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Surface Treatments

Dyeing – a common method of applying colour to fabrics.

Fabric is immersed in a dye bath
Resulting colour depends on

- type of fibre – natural fibres dye better
- Type of dye – synthetic dyes are stronger than natural dyes
- Type of product being dyed
- The stage in production when applied

Colourfastness is the strength with which the dye is held in the fibre.

- Spin dyeing – Colour is put into the spinning solution of synthetic fibres
- Stock dyeing – When natural fibres are dyed before they are spun into a yarn
- Yarn dyeing – Dyeing yarns before they are made into fabrics
- Piece dyeing – The dyeing of woven or knitted fabrics
- Garment dyeing – Made-up garments are dyed as required to meet consumer demand for different colours

Resist Dyeing

- Stop the dye reaching certain areas of fabric to produce pattern
- Wax, string, flour, paste used as 'resists'
- Batik and tie dye are examples of resist dyeing

Natural/vegetable dyes

- Uses colourings extracted from natural products like onion skins, beetroot
- More environmentally friendly

Specialist Techniques & Processes

Printing – is used to add colour and pattern to fabrics

Transfer printing – iron on transfers

- Uses image created on a computer
- Image printed onto transfer paper
- Transfers the design applying heat from iron or hot press

Transfer printing – sublimation printing

- Design printed on to sublimation paper
- Design transferred to fabric using heat

Digital printing

- Whole design and printing process carried out by a computer
- Complex designs quickly and easily
- Prints directly to fabric

Printing – is used to add colour and pattern to fabrics

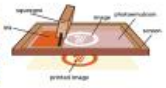
Block Printing

- Wooden block
- Design cut in relief
- 'stamps' design on fabric

Stencilling

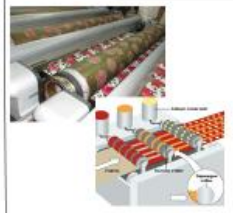
- Uses card with design cut out
- Colour applied directly to fabric using sponge, roller or brush
- Colour appears in areas where card is cut out

Screen Printing



- Uses a stencil under a nylon screen on a wooden frame
- Dye/ink pushed through the screen using a squeegee
- Different screen and stencil for each colour

Roller Printing



- Uses series of metal rollers with design engraved on them
- Separate roller for each colour
- Dye or pigment pushed through each roller to fabric

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Surface Treatments/Finishes

Applied Finishes

Textile products often have finishes applied to them.

Why?

- to protect the fabric or design features
- to change the feel/handle/drape of the fabric
- to improve resilience and durability, to make it last longer
- to improve the appearance of the fabric
- to add value to the product
- to make it safer
- to make it easier to care for or launder

Good finishing can greatly improve the aesthetic and functional properties of fabrics

Mechanical Finishes	Applied using machines
BRUSHING/RAISING Fabric passed through series of wire rollers that 'fluff' up the surface. Fabric left soft and fluffy with a raised surface called a nap. Raised surface traps air and keeps body warmer. Used on textiles for babies.  	**PRE-SHRINKAGE** Natural fibres that are prone to shrinking (wool and cotton) can be pre-shrunk. Reduces further shrinkage. Done by steaming on a vibrating conveyor belt. 
STONEWASHING A process used to give a new fabric or garment a worn appearance. Stone-washing helps to increase softness and flexibility of rigid fabrics like denim. Process uses large stones to roughen the fabric. 	**HEAT SETTING** A thermal process in a steam or dry heat atmosphere. Thermoplastic synthetic fibres soften in the heat and when cooled retain the shape for example, Permanent pleats. 

Chemical Finishes

STAIN RESISTANCE Fabrics can be made stain resistant with a finish an example coating is Teflon. Stop grease and dirt penetrating fabric. - Carpets and upholstery. 	**FLAME-PROOFING/RESISTANCE** Chemicals applied that make fabrics less likely to catch fire. Often used on flammable fibres like cotton. -Night clothes, interior fabric, workwear.  	**SHRINK-RESISTANCE** Finishes applied to fabrics such as wool which are prone to shrinking when machine washed. - Trousers 
CREASE RESISTANCE Finishes given to fabrics that crease easily for e.g. cotton and linen. Chemicals used can make fabric feel stiffer. - Suits, shirts. 	**WATER RESISTANCE** Silicon-based chemical sprayed on to fabric to make fabric repel water. It stops water droplets passing through. Can still be washed and dry cleaned. Nylon given water resistant finish for tents and coats. - Outdoor clothing. 	**THERMOCHROMIC DYES** These dyes change form one colour to another when the temperature changes. These are known as a 'Smart' finish – one that responds to changes in surroundings. 

Surface treatments and finishes

Finishes are added to a product's surface after production to improve its functionality and/or **aesthetic**. They can be applied to:

- stop **corrosion**
- prevent **decay**
- stop UV light degradation
- defend against attack (from insects or fungus etc)
- improve hygiene
- make a product tougher
- **insulate**
- decorate
- colour
- make a product smooth

Textiles Finishes

Stain protection, waterproof coatings, mould and mildew protection, printing, dyeing, distressing (making it look old), flameproofing, crease resistance

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Mechanical Devices

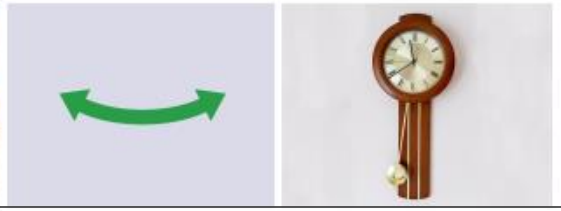
Types of Motion

Linear motion moves something in a straight line, e.g. a train moving down a track:

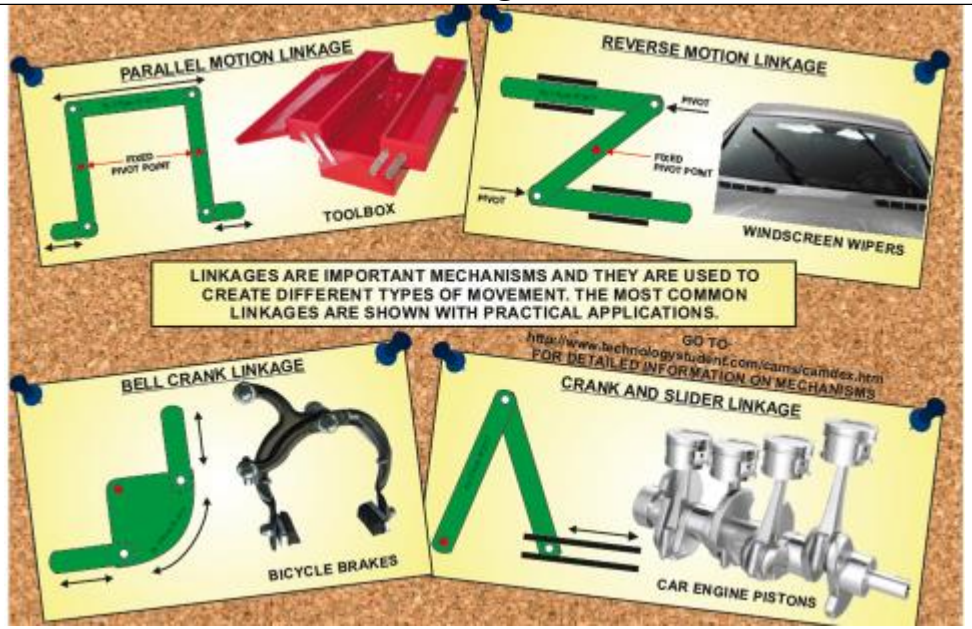
Reciprocating motion has a repeated up and down motion or back-and-forth motion, e.g. a piston or pump:

Rotary motion is where something moves around an axis or pivot point, e.g. a wheel:

Oscillating motion has a curved backwards and forwards movement that swings on an axis or pivot point, e.g. a swing or a clock pendulum:



Linkages



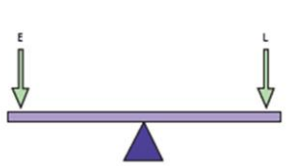
LEVERS

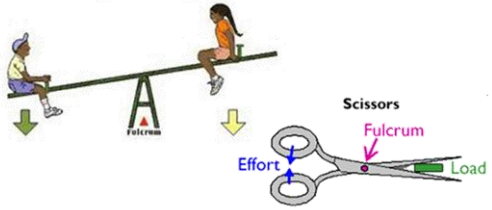
Levers use **mechanical advantage** to make lifting or applying pressure easier. All **levers** are made of a bar and a **pivot**, called a **fulcrum**. Levers have three main parts:

- **effort** - the amount of force applied by the user, also referred to as the **input**
- **fulcrum** - where the lever pivots
- **load** - the weight that needs to be moved, also referred to as the output

FIRST ORDER LEVER

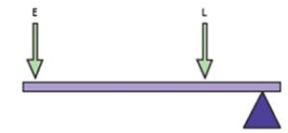
A first-order lever has the fulcrum between the effort and the load.

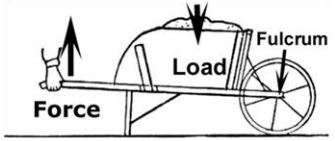




SECOND ORDER LEVER

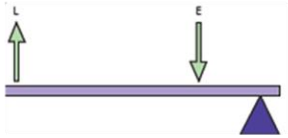
A second-order lever has the load and effort on the same side of the fulcrum. The load is nearer to the fulcrum, so less effort is required to move it.

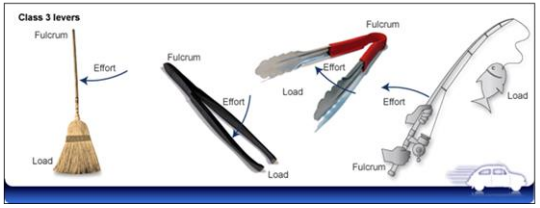




THIRD ORDER LEVER

A third-order lever has the load and effort on the same side of the fulcrum. The load is further from the fulcrum, so the effort required is greater than the load.





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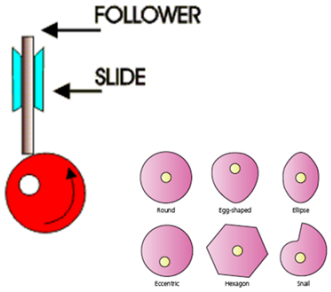
Mechanical Devices

ROTARY SYSTEMS

CAMs and followers



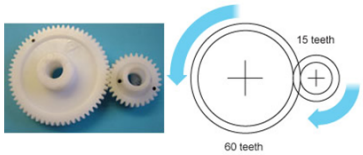
A cam mechanism has three parts – a **cam**, a **slide** and a **follower**.

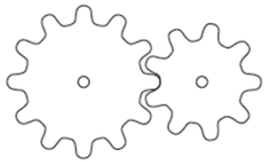
When the cam rotates, the follower moves up and down in a reciprocating motion.

A follower can: go up (rise)
go down (fall)
stay still (dwell)

Cams come in many different shapes to create different combinations of rise, fall and dwell.

Simple gear trains



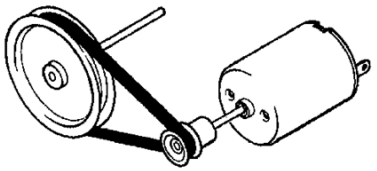


A **gear train** is a mechanism for transmitting rotary motion and **torque** (the turning force that causes rotation).

The gears have teeth that interlock to transmit the rotary motion.

Different-sized gears connected together either increase or decrease the speed of rotation and increase or decrease the torque transmitted.

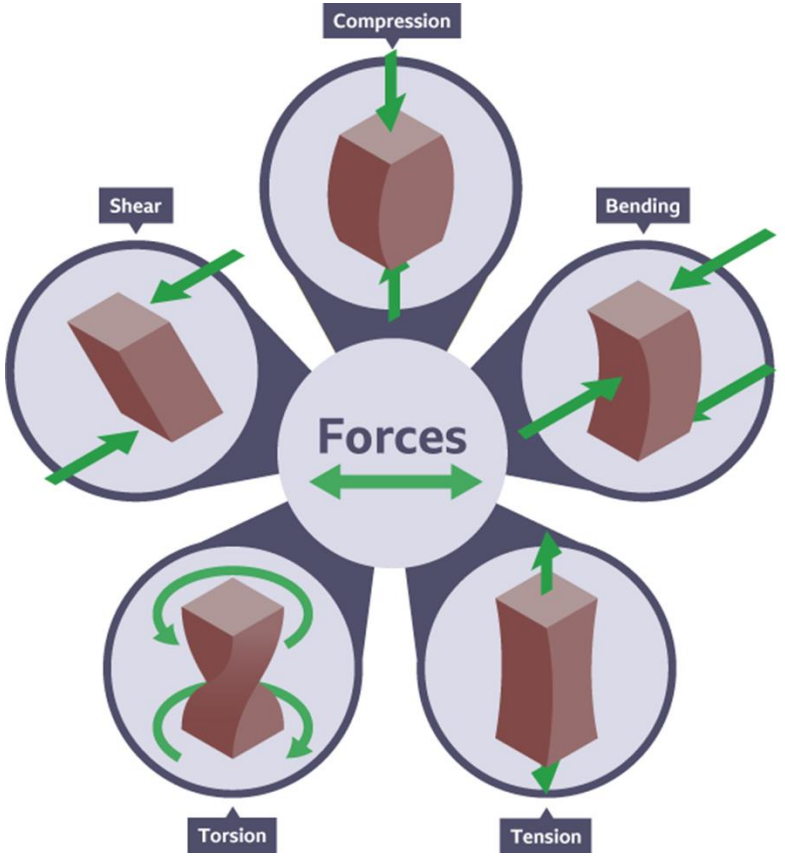
Pulleys and belts



Pulley systems transmit rotary motion to rotary motion in machines. A pulley is a wheel with a groove in its rim.

Two pulleys connected together by a flexible belt will transmit rotary motion and torque.

Forces and Stresses



Forces act on materials all the time - even if a material appears stationary it still has a force acting on it. There are five terms used to describe what type of force can act on a material:

- **tension** - a pulling force
- **compression** - a pushing force
- **bending** - forces at an angle to the material
- **torsion** - a twisting force
- **shear** - forces acting across the material

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Selection of Materials

Materials can be selected based upon their **working properties**. It is important to know and understand which materials can be used for a specific purpose:

- How do they look?
- What are they commonly used for?
- How can they be manufactured?
- How do they perform in use?
- What makes them unique - are they the most **durable**, the lightest etc?

Fabrics are developed to cover a variety of needs.

Function

How a textile behaves is vital to the selection of fabric. Fashion fabrics are usually lighter weight and more decorative than furnishing fabrics. Other **functions** such as warmth, **durability**, strength and **absorbency** may all need to be considered when selecting the right textile for a job.

Aesthetics

Textiles used for **soft furnishings** and clothing need to be attractive to look at to attract the consumer and keep up with fashion. Decoration can be **woven**, knitted, printed and embellished on to create a particular **aesthetic** style with thickness, finish and colour all contributing to the overall look.

Cost

There are several cost factors in the selection of textiles. The quality of a fabric affects the price - for example, coarser, easy-to-produce cotton is cheaper than **labour-intensive** silk. Decoration or specialist finishes will also add to the cost.

Environmental issues

Textiles made from plant or animal fibres, such as wool or cotton, are **renewable** and easily biodegradable. Man-made textiles are made from oil-based materials, which are **non-renewable** and harder to **degrade** when put into **landfill**. Some consumers may wish to consider the environmental impact when buying products.

Social factors

Some textiles products may not be made in good working conditions. There may be issues with child labour, poor working conditions and the use of hazardous chemicals. Selecting textiles from a fair trade background can help ensure that the producers have maintained standards of fair wages and conditions for the employees making the product.

Cultural factors

When choosing fabrics, it is important to consider elements that might cause offence. The use of fur or animal skins may upset some people, while certain colours have different meanings around the world. The use of symbols and writing needs to be carefully checked for any mistranslation.

Availability

Many textiles are available in **stock form**, which means they can be ordered in bulk to arrive at a manufacturer quickly. Stock textiles will generally be cheaper to buy than specialist materials. Other textiles may need specially decorating or weaving for a particular design, so would need to be ordered in advance from a specialist manufacturer.

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Sustainability/Environment

cotton = use of pesticides/fertilizers which pollute ground and waterways and use a lot of water to grow

use of valuable non-renewable resources like oil to produce polyester fibres

dyeing and finishing processes use vast amounts of water

dyes and chemicals used to finish fabrics can pollute waterways if not filtered.

heavy metals used in production of components release gas especially zips.

Some materials use chemicals and vast amounts of water to be created as well.

MATERIALS → **PRODUCTION**

DAMAGE MADE TO THE ENVIRONMENT DURING A PRODUCT'S LIFECYCLE

RETAIL → **USE** → **DISPOSAL**

packaging and distribution of products; excessive and nonbiodegradable packaging, energy and materials used to produce packaging, use of fuel for transportation

cleaning of textile products can waste energy and produce polluting effluent.

disposal of discarded products and offcuts of fabric requires huge landfill sites and som take many years to decompose.

No pesticides/fertilizers = 100% organic cotton – still uses lots of water to grow

- Bamboo, sashawashi and hemp don't use a lot of water, grow fast and are bug resistant

Don't use non-renewable resources like oil

Don't use dyes and chemicals or filter them. Or use vegetable/natural dyes.

Don't bleach materials like linen or cotton

Use processes that use less water – digital printing uses ionised salts (but back to chemicals again!)

Rethink use of components or use natural material or recycled plastics/metals

MATERIALS → **PRODUCTION**

SUSTAINABLE PRODUCT LIFECYCLE

RETAIL → **USE** → **DISPOSAL**

Packaging: reduce or get rid of packaging or use biodegradable packaging.

Make all of product locally-reduce transport.

Is transporting by ship/lorry less damaging than plane?

Transport – use of fuel –could it be eco friendly?

cleaning of textile products

Wash at lower temperatures

Use of chemicals to clean=can use concentrated options to reduce packaging
or
Use an eco option (washer and tumble dryer balls

Design product to be easy to clean (based on material, product design and the finish

Disposal
Recycle off cuts from factories

Can you re-use it?

Can it be used for another purpose when you have finished with it?

Could it be repaired easily?

Product could be designed to last

Is it recyclable? the material or can the product be refashioned into something else?

Is it biodegradable?

PRODUCING TEXTILES AND THE EFFECTS ON THE ENVIRONMENT

During the production of textiles a large amount of energy is used to power the factories. This then creates more pollution such as carbon dioxide

Dyeing, bleaching or adding finishes to fabrics often involve using highly toxic chemicals. Water used in the process is pumped into rivers and sewage affecting wildlife and humans.

Growing raw materials such as cotton requires large amounts of pesticides. These pesticides are harmful and often affect birds, the water system and insects.

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Ecological and Social Footprint

A growing population means that more raw products are needed to fulfil their textiles needs.

Farming

Growing natural fibres such as cotton or bamboo can lead to the **degradation** of soil. This can lead farmers to expand into other areas, destroying natural habitats. The use of **pesticides** and water supplies also affects the wildlife in an area. Rearing animals for their wool, such as sheep or alpacas, also leads to expanding land requirements, which can cause **deforestation** and loss of habitat.

Drilling

Drilling for oil to produce man-made synthetic textiles requires large storage areas and refining plants to change the oil into the materials needed for manufacturing. This process can be harmful to the environment. Oil is **non-renewable** and, when **refined**, produces fabrics that do not **biodegrade** easily.

Whenever environmental impact is to be reduced, **'the 6 Rs'** can be addressed to ensure an in-depth analysis has been done. The 6 Rs can be considered by the designer, the **manufacturer** and the consumer to reduce that negative impact on the environment.

Designers need to understand the challenges of using **raw materials** and the processes available to limit the amount of waste when manufacturing a product. The world has a bigger population than ever before, and the need for more raw materials causes a range of issues:

Deforestation - A lack of tree roots leads to **soil erosion**, causing rivers to **silt up**. It is possible to manage deforestation through responsible management of the forests. If more trees are planted than are cut, it is possible to minimise the impact. Designing to ensure less wastage will cost less and be better for the environment.

Mining and **drilling** - The environmental impact of mining and drilling is primarily to the area around the sites. Loss of **habitat** for wildlife is caused by the clearance of land above the sites as well as the noise and light pollution in the area. Water **run-off** can also create ponds of concentrated chemicals, which can harm the human and wildlife population. Designing products that use a more renewable set of materials will help solve this problem.

Carbon footprint - Mining, moving and processing raw materials, then moving them onto the consumer causes pollution of its own. CO_2 (carbon dioxide) **emissions** from factories, power stations and vehicles need to be reduced to stop further damage to the environment. Everything has a carbon footprint, from creating the raw material to delivering the product in a vehicle. The best way of combating CO_2 emissions is by using **the 6 Rs**.

Ethical Trade

Ethical issues are becoming more important to designers. It is becoming more likely that **consumers** will ask whether the products they're buying are harming the environment or treating people unfairly. **Fair trade** is a principle where everyone in the chain of manufacturing is offered fair wages and good working conditions:

•a minimum standard for the pay and conditions of workers is set:

- workers are paid a fair wage
- their conditions are monitored and kept safe
- the use of safety equipment like goggles and guards is encouraged
- toxic chemicals that could harm staff are changed
- the use of **sweatshops** and child labour is banned

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Environment

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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.

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Briefs, Specifications, ideas and development

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Design Briefs

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

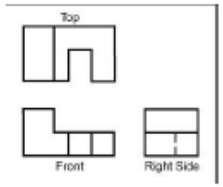
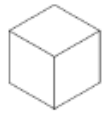
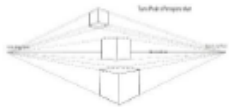
- Constraints/ limitations
- What the product is
- Materials/processes
- Any key information you know

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

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Design Strategies

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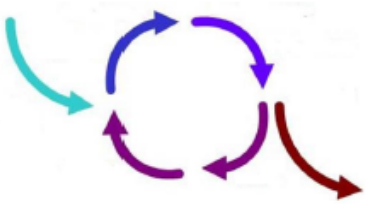
Design Strategies are used to solve **Design Fixation**, and help develop creative design ideas.



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

GCSE D&T Textiles Knowledge Organiser

Commercial Processes

Stock forms, types and sizes

Yarns

Staple yarns

Staple yarns are produced from short-length fibres called **staple fibres**. With the exception of silk, all natural are **staple**. Man-made fibres, such as polyester, can be cut into short lengths and spun together to create a **staple yarn**.

Continuous filament yarns

A continuous filament is a long and smooth yarn produced from a filament fibre. Most synthetic fibres are produced as filaments. Silk is the only natural fibre that is a continuous filament.

Spinning

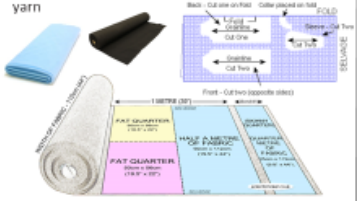
Yarns are fibres that have been **spun** (twisted) together.

There are two methods of spinning: the Worsted Spinning System which produces a smooth yarn and the Woollen Spinning System which produces a more hairy yarn.

Fabrics

Textiles are sold as different **stock forms**, depending on the standard sizes and thicknesses:

- **rolls and bolts** - fabric is sold by the metre in the roll (circular) or bolt (flat roll) and standard sizes are 90 cm, 137 and 154 cm
- **denier** - the unit of weight that measures fineness, used to describe the thickness of tights, where 30 denier is thin and 100 is thick, increasing commonly in increments of 10
- **ply** - yarn (wool) is sold in coils, reels or balls, and ply is the number of threads spun together to create a yarn

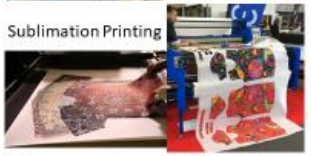


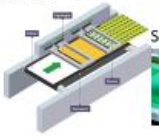
Components

- **buttons** - available in a range of sizes, colours and materials, such as plastic, wood and metal
- **zips** - fabric sides with plastic or metal teeth, sold in a variety of lengths with open (for coats) or closed (for trousers) ends
- **eyelets** - usually made of metal and used as a strengthening edge to small holes like lace holes in shoes
- **buckles** - an adjustable fastening made of plastic or metal for straps
- **hook and eye** - a two-piece fastening usually made of metal for either side of a join, such as at the top of a zip
- **velcro** - hook and loop fastening that is usually made from nylon and can be repeatedly ripped open and closed
- **press studs** - a two-piece fastening made from plastic or metal

Specialist techniques and processes

Commercial tools, equipment and processes





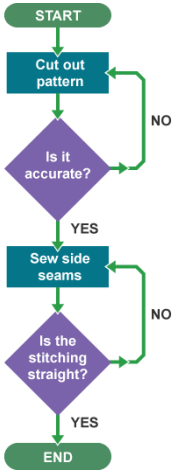
Tolerances

- 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:

A flow diagram demonstrating quality control checks during manufacture.



Prototypes can be full-size, working models of a product, and are the next stage of development after modelling. They are often made from the same material as the product and often have fully **functioning** parts. Prototyping is expensive, so a product needs to have already been modelled and tested. Modelling in Textiles is done using a **toile** – a test garment made from cheap fabric.

Reasons for prototyping

- a **manufacturing specification** can be produced from a prototype and allows for the planning of cost, materials and **quantities**
- following **client** and user feedback, small changes and improvements in **aesthetics** and **function** can be made before production starts
- **user trials** with a prototype can check functionality, marketability and whether a product is fit for purpose before spending money on production
- specialist tools and equipment can be planned for and costed for when the product is later produced for the **mass market**

Prototyping can help work out the cost of manufacturing a product, including how much material is needed and what machinery is required.

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Systems – Inputs, Processes, Outputs

Electronic Systems

When designing electronic systems, electrical engineers start with a block diagram called a systems diagram.
Systems diagrams help the designers to work out how the electronic system will work and which parts need to be connected together.

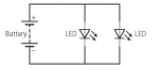
INPUT	PROCESS	OUTPUT
This is the trigger to make the circuit do what ever it is supposed to do. This is normally a switch or a sensor.	This is the part of the circuit that receives a signal from the input components and then tells the output components what to do. This could be a transistor or an integrated circuit, or even a microcontroller.	This is the part of the circuit that does the work, this could be an LED, a motor or a buzzer etc.

Interactive or Electronic Textiles

An interactive fabric incorporates electronics that are activated by a power source. They are still Smart fabrics, they just require a power source.

Conductive fabric and threads

- **Conductive fabric** is a fabric which can conduct electricity. Metal strands can be woven into the construction of the fabric.
- **Conductive threads** carry the electric current to make a circuit from battery to LEDs (light-emitting diodes), or to any other electronic device incorporated in the fashion and textiles product. These soft circuits merge electronics with fabric to allow flexibility and drape in the product. The diagram below shows a simple circuit using conductive thread stitched between battery and LED.



Developments in New Materials

Developments in new materials

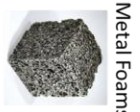
MODERN MATERIALS

Metal Foams

Graphene

Titanium

Nanomaterials



Nanoparticles are also used in clothing such as socks, due to their antibacterial properties.

Coated Metals

Liquid Crystal Display (LCD)

SMART MATERIALS

A **smart material** is one that reacts to an external stimulus or input. This means that it can alter its functional or aesthetic properties in response to a changing environment.
This group of materials can react to stimuli such as heat, pressure, moisture, stress, pH levels, light (including UV) and electricity.

Photochromic – react to UV rays

Thermochromic – react to a change in temperature

Shape Memory Alloys

Memory Foam

TECHNICAL MATERIALS

Technical textiles are textiles that are manufactured for their technical and performance properties rather than their aesthetic characteristics.

Kevlar

Nomex

Conductive Textiles – E-Textiles

Microencapsulation

The fibres hold chemicals in tiny capsules which gradually break, releasing chemicals like perfumes, insecticides or antiseptics.

COMPOSITE MATERIALS

Composite materials are formed when two or more distinctly different materials are combined together to make a new material with improved properties.

Carbon fibre and glass reinforced fibre plastics are examples of composite materials – a thermosetting plastic is combined with a matted or woven material to produce very lightweight and strong composites.

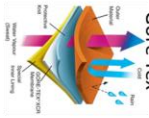
Carbon Fibre

Glass Reinforced Fibre

Interfacing

Laminated fabric

Gore Tex



Quilting

Fibres and Fabrics Knowledge Organiser

Natural Fibre Products

Traditional fibres from plants and animals.

Wool: Fibres from sheep's wool are spun into yarn and can be woven and knitted. The fibres can also be spun into finer yarn which is turned into cloth. Absorbent, soft or coarse handle, not durable.

Used in yarn form in knitwear, scarves, gloves, bags, dresses and suits.

Cotton: Thread is spun from fibres from the cotton plant. Used widely due to its good durability and soft handle. Can be machine washed, but requires ironing as creases easily. Highly-absorbent.

Used in canvas, muslin, calico and denim, clothing, home furnishings

Silk: Natural fibre from silkworms, woven into fine fabric, which has a high sheen or lustre. Cool to wear.

Used in high-class clothing and home furnishings in Satin form.

Linen Made from fibres of the flax plant, linen is a traditional fabric. Does not cause allergies and is cool to wear. Highly absorbent.

Used in home furnishings, summer clothing.

Leather: Made from animal skins, leather is not strictly a fabric. Comfortable in both hot and cold conditions. Untreated, leather is absorbent but can be treated with a range of finishes to improve its effectiveness and durability. Tough and elastic.

Used in clothing, car upholstery, home furnishings.

Manmade Fibre Products (synthetic)

Modern fibres manufactured using polymers.

Nylon: Strong and durable manmade polymer fibre. Has a wide range of applications, as a clothing fabric and in other uses where durability is important. Warm to wear, non-absorbent and good drape. Can be made with soft or coarse handle.

Used in wide range of clothing in pure and blended form. Waterproof coats, tents.

Polyester: Very durable polymer fibre, non-absorbent and cool to wear. Often blended with cotton to produce low cost, breathable fabrics and used widely in place of pure cotton.

Used in clothing and home furnishings, industrial polyester used for ropes, seat-belts.

Organza: A lightweight, sheer fabric traditionally made from silk, although more often now made from polyester. Its decorative properties make it popular for embellishments on clothing.

Used in home furnishings, hat decorations, wedding dresses.

Lycra (brand name for spandex/elastane): A 20th century 'wonder material', Lycra is commonly found in sportswear due to its breathable and elastic qualities. Excellent shape retention. When blended with natural fibres, clothing with the feel of natural fire, and the elasticity of Lycra can be achieved.

Used in tight-fitting sports wear, stockings and leggings, blended in denim, woollen clothing.

Property	Definition	Found in
absorbent	A fabric's ability to hold moisture.	wool, cotton, limen, non-woven fabrics such as felt
blended	A fabric or yarn made from a mix of natural and manmade fibres, purposefully created to use the features of both.	
breathable	A fabric that uses specific fibres and weave that allows air to pass through the clothing, thereby preventing heat and moisture build-up.	sportswear blended fabrics, line, cotton, wool
drape	The way a fabric looks when it is hanging down. Clothing designers must consider the drape of a fabric when choosing the material for a garment.	all fabrics
durable	Hard-wearing, stain resistant. Man-made fibres are mainly more durable, and are therefore blended with natural fibres to create more durable products.	nylon, polyester, denim, lycra
handle	What a fabric feels like to the touch, for instance: smooth, rough, stiff.	all fabrics
sheen	A smooth and slightly reflective surface finish to a fabric.	silk and synthetic satins, polyester products, some leathers
sheer	Fabrics that are flimsy and semi-transparent.	organza, voile, muslin lingerie products
shape retention	A fabric's ability to keep its shape and not become deformed through use.	lycra and lycra blends, leather, polyester, nylon
water-repellent	Non-absorbent. A fabric's natural ability, or manufactured finish, allowing water to not penetrate through the weave.	polyester, nylon, leather

Smart Fabrics

Advancements in modern technology have implications for fabrics and design. **Wearable technology** and **performance enhancing textiles** are important strands of sports and fashion design in the modern age.

This acupuncture therapy shirt allows the wearer to receive specific therapy at the same time as getting on with their job.

This light emitting fabric is an example of how designers can use fibre-optics to create high-impact visual clothing and accessories.

Wasting	Addition	Deforming and Reforming
Fabrics are a compliant material and are relatively easy to cut and shape. They are, however, an unforgiving material, and an incorrect cut will be often difficult to undo or disguise. Cutting: Fabric is normally cut with textile shears. The blades are 150mm long and the lower handle is always bigger. This allows for a steadier, longer cut. Rotary cutters are used for cutting non-woven fabrics such as felt. Shearing: Although shearing and cutting are the same force and movement, pinking shears give a zig-zag edge to their cut. This prevents woven fabric from fraying **Wasting Fabrics with CAD/CAM** Sections of fabric can be wasted effectively using a laser cutter. A pattern can be created using CAD software such as 2D Design and used to control the laser cutter. Identical patterns can be created very quickly using this method with a high level of accuracy. **Seam Allowance** Fabrics require a seam allowance; the material where the stitch joins two pieces of fabric together. This means fabric must be cut larger than the size needed by approximately 10mm on all sides where a join is required.	**Addition by hand-stitching** All projects will require some degree of hand-stitching. This may be to add a button, join one piece of fabric over the top of another, such as in applique, or embroidering by hand. There are a range of stitches which can be done using a needle and thread: • **Running stitch:** Quickly joints two fabrics along a line • **Overstitch:** Loops over the edge of the fabric preventing fraying. • **Blanket-stitch:** Ornamental stitch effective on decorative work. • **Back stitch:** Stronger that a running stitch and good for seams. Zips, buttons, hook and eye, press-studs and Velcro can all be added to fabrics and used to add and fasten pieces together. **Addition by machine-sewing** The correct method for joining fabrics is dependent on the type of fabric being used, and the loads and stresses that will act upon the join. An overlock machine is good for professional looking products as it binds the seam inside the join. Sewing machines are required to add fasteners such as zips. **Addition by computer sewing machine** Many jobs can be completed by a programmable CAM sewing machine. Some schools have embroidery machines. A design is created on a computer, before being uploaded to the embroidery machine. Decoration, detail and personalised names can be added to a panel of a product this way.	**Deforming by tailoring** Once the pattern and fabric pieces have been cut, the main tool for shaping an item of clothing is a tailor's dummy. Re-forming, adjustment and fitting can be done whilst seeing the overall shape of the product. Because fabrics are compliant materials, they deform as part of their nature. Imagine wearing a pair of skinny jeans which didn't deform as you moved! **Deforming by pleating and gathering** Shape can be created and accentuated through the use of gathering. Pleating can create a strong visual effect and allow for movement in a garment. **Pleat:** Repeated folds in a textiles product, usually stitched at the top. **Gather:** To shorted a piece of fabric by drawing it together, like the top of some curtains. **Deforming by heat and liquids** **Heat treatment:** Some specially laminated fabrics can be formed into shape using heat. This is useful where the designer needs parts of a design to hold a shape without support, such as collars. **Blocking:** Traditionally, moulded hats, for both men and women have been created by deforming felt on wooden blocks. A felt hood or cone is placed on the block and a liquid stiffener is applied. A steam iron is then used to shape the felt around the block before shaping the brim and cutting off waste material.

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Mechanical Systems

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Forces

Compression

Tension

Torsion

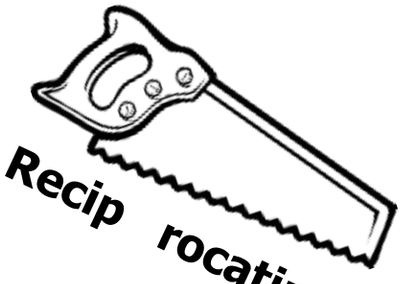
Shear

Motion

Linear

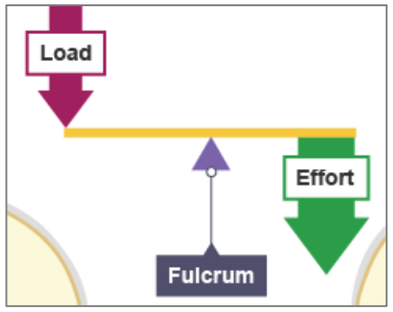
Rotation

Oscillating



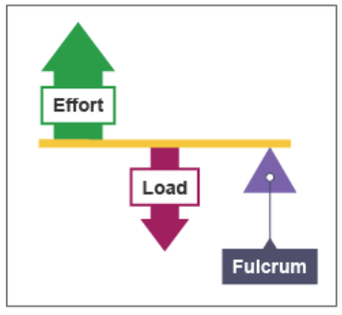
Reciprocating

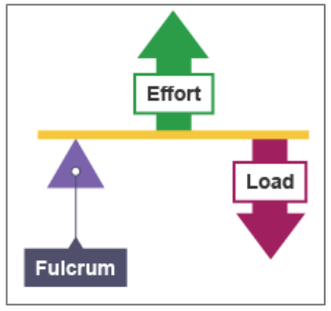
Levers



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

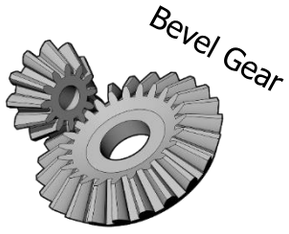
Gears and Pulleys

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

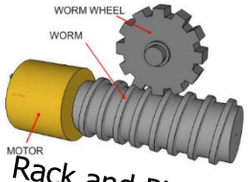
Gears have teeth that mesh together with each other (like teeth on a zip)

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

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Modern and Smart Materials

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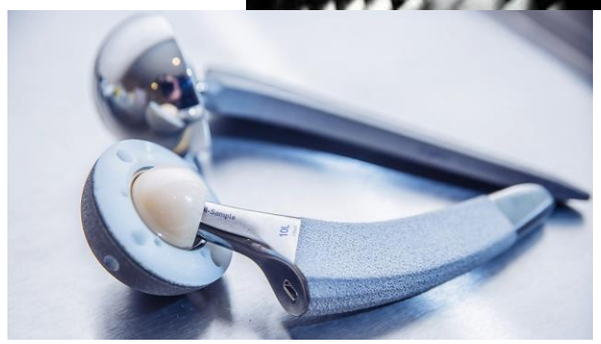
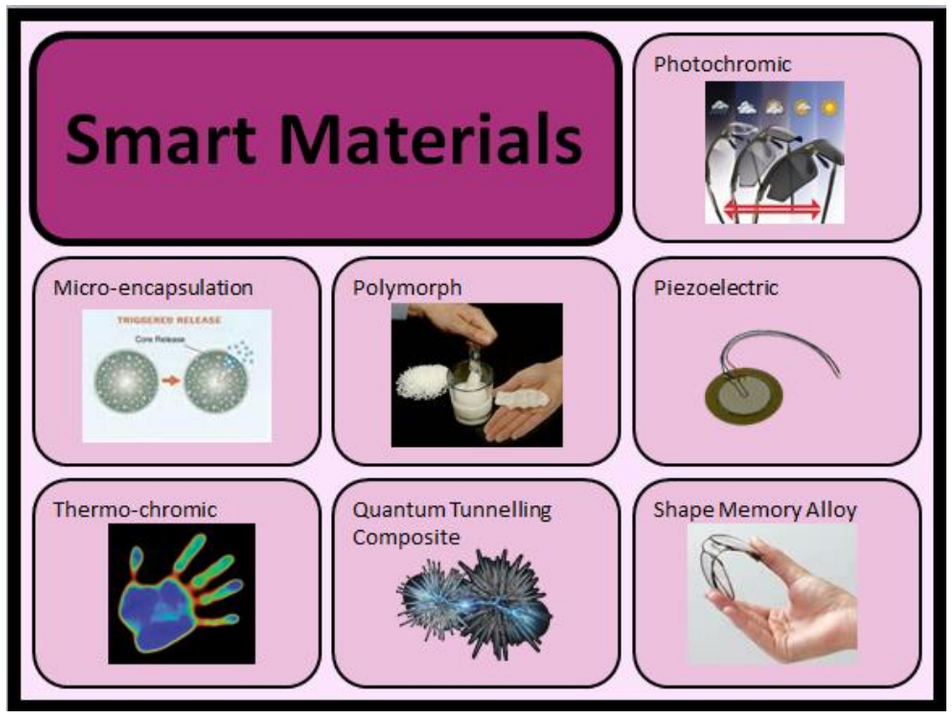


Modern Materials are materials that have been developed recently		
Material	**Key info**	**Examples**
Corn-starch Polymers	These are plant-based polymers that are a replacement for plastics that are **biodegradable** but cannot be recycled.	Plastic bottles, tubs, food containers, etc
Flexible MDF	Made 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

Design Engineering (Electronics) Knowledge Organiser

Input Components

These devices form the crucial control needed for a product to operate. Most input components need to be bought but some can be manufactured especially for a project. For instance, a pressure sensor.

Light dependent resistors (LDRs) are a type of variable resistor whose resistance increases with light.

Push to make switches are simple input devices which allow electrical current to flow when pushed.

Time delay switches lengthen the time a product operates for.

Motion sensors use infrared to detect changes in the environment to activate the system.

Tilt switches use mercury to connect two electrodes when moved.

Thermistors are a type of variable resistor whose resistance changes when it becomes hot or cold.

Process Components

These devices are used in combinations to turn the signal from the input component into the signal to the output component. Careful designing and a good knowledge of the way circuits are designed is crucial.

Resistors limit current flow in an electronic circuit and have to be placed before some components to prevent damage.

Capacitors store charge in circuits and release charge when the circuit is off.

Transistors are semi-conductor electronic switches which allow current to flow through their third leg to a separate part of the circuit.

Diodes allow current to flow in one direction only, acting as a safety valve. They are a semi-conductor.

Integrated circuits (ICs) are manufactured for many different uses and functions. A tiny circuit is encased in silicone (a semi-conductor material). Although they look complex, they follow the same logic as simple circuits. Because of their reduced size, smaller products can be achieved as more technology can be made to fit into smaller spaces. The 555 timer is an example of a pre-programmed 8 pin IC. It can be used to produce time delays.

Microcontrollers are tiny integrated circuits used widely in automatically controlled devices such as engine management in cars. These can be combined with **drivers** to control devices such as motors. **Raspberry Pi** and **BBC micro:bit** computers are examples used in schools.

Process Components

The output is the end function of the product. In most cases, the output can be classed as light, sound, motion or a combination of two or more functions.

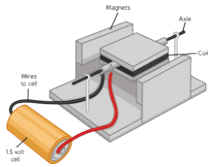
Light emitting diode (LED) come in different colours and levels of brightness. They have replaced the filament bulb in many everyday uses.

Light bulbs are not as widely used because of LEDs in an everyday context but mini-light bulbs do not require soldering, so can still be useful.

Buzzers use electric current to create their own sound. Used in alarm systems.

Speakers allow a sound signal from a circuit to be amplified.

Motors are magnetic devices and are behind nearly all moving parts in electronic systems.



Properties and Definitions in Electronics

Key Term	Definition
conductor	A material which allows heat or electricity to pass through it easily.
input	What has to happen to actuate the function of a circuit.
insulator	A material that does not conduct electricity and can therefore be used as a coating to components, circuit boards and wires.
heat sink	A conductive device, such as a crocodile clip, that allows heat to discharge from delicate components when soldering.
mono-filament	Single strand core found in some wire.
short-circuit	In a circuit, often as the result of a solder bridge, electricity will flow in the shortest path back to the battery.
resistance	How effective a conductor a material or component is.
semi-conductor	A component that allows current flow only under certain conditions, such as a transistor.

How to Read a Resistor

The fourth band tells you the tolerance % of the resistor. Gold is 5%. Silver is 10%. **Always on the right!**

The first band is a numerical value. Brown = 1

1 5 00 Ω ± 5%

The second band is a numerical value.

Green = 5

The third band is the multiplier- how many zeros the value has. Red = 2 (00)

0 1 2 3 4 5 6 7 8 9

Wasting in Electronics Design

Etching is a chemical process for PCB (printed circuit board) production that requires photo-sensitive copper board for best results. A design is produced and then 'photographed' onto the copper board before the board is placed in an acid bath. Only the circuit remains on the board. Effective for one-off high-quality PCBs.

Wasting using CAM in electronics.

Milling a PCBs is a quick and clean method of manufacture, ideal for batch production or one-offs. A CAD file is designed before being used to control a CAM milling machine to waste unwanted copper from a copper clad board.

Key Words

Printed Circuit Board (PCB) A hard-thermoset plastic board and copper circuit. Holes are drilled for components to be mounted on the reverse side.

Batch production manufacturing processes are planned so that a limited number of the same product can be manufactured.

Computer-Aided Design (CAD) Computer applications are used to support the design development of a product or component, such as PCB design.

Computer-Aided Manufacturing (CAM) A design file is used to control the machinery that creates a part or whole of the product.

Addition in Electronics Design

Electronic project 'bread-boards' are a practical method of creating functioning prototype circuits and developing them. Components push-fit into the board and are connected via a metal rail inside the casing. Extra boards can be joined using mono-filament wire for modular circuits.

Soldering is a permanent addition method for electronic components. Solder is a soft alloy usually made from copper and tin. An added substance, called flux, allows the solder to flow over the components to give a good join.

Soldering irons can be gas or electric. In schools, they are electric. Care must be taken to make sure the lead does not trail across the soldering area or off the desk.

A few components can be joined directly together, such as these LEDs in series. A heat-sink, such as a crocodile clip must be used.

Circuit boards can be created by adding adhesive copper strips to card or MDF. Components can then be surface mounted onto the copper with solder.

Veroboard (or stripboard) addition is suitable for one-off prototype circuits. Components are added on the blank side and soldered on the side which has copper 'rails'. The rails can be joined either by wire loops, components or a blob of solder. They can be 'broken' by removing part of the copper with a drill.

PCB component addition:

Once the holes for the component legs are drilled, the component is mounted on the blank side of the board and the legs are soldered in place on the printed circuit side.

Surface mount components:

Many commercial circuit boards have their components mounted directly onto the circuit side of the board. This method saves space as there are no holes to drill. Found in mobile phone technology.

Addition using CAM in electronics:

A CAD file can be quickly converted into a PCB using a cutter/plotter. Special adhesive-backed copper foil is loaded into the machine which then runs the program in exactly the same way as if it was on card or paper. It has to be very carefully transferred to card or a blank PCB. Holes can then be pierced or drilled for components to be mounted and soldered.

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Briefs, Specifications, ideas and development

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Design Briefs

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

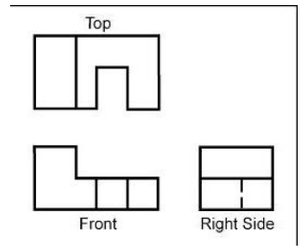
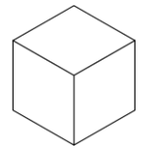
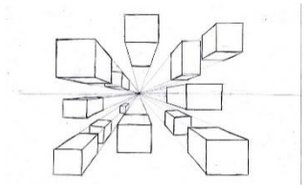
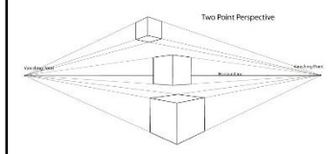
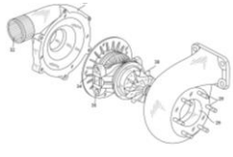
- Constraints/ limitations
- What the product is
- Materials/processes
- Any key information you know

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	

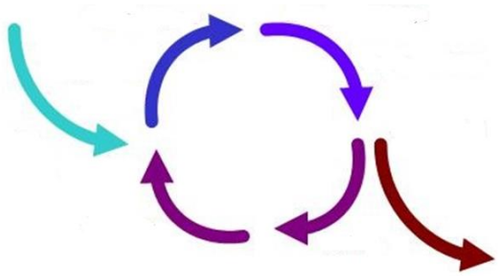
Modelling and Development

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

GCSE D&T Knowledge Organiser

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