Design Briefs

A Design Brief is the statement of how you will solve the Design Problem
It will often include:

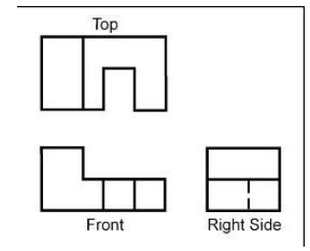
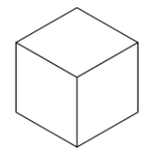
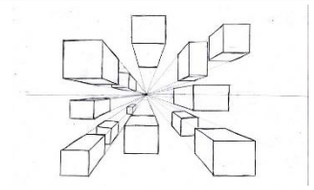
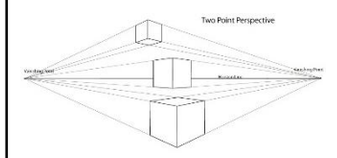
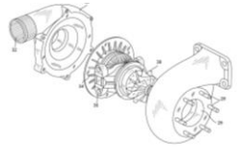
- Constraints/ limitations
- What the product is
- Materials/processes
- Any key information you know

Design Specifications

A Design Specification is a list of requirements your product has to meet in order to be successful

It is also useful for evaluation. If your product hasn't met the Spec then it gives you a starting point for improvements.

Aesthetics	What the product looks like? Style? Colour Scheme? Design Movement?
Customer	Who would buy it? (Age, gender, socio-economic, personality) How does the design appeal to them?
Cost	How much will it cost? (min-max) Why?
Environment	Where will it be used? Why? How will you make it suitable?
Safety	How is it safe? How will it be checked? Why must it be safe?
Size	What is the maximum or minimum size? Why?
Function	What does the product do? What features make it do that function well? How is it unique from similar products?
Materials	What is it made from? Why?
Manufacture	How might it be made? Why? What scale of production? Why?

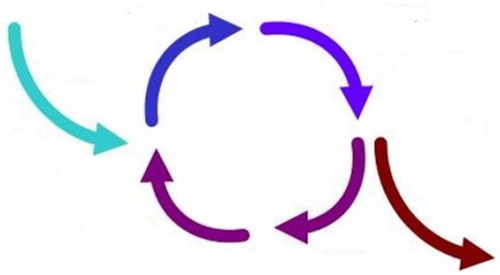
Technique	Description/ notes	Diagram
Orthographic Projection/ Working Drawings	• Includes "Front", "Plan" and "End" 2D Views, and often an Isometric 3D View • Standardised method for scale, dimensions and line types • Great for manufacturing	
Isometric	• Common 3D sketching method • Can be drawn free-hand or using isometric paper and ruler • Angles are at 30 degrees • Great for seeing most of the products	
1-Point Perspective	• A 3D drawing method • Often used by interior designers and architects • Gives drawings depth • Only uses 1 vanishing point	
2-Point Perspective	• Used for 3D designs • Exaggerates the 3D effect • Objects can be drawn above of below the horizon line but must go to the 2 vanishing points	
Annotated Drawings/ Free and Sketches	• Quick and easy way of getting ideas down • Range of ideas can be seen • Annotation helps explain designs further	
Exploded View	• Helps see a final design of a product and all it's parts • Can see where all the parts fit • Great for manufacturers	

Modelling and Development

Modelling and development are key to testing and improving products
This can be done physically using materials like; card, foam, clay, man-made boards or virtually in **CAD**
Modelling helps the designer get feedback from the customer, check aesthetics, function, sizes and even materials and production methods and change them if needed

Design Strategies

Design Strategies are used to solve **Design Fixation**, and help develop creative design ideas.



Iterative Design

- A Proposal is made
- It is then planned and developed to meet the brief
- It is analysed and refined
- It is then tested and modelled
- Then evaluated against the brief – many versions fail but that then informs development to make the idea better
- The cycle then repeats and if the product is successful it is then made and sold on the market

Iterative Design	
Advantages	**Disadvantages**
• Consistent testing helps solve problems earlier • Constant feedback • Easy evidence of progress	• Designers can loose sight of "the big picture" • Time consuming

User-Centred Design

- This is when designs are based on fulfilling the needs and wants of the Users/ Clients at every stage of the design process
- Questioning and testing is ongoing and is often found through interviews, questionnaires, surveys, etc

User-Centred	
Advantages	**Disadvantages**
• User feels listened to • Makes sure the product meets their needs	• Requires extra time to get customer feedback • If focused on just one person it can limit appeal to others

Systems Approach

- Usually used for electronic products
- Often uses diagrams to show systems in a visual way
- Planning the layout for the correct sequences e.g. inputs, outputs, timings, etc
- Electronics and mechanical systems need an ordered and logical approach

Systems Approach	
Advantages	**Disadvantages**
• Does not need specialist knowledge • Easy to communicate stages • Easy to find errors	• Sometimes over-simplifies stages • Can lead to unnecessary stages

Collaborative Approach

- Working with others to share data and solving problems and coming up with design proposals can help with creativity
- Numerous companies work in teams, and has been shown to improve the range and quality of ideas produced

Collaborative Approach	
Advantages	**Disadvantages**
• Gets multiple opinions and a range of views • Working in groups can produce more ideas	• Can be difficult to design ideas with opposing views • Can be difficult to find time to communicate with multiple people

Non-Renewable Energy Sources	This is when certain sources of energy will run out eventually
Fossil Fuels	• Coal, Oil and Gas • Burned to create steam, turned in turbines to create electricity. • Burning creates C02 which adds to **Global Warming**
Nuclear Power	• Nuclear Fission controls the reactor (that creates the electricity). This requires **Uranium** which is non-renewable • Accidents and waste can severely damage the environment and cause radiation poisoning • **Radiation poisoning** can be fatal and cause physical deformations • Nuclear waste has to be disposed of properly and is hazardous for thousands of years.

Storing Energy

Pneumatics: This is the production of energy using compressed gas or air. E.g. Pistons in an engine

Hydraulics: Like a Pneumatic system, but uses water or oil under pressure. E.g. Wheelchair lifts

Kinetic: Energy that is generated by movement. This is stored by items like springs in a "clickable" pen or balloons,

Batteries: Electrical power can be stored in batteries. Rechargeable batteries are becoming increasingly popular.

Renewable Energy Sources	This is when certain sources of energy will not run out.
Solar	• **Solar panels** are used to collect light and convert it into electricity • There is no waste and a consistent supply • However, the panels are not effective at night or in countries where there isn't a lot of sunlight
Wind	• **Turbines** harness wind energy • Not effective on non-windy days • Some people don't like turbines as they are noisy, and not attractive to look at
Hydro-Electrical	• This harnesses energy from water held behind a **dam** • Has to be created by flooding land – damaging wildlife habitats • **Tidal** energy comes from using energy from waves
Biomass	• This is fuel from natural sources e.g. crops, scrap woods and animal waste • Growing biomass crops produces oxygen and uses up C02 • However, is a very expensive method

The 6Rs	Meaning
Reuse	To use a product again either for the same purpose or a different one
Reduce	To have less of material/packaging/pollution when making products by making them more efficient
Recycle	Breaking down and forming the material into another product
Refuse	Customers not buying or supporting products that make an environmental impact
Rethink	Designers and customer rethinking their decisions when making and buying products.
Repair	Fixing a product rather than throwing it away. Extending its life rather than using more resources to make another Often products are **Designed for Maintenance** so can easily be repaired. E.g. Using screws so even non-specialists can take a product apart, or using components that can easily be replaced like fuses or batteries

Life Cycle Assessment

This is when a designer looks at the environmental impact a product makes over its life time and how it could be reduced. Including:

- Impact of materials
- Impact of processes
- Product Miles (how far a product has to travel to get from factory to consumer)
- Impact while in use
- Impact when disposed of (6Rs)

Sustainability is maintaining our planet and its resources and making a minimal negative impact

Finite Resources *Will run out of eventually*	**Infinite Resources** *Can be re-grown and re-bread. Will not run out of*
Plastics	Paper
Metals	Boards
Polymers (Textiles)	Natural Timbers
	Cotton
	Leather

Planned Obsolescence	This is where products "die" after a certain amount of time. E.g. Disposable cups, Phones, Lightbulbs, Printer Ink, etc This can have a big environmental impact as customers are throwing away lots of products, and resources are being used to create new ones.

Finishes

Finishes are used to improve the **aesthetics** and **durability** of products

Material Type	Finishes Used
Papers and Boards	• Paints • Varnishes • Laminating • Plastic coating • Wax coating
Timbers and Boards	• Paints • Varnishes • Wax and Polish • Staining • Oil
Metals and Alloys	• Painting • Lacquering • Electroplating • Galvanzing • Polishing • Plastic Coating • Powder Coating
Plastics	• Polishing • Painting • Decals (stickers)

Standard Components

Standard components are parts or components manufactured in the 1000s+
They are readily available, don't require specialist knowledge or tools to replace them and are universally recognised

Material Type	Components used
Papers and Boards	• Staples • Clips • Split pins
Timbers and Boards	• Nails • Screws • Panel Pins • Hinges
Metals and Alloys	• Nuts and bolts • Screw • Rivet • Washer
Plastics	• Plastic hinges

Tolerances

- The total amount a specific dimension or property is permitted to vary
This can apply to hole depth, length, angle, thickness, weight and elasticity
A gauge can be inserted into a gap or hole to check if the sizes fall within tolerance
If parts do not fit within the specified tolerances they are discarded or recycled

Quality Control and Quality Assurance

- QC is ***product*** oriented
Quality control is where products are regularly tested (during and after manufacture) to ensure they meet the defined set of quality criteria

- QA is ***process*** oriented
Quality assurance is ensuring that the processes used to test the product have been done correctly and consistently
You can test a product all you like, but if the tests are wrong/ inconsistent with each other than the results are invalid

- Below are examples of Quality Assurance symbols:

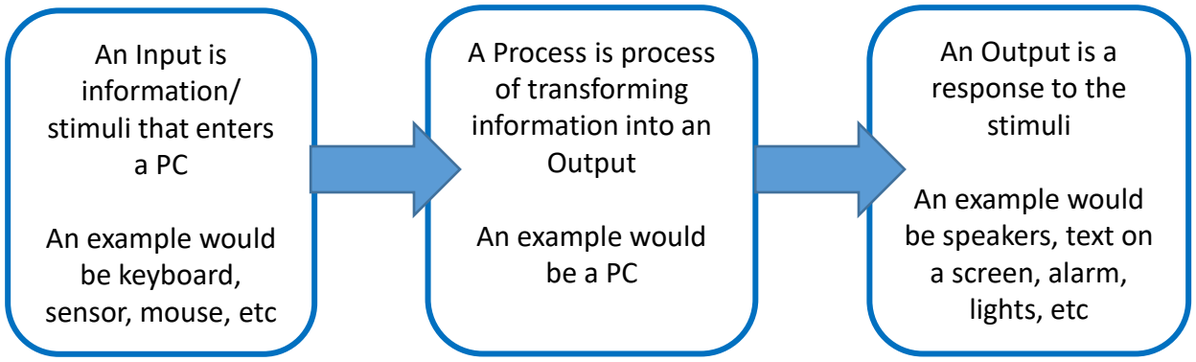

European Conformity


BSI Kitemark


Lion Mark

Registration Mark

Process Orders



Industry and Enterprise

Automation

This is when machines and robotics help make products or make them for you.
Often this is done by **CAD (Computer Aided Design)** and **CAM (Computer Aided Manufacture)**

This helps products be made quicker, with more accuracy. Reducing errors humans make to products.

However, these machines are expensive to buy, need specialist training to use and need constant maintenance to keep them working properly

Virtual Marketing

This is when websites, social media and email are used to promote and sell products. This has become very popular in recent years, with big social media apps being funded by advertisers

Companies can also pay search engines to push their company further to the top of the results page, so customers are more likely to click it.

Cooperatives

A Cooperative is an Enterprise that is run by members that are part of the workforce or customers.

This means the organisation is democratic and often supports the local community. They are set-up to protect the rights of their members and ensure the same rules apply to everyone

Enterprise

This is when an idea is developed into a business and produces a viable product.

Often, one of the biggest enterprises in in apps for smartphones

To make sure ideas are protected from being copied, a **Patent** can be applied for. This legally protects your idea on invention from being stolen.

Crowdfunding

This is where ideas are funded by large groups of ordinary people.

www.Kickstarter.com is a good example of this.

Fair Trade

This is an organisation that promotes fair pay, working conditions and better trade with farmers in developing countries

You can tell when something is Fairtrade as it will often have the symbol on the product or packaging. Common Fairtrade items include; bananas, cotton and chocolate.

FAIRTRADE

Modern and Smart Materials

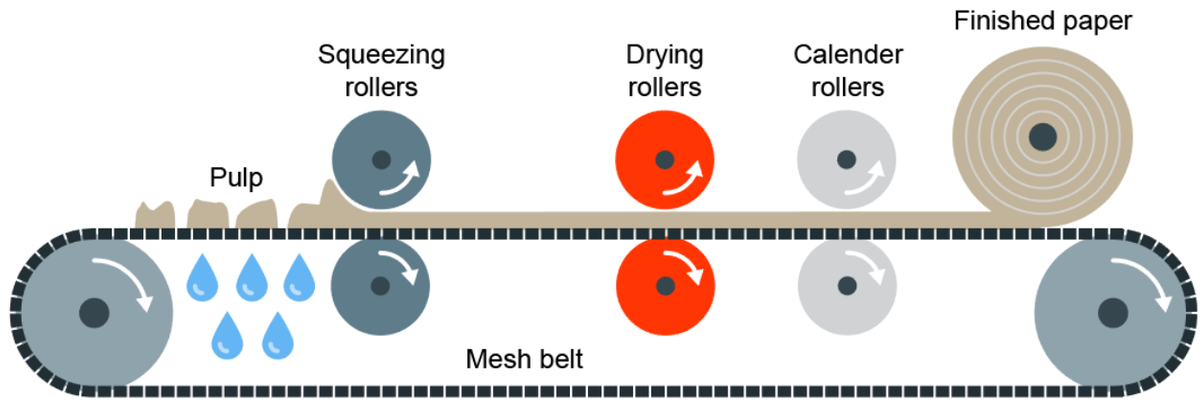
Papers and Boards

Modern Materials are materials that have been developed recently		
Material	**Key info**	**Examples**
Corn-starch Polymers	These are plant-based polymers that are a replacement for plastics that are **biodegradable** but cannot be recycled.	Plastic bottles, tubs, food containers, etc
Flexible MDF	Made in the same way as normal MDF but with grooves cut into the surface so it is flexible. **Flexiply** is the same but for Plywood. These can easily be shaped into curves	Modern furniture, interior walls and room dividers
Titanium	High strength to weight ratio. Doesn't corrode or rust. Suitable for medical use as its hypo-allergneic	Prosthetics, medical applications, sports cars, etc
Kevlar	A woven polymer with a high strength to weight ratio.	Bullet-proof vests, tyres, helmets, etc

Smart Materials are materials that change and react to the stimuli		
Material	**Key info**	**Examples**
Thermochromic Pigments	Change colour in reaction to heat	Kettles, baby bottles, etc
Photochromic Pigments	Change colour in reaction to light	Colour changing glasses, windows, etc
Shape Memory Alloy	Returns to its original shape, in reaction to heat	Braces and glasses
Polymorph	Granules that once exposed to hot water, become a modelling material (like a dough or clay)	Modelling and repairs

Papers and Boards come from trees. **The Stock forms** for papers are: rolls, sheets, A4, A3, etc		
Material	**Key info**	**Uses/ Examples**
Cartridge Paper	Thick white paper, completely opaque and more expensive than photocopy paper	Sketching, ink drawings
Layout Paper	Light, semi-translucent, good for blending inks and artist markers	Sketching, drawing and some tracing
Corrugated Cardboard	Strong but light. Rigid triangles of card sandwiched between a top and bottom layer.	Outer packaging, food packaging
Duplex Board	Light card with white outside layers. Waxy coating can be added	Cheap packaging. If waxy coating is applied, can be used for food
Foil-lined Board	White card coated with a thin aluminium layer. Foil is great for insulation and water resistance	Takeaway containers
Solid White Board	High-quality white card with a smooth finish. Stiff and holds colours well	Greetings cards, packaging and advertising

Primary Processing of Papers and Boards



Paper is made by first making pulp. Pulp is a mix of tree fibres and water. This is cooked and bleached white, and adding any other additives.
The pulp is then drained and goes through **Calendering** where the pulp is drained and goes through rollers to convert it to its stock forms

Natural Timbers

Softwoods are generally cheaper than hardwoods as they are more available, since they grow quicker.
But because man-made boards are manufactured they are cheaper than timbers.
Man-made boards also come in a better variety of sizes since they don't depend on tree growth.

Stock forms for both include; sheets, dowel, planks, etc

Hardwoods come from **Deciduous Trees.** These trees loose leaves in winter and grow fruit and flowers in spring		
Material	**Key info**	**Examples**
Ash	Flexible, tough and shock resistant	Sports equipment Tool Handles
Beech	Fine finish, tough and durable	Toys, furniture and veneers
Mahogany	Easily worked, durable, high quality finish	High-end furniture
Balsa	Very soft and spongy. Light	Modelling
Oak	Tough, durable and hard	Flooring, furniture and veneers

Softwoods come from **Coniferous Trees.** These have thin, needle-like leaves and grow all year round. Often have pine cones and sometimes nuts and seeds		
Material	**Key info**	**Examples**
Larch	Durable, tough, good water resistance and finishes well	Furniture, flooring and used outdoors
Pine	Light, easy to work with but can split	Cheap furniture, construction and decking
Spruce	Easy to work with, high stiffness but can decay quickly	Furniture, musical instruments and construction

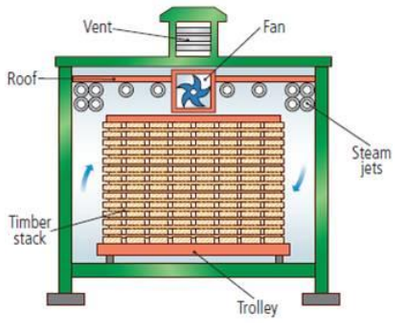
Man-Made Boards

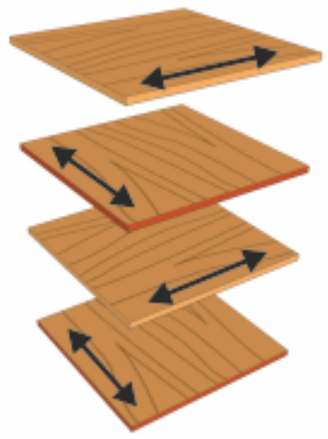
Manufactured boards are made from wood chips/dust/ layers and glue.		
Material	**Key info**	**Examples**
Chipboard	Prone to chipping but good compressive strength. Not-water resistant	Flooring, low-end furniture, flat-pack
MDF	Rigid and stable. Easy to finish. Absorbs liquid easily	Flat-pack furniture and kitchen unites
Plywood	Very stable. Exterior veneer can be used from more expensive woods	Shelving, furniture, toys

Primary Processing of Papers and Boards

Trees are cut then converted into planks by cut using saws
It is then seasoned to reduce the moisture in the wood.
This is done by either:

Air-drying – Planks are stacked and air allowed to circulate; causing evaporation
Kiln-drying – Where planks are put into a kiln and dried rapidly. This process is more costly than air-drying





Manufactured boards can be either be made by lamination or compression

Lamination – Layers of woods and adhesive are layered and compressed together. Usually with a more expensive wooden veneer on the top

Compression – Wood is shredded, heated and compressed with adhesive under extreme pressure

Metals

Metals come from ores in the ground. **Stock forms** are sheets, bars and rods

Ferrous Metals contain iron and are magnetic and rust		
Material	**Key info**	**Examples**
Low Carbon Steel	Tough and ductile and easily machined and welded	Construction, screws, cars
High Carbon Steel	Hard and wears well	Tools, blades and knives
Cast Iron	Hard but brittle. Easily cast but hard to machine	Pots, pans, vices

Non-Ferrous Metals do not contain iron, aren't magnetic and don't rust		
Material	**Key info**	**Examples**
Aluminium	Light, high strength to weight ratio and ductile	Pots, pans, cars, cans
Copper	Ductile, malleable and good conductor	Plumbing supplies and cables
Tin	Soft, malleable and good conductor	Used as a protective coating

Alloys

Alloys are mixtures of 2 or more metals to get the best of their properties		
Material	**Key info**	**Examples**
Brass	Malleable and easy to cast	Musical instruments, plumbing
Stainless Steel	Doesn't rust, hard and smooth	Cutlery, medical tools, etc

Plastics

Plastics come from crude oil. **Stock forms** are sheets, powders, granules and rods

Thermoplastics can be reheated and reshaped and infinite amount of times		
Material	**Key info**	**Examples**
PET	Easily **blow moulded,** food safe and easily recycled	Bottles, packaging, etc
PVC	Flexible, tough, easily **extruded**	Pipes, tape, hard hats
HIPS	Flexible, lightweight, food safe and easily **vacuum formed**	Containers and yoghurt pots
Acrylic	Tough, brittle, easily scratched	Car lights, baths, displays/ signs

Thermosets once heated and set **cannot** be reshaped		
Material	**Key info**	**Examples**
Melamine Formaldehyde	Food safe, hygienic, hard and brittle	Kitchenware and work surfaces
Urea Formalehyde	Good insulator, hard and brittle	Electrical casings, buttons and handles
Polyester Resin	Strong, heat resistant, can be transparent	Coatings, casings

Primary Processing of Metals and Alloys

Metals are mined from the earth and then go through an extraction process
Extraction happens by putting the ore in a blast furnace
The metal is then separated from the waste material

Primary Processing of Plastics

Crude oil is extracted from the earth and then processes into different types of fuels, etc. This is called **Fractional Distillation**

A process called **Cracking** then converts the large hydrocarbon molecules into plastics

Materials and their Properties: Timbers & Manufactured Boards

Hardwoods

They are deciduous trees which means that in winter, they lose their leaves.

These trees are broadleaved, bushy and slow growing.

Overall they tend to be harder to work with and more expensive than other types of timbers.

They are less porous and denser cell structure which makes them harder wearing and less prone to rotting.

Types:

Name	Characteristics	Uses
Ash 	Flexible, tough and shock resistant, laminates well. Pale brown/cream.	Sports equipment and tool handles.
Beech 	Fine finish, tough and durable. Dense close grain with an	Children's toys, models and furniture.
Mahogany 	Easily worked, durable and finishes well. Rich reddish brown in	High end furniture and joinery.
Oak 	Tough, hard and durable, high quality finish possible. Light brown with variable grain.	Flooring, furniture, and railway sleepers.
Balsa 	Very soft, and lightweight but can snap. Pale cream/ white in colour. Unusually fast growing	Prototyping and modelling - especially in model aircraft.

Softwoods

They are coniferous trees which means that they keep their leaves in winter = evergreen.

These trees are tall and 'Christmas tree' tree shaped.

Overall they tend to be easier to work with and less expensive than other types of timbers.

They are more porous (holes) and if unprotected will rot. They have cones for leaves and grow quickly.

Types:

Name	Characteristics	Uses
Larch 	Durable, tough and good water resistance. Machines well.	Exterior cladding, flooring, machine mouldings and furniture.
Pine 	Lightweight, easy to work but can split.	Interior construction, cheaper furniture and decking.
Spruce 	Easy to work, high stiffness to weight ratio.	Construction, furniture and musical instruments.
Redwood 	Easy to work and machines well, some rot resistance.	Outdoor furniture, beams, posts and decking.
Cedar 	Easy to work, can blunt tools, finishes well and naturally resistant to rot.	Outdoor furniture, fences and cladding for buildings.

Manufactured Boards

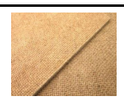
They are sheets of processed natural timber and adhesives - so they are human made boards

These are usually made from waste wood, low-grade and recycled timber.

Can be covered by thin slices of high quality wood known as veneer to make it look aesthetically pleasing.

Cheaper than natural timber. They come in boards and have no grain.

Types:

Name	Characteristics	Uses
MDF 	Rigid and stable, good value with a smooth easy to finish surface.	Flat pack furniture, toys and kitchen units.
Plywood 	Stable in all directions as alternating layers. Flexible versions available.	Furniture, shelving, toys, interior and exterior construction.
Chipboard 	Good compressive strength, not water resistant and prone to chipping on edges.	Flooring, low end kitchen units and worktops.
OSB 	Rigid and even strength, good water resistance.	Construction in interior and exterior house building.
Block board 	Stable, tough and heavy. Finishes well.	Furniture, doors, shelving and indoor construction.
Hardboard 	Flexible, even strength and easily damaged by water.	Furniture and photo frame backing.

Source/Origin

Timber comes from **trees** - this is known as the source or origin of the material. This is how we change into timber.

1. When trees are cut down, this is known as **felling.** This can be through machine or chain saws, just like the image.

2. Branches are cut off and the logs are stored until they are transported to a **sawmill.**

3. When at the sawmill, machines such as **band saws** and **circular saws** are used to create boards/planks.

Environmental Impact

Wood is considered a **sustainable resource** as new trees can be grown to replace those felled. Here are some **issues and positives** surrounding the impact that wood is having on the environment:

- In many places, wood is being used at a greater rate which means it is unsustainable.

- Illegal felling is leading to deforestation as people aren't replanting trees.

- Deforestation helps with global warming.

- To make sure you are buying sustainable timber, you need to make sure it is approved by the **Forest Stewardship Council** or the **Endorsement of Forest Certification.**

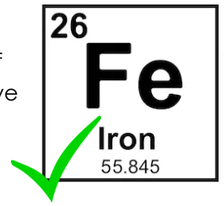
Materials and their Properties: Metals & Alloys

Ferrous

This group of metals all contain iron.

Most of these metals are magnetic and will rust if they are exposed to moisture without a protective finish.

Iron is what causes the metals to rust quicker. They tend to have a higher melting point.



Types:

Name	Characteristics	Uses
Low Carbon Steel (Mild Steel) 	Tough and ductile, easily machined, formed, brazed or welded.	Construction, nails, screws, nuts and bolts. Many car bodies.
High Carbon Steel 	Less ductile and harder than mild steel. Very hard wearing and keeps and edge well.	Garden or workshop tools, blades, scissors, wood and metal cutting tools.
Cast Iron 	Hard but brittle. Easily cast into complex shapes but some are hard to machine.	Kitchen pots and pans, machine bases and bodies, drain covers and vices.

Non Ferrous

This group of metals do NOT contain iron.

Most of these metals are not magnetic and do not rust.

These can **Oxidise**. React with oxygen that causes the surface to change colour.

They include precise metals such as gold, silver and platinum and others such as lead and mercury which are poisonous,

Types:

Name	Characteristics	Uses
Aluminium 	Lightweight, high strength to weight ration, ductile and difficult to weld.	Pots and pans, sports car body panels, bike frames, drinks cans, foil or takeaway trays.
Copper 	Ductile, malleable and a good electrical conductor.	Plumbing supplies, and electrical cables.
Tin 	Soft, malleable and ductile, a good electrical conductor.	Used to produce cans and plating surfaces to make them last.
Zinc 	Fair electrical conductivity, malleability and ductility; however, better when alloyed.	Mainly used to galvanise steel to prevent rusting.

Alloys

This group of metals is a mixture of at least one pure metal and another element.

The reason metals are alloyed is so that the added element makes the metal better - it improves it in some way.

These are more difficult to recycle as the metal has been mixed with something else.

Types:

Name	Characteristics	Uses
Brass 	A heavy alloy of zinc and copper that is malleable, easy to cast and machine.	Musical instruments, bushes and plumbing filaments.
Stainless Steel 	Hard very smooth but difficult to weld. A ferrous metal alloyed with chromium, nickel and manganese.	Cutlery, kitchen and medical equipment.
High Speed Steel 	Able to withstand the high temperatures created when machining at high speed, keeps cutting edges well.	Cutting tools such as drill bits, mill cutter, taps and dies.
Duralumin 	Alloy of aluminium, copper, magnesium and manganese. Creates greater hardness and tensile strength.	Aircraft components sports car wheels and casings.

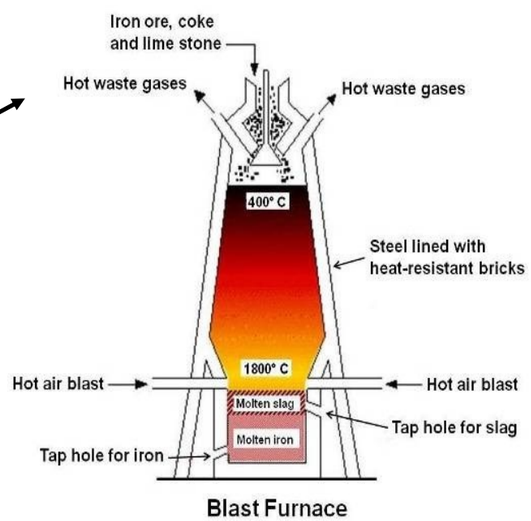
Source/Origin

Metals come from the **ground/rocks** typically the Earth's crust - this is known as the source or origin of the material.

This is how we **extract** (remove) metals from the ground and create **iron ore.**

1. The material is mined using machines - the main two types are **surface mining** and **underground mining.**

2. These rocks are then **transported** to a factory to be separated from waste material.



Blast Furnace

3. To create the **iron ore**, the rocks are placed through the top of the furnace and it is heated.

As it heats, it starts to become a liquid and this sinks to the bottom.

As it becomes a liquid it is carried away from the bottom to be **refined** further into metals.

The waste material leaves in the other direction and is known as the **slag.** Waste material also leaves as gases.

Environmental Impact

Metal is considered a **finite resource** - this means that it will run out eventually as we only have a limited amount. These are some of the impacts that metal has on the environment:

- Finite resource so it will run out eventually.
- Causes **air pollution** from the gases that are released.
- Causes **visual pollution** from the mines that are created to get the raw material.
- Takes a lot of energy to produce.

- Can be recycled over and over again. The quality will always be the same as the original so the material won't weaken over time.
- Lasts a long time and so it won't need to be replaced.
- Most metals can be recycled.

Materials and their Properties: Polymers (Plastics)

Thermoforming

This group of polymers are able to be formed into a different shape over and over again. Known as thermoplastics.

These are generally more flexible, especially when heated.

These are easier to recycle.

Can be formed into complex shapes.

Types:

Name	Characteristics	Uses
Polyethylene terephthalate 	Easily blow moulded and fully recyclable.	Bottles, food packaging, sheeting and some food wraps.
High density Polyethylene 	Lightweight, rip and chemical proof.	Milk bottles, pipes, hard hats and wheelie bins.
Polyvinyl Chloride 	Flexible, high plasticity, tough and easily extruded.	Raincoats, pipes, Electrical tape and blow up mattresses.
Low density Polyethylene 	Very flexible and tough with a high strength to weight ratio.	Plastic carrier bags and black bin bags.
Polypropylene 	Flexible, tough, lightweight, easily cleaned and safe with food.	Kitchen, medical and stationery products.
High Impact Polystyrene (HIPS). 	Flexible, impact resistant, lightweight and can be food safe. Toxic when burned.	Vacuum formed products such as food containers or yoghurt pots.
Acrylic 	Tough but brittle, easily scratched . Common in school workshop for the laser cutter.	Car lights, display stands, trophies, jumpers, hats and gloves.

Polymorph

Non toxic, easily mouldable and re-mouldable when heated. Used for modelling or personalisation of hand grips.

Thermosetting

This group of polymers, once set in shape CANNOT be reformed. Known as thermosets.

These are generally more rigid before and after they've been heated.

These are harder to recycle.

Make excellent electrical insulators.

Types:

Name	Characteristics	Uses
Epoxy resin 	Stronger than other resins, expensive and heat resistant.	Bonding different materials together.
Melamine formaldehyde 	Food safe, hygienic and lightweight.	Kitchenware - but it can't be put in the microwave
Urea formaldehyde 	Heat resistant and very good electrical insulator	Electrical fittings, casings, buttons and handles.
Polyester resin 	Reasonably strong, heat resistant and a good electrical insulator.	Waterproof coatings and flooring.
Phenol formaldehyde 	Very hard and brittle. An excellent electrical insulator.	Electrical components, mechanical parts.

Biopolymers

Newer plastics are made from **vegetable starches** and can be composted - these are great for the environment. Here are some:

PLA - Polylactic Acid

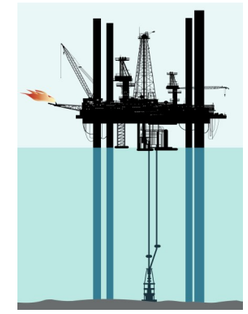
Non toxic, easily shaped and typically used for 3D printers.

Used for pens, phone cases, disposable food and drinks containers.

Source/Origin

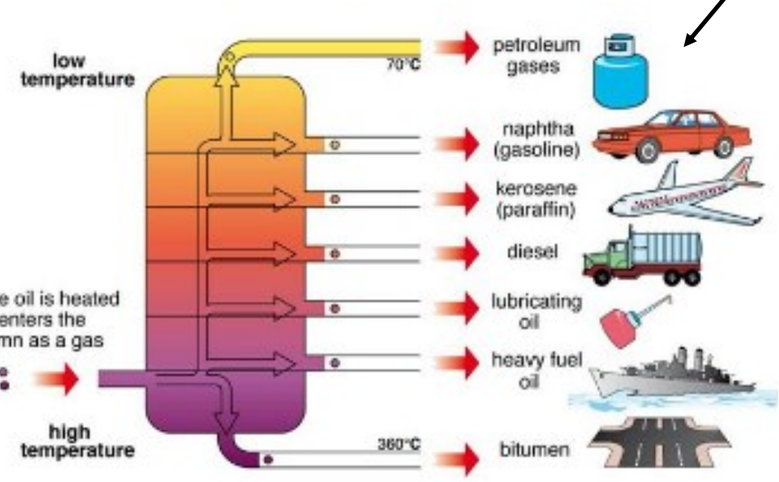
Polymers come from **crude oil.** They can also come from **gas** and **coal.** This can be found beneath the Earth's surface. Below is how we get it and change it into polymers:

1. The oil is **extracted** from beneath the surface and stored. This can be done on land or in the sea.



2. This oil is then **transported** via a **crude tanker** to somewhere called an **oil refinery.**

3. When at the refinery, the oil is heated and at **different temperatures** this creates the different **products.**



Environmental Impact

Polymers are considered a **finite resource** - this means that it will run out eventually as we only have a limited amount. However with development in technology there are some **biodegradable** ones, here are some of the impacts:

✗ - Do not biodegrade easily so release harmful toxins in landfills.

- Causes **air, visual** and **water pollution.**

- Takes a lot of energy to produce.

✓ - Some are able to be recycled so they don't use raw material (brand new e.g. crude oil).

- New technology has given way to fully biodegradable ones - **biopolymers,** so they are non toxic and not from a finite resource.

Materials and their Properties: Textiles

Natural Fibres

Natural fibres come from 2 sources – these are plant based and animal based.

Fabrics from plant based are renewable but take a long time to grow.

Types:

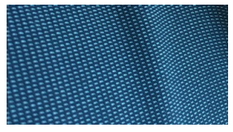
Name	Characteristics	Uses
Cotton **(plant)** 	Soft, strong and absorbent, cool to wear and easily washable. Good thermal properties.	Most clothing and can be used for denim.
Wool **(animal - sheep)** 	Can be fine and thick, naturally warm and crease resistant. Can shrink.	Jumpers, coats, suits and carpets.
Silk **(animal - silk worm)** 	Very soft and fine finish, gentle, warm in winter and cool in summer. Absorbent and strong.	Luxury clothing and bed sheets.

Synthetic Fibres

Synthetic fibres are ones that are man-made.

These can be made from recycled plastic bottles.

Types:

Name	Characteristics	Uses
Polyester 	Tough, strong, hard wearing, very versatile, holds colour well and non absorbent.	Clothing, fleece garments, bedsheets, carpets, backpacks and umbrellas.
Polyamide **(Nylon)** 	Good strength, hard wearing, non absorbent, machine washes well.	Clothing, ropes and webbings, parachutes and sports material.
Elastane **(Lycra)** 	Added to fabric to enhance working properties, to add stretch. Freedom of movement	Sportswear, exercise clothing, swimsuits and general clothing.

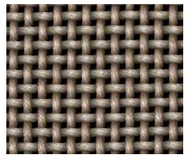
Blended & mixed fibres

These fibres have been blended and mixed together - so natural mixed with synthetic.

Types:

Name	Characteristics	Uses
Poly-cotton 	More durable than pure cotton but not as breathable. Can be produced more cheaply.	General clothing, sheets and bedding. Used as alternative to pure cotton.

Woven fabrics



These are fabrics where they follow a pattern - one piece goes up and over whilst the over does the opposite. Weaving.

Types:

Name	Characteristics	Uses
Plain weave e.g. muslin and calico.	Simple and cheaper to produce, stronger than other weaves.	General clothing, sheets and bedding. Used as alternative to pure cotton.

Non-woven fabrics

These are fibres that haven't been spun into yarn - they have been bonded together through heat or adhesive (glue).

Types:

Name	Characteristics	Uses
Bonded fabric 	Lack strength, no grain so can be cut in any direction and not fray.	Disposable products such as protective clothing
Feted fabric 	Can be formed with moisture and heart - no elasticity when it has dried. Pull apart easily.	Hats, soundproofing and insulation.

Knitted fabrics

This is when yarn is interlocked (connect) with each other.

Weft - hand or machine and loops across the width.

Warp - these interlock vertically and less prone to unravelling and laddering.

Types:

Name	Characteristics	Uses
Knitted fabric 	Warm to wear, different knits have different shapes, stretch and shape retention	Jumpers, cardigans, sportswear and tights.

Source/Origin

Fabric can be sourced from many places as you can see from the table. However they are mainly **animal sources, chemical sources and vegetable sources.** Then when you've got the source this is what happens:

1. This is what some of the **raw fibres** look like, this is once they have all been collected. E.g. you could have a pile of wool or cotton.

2. Then to turn this into **yarn**, the raw material is **spun or twisted** by hand or machine. It is spun and twisted until it becomes useable.

3. So it will look something similar to this once it has been further **processed,** such as being dyed. Some are further processed so they become thinner and smoother.

Environmental Impact

Here are some of the impacts that manufacturing textiles has on the environment:

- They use a lot of water in the processing stages to make sure that they are clean and useable.

- When being processed, they will release **CO2** into the environment causing **air pollution.**

- Throw away culture due to fashion

- Almost all textiles are recyclable or biodegradable.

- Most sources of textiles are considered **sustainable** as they are available such as the cotton plant s and sheep's wool.

- Can be reused or donated.

Materials and their Properties: Papers & Boards

BOARDS

The thickness of boards is measured in microns. 1000 microns = 1mm.

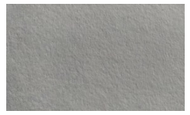
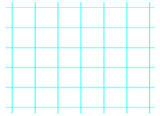
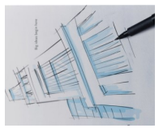
Types:

Name	Characteristics	Uses
Corrugated card 	1000-5000 microns, strong and lightweight. Insulative and easily printed on.	Packaging, boxes and impact protection.
Duplex board 	200-500gsm, stiff, lightweight coatings to improve functionality.	Cheaper version of white card used for packaging boxes. Waxy coating for protection.
Foil lined board 	200-400gsm, stiff, foil reflects heat and a water and oil resistant coating enables food and liquid based products to be contained.	Takeaway containers and lids, used to retain heat for longer.
Foam board 	3-10mm thick, lightweight and rigid in all directions. Can crease and crack under pressure.	Architectural models, model making, prototyping, mounting and framing of photographs.
Ink jet card 	120-350gsm medium to thick card treated to hold a high quality photo image.	High quality photographic images
Solid white board 	200-500gsm, stiff board, holds colour well, easily cut or creased.	Any uses including greeting cards, packaging and advertising.

PAPERS

Paper is measured by weight in grams per square metre (GSM). This is how heavy it will be.

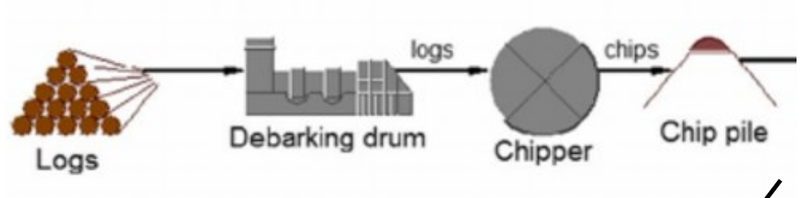
Types:

Name	Characteristics	Uses
Bleed proof paper 	70gsm, coated to stop solvent based markers staining. Ink stays on the surface.	Marker pens when designing and final designs.
Cartridge paper 	120-150gsm, completely opaque and more expensive.	Pencil and ink drawings, sketching and water colour.
Grid paper 	Usually printed onto 80gsm paper with faint lines and often in blue.	Used for graphical, scientific and mathematical diagrams.
Layout paper 	40-60gsm, semi translucent, takes pencil and most media well.	Creating sketches and working ideas.
Tracing paper 	10-120gsm, translucent, takes pencil and most colour well.	Copying and tracing images.

Source/Origin

Paper and boards come from finely shredded wood but has been prepared in a special way to make what you know as paper and boards. This is how they are made:

1. **Pulp** - this is the finely shredded wood. Logs are **debarked** into fine chips. These are added to a chemical solution and cooked under pressure to make them into a paper pulp. These are called **cellulose fibres.** Depending on the colour, the fibrous liquid is then bleached or coloured.



2. **Sizing** - this is a process where chemicals or other additives are beaten into the fibrous liquid. This stops it being so absorbent. This means it can then be photocopied, printed or painted onto.

Papers such as toilet roll or kitchen roll have little sizing so that they can absorb moisture. Otherwise they wouldn't work as toilet or kitchen roll.

3. **Converting Pulp to Paper** - the pulp (so the liquid fibrous) goes on a mesh conveyor belt to drain the excess water. It goes through lots of rollers to squeeze the last of the water out of the paper. Then through **drying rollers,** so it dries and finally through a set of **calender rollers** which give the paper the finish e.g. satin or matt. Here's a picture of the overall process together:

Environmental Impact

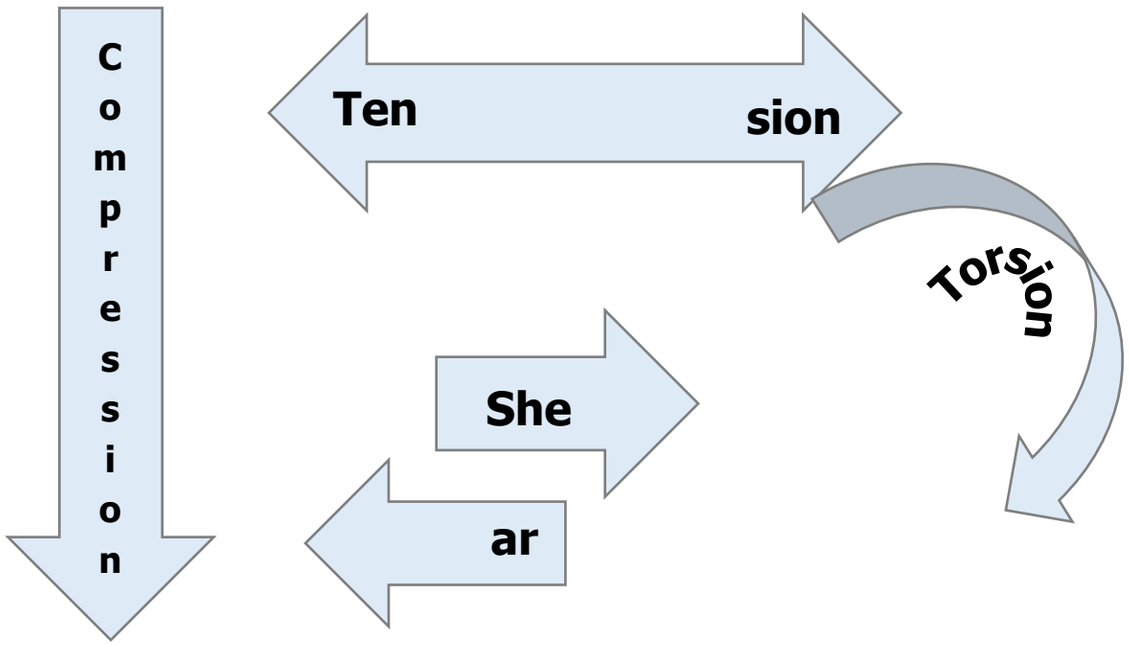
Paper is considered a **sustainable resource** which means it is something that can continue going as it can be **replenished** (replaced) for example, you cut down a tree, plant 2 new ones or a new one. Here are some of the impacts on the environment:

✗
- Processing of paper can release chemicals into the environment which is not good for the atmosphere.
- If put into a land fill, it will release methane over time which is bad for the atmosphere.

✓
- Sustainable resource
- Can be recycled over and over again
- Decomposes over time if it does go into a land fill or if left on the ground.

Mechanical Systems

Forces

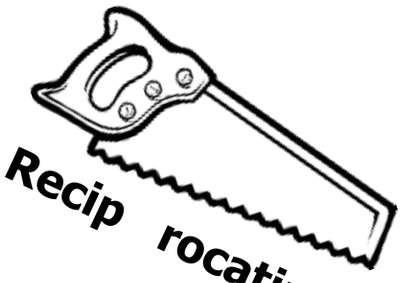


Motion

Linear

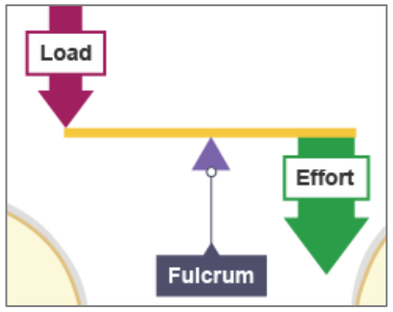
Rotation

Oscill ating



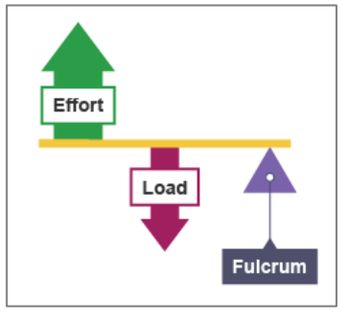
Recip rocating

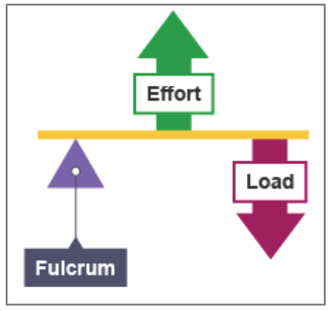
Levers



1st Class Lever:
Fulcrum in the centre
E.g. Scissors

2nd Class Lever:
Load in the centre
E.g. wheelbarrow





3rd Class Lever:
Force in the centre
E.g. Lifting a dumbbell

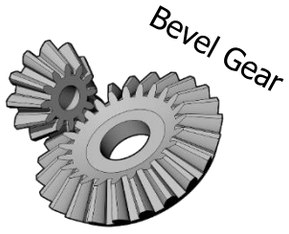
A Pulley is a grooved wheel, that has a belt running through it

This uses rotary motion and is often used to help with heavy loads, and transfer force from a motor to a tool in machines like drills, etc

Gears and Pulleys

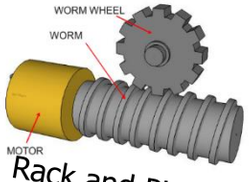
Gears have teeth that mesh together with each other (like teeth on a zip)

They mainly focus on rotary motion on tools and machinery e.g. car steering and pillar drills



Bevel Gear

Spur Gear



Rack and Pinion

Worm and Wheel

Market Pull and Technology Push

Technology Push is the development of new technology, materials and manufacturing methods to create new products or improve old ones.

Examples include; Smart Phones, Electricity, Mass Production, etc

Market pull is the demand from consumers for new products and improvements in old ones; this is often found via reviews, polls, surveys, etc

Examples include; Product **Aesthetics,** making products easier to use, etc

Cultures, Faith and Belief

Different groups of people have different interests and have to be catered for.

Different countries and cultures also react to products differently.

E.g. In India McDonalds don't sell beef burgers as it has a large Hindu population, and cows are seen as sacred – in contrast the UK sells its most amount of fish and chips on a Friday as it is a Christian tradition to not eat meat on that day.

Case Study: £5 note

Hindu, Sikh and some other faith-based communities may choose to follow a vegetarian diet, and this is part of their culture. In addition to not eating meat, many followers of these faiths, as well as vegans and vegetarians, take every opportunity to avoid using animal products in their day-to-day lives.

The revelation in 2016 that the new polymer Bank of England £5 note contained tallow, an animal fat-based substance, upset a number of communities. There was a prompt call for the Bank of England to find an alternative way to produce the note and in the first two days of an official petition well over 100,000 signatures were received.

Shortly after the Bank of England admitted that the new polymer £5 note contained the animal by-product, some establishments refused to take the notes as a method of payment. One café owner was repulsed by the idea that the note contained tallow and believed that her customers supported her view. They received no complaints.

The Bank of England say they currently have no plans to change the manufacturing process.

Fashion and Trends

Fashion and Trends will change quickly, and you can see major differences in fashions over decades.

Designers have to make sure their products meet the fashion and trends of the area they are designing and selling the product to.

The change of products over time is called **Product Evolution**. This is caused by Market Pull, Technology Push and Fashion and Trends.

Some products are seen as **timeless.** These products are called **Iconic Designs.** These products are timeless because they were innovative, set a bench mark for following products, changed their industry and are often copied.
Examples include; iPod, iPhone, Angle-Poise Lamp, Swiss Army Knife, Converse Shoes, Levi's Jeans, Classic Mini Cooper

Inclusive vs. Exclusive Design

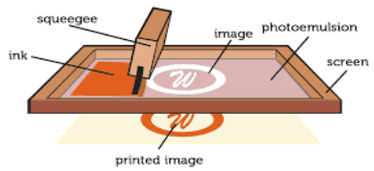
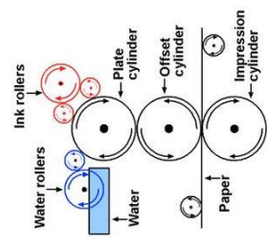
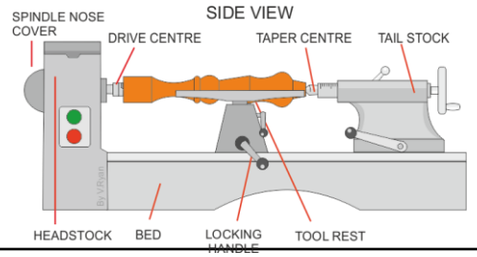
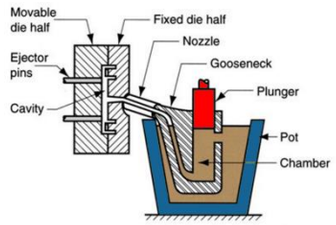
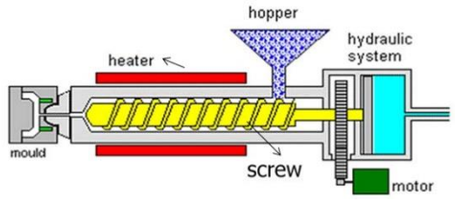
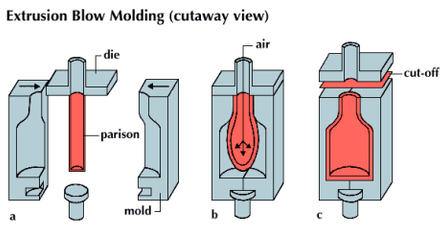
Inclusive Design: The aim to create a product that as many people as possible can use

Examples include; Cars, Doorframes, Adjustable Products, etc

Exclusive Design: The aim to create a product for a particular group and their needs

Examples include; Car seats for babies, Wheelchairs, Stair Lifts

Production Processes

Name of Process	Diagram	Material	Products Made	Key info
Screen-printing		Papers and Textiles	Posters, signs and t-shirts	Screen printing places paint on top of a screen. The screen has a stencil embedded in it, so when the paint is passed across it the desired shape is printed underneath. Good process in one-off and batch production as often done by hand
Offset Lithography		Papers and card (thin, flexible plastics)	Posters, newspapers, plastics bags	Rollers containing the colours and water go onto the plate cylinder. The water stops the colours sticking to certain places, creating the shape. The shape is transferred between rollers and onto the material. Can be used at batch and mass production
Lathe Turning		Wood and metal	Chair legs, baseball bats)(cylindrical items)	Material is placed between the tail stock and the headstock and spun at high speed. The material is then cut using specialist tools (either by hand or my automated machinery) to the desired shape. Can be used in one-off and batch production
Die Casting		Metal	Car parts, engine components, etc	Molten metal is poured into a chamber and a plunger forces the metal through the nozzle into the mould. Unlike sand casting, the mould is reusable. Good process for both one-of and batch production
Injection Moulding		Plastics	Chairs, toys, etc	Plastic granules are poured into the hopper and onto the screw. The screw moves the material towards the heater where it turns into a liquid. The liquid is then forced into the mould, cooled and released. Great process for mass production as it makes 100s+ of products at once, to a identical standard.
Blow Moulding		Plastics	Plastic bottles	A Plastic parison is heated and put into the mould. The parison is then filled with air (like blowing up a balloon) and is forced to fit the mould shape. It is then cooled and then released. This is a great process for mass producing bottles.

CAD Computer Aided Design	
Examples; 2D Design, Autodesk Inventor, Fusion 360, Photoshop, etc	
Advantages	**Disadvantages**
• Easy to change designs • Designs are easily saved and sent • Can be worked on by multiple people simultaneously • Can be used for virtual testing • Can produce high-quality designs	• Complex and time-consuming to learn • Expensive to buy • PCs can crash or be hacked – causing work to be lost • Takes up PC memory

CAM Computer Aided Manufacture	
Examples; 3D Printing, Laser Cutting, CNC Router, Automated Machines and Robotics, etc	
Advantages	**Disadvantages**
• Faster and more accurate than traditional tools • Repetitive accuracy/ consistent outcomes • Machines can run 24/7	• Expensive to buy the equipment, etc • Training takes cost and time • Need specialists to maintain and repair the machines • Dependence on CAM can cause unemployment

Flexible Manufacturing Systems
This is where **automated machines** are adaptable and can produce different products if needed. If a manufacture is making a product with machines that are just dedicated to specific tasks they have to be reprogrammed and re-tooled before changing to a new task. This is time consuming and expensive. Examples include; CNC Machines, 3D Printers, Laser Cutters, Robotic arms, etc

Lean Manufacturing
This is where waste and energy is kept to a minimum. This helps manufacturers save money and resources in production, as well as helping minimise the **environmental impact** of producing products.

Just-in-Time (JIT) Manufacture	
This is where manufacturers only order materials, parts, etc when needed. The customer's order triggers the production process and the resources needed for that order are the only ones bought. This can be used in any **scale of production** but is particularly useful for one-off production.	
Advantages	**Disadvantages**
• Saves on warehouse and storage costs • Money is not tied-up in stock • Little/minimal waste • Customer often pays in advance so money is secure before production	• All production stops if a part/ material is missing • Needs to have a fast, reliable and good quality supply chain to work properly • Can be time-consuming

GCSE DT

Revision

Topics

Process and Manufacture

Scales of Production	
Revised	
Exam Question	
Revised again	

Production Methods	
Revised	
Exam Question	
Revised again	

Tolerances	
Revised	
Exam Question	
Revised again	

Designing Products

Research and Investigation	
Revised	
Exam Question	
Revised again	

Developing and Communicating Ideas	
Revised	
Exam Question	
Revised again	

Prototyping and Development	
Revised	
Exam Question	
Revised again	

Briefs and Specs	
Revised	
Exam Question	
Revised again	

Materials

Paper and Boards	
Revised	
Exam Question	
Revised again	

Finishes	
Revised	
Exam Question	
Revised again	

Standard Components and Stock Forms	
Revised	
Exam Question	
Revised again	

Plastics	
Revised	
Exam Question	
Revised again	

Woods and Boards	
Revised	
Exam Question	
Revised again	

Properties of materials	
Revised	
Exam Question	
Revised again	

New and Smart Materials	
Revised	
Exam Question	
Revised again	

Approaches to Design

People, Society and Culture	
Revised	
Exam Question	
Revised again	

Work of Others	
Revised	
Exam Question	
Revised again	

Design Strategies	
Revised	
Exam Question	
Revised again	

Industry and Enterprise	
Revised	
Exam Question	
Revised again	

Environment	
Revised	
Exam Question	
Revised again	

Energy and Mechanisms

Mechanical Systems	
Revised	
Exam Question	
Revised again	

Energy Generation and Storage	
Revised	
Exam Question	
Revised again	

Process Orders	
Revised	
Exam Question	
Revised again	

Maths and Science

Energy	
Revised	
Exam Question	
Revised again	

Angles	
Revised	
Exam Question	
Revised again	

Forces	
Revised	
Exam Question	
Revised again	

Environment	
Revised	
Exam Question	
Revised again	

Decimals	
Revised	
Exam Question	
Revised again	

Area and Volume	
Revised	
Exam Question	
Revised again	

Charts and Graphs	
Revised	
Exam Question	
Revised again	

Ratios, Fractions and Percentages	
Revised	
Exam Question	
Revised again	

Scales of Production

Name/ Type	How many it makes	Key Info	Examples of Products
One-off Production	1	• Also known as Bespoke or Prototype manufacture • Custom-made products • Specialist workers/ skills • Specialist machines and materials • High Quality but expensive	• Towers / Bridges • One-off Houses • Custom made clothes
Batch	10s-1000s	• Uses a mix of workers and machinery • Uses jigs, moulds and templates to help make identical products • Stations of workers e.g. cutting station, painting station, etc • Can have some variation e.g. colour, finish, flavour	• Baked foods • Limited edition car • Socks • Chairs
Mass	10,000s - 100,000s	• Big assembly lines (and sub-assembly lines) • Heavily automated • Standard and identical products • Little worker input	• Cars • Bottles • Microchips • Plain shirts
Continuous	100,00s +	• 24/7 production • Heavily automated • Standard and identical products • Little worker input	• Energy • Water • Paper • Plastic

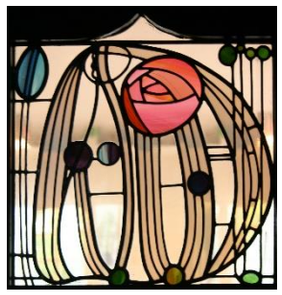
One-off Production	
Advantages	**Disadvantages**
• Custom made • High Quality Materials • High Quality Craftsmanship	• Time consuming • Specialist training for workers • Expensive to buy

Batch Production	
Advantages	**Disadvantages**
• Lower cost than one-off • Jigs, moulds and templates help products look identical • Can have some variety	• High storage costs • Jugs, moulds and templates have to be checked • Workers can become bored on their station

Mass Production	
Advantages	**Disadvantages**
• Large amounts made at once • All products are identical and to same standard • Using automation reduced human error	• Initial starting costs are high • If production line stops, the product can't be made • Workers become bored monitoring machines and repetitive tasks

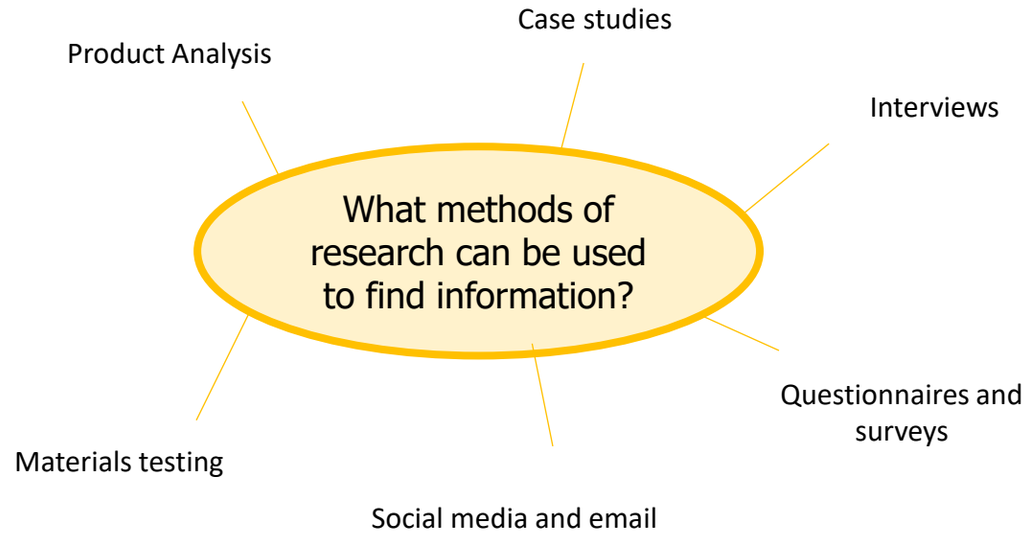
Continuous Production	
Advantages	**Disadvantages**
• Large amounts made at once • All products are identical and to same standard • Using automation reduced human error	• Initial starting costs are high • If production line stops, the product can't be made • Workers become bored monitoring machines and repetitive tasks

Work or Others

Image/ Example	Designer	Design Movement	Key info
	William Morris	Arts and Crafts	• British designer in 1880s • Simple natural crafts • Useful and beautiful products (wallpapers, cushions, etc)
	Charles Rennie Mackintosh	Art Nouveau	• Scottish designer in 1860s – 1920s • Known for light and shadow • Created stained glass and furniture • Inspired by nature and geometric lines
	Ettore Stottas	Memphis	• Italian designer in the 1950s/60s • Enjoyed making everyday objects wacky and bold • Used lots of bold colours and black lines

Image/ Example	Brand	Key info
	Alessi	• Italian Design Company • Homeware and kitchen utensils • "Post-modern" style • Phillipe Starke is a major designer
	Apple	• USA-based tech company • Famous for **iconic designs** of iPod and iPhone • Steve Jobs and Johnathon Ive are major designers • Known for innovative and modern design
	Dyson	• British engineering company • Famous for vacuum cleaners and innovative technology • James Dyson is a major designer

Research



Research can be divided into 2 categories; **Primary Research** and **Secondary Research**.
Primary is research you complete yourself.
Secondary is research from resources others can gathered e.g. books, magazines and internet

Primary research is generally more reliable as it is done by the person using it and can double-check the data

Another key piece of research, is **Anthropometrics and Ergonomics.** This helps develop the sizes of products, etc to make sure it fits the User

Anthropometrics	The study of measurements of the human body. E.g. Knowing the grip width of a palm, if designing a new travel coffee cup
Ergonomics	The application of anthropometrics to ensure products are safe and comfortable to use. This can also include; size, material, appearance, brightness, sound and texture. E.g. making sure the travel cup is the correct size, and an insulating smooth material to make it comfortable to hold for long periods