

Unit I: Introduction: Understanding Computers

Chapter 5: History: How did we get here?

5.1: Goal:

In this chapter, you will explore the evolution of computing from early calculating devices to today's powerful digital technologies. You will discover the people, inventions, and innovations that shaped modern computers and gain a deeper appreciation for how technological progress continues to influence society.

5.2: Objectives:

- Describe major milestones in the history of computing.
- Explain how computing evolved from mechanical devices to modern smartphones and cloud computing.
- Identify influential individuals who shaped the development of computing.
- Recognize the contributions of women and people from diverse backgrounds to computer science and technology.
- Describe the generations of computers and the technologies that defined each generation.
- Explain how advances in hardware, software, and networking changed society.
- Describe the impact of the Internet, mobile computing, cloud computing, and artificial intelligence.
- Evaluate how historical innovations continue to influence today's technology.

5.3: Think About It

Your smartphone is thousands of times more powerful than the computers that guided astronauts to the Moon.

How did computing evolve from simple counting tools to devices that fit in your pocket and can recognize speech, translate languages, and generate images with artificial intelligence?

5.4: Opening Scenario

Sophia is waiting for class to begin. In just fifteen minutes, she checks her email, pays a bill online, listens to music, asks an AI assistant for homework help, and video chats with a friend overseas.

Each of these tasks depends on inventions developed over hundreds of years by mathematicians, engineers, scientists, and programmers from many countries and cultures.

The smartphone in Sophia's hand is the result of countless innovations: from early mechanical calculators and punch cards to integrated circuits, the Internet, cloud computing, and artificial intelligence.

In this chapter, you'll meet many of the people whose ideas transformed computing and explore how those innovations continue to shape the world today.

5.5: Why This Chapter Matters

The history of computing is much more than a timeline of machines. It is the story of people solving problems, building on one another's ideas, and creating technologies that changed society.

Understanding this history helps us appreciate how innovation occurs and why modern computers work the way they do. It also reminds us that computing has always been a collaborative effort involving people from many backgrounds, disciplines, and countries.

Whether you pursue a career in healthcare, business, education, engineering, public service, or the arts, the technologies you use today were made possible by generations of innovators whose ideas continue to influence our daily lives.

5.6: Timeline of Computing History

The history of computing spans thousands of years, beginning with simple tools used to help people count and perform arithmetic. Early inventions such as the abacus and mechanical calculators made mathematical work faster and more accurate. During the nineteenth century, inventors began imagining machines that could follow instructions automatically, laying the foundation for programmable computers. By the mid-twentieth century, electronic computers replaced mechanical devices, dramatically increasing computing speed and capability.

Since then, computing has advanced at an extraordinary pace. Room-sized computers gave way to desktop computers, laptops, smartphones, and wearable devices. The development of the Internet connected billions of people around the world, while cloud computing made it possible to store data and run applications online. Today, artificial intelligence is transforming how people work, communicate, and solve problems, continuing the long history of innovation in computing.

TIMELINE OF COMPUTING HISTORY

From ancient counting tools to artificial intelligence: This timeline illustrates the major milestones in the evolution of computing, beginning with early calculating devices and progressing through mechanical calculators, electronic computers, personal computers, the Internet, mobile devices, cloud computing, and artificial intelligence. It emphasizes that modern computing developed through centuries of technological innovation.

Early Calculating Tools	Mechanical Innovation	Birth of Programmable Computing	Electronic Computers	The Rise of Microelectronics
3000 BCE-1600s	1600s-1800s	1800s	1940s-1950s	1960s-1980s



Personal Computer Revolution

1970s-1990s



The Internet Revolution

1990s-2000s



Mobile, Cloud & Smart Technologies

2000s-2010s



Artificial Intelligence Era

2010s-Present



Table: Timeline of Computing History

5.7: Early Calculating Tools

Long before electronic computers existed, people developed tools to help them perform calculations. One of the oldest known devices is the **abacus**, which was used in Asia, the Middle East, and Europe thousands of years ago. Users moved beads along rods to perform addition, subtraction, multiplication, and division. Although simple by today's standards, the abacus demonstrated that mathematical calculations could be assisted by a mechanical device.

Other important inventions included **Napier's Bones**, created by Scottish mathematician John Napier in the early 1600s, and the **slide rule**, which became an essential tool for engineers and scientists for more than three centuries. These devices helped people solve increasingly complex mathematical problems and inspired later inventors to develop mechanical calculators and, eventually, programmable computers.

Ancient Counting Devices

ABACUS

(c 3000 BCE)



NAPIER'S BONES

(1617)



SLIDE RULE

(1620s)



Figure: Ancient Counting Devices

Several early calculating tools, included the abacus, Napier's Bones, and the slide rule. These devices helped people perform mathematical calculations long before electronic computers were invented.

Mechanical Innovation

Mechanical calculators became more sophisticated, and inventors began designing machines that could automatically follow instructions, a key step toward modern programmable computers.

Pascal's Calculator (1642)



Figure:. Pascal's Calculator

Blaise Pascal built one of the first mechanical calculators to help with arithmetic. His mechanical calculator was known as the Pascaline. The device used interlocking gears to perform addition and subtraction automatically.

5.8: Birth of Programmable Computing

Inventors developed the first concepts for programmable machines, including Charles Babbage's Analytical Engine and the use of punch cards to provide instructions.

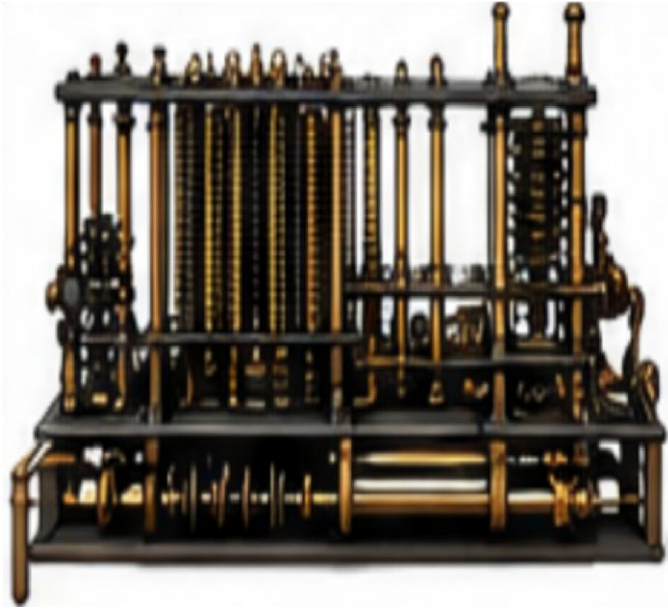
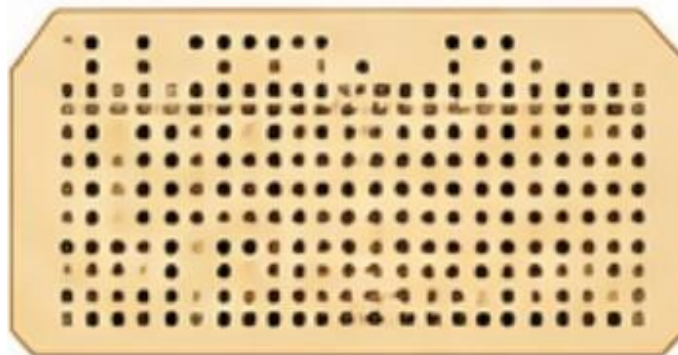


Figure: Charles Babbage designed this general-purpose machine. Ada Lovelace wrote the first published algorithm for it.

This figure shows Charles Babbage's design for the Analytical Engine, a proposed general-purpose mechanical computer. Although never completed, its design included many features found in modern computers, including memory, a processor, and



programmable instructions. .

Figure: This illustration shows a punched card used to store data by the presence or absence of holes.

Herman Hollerith used punch cards to store data and automate the U.S. Census. This was an early form of data processing. Punch cards were widely used for data processing and programming during the early years of computing.

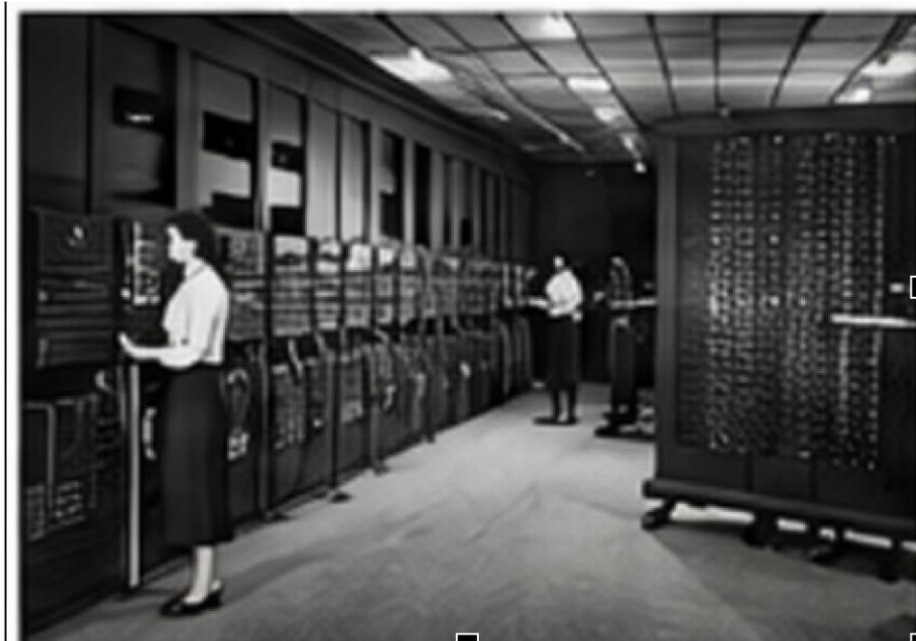
5.9: Electronic Computers

ENIAC: One of the first Electronic Computers (1946)

The first electronic computers used thousands of vacuum tubes to perform calculations at speeds that were impossible for mechanical machines, marking the beginning of the electronic computing era.

- Used vacuum tubes

- Filled a large room
- Performed thousands of calculations per second
- Was programmed by plugging cables and switches



5.10: Evolution of Storage Devices

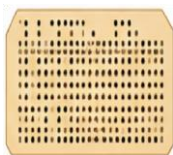
PUNCH CARD	MAGNETIC TAPE	FLOPPY DISK	HARD DRIVE	SSD	CLOUD STORAGE
1890s	1950s	1970s	1980s	2000s	2010s+
					

Figure: Evolution of Storage Devices

Storage has evolved from physical cards to fast digital media and now to online storage on the cloud.

The Rise of Microelectronics

The invention new technologies, including transistors, integrated circuits, and microprocessors and microprocessors made computers smaller, faster, more reliable, and more affordable devices that became practical for businesses, schools, and eventually homes.



5.11: The Five Generations of Computers

Historians often divide the development of computers into **five generations**, each marked by major technological advances.

The **first generation** (1940s–1950s) used vacuum tubes and consumed large amounts of electricity while occupying entire rooms.

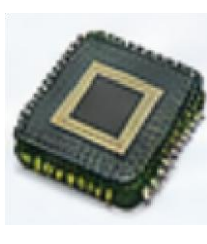
The **second generation** replaced vacuum tubes with transistors, making computers smaller, faster, and more reliable.

The **third generation** introduced integrated circuits, allowing many electronic components to be placed on a single chip.

The **fourth generation** began with the invention of the microprocessor, which combined the central processing unit onto one chip. This breakthrough led to the personal computer revolution.

Today, many experts describe the **fifth generation** as the era of artificial intelligence, machine learning, natural language processing, and other advanced computing technologies. Each generation has made computers more powerful, affordable, and accessible to people around the world.

The Five Generations of Computers: Timeline

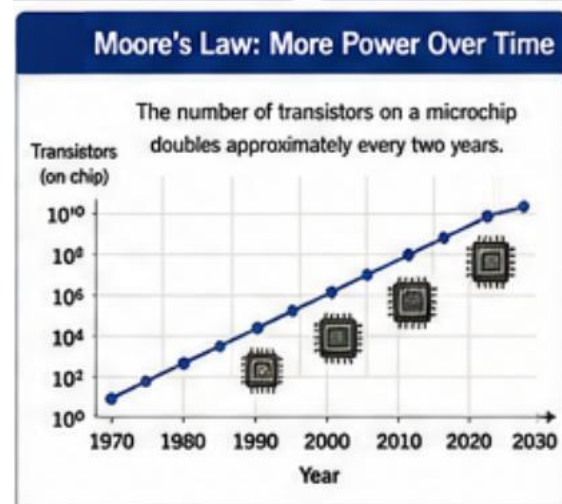
1st	2nd	3rd	4th	5th
1st	2nd	3rd	4th	5th
1940-1956 Vacuum Tubes	1956-1963 Transistors	1964-1971 Integrated Circuits	1971-Present Microprocessors	Present & Beyond AI & Quantum
				

Each generation made computers smaller, faster, cheaper, and more powerful.

This table summarizes the five generations of computer technology. Each generation is defined by a major technological advancement, beginning with vacuum tubes and progressing through transistors, integrated circuits, microprocessors, and today's artificial intelligence and emerging quantum computing technologies. [5.12: Moore's Law](#)

In 1965, engineer **Gordon Moore** observed that the number of transistors that could fit on a computer chip was doubling approximately every two years while the cost remained nearly the same. This observation became known as **Moore's Law**. Although it was not a scientific law, it accurately predicted the rapid growth of computing power for several decades.

This graph illustrates Moore's Law, showing the historical increase in the number of transistors that can be placed on a microchip. The trend demonstrates how computing power has increased dramatically while electronic components have become smaller and less expensive.



As more transistors fit onto a chip, computers became faster, smaller, and more energy efficient. Moore's Law helped explain why smartphones today are far more powerful than the room-sized computers used during the Apollo moon missions. Although the pace of transistor growth has slowed in recent years due to physical limitations, engineers continue to develop new technologies that increase computing performance.

Figure: Moore's Law: More Power Over Time

5.13: Evolution of Computer Size

The earliest electronic computers filled entire rooms and required specialized facilities with extensive cooling systems. Machines such as ENIAC weighed several tons and consumed enormous amounts of electricity. Over time, improvements in electronic components allowed computers to become dramatically smaller while increasing their processing power.

Today, powerful computers fit into laptops, tablets, smartphones, and even smartwatches. Many everyday devices, including automobiles, home appliances, and medical equipment, contain tiny computers known as **embedded systems**. This trend toward smaller, more portable devices has transformed how people communicate, learn, work, and entertain themselves.

ROOM SIZED	MAINFRAME	DESKTOP	LAPTOP	SMARTPHONE
1940s	1960s	1980s	1990s	2000s +



This table shows how computers have become progressively smaller and more portable over time, evolving from room-sized systems to mainframes, desktop computers, laptops, tablets, and smartphones while becoming increasingly powerful.

5.14: Personal Computer Revolution

Before the late 1970s, computers were primarily used by governments, universities, and large businesses. The introduction of personal computers changed that dramatically. Companies such as Apple, IBM, and Microsoft helped make computing available to individuals, schools, and small businesses. Affordable personal computers allowed people to write documents, manage finances, play games, and learn new skills from home.

Graphical user interfaces, computer mice, and productivity software made computers easier to use, even for people without technical backgrounds. As personal computers became common in homes and classrooms, digital literacy became an increasingly important skill. The personal computer revolution laid the foundation for today's connected digital society.

1977:
Apple
1977:
Apple



1981:
IBM PC
1981:
IBM PC



1985:
Microsoft Windows
1985:
Microsoft Windows



The emergence of affordable personal computers, including early Apple, IBM, and Microsoft systems brought computing power to businesses, schools and homes around the world.

5.15: Meet the Innovator: Mark Dean

Dr. Mark Dean's work on the IBM Personal Computer and the Industry Standard Architecture (ISA) bus helped establish hardware standards that made personal computers more expandable, reliable, and widely adopted. Mark Dean's innovations helped transform the personal computer from a specialized machine into a flexible platform that could support a wide range of hardware devices. His engineering contributions continue to influence computer design and demonstrate the importance of collaboration and standardization in technological innovation.



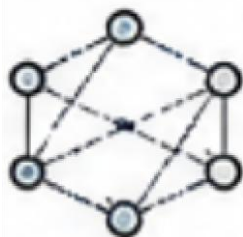
Mark Dean helped shape the personal computer by developing technologies that allowed hardware components to work together more efficiently.

5.16: The Birth of the Internet

The Internet began as a research project during the late 1960s called **ARPANET**, which connected a small number of computers so researchers could share information. As networking technology improved, additional institutions joined the network. During the early 1990s, **Tim Berners-Lee** introduced the **World Wide Web**, making it much easier for people to access information through web browsers.

Today, the Internet connects billions of computers and mobile devices worldwide. It supports communication, education, business, entertainment, scientific research, healthcare, and government services. The Internet has become one of the most important technological developments in modern history.

1969: ARPANET



The first network connected computers.

1989-1991: World Wide Web



Tim Berners-Lee creates the Web.

1990s: Web Browsers



Web browsers made the internet easier to use.

The Internet connected the world and changed everything.

5.17: Radia Perlman

Computer scientist **Radia Perlman** is often called the "**Mother of the Internet.**" She developed the **Spanning Tree Protocol (STP)**, which allows large computer networks to operate efficiently by preventing data from becoming trapped in endless loops. Her work made modern Ethernet networks more reliable and scalable.

Perlman has also made significant contributions to network security, routing protocols, and Internet design. Although many people are unfamiliar with her name, her innovations help keep computer networks functioning every day. Schools, businesses, hospitals, and data centers around the world rely on technologies based on her research.



This portrait highlights Radia Perlman's contributions to computer networking. She developed the Spanning Tree Protocol, a technology that allows large computer networks to operate reliably by preventing network loops.

5.18: Mobile, Cloud and Smart Technologies

The first mobile phones were designed primarily for voice communication and were often large, heavy, and expensive. As technology improved, manufacturers added text messaging, cameras, internet access, and multimedia capabilities. The introduction of smartphones combined the features of a telephone, camera, GPS, music player, and computer into a single handheld device.

Modern smartphones contain powerful processors, high-resolution displays, and advanced sensors. They allow users to access cloud services, participate in video conferences, navigate using GPS, and use artificial intelligence for tasks such as voice recognition and language translation. For many people, the smartphone has become their primary computing device.

1980s: Early Cell Phone	1990s: Feature Phone	2000s: Smartphone begins	2010s: Modern Smartphone	2020s: Advanced Mobile Devices
				

This table traces the development of mobile technology from early cellular phones to modern smartphones. Advances in computing, networking, and miniaturization transformed mobile phones into powerful handheld computers. Mobile devices evolved from communication devices to powerful computers in your pocket.

5.19: Cloud Computing



AI Timeline

- **1950s:** The idea of machines that can think is introduced
- **1960s-1980s:** Early AI research and expert systems
- **1990s-2010s:** Machine learning advances with more data and computing power
- **2020s:** AI becomes part of daily life: assistants, translation, recommendations, and more.

This timeline summarizes major developments in artificial intelligence from early theoretical research to modern machine learning and generative AI. It illustrates how advances in computing power, data, and algorithms have expanded AI capabilities over time.

5.21: Meet the Innovator: Ada Lovelace

Known For: Writing the first published computer algorithm

Why She Matters:

While working with Charles Babbage's proposed Analytical Engine in the 1840s, Ada Lovelace recognized that a machine could manipulate symbols and information, not just perform arithmetic. Her notes included what is widely regarded as the first published computer program.

Lasting Impact:

Today, every computer program, from smartphone apps to artificial intelligence systems, reflects the idea that computers can perform many kinds of tasks beyond mathematical calculations.



This portrait introduces Ada Lovelace and highlights her contribution to computing history. Her work on Charles Babbage's Analytical Engine included what is widely recognized as the first published computer algorithm and demonstrated that computers could process more than numerical calculations.

5.22: NASA Pioneers

Many of NASA's early successes were made possible by talented mathematicians, engineers, and programmers whose contributions were not widely recognized for many years.

Katherine Johnson, a mathematician, performed complex calculations that helped guide spacecraft safely into orbit and back to Earth.

Dorothy Vaughan, a computer scientist and programmer, became an expert programmer and supervised teams of mathematicians during the transition from manual calculations to electronic computers.

Mary Jackson, an aerospace engineer became NASA's first Black female engineer and contributed to aeronautical research.

These women overcame significant barriers related to race and gender while making essential contributions to the U.S. space program. Their achievements demonstrate that innovation depends on diverse perspectives and that many people have played important roles in the history of computing and engineering. Their work supported major space missions and helped expand opportunities for women and African Americans in science and technology.



Figure: This figure recognizes Katherine Johnson, Dorothy Vaughan, and Mary Jackson for their contributions to mathematics, engineering, and computer programming at NASA.

5.23: Grace Hopper

Meet the Innovator: Grace Hopper

Rear Admiral **Grace Hopper** was a pioneering computer scientist who believed programming should be easier for people to understand. During the 1950s, she helped develop one of the first **compilers**, software that translates programs written in human-readable languages into machine code that computers can execute.

Grace Hopper also played an important role in the development of **COBOL**, one of the first widely used business programming languages. Her work made computer programming more accessible and influenced nearly every modern programming language. She is remembered not only for her technical achievements but also for encouraging innovation and lifelong learning.

Historical Significance:

Grace Hopper's work on compilers allowed programmers to write instructions using words instead of machine language. Her innovations made programming more accessible and influenced the development of modern programming languages used today.



5.24: Alan Turing

Meet the Innovator: Alan Turing

British mathematician **Alan Turing** is considered one of the founders of modern computer science. In 1936, he described a theoretical computing machine capable of performing any computation that could be expressed as an algorithm. This concept became the foundation of modern programmable computers.

During World War II, Turing helped lead efforts to break encrypted German military communications, significantly contributing to the Allied war effort. After the war, he continued researching artificial intelligence and proposed the **Turing Test**, a method for evaluating whether a machine can exhibit behavior that appears intelligent. His ideas continue to influence computer science and AI research today.

