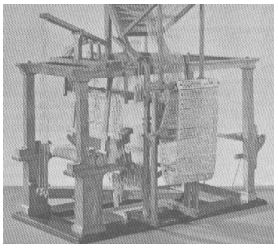
15-292 History of Computing

Computing in the 1800s: Punched Card Machines

Information Processing

- Industry demands for high-volume information processing grew greatly in 1800s
  - Census tabulations (nothing new)
  - Industrial revolution & mass production
  - Centralized financial institutions
  - Railway management
  - Telegram management
  - Insurance industry
    - The “thrift movement” & shift from agricultural to industrial societies were contributing factors

Jacquard Loom



- Developed in 1801 by Joseph-Marie Jacquard.
- The loom was controlled by a loop of punched cards.
- Holes in the punched cards determined how the knitting proceeded, yielding very complex weaves at a much faster rate.

from Columbia University Computing History
http://www.columbia.edu/

The U.S. in the 1800s

- 20-30 years behind Europe in economic development
  - While Europe was becoming industrialized in the 1830s, the U.S. was still mainly agricultural
  - After U.S. Civil War (1860s), American companies began to develop big offices
  - This delay (compared to Europe) allowed American companies to take full advantage of emerging office technologies

The U.S. in the 1800s

- 20-30 years behind Europe in economic development
  - Another important factor: American companies' "love affair with office machinery"
    - America was "gadget crazy"
    - American companies were more likely to buy useful or useless machinery than their European counterparts
    - America soon became the leading producer of information technology goods
      - Dominated type-writer, record keeping, & adding machine industries

U.S. Census

- Mandated by Article I, Section 2 of the U.S. Constitution
  - "Representatives and direct Taxes shall be apportioned among the several States... according to their respective Numbers... . The actual Enumeration shall be made within three years after the first meeting of the Congress of the United States, and within every subsequent Term of ten Years"
- Population counts required every 10 years
- (Next U.S. Census is happening this year, 2020)
- Steadily increasing population
  - Early census had little info collected concerning demographics to compile

    1790 – 3.9 million

U.S. Census

- 1800s – Century of Immigration, particularly from Europe
- 1840 – 17.1 million
  - 28 clerks in the Bureau of the Census
- 1860 – 31.4 million
  - 184 clerks
- 1870 – 38.6 million
  - 438 clerks
  - census report 3473 pages
- 1880 – 50.1 million
  - 1495 clerks
  - census report 21,000 pages
  - took 7 years to compile

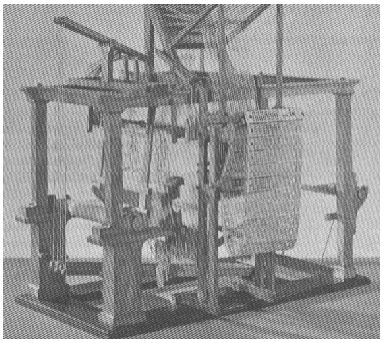
The 1890 census was predicted to take more than 10 years to process!

Herman Hollerith

- Born Feb. 29, 1860 in Buffalo, NY
- Son of immigrant parents from Germany
- Schooled at home privately
- Worked at the US Census Bureau as in 1880
- Joined MIT as a mechanical engineering lecturer in 1882.
- Joined the U.S. Patent Office in Washington DC in 1884.

The 1880 U.S. Census

- The amount of data that needed to be analyzed was growing quickly
  - Required seven years to process 1880 Census
- In 1882, Hollerith investigated a suggestion by Dr. John Shaw Billings
  - "There ought to be some mechanical way of [tabulating Census data], something on the principle of the Jacquard loom, whereby holes in a card regulate the pattern to be woven."



The Hollerith Electric Tabulating System

- Initially tried to store data as holes punched on paper tape.
  - inspired by train ticket
  - switched to the punched card as a better solution.
  - one card for each citizen
- A pin would push through holes in a card into mercury placed below the card to complete an electrical connection, causing a counter to advance.
- First tested on tabulating mortality statistics in 1887
- U.S. Census Bureau held a contest for a mechanical device to be used to count 1890 census
  - 3 entries
  - Hollerith's device won contest and so was used

The Hollerith Electric Tabulating System

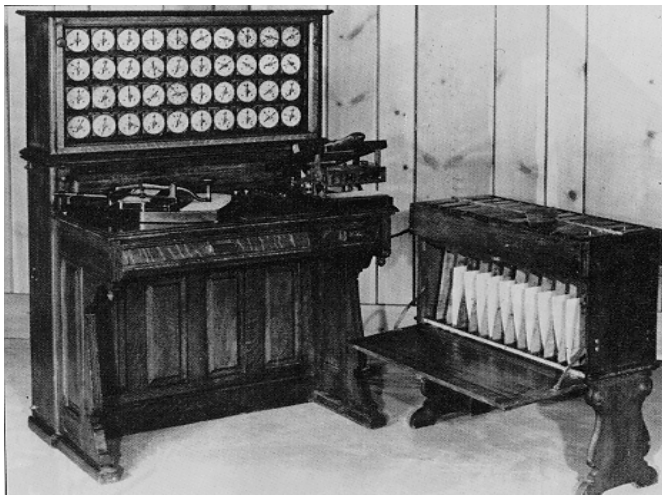
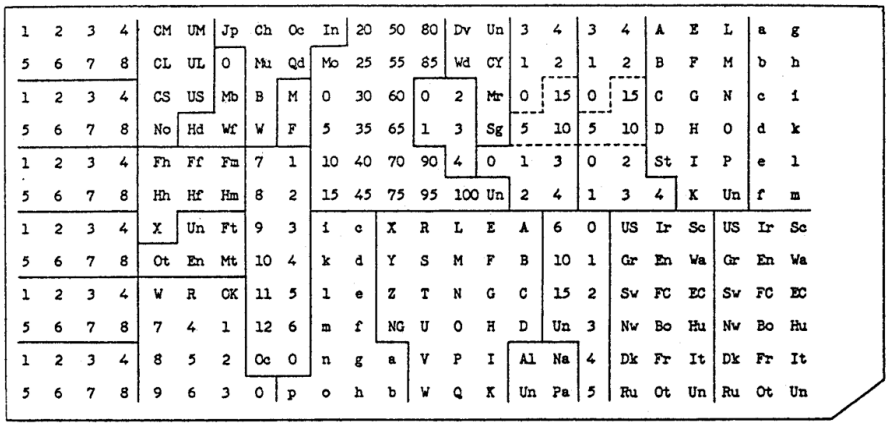


Photo: IBM

1890 U.S. Census Punched Card

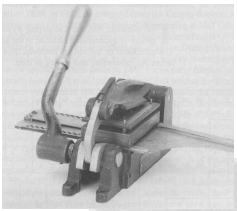
6.625" X 3.25"



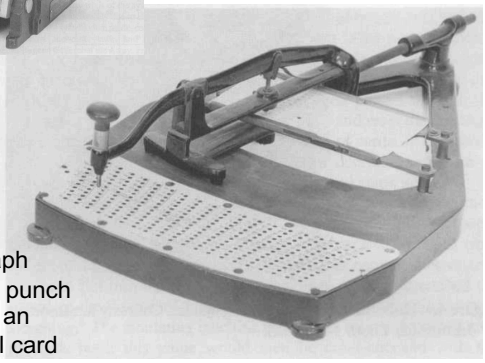
1890 U.S. Census Form

	INQUIRIES.	1	2
1	Christian name in full, and initial of middle name.		
	Surname.		
2	Whether a soldier, sailor, or marine during the civil war (U. S. or Conf.), or widow of such person.		
3	Relationship to head of family.		
4	Whether white, black, mulatto, quadroon, octoroon, Chinese, Japanese, or Indian.		
5	Sex.		
6	Age at nearest birthday. If under one year, give age in months.		
7	Whether single, married, widowed, or divorced.		
8	Whether married during the census year (June 1, 1889, to May 31, 1890).		
9	Mother of how many children, and number of these children living.		

Card punches



Gang punch
for 4-digit
Census
"enumeration" district



Pantograph
Punch to punch
holes for an
individual card

Card reader
(hand operated
press - "pin box")

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Hollerith Machine

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1890 U.S. Census

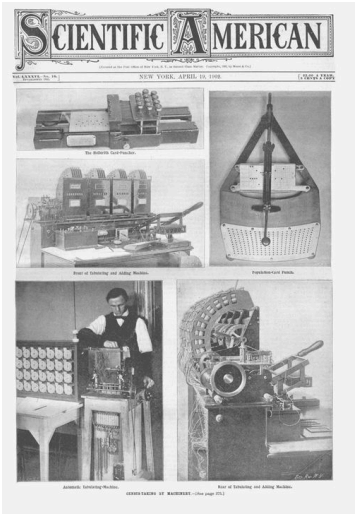
- The Hollerith machine saved the U.S. Government $5 Million
  - 2000 clerks
- The population count was tallied in 3 months
  Data was processed in 2 ½ years
  - Total population of the U.S.: 62,622,250
  - System was also used for census work in Canada, Norway, Austria and the UK
- Awards:
  - Elliot Cresson Medal by the Franklin Institute
  - Gold Medal of the Paris Exposition
  - Bronze Medal of the World's Fair in 1893

Another census

- Hollerith founded the Tabulating Machine Company in 1896.
- Machines used again in the 1900 U.S. Census
  - Automatic feeding of punched cards (7x improvement in counting speed)
  - Use of an "integrating tabulator": Cards could hold numerical quantities and the machine could total a series of cards.
  - New machine to punch cards using a calculator-style keypress.
  - Electrical sorting machine, independent of the counting operation
  - Census complete in 2.5 years

The Scientific Press

1890, 1902

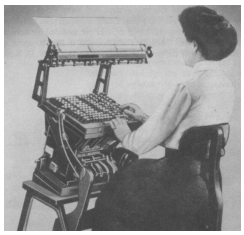


The Regional Press wasn't so enthused

- The public (and local politicians wanting more federal money) thought the 1890 count was inaccurate
- The press echoed these concerns
- "Useless Machines"
  - The Boston Herald
- "Slip Shod Work Has Spoiled the Census"
  - The New York Herald

Hollerith moves on

- Hollerith fails to secure contract for the 1910 Census
  - Moves on to the Railroads for business
- Advanced machines made by rival James Powers used in 1910 U.S. Census
  - Electric feed of punched cards into the machine
  - Data for card set up before entire card was punched to eliminate punch errors
  - Powers forms the Powers Tabulating Machine Company in 1911
  - Patent disputes between Hollerith and Powers



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The typewriter

- First practical typewriter invented by Christopher Latham Sholes in 1867
  - Soon sold by Remington
- One historian of manufacturing has noted, the "typewriter was the most complex mechanism mass produced by American industry, … , in the 19th century"
- Pioneered 3 key features of the office machine industry (and thus later the computer industry)
  1. The perfection of the product & low-cost manufacture
  2. A sales organization to sell the product
  3. A training organization to enable workers to use the technology

Other office technologies

- Adding Machine
  - Arithmometer by Thomas de Colmar of Alsace (1820)
    - impractical, slow to manufacture
  - Comptometer by Dorr E. Felt (1880s)
    - first "practical" adding machine, used key input
  - Burroughs Adding Machine by William Burroughs
    - Printed results, was commercially successful

- Cash Register
  - Invented by restaurateur James Ritty in 1879
    - Sold only one machine – to John H. Patterson
  - Patterson, "an aggressive, egotistical crank", ran with Ritty's invention
    - bought and then renamed Ritty's company to the National Cash Register Company (NCR)
    - innovated sales techniques

Thomas J. Watson, Sr.

- Born in Campbell, New York, in 1874
- Worked as salesman for NCR
  - moved up quickly in the company
  - worked on "secret project" for Patterson
    - helped him move up through company ranks
  - after success, he was abruptly fired in 1911
  - Hired by C T R (Computing-Tabulating-Recording Company) in 1914
    - CTR was a firm created by Charles Flint that had merged 3 others, including Hollerith's
    - Watson combined NCR sales techniques with Hollerith's technology
      Hollerith serves as consulting engineer with CTR until retirement in 1921.
    - renamed the company International Business Machines in 1924

Thomas J. Watson, Sr.

Powers vs CTR

- Hollerith improves the tabulator, automatic feed (150 cards/minute), plugboard to reconfigure counting functions
  - vertical sorter to conserve space - “back breaker”
- Powers develops the introduction of alphabetic equipment in 1924.
  - Letters of the alphabet are encoded in a single column of a punched card.
  - Opens up new commercial applications.
- IBM’s main competitor was Powers
  - Powers is bought out by Remington Rand

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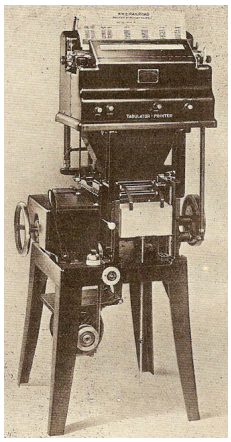
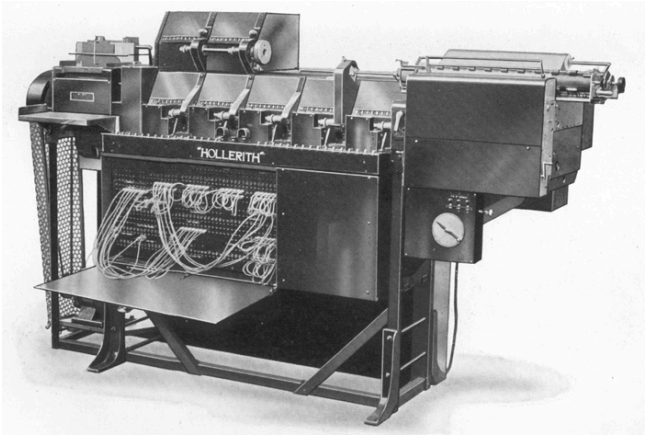
Powers vs CTR





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IBM Punched Card

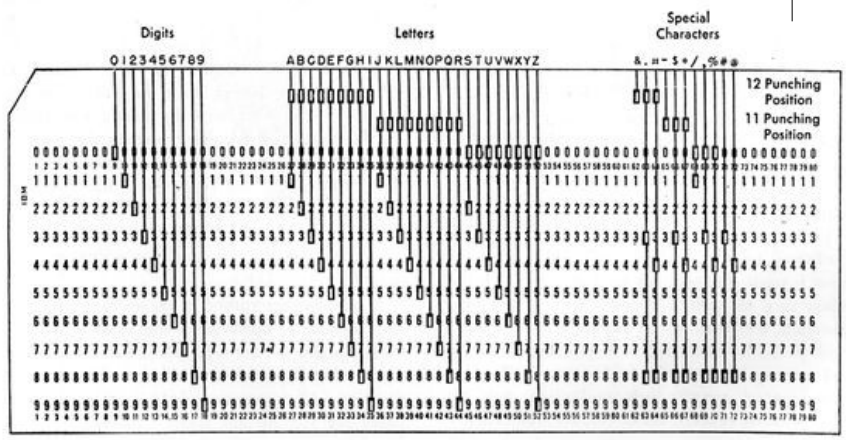

FIGURE 1. PUNCHING POSITIONS IN IBM CARD

- Used from 1928 until the mid 1970s.

IBM's Rise

- Hollerith was smart to rent machines rather than sell them
- Watson Sr. took advantage of this
  - resisted business & government pressure to sell machines
  - punched cards were sold for huge profit margins
- "rent and refill" nature of the punched-card business made IBM virtually recession proof
  - steady year-after-year income
    - even during the Great Depression
  - rarely lost customers
  - necessary accuracy of punched cards made competition nearly impossible

IBM's Rise (cont'd)

- Government contracts also helped
  - The government never goes out of business
  - Despite the Great Recession, Watson continues to build machines, put into storage for the right moment
  - FDR's New Deal gave IBM a lot of business
    - IBM wins contract to support Social Security Act
    - Watson's political support for the New Deal helped IBM get even more

First professional women hired by IBM (1935)
Product Showroom in Yokohama, Japan (1937)
Source: ibm.com

Social Security & IBM