COMP422 – Ethics and Professional Issues in Computing

Chapter 1

Catalysts for Change

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Learning Objectives

1.1 Milestones in computing

1.2 Milestones in networking

1.3 Milestones in information storage and retrieval

1.4 Milestones in artificial intelligence

1.5 Information technology issues

Information Age

- Unprecedented access to information in modern era

- Catalysts
  - Low-cost computers
  - High-speed communication networks

- New technologies continue to emerge
  - Smartphones
  - Video streaming services
  - Voice-activated digital assistants
  - Low-cost drones
  - Self-driving cars

Technological Marvel: The First Portable Cellphone in 1973

Portable means freedom.

Or is it?

Martin Cooper, the Motorola engineer who invented the first handheld cellular mobile phone.

https://www.openculture.com/2021/05/the-first-cellphone-discover-motorolas-dynatac-8000x.html#google_vignette

Pearson

Figure 1-1: Samsung Galaxy S9 Plus

Low-cost computers and high-speed communication networks make possible the products of the Information Age.

A smart phone now function as a phone, text messager, email client, Web browser, camera, video recorder, digital compass, and much more.

Impact of Modern Computing and Communications Systems
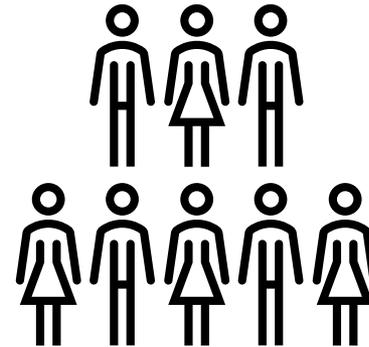
- World in 1950
  - Only a handful of electronic digital computers
  - Internet did not exist

- Contemporary world
  - Networked devices containing embedded microprocessors surround us
  - We engage with these devices for hours each day

Our Relationship with Technology is Dynamic

People create technology.

Once adopted, technology changes society (people, environment, etc.)
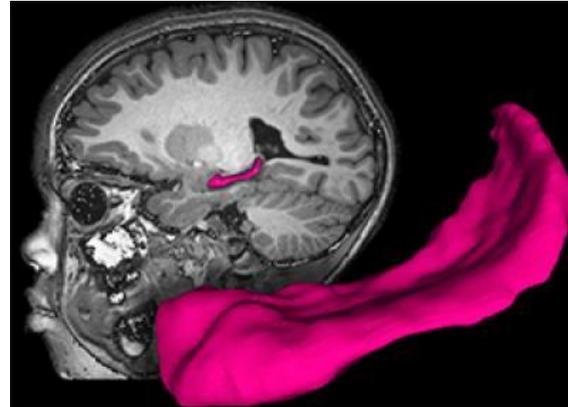
People have the need of a new technology for an existing problem.

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Our Relationship with Technology

- **Using technologies can change people**
  - **Physical**: London taxi drivers have increased **hippocampus** in their brain

  - **Physiological**: Watching funny shorts releases **dopamine** in brain, producing a desire to seek out more shorts

  - **Psychological**: Getting more dependency on cell phones

Our Relationship with Technology

- **Technologies solve problems, but may create new problems**
  - Automobiles
    - Greater mobility
    - Traffic jams
  - Web
    - Supports valuable information retrieval tools
    - Children may be exposed to inappropriate content
  - Low-cost international communication
    - Global access to news, entertainment
    - Jobs outsourced to less expensive labor markets

Our Relationship with Technology

- **We may not be able to prevent a new technology from being invented, but we do have control over whether to adopt it.**
  - Nuclear power
    - Create electricity without CO_2 emissions
    - Produce radioactive waste (need 100,000 years to become safe)
    - Action: Limit use/shutdown nuclear power plants (67 projects cancelled)

- **Influence rate that new technologies are developed**
  - IP laws to protect creative works
  - Laws regulate the use of new technologies (gene editing, AI in high-risk area)

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Theme of Chapter 1: Social-Technological Cycle

- Social conditions can lead to creation and adoption of new information technologies

- Adopting new information technologies can change social conditions

Group Discussion

- Give an example of how a social condition influenced the development of a new technology.

- Give an example of a social change brought about by the adoption of a new technology.

1.1 Milestones in Computing

Aids to Manual Calculating (1 of 2)

- Tablet to record numbers
  - Clay, wax tablets (ancient times)
  - Slates (late Middle Ages)
  - Paper tablets (19th century to present)

- Abacus to perform arithmetic
  - Probably developed 2000 years ago
  - Rods or wires in rectangular frame
  - Lines drawn on a counting board

Pearson
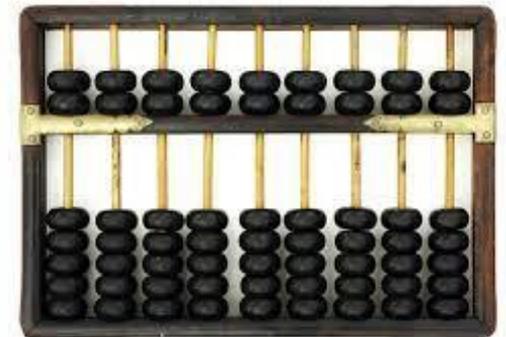
Slate and Counting Board

This is the classic engraving of Arithmetica (or the Allegory of Arithmetic) supervising a contest between Boethius, representing written calculation using Hindu-Arabic numbers, and Pythagoras, represented as using a counting board. (Library of Congress Prints and Photographs Division]LC-USZ62-95297])

Aids to Manual Calculating

- Mathematical tables
    - Tables of logarithms (17th century)
    - Income tax tables (today)

Salaries Tax

Regulations on Salaries Tax require that personal income tax be levied on working income. Personal income taxpayers are classified into two groups. One group is those working for others in any occupation, including daily wage earners and employees. The second group is self-employed freelance and specialised professionals. Salaries tax rates are as follows:

Taxable annual income	Percentage
Revenue of up to MOP 95,000	Waived
Progressively in excess of designated amount	
Up to MOP 20,000	7%
MOP 20,001 to MOP 40,000	8%
MOP 40,001 to MOP 80,000	9%
MOP 80,001 to MOP 160,000	10%
MOP 160,001 to MOP 280,000	11%
Over MOP 280,000	12%

Early Mechanical Calculators (1 of 2)

- Calculators of *Pascal* (French tax collector, 1640) and after *Leibniz* (German)
  - Worked with whole numbers
  - Unreliable

- Arithmometer of *de Colmar* (French entrepreneur) (19th century)
  - Took advantage of advances in machine tools
  - Adopted by insurance companies → enjoy commercial success

pascaline

Capable of adding whole numbers up to 6 digits.
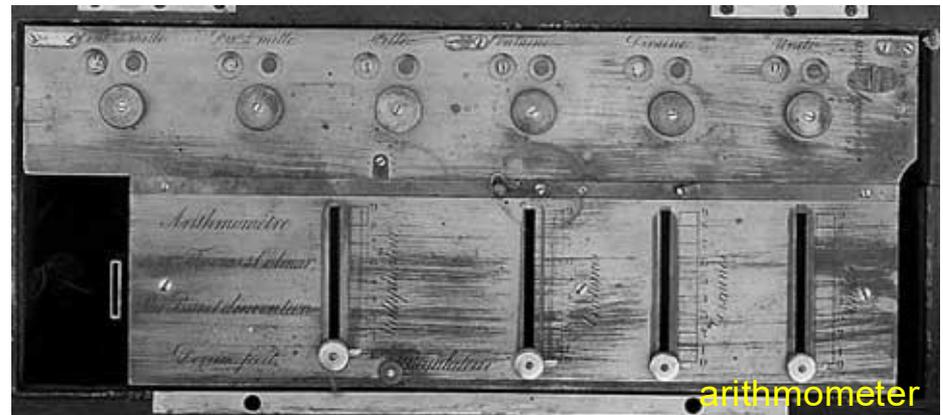
arithmometer

First digital mechanical calculator, can be reliably used in offices, can add, subtract, perform long multiplications & divisions too.

Early Mechanical Calculators (2 of 2)

- Printing calculator of Scheutzes (Swedish publisher) (19th century)
    - Capable of calculating mathematical tables and typesetting the values into molds
    - Used method of differences pioneered by Babbage
    - Adopted by Dudley Observatory in New York
    - Astronomical calculations: astronomers used it to compute motion of Mars and refraction of starlight

https://www.educalc.net/page/202485/
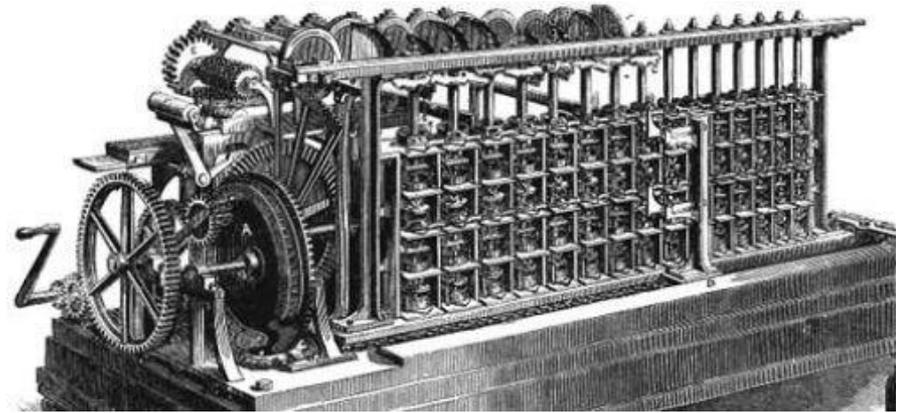
Social Change → Market for Calculators

- Gilded Age (late 19th century America)
  - Rapid industrialization
  - Economic expansion
  - Concentration of corporate power

- New, larger corporations
  - Multiple layers of management
  - Multiple locations
  - Needed up-to-date, comprehensive, reliable, and affordable **information**

1870s - 1900
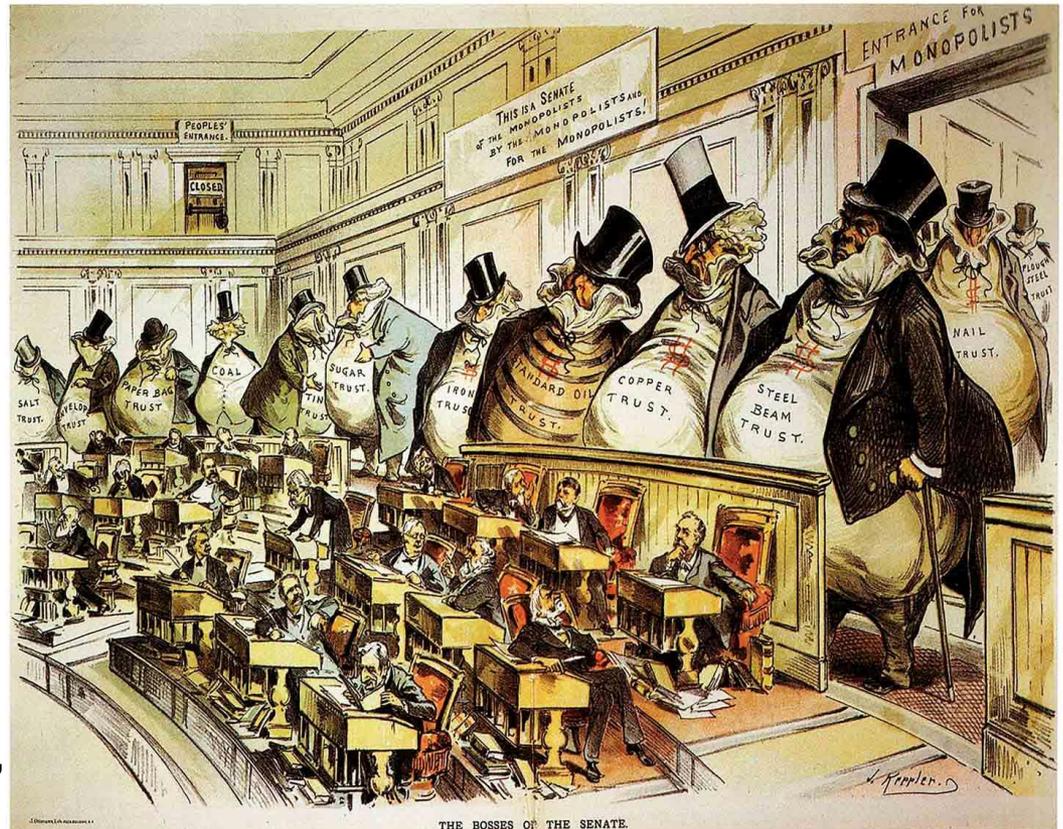
https://www.youtube.com/watch?v=Nmq7QqqY4vo   0:18 – 2:50

Calculator Adoptions → Social Change

- Fierce market
  - Continuous improvements in size, speed, ease of use
  - Sales increased rapidly

- Adopt mechanical (adding) calculator
  - "Deskilling" and feminization of bookkeeping
  - People of average ability quite productive
  - Calculators 6× faster than adding by hand
  - Wages dropped
  - Women replaced men

Figure 1-4: Feminization of Bookkeeping

Mechanical calculators led to the "de-skilling" and "feminization" of bookkeeping. (Automatic Data Processing (ADP))

wages. In 1880 only 5.7 percent of bookkeepers, cashiers, and accountants were women, but by 1910 the number of women in these jobs had risen to 38.5 percent [12].

Cash Register

- In late 1800s smaller stores evolved into "department stores" with multiple departments

- Two problems faced by department store owners
  - Keeping accurate sales records
  - Preventing fraud from clerks

- Response to problems: Cash Register
  - Created printed, itemized receipts
  - Maintained printed log of transactions
  - Rang bell every time drawer was opened
  - Become an important information-processing device

Cash Register

An NCR cash register in Miller's Shoe Shine Parlor, Dayton, Ohio (1904). (The NCR Archive at Dayton History)

Dealing with Great Volumes of Data

- But cash register was not able to process great volumes of information

- Consider
    - Census data – tens of milions of residents
    - Public transport
    - Sales of mega businesses

Herman Hollerith's Punch Card Machine (1890 Census)

Counter

Card reader

Card sorter

ELECTRICAL TABULATING MACHINES
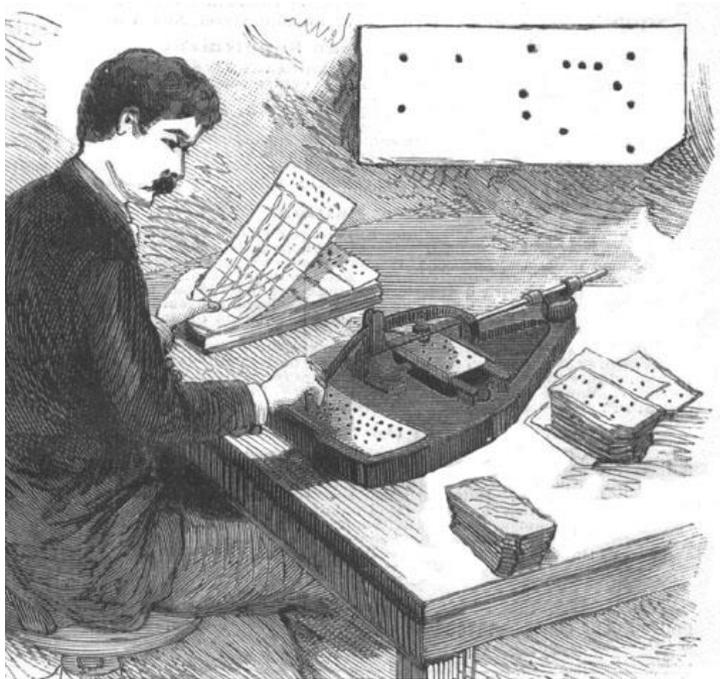
Data from 1890 Census forms were punched onto cards using a pantograph.
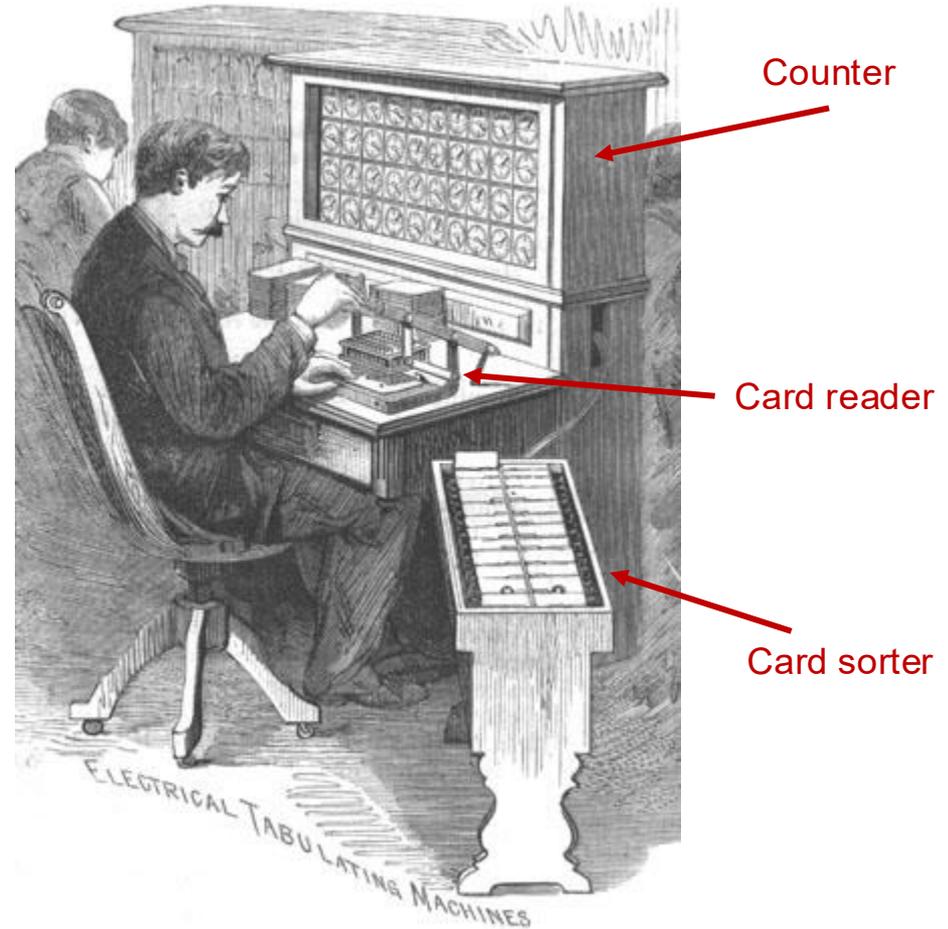
https://www.youtube.com/watch?v=GoUK2_vXqQk
Time: 1:40 – 3:40

https://www.officemuseum.com/data_processing_machines.htm

Punched Card Tabulation

- Punched cards (late 19th century)
  - One record per card
  - Cards could be sorted into groups, allowing computation of subtotals by categories

- Early adopters
  - U.S. Bureau of the Census
    - 1880 census took 8 years to complete the statistics
    - 1890 census took 2 years!
  - Railroads
  - Retail organizations
  - Heavy industries
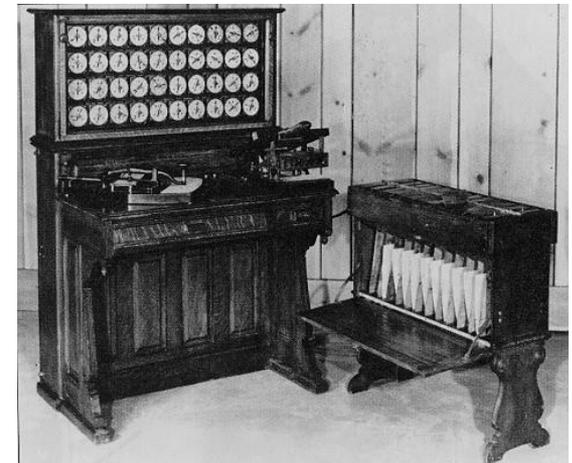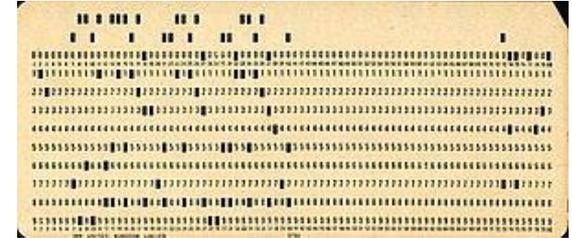
Tabulators → Data-Processing Systems

- Data-processing system
  - Receives input data
  - Performs one or more calculations
  - Produces output data

- Punched cards
  - Stored input data and intermediate results
  - Stored output
  - On most sophisticated systems, also stored **programs**

Hollerith found a company named Computing-Tabulating-Recording Company.
In 1924, it was renamed "International Business Machines" (IBM).

IBM and the Holocaust

- Hitler came to power in Germany in 1933

- IBM CEO Watson ignored anti-Semitic violence, creation of concentration camps

- IBM expanded German subsidiary and sought contracts with German government

- Nazis used IBM machines to conduct censuses, generate lists of Jews

- Lists facilitated seizure of assets and deportation to concentration camps

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First Commercial Computers

- Remington-Rand
  - Completed UNIVAC (universal automatic computer) in 1951
  - Delivered to U.S. Bureau of the Census
  - Predicted winner of 1952 Presidential election

- IBM
  - Larger base of customers
  - Far superior sales and marketing organization
  - Greater investment in research and development
  - Dominated mainframe market by mid-1960s

CBS News Coverage of 1952 Presidential Election Featured UNIVAC Computer

CBS news coverage of the 1952 presidential election included predictions made by a UNIVAC computer. When the computer predicted Eisenhower would win in a landslide, consternation followed. (Photo reproduced courtesy of Unisys Corporation)

Programming Languages

- Assembly language
  - Symbolic representations of machine instructions
  - Programs just as long as machine language programs

- FORTRAN
  - First higher-level language (shorter programs)
  - Designed for scientific applications
  - Initially, people are skeptical about quality of compiler generated machine code
  - Programmers wrote 5-20x faster

- COBOL
  - U.S. Department of Defense standard
  - Designed for business applications

Time-Sharing Systems and BASIC

- Time-Sharing Systems
    - Divide computer time among multiple users
    - Users connect to computer via terminals
    - Cost of ownership spread among more people
    - Gave many more people access to computers

- BASIC
    - Developed at Dartmouth College
    - Simple, easy-to-learn programming language
    - Popular language for teaching programming

IBM System/360

- Before System/360
    - IBM dominated mainframe marked in 1960s
    - IBM computers were incompatible
    - Switch computers → rewrite programs

- System/360
    - In 1964, IBM released series of 19 computers with varying levels of power
    - All computers could run same programs
    - Upgrade without rewriting programs
   - This feature was important, by then companies were making much larger investments in software

IBM System/360

In the 1960s, IBM dominated the mainframe computer market in the United States. (H. Armstrong Roberts/Classic Stock/Alamy)

Microprocessor

- An integrated circuit that contains all the functions of a central processing unit of a computer.

- "Computer inside a semiconductor chip"

- A general-purpose chip that could be programmed to perform a wide variety of tasks; each customer could then program the chip to meet its particular needs

FIRST INTEL PROCESSOR
INTEL C4004

- Intel 4004, world's first microprocessor

- Made personal computers practical

- Microprocessors made it possible to integrate computers into everyday devices!
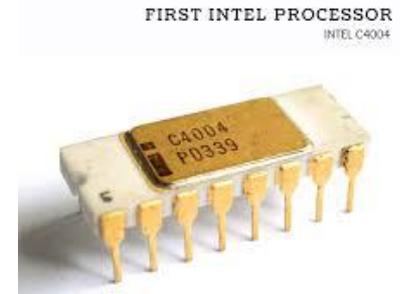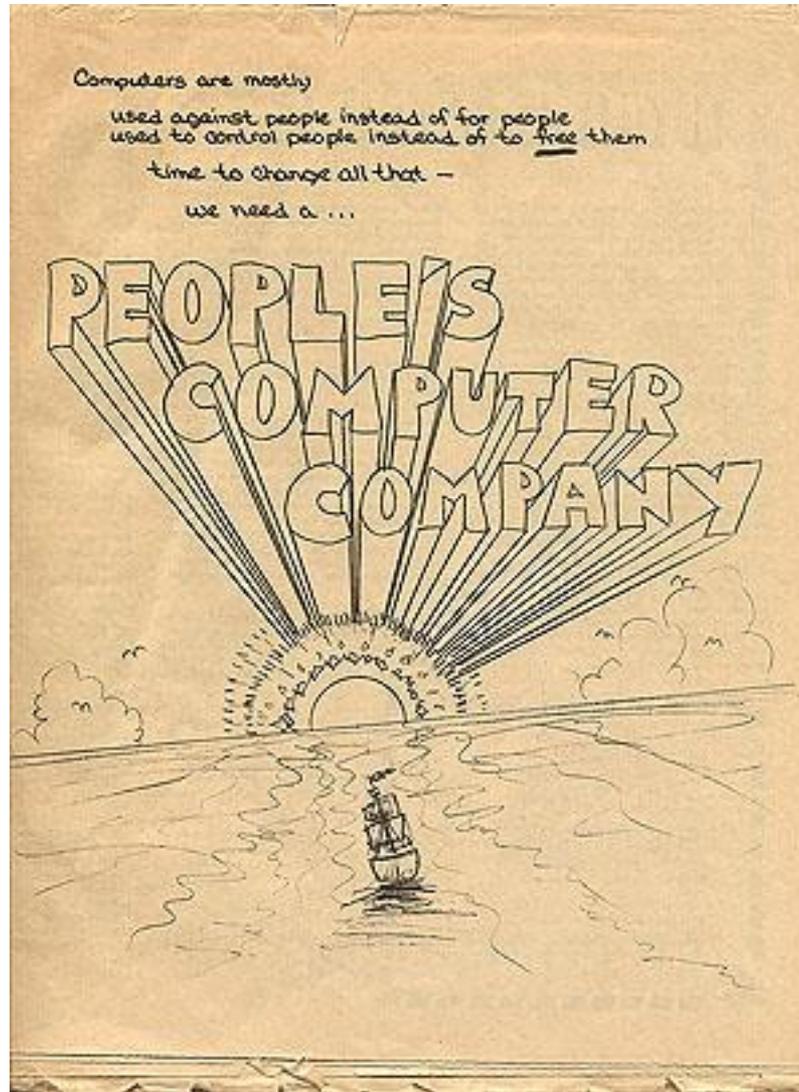
Antecedents to the Personal Computer (1 of 2)

- Whole Earth Catalog, between 1968 and 1972
  - DIY catalogs, focused on product reviews
  - "Sort of like Google in paperback form" (Steve Jobs)
  - Stewart Brand saw "technology as a tool for individual and collective transformation" (Fred Turner)

- People's Computer Company
  - Educated people on how to use computers
    - Publish code listings, mostly for games
  - Their center rent terminals to people to connect to time-share computers
  - Teenagers were drawn to computing through Friday evening game-playing sessions
  - Culture promoted free exchange of software

November-December 1978 People's Computers

Computers are mostly

used against people instead of for people
used to control people instead of to _free_ them

time to change all that —

we need a . . .

PEOPLE'S COMPUTER COMPANY

People's Computer Company Issue #1 - October 1972!

November 1975 People's Computer Company edition

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Antecedents to the Personal Computer

- Homebrew Computer Club
  - Meeting place for hobbyists interested in building personal computers out of microprocessors

  - Steve Wozniak created system that became Apple I

**March 5, 1975:** The Homebrew Computer Club, a hobbyist group that will help spark the personal computing revolution, holds its first meeting in Menlo Park, California.

Steve Wozniak and Steve Jobs With Apple 1 Personal Computer

Steve Jobs (right) convinced Steve Wozniak (left) they should go into business selling the personal computer Wozniak designed. They named their company Apple Computer. (Kimberly White/Reuters)

Personal Computer
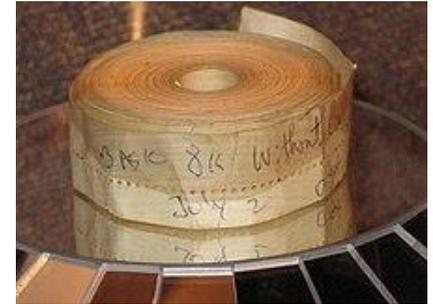
- Altair 8800 by the company MITS
  - Gates and Allen created BASIC interpreter (MicroSoft)
  - Interpreter pirated at Homebrew Computer Club meeting
  - Distributed 70x copies of tape of BASIC next day
    - Computer $395-495, Software $500
  - "An Open Letter to Hobbyists" to express frustration about unauthorized copying of software

- Personal computers became popular
  - Tandy Corporation: TRS 80
  - Apple Computer: Apple II

JOSH MARTIN

Altair computer $395-495
BASIC $500

"Less than 10% of Altair owners had purchased BASIC"

"The royalties Micro-Soft had received made the time spent on the software **worth less** than $2 an hour"

".. the **theft** … created very little incentive for his company to release new product"

February 3, 1976

An Open Letter to Hobbyists

To me, the most critical thing in the hobby market right now is the lack of good software courses, books and software itself. Without good software and an owner who understands programming, a hobby computer is wasted. Will quality software be written for the hobby market?

Almost a year ago, Paul Allen and myself, expecting the hobby market to expand, hired Monte Davidoff and developed Altair BASIC. Though the initial work took only two months, the three of us have spent most of the last year documenting, improving and adding features to BASIC. Now we have 4K, 8K, EXTENDED, ROM and DISK BASIC. The value of the computer time we have used exceeds $40,000.

The feedback we have gotten from the hundreds of people who say they are using BASIC has all been positive. Two surprising things are apparent, however. 1) Most of these "users" never bought BASIC (less than 10% of all Altair owners have bought BASIC), and 2) The amount of royalties we have received from sales to hobbyists makes the time spent of Altair BASIC worth less than $2 an hour.

Why is this? As the majority of hobbyists must be aware, most of you steal your software. Hardware must be paid for, but software is something to share. Who cares if the people who worked on it get paid?

Is this fair? One thing you don't do by stealing software is get back at MITS for some problem you may have had. MITS doesn't make money selling software. The royalty paid to us, the manual, the tape and the overhead make it a break-even operation. One thing you do do is prevent good software from being written. Who can afford to do professional work for nothing? What hobbyist can put 3-man years into programming, finding all bugs, documenting his product and distribute for free? The fact is, no one besides us has invested a lot of money in hobby software. We have written 6800 BASIC, and are writing 8080 APL and 6800 APL, but there is very little incentive to make this software available to hobbyists. Most directly, the thing you do is theft.

What about the guys who re-sell Altair BASIC, aren't they making money on hobby software? Yes, but those who have been reported to us may lose in the end. They are the ones who give hobbyists a bad name, and should be kicked out of any club meeting they show up at.

I would appreciate letters from any one who wants to pay up, or has a suggestion or comment. Just write me at 1180 Alvarado SE, #114, Albuquerque, New Mexico, 87108. Nothing would please me more than being able to hire ten programmers and deluge the hobby market with good software.

Bill Gates
Bill Gates
General Partner, Micro-Soft

Personal Computer

- Businesses drawn to personal computers
  - Computer spreadsheet program: VisiCalc (visible calculator), the killer application for the Apple II
    - Turning the microcomputer from a hobby for computer enthusiasts into a serious business tool
  - IBM launches IBM PC
    - Make its PC an open architecture, system was built from off-the-shelf parts, other companies could manufacture clones
   - Making it the dominant personal computer architecture

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1.2 Milestones in Networking

Early Networking: Semaphore Telegraph Tower

In 1790s, when France was at the brink of a revolution. This was a period of considerable unrest. People were rioting in the streets, and the monarch was at war with several of its neighbors. A system was needed that would allow the French government to send and receive intelligence in the shortest time possible.
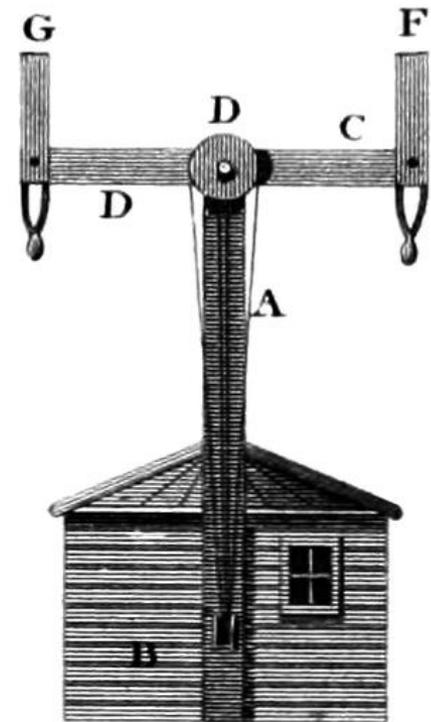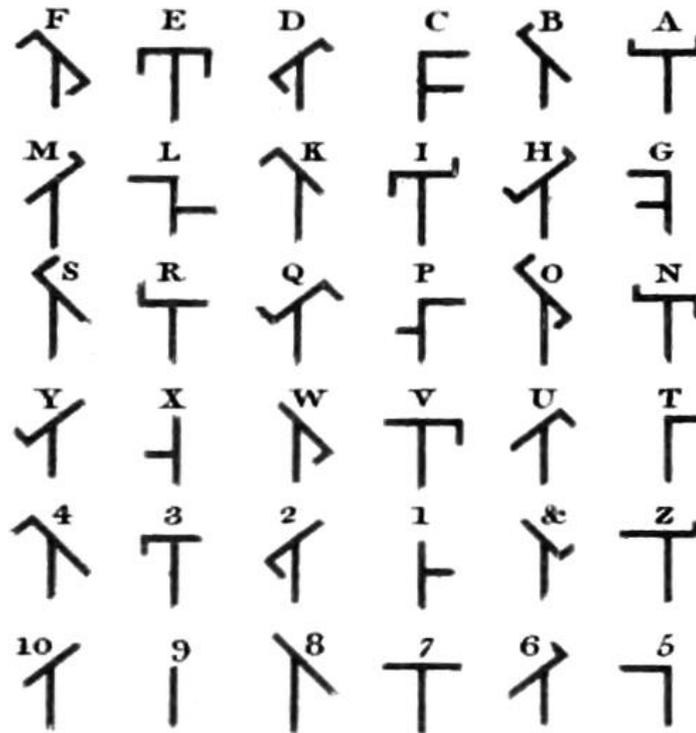
Full story at:

https://www.amusingplanet.com/2017/01/semaphore-worlds-first-telegraph.html
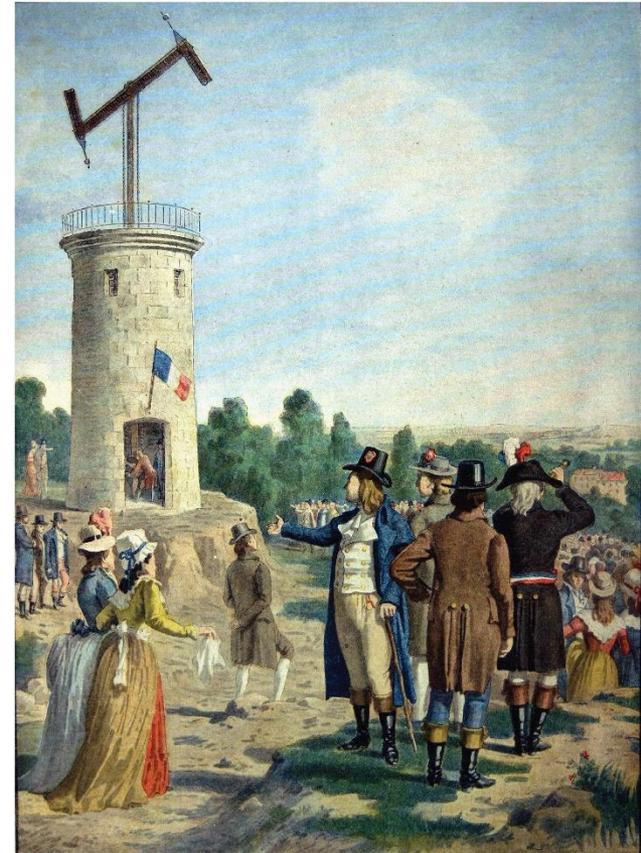
A semaphore telegraph tower on the first line from Paris to Lille (1794). (Interfoto/Alamy)

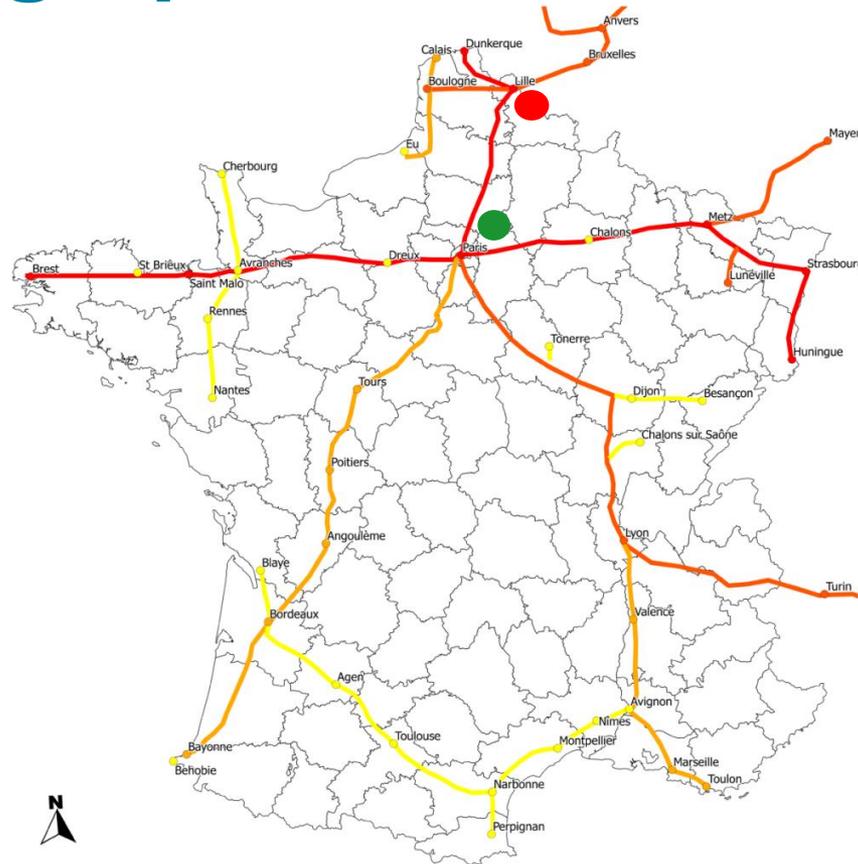# 196 Different Symbols Can be Transmitted by the Semaphore Tower

Claude Chappe

Semaphore Telegraph Lines Across France

- Each tower was placed 20 miles apart.
- A skilled operator could send 3 symols in a minute.
- At good visible days, a symbol sent over distance of 200 km (Paris to Lille) took 9 minutes!

The semaphores were so successful that the French government initially rejected Samuel Morse's electrical telegraph. The semaphore telegraph remained operational in France until 1852.
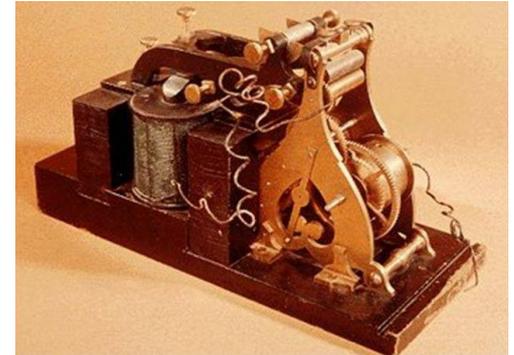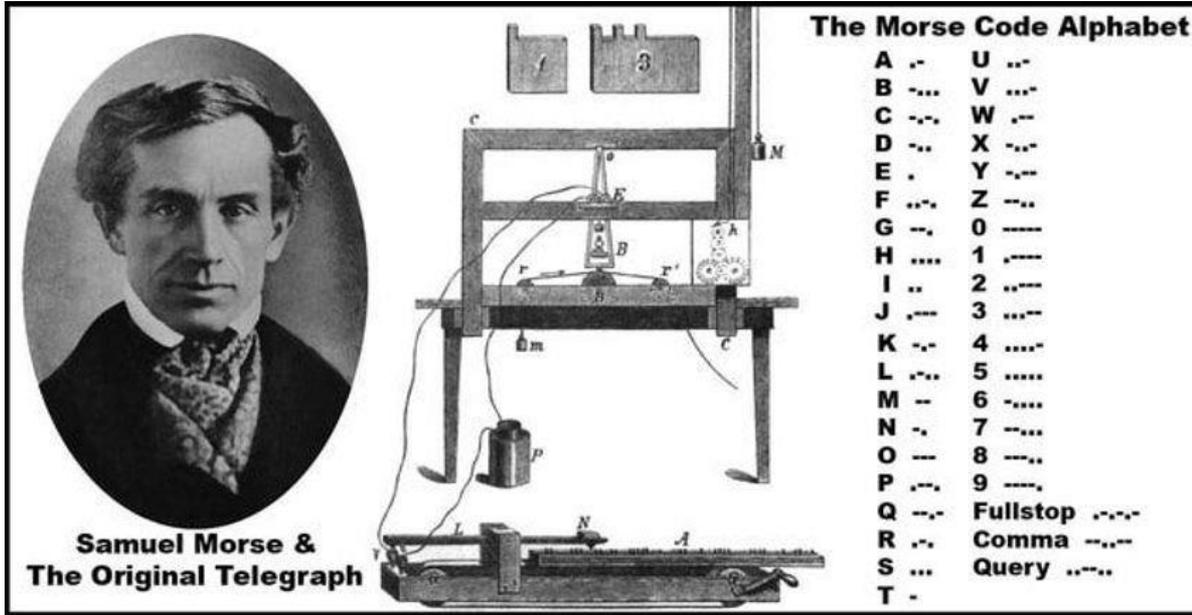

Le réseau Chappe en France

Directions (date de création)
- 1793-1800
- 1800-1815
- 1815-1830
- Après 1830

Lignes (date de création)
- 1793-1800
- 1800-1815
- 1815-1830
- Après 1830

Telegraph – A machine that could send messages long distances across wires

Telegraph

- U.S. government funded first line
  - 40 miles from Washington, D.C. to Baltimore
  - Built by Samuel Morse in 1843-1844

- Private networks flourished
  - 12,000 miles of lines in 1850
  - Transcontinental line in 1861 put Pony Express out of business
  - 200,000 miles of lines by 1877

Read the story at: https://www.loc.gov/collections/samuel-morse-papers/articles-and-essays/invention-of-the-telegraph/

Impact of Telegraph
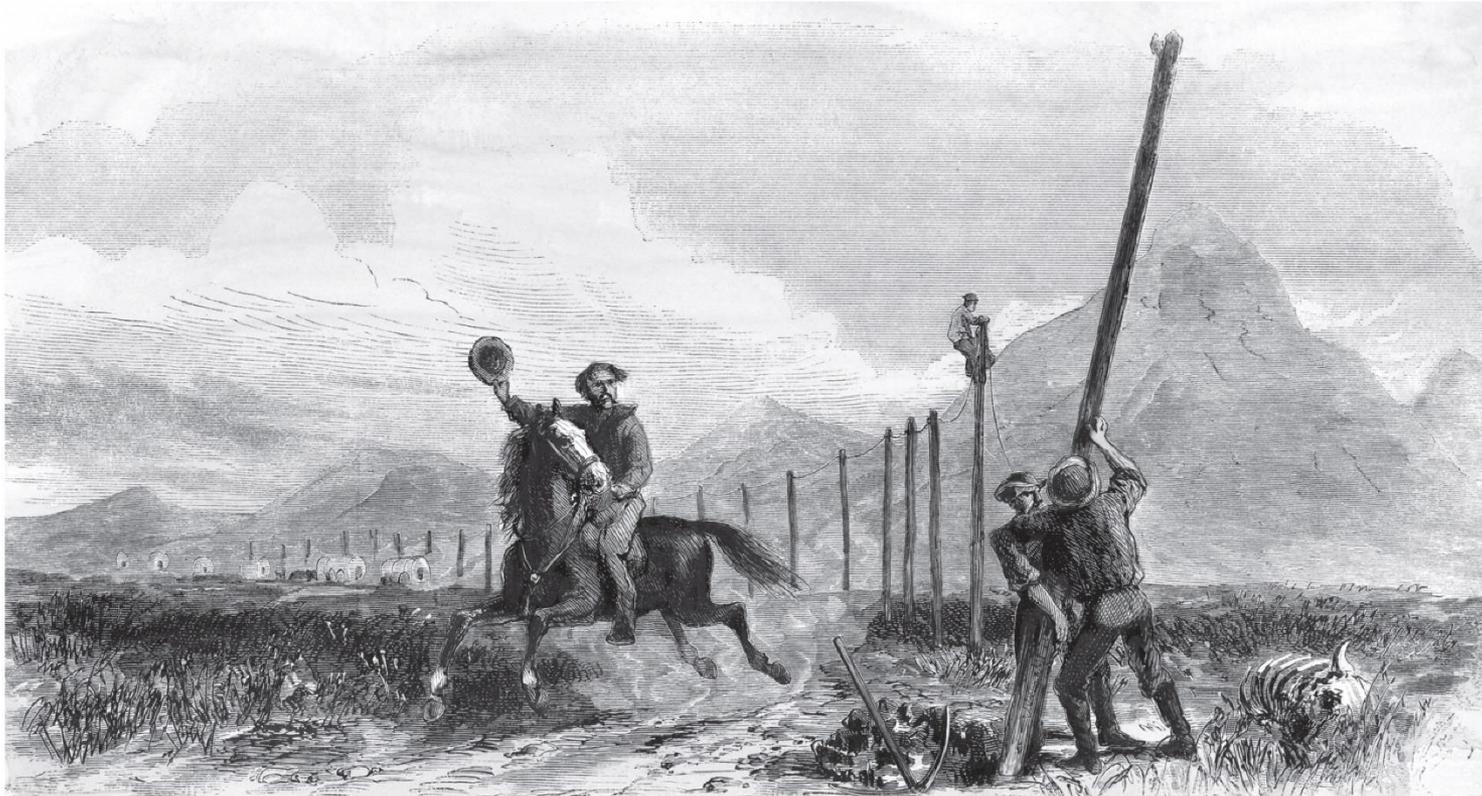
Pony Express riders lost their jobs when the US transcontinental telegraph line was completed in 1861. (North Wind Picture Archives / Alamy)

Telegraph

- Technology proved versatile
  - Fire alarm boxes
  - Police call boxes

When a person pulled the lever of the alarm box, it automatically sent a message identifying its location to a fire station.

THE NEW FIRE-ALARM TELEGRAPH—SIGNAL-BOX.—[SEE PAGE 247.]
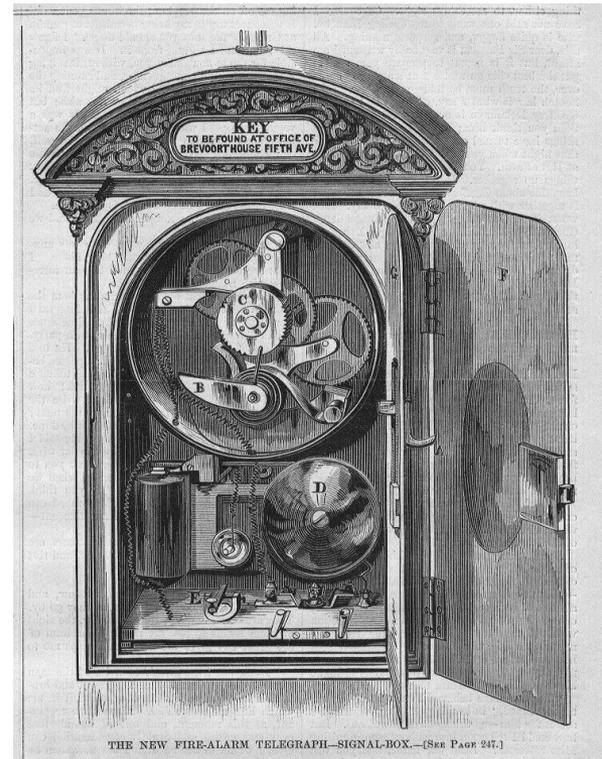
FIRE-ALARM TELEGRAPH-SIGNAL-BOX 1870 FIRE DEPARTMENT ALARM KEY AT BREVOORT HOUSE

Pearson

Telephone

- Alexander Graham Bell, Edinburgh, Scotland
  - Constructed the first telephone
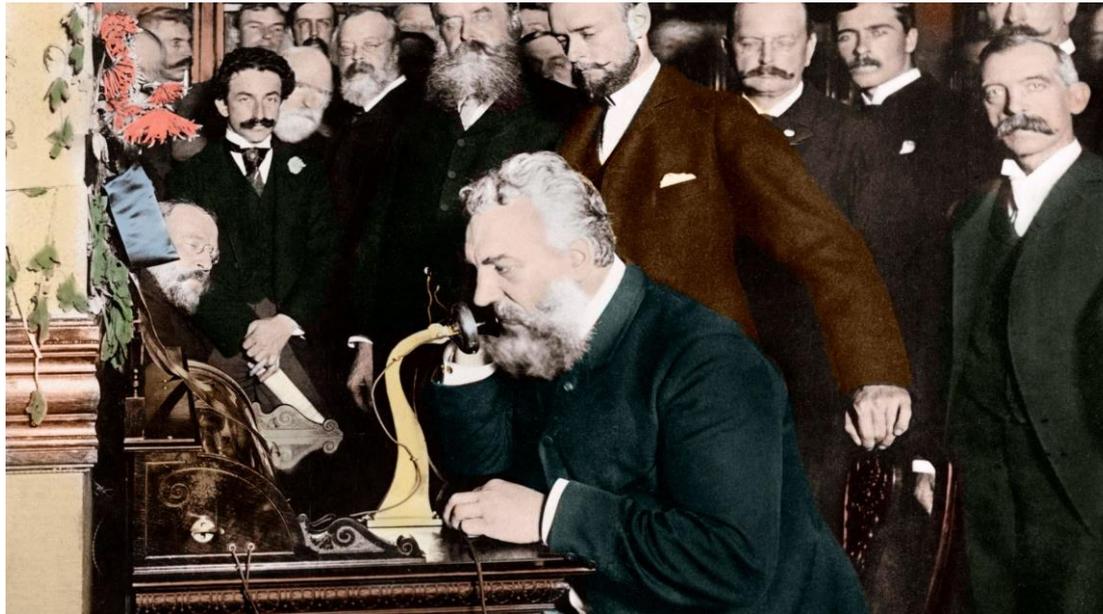
https://youtu.be/oJ8Kkgf4J3Y?si=MRaH-x8FNCOEqSyM   1:38-2:45
4:13 -

Telephone

- Alexander Graham Bell and Thomas A.Watson succeeded in transmitting speech electronically in 1876.

- Installing a phone was expensive! After Bell's first patent expired, the home-use phones increased rapidly.

- Once telephones were placed in the home, the traditional boundaries between private family life and public business life became blurred.

- People also worried about the loss of privacy: in 1877 the *New York Times* reported that telephone workers overheard many confidential conversations.

Social Impact of Telephone

- Blurred public life / private life boundary

- Eroded traditional social hierarchies

- Reduced privacy

Radio

- Pioneers
  - Scottish physicist James Clerk Maxwell published a mathematical theory showing relationship between electricity and magnetism.
  - German physicist Heinrich Hertz successfully generated electromagnetic waves in 1885
  - Italian engineer Guglielmo Marconi invented radio in 1895

- First used in business
  - Wireless telegraph
  - Transmit voices

- Entertainment uses
  - Suggested by the Russian in US, David Sarnoff, suggested the use of radio as an entertainment device.
  - Important entertainment medium by 1930s

Power of Radio

- The power of radio as a medium of mass communication was demonstrated on the evening of Oct 30, 1938 (night before Halloween).

- From CBS Radio Studio One in NYC, Orson Welles on air an one-hour radio drama "War of the Worlds" as a fake news bulletins……

Orson Welles (arms raised) rehearses his radio depiction of H.G. Wells' classic, *The War of the Worlds*. The broadcast, which aired on October 30, 1938, and claimed that aliens from Mars had invaded New Jersey, terrified thousands of Americans. © Bettmann/CORBIS

https://www.youtube.com/watch?v=OzC3Fg_rRJM (9:05-10:10; 10:28-)
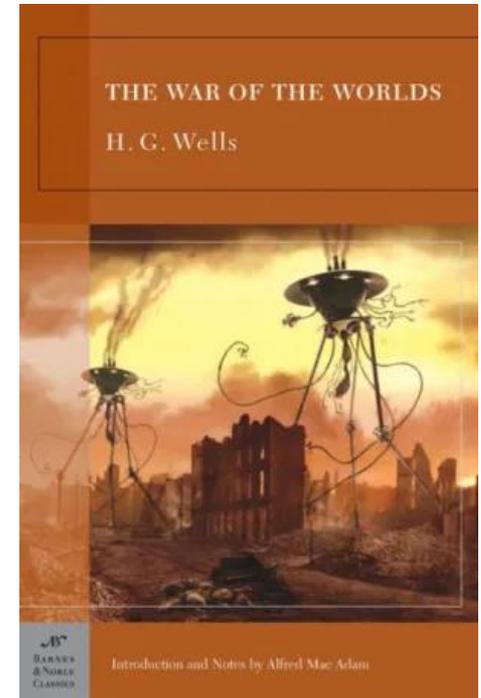
Power of Radio

- "…events occurring on a farm near New Jersey, a creature emerging from an alien spacecraft, incinerating people, releasing posion gas. "

- The drama used the "breaking news" style of storetelling, making many listeners believed and panicked!


Orson Welles explaining to reporters that he had not intended to cause panic. But is this the truth?

Television

- Became popular in 1950s
    - Price fell dramatically
    - Number of stations increased

- Social effects
    - Worldwide audiences
    - Commercial broadcast TV networks strive to be first to deliver news
   - Impact of incorrect information

Hundreds of Millions Watch Moon Landing in 1969
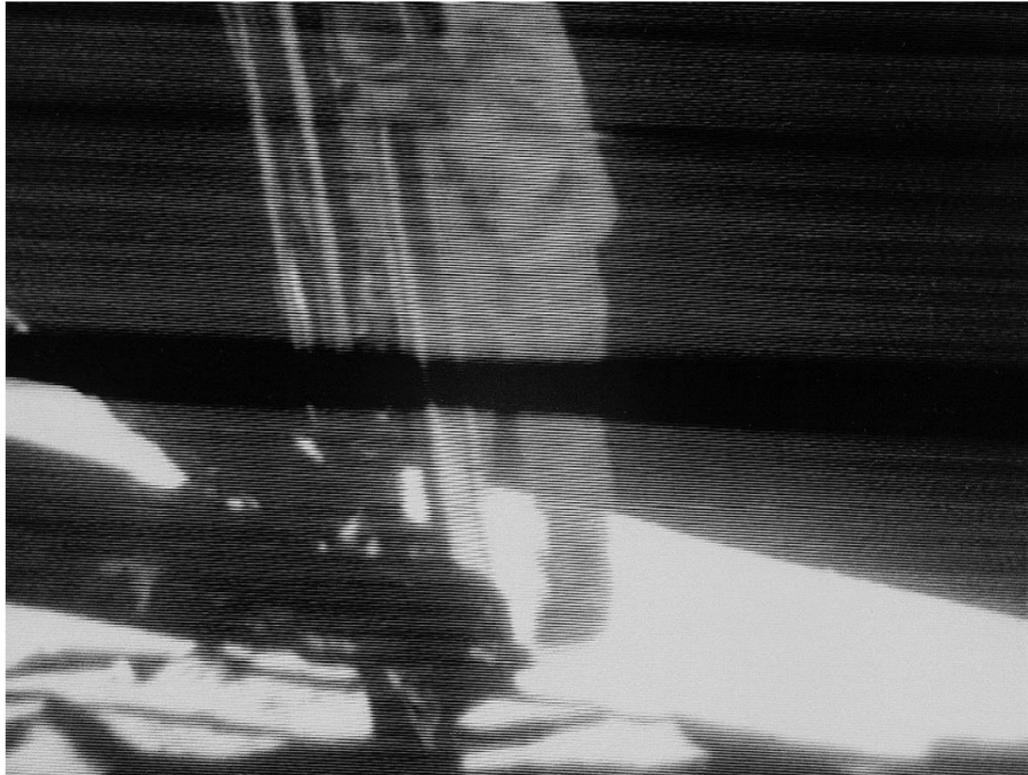
On July 20, 1969, television images of Neil Armstrong walking on the Moon were broadcast to hundreds of millions of viewers around the world. (Courtesy of NASA)

Remote Computing

- Stibitz and Williams built a Complex Number Calculator (CNC) at Bell Labs (part of AT&T, phone company)

- Allowed operator to be distant from machine

- Long-distance demonstration between New Hampshire and New York City in Sep 11, 1940
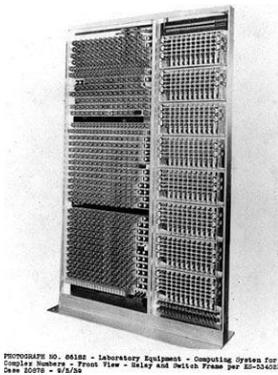
CNC at Bell Labs, New York City

A typist entered problems suggested by attendees at the American Mathematical Society meeting at Dartmouth, New Hampshire.

ARPANET
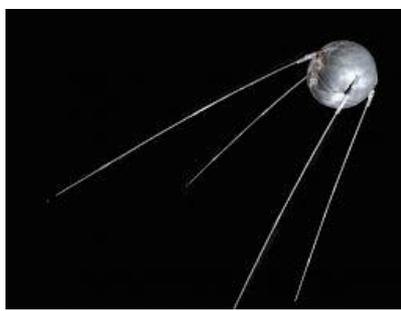
- In response to the launch of **Sputnik** by the Soviet Union in 1957, DoD created *Advanced Research Projects Agency Network* (ARPA) in late 1950s

- Aim for a global network that would facilitate the exchange of programs and data.
  - Conventional telephone network was not a good foundation for data transmission.
  - Decentralized design to improve survivability

- In 1967, ARPA initiated construction of ARPANET: Packet-switching replaced circuit switching

Circuit-Switched vs Packet-Switched Networks
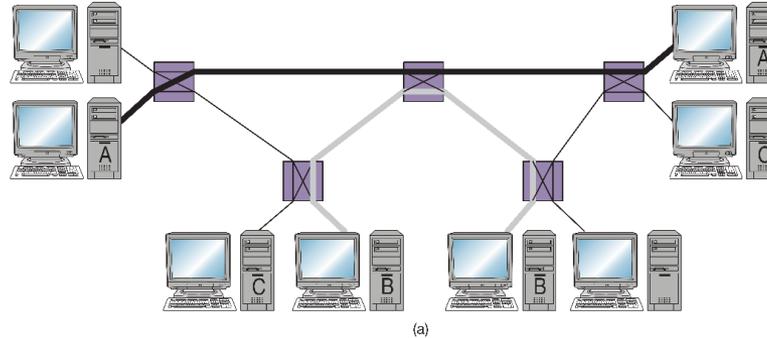
(a)
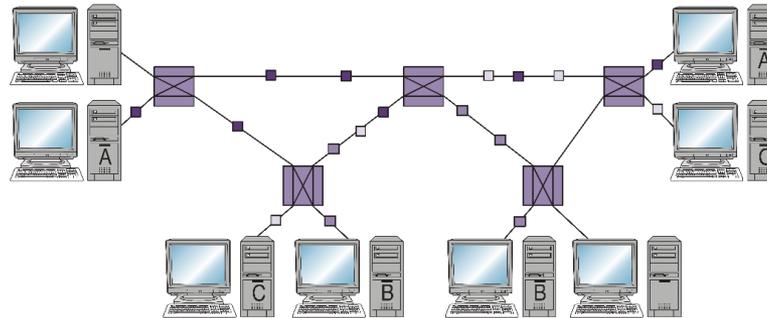
(b)

Comparison of circuit–switched networking and packet-switched networking. (a) In a **circuit-switched network**, a single physical connection is established between the two ends. The physical connection cannot be shared. In this illustration, one circuit links the two computers labeled A, and another circuit links the two computers labeled B. The computers labeled C may not communicate at this time, because no circuit can be established. (b) In a **packet-switched network**, a message is divided into small bundles of data called packets. Every packet has the address of the computer where it should be routed. If there is more than one path from the message source to the message destination, different message packets may take different routes. Packets from different messages may share the same wire. In this illustration, three pairs of computers (labeled A, B, and C) are communicating simultaneously over a packet-switched network.

Compar

Email

- Data can be transferred via ARPANET, but people still communicated via telephone.

- Creation
  - 1972, Ray Tomlinson wrote software to send, receive email messages
  - Lawrence Roberts created the "killer app" email utility

- Current status
  - One of world's most important communication technologies
  - Billions of messages sent daily worldwide

Internet

- The need to connect ARPANET with other networks based on different designs

- Robert Kahn conceived of open architecture networking, TCP/IP protocol, used in the Internet (network of networks)
  - TCP: Dividing a message into packets at the sending computer & resembling at the receiving computer
  - IP: rules to route data

- Jan 1, 1983, the birth date of the Internet, on which all ARPANET hosts converted to TCP/IP

Broadband

- Broadband
  - High-speed Internet connection
  - Makes feasible transfer of very large files (e.g., video)
  - Growth in file-swapping parallels growth in broadband

- Fastest countries (median download speeds, Oct 2025)
  - Singapore (#1): 406 Mbps
  - Chile (#2): 360 Mbps
  - HK (#3): 343 Mbps
  - Macau (#6): 314 Mbps

Cloud Computing

- Cloud computing: utilization of remote computing resources over Internet

- Enablers of cloud computing
  - High-speed networks
  - High-performance, low-cost microprocessors
  - **Virtualization**: software allowing a single physical computer to emulate many virtual computing devices

- Advantages of cloud computing
  - Massive data centers have an economy of scale
  - Users gain flexible use of computing resources

Cloud Computing (2 of 2)

- Software as a service

  – Use of remote computing resources to deliver applications to user

  – Microsoft Office 365, for example

- Infrastructure as a service

  – Use of remote storage and computational resources on a pay-as-you-go basis

  – Examples: Amazon Web Services, Microsoft Azure, Google Cloud Platform, IBM Cloud

1.3 Milestones in Information Storage and Retrieval

Greek Alphabet

- True alphabet: letters for both consonant and vowel sounds

- 750 BC: Greeks developed first true alphabet with 24 characters

- Simple, efficient way of transforming spoken words into written form

- Oral culture transitioned to written culture

- English is a direct descendant of the ancient Greek alphabet

Codex and Paper

- Codex
  - Rectangular pages sewn together on one side
  - Replaced papyrus scrolls as way of storing books
  - Allowed quicker access to particular passages
  - First produced by hand, then by wood engraving

- Paper
  - Invented by Chinese, brought to Europe in late Middle Ages
  - By 15th century replaced parchment for pages in less expensive codices

Papyrus scrolls

Roman Codex

Gutenberg's Printing Press

- Based on movable metal type

- Church principal customer of early publishers

- Powerful mass communication tool

- Printing press's impact on Reformation

  – More than 300,000 copies of Luther's publications

  – Protestants out-published Catholics by 10-to-1 in the middle 16th century

Newspapers

- Newspapers: Stimulated free expression

- Governments responded
  - Licensing
  - Censorship

- Impact on American Revolution
  - Newspapers helped unify colonies
  - Swayed public opinion toward independence

   https://www.youtube.com/watch?v=Y9GiS88ZMh8

Vannevar Bush's Visionary Essay: As We May Think (July 1945)

- Vannevar Bush, an American engineer, Vice President of MIT, inventor, director of US Scientific Research and Development Office and Chief of NSF

- He pointed out it is difficult for people to retrieve information, there is a need of "collective memory machine"

- "How can technology contribute to the wellbeing of humanity?"

- Premise: Human knowledge is a set of connected knowledge, and has a universal dimension that cannot be limited to the life of an individual.

MEMEX

- "Memory extender"

- An information retrieval system

- Form of a mechanical desk with a microfilm archive inside, storage of all books and documents

- Can move the next page and scroll more pages

- Operate by association, from one item snaps instantly to the next associated one

https://www.redhotcyber.com/en/post/vannevar-bushs-visionary-essay-as-we-may-think/
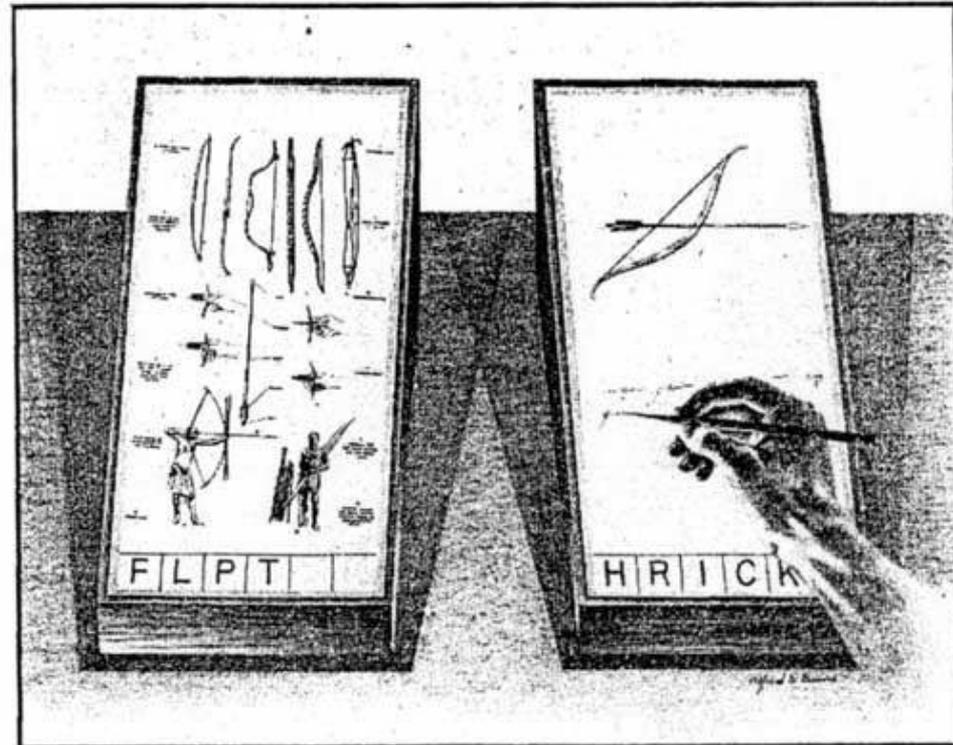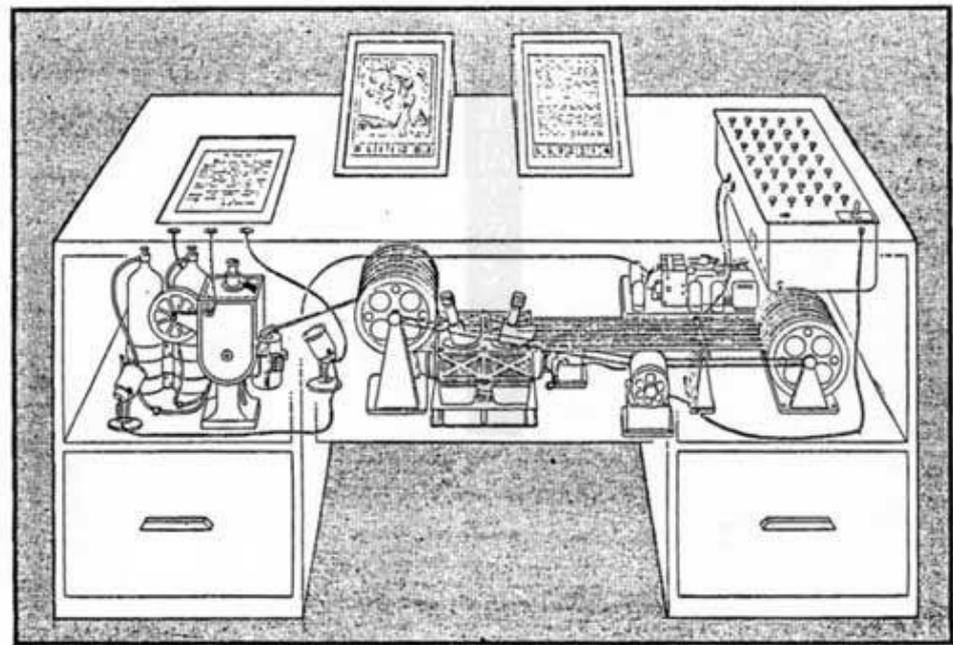
Hypertext

- Ted Nelson, sociology student at Harvard University
  - Coined word **hypertext**, refers to a linked network of nodes containing information

- Douglas Engelbart, EE, UCB, Stanford Research Institute
  - "How can my career maximize my contribution to mankind?"
  - Directed construction of NLS (oNLine System)
  - Demonstrated windows, email, mouse, videoconferencing

Douglas Engelbart Rehearses for "the Mother of All Demos" (1968)
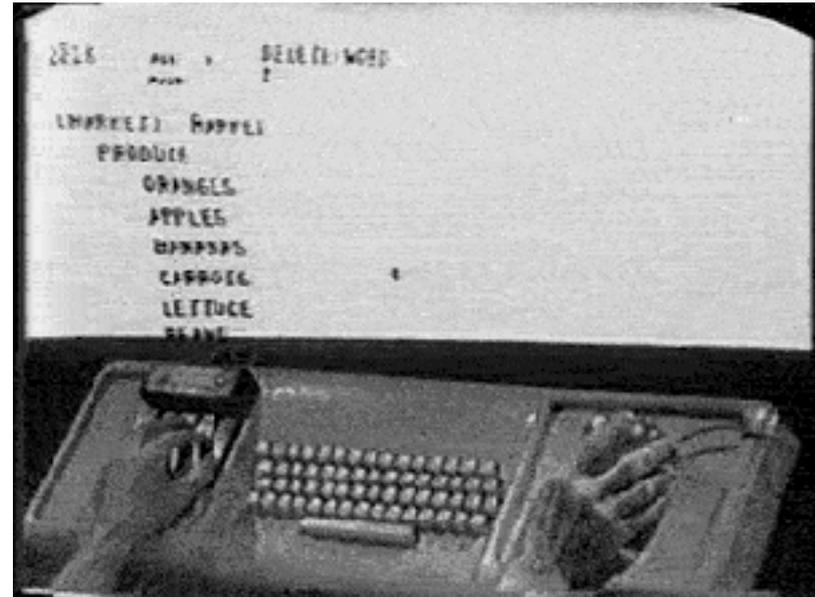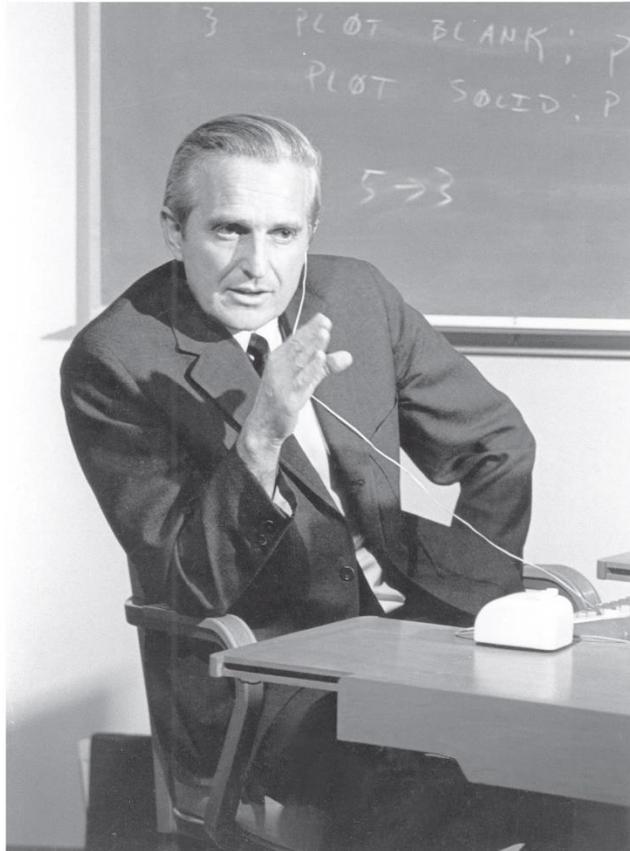
Douglas Engelbart rehearses for his presentation at the 1968 Fall Joint Computer Conference. It is still called "**the mother of all demos**." (PVDE/Bridgeman Images)

https://www.youtube.com/watch?v=UhpTiWyVa6k

Graphical User Interface (1 of 2)

- Xerox PARC (Palo Alto Research Center)
  - Alan Kay saw Doug Engelbart demo in 1968
  - Alto personal computer (early 1970s)
  - Bit-mapped display, keyboard, and mouse
  - But failed to market a commercial personal computer

- Apple Computer
  - Steve Jobs visited Xerox PARC in 1979
 - Macintosh (1984)
  - Bit-mapped display, keyboard, and mouse

Graphical User Interface

- Microsoft Windows 3.0 for IBM PCs (1990)
  - Released in May 1990
  - Quickly became dominant graphical user interface

Pearson
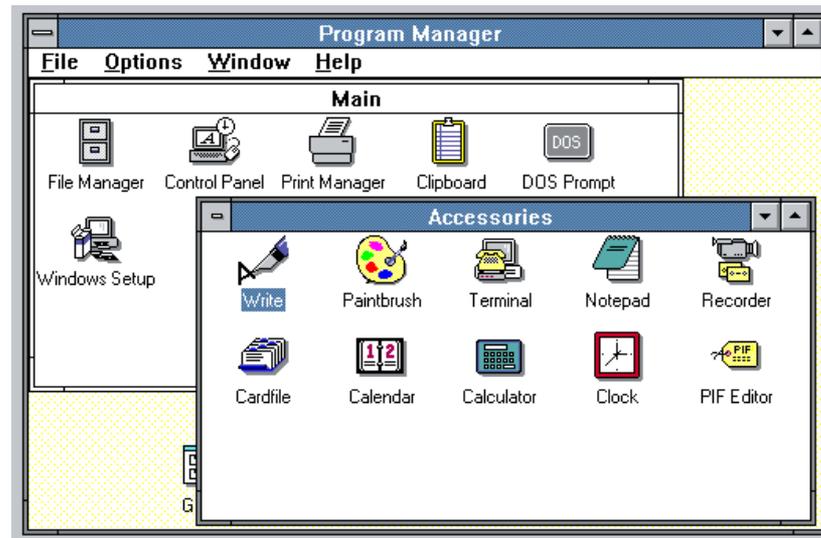
Networked Hypertext: World Wide Web

- First browser built at CERN in Switzerland
  - Tim Berners-Lee: **WorldWideWeb** (1990)
  - Berners-Lee created Web protocols
  - Protocols based on TCP/IP → general

- Mosaic, first widely used browser, developed at U. Illinois
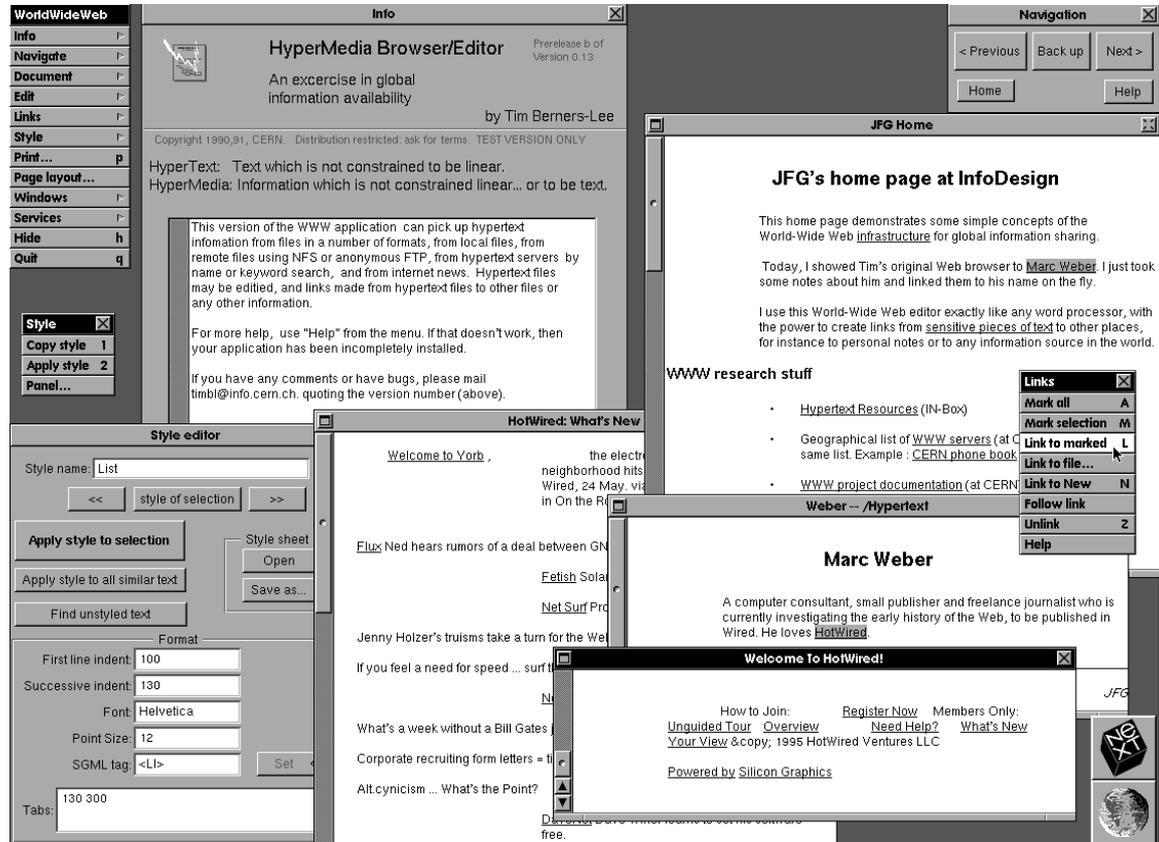
Search Engines

- Search engine
  - Accepts list of keywords from user
  - Searches a database of documents
  - Returns documents most closely matching keywords

- Today, "search engine" usually refers to programs that search databases of Web pages
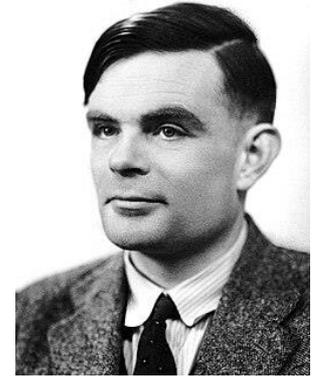
Search Engines

- Google's search engine indexes hundreds of billions of Web pages

- Google's Book Search allows searches of full text of millions of books

- PageRank
  - Key to high precision of Google search engine
  - Measures importance, quality of web page by number and quality of pages that link to it

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Cloud Storage

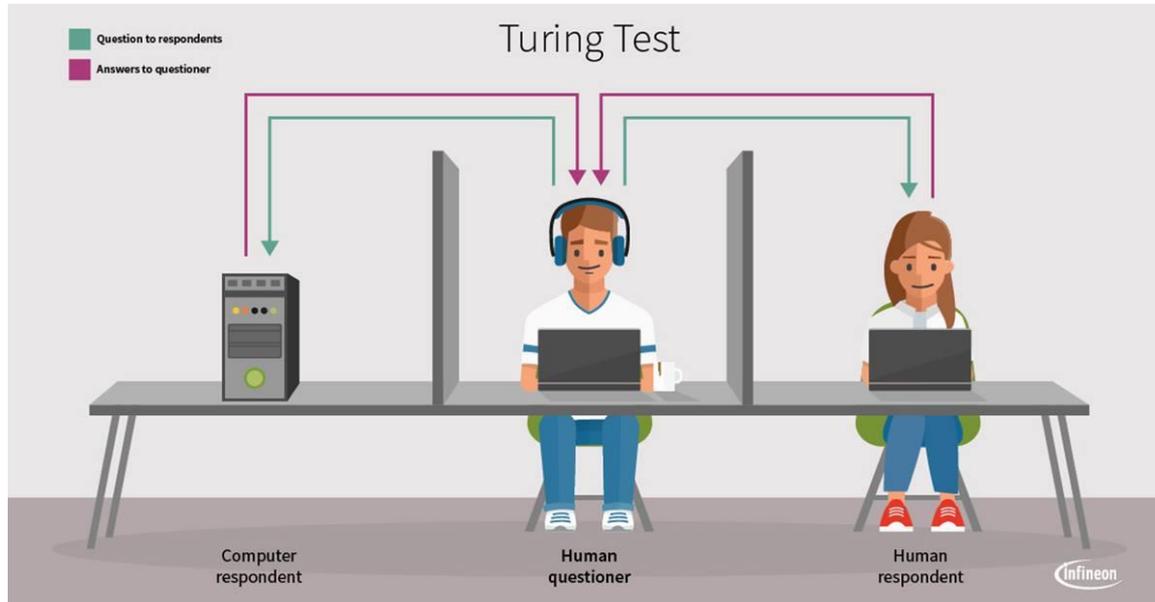- Cloud storage: Storing data remotely on Internet-accessible servers

- Examples of cloud storage services: Dropbox, Box, Google Drive, iCloud from Apple, Amazon Drive, Mega, pCloud

- Simplifies accessing files from multiple devices

- Simplifies file sharing

- Provides massive data storage at a relatively low price

- Provides automatic backups of data

1.4 Milestones in Artificial Intelligence

Can Machines Think? (1950)

Turing Test

Question to respondents
Answers to questioner

Computer respondent   Human questioner   Human respondent

Alan Turning
The "Father of
Computer Science"

Pearson

Birth of AI (1956)

- The Dartmouth Workshop is a two-month conference which laid the groundwork for AI research.

- Explored topics such as problem-solving, learning, and language processing, setting the stage for future advancements in the field.

- Founding AI as an academic discipline.

John McCarthy: "Every aspect of learning or any other feature of intelligence can be so precisely described that a machine can be made to simulate it"

https://www.youtube.com/watch?v=eSj80Zr6TEE

https://home.dartmouth.edu/about/artificial-intelligence-ai-coined-dartmouth

https://medium.com/higher-neurons/10-historical-milestones-in-the-development-of-ai-systems-b99f21a606a9

The Perceptron (Frank Rosenblatt, 1957)

- Pioneering work introduced the concept of perceptrons: single-layer neural networks capable of learning and making decisions

perceptron

neuron
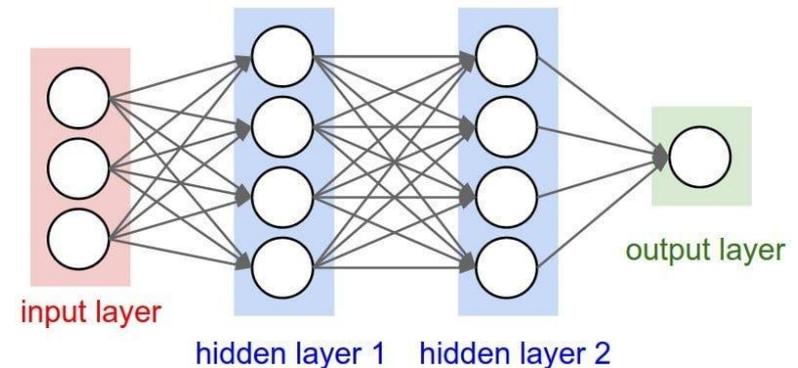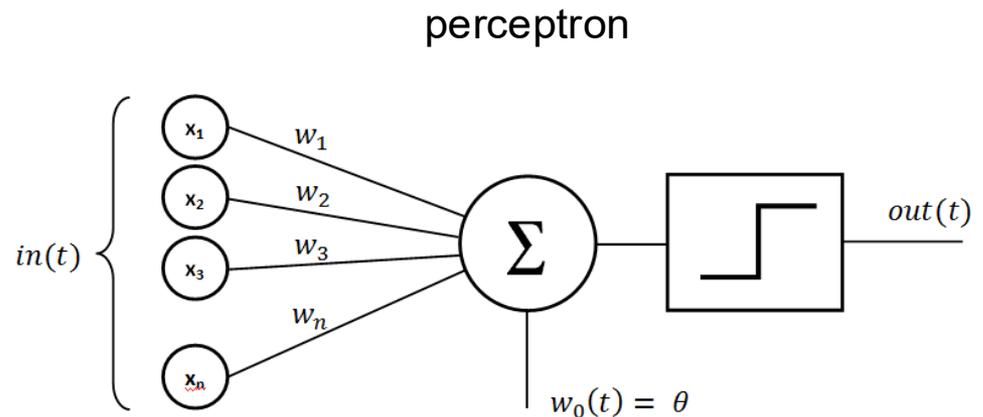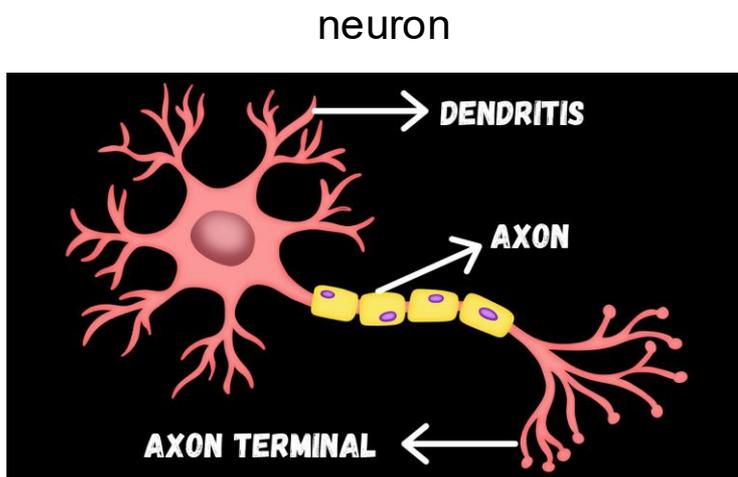
ELIZA (Joseph Weizenbaum, 1966)

- Chatbot that simulated human conversation

- Showcased potential for natural language processing in AI

- Machine can generate human-like response

```
Welcome to
                EEEEEE  LL        IIII   ZZZZZZ   AAAAA
                EE      LL         II        ZZ  AA    AA
                EEEEE   LL         II       ZZZ   AAAAAAA
                EE      LL         II     ZZ      AA    AA
                EEEEEE  LLLLLL   IIII ZZZZZZ      AA    AA

Eliza is a mock Rogerian psychotherapist.
The original program was described by Joseph Weizenbaum in 1966.
This implementation by Norbert Landsteiner 2005.


ELIZA: Is something troubling you ?
YOU:   Men are all alike.
ELIZA: What is the connection, do you suppose ?
YOU:   They're always bugging us about something or other.
ELIZA: Can you think of a specific example ?
YOU:   Well, my boyfriend made me come here.
ELIZA: Is it important to you that your boyfriend made you come here ?
YOU:   He says I'm depressed much of the time.
ELIZA: I am sorry to hear that you are depressed.
YOU:   It's true. I am unhappy.
ELIZA: Can you explain what made you unhappy ?
YOU:
```
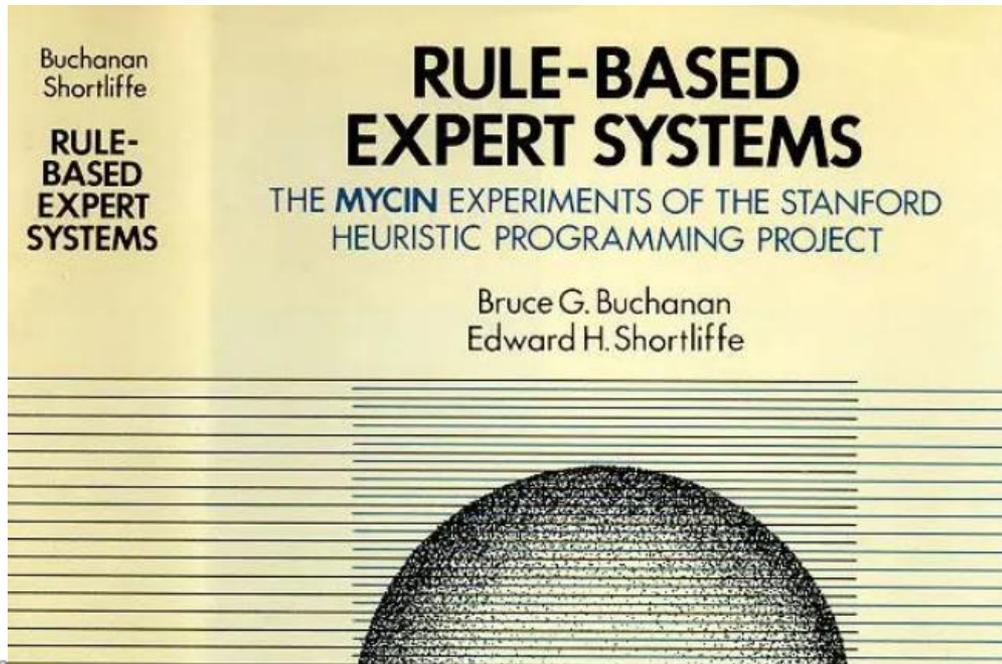
First AI Winter …
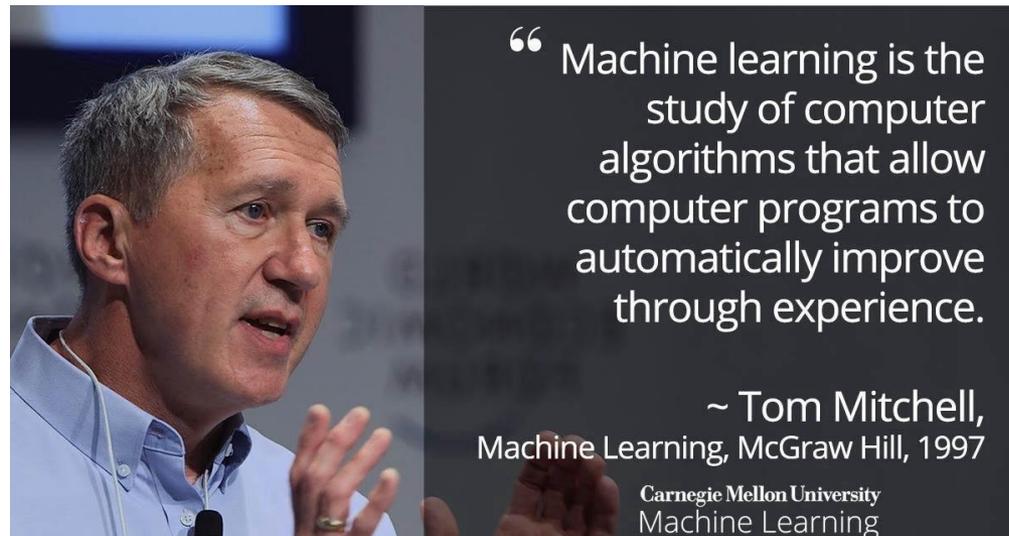
The Expert Systems Era (1970-1980s)

- Rule-based reasoning to mimic human expertise in specific domains

- Expert systems provided practical business value, renewed industry investment

- E.g., MYCIN, from Stanford University, a medical expert for infectious disease prediction

Second AI Winter …

Machine Learning

- "A scientific discipline that explores the construction and study of algorithms that can learn from data."

- Bring the concept of data-driven algorithms, enabling systems to adapt and improve their performance over time

- Shift from symbolic AI to machine learning approaches

> " Machine learning is the study of computer algorithms that allow computer programs to automatically improve through experience.
>
> ~ Tom Mitchell,
> Machine Learning, McGraw Hill, 1997

Carnegie Mellon University
Machine Learning

Deep Blue (1997)

- The historic chess match between Deep Blue (Win), an IBM supercomputer, and the world chess champion Garry Kasparov (Russian chess grandmaster)

- A machine can outperform a human in a complex game

Other Milestones

- LeNet – first practical CNN (Yann LeCun, 1989)

- Deep learning's layer-by-layer training breakthrough (Geoffrey Hinton, 2006)

- Generative Adversarial Networks, GANs (Ian Goodfellow, 2014)

- AlphaGo beats Lee Sedol in Go (Alphabet, 2016)

- Transformers and Natural Language Processing (Vaswani, 2017)

- AlexNet ImageNet victory (2021)

- OpenAI's GPT-3 (2020), ChatGPT (2022)

- AlphaFold2 solves protein structure prediction (2020)

- DALL-E (OpenAI, 2022)

1.5 Information Technology Issues

Information Technology

- Definition of information technology:
  - Devices used in creation, storage, manipulation, exchange, and dissemination of data, including text, sound, and images

- Examples
  - Tablets, smartphones, laptop computers

- People making greater use of IT
  - Costs keep falling
  - Capabilities keep rising

IT Issues

- Pirating copyrighted content
    - Digitization → perfect copies of content
    - Internet → fast, inexpensive distribution
    - Result: illegal downloading
    - 1st episode of season 5 of **Game of Thrones** illegally downloaded more than 1 million times in U.S.
    - Three-quarters of Chinese users of Microsoft products do not have properly licensed software
    - What are reasonable intellectual property rights in the Information age? Do the laws need to change? How must businesses adapt?

IT Issues

- Cloud storage services
  - Convenient to store all kinds of data, access from multiple devices, and share with others
  - Will data be safely stored and secure from hackers?

- Credit cards
  - Convenience over cash and checks
  - Increases possibility of identity theft
  - Who owns information about transactions (e.g., the client's spending habit)?

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IT Issues

- Loan applications
  - Based on credit history, not personal interview
  - What are the advantages and disadvantages?

- Computers in embedded devices
  - When systems fail and harm humans, who should be liable?

- Employees use IT devices in their work
  - Companies can monitor their actions closely
  - Web visited, email sent & received, keystrokes per minutes
 - How such monitoring affect the workplace? Does it create unacceptable level of stress?

IT Issues

- Improved global communication network, decentralized IT industry landscape
  - Allows companies to sell to entire world
  - Allows companies to move jobs out of U.S.
  - Should consumers be concerned about working conditions in factories in developing countries?

- Social media
  - Anyone can share information easily
  - They can generate and spread fake news
  - Does it strengthen democratic ideas or undermine them?

Summary (1 of 2)

- We are living in Information Age, but information technology has a long history

- Today's devices are culmination of centuries of incremental progress

- Social conditions give rise to new technologies

- Adoption of technologies can change society

- Computing professionals have a responsibility to be thoughtful about their role in creating the future

Summary
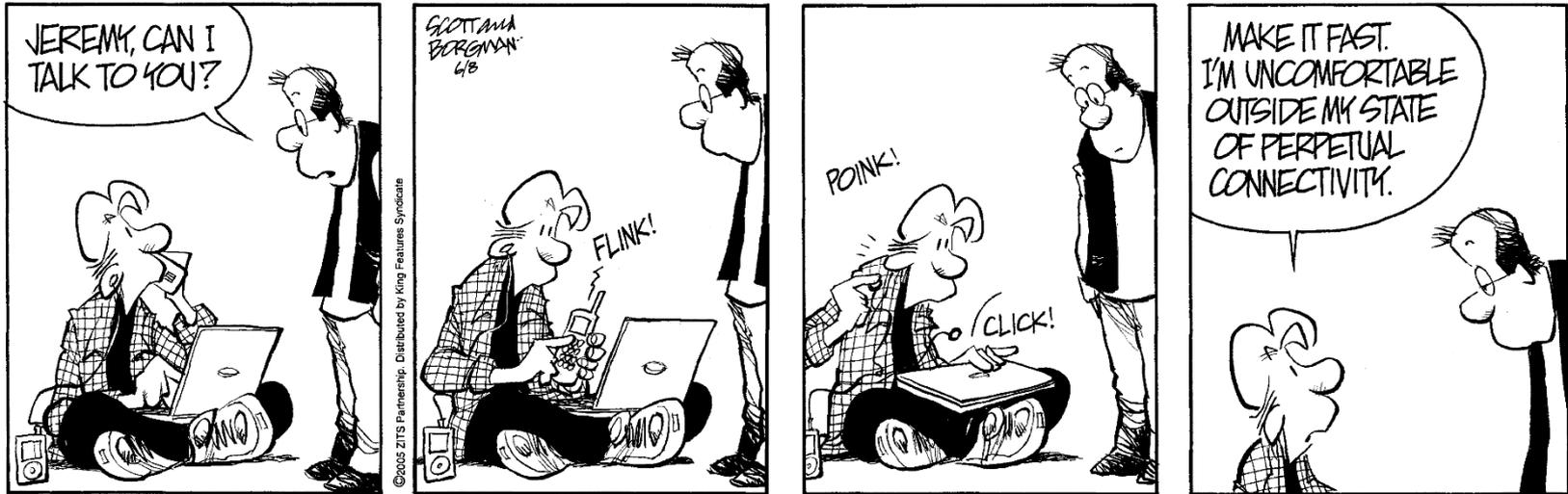
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