Knowledge Organiser **Timber**

Resistant Materials

Hardwood

Timber from a deciduous tree. They are slower growing and more expensive.

ash: a pale and attractive hardwood. Tough, flexible. Open grained.
Used in furniture, steam bending, wood turning.

balsa: soft and lightweight, the wood is actually from a deciduous flowering plant, not a tree. Very light in colour with a distinct, straight grain.
Used in model making, prototypes, craft, model aeroplanes.

beech: hard, tough, strong/close grained, white/pinkish brown. Prone to warping.
Used in functional furniture, chairs, tables, tools, veneers.

Iroko: African tropical hardwood. Deep reddish brown, is a less ecologically damaging alternative to mahogany. Also known as African Teak.
Used in boat-building, decorative furniture, traditional musical instruments.

mahogany: fairly strong, medium weight, durable. Interlocking grain. Pink reddish brown. Prone to warping.
Used in indoor furniture, panelling, veneers

oak: strong, heavy, durable, hard and tough. Open grained. Light brown. Finishes well. Expensive.
Used in construction, high-class furniture, boat building, veneers.

teak: very strong, hard, durable. Natural oils make it resistant to moisture. Golden brown. Very expensive. Blunts tools easily.
Used in quality furniture, outdoor furniture, boat building, veneers.

walnut: an extremely durable, tight-grained wood. Its hard, dense grain make it ideal for machining and joint making. Polishes to a high quality finish.
Used in restaurant tabletops, cabinet making, decorative features such as handles, bannisters, veneers and layers in plywood.

Softwood

Timber from an evergreen or coniferous tree. Fast growing.

Douglas Fir: pale to medium red/brown colour. Works well. Straight grained, dries quickly, fast growing.
Used in construction, railway sleepers, joinery, flooring, decking.

Paraná Pine: fairly strong and durable. Straight grain. Pale yellow, red/brown streaks. Almost knot free. Tends to warp.
Used in best quality indoor joinery, staircases, built-in furniture.

Scots Pine: pronounced straight grain. Light brown/yellow in colour. Polishes well.
Used in general construction work and joinery.

spruce: fairly strong with small, hard knots. Creamy white, resistant to splitting. Not very durable.
Used in general indoor work such as stud-walls, shelves.

Western Red Cedar: straight silky grain, dark reddish brown. Lightweight and not very strong. Natural oils make it durable against weather.

Properties of Timber and Sheet Materials

Property	Definition	Found in
hardwood	Timber from a deciduous tree.	oak, ash, mahogany, walnut, beech, balsa
softwood	Timber from an evergreen or coniferous tree.	pine, red deal, cedar
tight-grained	Timber with a high ring count, slower growing and denser.	oak, beech
loose-grained	Timber with a low ring count- faster growing.	scots pine, red deal
dense	Can be deformed without losing toughness.	oak, beech
straight-grained	Timber which has grown straight, has a uniform grain.	oak, beech, red deal
knot	Irregularity in wood grain, where a branch or offshoot existed.	spruce, ash, some plywood
weather resistant	A tight-grained timber has good water and heat resistance.	oak, beech, ash, plywood
stiff	A timber that does not bend easily.	oak, ash, beech, plywood, MDF
easy to work	A timber that is either low or medium density. Easy to cut and shape.	red deal, scots pine, balsa, MDF
lightweight	A timber that is light in weight.	balsa, plywood, MDF
attractive grain	When polished or varnished, a timber's grain is eye-catching.	walnut, oak, ash, some plywood

Timber products

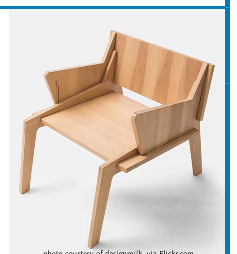
Sheet materials manufactured from layers or particles of wood including MDF, plywood and hardboard.

MDF: mid-brown colour. Will swell if exposed to moisture. Sheets can be heavy. Smooth finish. No grain. Available in a wide range of sheet sizes and thicknesses.
Used in flat-pack furniture, vacuum-form moulds, product modelling, architectural models. Often covered in veneer for a natural timber appearance.

veneer: very strong, hard, durable. Natural oils make it resistant to moisture. Golden brown. Very expensive. Blunts tools easily.
Used in table tops, flat pack furniture, plywood, cabinet-making.

hardboard: Made from wood chip and pulp, cheaper substitute to plywood. Used when space filling as opposed to requiring strength. No regular grain.
Used in countertops, flooring, flat-pack furniture.

plywood: Reddish brown or white in colour. Layered in odd numbered sheets. Strong. Susceptible to splintering
Used in sheds and cladding, furniture, flooring, boats (marine ply).



Wasting

Wasting timber by hand

Most solid woods can be easily wasted and shaped using a range of workshop tools.

- **Sawing:** tenon saw, bench saw, coping saw, jigsaw.
- **Filing:** rasp, bastard, second cut, half round, round.
- **Chiselling:** chisels are used along with vices and mallets to remove areas that have been pre-cut.
- **Planing:** shape and finish edges using a plane or spoke-shave. Edges require no further finishing after planing.

Wasting timber using machinery

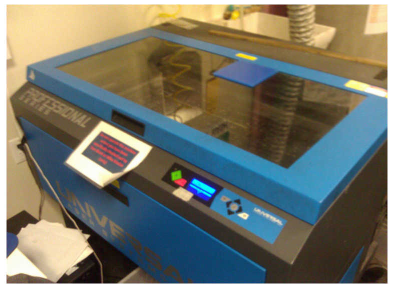
Using machinery to waste timber can speed up the manufacturing process and give accurate results.

- **Turning:** lathes, used with special chisels, allow the shaping along the profile of a piece of solid wood, or laminated MDF as it is spun. Formers for vacuum forming can be made in this way.
- **Drilling:** chain drilling solid wood and sheet materials can speed up the wasting progress. A series of holes are drilled along a path, the waste is then removed using a coping saw or chisel.

Wasting timber using CAD/CAM

Sheet timber lends itself to being wasted on flat-bed machinery. CAD files can be easily prepared to control these machines.

- **Laser cutters:** can quickly cut thin sheet timber such as MDF and plywood. Precision features such as joints can be cut accurately on a laser cutter.
- **Computer controlled routers and milling machines:** can effectively translate a computer design into a component. Double-sided tape is often used to secure the timber to the machine's



Addition

Addition using adhesives

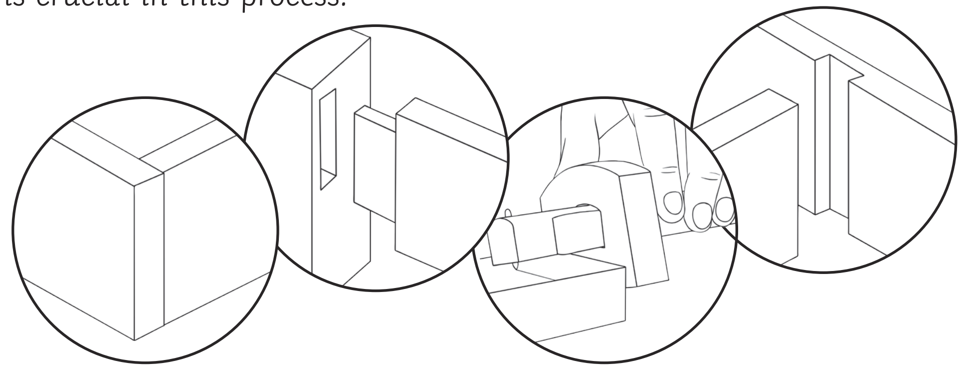
- **White glue (PVA):** a strong and inexpensive glue to use with all timber.
- **Sheet material:** easily glued surface-to-surface, as the large surface area gives a strong bond.
- **Some decorative detail:** can be added using white glue alone.
- **Cramps:** should be used to tighten the joint whilst the glue is drying.

For most other joins, white glue is used in combination with other addition methods.

Addition using joints

Solid wood can be precisely cut using chisels and a tenon saw to create tight-fitting joints which lock together. This can look attractive and give a strong join, especially when glued.

All joints require careful marking out and cutting. A **marking gauge** is crucial in this process.



Addition using slotting

Sheet timber products can be joined using slots in the same way as sheet polymers. Slots can be cut by hand or cut using CAM machinery.

Timber fastening hardware

The use of fasteners and joining hardware can be used in the addition of timber in combination with joints and adhesives. These include:

- **Woodscrews**
- **Coach bolts**
- **Dowel**

Deforming and Reforming

- **Steaming:** soaking a thin length of solid wood or plywood in a special steamer box makes the timber flexible enough to twist and bend.
- **Laminating:** thin sheets of wood can be pressed together in a mould to form a three-dimensional structure. This technique requires plenty of space, glue and clamps!
- **Kerfing:** a technique which allows a strip or sheet of timber (either solid or man-made) to be deformed into curves and bends. Cuts are made along the inside of the material at regular intervals. The closer together, the tighter the bend. Once the cuts have been made, glue is applied to the cuts and the material is manipulated into shape and cramped to set.

Reforming Timber

The term most commonly applies to the range of timber products that have been manufactured from solid wood. These include:

- **MDF (Medium Density Fibreboard):** this sheet material is reformed from material recycled from solid wood manufacturing. The tiny fibres are pressed together and bonded with a resin which gives the material its density. Easy to shape, but prone to causing dust.
- **Chipboard (Particleboard):** this sheet material is reformed from larger chips left over from solid wood manufacturing. Glue and sawdust is added and these are pressed together to create the sheet material Chipboard. This is a low-grade material and used most commonly in building projects such as barns, garages, flooring.
- **Hardboard:** this sheet material is reformed from pulped wood waste. The pulp is steamed under pressure before glue is added and the material is pressed flat with one smooth, hard side, and one textured surface. Low cost, this material can be used in a range of projects, but is not suitable for outdoor use.

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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:

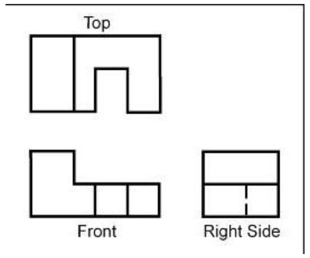
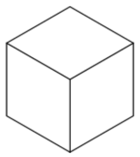
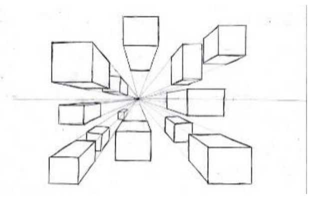
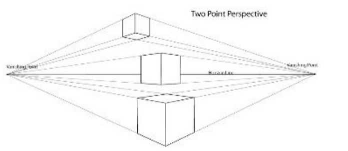
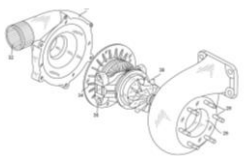
- Constraints/ limitations
- What the product is
- Materials/processes
- Any key information you know

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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Production Processes

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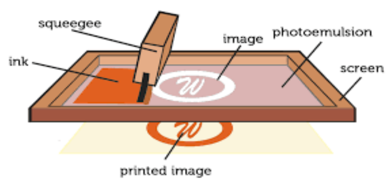
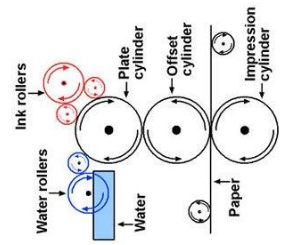
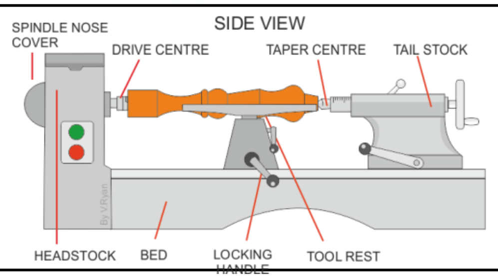
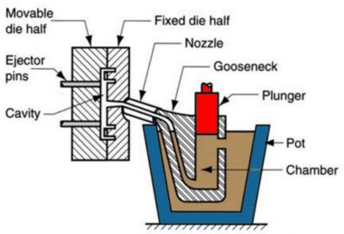
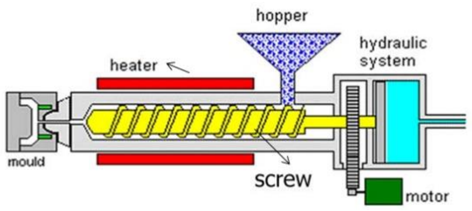
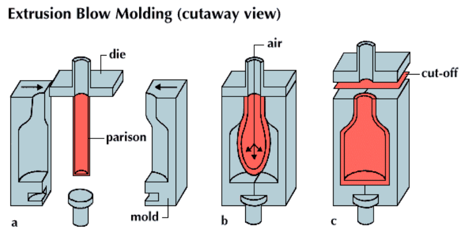
Name of Process	Diagram	Material	Products Made	Key info
Screen-printing		Papers and Textiles	Posters, signs and t-shirts	Screen printing places paint on top of a screen. The screen has a stencil embedded in it, so when the paint is passed across it the desired shape is printed underneath. Good process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

Production Techniques and Systems

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

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

Flexible Manufacturing Systems

This is where **automated machines** are adaptable and can produce different products if needed.

If a manufacture is making a product with machines that are just dedicated to specific tasks they have to be reprogrammed and re-tooled before changing to a new task. This is time consuming and expensive.

Examples include; CNC Machines, 3D Printers, Laser Cutters, Robotic arms, etc

Lean Manufacturing

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

Just-in-Time (JIT) Manufacture

This is where manufacturers only order materials, parts, etc when needed. The customer's order triggers the production process and the resources needed for that order are the only ones bought.

This can be used in any **scale of production** but is particularly useful for one-off production.

Advantages	**Disadvantages**
• Saves on warehouse and storage costs • Money is not tied-up in stock • Little/minimal waste • Customer often pays in advance so money is secure before production	• All production stops if a part/ material is missing • Needs to have a fast, reliable and good quality supply chain to work properly • Can be time-consuming

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Work of others and Customer Research

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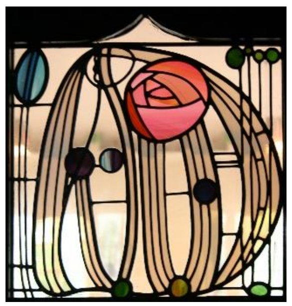
Work or Others

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

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

Research

What methods of research can be used to find information?

- Product Analysis
- Case studies
- Interviews
- Questionnaires and surveys
- Social media and email
- Materials testing

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

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Design Strategies

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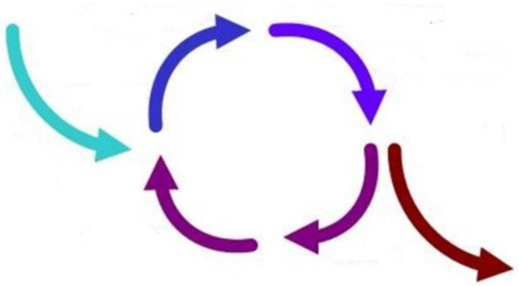
Design Strategies are used to solve **Design Fixation**, and help develop creative design ideas.

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

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Scales of Production

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

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

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

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

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