

# Chapter 1: Catalysts for Change



## COMP422 Ethics and Professional Issues in Computing Dr. Patrick Pang

Based on  
*Ethics for the Information Age (5<sup>th</sup> Ed.)*  
by  
Michael J. Quinn



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# About Me

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  - Location: N46B
  - Thursdays 9:00-11:30, Fridays 9:30-13:00

# Learning Outcomes


After completing the learning module, students will be able to:

1. Point out the milestones in computing and networking which served as catalysts for change in the society
2. Compare and contrast different ethical theories
3. Summarize ethical issues in networked communications
4. Demonstrate the knowledge of ethical issues in intellectual property, privacy, computer and network security, computer reliability, professional ethics, work and wealth, and plagiarism
5. Analyze the “Digital Divide” and “Winner-Take-All” phenomena



# Key Topics

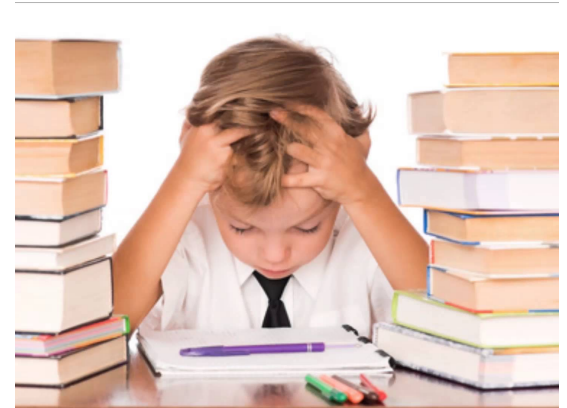
- Milestones of technology development and their issues
- Theories related to ethics in IT
- Ethical issues in network communication
- Intellectual Property
- Privacy and the government
- Computer and network security, reliability
- Professional ethics
- Work, wealth and sustainability



**Attendance  
will be taken  
in every  
session**

# Assessments

- Assignments (25%)
  - 2 assignments (12.5%): Q&A
  - Due Weeks\* 5 and 12
  - Assignments will be released on and submitted to Canvas
- Test (25%; Week 8\*)
- Final Exam (50%)



*\* Dates are tentative and may be adjusted based on the teaching progress*

# How to survive this module?



**All materials of this unit  
can be downloaded  
online from Canvas.  
Check regularly for  
updates.**



**You can contact your teacher  
via email. I aim to respond in  
24-48 hours (exclude weekends  
and holidays).**



**Prepare before you  
come to the class. Read  
slides and other  
provided material before  
class.**



**Attend your classes on time.  
Submit your assessments on  
time.**



**Ask questions early.  
Don't wait until the last  
minute otherwise  
nobody will be able to  
help!**



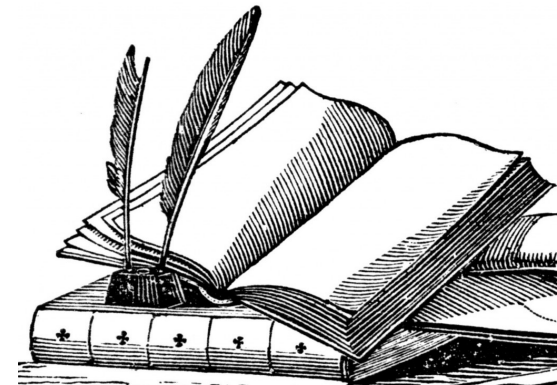
**No plagiarism and  
academic misconduct!  
They are taken very  
seriously.**

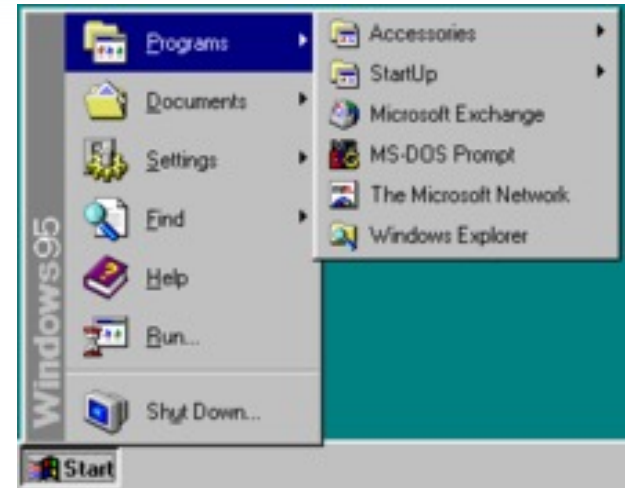


**Students are often asked to work in groups.  
Communicate and collaborate with each  
other actively.**

# Readings

- Readings will be provided for some lessons
- You **MUST**:
  - Bring your laptop/tablet so that you can read in class;  
or
  - Print and bring them to class
- It is recommended that you skim the readings before coming to class





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# Let's start!



# Organization of Chapter

- Introduction
- Milestones in computing
- Milestones in networking
- Milestones in information storage and retrieval
- Information technology issues

# 1.1 Introduction

# Information Age

- Era characterized by unprecedented access to information
- Catalysts
  - Low-cost computers
  - High-speed communication networks

# Apple iPhone

## Product of the Information Age



# Advances in Past Two Decades

- Cell phones
- MP3 players
- Digital photography
- Email
- World Wide Web
- Wearables (for example, smart watches)
- Artificial Intelligence (AI)
- Cryptocurrencies
- ...

# Technology and Values

- Dynamic between people, technology
  - People adopt technology
  - Technology changes society
- Using technology can change people
  - Physical changes (e.g., laptops)
  - Mental changes (dopamine increases desire for more information)
  - Psychological changes (e.g., cell phones)
- Technologies solve problems, but may create new problems
  - Automobile
  - Refrigerator
  - Low-cost international communication

# Amish Selectively Adopt New Technologies



AP Photos/The Indianapolis Star and News, Mike Fender

- Use gas barbecues – bring people together
- Don't use telephones – interfere face-to-face conversation

# Control over New Technologies

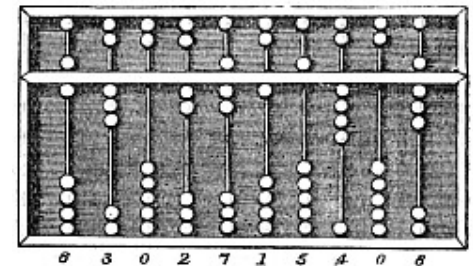
- Examples of control over adoption
  - Nuclear power moratorium in United States for 25 years
  - Nuclear power advances in rest of world
- Examples of control over rate at which technologies are developed
  - Intellectual property laws
  - Tax structure



# **1.2 Milestones in Computing**

# Aids to Manual Calculating

- Tablet
  - Clay, wax tablets (ancient times)
  - Slates (late Middle Ages)
  - Paper tablets (19<sup>th</sup> century)
- Abacus
  - Rods or wires in rectangular frame
  - Lines drawn on a counting board
- Mathematical tables
  - Tables of logarithms (17<sup>th</sup> century)
  - Income tax tables (today)



# Slate and Counting Board



© Science Museum Library/Science & Society Picture Library

# Early Mechanical Calculators

- Calculators of Pascal and Leibniz (17<sup>th</sup> century)
  - Worked with whole numbers
  - Unreliable
- Arithmometer of de Colmar (19<sup>th</sup> century)
  - Took advantage of advances in machine tools
  - Adopted by insurance companies
- Printing calculator of Scheutzes (19<sup>th</sup> century)
  - Used method of differences pioneered by Babbage
  - Adopted by Dudley Observatory in New York
  - Completed astronomical calculations

# Social Change → Market for Calculators

- Gilded Age (late 19<sup>th</sup> 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**

# Calculator Adoptions → Social Change

- Fierce market
  - Continuous improvements in size, speed, ease of use
  - Sales increased rapidly
- “Deskilling” and feminization of bookkeeping
  - People of average ability quite productive
  - Calculators 6× faster than adding by hand
  - Wages dropped
  - Women replaced men

# Feminization of Bookkeeping



Princeton University Press

# Cash Register

- Store owners of late 1800s faced problems
  - Keeping accurate sales records for department stores
  - Preventing embezzlement from clerks
- Response to problems: cash register
  - Created printed, itemized receipts
  - Maintained printed log of transactions
  - Rang bell every time drawer was opened



# Cash Register

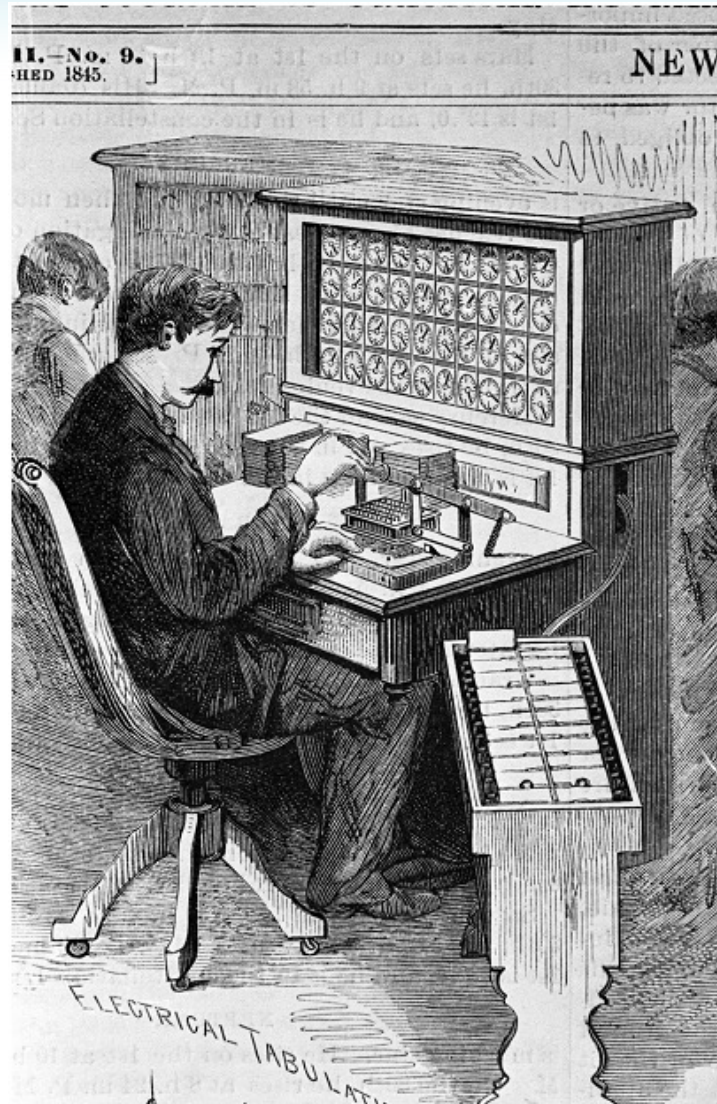


The NCR Archive at Dayton History

# Punched Card Tabulation

- Punched cards (late 19<sup>th</sup> 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
  - Railroads
  - Retail organizations
  - Heavy industries

# Electric Tabulator at U.S. Census Bureau



© Bettmann/CORBIS

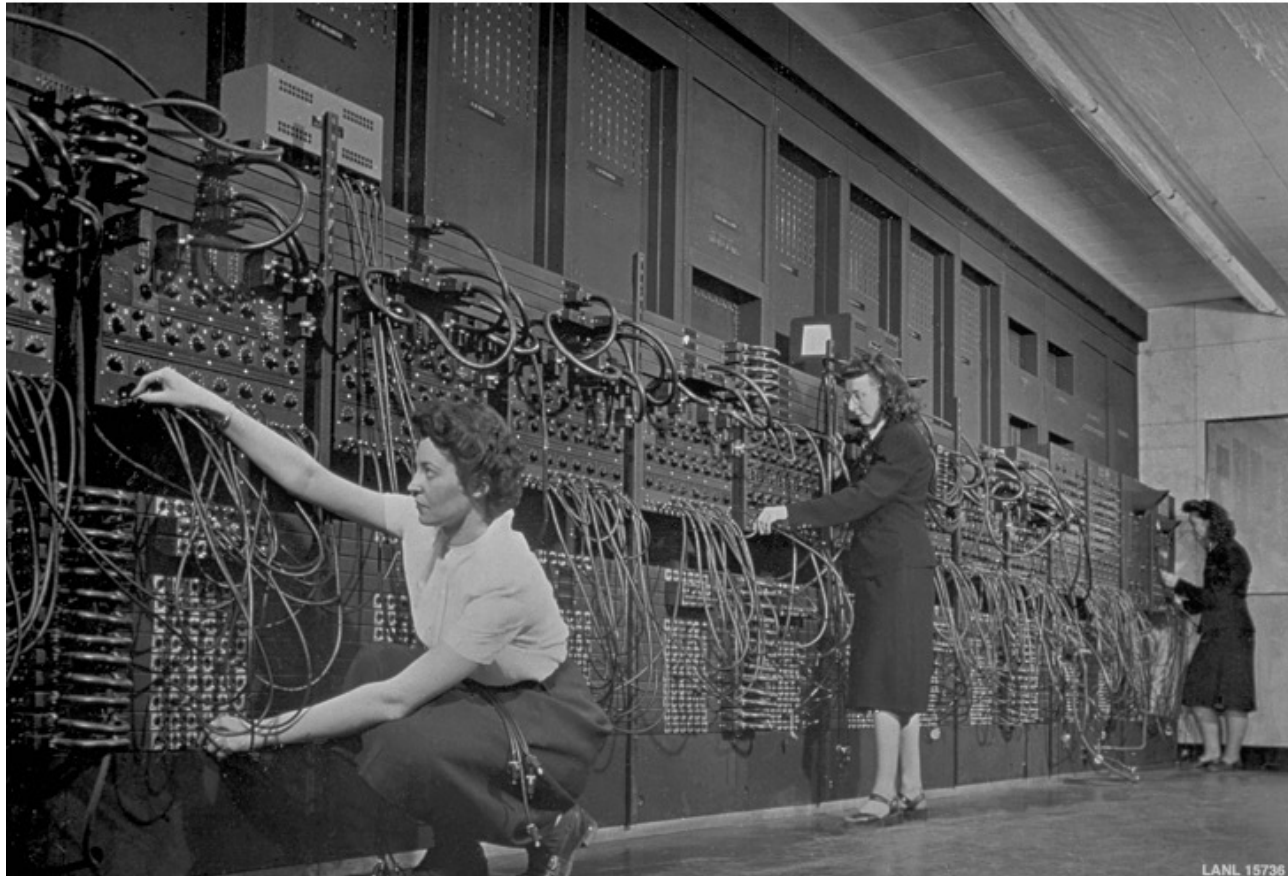
# Tabulators → Data-processing Systems

- Data-processing system
  - Receives input data
  - Performs one or more calculations
  - Produces output data
- Punched cards
  - Stored input data and intermediate results
  - Stored output
  - Stored programs on most complicated systems

# Precursors of Commercial Computers

- Atanasoff-Berry Computer: vacuum tubes
- ENIAC (**E**lectronic **N**umerical **I**ntegrator **A**nd **C**omputer): externally programmed with wires [1946]
- EDVAC: program stored in memory [1949]
- Small-Scale Experimental Machine: CRT memory

# Programming the ENIAC



© CORBIS



# 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



Hagley Museum and Library. Accession number 1984.240



# 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
- 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

# Transistor

- Replacement for vacuum tube
- Invented at Bell Labs (1948)
- Semiconductor
  - Faster
  - Cheaper
  - More reliable
  - More energy-efficient

# Integrated Circuit

- Semiconductor containing transistors, capacitors, and resistors
- Invented at Fairchild Semiconductor and Texas Instruments
- Advantages over parts they replaced
  - Smaller
  - Faster
  - More reliable
  - Less expensive

# Fairchild Semiconductor Founders



Wayne Miller/Magnum Photos, Inc.

# IBM System/360

- Before System/360
  - IBM dominated mainframe market in 1960s
  - IBM computers were incompatible
  - Switch computers → rewrite programs
- System/360
  - Series of 19 computers with varying levels of power
  - All computers could run same programs
  - Upgrade without rewriting programs

# Engineers Test IBM System/360 CPUs



Courtesy of International Business Machines Corporation

# Microprocessor

- Computer inside a single semiconductor chip
- Invented in 1970 at Intel
- Made personal computers practical



# Antecedents to the Personal Computer

- *Whole Earth Catalog* (1968)
  - “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 (1971)
  - Educated people on how to use computers
  - People gathered around time-share computers
  - Culture promoted free exchange of software
- Homebrew Computer Club (1975)
  - Meeting place for hobbyists interested in building personal computers
  - Member Steve Wozniak created system that became Apple I

# Steve Wozniak and Steve Jobs with Apple I Personal Computer



# Personal Computer

- Altair 8800 (1975)
  - Gates and Allen create BASIC interpreter
  - Interpreter pirated at Homebrew Computer Club meeting
- Personal computers become popular
  - Apple Computer: Apple II (1977)
  - Tandy Corporation: TRS 80 (1977)
- Developments draw businesses to personal computers
  - Computer spreadsheet program: VisiCalc (1979)
  - IBM launches IBM PC (1981)

# **1.3 Milestones in Networking**

# Early Networking: Semaphore Telegraph Tower



Photo l'Adresse Musée de La Poste, Paris / La Poste

# Electricity and Electromagnetism

- Volta invents battery
- Oersted: electricity creates magnetic field
- Sturgeon constructs electromagnet
- Henry: communication using electromagnets

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

# Transcontinental Telegraph: Pony Express Riders Lose Jobs





# Telephone

- Alexander Graham Bell
  - Constructed harmonic telegraph
  - Leveraged concept into first telephone
- Social impact of telephone
  - Blurred public life / private life boundary
  - Eroded traditional social hierarchies
  - Reduced privacy
  - Enabled first “online” communities

# Typewriter and Teletype

- Typewriter
  - Individual production of “type set” documents
  - Common in offices by 1890s
- Teletype
  - Typewriter connected to telegraph line
  - Popular uses
    - Transmitting news stories
    - Sending records of stock transactions

# Radio

- Pioneers
  - Hertz creates electromagnetic waves
  - Marconi invents radio
- First used in business
  - Wireless telegraph
  - Transmit voices
- Entertainment uses
  - Suggested by Sarnoff
  - Important entertainment medium by 1930s

# Orson Welles Broadcasts *War of the Worlds*

Orson Welles's radio  
adaption of *War of the  
Worlds* on the evening of  
October 30, 1938,  
convinced many  
Americans that Martians  
were attacking New  
Jersey.

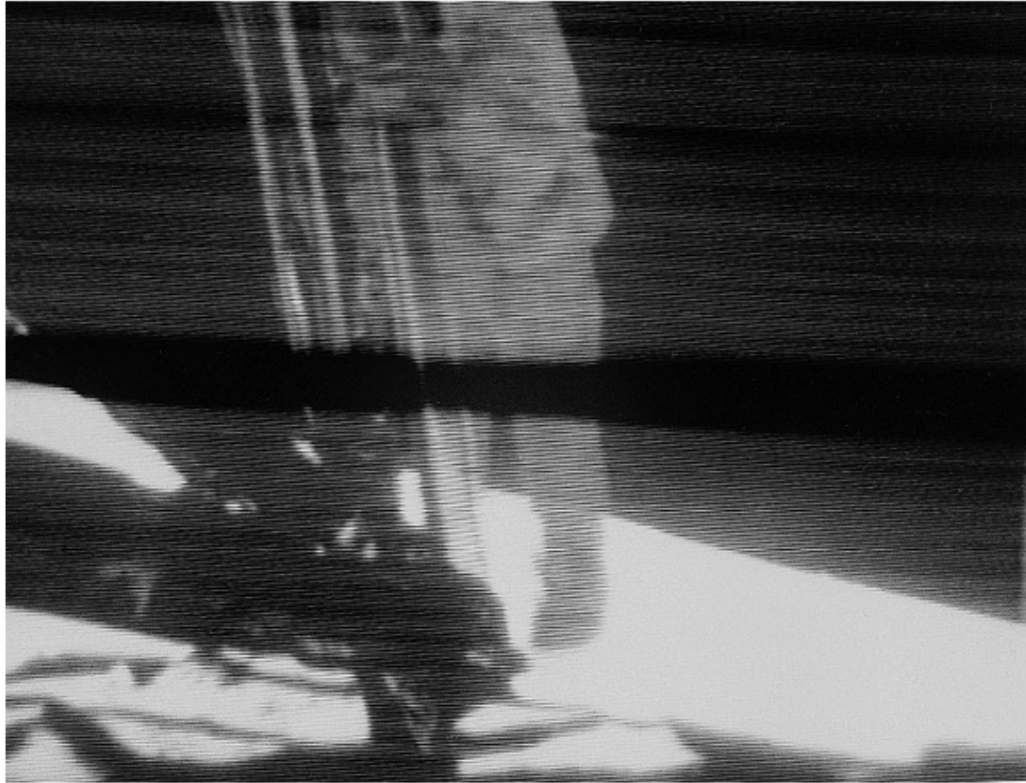


© Bettmann/CORBIS

# Television

- Became popular in 1950s
  - Price fell dramatically
  - Number of stations increased
- Social effects
  - Worldwide audiences
  - Networks strive to be first to deliver news
  - Impact of incorrect information; e.g., 2000 presidential election

# Hundreds of Millions Watch Moon Landing in 1969



Courtesy of NASA

# Remote Computing

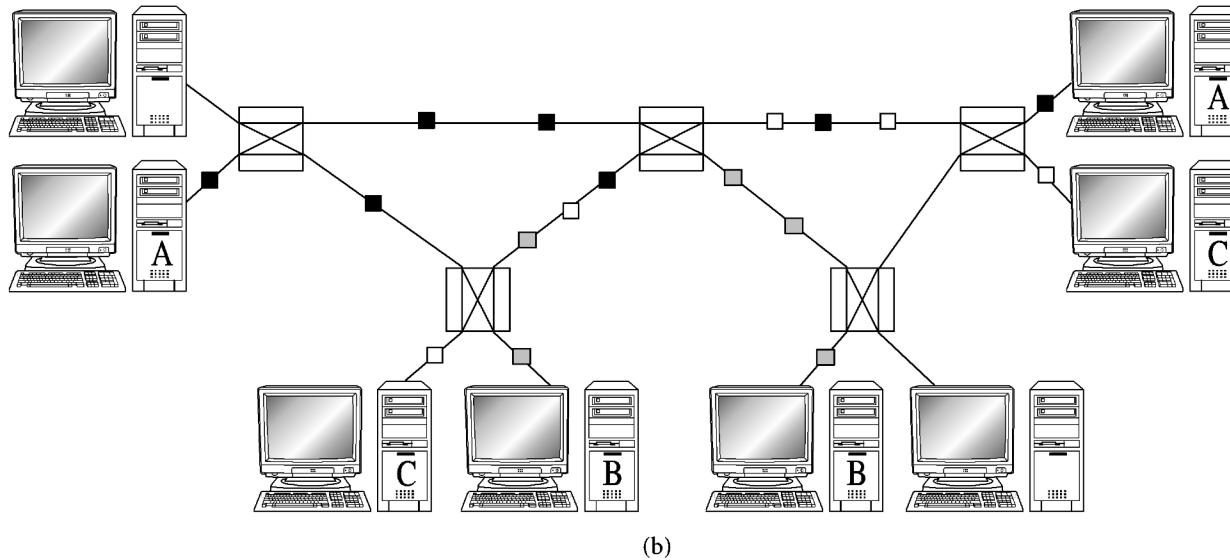
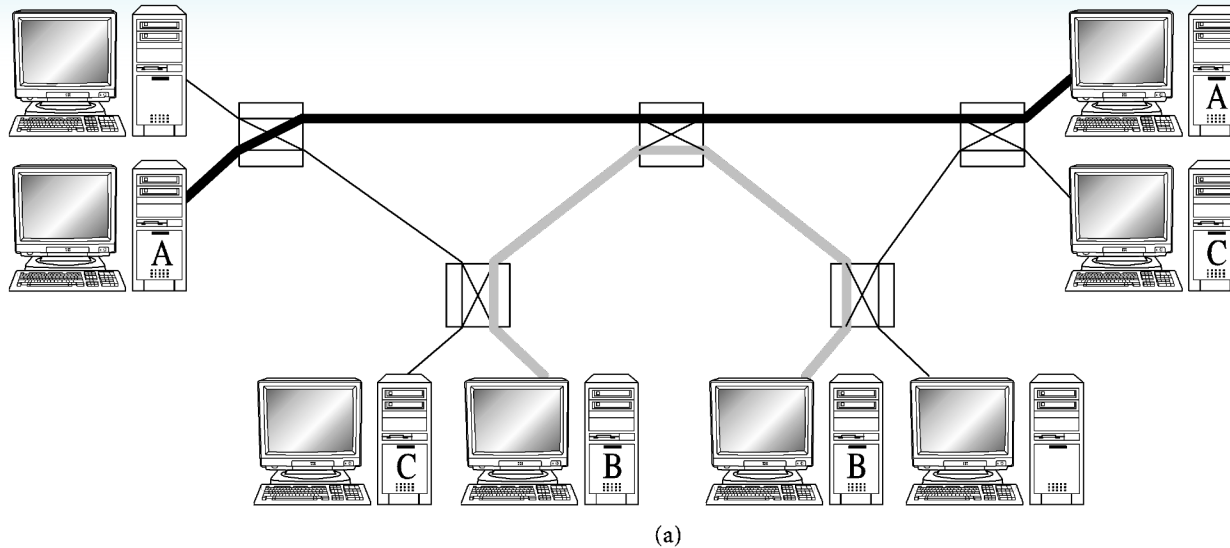
- Stibitz and Williams build Complex Number Calculator at Bell Labs
- Bell Labs part of AT&T (phone company)
- Teletype chosen for input/output
- Allows operator to be distant from machine
- Long-distance demonstration between New Hampshire and New York City

# ARPANET

- DoD creates ARPA in late 1950s
- Licklider conceives of “Galactic Network”
- Decentralized design to improve survivability
- Packet-switching replaces circuit switching



# Circuit-switched v. Packet-switched Networks



# Email

- Creation
  - Tomlinson at BBN writes software to send, receive email messages
  - Roberts creates email utility
- Current status
  - One of world's most important communication technologies
  - Billions of messages sent in U.S. every day

# Internet

- Kahn conceives of open architecture networking
- Cerf and Kahn design TCP/IP protocol
- Internet: network of networks communicating using TCP/IP

# NSFNET

- Created by National Science Foundation
- Provided access grants to universities
- Encouraged commercial subscribers for regional networks
- Banned commercial traffic on NSFNET Backbone
- Private companies developed long-distance Internet connections
- After private networks established, NSF shut down NSFNET Backbone

# Broadband

- Broadband
  - High-speed Internet connection
  - At least 10x faster than dial-up connection
  - Enhanced by fiber optic networks
- Typical broadband speeds
  - Japan (#1 in world): 63 megabits/second
  - South Korea (#2): 40 megabits/second
  - United States (#15): 2 megabits/second

# **1.4 Milestones in Information Storage and Retrieval**

# Codex

- Codex
  - Rectangular pages sewn together on one side
  - Replaced papyrus scrolls as way of storing books
- Advantages of codex over scroll
  - More durable
  - Allows quicker access to particular passages
- Manufacturing technologies
  - Copying by hand
  - Wood engraving



Image by Kungl. biblioteket

# Gutenberg's Printing Press (1436-55)

- 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 16<sup>th</sup> century



# Newspapers

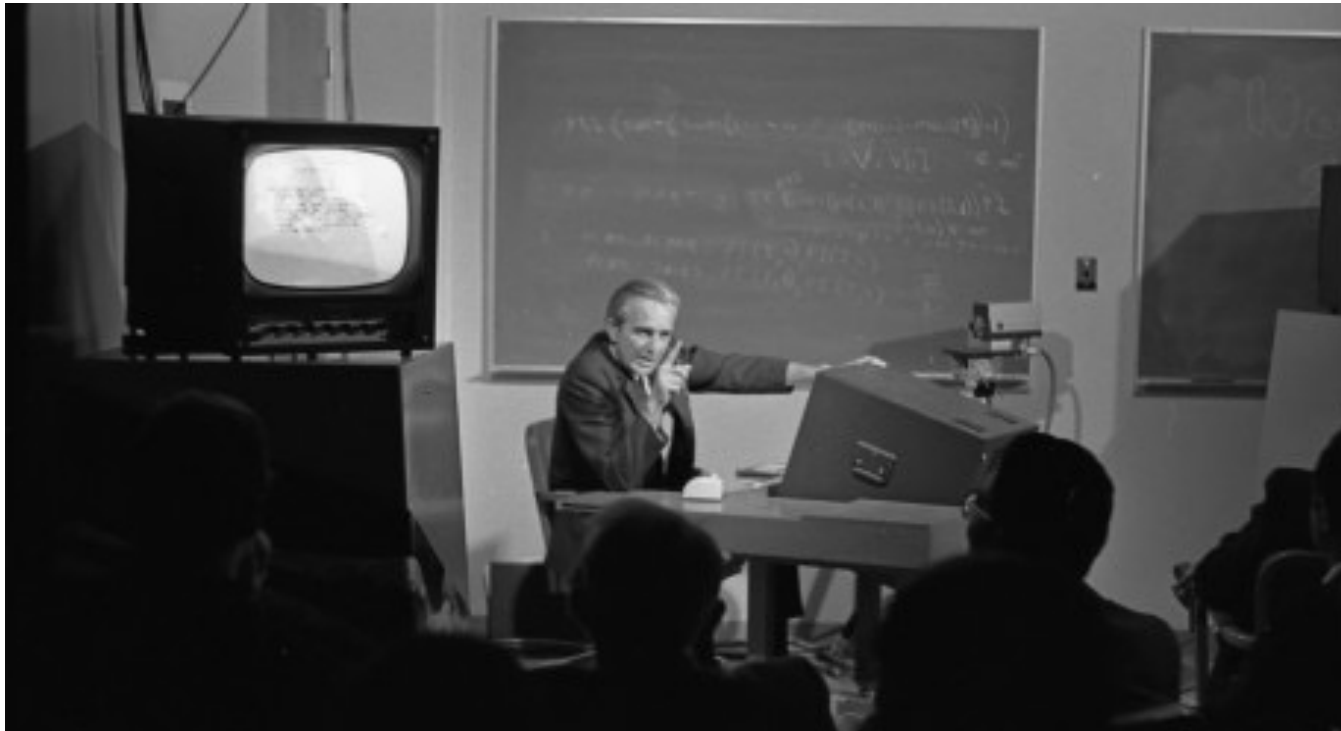
- Newspapers: Stimulated free expression
- Governments responded
  - Licensing
  - Censorship
- Impact on American Revolution
  - Newspapers helped unify colonies
  - Swayed public opinion toward independence

# Hypertext

- Vannevar Bush envisions Memex
- Ted Nelson
  - Coined word hypertext
  - Proposed creation of Xanadu
- Douglas Engelbart
  - Directed construction of NLS (oNLine System)
  - Demonstrated windows, email, mouse, videoconferencing

# Douglas Engelbart:

## “The Mother of All Demos”



Courtesy of  
SRI

**The Mother of All Demos** is a name given to Douglas Engelbart's December 9, 1968, demonstration of experimental computer technologies that are now commonplace.

# Graphical User Interface

- Xerox PARC (Palo Alto Research Center)
  - Alan Kay sees Doug Engelbart demo in 1968
  - Alto personal computer (early 1970s)
  - Bit-mapped display, keyboard, and mouse
- Apple Computer
  - Steve Jobs visits Xerox PARC in 1979
  - Macintosh (1984)
  - Bit-mapped display, keyboard, and mouse
- Microsoft Windows (1990)
  - Released in May 1990
  - Quickly became dominant graphical user interface

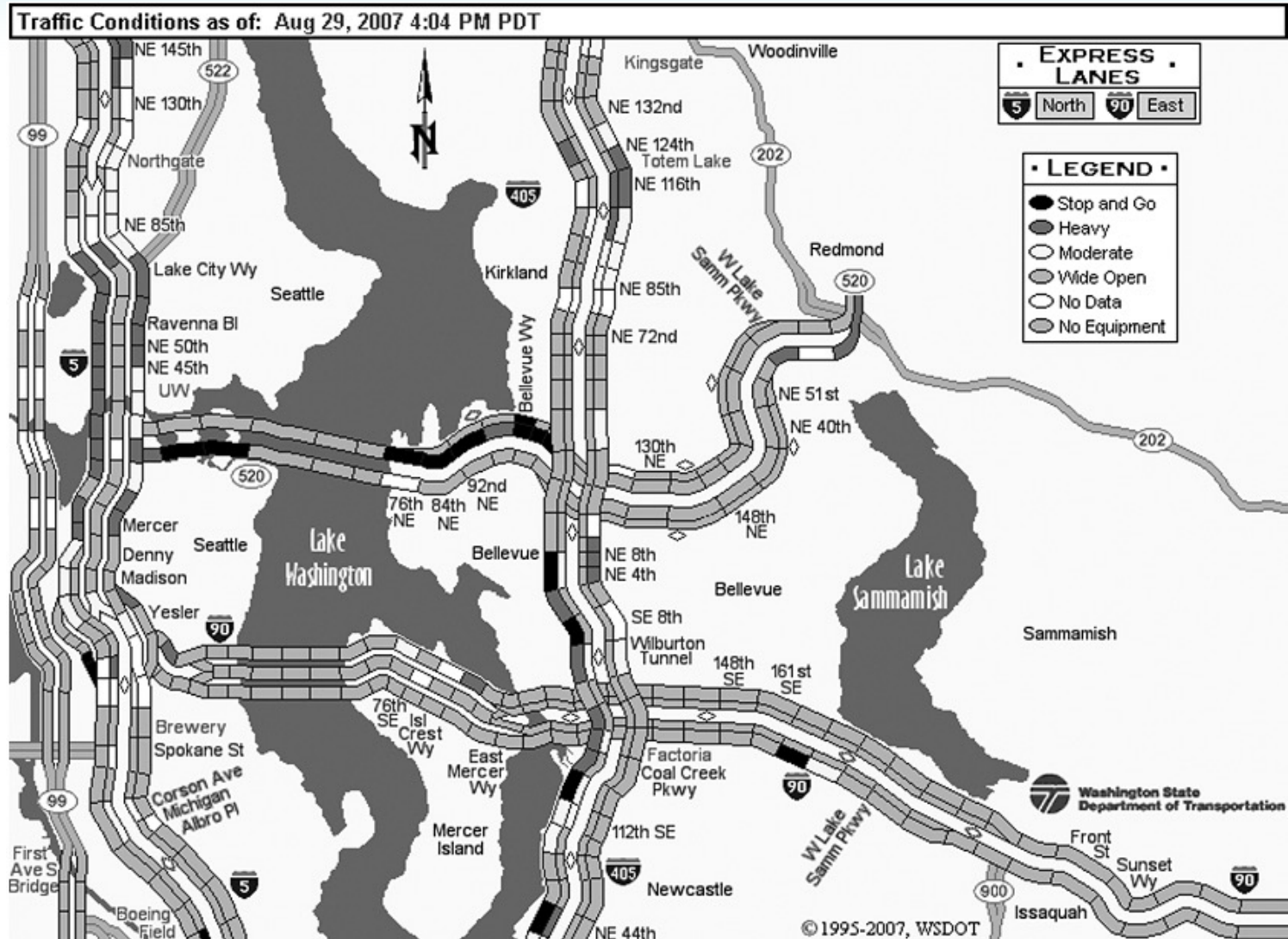
# Single-Computer Hypertext Systems

- Peter Brown at University of Kent
  - Guide (1982)
  - Released versions for Macintosh and IBM PC
- Apple Computer
  - HyperCard (1987)
  - Hypertext system based on “stacks” of “cards”
  - Links represented by buttons
  - Basis for best-selling games Myst and Riven

# 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
- Later browsers
  - Mosaic
  - Netscape Navigator
  - Netscape Mozilla
  - Microsoft Internet Explorer (most popular)

# Traffic Information on the Web



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# Search Engines

- Crawler-based engines (Google, AltaVista)
  - Programs called spiders follow hyperlinks and visit millions of Web pages
  - System automatically constructs Web page database
- Human-assisted engines (Open Directory)
  - Humans build Web page database
  - Web page summaries more accurate
  - Far fewer Web pages in database
- Hybrid systems (MSN Search)



# **1.5 Information Technology Issues**

# Information Technology

- Definition: Devices used in creation, storage, manipulation, dissemination of data, sound, and/or images
- Examples: Computers, telephones, video cameras, MP3 players
- People making greater use of IT
  - Costs keep falling
  - Capabilities keep rising

# IT Issues (1/3)

- Email
  - Easy way to keep in touch
  - Spam has become a real problem
- Web
  - Free access to huge amounts of information
  - Harmful consequences of some sites
- CDs, MP3s
  - Free or cheap copies readily available
  - May be unfair to musicians

# IT Issues (2/3)

- Credit cards
  - Convenience over cash and checks
  - Increases possibility of identity theft
  - Who owns information about transactions?
- Telecommuting
  - Saves time, allows more flexible work hours
  - Can lead to longer work hours
  - May result in fewer chances for promotion

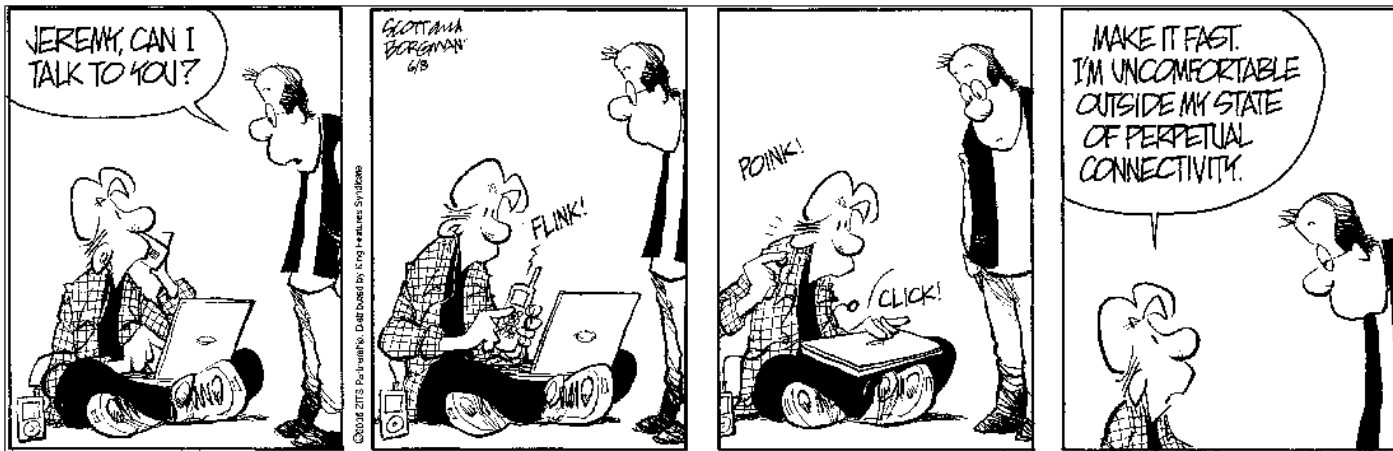
# IT Issues (3/3)

- Improved global communication network
  - Allow companies to sell to entire world
  - Allow companies to move jobs out of U.S.
- World Wide Web
  - A conduit for democratic ideas?
  - Another tool for totalitarian governments?

# Summary

- Revolutionary discoveries are rare
- Information technology has long history
- Rate of technological change accelerating
- Wrong question: “What will the computer do to us?”
- Right question: “What will we make of the computer?”

(quoting Seymour Papert)



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