1942–1946
First Electronic Computers: *Colossus and ENIAC*

Learning Outcomes addressed in this section are listed below.

1.11 discuss the complex relationship between computing technologies and society including issues of ethics

1.12 compare the positive and negative impacts of computing on culture and society

1.13 identify important computing developments that have taken place in the last 100 years and consider emerging trends that could shape future computing technologies

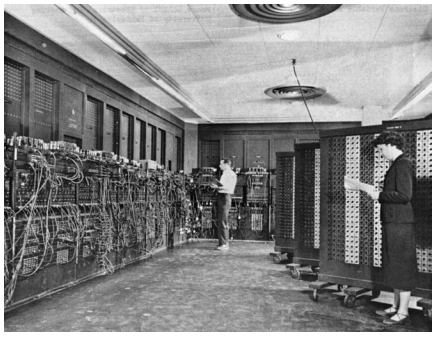
1.18 recognise the diverse roles and careers that use computing technologies

2.11 describe the different components within a computer and the function of those components

When other Learning Outcomes are addressed, for instance in classroom activities or through related online resources, the LO is numbered.

What constitutes a computer? Charles Babbage designed a mechanical computing machine called the Difference Engine, in 1822. Babbage's later concept for an Analytical Engine is considered the first general mechanical computer comprising a basic processing and storage of data. In addition Ada Lovelace published an algorithm for the machine and showed it could be programmed by punch cards. In the late 1930s Konrad Zuse designed the Z1, an electro-mechanical programmable computer. The Harvard Mark 1 was a more sophisticated version which was first programmed by John von Neumann at the end of World War II. However the Colossus was the first fully programmable electric computer. Invented and designed by Tommy Flowers and Alan Turing, it made a major contribution to ending WWII when it helped to crack the codes of Nazi encryption machines. Simultaneously in the USA, Eckert and Mauchly built the ENIAC (Electronic Numerical Integrator and Computer), which is often considered to be the first example of a general purpose digital computer.

The components of the first programmable computers



The ENIAC

The first electronic computers, Colossus and ENIAC, weighed tons, occupied large rooms, and before the invention of semiconducting transistors, switching was executed by vacuum tubes (thermionic valves). Military advances during WWII spurred innovation and fast-tracked the invention of the ENIAC. The Colossus was re-built in Bletchley Park, the top secret British site of WWII decryption. It went live on 6th June 1996. Watch this Computerphile tour of the operation of the machine.

The Babbage analytical machine, as explained in the video on the evolution of computing devices, had 4 revolutionary features: Input, Storage, Processing and Output components. Sequential flow control and looping operations were fundamental to his concept. Today, the inside of modern computers is not that different.

Watch a short video on the evolution of computing devices.

- What 4 features of the Babbage machine made it revolutionary?
- Name components that act as switches?
- What was the first microprocessor used for?

Explore the Human Brain Project website to see the latest advances in how our brains could be simulated.

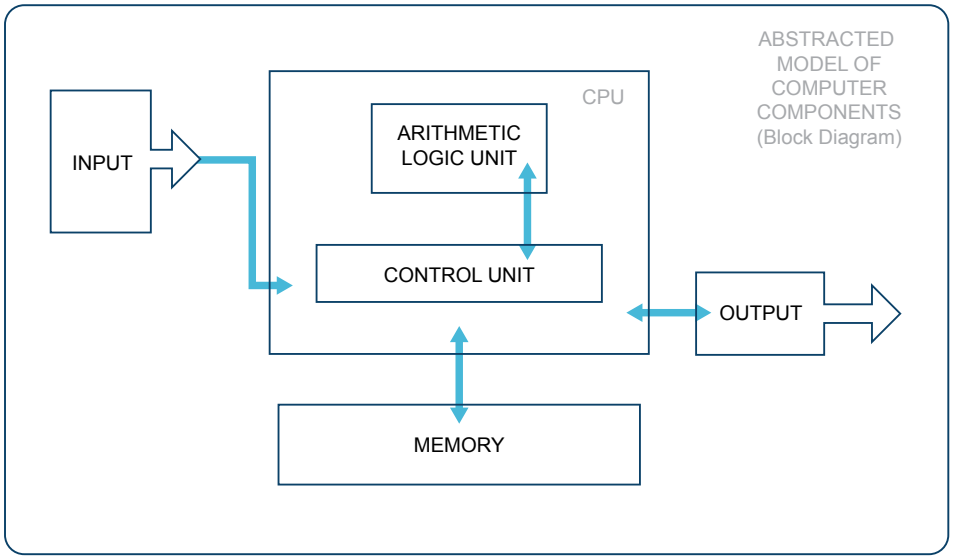
LO 1.13
LO 2.11

From Enigma to ENIAC and John von Neumann's contribution to the modern programmable computer. The first use of computers in 1952 to predict US election results.

The history and development of the ENIAC (0–7:44) and the path forward after WWII (7:44–12:47)

LO 1.11
LO 2.11

The Arithmetic Logic Unit (ALU), where instructions are actually carried out, is probably the only functional unit that is extra to the original concept, as shown in the schematic block diagram below.



The complex relationship between society and computing technology is demonstrated clearly through the invention of the Colossus and ENIAC. The Colossus had a real impact on the war, shortening it by 2 or 3 years.[5] Processing data, encrypting and deciphering codes and crunching numbers became key factors in deciding the outcome of WWII.

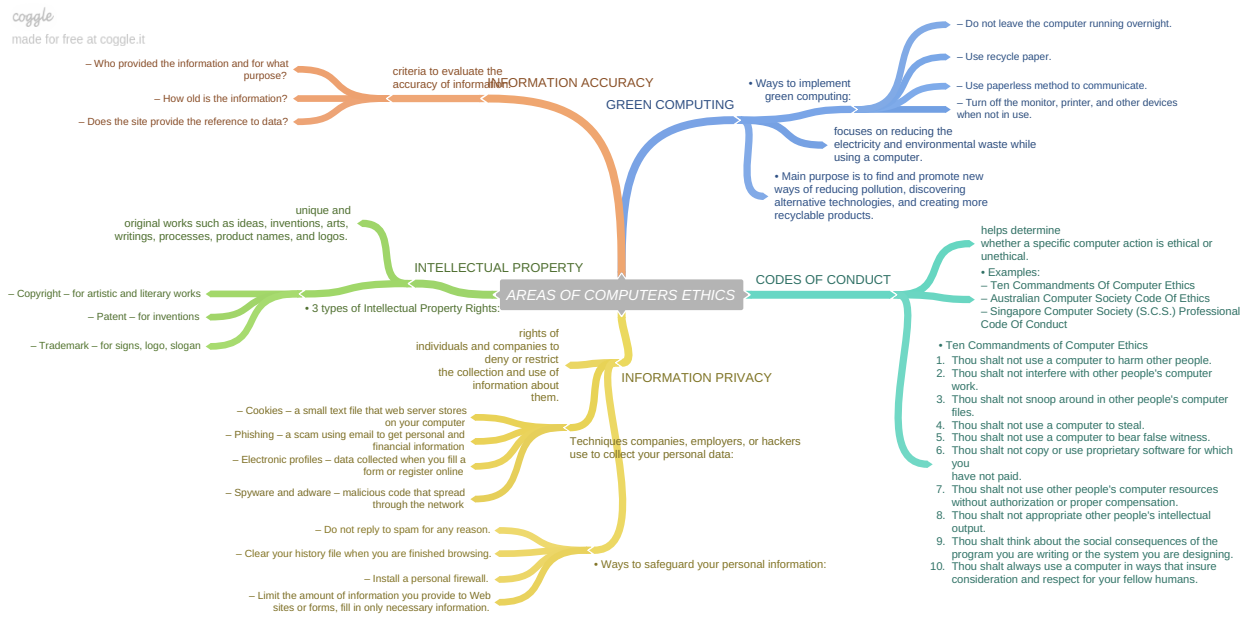
Would the first electronic computers have evolved so rapidly, almost independently of each other, without the impetus of a world at war? Many military innovations become mainstream technologies. For example, the US Defence Advanced Research Projects Agency (DARPA) developed the Arpanet[6] in the late 1960s. It connected 4 nodes in the USA, developed IP addresses and invented TCP and UDP networking protocols. In the 1980s it evolved into the Internet.

5 BBC homepage and news http://www.bbc.com/news/technology-18419691

6 Wang (2016) *From Computing to Computational Thinking* CRC Press (p 97–98).

However ethics and computing technology spreads into our everyday life. The coggle mindmap below delves into all the areas where people, society and business must think not just about "Can I do this?" but "Should I do this?".

Lots of websites suitable for LCCS that explore computers and society can be filtered on www.compsci.ie.



The following is a worked example suggesting how to *Stimulate a Debate* on an ethical question. It creates a classroom context in which to explore the complex relationship between military innovations, especially during wartime, influencing computing technology in society.

Stimulate a Debate on the positive and negative impact of military innovations on both society and technological developments.

The model for this activity is explained in A Summary of Teaching & Facilitation Methodologies.

1. Watch a Stimulus Video or read a stimulus piece.

A video of 5 DARPA innovations that have become everyday technologies

2. Prompt questions to provoke class discussion and elicit initial viewpoints.

- Can you name some military inventions that have shaped our world, both positively or negatively? (from nuclear technology to drones to GPS!)
- How would the Internet be different if a commercial company invented it instead of the US Arpanet?
- Without the invention of the nuclear bomb, would we have nuclear power stations? Would we have less or more understanding of our universe and the sub-atomic world?
- Do you think the first electronic computers (Colossus and ENIAC) would have developed in different ways and at a different pace?

3. Divide into research groups to explore the topic from key standpoints.

The positive and negative impacts of military innovations on society and on technology.

Themes for different groups:

1. Military innovations, including wartime inventions, have an overall positive impact on society and on technology.
2. Military innovations, including wartime inventions, have an overall negative impact on society and on technology.
3. Societies advance rapidly, from a technological point of view, when there is a strong military and especially during wartime.
4. Societies advance slowly or not at all, from a technological point of view, when there is a weak military or no military at all.

4. Choose a teaching and facilitation methodology.

a. Students first research each topic in research groups of 3.

b. Use a Jigsaw technique to create groups of 3 comprising one student from 3 different themes. Each person discusses their research within their new group.

c. Reassemble into original groups.
Each group has up to 5 minutes in the *Hot Seat* OR
A *Power of Persuasion* technique is used to group students into their preferred category and try to convince other students over to their viewpoint. OR
Think-Pair-Share-Snowball a general class discussion.

LO 1.11

Students should be able to discuss the complex relationship between computing technologies and society including issues of ethics.