1 Computer Evolution: From Abacus to Smartphone

CONNECT

You use different machines in your daily life. Find out who invented the following machines?

1. 

2. 

3. 

4. 

Which of these machines do you use in daily life? .....

LEARN

You will learn about:

- The need to invent devices
- Generations of computers
- Functions of devices used in the past and present

TASK

For the coming computer week, the computer teacher has planned a role-play for Grade 5 students. The topic is 'Computers from different periods of time'. The students will have to **enact** as different devices. They can speak about its invention, its inventor and its usage. After the act, the teacher will conduct a quiz on the different devices related to computers that were developed over time.

Look Up

Enact: to act out

EARLY COUNTING TECHNIQUES

How did people do lengthy calculations in olden days?

They did not have any calculating machines as you have today. They used pebbles, bones (Fig. 1.1), sticks and fingers of their hands to count and calculate. They also used ropes for long calculations. They even made shapes for some measurements. But, these things did not give **accurate** results.

Fig. 1.1 *Bones used for calculations*

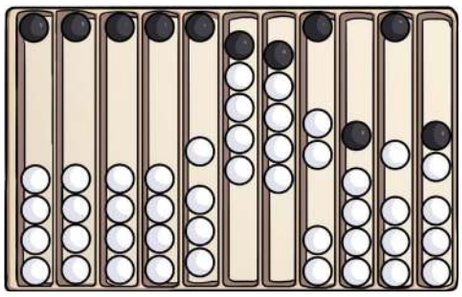

Fig. 1.2 *Counting board*

Later, counting boards were used for everyday calculations (Fig. 1.2). They were used to calculate the **trade** between goods bought and sold. The oldest counting board is the **Salamis Tablet**. It was used by the Babylonians circa 300 BCE. It was a piece of wood carved with stone or metal grooves. Between the grooves, beads or pebbles were moved for calculation.

SIEVE OF ERATOSTHENES

In the third century BCE, Eratosthenes invented a simple algorithm called the **Sieve of Eratosthenes** (Fig. 1.3). This **algorithm** was used to find all the prime numbers up to any given limit.

	2	3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30
31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50
51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70
71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90
91	92	93	94	95	96	97	98	99	100
101	102	103	104	105	106	107	108	109	110
111	112	113	114	115	116	117	118	119	120

Fig. 1.3 *Sieve of Eratosthenes*

Prime Numbers

2	3	5	7
11	13	17	19
23	29	31	37
41	43	47	53
59	61	67	71
73	79	83	89
97	101	103	107
109	113		

Look Up

Accurate: correct
Trade: to exchange
Algorithm: a set of mathematical instructions

ACTIVITY 1

Find out about Eratosthenes, the Greek Mathematician. Share your information in class.

ABACUS

In the sixth century BCE, **Abacus** was invented by the Chinese (Fig. 1.4). It is the first known calculating device. It is made up of a metal or wooden frame, which is divided into two parts by a horizontal bar and 13 vertical bars. Each bar contains seven beads. Two beads are placed at the upper section and five beads are placed at the lower section. It is used to do simple addition and subtraction.

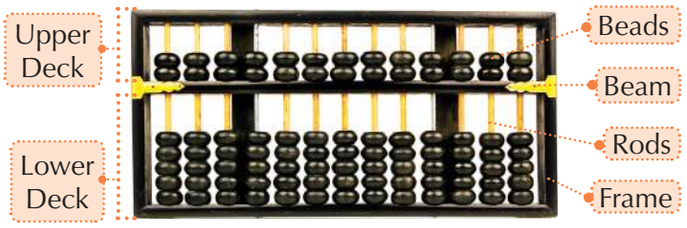

Fig. 1.4 *Abacus*

At present, it is learnt by many students in order to do calculations quickly and easily. They use abacus which contains only five beads in each bar. There is one bead in the upper section and four in the lower section (Fig. 1.5).

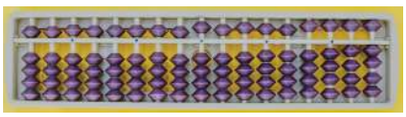

Fig. 1.5 *Abacus with one bead in upper deck*

ACTIVITY 2

There is a popular saying: 'Necessity is the mother of invention'. Which necessity do you think led people to invent better calculating machines? Discuss with your classmates.

NAPIER'S BONES

By the middle of the 16th century, explorations of various continents led to an expansion of trade. The merchants needed devices for **precise** calculations of sea routes, accounting, planetary positions and so on.

People with mathematical **proficiency** were hired for such jobs. They used to do the repetitive calculations manually.

In 1617, Sir John Napier invented Napier's bones (Fig. 1.6), also called Napier's rods. In this, the numbers 0 to 9 were marked on a set of ivory sticks. These numbers were marked in such a way that the product of any number could be found by placing the sticks side by side.

Fig. 1.6 *Napier's bones*

Later, many improved versions of Napier's bones were developed. They could also be used for doing division.

Look Up

Precise: exact

Proficiency: when you can do something very well

Napier's invention also led to the invention of the slide rule. It was first built in England in 1632. It was used by NASA engineers to plan and execute the mission that landed Apollo 11 on the moon.

PASCALINE CALCULATOR

In 1642, Blaise Pascal invented a machine for his father. His father was a tax collector. He named the machine as **Pascaline** or **Arithmetique** (Fig. 1.7). It could add and subtract numbers automatically.

Fig. 1.7 *Pascaline*

ACTIVITY 3

A. Is the product of 4 and 5 equal to 5 added four times?

B. Do you think multiplication is repeated addition?

C. Did the mathematicians use the same logic to multiply numbers?

Fig. 1.8 *Leibniz's calculator*

LEIBNIZ'S CALCULATOR

In 1673, Gottfried Von Leibniz invented calculator known as **Leibniz's calculator** (Fig. 1.8). It was also called the Step Reckoner. It was superior to Pascaline. It could add, subtract, multiply and divide numbers.

This led to the automation of machinery in the 18th–19th centuries.

JACQUARD LOOM

In 1801, Joseph Marie Jacquard invented the **Jacquard loom** (Fig. 1.9). It used punched cards to control the sequence of operations. A pattern of the loom's weave was changed by changing the punched card.

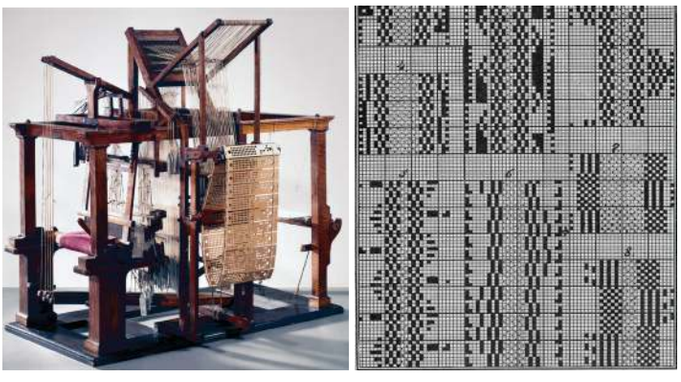

Fig. 1.9 *Jacquard loom and a close-up of a Jacquard punched card*

DIFFERENCE AND ANALYTICAL ENGINES

In 1822, Charles Babbage designed the **Difference engine** (Fig. 1.10). This machine was to be used for calculating and printing of simple Mathematical tables. But he could not complete this machine.

Fig. 1.10 *Difference engine*

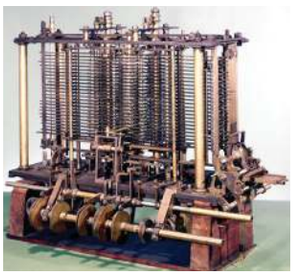

Fig. 1.11 *Analytical engine*

Later in 1834, Charles Babbage invented the **Analytical engine** (Fig. 1.11). The main parts of his machine were called the *store* and *mill*. The data were stored with the help of punched cards. Mill processed the data to give a result. The calculating machines made then and now are based on the designs of the Analytical engine. The storage of the Analytical engine was similar to presently used memory devices. The mill is similar to the Central Processing Unit which we use today.

Tech Fact

Charles Babbage is known as the **Father of Computers**.

Lady Ada Augusta Lovelace suggested some programs to Charles Babbage for the Analytical engine. She is known as the first programmer. A programming language used chiefly by the US government was named Ada in her honour.

TABULATING MACHINE

In 1888, Herman Hollerith invented the **Tabulating Machine** (Fig. 1.12). The increase in the population in the USA, and the need of recording the population data was a tiring process. He used the notes that were left by Charles Babbage. He used the machine to calculate the results of the US Census. Punched cards were used to feed the census data into the machine. He completed the processing of the census data in about two years. Earlier, it would take several years to complete similar data.

Fig. 1.12 *Hollerith Printing and Listing Tabulating Machine*

Fig. 1.13 *The Harvard Mark I, an electromechanical computer*

MARK I

In 1944, Howard Aiken designed **Mark I** (Fig. 1.13). It was a fully automatic machine in **collaboration** with International Business Machines (IBM) Corporation.

Mark I was the first electromechanical computer. It ran non-stop for 15 years. It sounded like a room full of ladies knitting. It was also called Automatic Sequence Controlled Computer (ASCC).

Look Up

Collaboration: When two or more people work together to create or achieve the same thing.

ACTIVITY 4

Number the given devices according to the order in which they were invented.

A. Abacus	B. Counting boards	C. Leibniz's calculator
D. Pascaline	E. Napier's bones	F. Difference engine
G. Jacquard loom	H. Mark I	I. Analytical engine
J. Tabulating machine		

GENERATIONS OF COMPUTER

Researches and advancements in every field required increased speed, **precision** and instant results. To store programs in a digital computer with CPU as well as memory to hold instructions and data was the need of the hour. These computers were built by using vacuum tubes, transistors and integrated circuits. These developments are classified into the various generations of computers. The classification is based on the technology, speed, storage, reliability and cost of machines.

Look Up

Precision: accuracy

FIRST-GENERATION COMPUTERS (1940–1956)

First-generation computers were made by using **vacuum tubes** (Fig. 1.14). They were huge in size. For example, ENIAC, EDVAC and UNIVAC.

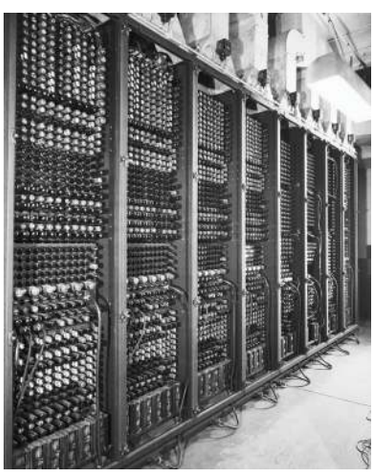

Fig. 1.14 *Vacuum tubes of ENIAC*

In 1946, John Presper Eckert and John W. Mauchly developed the **E**lectronic **N**umerical **I**ntegrator and **C**omputer (**ENIAC**) (Fig. 1.15). It was the first electronic general-purpose computer.

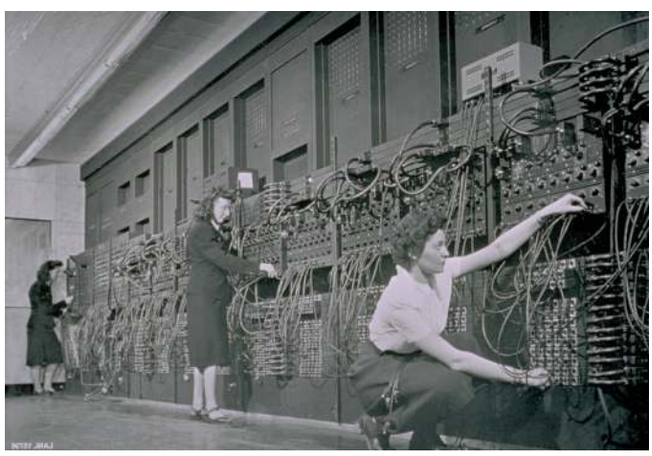

Fig. 1.15 *ENIAC*

In 1951, John Presper Eckert and John W. Mauchly got an idea to have stored program computer. **E**lectronic **D**iscrete **V**ariable **A**utomatic **C**omputer (**EDVAC**) (Fig. 1.16) was to be a huge improvement on ENIAC. The ON/OFF switch ability for the memory was required

Fig. 1.16 *EDVAC*

Fig. 1.17 *UNIVAC I*

because EDVAC used binary numbers, that is, 0 or 1 rather than decimal numbers. This simplified the calculation of the arithmetic units.

In 1951, John Presper Eckert and John W. Mauchly designed **UNIVAC I** (**UNIV**ersal **A**utomatic **C**omputer I) (Fig. 1.17). It was introduced as the first commercial computer made in the United States. Each machine contained about 5,000 vacuum tubes. Each unit was bulky and needed a lot of maintenance.

SECOND-GENERATION COMPUTERS (1956–1963)

Second-generation computers used **transistors** in place of vacuum tubes. Transistors were more reliable, cheaper and smaller. The computers were also smaller in size, but they had more computing power. They were easier to maintain and more affordable than the previous generation of computers (Fig. 1.18).

The development of High-level Languages, such as FORTRAN, COBOL, ALGOL and SNOBOL, took place during this generation.

Fig. 1.18 *World's first transistor computer*

Tech Fact

The first transistor was invented at **Bell Laboratories** on December 16, 1947 by John Bardeen, William Shockley and Walter Brattain.

John Bardeen

William Shockley

Walter Brattain

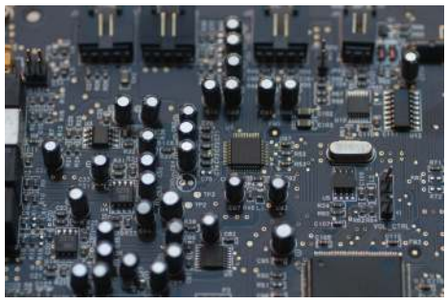

Fig. 1.19 *Integrated Circuits*

THIRD-GENERATION COMPUTERS (1964–1971)

Third-generation computers used **integrated circuits** (Fig. 1.19). The transistors were further reduced in size. They were kept on silicon chips called semi-conductors, which increased the speed and efficiency of computers.

Tech Fact

From 1958 to 1959, both electrical engineers Jack Kilby and Robert Noyce were unaware of each other's activities. They both invented almost identical integrated circuits or ICs at nearly the same time.

Jack Kilby

Robert Noyce

FOURTH-GENERATION COMPUTERS (1972–PRESENT)

Fourth-generation computers were developed in the 1970s. The Intel Corporation engineer Dr. Ted Hoff invented the **microprocessor** Intel 4004 (Fig. 1.20). It was the world's first microprocessor, smaller than a postage stamp. The revolution of microprocessor reduced the size of the computer along with its cost. It also increased the speed, storage space and reliability of computers.

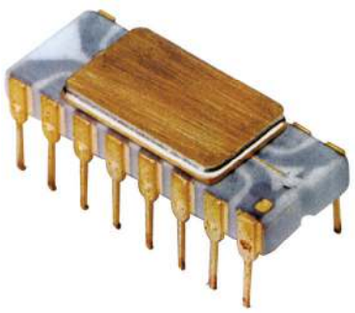

Fig. 1.20 *Intel 4004*

Another major development that took place in this period was of the high-speed computer networks such as Local Area Network (LAN) and Wide Area Network (WAN). LAN typically covers an area almost equivalent to a building and WAN covers an area almost as big as a continent. You may say that the WAN is a global connection for today's computers.

FIFTH-GENERATION COMPUTERS (PRESENT AND BEYOND)

Scientists are working on the concept of Artificial Intelligence (AI). It is similar to human intelligence, in terms of capability to decode and respond to human language.

The fifth-generation computers use super-large-scale integrated chips. The devices that are developed respond to inputs in human languages and are capable of further learning. The devices use more than one CPU and have a faster processing speed while using molecular and nano technology.

Tech Fact

Mainframe is a very large and expensive computer. It is capable of supporting hundreds or even thousands of users simultaneously. The speed of mainframe computers is expressed in million instructions per second (MIPS). Therefore, they are used by large organisations.

IBM mainframe

Supercomputer is a computer with great speed and memory. They are very expensive and are engaged for specialised applications that require huge amounts of mathematical calculations. For example, weather forecasting requires a supercomputer.

PARAM 8000 is India's first supercomputer. It was built in 1991 by Centre for Development of Advanced Computing (C-DAC).

Supercomputer

The first smartphone, IBM Simon, was designed with a touch screen. It was released in 1993. It had an address book, calendar, world clock, calculator, notepad, email client, games and the ability to send and receive faxes.

The advancements have paved the way to smartphones and wearable devices which contain many features also available on a computer. For example, apart from calling and messaging, you can browse the Internet, check email, play games and do many more things.

Look Up

Humanoid: something that has an appearance resembling a human without actually being one

The term **artificial intelligence** is composed of two words, that is artificial and intelligence. According to the father of Artificial Intelligence, John McCarthy, it is '*The science and engineering of making intelligent machines, especially intelligent computer programs, is called artificial intelligence*'.

ASIMO (Advanced Step in Innovative Mobility) is a **humanoid** robot that can run, dance, hop and even kick a soccer ball. It was created by Honda in 2000, and it is an example of a machine running on AI. It travels the world as an ambassador to robokind.

Sophia is a social humanoid robot developed by Hong Kong-based company Hanson Robotics. Sophia was activated on February 14, 2016 and can show more than 60 facial expressions.

ACTIVITY 5

Discuss and appreciate the efforts that have been made in the past by various inventors to make the present-day machines available to you.

RECAP

- In the olden days, people used pebbles, bones with marks carved into them along with the fingers on their hands to count and calculate.
- Some of the early calculating devices are Abacus, Napier's Bones, Pascaline calculator.

- First-generation computers were developed between 1940 and 1956. They were made out of vacuum tubes.
- Second-generation computers were developed after 1955. They had transistors in the place of vacuum tubes.
- Third-generation computers were developed in the 1960s. They used integrated circuits.
- Fourth-generation computers were developed in the 1970s. They used microprocessors.
- Fifth-generation computers are being developed based on the concept of Artificial Intelligence (AI).

CHECKLIST

Put a ✓ to show whether you have understood these terms or need help.

Term	I got it!	I need help!
Early calculating devices		
Vacuum tubes		
Transistors		
IC chip		
Microprocessor		
Artificial Intelligence		

ASSESS

A. Fill in the blanks with the help of the given words.

Tabulating Machine Sophia Leibniz's calculator Artificial Intelligence Abacus

1. ..... is a social humanoid robot developed by Hong Kong-based company Hanson Robotics.
2. In 1888, Herman Hollerith invented the ..... .
3. In 1673, Gottfried Von Leibniz invented the calculator known as ..... .
4. ..... is the first known calculating device.
5. The science and engineering of making intelligent machines, especially intelligent computer programs, is called ..... .