GCSE DESIGN & TECHNOLOGY

CORE KNOWLEDGE & UNDERSTANDING:

2.1.1C - How energy is generated and stored

2.1.1E - Ecological and social footprint

This section has been designed to develop your **core** knowledge and understanding in design and technology and its impact on our daily lives. This will prepare you for designing and making your own products and also prepare you for the final assessments/examination.

You will use your workbook during each theory lesson to help you understand the key areas shown in the box on the right…

You will learn about two areas:

How energy is generated and stored in order to choose and use appropriate sources to make products
&
The **ecological and social footprint** of materials and components

Core Knowledge & Understanding – 2.1.1C

- Types of renewable and non-renewable energy sources including: wind, solar, geothermal, hydroelectric, wood/biomass, wave, coal, gas, nuclear and oil.

- Issues surrounding the use of fossil fuels including coal, oil and gas.

- The advantages and disadvantages of renewable energy sources.

- The use of renewable energy sources in modern manufacturing production systems including the use of solar panels and wind turbines in manufacturing sites.

- Renewable energy sources for products including wind-up and photovoltaic cells.

- Energy generation and storage in a range of contexts including motor vehicles (e.g. petrol/diesel, electricity) and household products (e.g. battery, solar, mains electricity).

2.1.1C – How Energy is Generated & Stored

This section will further your understanding of how energy is generated and stored and how this affects you as a designer. You were introduced to some non-renewable (finite) and renewable (non-finite) materials and energy sources during 2.1.1A, now your will learn more about these, including the advantages and disadvantages and how they affect designers and industries.

We all know we need energy to go about our daily lives from basic needs such as heating and lighting our homes or sustaining our modern lives by charging our phones or streaming movies online. However, one of the biggest uses of energy is during the design, manufacture, transportation and use of our products.

There are two main sources of energy:

Non-Renewable/Fossil Fuels – These are *finite* sources meaning they will eventually run out and not be able to replenish themselves. Burning fossil fuels generates greenhouse gases leading to global warming. These are **unsustainable** sources of energy and should not be relied on.

Renewable Energy – Are *non-finite* sources of energy meaning they are from sources that can quickly replenish themselves, meaning they can be used again and again for future generations. These are **sustainable** sources of energy, this is the future of energy generation.

NOTE: Some energy can be both renewable and non-renewable, for example using wood for fuel is sustainable if more trees are planted, but if they are not planted then wood is unsustainable.

Non-Renewable (Finite) Energy

COAL FOSSIL FUEL	OIL FOSSIL FUEL	GAS FOSSIL FUEL	NUCLEAR
From formed fossilised plants which are millions of years old. Coal contains carbon and is mined from layers of rock in earth. Burned to provide heat and electricity.	A carbon based liquid from fossilised animals. It forms in "lakes" between layers of rock in the earth. Pipes are sunk to pump the oil out. It is used for transport, products & industry.	Natural gases such as methane are trapped between rock under the earths surface. Pipes are sunk to release the gas. It's used for heating and cooking.	Radioactive minerals such as uranium are mined and then the atoms are split in power stations. This then generates electricity in nuclear reactors. Many uses of electricity.
ADVANTAGES • Ready made fuel. • Cheap to mine. • Coal supplies will last longer than oil or gas.	**ADVANTAGES** • Ready made fuel. • Cheap to source • Cheap to convert to energy.	**ADVANTAGES** • Ready made fuel. • Cheap source of energy. • Slightly "cleaner" fuel than coal or oil.	**ADVANTAGES** • Ready made fuel. • Cheap to produce. • Supplies will last longer.
DISADVANTAGES • Atmospheric pollutants: When burned, coal releases carbon which is a greenhouse gas.	**DISADVANTAGES** • Atmospheric pollutants: When burned, oil releases carbon which is a greenhouse gas. • Limited supply	**DISADVANTAGES** • Atmospheric pollutants: When burned, gas releases carbon which is a greenhouse gas. • Limited supply	**DISADVANTAGES** • Expensive to run reactors • Nuclear waste is highly toxic needing to be stored. • Leakage of waste can lead to nuclear disaster – Environment/Chernobyl

Both Non–Renewable & Renewable Energy

BIOMASS	WOOD
Generated from decaying plant or animal waste and also organic materials which is burned to generate electricity or heat. It can also be used to fuel diesel engines after chemical treatment.	This is obtained from felling trees (cutting down), which is then burned to generate heat and light. Wood often needs to be stored to dry before burning.
ADVANTAGES • Cheap and readily available. • If crops are replanted it is a long-term renewable energy source (sustainable).	**ADVANTAGES** • Cheap and readily available. • If trees are replanted it is a long-term renewable energy source (sustainable).
DISADVANTAGES • When burned, biomass releases atmospheric pollutants including greenhouse gases. • If crops are not replanted biomass is a non-renewable source of energy – unsustainable.	**DISADVANTAGES** • When burned, wood releases atmospheric pollutants including greenhouse gases. • If trees are not replanted wood is a non-renewable source of energy – unsustainable.

Renewable (Non-Finite) Energy

SOLAR	WIND	WAVE	GEOTHERMAL	HYDROLOGICAL
				HYDROELECTRIC POWER (HEP)
Energy from sunlight is stored in solar panels (Photovoltaic/PV cells) and converted into electricity.	Huge wind turbines turn the wind into electricity. These are like modern windmills.	Electricity is generated from the movement of sea water (waves) which drives a turbine.	In volcanic regions the natural heat of the earth: Water is pumped into the ground to release steam, for heating or electricity.	Energy is generated from the movement of water from rivers, lakes and dams. This is used for electricity.
ADVANTAGES • Infinite energy. • Single homes can have own electricity supply.	**ADVANTAGES** • Infinite energy. • Can be an individual turbine or in multiple farms.	**ADVANTAGES** • Ideal for islands. • Small local supplies, self-sufficiency.	**ADVANTAGES** • Infinite energy. • Successful in many countries such as New Zealand.	**ADVANTAGES** • Creates water reserves as well as energy supplies. • Local habitats.
DISADVANTAGES • Manufacture and installation can be expensive.	**DISADVANTAGES** • Expensive to set up. • Some say it spoils the countryside.	**DISADVANTAGES** • Construction is expensive. • Local groups & environmentalists may oppose it.	**DISADVANTAGES** • Expensive to setup. • Volcanic areas only. • Dangerous elements can be found.	**DISADVANTAGES** • Expensive to build. • Can cause flooding. • Major ecological impact of local water supplies.

Renewable Energy & Manufacturing

With growing concerns of global warming and the unsustainability of finite sources of energy many industries are turning to renewable energy sources to power the manufacturing of products.

Examples of renewables in general product manufacturing:

- *Solar electricity to power factories or head offices.*
- *On site wind farms to power larger manufacturing sites.*
- *Use of hydro power to power remote factories.*
- *Use of electric vehicles during transportation of products.*
- *Use of food waste for biomass to power food production factories.*

Can you think of any other examples?

Renewable Energy Companies

APPLE: As part of its commitment to combat climate change and create a healthier environment, Apple announced in 2018 its global facilities are powered with 100 percent clean energy. Apple owns the largest private solar farm in the United States which generates about 167 million kilowatt-hours (kWh) of electricity per year. It also has solar farms in China and other locations.

IKEA: Since 2009, IKEA Group has invested EUR 1.7 billion in renewable energy. They have committed to own and operate 416 offsite wind turbines and have installed around 750,000 solar panels on IKEA buildings. They also have a goal of being 100% renewable by 2020. They also use renewable and responsibly sourced materials in their products.

TEEMILL: Teemill are an online platform which manufactures and sells fashion products for a wide range of designer such as Vivienne Westwood, Katharine Hammnet and smaller brands such as Welsh label Rhetorik. They use only organic cotton but the entire supply chain is powered by 100% renewable energy.

Renewable Energy Products

Modern technology allows designers to develop and create a range of renewable energy powered products.

Examples of renewable energy products:

- *Solar powered lights using Photovoltaic (PV) cells*
- *Wind up radios, torches or toys.*
- *Solar PV powered battery packs or phone chargers.*
- *Miniature wind turbine guy ropes to power tents.*
- *Backpacks with solar PV panels which charge products.*

Can you think of any other examples specific to your area?

Energy Storage

Energy storage is when we capture energy produced and keep it to use at a later time. Energy is usually stored in batteries or accumulators. Most energy is stored in large scale power stations. We also store energy in the form of cars such as petrol/diesel, electric car batteries and within our homes through mains electricity, heating systems, batteries or rechargeable battery devices e.g. phones etc.

Create a mind map in your workbooks of all the different types of energy/uses/storage in our daily lives.
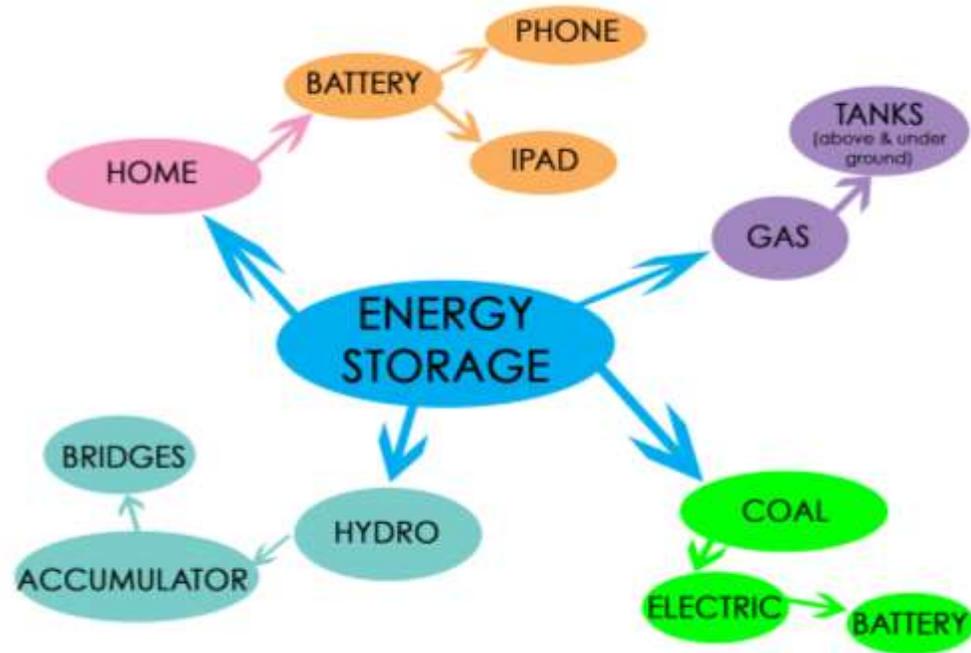
You may also remember some issues about batteries from the previous sections.
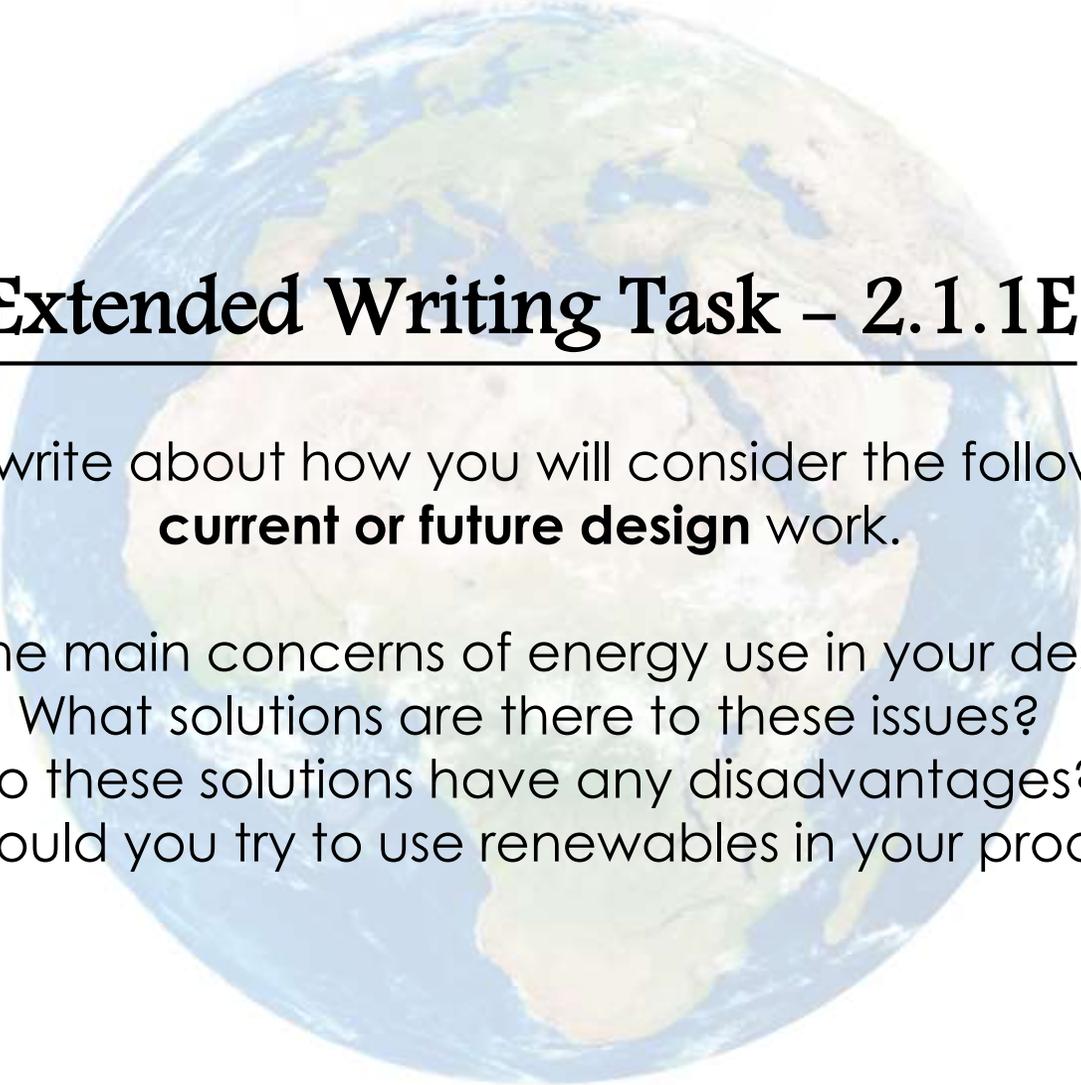
Extended Writing Task – 2.1.1E

In your workbooks write about how you will consider the following points in your **current or future design** work.

What are the main concerns of energy use in your design area?
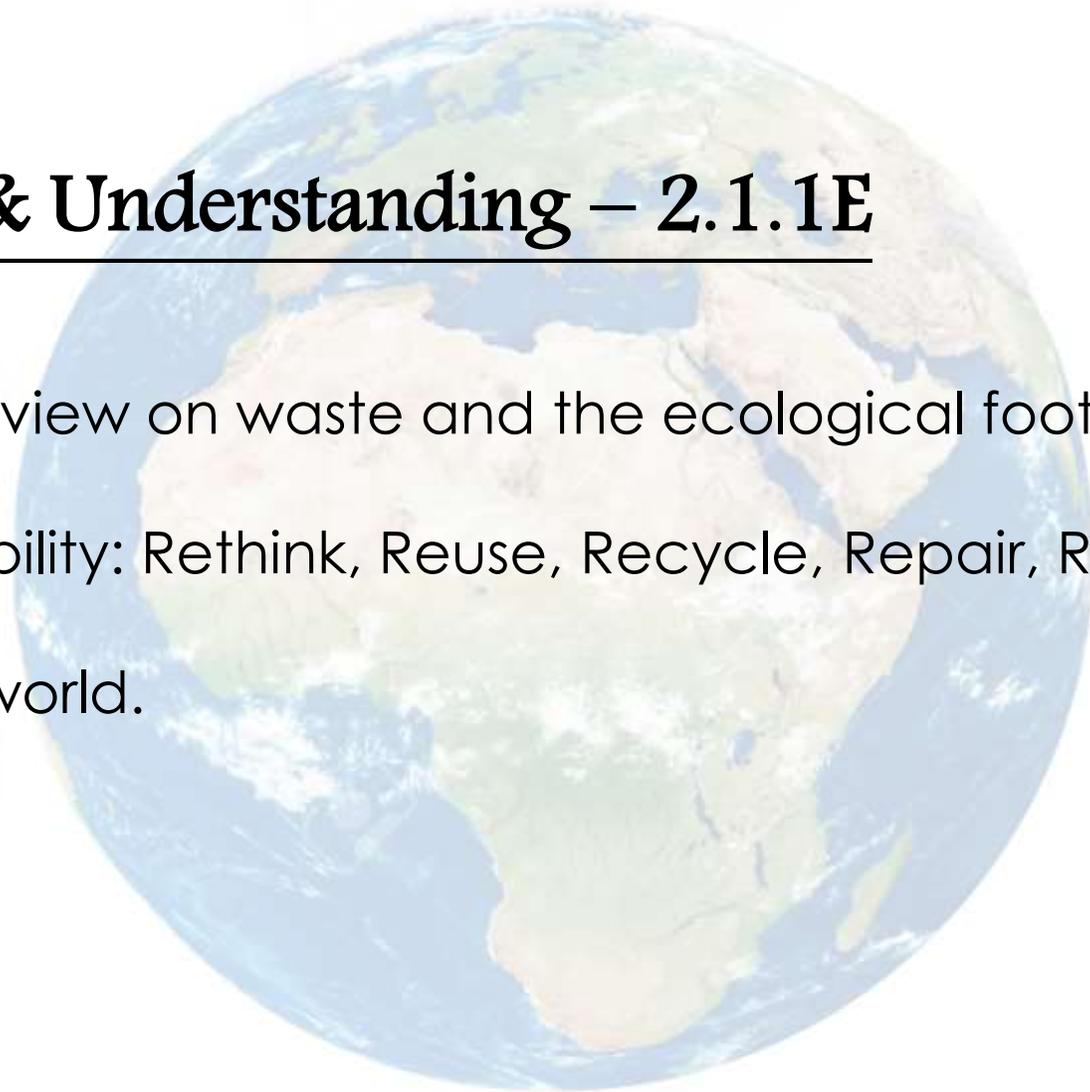What solutions are there to these issues?
Do these solutions have any disadvantages?
How would you try to use renewables in your products?

Core Knowledge & Understanding – 2.1.1E

- Changing society's view on waste and the ecological footprint.

- The 6R's of sustainability: Rethink, Reuse, Recycle, Repair, Reduce & Refuse.

- Living in a greener world.

- Fair-trade policies.

Ecological Footprint

We have already discussed how design industries impact on the environment from manufacture, transportation and waste.

Now we we learn about our ecological footprint.

The term "*Ecological Footprint*" is used to measure the impact we have on areas of land and water required to produce the goods we use and the waste we generate, in particular pollution and carbon.

People all around the globe live and consume very differently, some humans have very little impact on the environment while people in developed countries like ours have a huge and negative impact on the planet.

We use ecological footprints to work out how many planets we would need if we all lived in high consumption places like the UK and USA. It also helps us to realise whether we are living sustainably.

So how many planets would we need, if we lived like…?
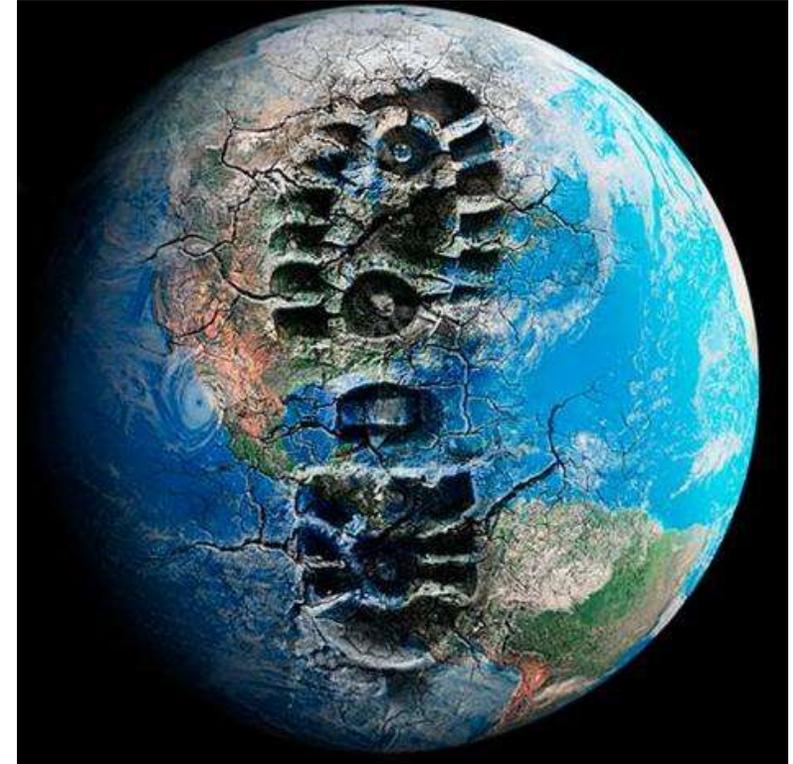
IF THE WORLD'S POPULATION LIVED LIKE...

How much land would 7 billion people need to live like the people of these countries?

PER SQUARE MILE

BANGLADESH

INDIA

UGANDA

CHINA × 1.1

COSTA RICA × 1.4

NEPAL × 1.9

FRANCE × 2.5

UNITED STATES of AMERICA × 4.1

UNITED ARAB EMIRATES × 5.4

WHAT IS YOUR

Ecological Footprint? beta

How many planets do we need if everybody lives like you?

When is your personal Overshoot Day?

TAKE THE   FIRST STEP

http://www.footprintcalculator.org

The 6R's of Sustainability

The 6R's are used by designers to reduce the environmental impact of products. The 6R's stand for:

Reduce -is it possible to reduce the amount of materials used? This will help to protect valuable resources. Designing well-made long-lasting items help this.

Rethink - is there a better way to solve this problem that is less damaging to the environment? Designing eco-friendly items or using eco materials etc.

Refuse - this means not accepting things that are not the best option for the environment. Refusing items which aren't biodegradable/natural or those with excess packaging.

Recycle - could recycled materials be used, or is the product made from materials that are easy to recycle?

Reuse - could the product have another use? Could its parts be used in other products? Is this information clearly communicated on the product? This will extend its life.

Repair - is the product easy to repair? This will extend its life.

Why are the 6R's important?

Using the 6R's as a guide when designing products helps us to reduce the negative impact on the environment, humans and other living creatures. Here are some of the main benefits:

- **It saves energy**

- **It reduces waste & landfill**

- **It reduces pollution**

- **It saves money!**

- **It helps us live in a greener world…**

Living in a Greener World

We should know by now that whatever we do as consumers or designers has an impact on the environment. Every product we create has an impact on the environment such as:

- **Energy used to design, grow, make and transport products.**

- **Raw materials used in the products, both finite and non-finite. Can these be reused/recycled at the end of life?**

- **The impact a product has during its life time (washing, electric).**

- **What impact a product has at the end of its life (waste, pollution).**

By thinking about each of these points we can reduce the negative impacts our products have on the environment and design for a greener world.

We will now look at some important points to consider when designing products for a greener world…

Materials

The materials we use have a huge impact on the environment. Are the materials renewable or will they eventually run out? Will the materials create a waste or pollution problem? We can overcome negative impacts by either reducing the amount used in each product or by using materials that are responsibly and sustainably sourced: Choosing FSC biodegradable wood rather than polluting plastic or use organic chemical free natural fabrics rather than energy intensive polyester.

Product Life

The use phase of a product can have an impact on the environment. For example every time we plug in our phones, wash our clothes or turn on a lamp we are using energy. To become greener designers we should design products that need less expensive maintenance or replacement or those that last a longer time, reducing the need for new products.

Maintenance

As mentioned in one of the 6R's repairing or maintaining our products can make them have a longer life, for example can our products be easily taken apart to repair them ourselves or do they need to be replaced? By reducing the need to replace items we are having a positive impact through products.

Disposal

At the end of a products life it needs to be disposed of, how we do this can have either a positive or negative impact on the environment. A huge number of items we dispose of end up in landfill sites, many of this causes pollution or hazardous waste, especially from electronics. Products need to be designed with disposal in mind, can it be taken apart and recycled?

Recycling

By using either parts of or a whole product we can recycle old into something new. This reduces damage to the environment as we do not need new raw materials for the new item. We can use a range of recycled materials to create similar or even very different products: Using recycled wood for 3D printing filament or using plastic bottles to create yarn and new fabrics/garments.

Biodegradability

If a product cannot be reused or recycled, then it will end up in a landfill site. In this case it is important to ensure it is biodegradable, this means that it will decompose or naturally break down. Plastic products are is not considered biodegradable as it takes hundreds or thousands of years to biodegrade, likewise polyester (a type of plastic) is also not biodegradable. It may not always be possible make biodegradable products, but packaging should be biodegradable.

Living in a Fairer World

We have previously discussed the social and cultural issues when designing and making products, especially in other countries. Many products are made by people in developing countries who often get exploited: They are paid unfairly and many work in very unsafe conditions.

There are many organisations set up to ensure the products we make and sell are fair and ethical, the Fairtrade Foundation is the most well known of these organisations. They help designers/companies create their own Fairtrade policies: Fairtrade work with businesses, consumers and campaigners to ensure that farmers and workers have an equal rights and fair say in supply chains. They work to empower workers to have secure and sustainable livelihoods, promote fairer working conditions and combat poverty and exploitation.

They set **social, economic** and **environmental** standards to ensure products are sustainable and ethical. They strictly assess and certify products and in return producers are able to use the Fairtrade mark (logo on the right) on their packaging. This mark is a widely recognisable way to identify that products or ingredients are grown or produced fairly. Products include: Food, clothing, furniture and even gold!


"Fairtrade is a simple way to make a difference to the lives of the people who grow the things we love. We do this by making trade fair."

Fairtrade Foundation 2018

Who benefits from Fairtrade?

The Farmers/Producers	The Retailers	The Consumers
• They earn more money. • Safer working conditions. • Develop business skills. • Better quality product. • More sustainable livelihoods. • Improved local communities. • Better local infrastructure (hospitals, schools etc.) • Can send their children to school (better futures for the children).	• Selling a better quality product. • Quality leads to more sales. • Helps businesses. • Ethical sourcing – more knowledge about the supply chain. • Tracking products to the producer is easier.	• Better quality products. • More choice. • Effective way to change the world.
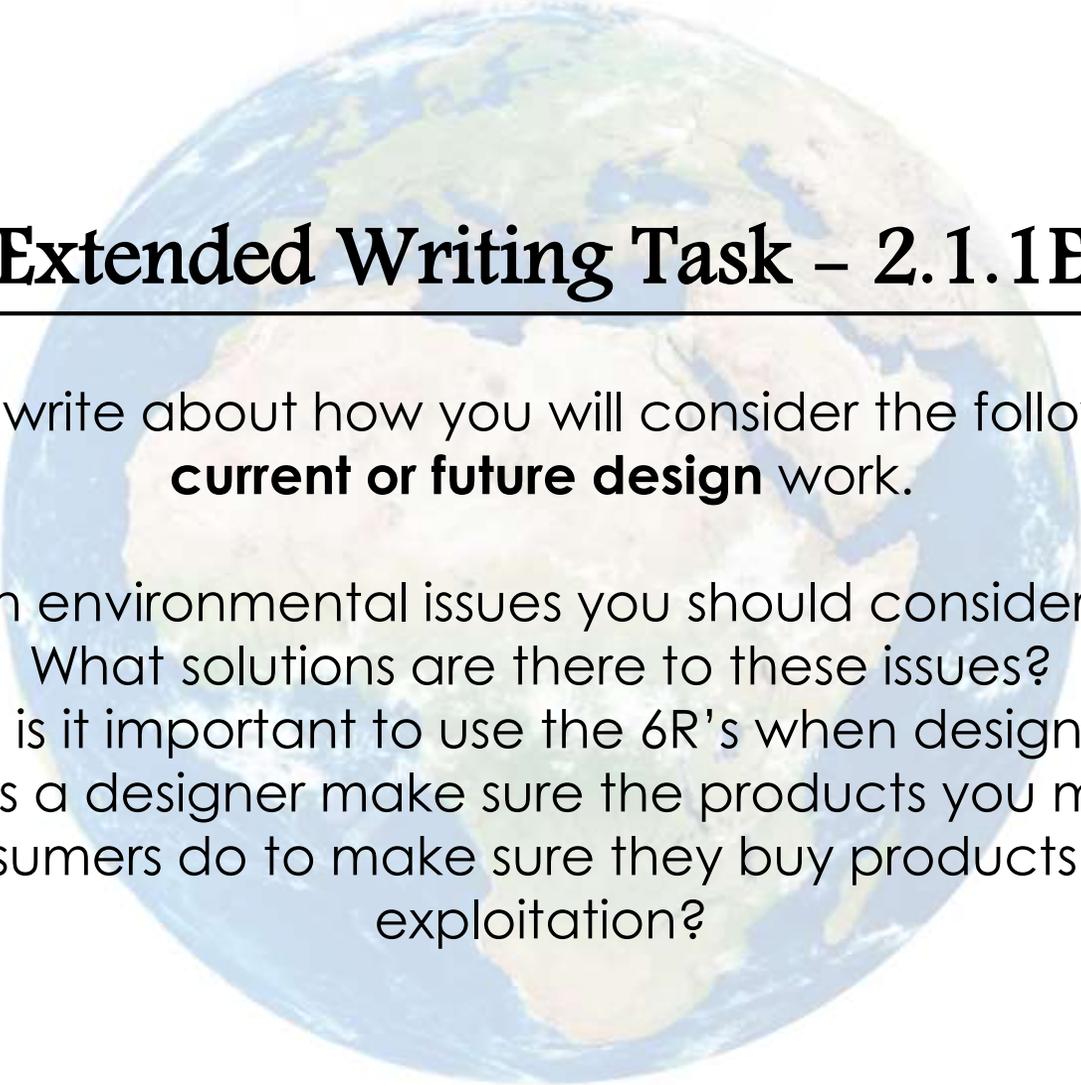
Extended Writing Task – 2.1.1E

In your workbooks write about how you will consider the following points in your **current or future design** work.

What are the main environmental issues you should consider when designing?
What solutions are there to these issues?
Why is it important to use the 6R's when designing?
How could you as a designer make sure the products you make are ethical?
What should consumers do to make sure they buy products which are free of exploitation?

Next you will be learning about:

Modern & Smart Material (Unit 2.1.1 d)