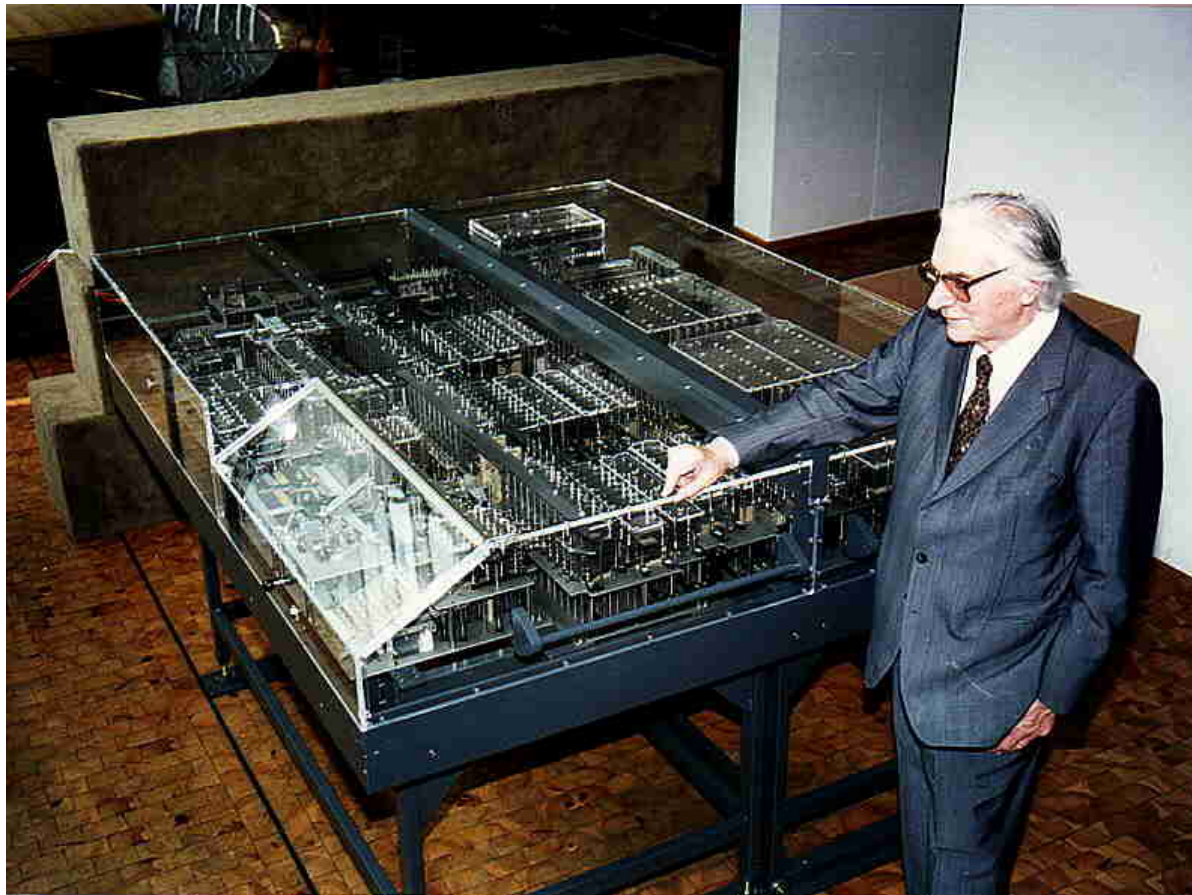
1944 – Howard Aiken & Grace Hopper – Harvard Mark I Computer

The IBM Automatic Sequence Controlled Calculator (ASCC) Computer was created by IBM for Harvard University, which called it the Mark I. First universal calculator.

1943/1944 – Colossus Mark I & II

The Colossus Mark I & II are widely acknowledged as the first programmable electric computers, and were used at Bletchley Park to decode German codes encrypted by the Lorenz SZ40/42.
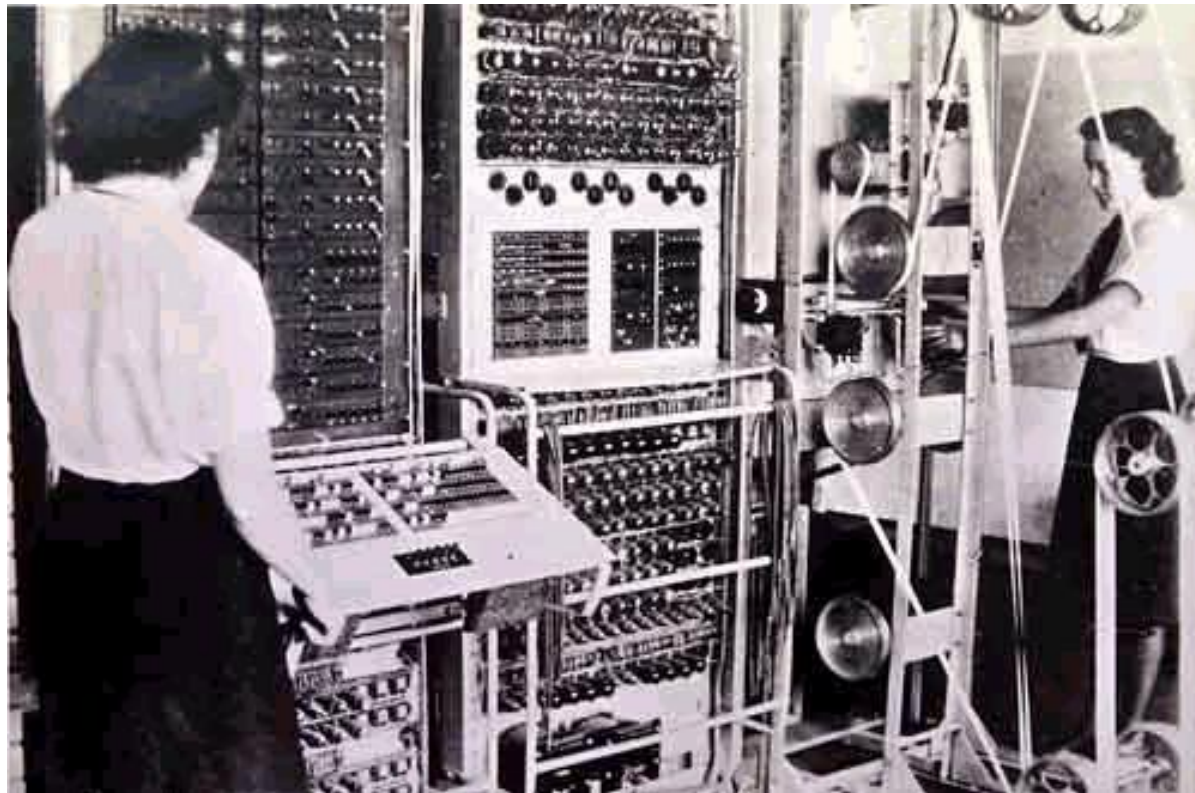
1946 –John Eckert & John W. Mauchly – ENIAC 1 Computer

ENIAC was short for **E**lectronic **N**umerical **I**ntegrator **A**nd **C**omputer. It was the first general purpose (programmable to solve any problem) electric computer. It contained over 17,000 vacuum tubes, weighed 27 tons and drew 150 kW of power to operate.
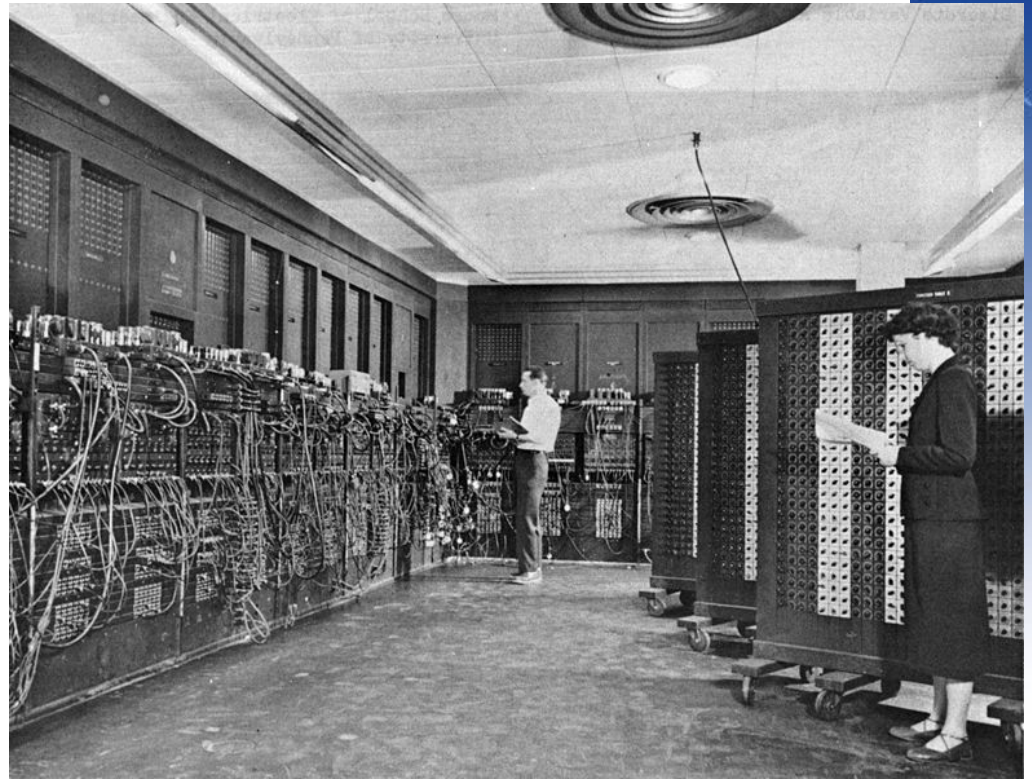
1947 –The transistor

Invented by William Shockley (seated) John Bardeen & Walter Brattain at Bell Labs.

The transistor replaces bulky vacuum tubes with a smaller, more reliable, and power saving solid state circuit.

2011-01-13

1951 – UNIVAC

25 feet by 50 feet in size
5,600 tubes,
18,000 crystal diodes
300 relays

Internal storage capacity of 1,008 fifteen bit words was achieved using 126 mercury delay lines

First commercial computer - Between 1951 and 1958, 47 UNIVAC I computers were delivered.

1951 – UNIVAC Mercury delay unit (1 of 7)
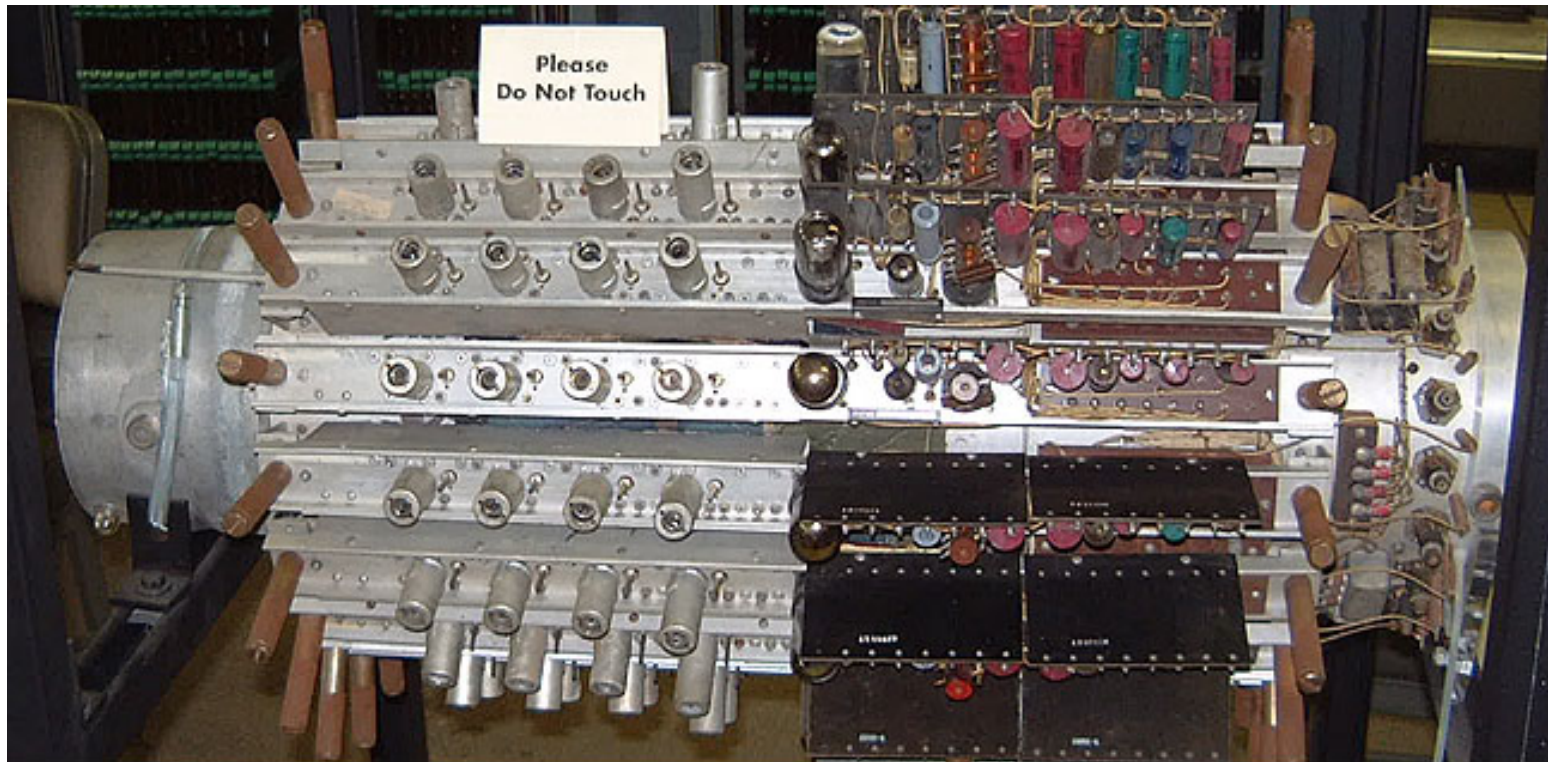
UNIVAC mercury delay units containing 18 delay lines, each of which stored 120 bits. Total of 2,160 bits, or 144 fifteen bit words per memory unit.
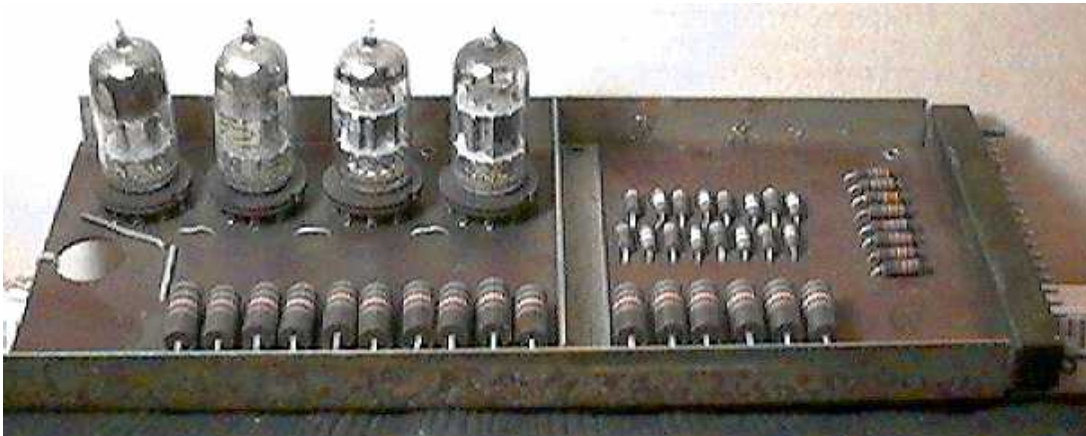
1951 – UNIVAC

UNIVAC tape units.

1951 – UNIVAC
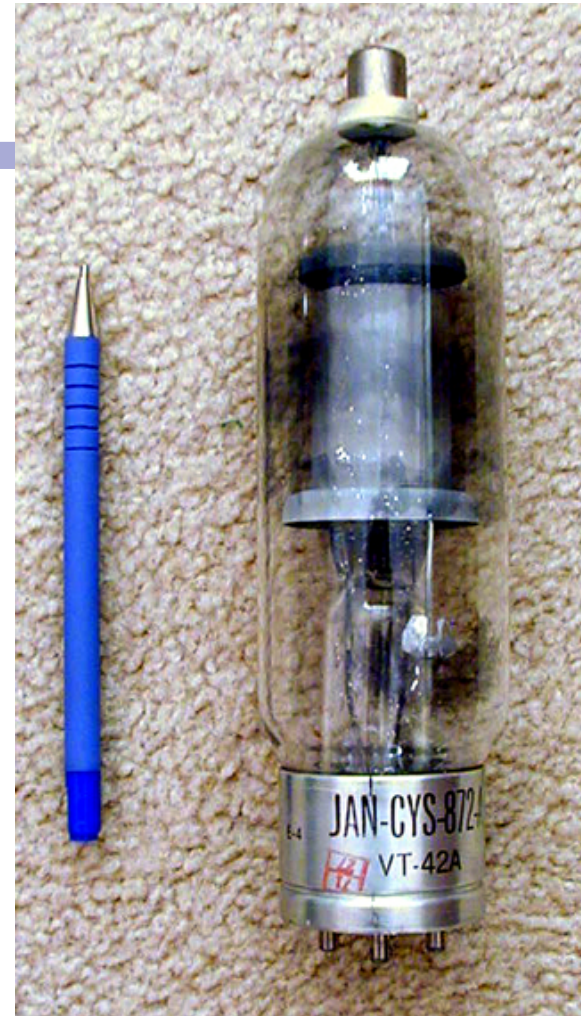
UNIVAC tube board and individual vacuum tube.

1953 – IBM 701 EDPM Computer

IBM enters the market with its first large scale electronic computer.

It was designed to be incompatible with IBM's existing punch card processing system, so that it would not cut into IBM's existing profit sources.

1956 – Bendix G-15

- Base system: $49,000; with peripherals: $60,000

- Weighed 950 lbs

- Chief designer, Harry Huskey, had worked with Turing

- Discontinued in 1963

- (My first computer!)

BENDIX G-15 COMPUTER

1956 – Bendix G-15 magnetic drum memory

- Simulates mercury delay lines

- 2160 "words" of 29 bits each (so about 8000 bytes of memory)

- Average access time 14.5 msec

- Registers were stored on the drum multiple times to allow quicker access

Drum Memory
from a
Bendix G-15 Computer
(3" x 12.5")

1956 – Bendix G-15

2160 words in 20 channels of 108 words each. Avg. access time 14.5 ms
Note IBM peripherals. Monthly rental $1485.00 Purchase $49,500

Grace Hopper 1906-1992

Developed the first compiler (A-0, later ARITH-MATIC, MATH-MATIC and FLOW-MATIC) while working at the Remington Rand corporation on the UNIVAC I.

Later returned to the NAVY where she worked on COBOL and was eventually promoted to Rear Admiral.

Grace Hopper 1906-1992

Grace Hopper, US Navy, and other programmers at a UNIVAC console - 1957

Rear Admiral Grace Hopper (January 1984)

Some of Grace Hopper's Awards

- She won the first "man of the year" award from the Data Processing Management Association in 1969.

- She became the first person from the United States and the first woman of any nationality to be made a Distinguished Fellow of the British Computer Society in 1973.

- Upon her retirement she received the Defense Distinguished Service Medal in 1986

- She received the National Medal of Technology in 1991

9/9

0800   antan started

1000   "   stopped   – antan ✓   { 1.2700   9.037 847 025
        13"vc (032) MP - MC   1.982647000   9.037 846 995 correct
                              2.130476415 (-3)   4.615925059(-2)
        (033)   PRO 2   2.130476415
        correct   2.130676415
        Relays 6-2 in 033 failed special speed test
        in relay   "   10.000 test .
                Relays changed

1100   Started Cosine Tape (Sine check)
1525   Started Mult+ Adder Test.

1545   Relay #70 Panel F
                                        (moth) in relay.

        First actual case of bug being found.
1630   antangent started.
1700   closed down .

Relay
5145
Relay 3370

37

1954 – FORTRAN

John Backus & IBM invent the first successful high level programming language, and compiler, that ran on IBM 701 computers.

FORmula TRANslation was designed to make calculating the answers to scientific and math problems easier.
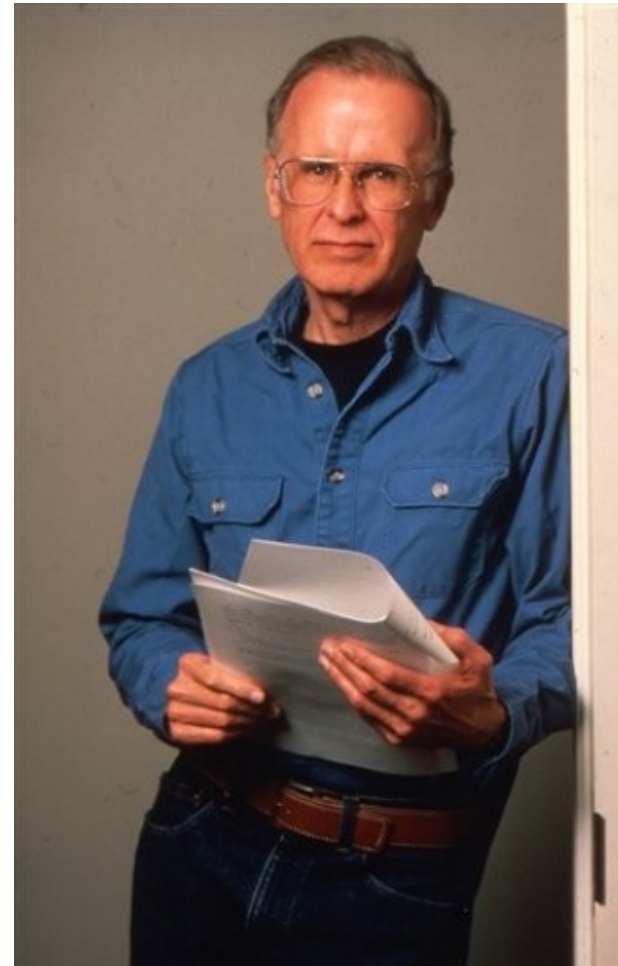
1958 – Integrated Circuit

Jack Kilby at Texas Instruments & Robert Noyce at Fairchild semiconductor independently invent the first integrated circuits or "the chip".
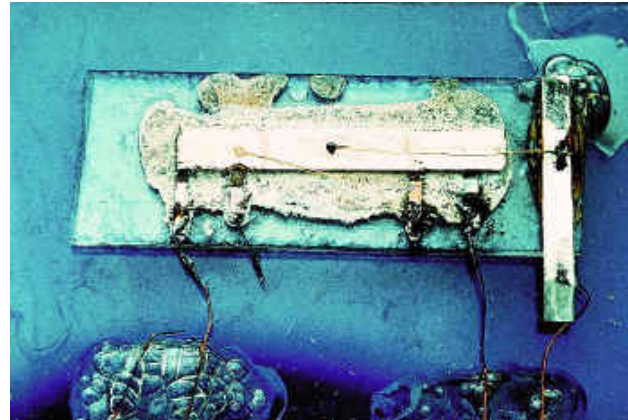
Jack Kilby was awarded the National Medal of Science and was inducted into the National Inventors Hall of Fame, and received the 2000 Nobel Prize in Physics for his work on the integrated circuit.

1960 – First commercial transistorized computers

DEC introduced the PDP-1and IBM released the 7090 which was the fastest in the world.
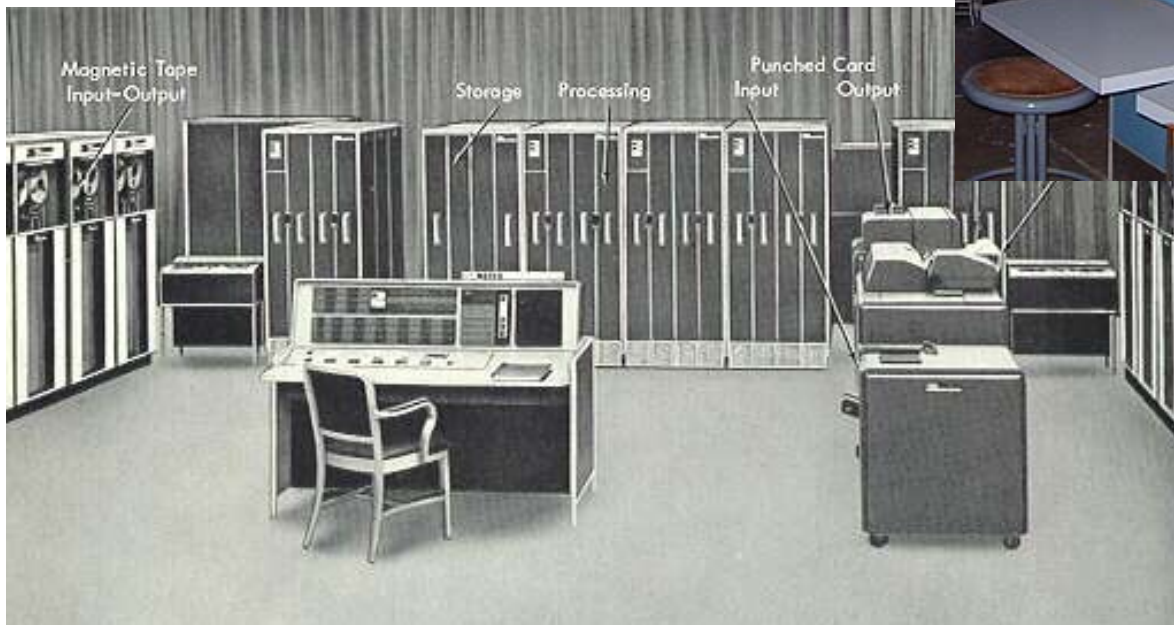
1962 – First computer game & word processor

Steve Russell at MIT invents Spacewar, the first computer game running on a DEC PDP-1.

Because the PDP-1 had a typewriter interface, editors like TECO (Text Editor and Corrector) were written for it.

Steve Piner and L. Peter Deutsch produced the first "word processor" called Expensive Typewriter (MIT's PDP-1 cost $100,000).
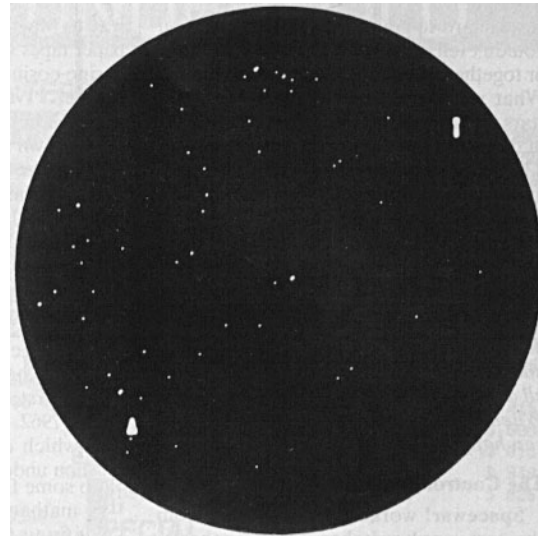
1964 – CDC 6600

- Transistorized "supercomputer"
- Cost: $10 million
- One very fast central processor + 12 slower peripheral processors
- 3 million instructions per second
- Typical memory: 130K of 60-bit words (about one megabyte)
- Hard disks: ~100 MB
- (my college computer!)
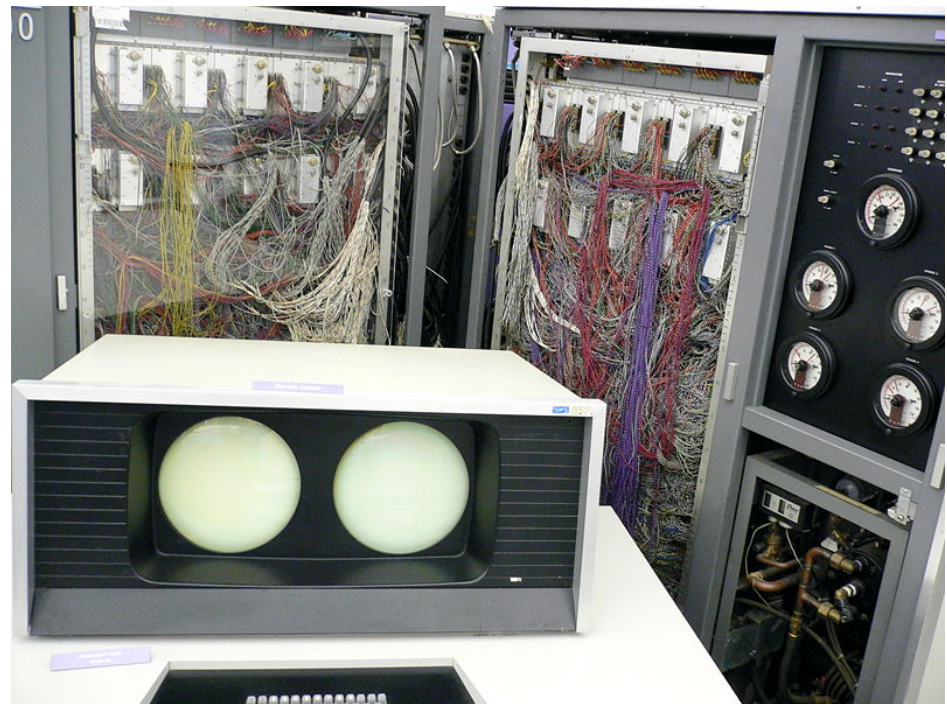
1964 – CDC 6600 dual display console

- First full-screen text editor (1967)

- Automatic command completion

- Many simple video games

2011-01-13

43

1964 – The mouse and window concept

Douglas Engelbart demonstrates the worlds first "mouse", nicknamed after the "tail".

SRI (Stanford Research Institute) received a patent on the mouse in 1970, and licensed it to Apple for $40,000.

1968 – "The Mother of All Demos"

- At the FJCC, Engelbart demonstrates his NLS (oNLine System)
- First public demo of mouse, *but also*…
- Windows
- Graphical interfaces
- Demonstrated hypertext (basis of web pages)
- Structured text editing (outliners)
- Also demonstrated videoconferencing, teleconferencing, email, etc.
- See <sloan.stanford.edu/ MouseSite/1968Demo.html>

monday afternoon

december 9

3:45 p.m. / arena

Chairman:
DR. D. C. ENGELBART
*Stanford Research Institute
Menlo Park, California*

a research center for augmenting human intellect

This session is entirely devoted to a presentation by Dr. Engelbart on a computer-based, interactive, multiconsole display system which is being developed at Stanford Research Institute under the sponsorship of ARPA, NASA and RADC. The system is being used as an experimental laboratory for investigating principles by which interactive computer aids can augment intellectual capability. The techniques which are being described will, themselves, be used to augment the presentation.

The session will use an on-line, closed circuit television hook-up to the SRI computing system in Menlo Park. Following the presentation remote terminals to the system, in operation, may be viewed during the remainder of the conference in a special room set aside for that purpose.

1969 - ARPANET

The precursor to the Internet as we know it, funded by ARPA (Advanced Research Projects Agency, now DARPA) begins.
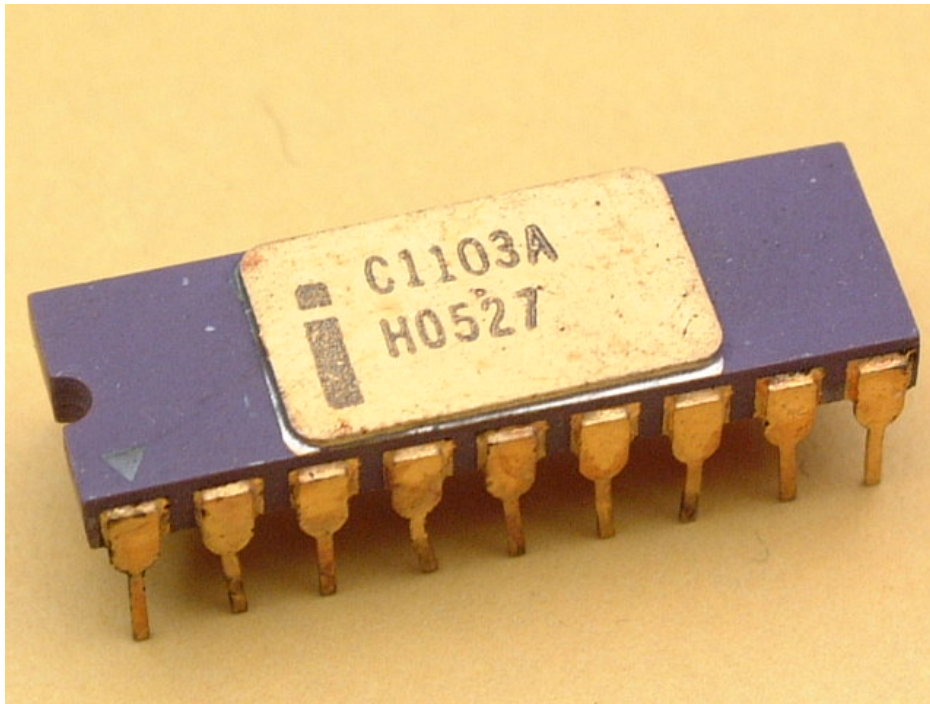
The first four nodes were located at:

- UCLA
- Stanford Research Institute
- UC Santa Barbara
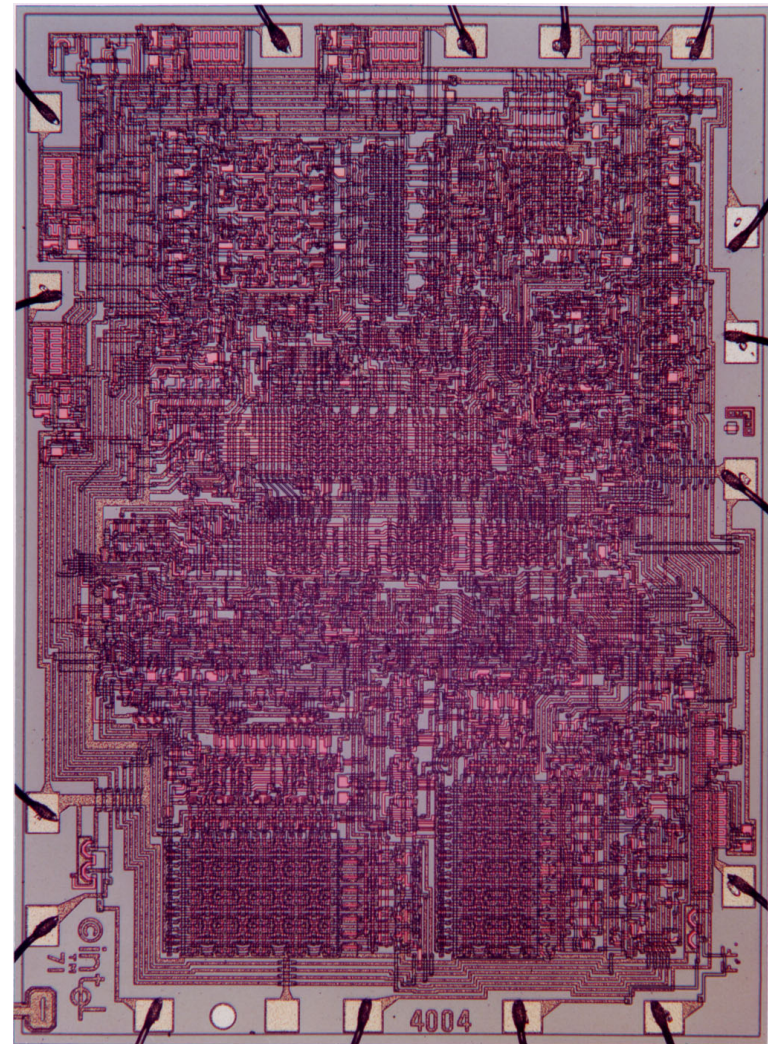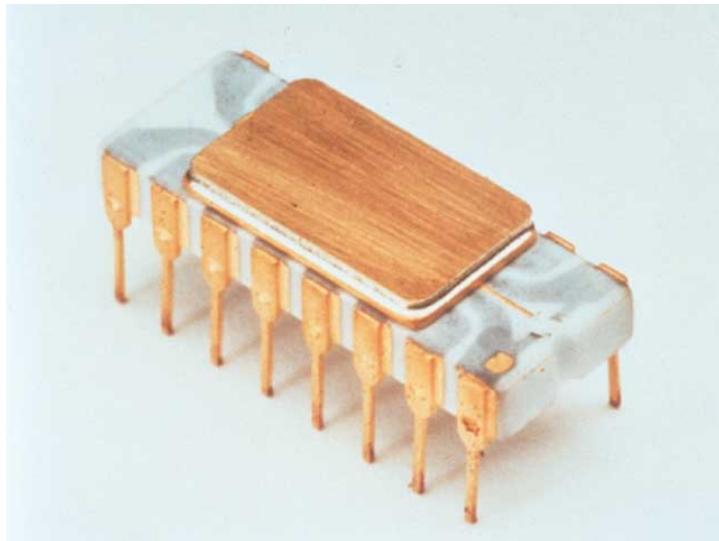- University of Utah

1970 – Intel 1103 Dynamic Memory Chip

Worlds first commercially available dynamic memory chip, 1024 bytes or 1KB
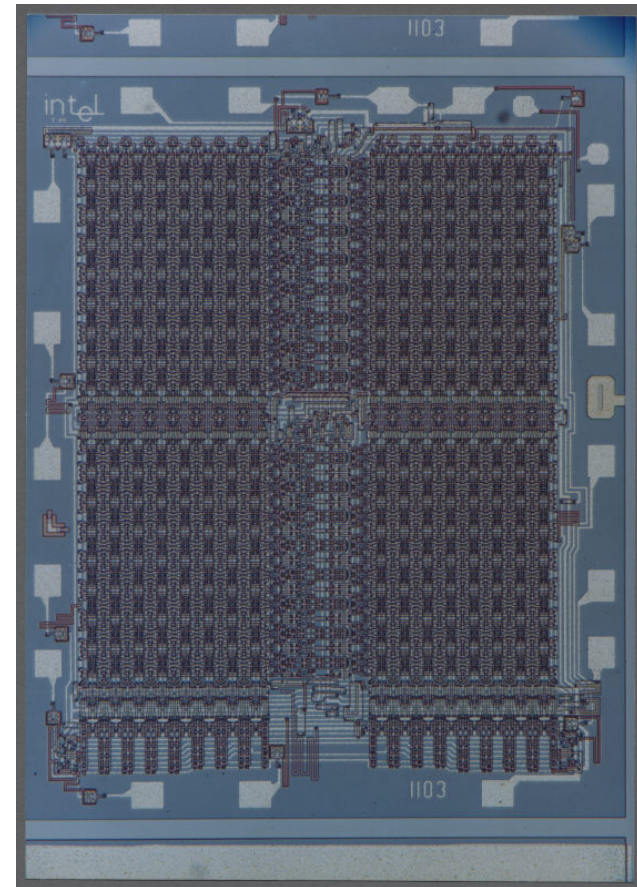
1971 – Intel 4004 Microprocessor

Worlds first microprocessor with 2,300 transistors, had the same processing power as the 3,000 cubic-foot ENIAC.

1973-1976 – Ethernet

Robert Metcalfe at Xerox invents Ethernet so that multiple computers can talk to a new laser printer. Originally, Ethernet used a large coaxial cable and ran at 3Mbit/sec.

Ethernet today runs over twisted pair (usually CAT5, or CAT6) and can achieve speeds of 10Megabit/sec to 1Gigabit (1000 Mbit) / sec.
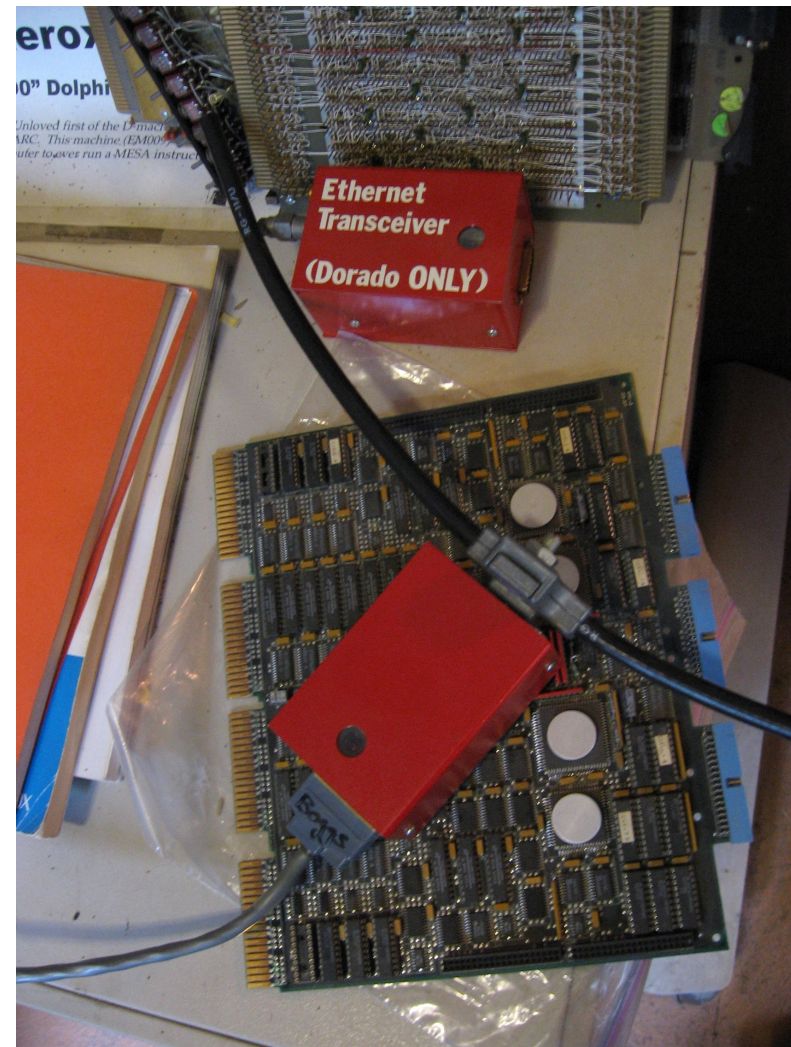
1974/1975 – Personal Computers

Scelbi Mark-8 Altair and IBM 5100 computers are first marketed to individuals (as opposed to corporations). They are followed by the Apple I, II, TRS-80, and Commodore Pet computers by 1977.

ARPANET LOGICAL MAP, MARCH 1977
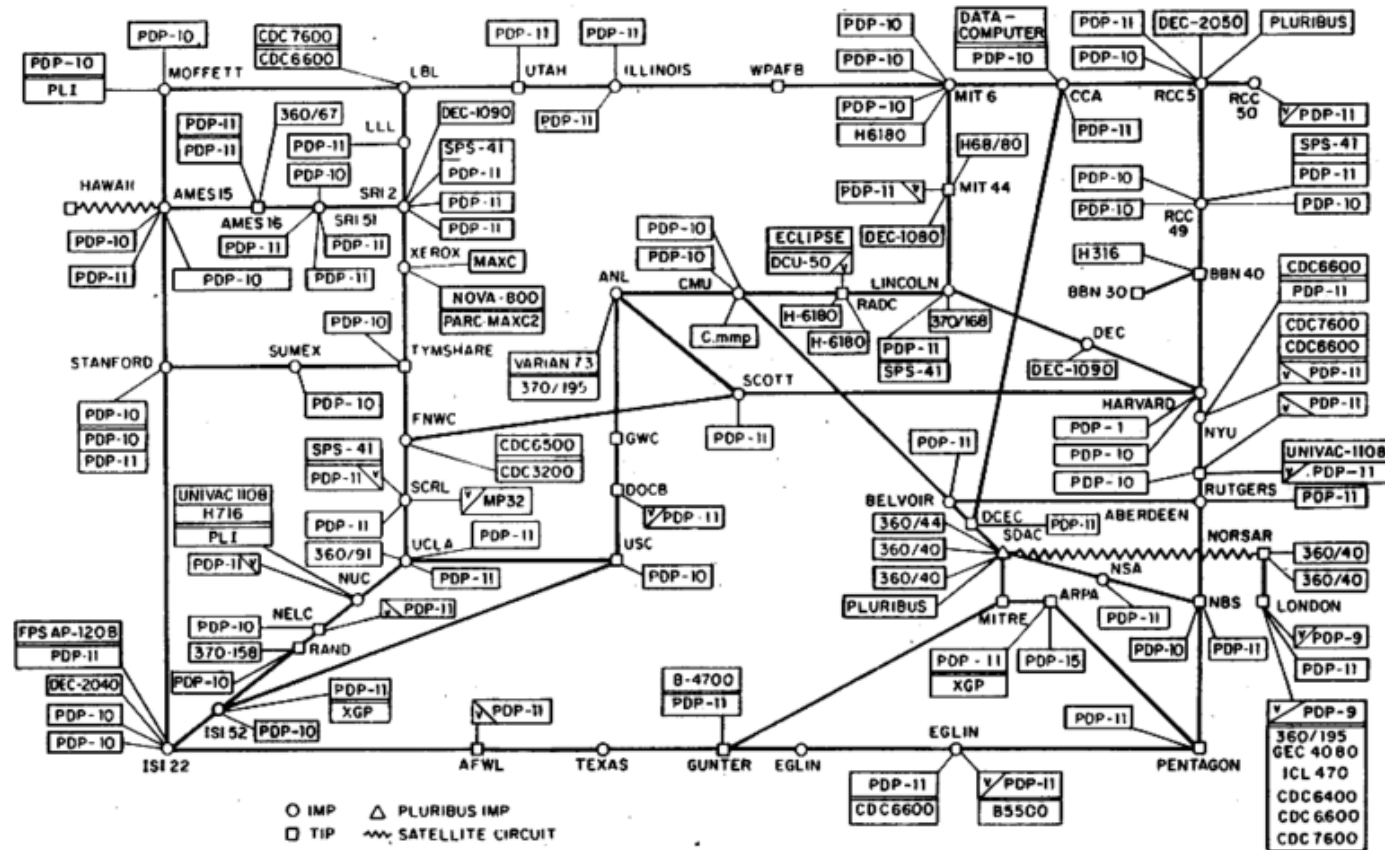
1978 – Intel 8086 microprocessor

- Continued in use through 1990s
- Basis for the x86 computer architecture, still widely used
- 5 – 10 MHz clock rate
- About 20,000 transistors
- (I participated in the architectural design)

2011-01-13

1978/1979 – First individual productivity software

VisiCalc Spreadsheet software and WordStar word processor are the "killer applications" for personal computers, especially for small business owners.

1981 – IBM PC

The IBM PC is introduced running the Microsoft Disk Operating System (MS-DOS) along with CP/M-86. The IBM PC's open architecture made it the de-facto standard platform, and it was eventually replaced by inexpensive clones.

CPU: Intel 8088 @ 4.77 MHz

RAM: 16 kB ~ 640 kB

Price: $5,000 - $20,000

1984 – Apple Macintosh

Apple introduces the first successful consumer computer with a WIMP user interface (Windows - Icons - Mouse - Pointer), modelled after the unsuccessful Xerox Alto computer.

Motorola 68000 @8Mhz

128KB Ram

US$1,995 to US$2,495

1989 – The Difference Engine (#2) is built

Using Charles Babbage's original plans and 19th century manufacturing tolerances, the London History Museum built two functioning replicas of the Difference Engine.