GCSE DT

Theory Topics

Remember
90% Theory 10% Making!

Process and Manufacture

Scales of Production	
Revised	
Exam Question	
Revised again	

Production Methods	
Revised	
Exam Question	
Revised again	

Tolerances	
Revised	
Exam Question	
Revised again	

Designing Products

Research and Investigation	
Revised	
Exam Question	
Revised again	

Developing and Communicating Ideas	
Revised	
Exam Question	
Revised again	

Prototyping and Development	
Revised	
Exam Question	
Revised again	

Briefs and Specs	
Revised	
Exam Question	
Revised again	

Materials

Paper and Boards	
Revised	
Exam Question	
Revised again	

Finishes	
Revised	
Exam Question	
Revised again	

Standard Components and Stock Forms	
Revised	
Exam Question	
Revised again	

Plastics	
Revised	
Exam Question	
Revised again	

Woods and Boards	
Revised	
Exam Question	
Revised again	

Properties of materials	
Revised	
Exam Question	
Revised again	

New and Smart Materials	
Revised	
Exam Question	
Revised again	

HALEWOOD ACADEMY
WADE DEACON TRUST

Approaches to Design

People, Society and Culture	
Revised	
Exam Question	
Revised again	

Work of Others	
Revised	
Exam Question	
Revised again	

Design Strategies	
Revised	
Exam Question	
Revised again	

Industry and Enterprise	
Revised	
Exam Question	
Revised again	

Environment	
Revised	
Exam Question	
Revised again	

Energy and Mechanisms

Mechanical Systems	
Revised	
Exam Question	
Revised again	

Energy Generation and Storage	
Revised	
Exam Question	
Revised again	

Process Orders	
Revised	
Exam Question	
Revised again	

Maths and Science

Energy	
Revised	
Exam Question	
Revised again	

Angles	
Revised	
Exam Question	
Revised again	

Forces	
Revised	
Exam Question	
Revised again	

Environment	
Revised	
Exam Question	
Revised again	

Decimals	
Revised	
Exam Question	
Revised again	

Area and Volume	
Revised	
Exam Question	
Revised again	

Charts and Graphs	
Revised	
Exam Question	
Revised again	

Ratios, Fractions and Percentages	
Revised	
Exam Question	
Revised again	

Design Briefs

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

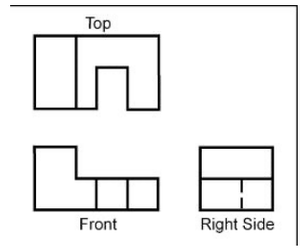
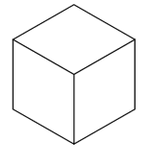
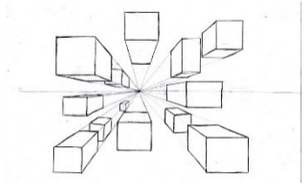
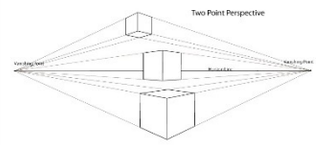
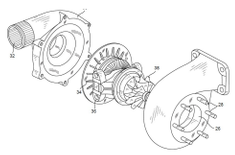
- Constraints/ limitations
- What the product is
- Materials/processes
- Any key information you know

Design Specifications

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

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

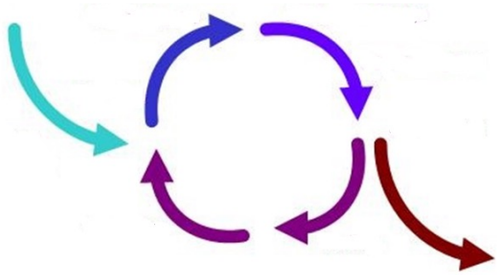
Aesthetics	What the product looks like? Style? Colour Scheme? Design Movement?
Customer	Who would buy it? (Age, gender, socio-economic, personality) How does the design appeal to them?
Cost	How much will it cost? (min-max) Why?
Environment	Where will it be used? Why? How will you make it suitable?
Safety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

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

Modelling and Development

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

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



Iterative Design

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

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

User-Centred Design

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

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

Systems Approach

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

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

Collaborative Approach

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

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

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

Storing Energy

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

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

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

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

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

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

Life Cycle Assessment

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

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

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

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

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

Finishes

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

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

Standard Components

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

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

Tolerances

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

Quality Control and Quality Assurance

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

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

- Below are examples of Quality Assurance symbols:

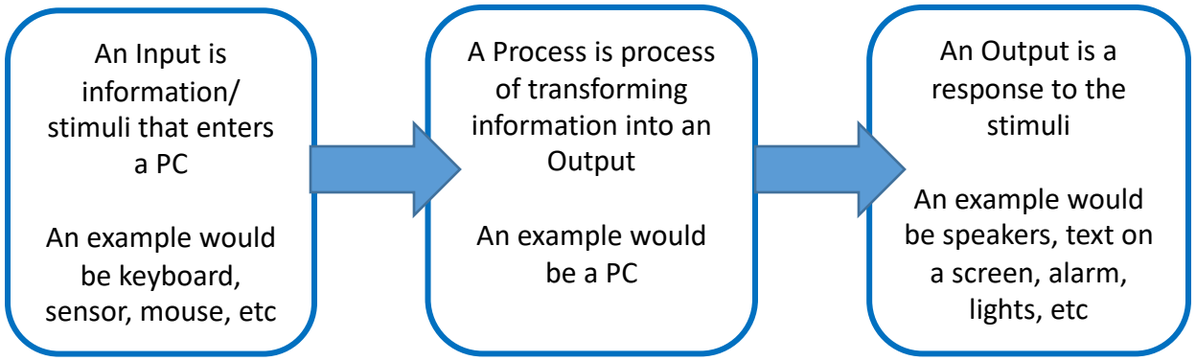

European Conformity


BSI Kitemark


Lion Mark

Registration Mark

Process Orders



Industry and Enterprise

Automation

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

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

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

Virtual Marketing

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

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

Cooperatives

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

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

Enterprise

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

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

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

Crowdfunding

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

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

Fair Trade

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

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

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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 loose leaves in winter and grow fruit and flowers in spring

Material	Key info	Examples
Ash	Flexible, tough and shock resistant	Sports equipment Tool Handles
Beech	Fine finish, tough and durable	Toys, furniture and veneers
Mahogany	Easily worked, durable, high quality finish	High-end furniture
Balsa	Very soft and spongy. Light	Modelling
Oak	Tough, durable and hard	Flooring, furniture and veneers

Softwoods come from **Coniferous Trees.** These have thin, needle-like leaves and grow all year round. Often have pine cones and sometimes nuts and seeds

Material	Key info	Examples
Larch	Durable, tough, good water resistance and finishes well	Furniture, flooring and used outdoors
Pine	Light, easy to work with but can split	Cheap furniture, construction and decking
Spruce	Easy to work with, high stiffness but can decay quickly	Furniture, musical instruments and construction

Man-Made Boards

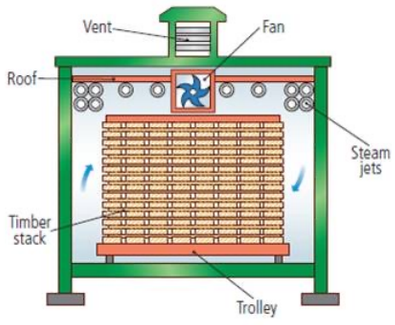
Manufactured boards are made from wood chips/dust/ layers and glue.

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

Primary Processing of Papers and Boards

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

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



Manufactured boards can be either be made by lamination or compression

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

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

Mechanical Systems

Forces

Compression

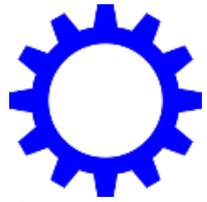
Tension

Torsion

Shear

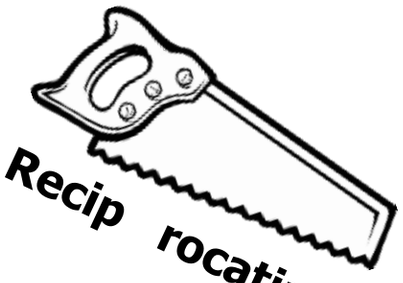
Motion

Linear



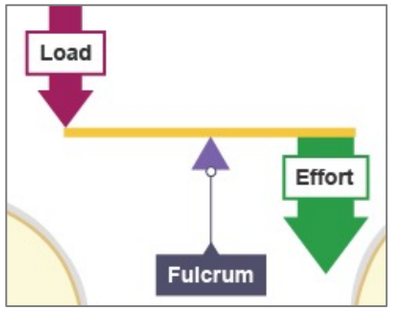
Rotation

Oscillating



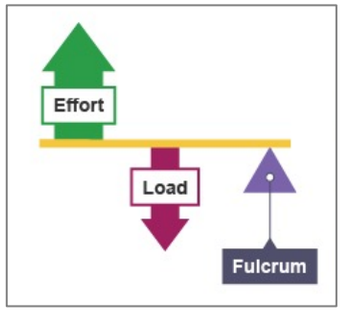
Reciprocating

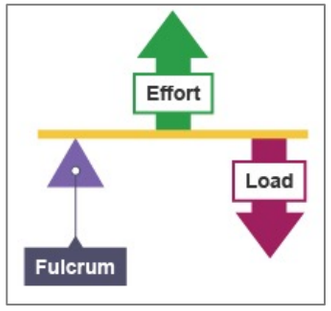
Levers



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

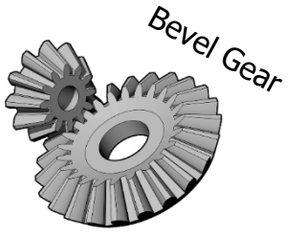
A Pulley is a grooved wheel, that has a belt running through it

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

Gears and Pulleys

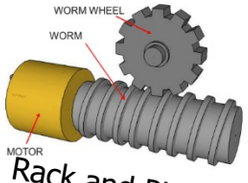
Gears have teeth that mesh together with each other (like teeth on a zip)

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



Bevel Gear

Spur Gear



Rack and Pinion

Worm and Wheel

Market Pull and Technology Push

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

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

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

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

Cultures, Faith and Belief

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

Different countries and cultures also react to products differently.

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

Case Study: £5 note

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

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

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

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

Fashion and Trends

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

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

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

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

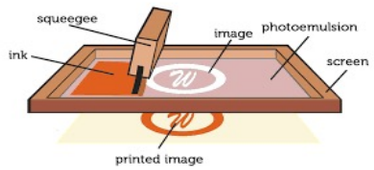
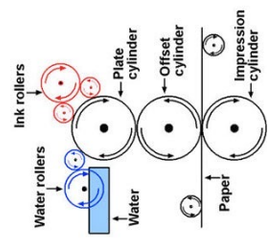
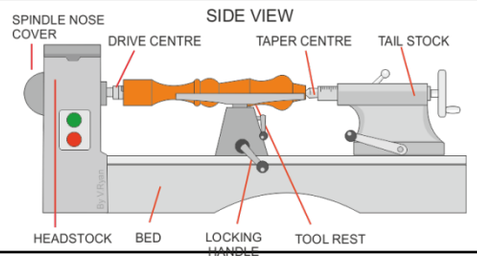
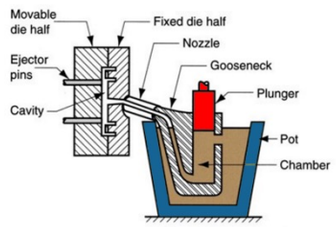
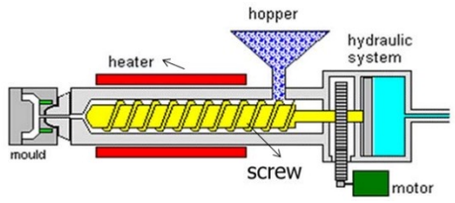
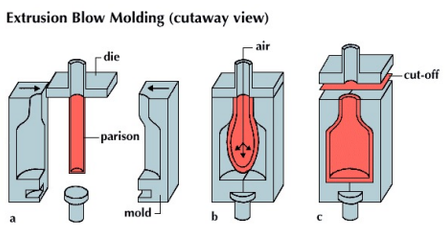
Inclusive vs. Exclusive Design

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

Examples include; Cars, Doorframes, Adjustable Products, etc

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

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

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

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

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

Flexible Manufacturing Systems

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

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

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

Lean Manufacturing

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

Just-in-Time (JIT) Manufacture

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

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

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

Scales of Production

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

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

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

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

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

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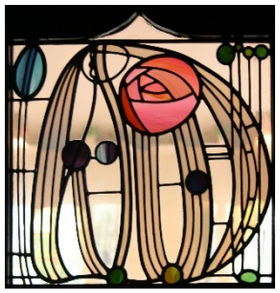
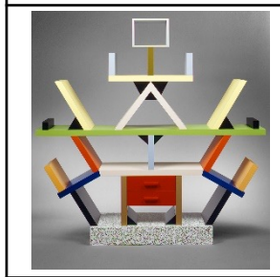
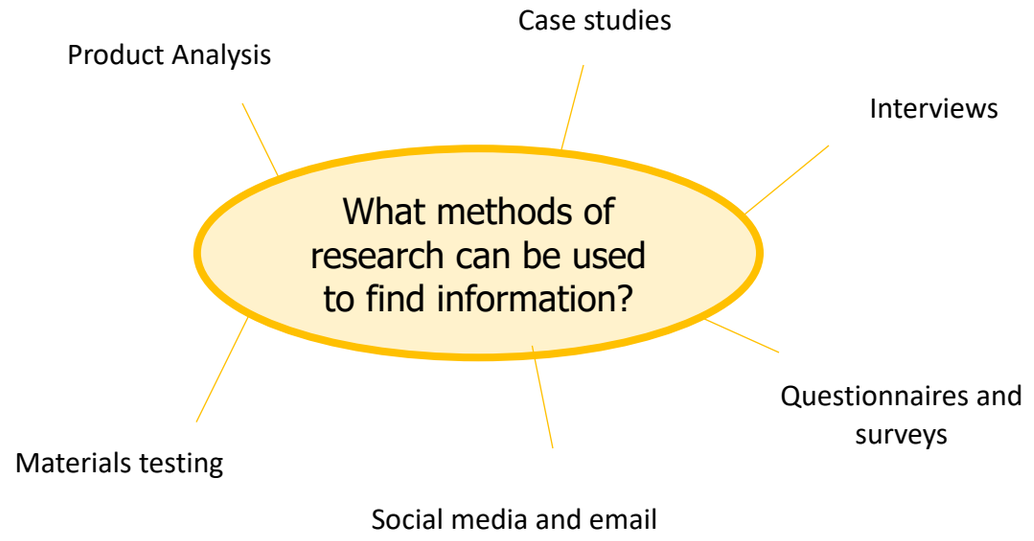
Work or Others

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



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