Herman Hollerith and the Evolution of Electronic Accounting Machines

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Instant Quiz

- What is technology?
- Identify five examples of different technologies.
- How does technology arise, i.e., what is the process of invention?
- Identify three early tools.
- Identify the technique used to make these tools.
Technology, *n*, is the branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment drawing upon such subjects as industrial arts, engineering, applied science and pure science.

**technical, adj.**, belonging or pertaining to an art, science, or the like.

**technique, n**, the body of specialized procedures and methods used in any specific field, esp. in an area of applied science.
Homo farber (man the tool-maker)

- Homo, n, the genus of bipedal primates that includes modern humans and several extinct forms, distinguished by their large brains and a dependence upon tools.
- Christian Jurgensen Thompsen (c 1816) in dividing artifacts for a Museum, identified the Stone, Bronze and Iron ages.
- The Stone age was later divided into Greek-derived technical terms Paleolithic, Neolithic, and Mesolithic (old, new, middle).
We are surrounded by technology

Technology is embodied in the tools and techniques/processes that solve problems or empower people to do things.

- **saw**: enables us to cut wood
- **hammer**: enables us to build homes
- **automobile**: enables us to move about
- **cities**: enable us to have shelter and safety
- **stove**: allows us to cook indoors
- **telephone**: allows us to communicate
Philosophical Questions:

- Which came first the chicken or the egg?
- Does technology result from man’s needs? (“pull” theory)
  or
- Do people invent things that enable man to improve his lifestyle? (“push” theory)
- In truth, both processes are operative at all times and in all ages.
Census

- Article I, Section 2: Representatives and direct Taxes shall be apportioned among the several states...according to their respective numbers...(and) every ...term of ten years
- 1790: 1st US census
- Population: 3,929,214
- Census Office
Population Growth:

- 1790  4 million
- 1840  17 million
- 1870  40 million
- 1880  50 million
- 1890  63 million
Census Process

- Originally done by Deputy Marshals on paper
- Problems of mountains of paperwork recognized almost immediately
- Results of 1880 Census not available until 1888
- Concern that 1890 Census would not be finished before 1900
Herman Hollerith (1860-1929)
Herman Hollerith

- Born: February 29, 1860  
  (American Civil War: 1861-1865)
- Columbia School of Mines (New York)
- 1879 hired at Census Office
- 1882 MIT faculty (T is for technology!)
- 1883 St. Louis (inventor)
- 1884 Patent Office (Wash, DC)
- 1885 “Expert and Solicitor of Patents”
Patents

- The exclusive right granted by a government to an inventor to manufacture, use, or sell an invention for a certain number of years; an official document conferring such a right....

- The purpose of patent laws is not to protect the inventor, but to encourage disclosure of new discoveries for the benefit of society.
In the U.S., the law provides that a patent may be granted, for a term of 20 years from the date of application, to any person who has invented or discovered any new and useful art, machine, manufacture, or composition of matter, as well as any new and useful improvements thereof.

A patent may also be granted to a person who has invented or discovered and asexually reproduced a new and distinct variety of plant (other than a tuber-propagated one) or has invented a new, original, and ornamental design for an article of manufacture, for a term of 20 years and 14 years, respectively.
Observation, Inspiration and Perspiration

- John Shaw Billings, MD, physician (responsible for health statistics)

  “There ought to be some mechanical way of doing this job, something on the principle of the Jacquard loom, whereby holes in a card regulate the pattern to be woven.”

- Rail Road Ticket -- characteristics of the passenger punched into a card!
- Hollerith’s brother-in-law was in the silk weaving business
- Seaton machine
Census Trials

- 1880 Transcribe and Process 10,491 inhabitants
- Record Tabulate
- Hollerith 72.5 hours 5.5 hours
- Pidgin 111 hours 45 hours
- Hunt 145.5 hours 55.5 hours
Smithsonian Exhibit (old)
Data recording

Pantograph
Punch
Tabulating
Sorting
Enumeration and Tabulation

- Enumeration was the “simple” counting of the population.
- Tabulation was the creation of specific reports on industries, medical statistics, literacy, etc.
- Porter: The Office could not make valuable compilations that had previously been neglected because of time and expense.
1890 Census

- Rough population count: 6 weeks!
- Census completed in less than 2 years
- **Contract**: machines were rented for 2 shifts; extra machines available; penalty of $10/day; 24 hour maintenance; pantograph punches were sold
- 10,220 pages of published reports estimated at 14 years, if done manually (14:2) $5,000,000 savings
Hollerith as Inventor

- 1885 Patents for railway air brakes
- 1886 Baltimore: machine for the compilation of mortality statistics
- 1887 Census Office
  files for patents on card system:
  \textit{U.S. Patent Number: 395,781}
  \textit{card = person; hole = characteristic}
- 1888 Surgeon Generals Office
  \textit{in 6 months: 50,000 cards and dependency}
- 1889 Paris Universal Exposition: Gold Medal
Scientific American (1890)
THE FIRST
"HOLLERITH"
Electrical
CENSUS COUNTING MACHINE
1890

- Electrically operated
- Sorting box
- Hand operated pass
- Choral counters
- Pin box

Sifting station
With mercury cups

Hand stacker
December 3, 1896, the **Tabulating Machine Company** is chartered with Herman Hollerith as General Manager

1900 Census:
- automatic card feed (84,000/day)
- key punch (0 to 9)
- integrating tabulator (accumulator)
- census completed in 2 1/2 years

1905 Hollerith terminates association with Census Office
Numeric key punch

photo courtesy of IBM Corporation
James Powers

- 1905: Original Hollerith patents expire
  - Simon North: establishes machine laboratory at the Census Office (direct competition)
- Powers was a Russian immigrant
- 1907 hired at Census Office
- 1910 Census used Burroughs adding machines
- 1911 Powers Accounting Machine Company
- 1924 Powers encodes the alphabet
- 1927 Remington Rand (James Rand)
Computing Tabulating Recording Company, (C-T-R)

- 1911: Charles Flint
  **Computing** Scale Company (Dayton, OH)
  **Tabulating** Machine Company, and
  International Time **Recording** Company (Binghamton, NY)
CTR

- Thomas J. Watson (1874-1956) hired as first president
- 1924 Watson renames CTR as International Business Machines
The Industry:

- 1929 Herman Hollerith dies (age 17!)
- 1928 IBM: 80 column card *rectangular holes*
- 1930 RemRand: *90 column card round holes*
- 1930 Census uses commercial machines
- 1930’s EAM industry expands:
  
  Agriculture Adjustment Administration: **CHECK$**
  Social Security Administration
  virtually all large public and private organizations are **dependent on** Electric Accounting Machines
What seems to be the problem?

photo courtesy of IBM Corporation
Lab: Punched Cards

- “What the Punched Card Can Do”
- Slide of Punched Card
- Punched Cards
  - Plain
  - Alphabet and Numbers
  - “Add 8 and 12 SMILE”
  - How much is six and seven....
  - Binder of Sample Cards & brush
  - Slides of IBM Equipment
- Plug board
IBM 80 column card
"Hollerith" Code

- **Numeric**: 0 to 9 (one hole)

- **Alphabetic** (two holes)
  - A to I: 12 punch + 1 to 9
  - J to S: 11 punch + 1 to 9
  - T to Z: 10 punch + 2 to 9

- **Special Characters** (three holes)
  - , . ; # $ ( ) * & @
A great idea, now how do we make it work?

- Basic idea is to break all processing into specific tasks, and
- Build machines to do each task
  - encoding and verifying
  - counting
  - addition and subtraction
  - sorting and merging
  - printing
  - transmitting to another location
The following slides are from a "Data Processing Orientation" prepared by the IBM Corporation for their customers in the 1950's (done as 35 mm slides).

Dr. Bergin was given these slides when he was employed by the US Veterans Administration (from 1966 to 1982).
stages in development in data processing

- Simplification of Individual Functions
- Mechanization Introduces Combinations of Functions
- Punched Card Introduces Compatibility of Equipment
- Punched Tape Introduce Compatibility to Wide Range of Equipment
- Electronic Computers Introduce Intercommunication and Rapid Processing
1st STAGE

SIMPLIFICATION OF INDIVIDUAL FUNCTIONS

C  X  R
S  +

BETTER WORK FLOW
BETTER ARRANGEMENT OF DATA
BETTER RECORDING OF DATA
BETTER STORING OF DATA
BETTER COMMUNICATIONS
2nd STAGE
Mechanization Introduces Combinations of Functions

PRINTING ADDING MACHINE
CASH REGISTER
MICROFILM CARD FILE
COMPUTING BILLING MACHINE
PROOF MACHINE
3rd STAGE

Punched Card Introduces Compatibility of Equipment

Key Punch
Verifiers
Sorters
Statistical Machines
Collators
Reproducers
Accounting Machines (Tabulators)
Summary Punch
Calculating Punch
4th STAGE

Punched Tape Introduces Compatibility to Wide Range of Equipment

- Teletypewriter
- Cash Register
- Computyper
- Flexowriter
- Tape-to-Card Converter
- Typewriter Tape Punch
machine functions
Machine Functions

- The following slides were converted from 35mm slides used by IBM salesman. These slides were given to Dr. Bergin while he was employed by the US Veterans Administration.
- The photographs are from the IBM Archives and are used with permission.
Deck of Punched Cards
IBM 026 Keypunch

*photo courtesy of IBM Corporation*
IBM 603 Electronic Multiplier
(September 1946) photo courtesy of IBM Corporation
IBM 603 *photo courtesy of IBM Corporation*
Horizontal Sorter (1930s)

*photo courtesy of IBM Corporation*
Using a sorter (1950s?)

*photo courtesy of IBM Corporation*
IBM 402 Accounting Machine

photo courtesy of IBM Corporation
Plug Boards

- Some of the machines were able to perform more than one task. Such machines were controlled by a "plug board" in which the steps were "programmed" into the board with wires. In most cases, these boards were wired for one process such as "monthly billing" and used over and over again.
Typical Small Installation

photo courtesy of IBM Corporation
BIGGEST BOOKKEEPING JOB BEGINS

Social Security Board Has Gigantic Task

By GILRICHARDS.

Baltimore, Jan. 9—The world's biggest bookkeeping job is under way here.

Thanks to the Social Security Board, this city is now famous for one thing more than fried chicken and terrapin—a Social Security Board. For here's where all the money goes after the deadline, in figures as big as haystacks, they're being counted, sorted, and added up on sheets that will pay pensions a good many years away.

When you finished your work of filling out forms and sending in the books last month, the agent just started in this field of uncountable numbers.

By train and by truck, the big white bags come rolling in, in bundles of 1,000, all headed up in a postmaster's brown wrapper. They're still coming.

$60,000 A DAY

At the rate of 100,000 a day, the old age retirement accounts of 25,000,000 workers are being entered and filed away in the seven-story Chandler Building, right on the edge of Baltimore Harbor. Day and night the giant machines handle the workers, switching in 2,000 employees and the 24-hour clock of 60,000 workers.

The machines which carry the load. Without them, the Social Security Act would have been impossible, its administration would have been impossible.

John G. Winant

He's the boss of the world.
Typical Office

photo courtesy of IBM Corporation
Payroll Department

photo courtesy of IBM Corporation
Data Processing Installation

photo courtesy of IBM Corporation
USES of punched cards

- Library books  UMD ID
- Retail clothing sales
- Engineering drawings using microfilm
- Warehouse stock management
- Bills of lading for railroads and truck lines
- Mortgage payments
- Loan and insurance payments

PASS AROUND Card Notebook with samples.
In conclusion....

United States census: www.census.gov

- 228,289,000 on 12/1980
- 248,143,000 on 1/1/1990
- 274,245,985 at 10:54 EST on Feb. 13, 2000
References

Biographies:

- Thomas Watson, Jr., *Father, Son and Company*, Bantam, 1990
Show and Tell

- Census Sheets from 12th Census
- Rail road ticket
- Slides of Hollerith Machines
- Player Piano Roll
- Punched cards
Show and Tell: Punched Cards

- 1945 IBM Sales Booklet
- Punched Card Annual
- IBM Manuals
- IBM Home Study Course
- Casey’s Punched Cards
- UNIVAC Booklet with 90 column card
- MUSEUM: IBM 029 Keypunch
1st STAGE

SIMPLIFICATION OF INDIVIDUAL FUNCTIONS

C X R

S + J

BETTER WORK FLOW
BETTER ARRANGEMENT OF DATA
BETTER RECORDING OF DATA
BETTER STORING OF DATA
BETTER COMMUNICATIONS