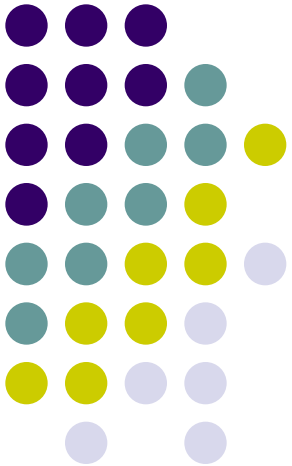
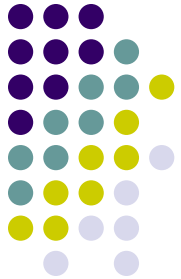
CSE 301
History of Computing

The Dawn of Commercial Computing in the 1950s

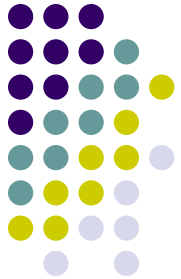


1950s



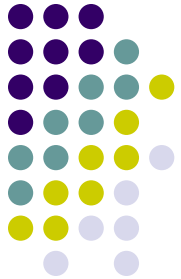
- Computer makes a transition
  - from a mathematical instrument
  - to an electronic data-processing machine
  - transition led mainly by:
    - computer manufacturers
    - business leaders
    - defense industry

The Commercial Computer



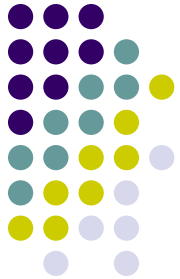
- Soon:
  - 30 American computer companies
  - 10 British computer companies
- Who was properly positioned to take foster and benefit most from this transition?
  - IBM of course
    - in 1950, they had a 0% share in computer market
    - by 1960, they would have a 70% share in computer market

The Cold War



- For US Government, replaced technological competition of WW II
  - U.S. vs. U.S.S.R.
  - made US Government, military, & military contractors perennial cutting edge computer customers
  - continually fed competition & progress in private sector

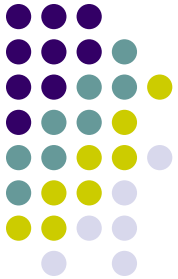
EMCC



- 1946 - Eckert and Mauchly left the Moore School
- Start the Eckert & Mauchly Computer Company
- Financial problems early on
- Parallel Projects:
  - UNIVAC
  - BINAC

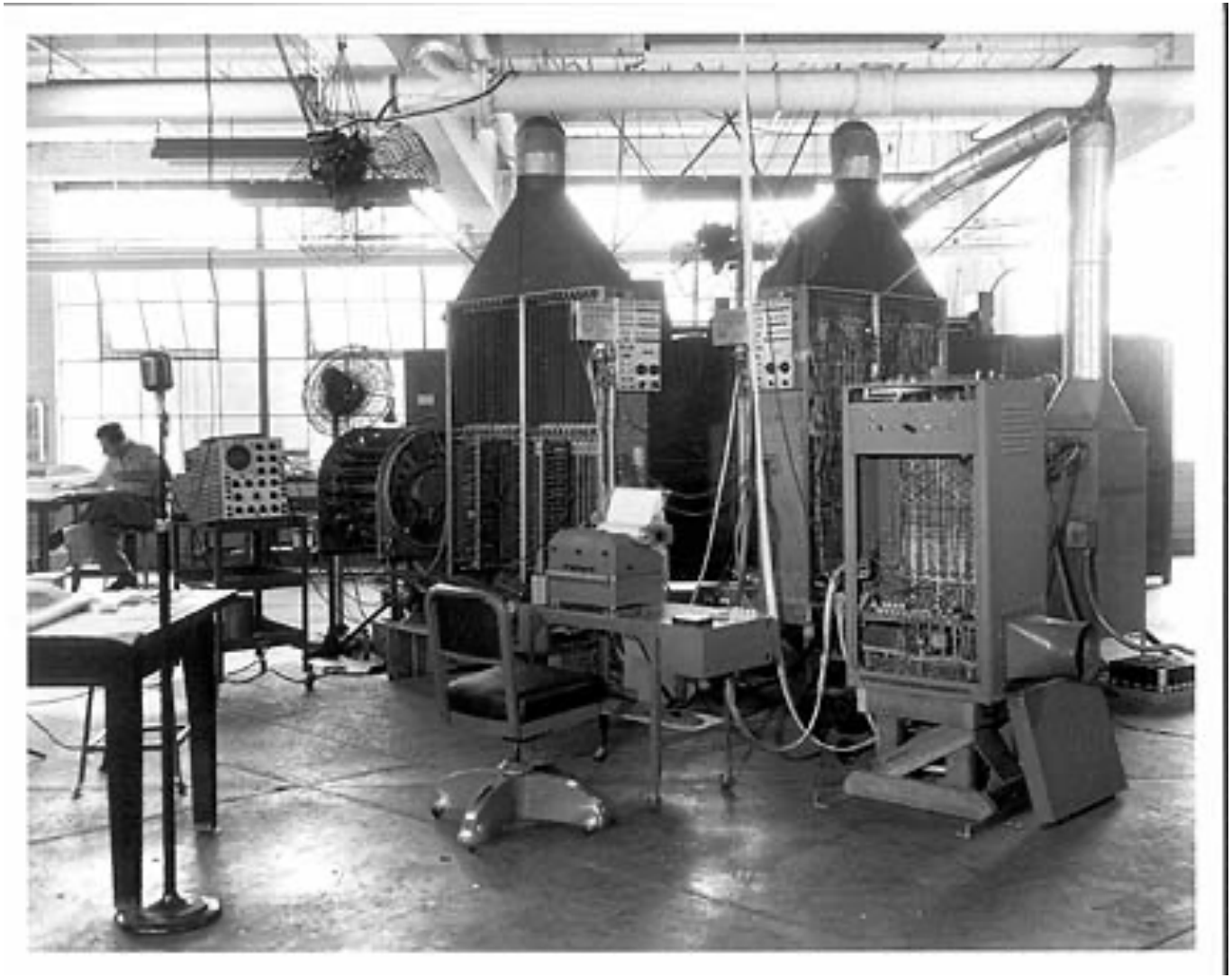
- First customer: Bureau of the Census
  - Paid $300K up front
  - Actual cost to build the first UNIVAC was $1M

BINAC



- Completed in 1949 for Northrop Aircraft
- First operational American stored-program computer
- Smaller than UNIVAC
- Scientific Computer, for researchers
  - bought by defense companies

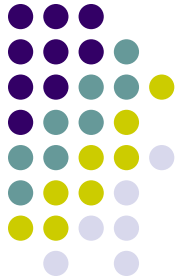
BINAC



UNIVAC

- Remington Rand buys EMCC in 1950
- Eckert & Mauchly envisioned a general purpose computer (UNIVAC)
- Government receives delivery of first UNIVAC in 1951 after U.S. Census processing started
- By 1954, 20 had been built and delivered for $1 million each

Some UNIVAC Features

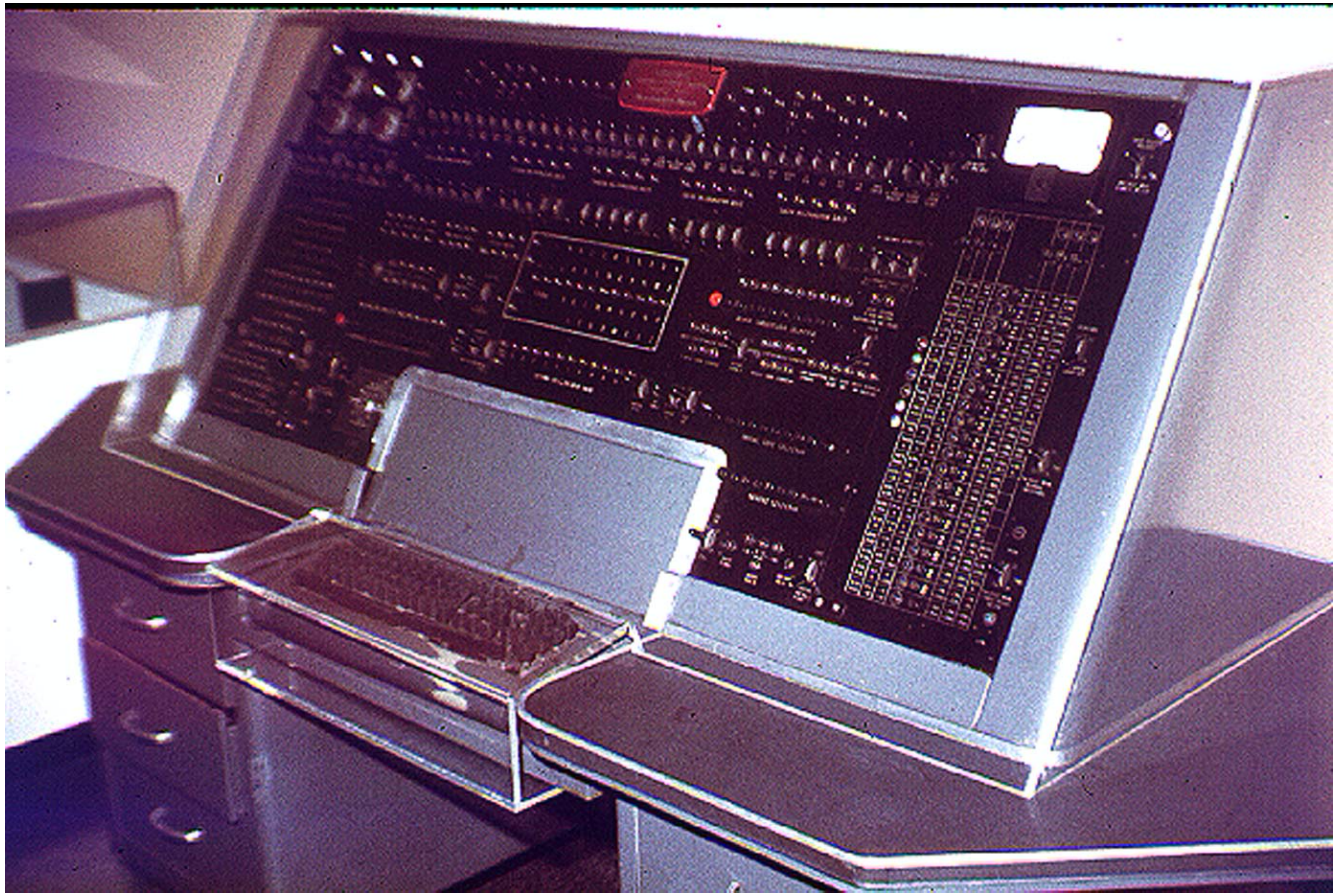


- Used magnetic tape to store data rather than punched cards
  - Transfer rate 12800 characters/second
  - Read in speed 100 inch/second
  - Card-to-tape 240 cards/minute
- Processing times:
  - Addition 120 microseconds
  - Multiplication 1800 microseconds
  - Division 3600 microseconds
- Output
  - High speed printer 600 lines/minute

UNIVAC

UNIVAC I, from
IEEE Computer Society

UNIVAC



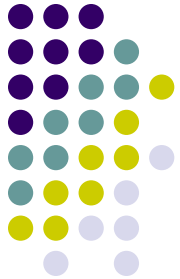
The UNIVAC I
console,
from Virginia Tech

The UNIVAC Stunt

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

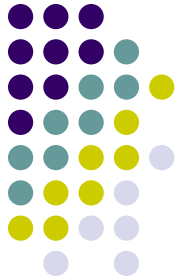
- Used to predict the winner of the 1952 U.S. Presidential Election based on ~3.4M votes
  - predicted an electoral vote of 438 for Eisenhower and 93 for Stevenson.
  - official count was 442 to 89 -- an error of less than 1%.
  - UNIVAC became synonymous with computer

IBM's Entry into Computers



- After Northrop ordered a UNIVAC from EMCC, defense companies asked IBM for similar machines
  - IBM would be a little slow
- First 4 IBM computers:
  - SSEC
  - Defense Calculator (701)
  - Tape Processing Machine (702)
  - Magnetic Drum Computer (650)

IBM & Columbia's Selective Sequence Electronic Calculator



- Following ENIAC, IBM looked to incorporate electronics into their existing machines
- Led by Columbia's Wallace Eckert
- Watson's objective:
  - thumb his nose at Aiken
  - ensure IBM had a test bed for new ideas & devices
- SSEC Completed in 1948
  - Not a stored-program computer
  - the most powerful & advanced machine available when it was completed
  - not commercially viable, it went on display
  - it's real importance was that its production trained IBM engineers

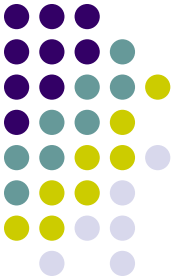
IBM 701 (1952)
(Defense Calculator)

- Designed as a response to get government contracts during the Korean War in 1950
- Advocated by Thomas J. Watson Jr.
- Stored program computer
  - optimized for scientific calculations.
- Design used parallel architecture
  - Made performance much faster than UNIVAC
  - Would subsequently be adopted by Remington Rand computers
  - Designed out of modular components for easy transport and configuration

IBM 701 Components

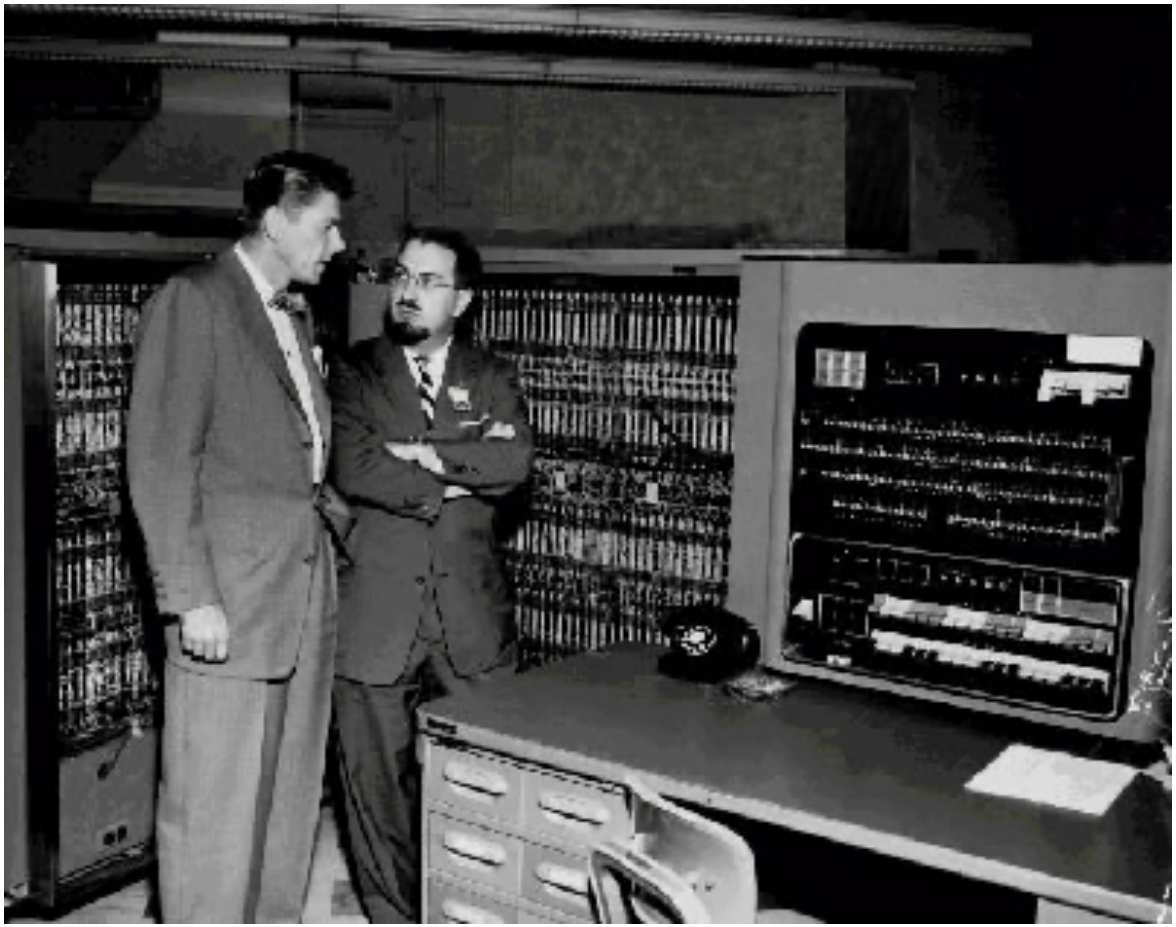
- IBM 701 Electronic analytical control unit
- IBM 706 Electrostatic storage unit
- IBM 711 Punched card reader
- IBM 716 Printer
- IBM 721 Punched card recorder
- IBM 726 Magnetic tape reader/recorder
- IBM 727 Magnetic tape unit
- IBM 731 Magnetic drum reader/recorder
- IBM 736 Power frame #1 (not shown)
- IBM 737 Magnetic core storage unit
- IBM 740 Cathode ray tube output recorder
- IBM 741 Power frame #2
- IBM 746 Power distribution unit
- IBM 753 Magnetic tape control unit

IBM 701 Customers



1 IBM World Headquarters, New York, N.Y. Dec. 20, 1952
2 University of California., Los Alamos, N.M. Mar. 23, 1953 (a)
3 Lockheed Aircraft Company, Glendale, Cal. Apr. 24, 1953 (b)
4 National Security Agency, Washington, D.C. Apr. 28, 1953
5 Douglas Aircraft Company, Santa Monica, Cal. May 20,1953 (c)
6 General Electric Company., Lockland, Ohio May 27, 1953
7 Convair, Fort Worth, Tex. Jul. 22, 1953
8 U.S. Navy, Inyokern, Cal. Aug. 27, 1953 (d)
9 United Aircraft, East Hartford, Conn. Sep. 18, 1953
10 North American Aviation, Santa Monica, Cal. Oct. 9, 1953 (e)
11 Rand Corporation., Santa Monica, Cal. Oct. 30, 1953 (f)
12 Boeing Corporation, Seattle, Wash. Nov. 20, 1953 (g)
13 University of California, Los Alamos, N.M. Dec. 19, 1953
14 Douglas Aircraft Company, El Segundo, Cal. Jan. 8, 1954 (h)
15 Naval Aviation Supply, Philadelphia, Pa. Feb. 19, 1954
16 University of California, Livermore, Cal. Apr. 9, 1954
17 General Motors Corporation, Detroit, Mich. Apr. 23, 1954
18 Lockheed Aircraft Company, Glendale, Cal. Jun. 30, 1954 (b)
19 U.S. Weather Bureau, Washington, D.C. Feb. 28, 1955 (i)

IBM 701

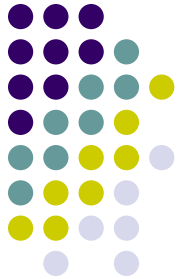


Ronald Reagan and IBM's Herb Grosch in 1956

IBM 701

Views of the IBM 701
(from IBM Archives)

IBM 702
(Tape Processing Machine)

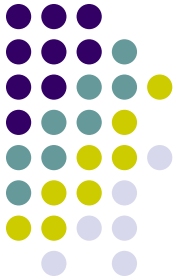


- First shipped in 1955
- The first large IBM computer designed for business data processing
- 15 are eventually installed
  - a bit of a financial flop
- First commercially available computer to use transistors
- The machine developed some new standards for subsequent machines.
  - Very high speed magnetic tape machines

IBM 702
(Tape Processing Machine)

The IBM 702 is seen in 1952 at IBM's new Data Processing Center in its headquarters at 590 Madison Avenue in New York City. (IBM Archives)

IBM 650
(Magnetic Drum Computer)



- First IBM 650 delivered in 1954
- Inexpensive, punch-card oriented computer
  - "Model-T of computing“
- 2,000 are eventually produced
- Applications:
  - Calculation of insurance sales personnel commissions, market research analysis, payroll processing, missile design, customer billing for a utility, oil refinery design and engineering calculations, analyses of flight tests made by supersonic aircraft, actuarial computations, centralized branch store accounting.
- Discounts of 60% provided to universities in exchange for courses in data processing

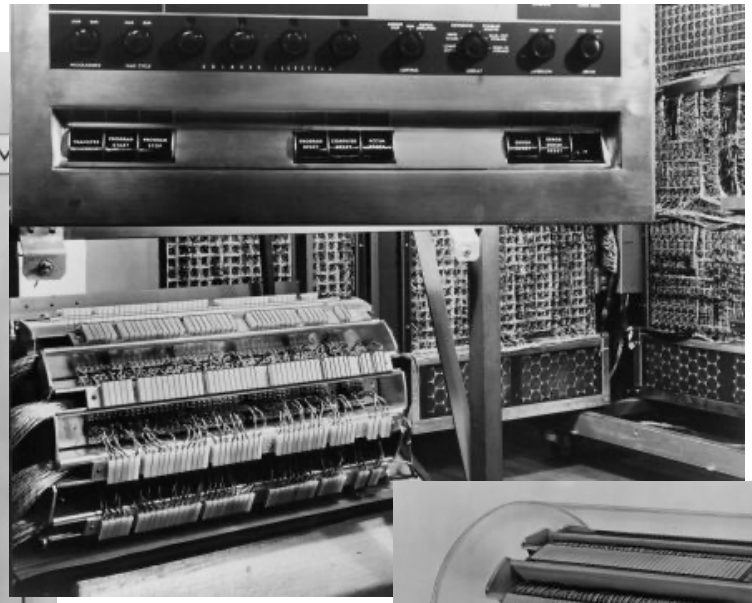
IBM 650 Customers

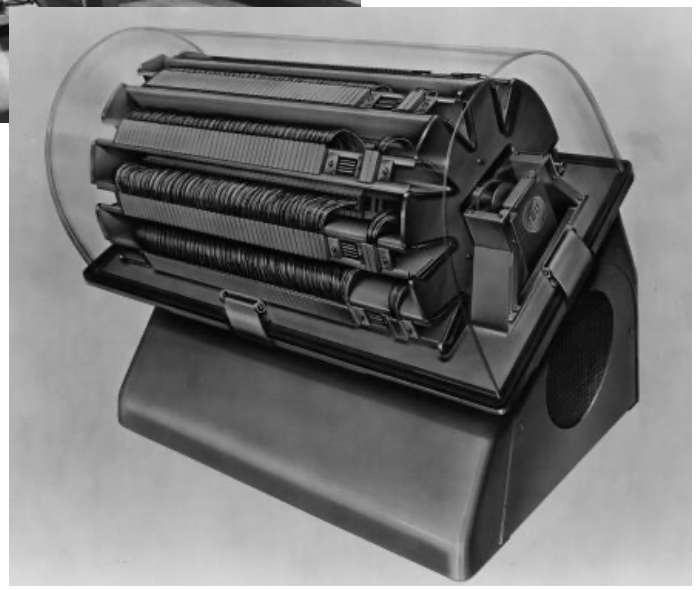
ACF Industries Inc.*·ALCO Products, Jamestown*·Allied Chemical, Richmond*·Allis Chalmers, Milwaukee, Wisconsin*·Atlantic Refining, Philadelphia, Pennsylvania.*·Avco Manufacturing, Cincinnati, Ohio*·Avco Manufacturing Corp., Cambridge, Massachusetts·Belknap Hardware & Manufacturing Company, December 13, 1955·Bell Aircraft Corporation, Buffalo, New York*·Bell Telephone, Elizabeth (3)*·Bell Telephone, Philadelphia, Pennsylvania*·Bethlehem Steel, Baltimore, Maryland*·Boeing Airplane Company, August 11, 1955*·Bonneville Power Administration, April 24, 1956·Budd Company, Philadelphia, Pennsylvania*·Business Men's Assurance Company·Carnegie Institute of Technology, August 28, 1956*·Carrier Corp., Syracuse, New York*·Carter Oil, Tulsa, Oklahoma*·Case Institute, Cleveland, Ohio*·Chance Vought Aircraft, Dallas, Texas (2)*·Chrysler, Detroit, Michigan, May 1955*·Clarke Brothers, Jamestown*·Colorado River Association, February 17, 1958·Combustion Engineering Inc., New York, New York*·Cornell University, Elmira, New York, February 3, 1957*·Datamatic Corp., Cambridge, Massachusetts*·Detroit Edison Company, May 10, 1955·Doane Agricultural Service, Inc.·Drexel Institute of Technology, November 20, 1958·E. I. duPont de Nemours & Company, February 15, 1955·Francis I. duPont & Company, November 22, 1955·El Paso National*·Equitable Life, New York, New York, April 1955·Esso Research, Elizabeth*·Esso Standard Oil Co., Baton Rouge Refinery, February 14, 1955·Fairchild Engineering, Garden City, New York*·Fairchild Engineering, Hagerstown, Maryland·General Dynamics, Tyler*·General Dynamics Corporation, Electric Boat Division, August 11, 1955 (for design of USS *Seawolf* (SSN-575), the U.S. Navy's second nuclear-powered submarine)*·General Electric, Boise*·General Electric Aircraft, Cincinnati, Ohio (2)*·General Electric Analytical, Schenectady, New York (2)*·General Electric Apparatus Sales Division, January 26, 1955·General Electric Engineering Lab, Schenectady, New York*·General Electric Heavy Military Electronic Equipment, Syracuse, New York*·General Electric Knolls Atomic Power Lab., Schenectady, New York*·General Electric Large Motor & Generator, Schenectady, New York*·General Electric Medium Induction Motor, Schenectady, New York*·General Electric Missile & Ordnance Systems Department, June 16, 1957·General Electric Special Products, Philadelphia, Pennsylvania*·General Electric Switchgear, Philadelphia, Pennsylvania*·Georgia Institute of Technology, Atlanta, Georgia.*·Goodyear Atomic, Huntington*·Grumman Aircraft Engineering Corporation, Garden City, New York, May 26, 1955 (2)*·Gulf Life Insurance Co., July 14, 1959·Gulf Oil Corporation, September 10, 1956 and June 10, 1957 (2)·Harrison Radiator, Buffalo, New York*·Hartfield Stores, Inc., July 30, 1957·H.P. Hood & Sons·Hughes Aircraft Company, February 19, 1955 (3)*·Humble Oil, Houston (2)*·IBM de Venezuela, February 19, 1957·Illinois Institute of Technology, Chicago, Illinois*·Indiana University, Indianapolis, Indiana*·Interstate Life & Accident Insurance Company, August 16, 1957·Iowa Mutual Insurance Company·Iowa State College Statistical Laboratory, March 9, 1957·John Hancock Mutual Life Insurance Company, December 8, 1954 (2)·Johns Hopkins, Baltimore, Maryland*·Jones & Laughlin Steel Corporation, Aliquippa and Pittsburgh Works Divisions, December 22, 1955·Lockheed Aircraft Corporation, Missile Systems Division, February 11, 1955 (2)*·Los Angeles (city of), June 14, 1956·Massachusetts Institute of Technology, Cambridge, Massachusetts, February 29, 1960*·McDonnell Aircraft Corporation, June 19, 1955*·McLean Trucking Company, April 24, 1959·Mellon National Bank & Trust Company, November 11, 1955·Montgomery Ward & Company, April 2, 1955·National Advisory Committee for Aeronautics [NASA], Ames Aeronautical Laboratory, May 14, 1955*·National Advisory Committee for Aeronautics [NASA], Langley Aeronautical Laboratory, March 16, 1955·National Bureau of Standards, Boulder Laboratories·Nationwide Insurance·New York City Department of Public Works, December 31, 1959·New York University College of Engineering, January 22, 1957·Newport News Shipbuilding, Norfolk, Virginia*·A. C. Nielson, Chicago, Illinois, January 1955·North American Aviation, Columbus*·North Carolina State College, Raleigh*·Northern Pacific Railroad, June 20, 1957·Ohio Oil Company, February 10, 1956·Ohio State University, June 21, 1956*·Oklahoma A & M College, Stillwater*·Olin Mathieson, Buffalo, New York*·Ordnance Aerophysics Laboratory·Charles Pfizer & Company, Inc.·Pennsylvania Railroad, Philadelphia, Pennsylvania*·Phillips Petroleum, Boise*·Pittsburgh Pirates, March 15, 1955·RCA, Trenton*·Republic Aviation, Garden City, New York*·Ryan Aero Co., San Diego*·Shell Oil, Houston (2)*·Society of the Divine Savior·Standard Oil Company (Ohio), April 4, 1955·Stanford University*·State Farm Mutual, December 7, 1956·State Mutual Life Assurance Company·Union Carbon & Carbide, February 3, 1955·Union Carbide, Knoxville (2)*·University of California (3)*·University of Houston, Houston, Texas*·University of Michigan, Ann Arbor, Michigan*·University of Pittsburgh, Pittsburgh, Pennsylvania*·University of Rochester*·University of Wisconsin, Madison*·U.S. Air Force Air Weather, Asheville*·U.S. Air Force Marquardt Jet Laboratory, Van Nuys·U.S. Air Force Proving, Mobile, Alabama*·U.S. Army Guided Missile Division Computational Lab (2)*·U.S. Army Signal Corps, Trenton*·U.S. Navy, July 20, 1955·U.S. Navy Aero Research, February 23, 1955·U.S. Steel, American Bridge Div., Pittsburgh, Pennsylvania, April 1955·Vertol Aircraft Corporation, August 28, 1956*·Washington University, St. Louis, Missouri*·Wayne University, Detroit, Michigan*·Westinghouse Electric, Baltimore. Maryland, May 1955*·Westinghouse Electric Corporation, Analytical Section, E. Pittsburgh Works, March 15, 1955*·Westinghouse Electric Corporation, Steam Turbine Division, December 18, 1956·Wisconsin (state of), Madison*·Yale University, November 17, 1958

IBM 650
(Magnetic Drum Computer)

This "white room" view of a 650 installation shows an IBM 533 Card Read Punch in the foreground at left; the 650 Console Unit at center, with an IBM 655 Power Unit behind it; and an IBM 537 Card Read Punch at right. (IBM Archives)

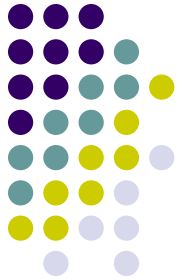
IBM 650
(Magnetic Drum Computer)





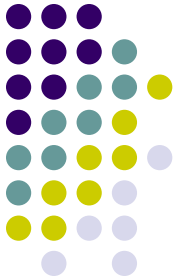
**The console of the IBM 650,
the 650 with its cover off,
and the magnetic drum. (IBM Archives)**

IBM advantages over UNIVAC



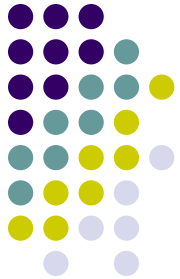
- IBM's computers soon outdistanced UNIVAC in the marketplace
- 1955 – IBM's 700 series sales first surpassed UNIVAC
- Better technologies?
  - Williams Tube memory rather than mercury delay lines?
    - both had shortcomings speed vs. reliability
  - Superior magnetic tape system
  - Forrester core memory
- Modular designs
  - pluggable components
  - flexibility
- Superior training & service infrastructure
- Rentals vs. Sales

Was it Remington Rand's fault?



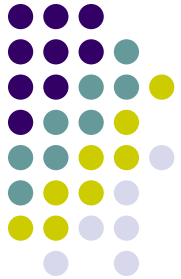
- What do the business majors think?
- Many would later comment that Remington-Rand had snatched defeat from the jaws of victory
  - Sperry Rand?
- RR was criticized for not investing enough in further development of the machine

Was it inevitable?



- For IBM:
  - timing is everything
  - being the biggest doesn't hurt either
    - great resources
    - large margin for error
    - large customer base
  - strong leadership with Watsons
    - they made a commitment to change with the times
  - "losing is not an option" culture at IBM
    - culture of fear (reminiscent of NY Yankees)

Evolution of Circuitry & Memory in the 1940s and 1950s



- vacuum tubes used by 1st generation computers
- transistors used by 2nd generation computers
- how about 3rd generation computers?

- Other technological developments:
  - magnetic tape
  - magnetic drum
  - core memory

Invention of Vacuum Tubes

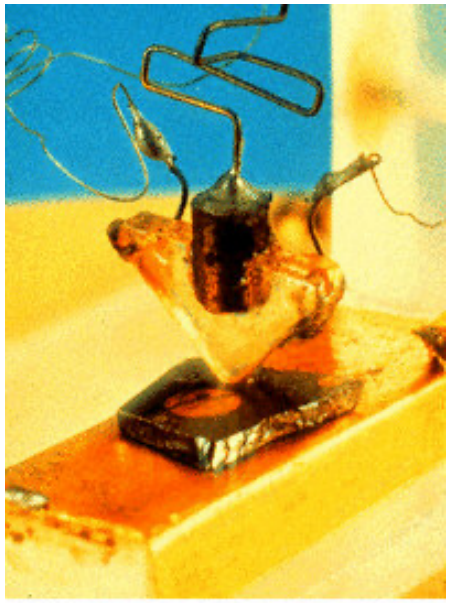
- 1879 – Edison invents incandescent electric light bulb
  - air removed from bulbs causing vacuum
- 1883 – Edison discovers he could detect electrons flowing through his vacuum bulbs
  - placed second electrode in bulb
  - known as the Edison Effect
- 1904 – English physicist John Fleming extends the Edison Effect, and invents two-element vacuum tube called a ***diode***
  - One-way current
  - Converts AC to DC
- 1906 – American inventor Lee de Forest introduced a third electrode called the grid into the vacuum tube
  - allowing into to act as an amplifier and a switch

Vacuum Tubes

- A glass tube from which all gas has been removed
  - contained electrodes for controlling electron flow
  - commonly used in early computers as switch or amplifier
  - poor reliability: burned out easily

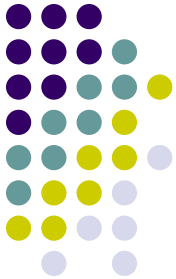
- Vacuum tubes are no longer used and were replaced by transistors

Transistors



- First invented & tested in 1947 by William Shockley, Walter Brattain, and John Bardeen for AT&T Bell Labs in New Jersey
  - Awarded Nobel Prize in Physics in 1956
    - http://nobelprize.org/physics/laureates/1956/
- One of the most important inventions of the 20th Century
  - Certainly for modern computers
- Started the trend towards miniaturization

So what's a transistor?



- Uses semiconductor materials like silicon
  - Semiconductors are in between electrical conductors & insulators
  - Can function as one or the other
  - It's ability to change states is what allows it to switch (for computers) or amplify (for radios)
  - Transistor switches can be cascaded together to build up complicated logical control circuits
- Today's computers still use transistors (ex: CPU)
- For complete technical answer (and fun & games):
  - http://nobelprize.org/physics/educational/transistor/function/intro.html
  - http://www.lucent.com/minds/transistor/history.html

Silicon Junction Transistor

- perfected by Gordon Teal of Texas Instruments Inc
- brought the price of this component down to $2.50
- These are not terribly complicated devices
  - Combine a whole bunch of them and you can create something complicated
- Other advances by Philco
- IBM started designing computers with transistors in the late 1950s

TRANSAC S-2000

In Large-Scale Data Processing

The World of Tomorrow is Now

Conceived and created by the top technical skills in the industry, TRANSAC S-2000 is recognized as the first and finest in transistorized data processing. With unmatched speed and incomparable quality, TRANSAC S-2000 is the ultimate for accurate, uninterrupted data processing...a new horizon in the state of the art. Philco has the resources and the organization to solve your computer problems and assure you long and dependable service.

transac* S-2000 by PHILCO

...First in Transistorized Data Processing

from www.luminquest.com/HOC

The Transistor vs the Vacuum Tube

- Vacuum tubes
  - Generate a lot of heat (like light bulbs)
  - Burn out
  - Slow, big, & bulky
- Transistor
  - Small
  - Fast
  - Reliable
  - Require less energy