Engineering L2

– Sustainably Engineered Products – Smartphones

# 1 of 17 – Welcome

Welcome to this session on sustainably engineered products - smartphones.

By the end of this session, you will be able to:

* Explain the environmental impact of manufacturing smartphones
* Identify the stages of life cycle assessment
* Understand the processes used to recycle smartphones

# 2 of 17 – Sustainable engineering

Sustainable engineering is the process of designing and operating systems or processes in such a way that they use energy and resources sustainably, considering their wider impact on the natural environment and the needs of future generations.

This includes the need to consider the type of materials used as well as the rate at which they are being used. If no consideration is made towards being sustainable then there are negative consequences in the short and long term; habitats may be destroyed, animals or plants may become extinct, raw materials could run out and future generations could be left without the things they need to live long, happy, healthy lives.

# 3 of 17 – Smartphones

Smartphones are an integral part of our modern lives. It was estimated that in 2021 nearly half of the world’s entire population own one, which amounts to over 3.8 billion people worldwide. The average person owns a single handset for an average of 4.7 years, though many people replace theirs in just two or three years after getting it to acquire a newer model.

There are so many smartphone handsets in the world, and the number is constantly growing. Because of this it is important that manufacturers of smartphones give consideration to the environmental impact of making and disposing of their product; smartphones need to be sustainably engineered.

# 4 of 17 – Product impact

Just like any other product, there are many different aspects of a smartphone than will have an environmental impact in some way and will need to be considered if it is to be manufactured sustainably. Can you think of what they might be?

**Materials** – the raw materials used to make the phone, such as metal, glass and plastic

**Transport** – getting the raw materials to the factory and the finished product to consumers

**Expertise** – the people who design, make, market and distribute the product

**Packaging** – how the product packaged for distribution and sale

**Behaviour** – how the product will change the behaviour of the person who uses it

**Disposal** – what happens when the product is no longer wanted and is thrown away or recycled

# 5 of 17 – Life cycle assessment

Life cycle assessment is one way of considering the impact that a product will have. This is the first step in ensuring sustainable engineering, as to make sustainable decisions you first need to understand the impact that the product will have during its whole lifetime, from initial concepts through to the point it is thrown away and becomes waste.

A life cycle assessment will consider the impact of a product at each of a set of predetermined points throughout its life. When carrying out the assessment, judgements about the findings are not made until the entire assessment is completed. Observations should be unbiased and factual so that they can be evaluated by an individual or team later, who may not be the person who carried out the assessment.

Life cycle assessment allows for the environmental footprint of a product to be mapped and assessed.

# 6 of 17 – Stages of a life cycle assessment

A life cycle assessment will consider the impact of a product at each of the following stages in its lifecycle.

1. **Raw materials extraction** is the starting point of the life cycle, often where materials are extracted from underground.
2. **Material production** is the stage where the extracted raw materials are processed into the more familiar state, such as sheet metal.
3. **Production of parts** converts the processed material into a specific individual component required in the manufacturing process.
4. **Assembly of products** involves joining individual components together to form a finished product.
5. **Product use** is where consumers use the product for the purpose it was designed for, such as taking a photo with a smart phone.
6. **Product disposal** is where a used product that may be damaged or worn is discarded or recycled.

# 7 of 17 – Parts of a smartphone

Although all smartphones vary in design, there are several components common to all models. The casing, which is usually made from plastic

* The supports, which are made from steel
* The screen, which is a liquid crystal display (LCD)
* The touch digitiser, which is made from glass
* The board, which contains electronic components
* The microphone, speak and camera, which are made from various materials
* The battery, which powers the phone

# 8 of 17 – The raw materials in a smartphone

Several kilograms of raw materials are required to manufacture one mobile phone, which only weighs a few grams itself. This is because many of the materials will be acquired in an unprocessed form and required processing to make them suitable for use in the phone. This could be through smelting, forming, die cutting or other methods, all of which produce some waste.

Plastics and fiberglass are used for the housing and circuit board. Many different metals are found in cell phones. A thin coat of gold is applied over the circuit board. Chips are soldered onto the circuit board with a metal compound. Metal is present in the battery as well.

It is interesting to note that in the manufacture of mobile phones, there is often enough mercury, lead, and arsenic in them to classify them as hazardous waste.

# 9 of 17 – Smartphone material and component production

Many large industrial machines would be used to make the components of a modern smart phone. These machines will have a significant environmental impact. Most of the machines would require large amounts of energy to run them and some of the processes involved would create waste material which would need to be disposed of in a safe manner.

For example, if the case of the phone was made of plastic it would most likely be injection-moulded. This would require energy for heating and driving the machine.

Mobile phones have to be assembled, which itself can have a negative environmental impact. A mixture of automated and manual labour is used. Each operator-controlled workstation requires special purpose tooling, some of which would be powered requiring energy.

Energy is also needed for the automated machinery and for the factory’s lighting and heating to make it a comfortable environment to work in.

# 10 of 17 – Smartphone usage

Mobile phones used to be quite heavy and large, but nowadays they are much lighter and more portable. In addition to the standard communication features, current mobile phones may assume diverse additional functions. These additional features can replace other devices. This functionality will have a positive impact on the environment.

Examples of positive impacts smartphone can have on the environment include:

* Eliminating the need for using or owning additional devices such as cameras, music players, games consoles, sat navs, tablets or laptops, thus reducing power use and material production
* Encouraging the use of digital communication such as email and text message instead of using written letters that consume paper and require fuel to deliver

The environmental impact of using a smartphone is not that great on its own, however the environmental impact increases when additional factors are considered such as phone masts and wi-fi hotspots. They are required to make smartphones function in the way users expect, but also add to the environmental impact of their use.

# 11 of 17 – Smartphone end-of-life

Effective end-of-life practices close the life cycle loop, putting energy and materials back into circulation. Recycling smartphones means that we don't need to extract and refine as much material for new products, saving energy, chemicals and waste.

Between 65 and 80% of the material content of a smartphone can be recycled and reused, including some plastics. The non-recyclable plastic can also be used as fuel, bringing the total reusable parts of a smartphone up to 90%.

If every smartphone user recycled just one unused phone at the end of its life, that could generate nearly 80,000 tonnes of raw materials. Recycling metals requires 60 to 90% less energy than mining and processing metal from ore.

Some of the components of a smartphone, such as the printed circuit board, contain useful components that can be extracted and used in future manufacture. These are often valuable materials, so recycling them has a positive economic as well as environmental impact.

# 12 of 17 – How are smartphones recycled?

Before anything else takes place, batteries are removed for recycling and pre-treated to avoid possible explosions during the recycling process. Disintegration of batteries is conducted in a sealed place to prevent the leakage of toxic metals.

Smartphone recycling begins in a shredder, which literally rips the phone apart. Plastic shreds are separated from the circuit boards and recycled. The plastic can be re-used not only as raw material but also as a source of heat energy through environmentally friendly burning. The raw material may be processed into a number of new products.

The shredded circuit boards are melted down to recover the precious metals. Any remaining components are sent to a precious metals' recovery facility where precious and base metals are extracted from the electronic scrap using a combined furnace and water separation process. Click [here](https://youtu.be/zU62hh3DBfg) to watch this video to learn more about how precious metals are recovered from old circuitry.

Materials extracted from smartphones don't have to be rebuilt into phones, they can become entirely new products. Recycling puts materials back in circulation for a wide range of uses.

# 13 of 17 – Question 1

Put the stages of lifestyle assessment into the correct order.

* **Material production** is the stage where the extracted raw materials are processed into the more familiar state, such as sheet metal.
* **Product use** is where consumers use the product for the purpose it was designed for, such as taking a photo with a smart phone.
* **Product disposal** is where a used product that may be damaged or worn is discarded or recycled.
* **Production of parts** converts the processed material into a specific individual component required in the manufacturing process.
* **Assembly of products** involves joining individual components together to form a finished product.
* **Raw materials extraction** is the starting point of the life cycle, often where materials are extracted from underground.

Answers:

1. **Raw materials extraction** is the starting point of the life cycle, often where materials are extracted from underground.
2. **Material production** is the stage where the extracted raw materials are processed into the more familiar state, such as sheet metal.
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# 14 of 17 – Question 2

Why is it worth recycling printed circuit boards?

1. They contain precious metals
2. The plastic is very valuable
3. The green dye is toxic if it goes to landfill

Answer:

It is worth recycling printed circuit boards because they contain precious metals

# 15 of 17 – Question 3

Which of the following statements is correct?

1. Smartphones offering cameras and mapping functions is good for the environment because it means people are less likely to own extra devices.
2. Smartphones offering cameras and mapping functions is bad for the environment because the smartphone uses energy to perform these functions.

Answer:

Smartphones offering cameras and mapping functions is good for the environment because it means people are less likely to own extra devices.

# 16 of 17 – Question 4

Match the phone components to the primary materials used to make it.

1. Casing
2. Supports
3. Screen
4. Touch digitiser

* made from steel
* made from glass
* liquid crystal display (LCD)
* usually made from plastic

Answers:

**Casing** - usually made from plastic

**Supports** - made from steel

**Screen** - liquid crystal display (LCD)

**Touch digitiser** - made from glass

# 17 of 17 – End

Well done. You have completed this session on sustainably engineered products - smartphones.

You should now be able to:

* Explain the environmental impact of manufacturing smartphones
* Identify the stages of life cycle assessment
* Understand the processes used to recycle smartphones

If you have any questions about anything covered in this session, speak to your tutor for more help.