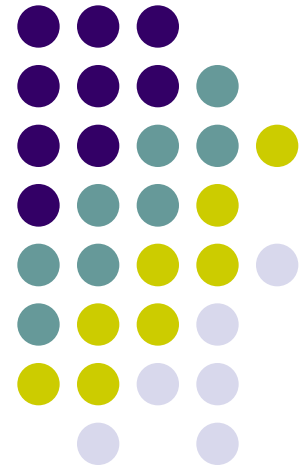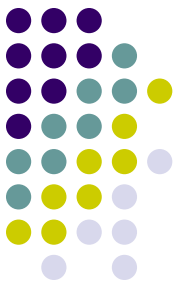# CSE 301
History of Computing

Mainframe and Minicomputers

IBM

- 1962 – first year that computers revenue exceeded that of punched-card machines
- By end of '60s, no more punched-card machines
- '60s – growth of 15-20% per year
  - 1960 - $1.8 billion in sales, 104,000 employees
  - 1970 - $7.2 billion in sales, 259,000 employees
  - sustained 70% share of computers market throughout the decade
- The next great success: IBM's 1401
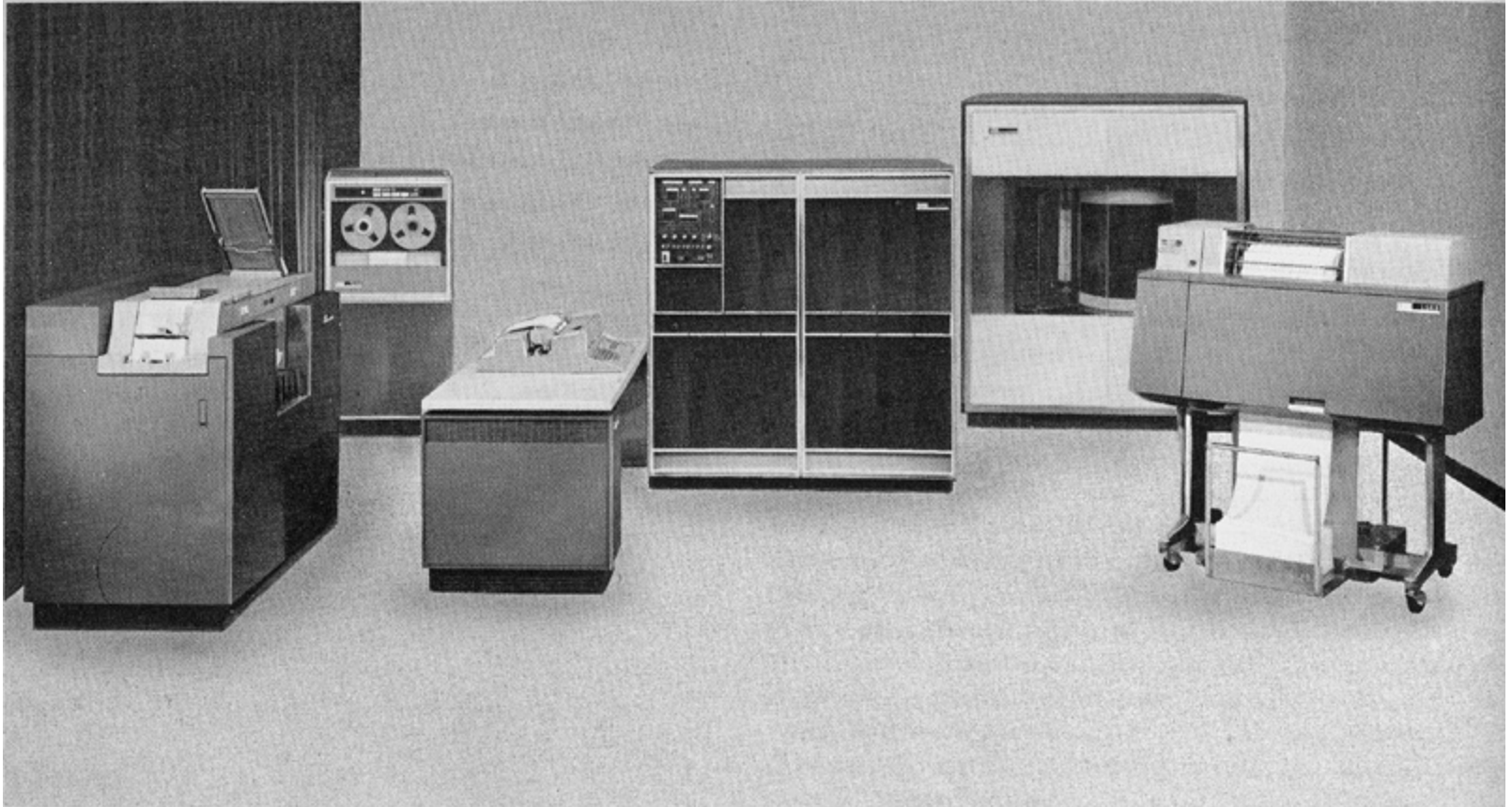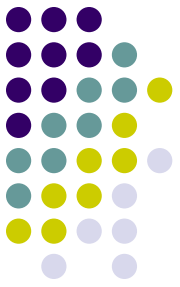
IBM 1401

- A stored-program transistor-logic computer *system*
  - follow-up to 650
    - aimed to be cheaper, faster, & more reliable
    - transistors for vacuum tubes, core memory for magnetic drum
    - high-speed printer (600 lines/minute)
      - helped lure customers using punched-card machines
  - $2500 per month minimally configured in 1960
  - It was the first computer to deploy 10,000 units
  - IBM concentrated on computer systems rather than just individual machines & architectures
   - customer driven
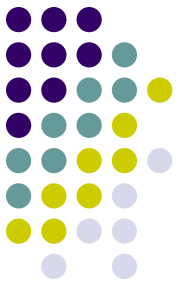
Other 1401 Specs

- The 1401 was a decimal (not binary) computer intended primarily for business applications

- Originally programmed only in Autocoder (assembler)
  - proved difficult for many people

- Soon used one of the earliest high-level business-oriented programming languages, RPG
  - Report Program Generator
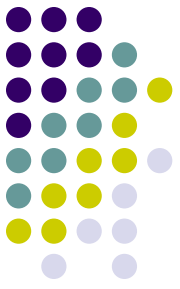 - increased its usability and popularity

IBM 1401

IBM 1401
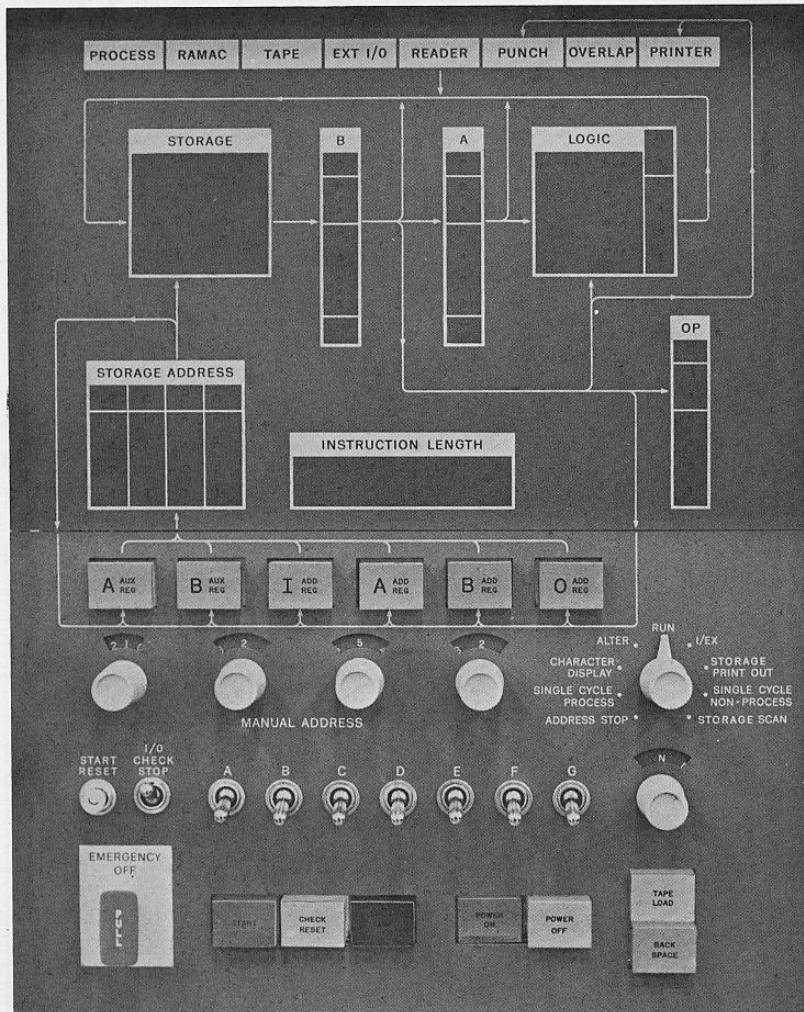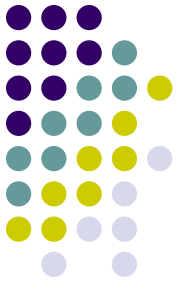
IBM Competition

- IBM and the Seven Dwarves – late 1950's
  - Sperry Rand, Control Data Corp. (CDC), RCA, Honeywell, GE, Burroughs, NCR
- IBM enters into a consent decree with the U.S. Government in 1956 agreeing to *sell* as well as lease its computers
  - Leads to many leasing companies
- Companies like Honeywell, GE, & RCA started to produce IBM-compatible machines
  - to target IBM customers
  - Honeywell's 200 was an improvement over IBM 1401
    - 400 orders in first week (more for Honeywell than in previous 8 years)
- Additional IBM competition: itself
  - too many different machines (7 lines) not fully compatible
    - a particular problem with software
    - not one of IBMs models could run the software of another

SPREAD Task Group
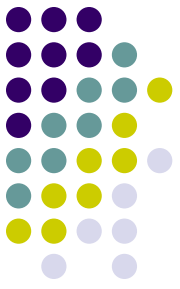
- SPREAD: Systems, Programming, Review, Engineering And Development
- Established by Vincent Learson in October 1961
  - Consisted of IBM's 13 most senior engineering, software and marketing managers.
  - Banished to Sheraton New Englander in Cos Cob, Connecticut to come up with a new product line of *compatible* computers
    - Proposed a range of compatible computers that would replace all of IBM's existing computers – System/360
      - enormous, secret undertaking
    - Software development estimate: $125 million?!?!?!?
    - Project nicknamed "You bet your company" by IBM engineers
    - Resulting direct research costs: $500 million
    - Resulting development costs: $5 billion
      - Second in '60s only to Apollo project

IBM System/360

- "the computer that IBM made that made IBM"
- Called 360 because of its "betokening all points of the compass"
  - Suggesting universal applicability of the machines
- An entire line of computers
  - small to large
  - low to high performance
  - all (with but one exception) running the same command set
- Announced with much drama on April 7, 1964
  - Watson Jr, "the most important product announcement in computer history"
- An immediate success, IBM could not fulfill all the orders it got
- Some models (e.g., the 360/30) even offered the option of microcode emulation of the customer's previous computer
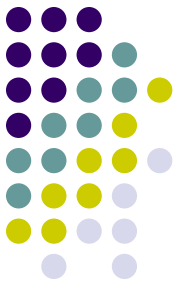 - old programs could still be run on the new machine

IBM System/360
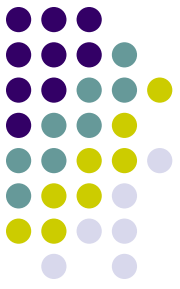
- The most expensive CPU project in history.
  - Fortune magazine: "$5 Billion gamble"
    - $5 billion in 1964 dollars translates to about $30 billion in 2005 dollars.
- The System/360 introduced a number of industry standards to the marketplace, such as:
  - the 8-bit byte (against financial pressure during development to reduce the byte to 4 or 6 bits)
  - byte-addressable memory (as opposed to word-addressable memory)
  - 32-bit words
  - segmented and paged memory
  - commercial use of microcoded CPUs
  - could be configured for networked applications
- Some would say the implementation was "pedestrian"
  - Ex: did not support time-sharing
    - where multiple parties/programs may share use of a machine
  - IBM Audit said "IBM engineering was mediocre"
  - "technology secondary to marketing in IBM's success"? – Campbell-Kelly/Aspray

IBM System/360

- The S/360 family initially consisted of six computers and forty common peripherals
  - There were thirteen models in all.
  - The cheapest model was the 360/20
    - 24K of memory
    - half the registers of other models
    - the instruction set was not binary-compatible with the rest of the range
  - The most significant model was the 360/67
    - first shipped in August 1966
    - the first to offer virtual machine computing to its users through its CP-67 operating system
  - RCA would immediately make 360-compatible clones
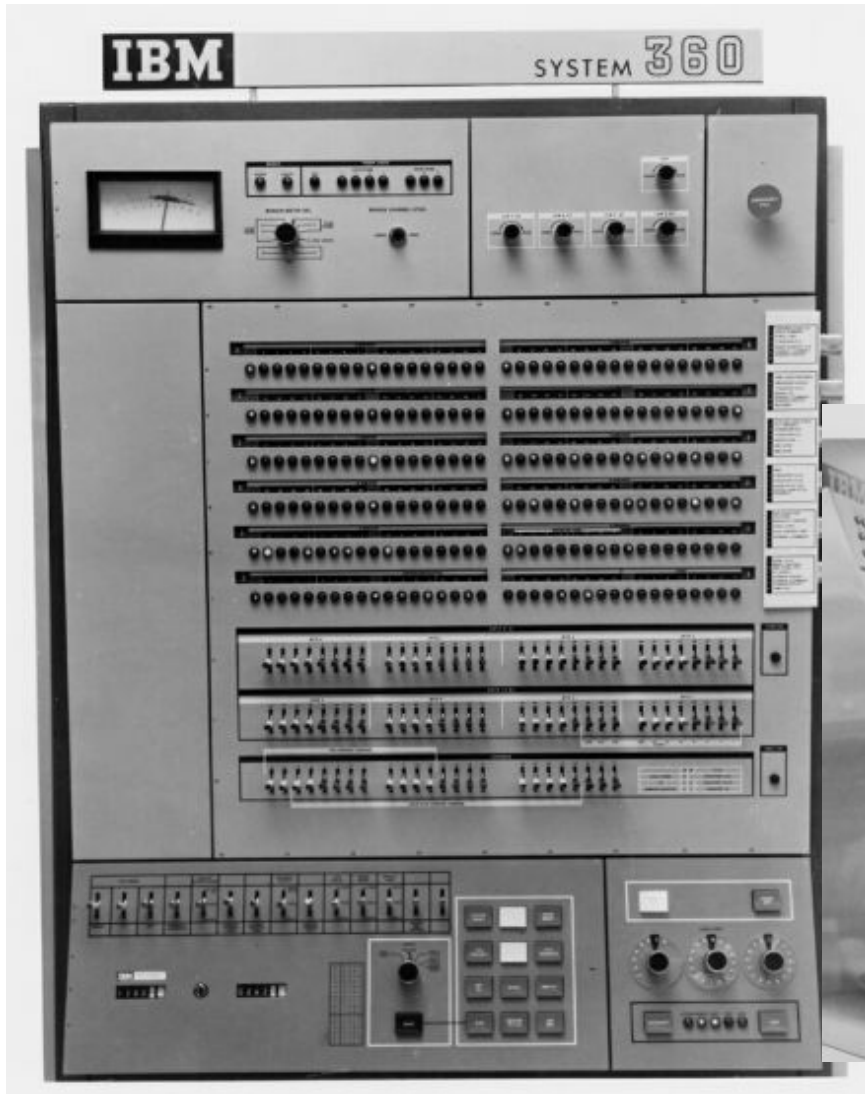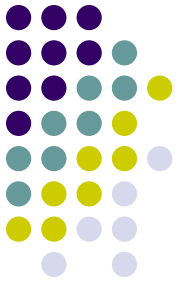
IBM System/360

IBM 360 Model 75 - 1965
(IBM Archives)

IBM 360 Model 25 - 1968
(IBM Archives)

IBM System/360

IBM 360 Model 65 console - 1965
(IBM Archives)

IBM 360 Model 91 - 1968
(IBM Archives)

OS/360 & Fred Brooks

- A batch processing operating system developed by IBM for the System/360
- Versions:
    - PCP – Primary Control Program
    - MFT – Multiprogramming w/ Fixed Number of Tasks
    - MVT – Multiprogramming w/ Variable Number of Tasks
- Delayed for over a year due to organizational disarray and inexperience in developing large-scale software systems
- Frederick P. Brooks publishes The Mythical Man-Month in 1975 describing the *second-system effect*
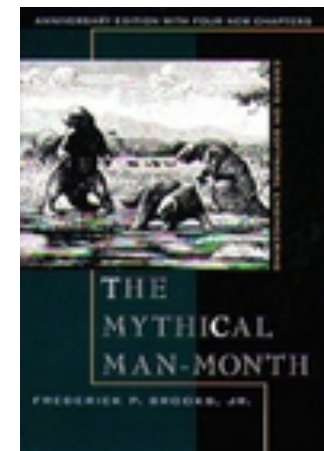
Brooks' Law
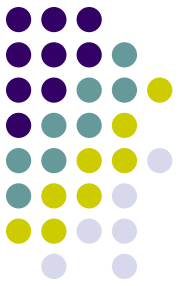
Programming work performed increases with direct proportion to the number of programmers (N), but the complexity of a project increases by the square of the number of programmers (N^2). Therefore, it should follow that thousands of programmers working on a single project should become mired in a nightmare of human communication and version control.

IBM System/370
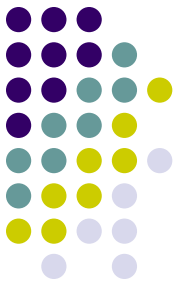
- A line of IBM mainframes to be the successor to the System/360 family (announced 1970)
- Cheaper & better technology than 360
  - used true integrated circuits (ICs)
  - semiconductor RAM rather than core memory
  - enhanced address space
  - virtual memory
    - Developed first at Manchester University
  - "As always, IBM's publicity machine was stronger than its technology."? – Campbell-Kelly, Aspray

IBM System/370

IBM System 370 Model 135 console (IBM Archives)

IBM System 370 Model 125 console (IBM Archives)
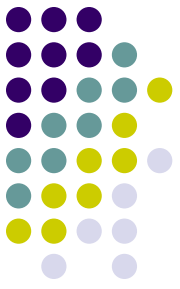
IBM System/390 & zSeries

IBM System 390
(IBM Archives)
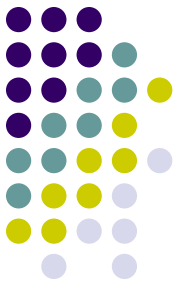
IBM zSeries z990
(IBM Archives)

IBM Future Series (FS)

- Launched in the 1970s to make another major leap to create a platform that would have reduced software costs.
- Planned for late '70s release
  - In 1975, IBM stopped the project after many delays.
  - Reasons for failure:
    - Vague objectives?
    - Objectives too far ahead of available technologies?
    - Poor management after Watson Jr. retired (1971)?
    - Specter of existing software investment
    - $100 million for nothing, "the most expensive development-effort failure in IBM's history"
    - "IBM had been hoist by its own petard" – Campbell-Kelly, Aspray borrowing from Shakespeare's Hamlet
      - To this day mainframes use ancient architectures
- The 370/ESA was eventually rebranded as the System/390, and later still as the zSeries.

The Decline of the IBM Empire

- More of a broadening of the market than a collapse of IBM
  - Still one of the most profitable companies in the world
    - Though it lost $5 billion in 1992, more than any U.S. company had ever lost in a single year
  - Still the industry leader in mainframe computers
- Emergence of mini & then micro computers
- Low-cost ICs allowed new companies to enter what was once an exclusive club
- As software advanced, companies needed less of IBM's service, which was their greatest asset
- By 1976, IBM has 50% of global computer market
- By 1985, 25%

The Minicomputer

- A class of multi-user computers
- In terms of size & computing power, in the middle range of the computing spectrum
  - in between mainframes (the largest) and the personal computers (the smallest)
- emerged in the 1970s (before the PC)
- the term evolved in the 1960s to describe the "small" 3rd generation computers that became possible with the use of the newly invented IC technology
- took up one or a few cabinets, compared with mainframes that would usually fill a room
- led to the microcomputer (the PC)
- Some consider Seymour Cray's CDC-160 the first minicomputer
- The PDP-8 was the definitive minicomputer
  - as important to computer architecture as the EDVAC report

Digital Equipment Corporation
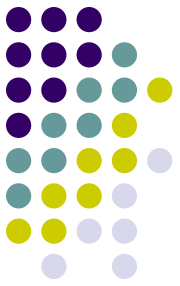
- Founded in 1957 by Ken Olsen, a Massachusetts engineer who had been working at MIT Lincoln Lab on the TX-0 and TX-2 projects.

- Began operations in Maynard, MA in an old textile mill

- In 1961 DEC started construction of its first computer, the PDP-1.
 - PDP = Programmable Digital Processor
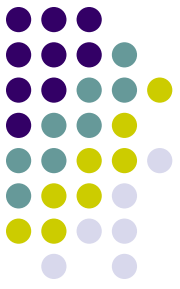
PDP Influence

- Architecturally: allowed I/O to go directly from input device to core memory
  - Allowed fast I/O with minimal impact on processor
  - Called Direct Memory Access (DMA)
  - Defined the architecture of the minicomputer
  - Is built into the microprocessors used in PCs today
- Culturally: encouraged customer modification of its models
  - Provided catalogs with self-instruction
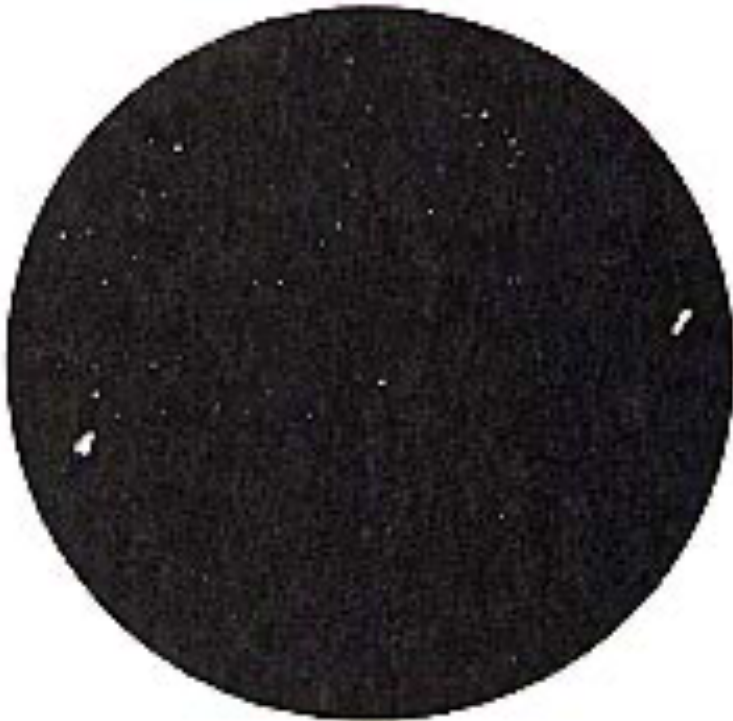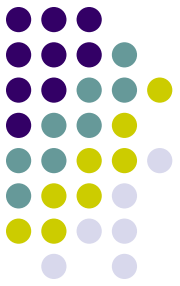   - Done out of necessity, but appreciated by clients

PDP-1
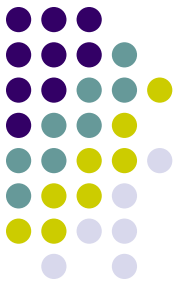
PDP-1
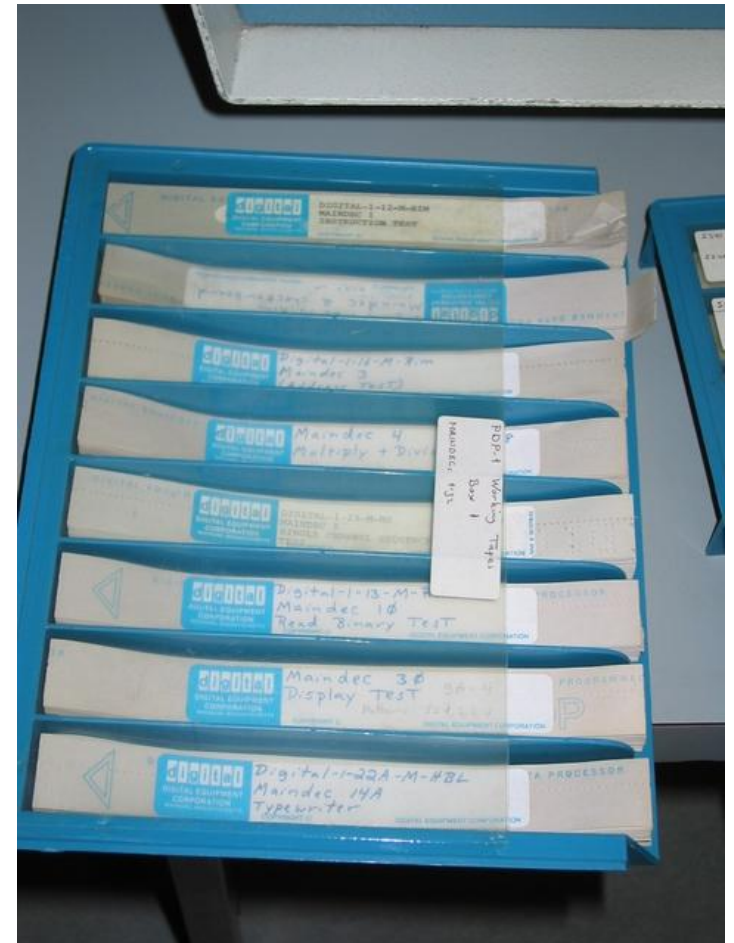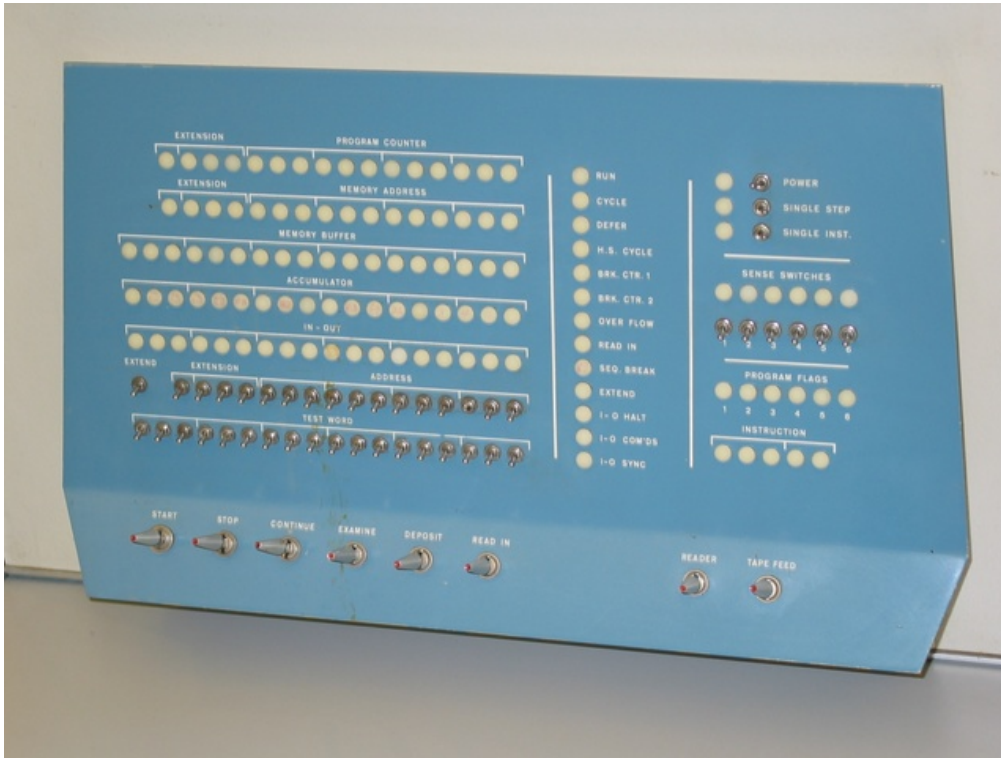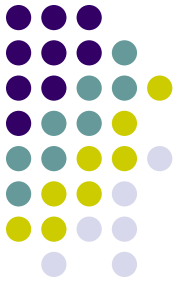
console and
program tapes for PDP-1
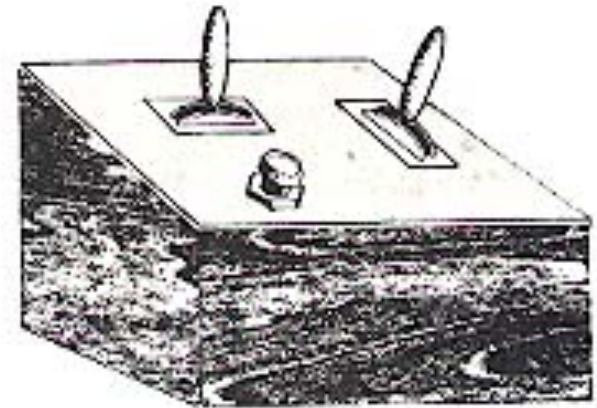(Computer History Museum)

Spacewar!

The first computer game, created on the PDP-1

`http://www.atarimagazines.com/cva/v1n1/spacewar.php`

The original control boxes looked something like this. The controls are a) right-left rotation, b) acceleration (pulled back) and hyperspace (pushed forward), and c) torpedo button.
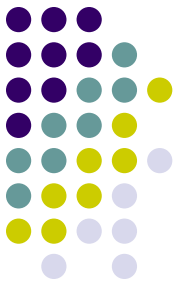
The Starting Position.
The ships are in the centers of diagonally opposite quadrants.The vee of stars at top center is the horns of Taurus. You should be able to pick out the stars of Orion at the left (the bright star just above the wedge-ship is Rigel).
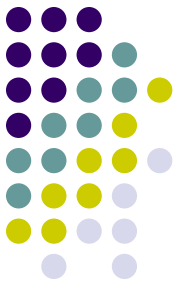
PDP-8

- True success for DEC followed with the introduction of the famous PDP-8 in 1965
    - under the leadership of C. Gordon Bell
    - the first to be called a minicomputer
        - taken from miniskirt?
    - 50,000 units would be sold
    - weighed 250 lbs.
    - Initially priced at $18,000
- the first computer that was regularly purchased by a handful of end users as an alternative to using a larger system in a data center
- far simpler architecture than mainframes

PDP-8 and PDP-11

Digital Tidbits

- 1965 - $15 million in revenues (876 employees)
- 1970 - $135 million in revenues (5,800 employees)
- DEC was shipping as many PDP-8s as IBM was of 360s
- Digital would also produce the popular 32-bit VAX computer family
- The first versions of the C programming language and the UNIX system ran on Digital's PDP series of computers
- At its peak in the late 1980s, Digital was the second-largest computer company in the world, with over 100,000 employees.
- Later acquired by Compaq, which subsequently merged with Hewlett-Packard.