The von Neumann Architecture

von Neumann is generally considered to be a genius. He moved to the US in 1929 and worked on the Manhattan Project – the project to build the first atomic bombs during World War II

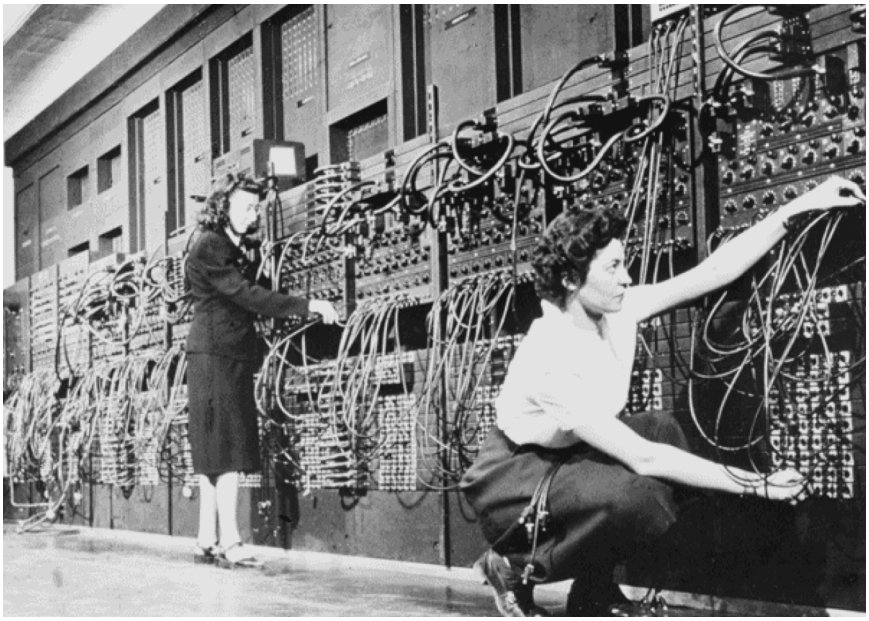
The **von Neumann architecture** describes the way in which a **Central Processing Unit** (CPU) is structured and the ways that it is linked to other key parts of computer systems.

It is named after John von Neumann, a Hungarian-American mathematician who first wrote about it in 1945.

Background to von Neumann's work

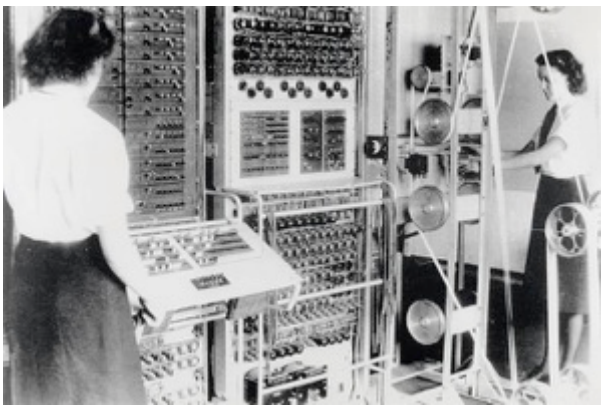
Computers in 1945 were huge machines which filled large rooms. Programs were either wired directly into the circuitry or could be created by plugging in leads between plug points on the front of the machine. This was a long and tedious process - it could take three weeks to debug a simple program.

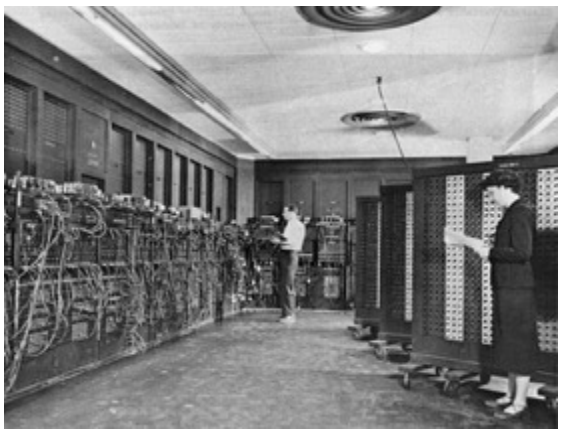
There were no computer screens, keyboards or mice when von Neumann was working. Data was inputted using paper tape or punched cards or by being entered directly using switches or dials. Output was by a series of lights or dials or through paper tape, which then had to be decoded.



Speeding up data processing is pretty much a definition of why we use a computer.

These machines were used to speed up data processing. One famous example was a machine called Colossus which was built in Britain during the war to help crack German secret codes. It is generally considered to have helped the allied countries win the war and was one of the first programmable computers - one where the program could be changed, albeit by using plugs.





The von Neumann Architecture

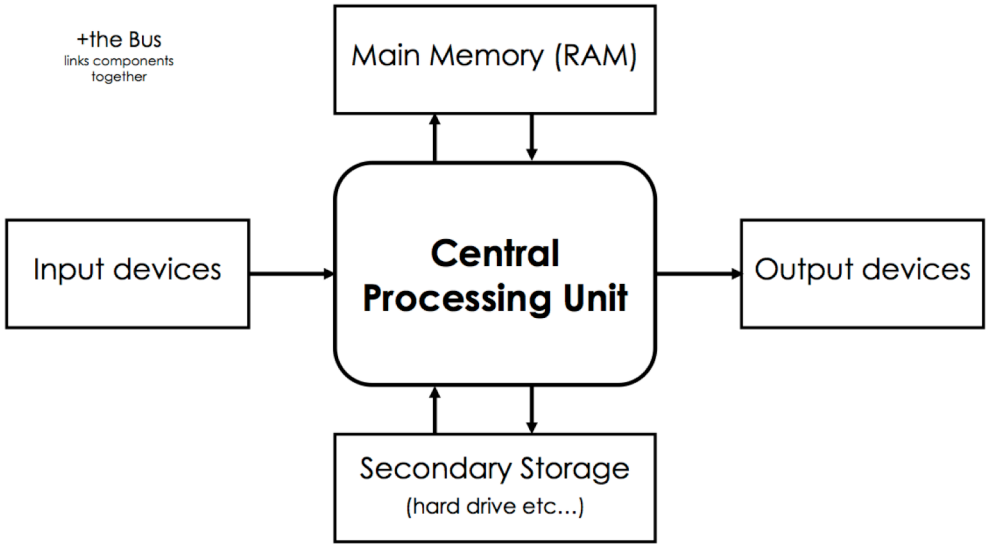
Von Neumann's architecture for how a **CPU** would work said that it needed:

- a **central arithmetic part** – to do the calculations and logic tests
- a **central control part** – to control which step of the program happened next
- **memory** – to store the results of calculations and other variables. This was all **RAM** – nothing was stored when the computer shut down
- ways of **inputting** data
- a way to get some sort of **output** – von Neumann would have been used to lights, bells or paper tape output
- slow **external memory** – a place to store data so that it didn't need to be inputted by hand each time. Von Neumann was most used to using paper tape or punched cards to do this – the modern equivalent is a hard drive

There are 6 key elements in von Neumann's architecture.

Remember, von Neumann was writing in 1945 in a world in which computers were huge and specialised machines.

These elements provide a structure for the CPU that is still used today.



The wires connecting each part together are called the Bus.

The Central Processing Unit contains the Central Arithmetic Part and the Central Control Part of von Neumann's architecture.

The Stored Program Computer Idea

Von Neumann's architecture introduced the idea of a **Stored Program Computer**.

This was the idea that a program could be stored in memory (**RAM**) rather than being wired into the circuit board or controlled using plugs. Programs would use the same memory as the data they were processing – so an individual memory location could be used to store an instruction or a piece of data as required.

This is an incredibly important idea that made computing devices much more flexible. It led to the development of true **General Purpose Computers** that can be used for many tasks rather than just one job.

Activities:

You need to know:

1. the 6 parts of von Neumann's architecture and what each was to do
2. the idea of the stored program computer
3. why this is such a powerful idea