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.)

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

Courtesy of IBM Archive
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.)

Figure 1-2, The Hollerith census counting machine

Courtesy of IBM Archive
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.)

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.)

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

Figure 1-5, Grace Murray Hopper and the UNIVAC

Courtesy of IBM Archive
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.)

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

Courtesy of IBM Archive
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.)

Figure 1-8, The MITS Altair 8800—assembled

Courtesy of Microsoft Archives
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.)

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

Courtesy of Microsoft Archives
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.)

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