

# Evolution of Computers

**Turbo**

Hey, Tina! What do you remember about computers?

**Tina**

Well.... Ummm... A computer is a machine that accepts data, processes it as per a set of instructions, and displays an output.

**Turbo**

Not bad, Tina! Do you know how computers were developed?

**Tina**

No, Turbo!

**Turbo**

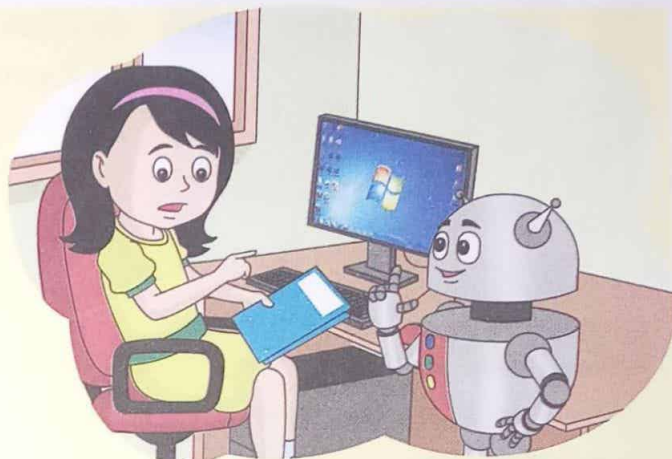
Well, computers, as you know them today, were not always like these.

**Tina**

Really...!

**Turbo**

Yes, computers have passed through a number of stages to reach their current form. Let me begin the story with the early calculating devices.



## EARLY CALCULATING DEVICES

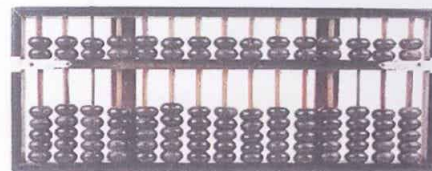
Human beings have felt the need for calculations for a long time. However, early calculating devices were quite different from the modern ones. Here is a brief history of these devices.

### Abacus

The abacus (Fig. 1.1) is believed to be the first calculating device. The earliest reference to abacus

### We'll Learn About

- » Early Calculating Devices
- » Generations of Computer
- » Characteristics of Modern Computers
- » Limitations of Computers



**Fig. 1.1** Abacus

dates back to 2700–2300 BCE in the Mesopotamian civilization. Simple calculations, such as addition and subtraction, could be performed using the abacus.

It is still in use in many countries, especially in countries of Asia and Africa. The abacus is used to teach school children about place values in the numbering system,

and also for teaching arithmetic operations to visually challenged students.

### Fact Bytes

Some of the most popular abacuses were developed in China, Japan, and Russia.



Learning calculations using the abacus is believed to improve concentration and memorization skills.

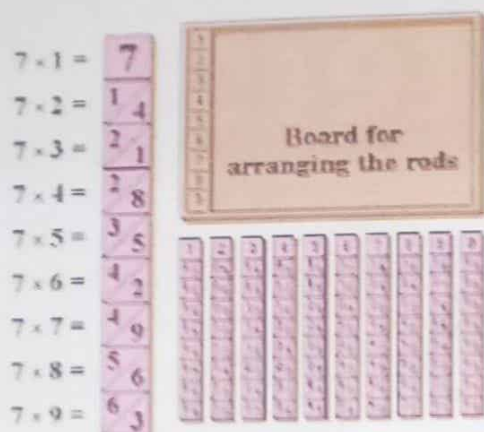


Fig. 1.2 Napier's Bones

### Napier's Bones

In 1616, Sir John Napier made a calculating device and called it Napier's Bones. It was used for addition, subtraction, multiplication, and division. The device was so named because it had numbers carved on bones or on strips of wood. (Fig. 1.2).

#### Fact Bytes

An improved form of Napier's Bones is used even for performing division and finding square roots.

### Pascaline

The Pascaline was the first mechanical calculator and was invented by Blaise Pascal in 1641. It consisted of a rectangular box with eight movable wheels (Fig. 1.3). It was used for addition, subtraction, multiplication, and division of numbers up to hundreds and thousands.



Fig. 1.3 Pascaline

### Difference Engine

In the 19th century, Charles Babbage invented the first mechanical computer. It was called the Difference Engine (Fig. 1.4).

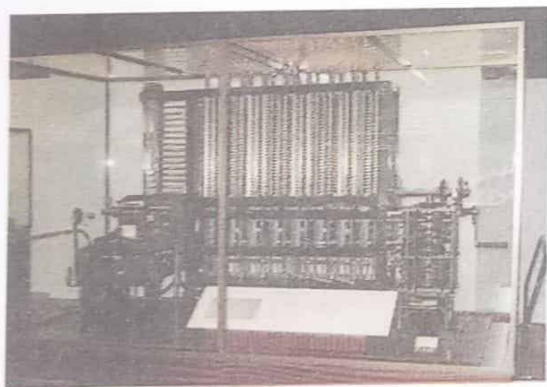


Fig. 1.4 Difference Engine

### Analytical Engine

Charles Babbage also invented the first general-purpose computer known as the Analytical Engine (Fig. 1.5). The Analytical Engine had the same basic elements as modern computers—input, output, and memory devices.

Charles Babbage is known as the *father of modern computers*.

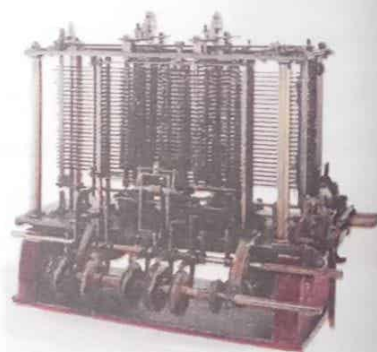


Fig. 1.5 Analytical Engine

## GENERATIONS OF COMPUTER

Computers were not invented in a single day. They have evolved through several years and many generations. Computers are generally classified into different generations based on the technological advancements.

### First-Generation Computers (1940–1958)

Some of the characteristic features of the first-generation computers were:

- They used *vacuum tubes* (Fig. 1.6).
- They were very large in size, had small internal storage, and were very expensive.
- Input was based on punched cards and paper tape.

Some examples of the first-generation computers are as follows:

#### Mark I

Mark I (Fig. 1.7) was designed by Howard H. Aiken in the year 1944. It was about 15 metres long and the wires connecting the various parts of the machine were about 800 kilometres long!

The machine was slow and took 3 to 5 seconds per calculation, but it was the **first fully automatic calculator** ever.

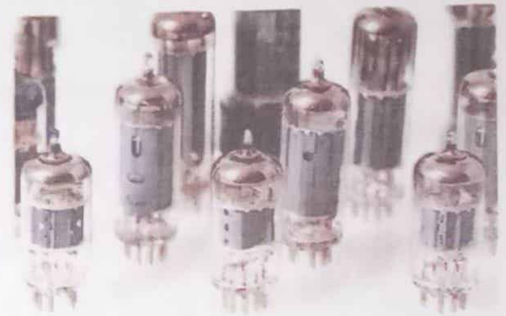


Fig. 1.6 Vacuum tubes



Fig. 1.7 Mark I



Fig. 1.8 ENIAC

### ENIAC (Electronic Numerical Integrator and Computer)

The ENIAC (Fig. 1.8) was developed by John Presper Eckert and John W. Mauchly in the year 1946. It was the first **fully electronic digital computer**.

It consisted of 18,000 vacuum tubes, occupied an area of 63 square metres, and weighed more than 27,000 kilograms! Whereas Mark I took about 5 seconds for adding two large numbers, the ENIAC could do it in 200 microseconds. It was originally built to help the army in launching bombs and missiles more accurately. It did not have **stored programs**; it had to be programmed by manually wiring the code for each task.

#### Fact Bytes

A *stored program* refers to a set of instructions stored in the computer for quick calculations. These instructions can be written in different technical languages understood only by a computer. These languages are known as *programming languages*.



## EDSAC (Electronic Delay Storage Automatic Calculator)

The EDSAC was designed by Professor M. Wilkes of Cambridge University, England, in the year 1949 and was slightly faster than the ENIAC. It weighed approximately 6000 kilograms and occupied an area of 20 square metres. It was the **first electronic computer that used stored programs**.

### Fact Bytes

Although the EDVAC was designed earlier than the EDSAC, its development got delayed. This made the EDSAC the first computer that used the concept of stored programs.

## EDVAC (Electronic Discrete Variable Automatic Computer)

The EDVAC was proposed by John Presper Eckert and John W. Mauchly in 1944 even as the ENIAC was being developed. John von Neumann, who also gave the concept of stored programs, joined them later to help in designing the EDVAC. It was completed in 1948.

The EDVAC weighed approximately 8000 kilograms and covered an area of 45.5 square metres.

It had the capacity to hold **stored programs as well as data**.

## UNIVAC I (Universal Automatic Computer)

UNIVAC I was developed in the year 1951, again by John Presper Eckert and John W. Mauchly. It weighed approximately 13,000 kilograms and occupied an area of 35.5 square metres. It was the first commercially available electronic computer and also the first computer to handle both numeric and text data.

## Limitations of First-Generation Computers

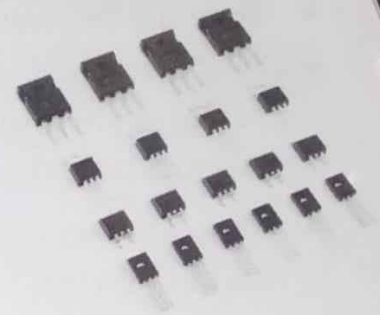
The major limitations of the first-generation computers were as follows:

- Their operating speed was quite slow.
- Their power consumption was very high.
- They required large space for installation.
- Their potential to be programmed for tasks was quite limited.
- They could solve only one problem at a time.
- They were hugely expensive to build.

## Second-Generation Computers (1959–1964)

Some of the characteristics of the second-generation computers were:

- ① ✓ They were faster and smaller in size than the first-generation computers.
- They were more reliable than the first-generation computers.
- They had many components — printer, memory, disk storage, operating system, etc. — which are associated with modern-day computers.
- ② ✓ Transistors (Fig. 1.9) were used as their main component, which replaced the vacuum tubes used in the first generation computers.
- They were easier to program than the first-generation computers. So they had greater commercial use.
- The programming languages, such as COBOL and FORTRAN came into use during this time.



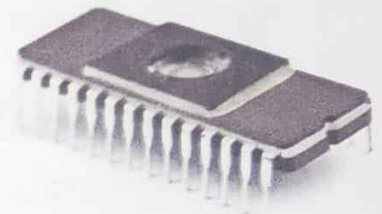
**Fig. 1.9** Transistors

**IBM 1401** and **RCA 501** are examples of second-generation computers.

### Third-Generation Computers (1964–1970)

The third-generation computers were smaller as compared to the second-generation computers. Their characteristics were:

- They were faster and smaller than the second-generation computers.
- They used Integrated Circuits (ICs) (Fig. 1.10) as their main component, which are popularly called *chips*.
- They used new input and output devices such as scanners, magnetic ink character readers, etc.
- Memory capacity was greatly enlarged.
- They used an operating system that allowed machines to run many programs simultaneously.
- They were general-purpose computers and had both scientific and commercial use.
- These computers used a keyboard to input data and a monitor to display the output.



**Fig. 1.10** A chip

The **IBM 360** and **370** series are examples of the third-generation computers.

### Fourth-Generation Computers (1971 – present)

The fourth-generation computers, i.e., the present-day computers, are unique in the following ways: ●



- They use **microprocessors**, a type of very-large-scale integrated circuits (VLSIC), which contain all the components of the CPU on a single chip. The VLSICs perform the bulk of processing and control all parts of the system. The use of microprocessors has resulted in decreased size and increased efficiency.
- They have much greater computing power and storage capacity than the earlier generations of computer.
- They use improved storage devices that are cheaper than the earlier ones.
- They can be linked together (i.e., networked) to share storage capacity, space, data, etc.

**IBM PC and Apple Macintosh** are examples of fourth-generation computers.

In addition to the desktop computers, nowadays, laptops, palmtops, and tablets, which can be carried anywhere with ease, have become very common.

In the various stages of the evolution of computers so far, the focus has been on reducing the size and improving the efficiency. This has resulted in smaller yet faster computers. However, these computers do not yet have the ability to think.

#### Fact Bytes

Intel developed the first commercially available microprocessor, called Intel 4004, in 1971.

### Fifth-Generation Computers (1989–Future)

The fifth-generation computers are referred to as **supercomputers**. Supercomputers have very high storage capacities, extremely high speeds, and the ability to carry out highly sophisticated operations, such as weather forecasting.

The **CRAY CS300** series is an example of supercomputers.

Fifth-generation computing also involves *artificial intelligence* (AI). **Artificial intelligence** is a branch of computer science that aims to create computers that can think, behave, and react in the same way as humans do.

The fifth-generation computers would possibly be able to think like humans.

Japan was one of the first countries that tried developing artificial intelligence in the late 1980s and the early 1990s, but they did not succeed. Even today, we have achieved only limited success.

However, scientists believe that by 2030 we would be able to have machines that equal the complexity of a human brain.

#### Fact Bytes

PARAM 8000 was the first supercomputer made in India, completed and installed in 1991.

**Table 1.1** summarizes the five computer generations with their key features.

**Table 1.1** Computer generations at a glance

GENERATION	PERIOD	MAIN COMPONENT	CHARACTERISTICS	EXAMPLES
First	1940–58	Vacuum tubes	<ul style="list-style-type: none"><li>• Very large in size, small internal storage, slow speed</li><li>• High power consumption</li><li>• Large installation area</li><li>• Difficult to program</li></ul>	Mark I ENIAC EDSAC EDVAC UNIVAC I
Second	1959–64	Transistors	<ul style="list-style-type: none"><li>• Smaller, faster, and cheaper</li><li>• Contained many components associated with modern day computers – printer, memory storage, operating system, etc.</li><li>• Programming languages, such as COBOL and FORTRAN came into use.</li></ul>	IBM1401 RCA 501
Third	1964–70	Integrated circuits (chips)	<ul style="list-style-type: none"><li>• Smaller size, greater speed and efficiency</li><li>• Increased storage capacity</li><li>• Different programs could be run together</li></ul>	IBM 360 and 370 series
Fourth	1971–present	Microprocessors	<ul style="list-style-type: none"><li>• Greater computing power</li><li>• Greater storage capacity</li><li>• Use better storage devices that cost less</li><li>• Can be linked together or networked</li></ul>	Modern day PCs, laptops, palmtops
Fifth	1989–Future	Artificial intelligence	<ul style="list-style-type: none"><li>• Extremely high speed and enormous storage capacity</li><li>• Ability to carry out sophisticated operations such as weather forecasting</li><li>• Might overcome the lack of thinking power</li></ul>	CRAY CS300 series

## CHARACTERISTICS OF MODERN COMPUTERS

The word “computer” is derived from the verb “compute” which means “to calculate”. However, computers are not just fast calculators. They can also perform non-arithmetic operations such as copying, moving, comparing, and so on.



The characteristics that make modern computers unique are:

### Speed

Computers can perform complex mathematical calculations as well as other operations at very high speed.

### Accuracy

Computers are very accurate. If the data and instructions entered into a computer are correct, the result produced will be accurate. A computer performs every calculation with the same accuracy.

However, errors can occur if the inputs provided to them by humans are incorrect.

### High Storage Capacity

Computers have very large memory. They can store a huge amount of data in small space. The data stored can be retrieved instantly and correctly whenever desired.

### Diligence (Untiring)

Being a machine, a computer does not suffer from boredom, tiredness, or lack of concentration.

Even if a million operations are to be performed by a computer, it will perform the last calculation with the same accuracy and speed as the first one.

### Versatility

Computers can perform different types of jobs efficiently. They can work with different types of data, such as graphics, audio, video, etc.

## LIMITATIONS OF COMPUTERS

In spite of so many advantages, computers do have some limitations.

Computers lack decision-making abilities. Computers need to be instructed at each and every step. If an unanticipated situation arises, they will either produce incorrect results or not complete the task.

Besides, being machines, computers lack emotions.

Computers that involve artificial intelligence are also called *expert systems*.

An **expert system** is a computer system that has decision-making ability like humans.



## Tech Terms

**Abacus** Believed to be the first calculating device

**Napier's Bones** A calculating device developed by Sir John Napier that had numbers carved on bones or strips of wood

**Pascaline** The first mechanical calculator, invented by Blaise Pascal

**Difference Engine** The first mechanical computer, invented by Charles Babbage

**Analytical Engine** The first general-purpose computer, invented by Charles Babbage

**ENIAC** Electronic Numerical Integrator and Computer

**EDSAC** Electronic Delay Storage Automatic Calculator

**EDVAC** Electronic Discrete Variable Automatic Computer

**UNIVAC** Universal Automatic Computer

## To Sum Up

### Early Calculating Devices

- The abacus was probably the first calculating device.
- In 1616, Sir John Napier made a calculating device called Napier's Bones. It was used for addition, subtraction, multiplication, and division.
- Pascaline, the first mechanical calculator, was invented by Blaise Pascal.
- The Difference Engine, used to prepare mathematical tables, was invented by Charles Babbage. Charles Babbage also invented the Analytical Engine, the first general-purpose computer.

### Evolution of Computers

- Computers are classified into different generations based on the technology used.

- First-generation computers used vacuum tubes, and were heavy and expensive.
- Second-generation computers used transistors, and were smaller and faster than the first generation computers.
- Third-generation computers used integrated circuits (ICs), and were smaller than the second generation computers.
- Fourth-generation computers use micro-processors, have much-improved computing power, and high storage capacity.
- Supercomputers have huge storage capacity and extremely high speed; they have the ability to make decisions and carry out highly sophisticated operations, such as weather forecasting.

# Exercises

## Objective Type Questions

**A** Fill in the blanks with the correct words.

Vacuum Tubes

Second

Fifth

Transistors

Abacus

1. The Abacus was probably the first calculating device.
2. The first-generation computers used Vacuum Tubes as their main component.
3. In the second-generation computers, the Transistors were used for the first time.
4. The COBOL language came into use in the Second generation computers.
5. Fifth generation computing also involves artificial intelligence.

**B** Write T for the true statement and F for the false one.

1. Learning calculations using an abacus is believed to improve concentration and memory skills. ☒ T
2. The second-generation computers were bigger in size than the first-generation computers. ☐ F
3. The IBM 360 series is an example of the third-generation computers. ☒ T
4. The keyboard and the monitor were first used in the second-generation computers. ☐ F
5. Computers lack the ability to make decisions. ☒ T

**C** Choose the correct option.

1. Mark I was designed by
  - a. John Presper Eckert
  - b. ☒ Howard H. Aiken
  - c. M. Wilkes
  - d. None of these
2. The first electronic computer that used stored programs was
  - a. ☒ EDSAC
  - b. ENIAC
  - c. EDVAC
  - d. None of these
3. The UNIVAC I was developed in the year
  - a. ☒ 1951
  - b. 1941
  - c. 1931
  - d. None of these



## 1. EVOLUTION OF COMPUTERS

### Objective Type Questions

- |              |                 |                |           |          |
|--------------|-----------------|----------------|-----------|----------|
| A. 1. Abacus | 2. Vacuum tubes | 3. Transistors | 4. Second | 5. Fifth |
| B. 1. T      | 2. F            | 3. T           | 4. F      | 5. T     |
| C. 1. b      | 2. a            | 3. a           | 4. c      | 5. a     |

### Descriptive Type Questions

- D. 1. Two limitations of the first-generation computers:
- Their operating speed was quite slow.
  - Their power consumption was very high.
2. ENIAC – Electronic Numerical Integrator and Computer  
UNIVAC – Universal Automatic Computer
3. Two features of the second-generation computers:
- They were faster and smaller than the first-generation computers.
  - Transistors were used as their main component instead of vacuum tubes.
4. Two examples of fourth-generation computers – IBM PC and Apple Macintosh
5. Microprocessors are a type of very-large-scale integrated circuits (VLSIC), which contain all the components of a CPU on a single chip.  
The use of microprocessors has decreased the size and increased the efficiency of modern computers.