Connecting with Computer Science, 2e

Chapter 1

History and Social Implications of Computing

Objectives

- In this chapter you will:
  - Learn why today almost everyone is a computer operator
  - Learn about the predecessors of modern computer hardware and software
  - Learn that sometimes good ideas flop and bad ones survive
  - Meet some interesting figures—some famous, some infamous, some wealthy, and some obscure
  - See the historical and social implications of computing

Why You Need to Know About…the History of Computing

- Fields altered by computer communication devices
  - Tool for artists, architects, and designers
  - Information archive
  - Entertainment device
  - Trains, planes, and automobiles
- Ubiquitous computer presence
  - Examine student's relationship to the machine
  - Examine historical and biographical studies
- Look at the future

Ancient History

- Origins of computer in ancient Assyria
  - Tablets with arithmetic/trigonometric solutions
  - Math solves societal and personal problems
- Drivers of mathematical development
  - Property ownership and the need to measure
  - Vertical construction and the pyramids
  - Navigation and the need to control time
- Computers do math

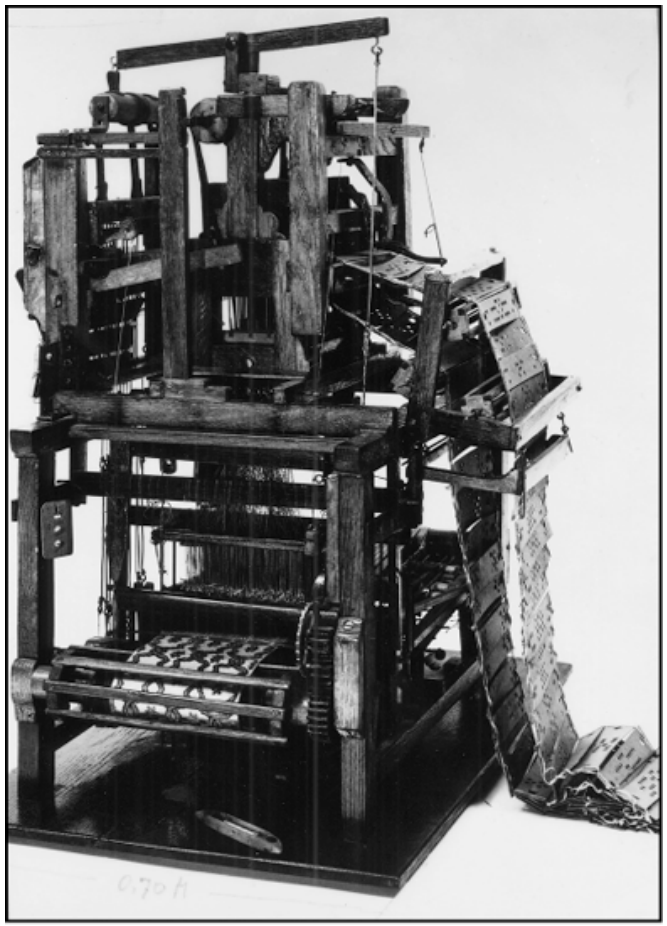
Pascal and Leibniz Start the Wheel Rolling

- Paper, wood, stone, papyrus tables, and abacuses as “computers”
  - 1622: invention of slide rule
  - 1642: invention of mechanical calculator by Pascal
  - 1694: Leibniz Wheel expands arithmetic operations

Joseph Jacquard

- Invents programmable loom in 1801
  - Jacquard loom weaved patterns in fabric
  - Allowed input and storage of parameters
  - Selection pins oriented with punch cards
  - Similarities with player piano
- Concept of the stored program

Joseph Jacquard (cont'd.)



Courtesy of IBM Archive

Figure 1-1, The Jacquard loom, using a string of punched cards that feed into the machine

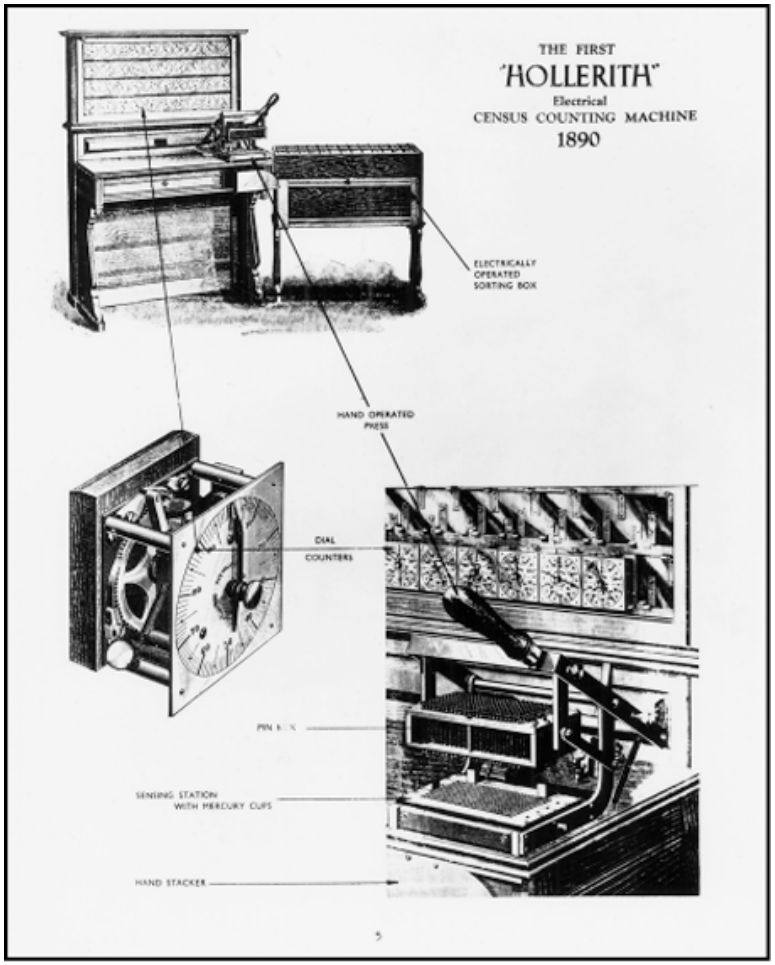
Charles Babbage

- Invents Difference Engine in 1823
  - Adds, subtracts, multiplies, and divides
- Designs Analytical Engine
  - Components of modern computer
    - Input and output devices
    - Memory and CPU
  - Not built due to lack of funds
- Collaborates with Ada Lovelace Byron
  - Attribution of program loop concept
  - Ada programming language namesake

Herman Hollerith

- Invents electromechanical counter in 1880s
  - Serves tabulation role in 1890 U.S. census
  - Machine uses punch cards as input
  - Single-purpose machine
- Company created around technology becomes IBM
  - IBM rolls out multipurpose Mark I in 1944
  - Mark I rapidly made obsolete by vacuum tubes

Herman Hollerith (cont'd.)



Courtesy of IBM Archive

Figure 1-2, The Hollerith census counting machine

Progression of Computer Electronics

- Charles Sanders Peirce extends work of Boole
  - Electric switches emulate true/false conditions of Boolean algebra
  - Benjamin Burack implements concepts in 1936 logic machine
- John Atanasoff and Clifford Berry build a computer using vacuum tubes
- World War II
  - Developmental turning point

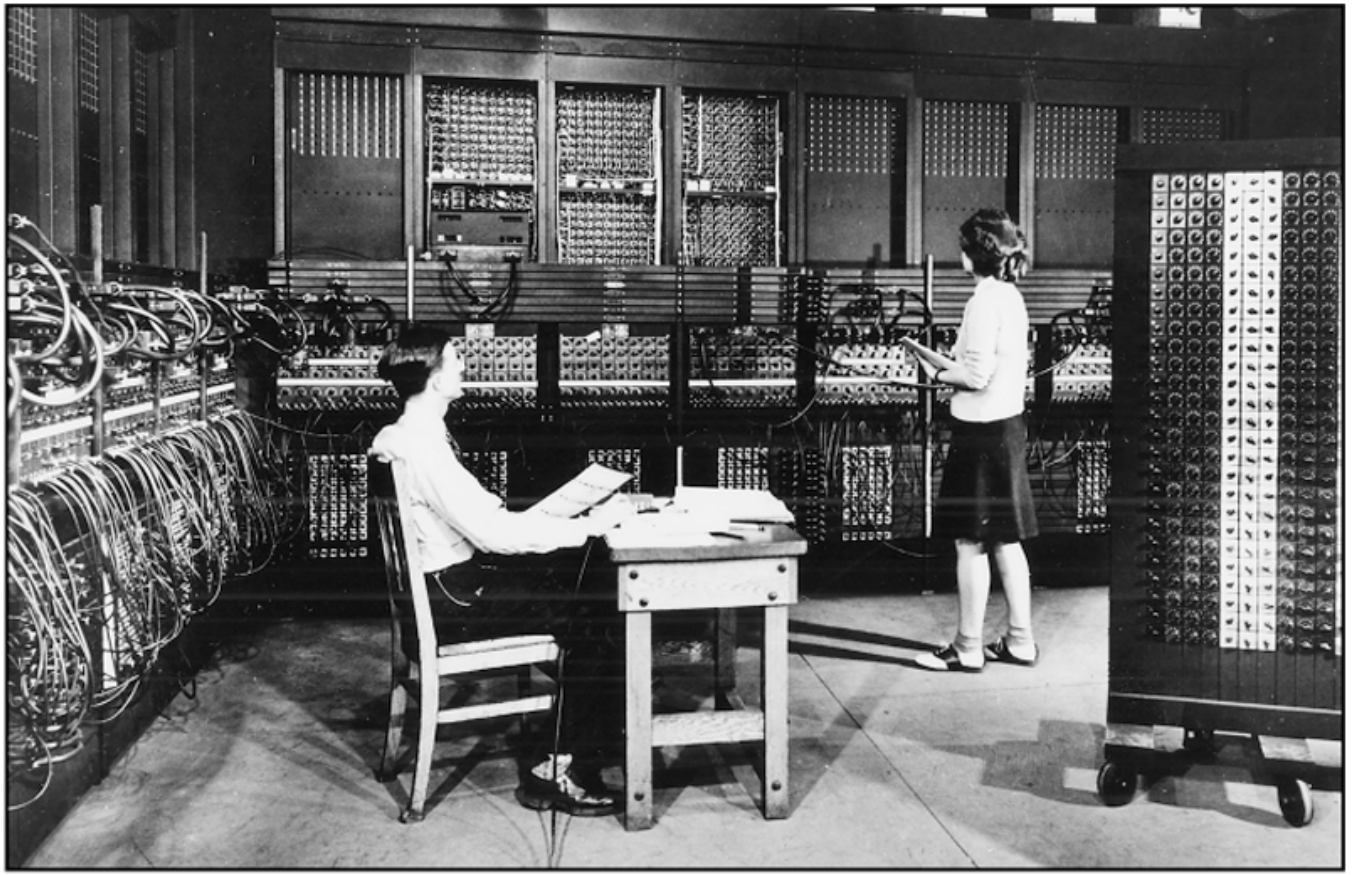
Wartime Research Drives Technological Innovation

- Military need for trajectory tables
  - Weapons testing
    - U.S. Navy Board of Ordnance helps fund Mark I
    - U.S. Army funds ENIAC (Electronic Numerical Integrator and Computer)
- ENIAC runs 1000 times faster than Mark I
  - Both were too late for the war effort

ENIAC and EDVAC

- ENIAC's overhead
  - Loud and large: 30 tons
    - 18,000 vacuum tubes needed constant attention
    - 6000 switches needed for arithmetic operations
- ENIAC's strengths
  - Performs arithmetic and logic operations
  - Made multipurpose with symbolic variables
- ENIAC'S weaknesses
  - Could not modify program contents
  - Had to be programmed externally

ENIAC and EDVAC (cont'd.)



Courtesy of IBM Archive

Figure 1-3, The ENIAC and some of its programmers

ENIAC and EDVAC (cont'd.)

- EDVAC (Electronic Discrete Variable Automatic Computer) created in 1944
  - Recognized as the Von Neumann machine
  - Superior model for descendant computers
  - Operation governed by program in memory
  - Programs could be modified
  - Stored program concept made programs reusable
- British response: Colossus
  - Helps crack German U-boat Enigma code
  - All machines destroyed by 1960s

ENIAC and EDVAC (cont'd.)

Courtesy of NSA

Figure 1-4, The Enigma machine was used to encode German military intelligence in World War II

The Computer Era Begins: The First Generation

- 1950s: First Generation for hardware and software
  - Vacuum tubes worked as memory for the machine
  - Data written to magnetic drums and magnetic tapes
  - Paper tape and data cards handled input
  - The line printer made its appearance
- Software separates from hardware and evolves
  - Instructions written in binary or machine code
  - Assembly language: first layer of abstraction
  - Programmers split into system and application engineers

UNIVAC

Courtesy of IBM Archive

Figure 1-5, Grace Murray Hopper and the UNIVAC

UNIVAC (cont'd.)

- UNIVAC
  - First commercially viable computer
  - U.S. Census Bureau is the first customer
  - Faces skepticism from Howard Aiken (Mark I builder)
- UNIVAC and the 1952 presidential election
  - Successfully predicts outcome during CBS broadcast
  - Quickly adopted by all major news network

IBM (Big Blue)

- IBM dominates mainframe market by the 1960s
  - Strong sales culture
  - Controlled 70% of the market
- IBM vision
  - Sharp focus on a few products
  - Leverage existing business relationships
  - Introduce scalable (and hence flexible) systems
  - Lease systems with 10- to 15-year life spans

IBM (Big Blue) (cont'd.)

Courtesy of IBM Archive

Figure 1-6, IBM 360 mainframe computers were the size of refrigerators and required a full staff to manage them

Transistors in the Second Generation

- Software innovations
  - Assembly language limitations
  - Appearance of high-level languages: FORTRAN, COBOL, LISP
- Hardware development
  - Transistor replaces vacuum tube
  - RAM becomes available with magnetic cores
  - Magnetic disks support secondary storage

Circuit Boards in the Third Generation

- Integrated circuits (IC) on chips
  - Miniaturized circuit components on board
  - Semiconductor properties
  - Reduce cost and size
  - Improve reliability and speed
- Operating systems (OS)
  - Program to manage jobs
  - Utilize system resources
  - Allow multiple users

Circuit Boards in the Third Generation (cont'd.)

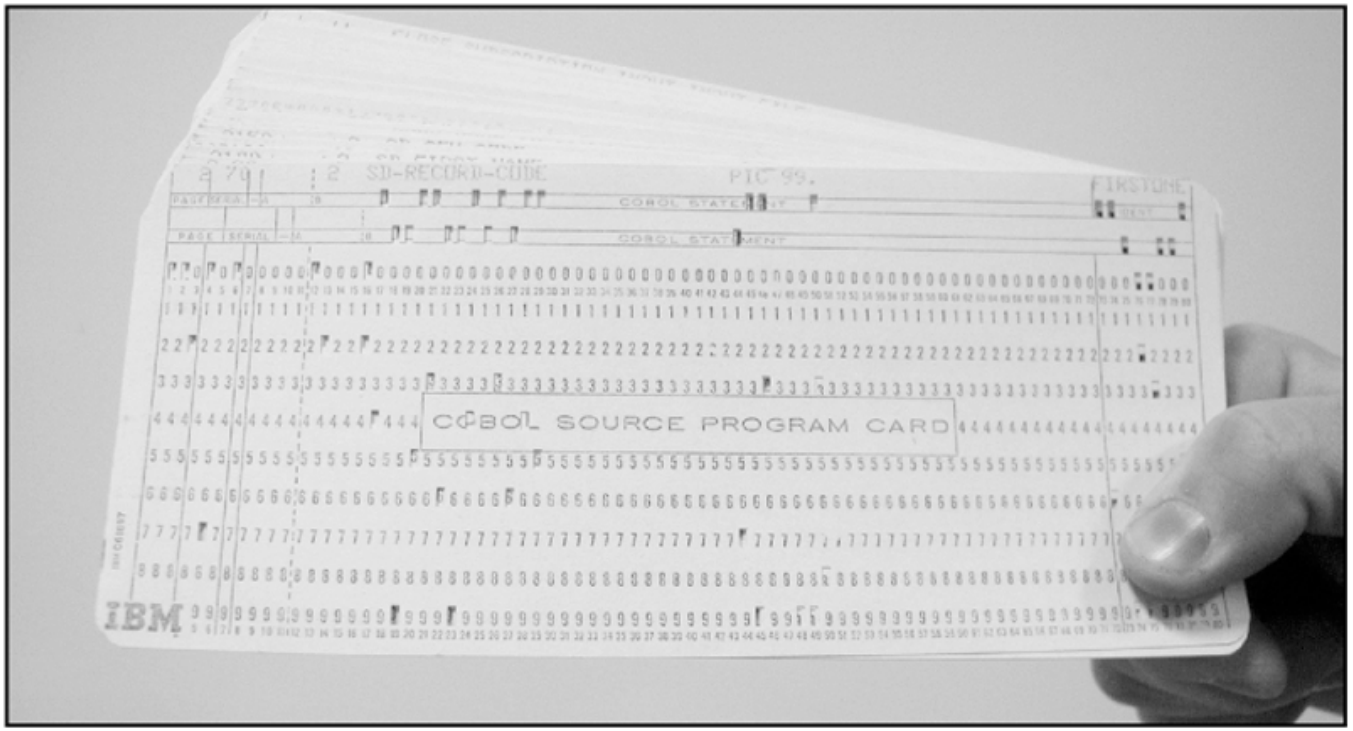


Figure 1-7, A very short stack of IBM punched cards

Time-Sharing

- Allocates system resources to multiple users
  - Input with long paper rolls instead of punch cards
  - Productivity gains offset by increased response time
- General-purpose machines broaden appeal
- Programmers gear software toward end user
  - Distinctions between application level and OS level
  - Statistical and accounting programs hide implementation details

Living in the ’70s with the Fourth Generation

- Era of miniaturization
  - LSI chips contain up to 15,000 circuits
  - VLSI chips contain 100,000 to 1 million circuits
- Minicomputer industry grows
- UNIX operating system was created
  - Free to educational institutions
- Microcomputer makes appearance

The Personal Computer Revolution

- Causes:
  - Hardware vision of engineers
  - Software developers seeking challenges
  - Electronic hobbyists realizing a dream
  - All necessary hardware and software elements were at hand or being developed
  - Social, economic, and personal forces came together for support

Intel

- Intel 4004 chip
  - 4004 transistors onboard
  - Accrues greater functionality
  - Precursor to central processing unit (CPU)
- Gary Kildall
  - Writes OS for Intel microprocessor
- Software and hardware become separate commodities

The Altair 8800

- Development spurred by *Popular Electronics*
- Ed Roberts reports on the Altair 8800
  - Kit based on Intel 8080
  - Generates 4000 orders within three months
- Altair 8800 features
  - I/O similar to ENIAC's
  - Open architecture provides adaptability
  - Portable

The Altair 8800 (cont'd.)

Courtesy of Microsoft Archives

Figure 1-8, The MITS Altair 8800—assembled

Enter Bill Gates, Paul Allen, and Microsoft

- Gates and Allen
  - Develop a BASIC interpreter
  - High-level language for microcomputer programmers
- Briefly associate with MITS
- Formed Micro-Soft company in 1975
  - By 1981, Microsoft was on its way to becoming a multibillion-dollar company

Enter Bill Gates, Paul Allen, and Microsoft (cont'd.)

Courtesy of Microsoft Archives

Figure 1-9, Paul Allen and Bill Gates in 1981

The Microcomputer Begins to Evolve

- Microcomputer's profitability lures more players
  - Enter Radio Shack, IMSAI, Sphere, and others
- Altair's bus becomes S100 industry standard
- MITS stumbles
  - Links prices of faulty hardware to BASIC
  - Develops new model incompatible with 8080
- 1977
  - MITS sold off
  - Hardware companies introduce competing models

An Apple a Day…

- 1976: Steve Jobs and Steve Wozniak offer Apple I
- 1977: Apple II developed and released
  - Based on Motorola 6502 processor
  - Gains respect in industry, as well as among hobbyists
  - Promotes application development
- VisiCalc spreadsheet program
  - Drives Apple II sales
  - Earns new title: killer app
  - Draws attention of wider business community

IBM Offers the PC

- IBM builds a microcomputer
  - Adopts the Intel 8088 off the shelf
  - Uses a nonproprietary CPU
  - Creates approachable documentation
  - Offers open architecture
- New product name: personal computer (PC)
- PC sold through retail outlets

MS-DOS

- IBM chooses Microsoft to develop OS
- Microsoft introduces MS-DOS
  - Based on Kildall's 8-bit CP/M
  - Runs on 16-bit CPU (Intel 8088)
  - Prevails over competition
- IBM calls operating system PC-DOS

The Apple Macintosh Raises the Bar

- Steve Jobs visits Xerox PARC
  - Alto: graphics, menus, icons, windows, and mouse
  - Observes functioning Ethernet network
  - Learns about hypertext
- Jobs succeeds with Xerox ideas
  - Picks up where Xerox (focused on copiers) leaves off
  - Incorporates Palo Alto components in Macintosh
- 1984: Macintosh unveiled
  - Graphical user interface (GUI)
  - Mouse: point-and-click and ease-of-use

Other PCs (and One Serious OS Competitor) Begin to Emerge

- Microsoft two-fold argument to IBM
  - Adapt open architecture concept to OS
  - Allow Microsoft freedom to license its OS
- Microsoft answers Apple
  - Windows 3.1 incorporates Mac's GUI features
  - Competing PC clones appear with Microsoft's OS
- Microsoft leverages position
  - OS presence drives application software sales
  - Sales synergies and licensing give 90% of PC pie

The Latest Generation (Fifth)

- Parallel computing
  - Aka parallel architecture
  - CPUs joined for simultaneous task execution
- Three approaches
  - SIMD (single instruction, multiple data) stream
  - MIMD (multiple instruction, multiple data) stream
  - Internetworking
- Uses
  - Control Web pages, databases, and networks
  - Mathematical modeling and scientific research

The Internet

- ARPA origins of new communication system
  - Resource sharing
  - Common protocols
  - Fault tolerance
- 1969: ARPANET born
  - Consisted of four computers at four locations
  - Systems linked with Interface Message Processor
- ARPANET grows rapidly
  - Protocols allow easy entry into network
  - Electronic mail constitutes two-thirds of network traffic

LANs and WANs and other ANs

- The Internet as a network of networks
  - Wide area network (WAN)
  - Local area network (LAN)
  - Wireless local area network (WLAN)
  - Metropolitan area network (MAN)
  - Urban area network (UAN)
- Network technologies
  - Ethernet dominates
  - Wireless technologies

Super Software and the Web

- Object-oriented programming (OOP)
- Computer-aided software engineering (CASE)
- Origin of the World Wide Web (WWW)
  - 1990: Tim Berners-Lee develops hypertext
  - Microsoft and Internet Explorer
- Web components
  - Web pages
  - Browser
  - Network technology

Super Software and the Web (cont'd.)

Donna Coveny/Courtesy of the World Wide Web Consortium (W3C)

Figure 1-10, Tim Berners-Lee, inventor of the World Wide Web

The Microsoft Era and More

- The “browser wars”
  - Microsoft integrates IE browser into Windows
  - Netscape opposes Microsoft: goes open source
- The wars continue in court
  - U.S. government files antitrust suit against Microsoft
  - By 2001, most of antitrust suit was dropped or lessened
- Linux OS threatens Windows: Low cost, open source, and reliability

What About the Future?

- Parallel computing
  - Massive amplification of computing power
  - Can be hosted by local networks as well as the Internet
- Wireless networking
  - Bluetooth
  - Embedded or ubiquitous computing
- Digitization of economy
- Privacy and security
- Open-source movement

One Last Thought

- Development as a product of needs and wants
- Mixture of forces driving innovation
  - Commercial and physical requirements (IC)
  - Need to solve a problem (Analytical Engine)
  - Desire to create something new (Apple I)
  - Goal of winning a war (World War II)
  - Need to succeed (Bill Gates)
- Evolutionary view
- Purpose of historical study
  - Avoid mistakes and emulate triumphs

Summary

- The evolution of computers
  - Tied to mathematical evolution and driven by the need to master time and space
- From stone tablets to electronic machines
  - Computer's chief purpose: manipulate mathematical and linguistic symbols
- Civilizations from the times of the ancients to the present
  - Contributed to the development of computers and their science

Summary (cont'd.)

- Past leading to computer development included:
  - Mechanical calculators invented in the 17th century by Pascal and Leibniz
  - Jacquard loom of 1801 introduced the punch card and the concept of a stored program
  - Charles Babbage designed a prototype of the modern computer: the Analytical Engine
  - Herman Hollerith incorporated punch cards in his mechanical tabulating machines

Summary (cont'd.)

- World War II drove computer innovation in the mid-20th century: ENIAC, Mark I, Colossus
- EDVAC's Von Neumann architecture
  - Basic model for all later development
- Progress from vacuum tubes to integrated circuits
  - Exponentially increased computer speed and simultaneously reduced the size and cost
- Microcomputer and Internet
  - Latter 20th-century development
  - Made computers ubiquitous