

GCSE D&T Textiles Knowledge Organiser

Commercial Processes

Weaving Loom



Circular Knitting Machine



Flat Bed Knitting Machine



Scales of Production

One Off



Batch



Mass



One-off Production	
<p>Advantages</p> <ul style="list-style-type: none"> • Custom made • High Quality Materials • High Quality Craftsmanship 	<p>Disadvantages</p> <ul style="list-style-type: none"> • Time consuming • Specialist training for workers • Expensive to buy

Batch Production	
<p>Advantages</p> <ul style="list-style-type: none"> • Lower cost than one-off • Jigs, moulds and templates help products look identical • Can have some variety 	<p>Disadvantages</p> <ul style="list-style-type: none"> • High storage costs • Jugs, moulds and templates have to be checked • Workers can become bored on their station

Mass Production	
<p>Advantages</p> <ul style="list-style-type: none"> • Large amounts made at once • All products are identical and to same standard • Using automation reduced human error 	<p>Disadvantages</p> <ul style="list-style-type: none"> • 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	
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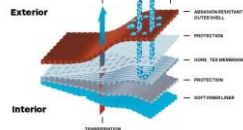
Composite/Lamination

Composites are materials made from two or more different materials and combine the properties of the materials they are made from.

Quilting



Gore-Tex



Carbon fibre reinforced plastic



Laminated fabrics are made when two or more layers of fabrics are bonded together using a polymer film, this is what creates the laminate material to have its shiny effect.



Manufacturing Processes - Wastage, Addition, Forming

Wastage

Cutting/Shearing



Laser cutting



Addition

Sewing



Dyeing and Printing



Batik



Screen printing

Computerised Embroidery



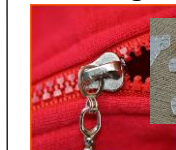
Quilting



Bonding fabric



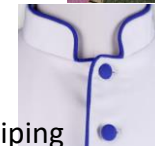
Fastenings



Applique

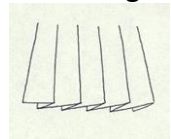


Piping



Forming

Pleating



Gathering



Tailoring



GCSE D&T Textiles Knowledge Organiser

Tools & Equipment

Laser cutter



Tailor's Chalk



Hot Press

Wood blocks for printing



Mannequin



Rotary Cutter



Screen Printing – screen and squeegee



Overlocker



Pinking Shears



Computerised Embroidery Machine



Patternmaster



Fabric Shears



Wax pot & Tjanting



Embroidery Hoop



Techniques and Processes

Joining (Seams)	Plain 	French 	Double Stitched 	Finishing Seams	Over locked 	Pinked Edge 
Shaping	Darts 	Tucks 	Gathers 	Pleats 	Casings (Draw Cord) 	Casings (Elastic) 
Finishing Edges	Hems 	Facings 	Frills 	Piping 	Binding 	

Shape & Form

Plain Seam
French Seam
Double Machine Stitched Seam
Pinking Edge
Inverted pleat
Overlocking
Curved Seams
Gather
Dart
Knife pleat
Box Pleat
Accordion Pleat
Zig Zag edge

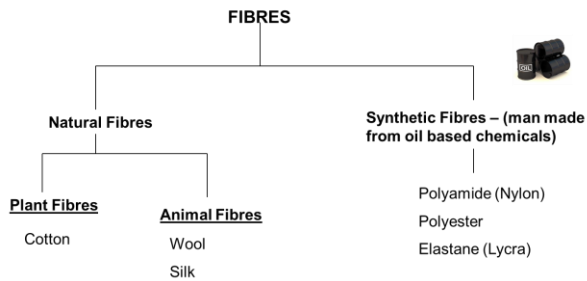
Production Aids

Dressmaking Pattern
Templates
Block Patterns

GCSE D&T Textiles Knowledge Organiser

Fibres, Yarns & Fabrics

Classification of fibres



Fibres look like fine hairs. They are the smallest particle that makes up fabrics & can vary in size depending on the type of fibre.

Continuous Filament Fibres
(long & smooth e.g. silk)

Staple Fibres
(short fibres e.g. wool)

Many fibres are twisted together (spinning) to make a **yarn**.

Natural fibres grow on animals & plants. Manufactured fibres are partly or entirely made by man.

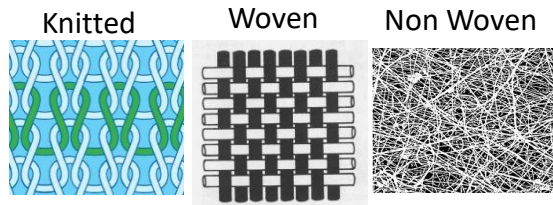
The type of fibre and whether it is long or short impacts on the properties of the yarn & fabric it is made into



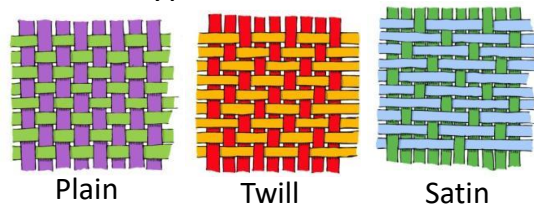
Textiles & their working properties

- Absorbency - **soaks up water/sweat**
- Strength - **strong, doesn't break easily**
- Elasticity - **has some stretch**
- Warming/cooling - **traps air/air flows through**
- Flammability - **ability to catch fire**
- Durability - **hard wearing**
- Crease resistance - **does not crease**
- Comfort - **soft against skin**
- Drape - **hangs well**
- Water repellent - **ability to repel water**
- Shrink resistance - **will not shrink when washed**
- Thermoplastic - **will soften when heated and can be heat-set into new shapes that it will maintain when cooled (synthetic fibres)**
- Lightweight - **not heavy/dense**
- Texture - **smooth or coarse**

Fabric Construction



Types of Weaves



Sources & Origin

Natural

Cotton



- Comes from a bushy plant
- Grown in the tropical parts of the world
- The seedpods are called bolls
- When they ripen the seeds inside the boll become coated with very fine cotton fibres
- The seedpod bursts to become a fluffy ball which looks like cotton wool
- Cotton fibres are hollow tubes but collapse when the sun dries them to become flat like a ribbon and twisted
- Staple fibres (short in length)
- Must be cleaned and twisted to make a yarn before turning into a fabric.

Silk



- Comes from the cocoon of the silk caterpillar
- The caterpillar spins the cocoon from two triangular shaped filaments, one on each side of its mouth
- The filaments are held together with a natural gum produced by the caterpillar
- When the caterpillar is ready to turn into a moth it will break through one end of the cocoon - this spoils the silk thread stopping it from being a continuous filament fibre
- When the cocoon is needed for silk fibres, the caterpillar is killed before it turns into a moth by dropping the cocoon into boiling water
- The silk filament can then be unwound as continuous lengths

Wool



- A hair fibre and comes from sheep
- Other hair fibres can come from goats, rabbit, llamas and other hairy animals
- They are staple fibres
- To obtain wool, sheep are sheared
- Wool is sent to a mill where it is cleaned and scoured to remove grease and dirt, graded and sorted for quality
- Carding and combing is done to straighten the fibres before spinning to make a yarn

Synthetic - man made using oil

Polyester

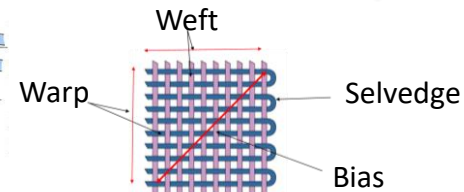


- Chemical are made into a polymer, which is cut into small pieces
- These are melted to make a solution
- This solution is spun into continuous lengths of fine fibres called filament fibres

Polyamide (Nylon)



Elastane



Name/ Type	How many it makes	Key Info	Examples of Products
One-off Production	1	<ul style="list-style-type: none"> Also known as Bespoke or Prototype manufacture <ul style="list-style-type: none"> Custom-made products Specialist workers/ skills Specialist machines and materials High Quality but expensive 	<ul style="list-style-type: none"> Towers / Bridges One-off Houses Custom made clothes
Batch	10s-1000s	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> Baked foods Limited edition car <ul style="list-style-type: none"> Socks Chairs
Mass	10,000s - 100,000s	<ul style="list-style-type: none"> Big assembly lines (and sub-assembly lines) <ul style="list-style-type: none"> Heavily automated Standard and identical products Little worker input 	<ul style="list-style-type: none"> Cars Bottles Microchips Plain shirts
Continuous	100,00s +	<ul style="list-style-type: none"> 24/7 production Heavily automated Standard and identical products Little worker input 	<ul style="list-style-type: none"> Energy Water Paper Plastic

One-off Production	
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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 fibre, and the elasticity of Lycra can be achieved.

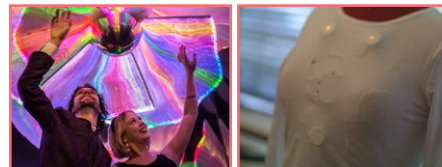
Used in tight-fitting sports wear, stockings and leggings, blended in denim, woollen clothing.

Photo courtesy of (@flickr) Mediatomic Hybrid Wearables - granted under creative commons licence - attribution.
Photo courtesy of (@flickr) Those Who Affected Me - granted under creative commons licence - attribution

Property	Definition	Found in
absorbent	A fabric's ability to hold moisture.	wool, cotton, linen, 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, linen, 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.


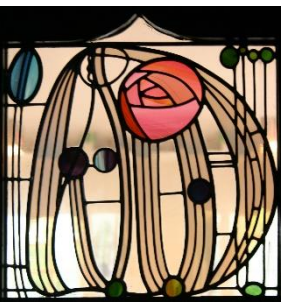






This acupuncture therapy shirt allows the wearer to receive specific therapy at the same time as getting on with their job.

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

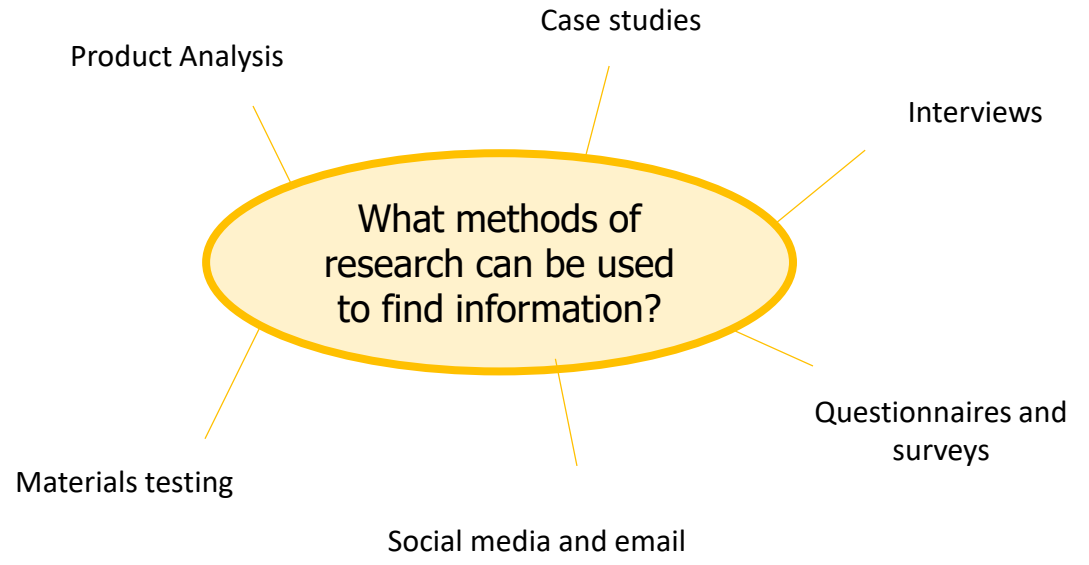
Wasting	Addition	Deforming and Reforming
<p>Fabrics are a compliant material and are relatively easy to cut and shape. They are, however, an unforgiving material, and an incorrect cut will be often difficult to undo or disguise.</p> <p>Cutting: Fabric is normally cut with textile shears. The blades are 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.</p> <p>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</p> <p>Wasting Fabrics with CAD/CAM</p> <p>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.</p> <p>Seam Allowance</p> <p>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.</p>	<p>Addition by hand-stitching</p> <p>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:</p> <ul style="list-style-type: none"> • 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 than a running stitch and good for seams. <p>Zips, buttons, hook and eye, press-studs and Velcro can all be added to fabrics and used to add and fasten pieces together.</p> <p>Addition by machine-sewing</p> <p>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.</p> <p>Addition by computer sewing machine</p> <p>Many jobs can be completed by a programmable CAM sewing machine.</p> <p>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.</p>	<p>Deforming by tailoring</p> <p>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!</p> <p>Deforming by pleating and gathering</p> <p>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.</p> <p>Pleat: Repeated folds in a textiles product, usually stitched at the top.</p> <p>Gather: To shorten a piece of fabric by drawing it together, like the top of some curtains.</p> <p>Deforming by heat and liquids</p> <p>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.</p> <p>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.</p>

Work of Others

Image/ Example	Designer	Design Movement	Key info
	William Morris	Arts and Crafts	<ul style="list-style-type: none"> British designer in 1880s Simple natural crafts Useful and beautiful products (wallpapers, cushions, etc)
	Charles Rennie Mackintosh	Art Nouveau	<ul style="list-style-type: none"> Scottish designer in 1860s – 1920s Known for light and shadow Created stained glass and furniture Inspired by nature and geometric lines
	Ettore Sottas	Memphis	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Italian Design Company Homeware and kitchen utensils “Post-modern” style Phillipe Starke is a major designer
	Apple	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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

Paper and Board Knowledge Organiser

Compliant/ Resistant Materials

Virgin Products

Mount Board: A thick, flexible board, available usually in black or white.



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Moulded Pulp Board: Recycled paper and card is turned into a pulp and moulded into shape which forms protective packaging.



Photo courtesy of John Lodder (@flickr.com) - granted under creative commons licence - attribution

Used in drinks bottles, food packaging, cosmetic packaging.

Corrugated Card: Thick, lightweight and strong, this laminate board is used widely in transit packaging. Normally only printed on one side and unbleached.



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Used in transit packaging/warehouse storage.

Foam Board: Thick, lightweight and stiff. A layer of foam is laminated between bleached card. Can be slotted and jointed to give strength to larger constructions.



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Used in model-making, architectural prototypes.

Carton Board: Durable, lightweight card, can have glossy or matt finish. Excellent print qualities and bends easily into nets.

Used in dry food packaging.



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Paper Weights and Uses

Weight (grams per square metre)	Suitable for
80gsm	printing, general use
90gsm	standard printer paper, thick enough to be colour-printed
100gsm	good quality paper for letters, certificates, drawing
120gsm	stiff, printable paper, suitable for menus, leaflets, small scale packaging
160gsm	light card suitable for printing/cutting/plotting, packaging

Properties and Definitions of Paper and Boards

Property	Definition	Found in
virgin	A paper or board product which has been made from tree pulp without the addition of any recycled or alternative fibres. All true white paper products are virgin.	printer paper, envelopes, books etc.
recycled	A paper or board product which has been made using some or all waste material, usually from paper mills. Colour tends to be grey (from the print on the paper used) or dyed darker colours.	paper towels, toilet roll tubes, greetings cards, newspapers
laminated	Layers of paper or card glued together to create stiffer product.	foam board, corrugated cardboard, mount board
compliant	Bends, twists, tears and folds easily and without tools.	thinner paper and board products.
resistant	Does not deform easily without tools or force.	thicker/laminated paper, board products
stiffness	A material that resists bending, remains rigid.	foam board, corrugated card
tough (durable/strong)	Able to withstand rough handling or treatment. Offers good weather resistance.	corrugated card, carton board
tension	A pulling force. Paper and board products when assembled often are glued in tension.	glued together packages
corrugated	In card, a rippled middle layer is laminated between two flat layers, thus creating a thick, lightweight yet stiff board.	transit packaging

Wasting

Most paper and board can be cut and shaped easily with basic equipment.

Hand Punch

Advantages:

Quick, perfect holes.

Disadvantages:

Limited range of hole sizes available. Not suitable for very thin paper or thicker card.



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Craft Knife and Safety Rule

Advantages:

No set-up time, good for one-offs

Disadvantages:

Finish relies on the skill-levels of the maker. Not suitable for repeat-production.

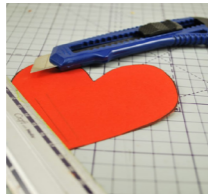


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Wasting Paper and Board Using CAD/CAM

Thin card can be wasted effectively using CAM such as laser cutters and cutter/plotters. Nets are developed on CAD software such as 2D Design and CorelDRAW. These files are sent to the CAM machine for accurate cutting and scoring.

Laser Cutter

Advantages:

Allows for repetitive flow production, with reliable, identical results.

Disadvantages:

Not suitable for foam-board due to the fumes released.

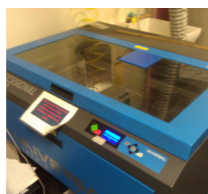


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Cutter/Plotter

Advantages:

Allows for repetitive flow production, with reliable, identical results.

Disadvantages:

Not suitable for thicker card products.

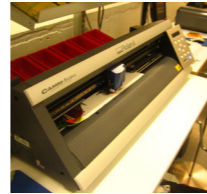


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Addition

Prototype modelling uses a wide range of addition or joining techniques, but often leaves a low-quality finish.

Permanent addition methods suitable for high quality finish include:

Double-Sided Tape

Advantages:

Instant, permanent, strong bond. Invisible.

Disadvantages:

Cannot be undone. Fiddly.



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Hot Glue

Advantages:

Permanent, strong bond.

Disadvantages:

Cannot be undone. Can leave a stringy or thick edge.



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White Glue (such as PVA)

Advantages:

Permanent, strong bond, even on small tabs. Invisible.

Disadvantages:

Cannot be undone, takes a long time to set.



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Temporary Addition Methods:

Adhesive Velcro

Advantages:

Allows for adjustment.

Disadvantages:

Expensive, not suitable for thinner, less stiff materials.



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Paper Fasteners

Advantages:

Easily undone. Quick.

Disadvantages:

Hard to disguise, Sharp edges make it unsuitable for many applications.



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Deforming and Reforming

Paper and thin board are compliant materials and will bend and fold easily in one direction. Stiffer or thicker board requires the use of specific techniques.

Paper Fasteners Scoring and Folding

For most prototype package and models, scoring and folding is the best method. This can be done by hand but also using CAD/CAM by carefully designating the lines to be scored a colour which controls a lighter, scoring pressure on the cutting head of the machine.

With research and skill, sophisticated three-dimensional shapes can be created by scoring and folding nets or developments.

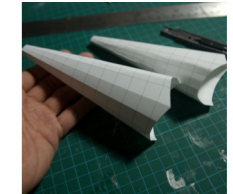


Photo courtesy of (@wikipedia.org) - granted under creative commons licence - attribution

Press Moulding (using paper pulp)

Although the finish of press-moulded products is quite poor, strong inserts can be created for products such as food and perfumes to ensure bottles and jars are held tightly inside the container. Because pulp is made from recycled paper, this method can help a product have an 'environmentally friendly feature'.



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 Formaldehyde	Good insulator, hard and brittle	Electrical casings, buttons and handles
Polyester Resin	Strong, heat resistant, can be transparent	Coatings, casings

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

Metals Knowledge Organiser

Resistant Materials

ferrous: Metals that contain iron. Besides iron itself, all ferrous metals are alloys.

iron: Heavy and strong, iron is most commonly found nowadays in various alloys. Historically, iron was the key material which enabled the industrial revolution to thrive in the UK. Machines, bridges and weapons could all be cast in iron, allowing mass-production.

Used in heavy kitchen skillets, radiators and fireplaces in older houses.

The Iron Bridge

(opened 1781) in Shropshire was the first bridge to use cast-iron structurally.



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ferrous alloys

mild steel: General purpose metal for general engineering. Good strength and cold-forging properties. Corrodes quickly without protection. Can be welded and braised.

Used in structural components, general workshop projects.

high speed steel: Very hard, resistant to frictional heat.

Used in lathe cutting tools, drills, milling cutters.

high carbon steel: Very hard, difficult to cut, easily joined by carbon treatment.

Used in hand tools, hammers, screwdrivers, chisels.

stainless steel: Hard, tough, resists wear, corrosion resistant, difficult to cut.

Used in dishes, sinks, teapots, cutlery.

non-ferrous: Metals that do not contain iron.

aluminium: High strength to weight ratio, light, soft, difficult to join.

Used in kitchen utensils, packaging, cans, foils, window frames.

copper: Bright and decorative colour when polished. Corrosion resistant. Soft and easy to work by hand. Good heat and electrical conductor.

gold: Soft, malleable, ductile, often alloyed to give more strength, doesn't corrode or tarnish.

Used in jewellery, electronics, hi-fi equipment, dentistry.

tin: Soft, corrosion-resistant pure metal. Silver-coloured and bright when polished. Can be worked by hand. Used to plate other metals.

non-ferrous alloys

brass: Corrosion resistant, casts well, work-hardens, polishes well.

Used in castings, boat fittings, ornaments.

bronze: Corrosion resistant, casts well, work-hardens, polishes well.

Used in castings, boat fittings, ornaments, statues.

pewter: Soft alloy of tin, copper, lead or silver. Low melt temperature makes it ideal for casting projects.

Used in sand-casting, old-fashioned tableware.

solder: Soft alloy, usually made from copper and tin. An added substance, called flux, allows the solder to flow over other metals when heated.

Used in jewellery manufacture, electronics.

Properties of Metals

Property	Definition	Found in
brittle	Hard, but easily broken or cracked.	cast-iron, steel with high carbon content.
conductor	Metal which allows heat or electricity to flow through it easily.	copper, gold, brass.
corrode	To become damaged by chemical reaction (normally water).	ferrous metals in the form of rust, some alloys become powdery.
corrosion-resistant	A metal which resists damage by chemical reaction.	copper, gold, bronze.
ductile	Can be deformed without losing toughness.	lead, copper, gold.
hard	Not easily bent or broken.	steel, iron, brass.
lightweight	A metal which has a good strength-to-weight ratio.	aluminium, duralumin.
malleable	Can be deformed by beating, bending or pressing into shape.	lead, copper, gold, silver, tin
soft	Metals with comparatively low melting temperatures. Easily scratched and malleable.	lead, copper, gold, tin.
tensile strength	A material with good tensile strength resists breaking under tension.	steel, iron, aluminium.
tough/durable/strong	Able to withstand rough handling or treatment.	iron, stainless steel.

base metal: Pure, non-precious metals, such as iron, copper and tin. Commonly electro-plated with other metals such as chromium to achieve a higher quality finish.

alloy: Metals which are a mixture of two or more elements, at least one of which is a metal. The purpose of an alloy is to create a metal with improved properties over the original.

precious metals: Pure metals which are valued for their ductility, colour and lustrous natural finish and other properties. Platinum, gold and silver are commonly used in jewellery design.



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Wasting

Wasting metals by cutting and shaping.

Metals can be very resistant to shaping by wastage and tools require special blades to cut metals accurately.

Sawing: hacksaw, junior hacksaw, abra file, jigsaw (with metal cutting blade).

Shearing: Thin sheet metal can be marked out and cut with special metal sheers or tin snips.

Filing: Edge shaping and finishing can be achieved by hand with a range of metal files.

Wasting metals by drilling and boring.

Metals need specially hardened bits for holes to be bored or milled successfully.

Drilling: Hand drill and pillar drill with high-speed bits.



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Turning: CAM or manual metal lathes can waste metal rod accurately by both boring and turning.

Milling: Using a flat-ended slot drill, a milling machine cuts laterally, giving a high degree of control to the three-dimensional wasting of metals.

Wasting Metals Using CAD/CAM

Computer controlled milling machines and lathes are used in schools and industry to waste and shape metals.



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Aluminium is the most common material used to mill in schools.

Addition

Permanent bonding

Metals require specific joining methods based on the type of material and shape of product.

Adhesives

Some metals can be bonded permanently with solvent adhesives such as epoxy resin.



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Welding/Brazing

Using high temperatures, welding creates fused joints which can be as strong as the material. Brazing uses lower temperatures to melt a soft alloy, which flows between the joint and creates a bond.



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Fixing and Fastening

Riveting

Riveting gives a quick and clean alternative to welding. It requires an overlap in the material.

Temporary Fixing

Nuts and bolts, machine screws, self-tapping screws.

Washers are often needed to create a secure, vibration proof fastening.

Deforming and Reforming

Cold Forming

Thin sheet material and narrow-gauge rod and wire can be deformed using a range of cold-forming processes. Simple bends can be made using a vice and ball-peen hammer.

Bending

Thicker rod materials can be bent and shaped when heated to red-hot. Quenching the material will harden the bend.



Casting

In industry, casting can produce highly successful products. Some schools have sand casting facilities, which allow an alloy to be re-formed into a three-dimensional shape.

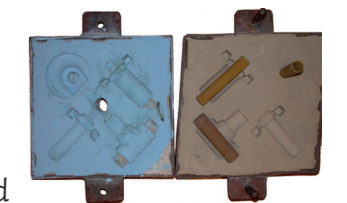


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Natural Timbers

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 lose 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

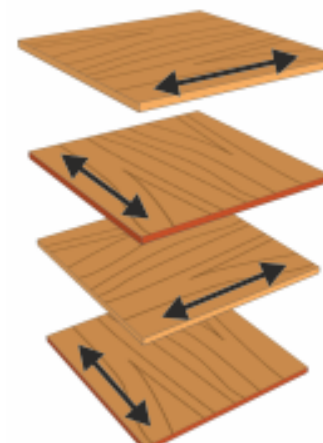
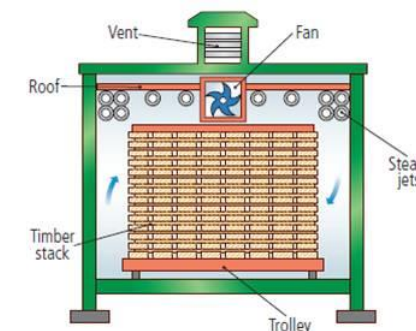
Man-Made Boards

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 units
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

CAD Computer Aided Design	
Examples; 2D Design, Autodesk Inventor, Fusion 360, Photoshop, etc	
Advantages	Disadvantages
<ul style="list-style-type: none"> • 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 	<ul style="list-style-type: none"> • Complex and time-consuming to learn <ul style="list-style-type: none"> • Expensive to buy • PCs can crash or be hacked – causing work to be lost • Takes up PC memory

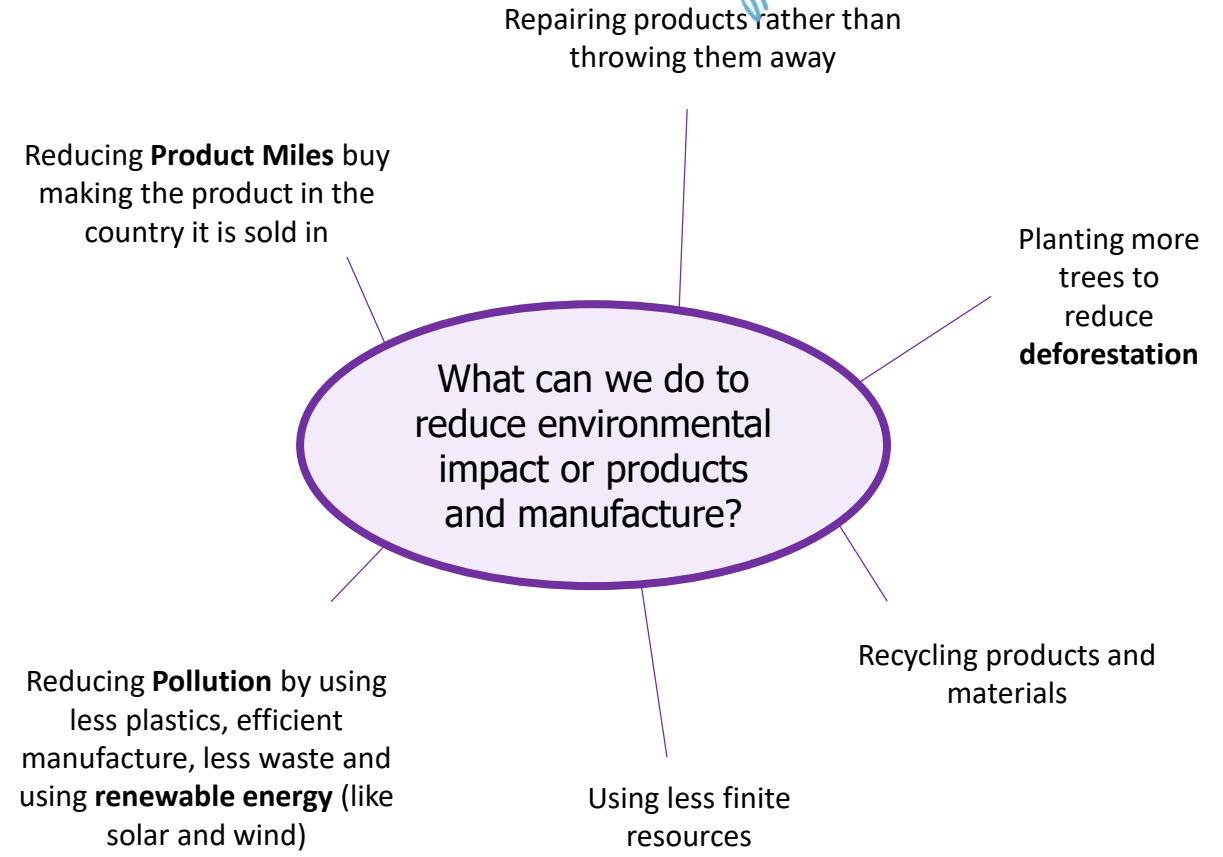
CAM Computer Aided Manufacture	
Examples; 3D Printing, Laser Cutting, CNC Router, Automated Machines and Robotics, etc	
Advantages	Disadvantages
<ul style="list-style-type: none"> • Faster and more accurate than traditional tools • Repetitive accuracy/ consistent outcomes <ul style="list-style-type: none"> • Machines can run 24/7 	<ul style="list-style-type: none"> • 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
<p>This is where automated machines are adaptable and can produce different products if needed.</p> <p>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.</p> <p>Examples include; CNC Machines, 3D Printers, Laser Cutters, Robotic arms, etc</p>

Just-in-Time (JIT) Manufacture	
<p>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.</p> <p>This can be used in any scale of production but is particularly useful for one-off production.</p>	
Advantages	Disadvantages
<ul style="list-style-type: none"> • Saves on warehouse and storage costs • Money is not tied-up in stock <ul style="list-style-type: none"> • Little/minimal waste • Customer often pays in advance so money is secure before production 	<ul style="list-style-type: none"> • 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

Lean Manufacturing
<p>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.</p>

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 <i>Will run out of eventually</i>	Infinite Resources <i>Can be re-grown and re-bred. Will not run out of</i>
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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Accuracy and Process Orders

Finishes

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

Material Type	Finishes Used
Papers and Boards	<ul style="list-style-type: none"> • Paints • Varnishes • Laminating • Plastic coating • Wax coating
Timbers and Boards	<ul style="list-style-type: none"> • Paints • Varnishes • Wax and Polish • Staining • Oil
Metals and Alloys	<ul style="list-style-type: none"> • Painting • Lacquering • Electroplating • Galvanizing • Polishing • Plastic Coating • Powder Coating
Plastics	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • Staples • Clips • Split pins
Timbers and Boards	<ul style="list-style-type: none"> • Nails • Screws • Panel Pins • Hinges
Metals and Alloys	<ul style="list-style-type: none"> • Nuts and bolts • Screw • Rivet • Washer
Plastics	<ul style="list-style-type: none"> • Plastic hinges

Tolerances

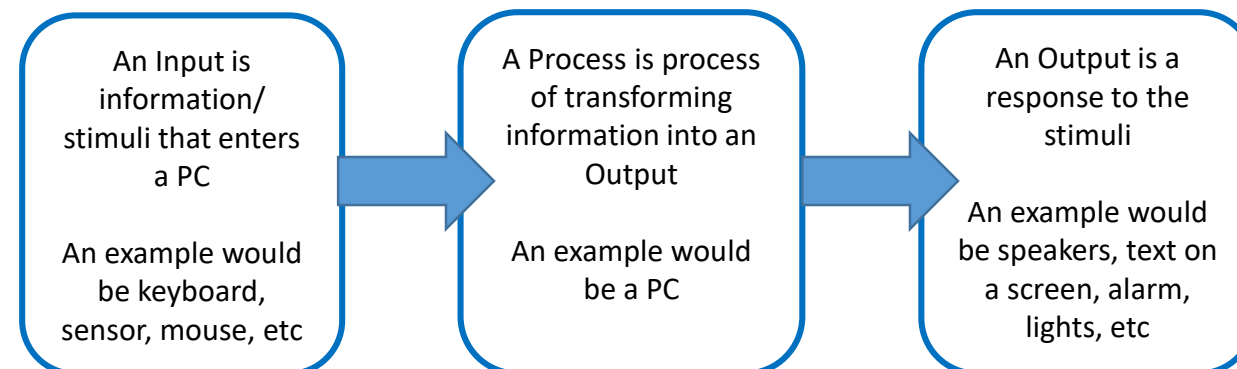
- The total amount a specific dimension or property is permitted to vary
This can apply to hole depth, length, angle, thickness, weight and elasticity
A gauge can be inserted into a gap or hole to check if the sizes fall within tolerance
If parts do not fit within the specified tolerances they are discarded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

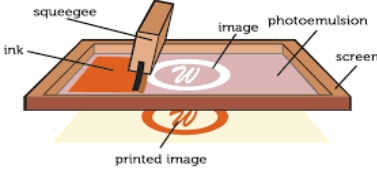
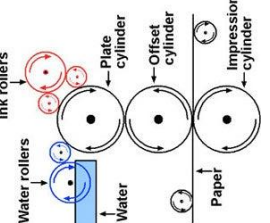
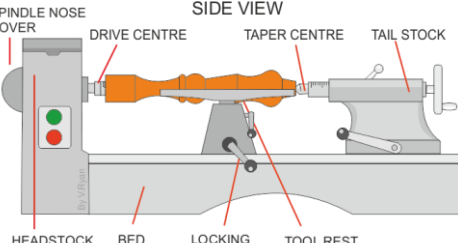
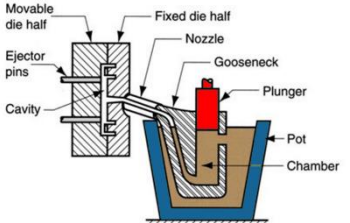
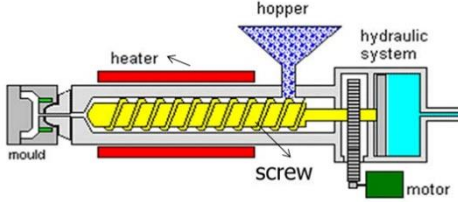
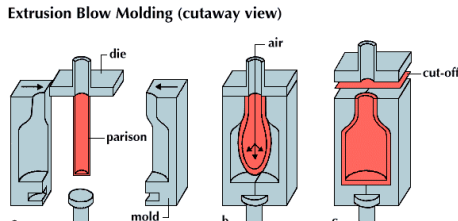
Quality Control and Quality Assurance

- 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:



Process Orders



Name of Process	Diagram	Material	Products Made	Key info
<p>Screen-printing</p>		<p>Papers and Textiles</p>	<p>Posters, signs and t-shirts</p>	<p>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</p>
<p>Offset Lithography</p>		<p>Papers and card (thin, flexible plastics)</p>	<p>Posters, newspapers, plastics bags</p>	<p>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</p>
<p>Lathe Turning</p>		<p>Wood and metal</p>	<p>Chair legs, baseball bats (cylindrical items)</p>	<p>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 by automated machinery) to the desired shape. Can be used in one-off and batch production</p>
<p>Die Casting</p>		<p>Metal</p>	<p>Car parts, engine components, etc</p>	<p>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-off and batch production</p>
<p>Injection Moulding</p>		<p>Plastics</p>	<p>Chairs, toys, etc</p>	<p>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.</p>
<p>Blow Moulding</p>		<p>Plastics</p>	<p>Plastic bottles</p>	<p>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.</p>