Name:

Engineering Design

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KNOWLEDGE ORGANISER KS4

R105: OCR Engineering Design: Examination subject knowledge

Clients & Customers

NEEDS OF THE CLIENT

There will be some non-negotiables that the client needs to see involved in the design

- Corporate Branding – e.g. what colours or logos do they use
- Target Audience – who are the company focused on already

DISCUSSION BETWEEN CLIENT AND DESIGNER

The discussion meeting is the engineers chance to explore the brief and work out what the client requires.

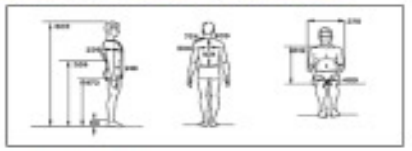
- What is possible – in terms of cost or technologies
- What can be done within budget
- Essential features – what the product MUST do/ have
- Desirable Features - what the product COULD do/ have
- Timeframes – how long is available to design and develop

Specification Requirements

– aesthetics – how they might require it to look

– ergonomics – suitability for human sizes e.g. hand size, height, weight, finger length

– anthropometrics – Physical sizes/ measurements recorded and used to design ergonomic products



-Function – the purpose of a product e.g. a television displays programmes

-Features – the additions that make the product unique e.g. remote controls,etc.

Investigating the design context

There are areas that can be researched to find out more about the product requirements:

-Focus groups – talking to the likely customer
-Surveys – getting general information from the pubic
- Needs of target market – a product that fills a gap
-Changing consumer trends – a "must have" item

Sustainability

SUSTAINABLE DESIGN

Environmental considerations about the products effect on the environment. There is also pressure to be ethical and socially responsible

Renewable energy sources – made products cost resources, energy and pollution
Materials that are replaceable – materials that are plentiful/materials that regrow or replenish
Recycled- Using materials from reclaimed sources
Recyclable – Enabling a product to be recyclable – through material choice or disassembly

LIFE CYCLE ANALYSIS

Product life cycle affects how well a product is designed and how long it is required to work.

Lifespan – how long a product is intended to be used
Lifecycle – including what happens to it afterwards
Planned Obsolescence – A product designed on purpose to become outdated or unusable after time

Manufacturing

REQUIREMENTS

chain -

s that are easy to do and quickly
very few stages e.g. injection moulding,

cheap in high volume
changes in features, colour etc.
total customisation

erances – how accurate it must be:
High: can be innacurate, less wasted products, less accurate mchines
Low: Lot of wasted products, expensive machinery, very accurate

maintain/repair

OF MANUFACTURE

ow easy it needs to be to make and assemble:
made components e.g. screws
using premade parts e.g. speakers
mbly (DFMA) – Less stages, less parts, standard

repair or if it must be recycled or reused
– if a certain process must be used; injection

Regulations

REGULATIONS

- Copyright – Protecting a piece of creative work, eg a drawing by LAW
– patents – a protected design IDEA by LAW
– registered designs &
– trademarks – images/logos associated with the company protected BY LAW

SAFEGUARDS

– British Standards – Are guides to ensure QUALITY
– European Conformity (EC) – are guides to ensure SAFETY

Vs

New Technologies

Market Pull – a need or gap needs filling – the customer wants something new e.g. longer battery life on mobile phones
Technological Push – new technologies allow new ways of doing something – e.g. facial recognition or AR

IMPROVEMENTS IN MATERIALS

Engineering often creates new materials that create opportunities for better products. E.g. Recently carbon fibre has offered better products in some areas.

NEW PRODUCTION PROCESSES

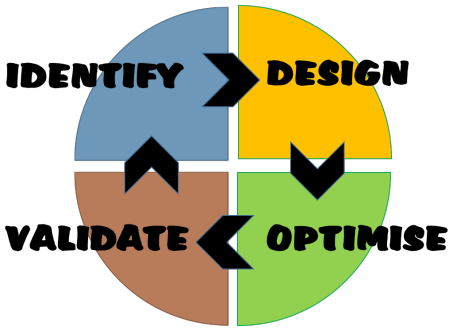
Engineering often creates new ways of making that allow a product to be better or made cheaper. E.g. Recently 3D printing has created new opportunities.

Iconic Products

INSPIRATIONAL / ICONIC PRODUCTS

ne products are so popular they set an expectation. E.g. the inimalist design and easy use of e Ipod influenced the design of nany other electronic gadgets.

What is the Design Cycle?



The Design Cycle is the process a Designer goes through to create a product. Once they reach the evaluate stage, designers can return to identify, to correct any issues they found in the testing and evaluation stages.

Designers will also use The Design Cycle as structure to make sure designs are thoroughly developed and reviewed at each stage, and allows the Designers to discuss the design with Client at regular intervals

What happens in each stage?

Identify phase (first phase)

- Ensures designer has a clear understanding of the design brief
- Defines client and user needs through research
- Considers processes to be followed (process planning)

Design (second phase)

- Create a specification uses info gathered in identify stage
- Create detailed engineering drawings and manufacturing plans

Optimise (third phase)

- Find ways to improve designs (prototypes & gaining feedback)

Validate phase (final stage)

- Review design choices
- Test the design (market and product testing)
- Evaluate against brief and specification
- Evaluate impact of solution, social, moral and environmental issues

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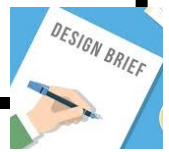
Designing products.

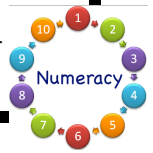
Design Brief

Design brief
A short description of a problem and how it will be solved.
It is typically written in a few short paragraphs



Client needs/wants
You must consider the needs, wants, interests of the end users of the product

Situation
The situation normally identifies a need that requires a solution.
E.G Developing numeracy skills can equip young children well for school.



ACCESSFM

Aesthetics – How will the product look. E.g. Colour, texture, shape.
Client- Who is the product for? Gender and age of user.
Cost- How much will it cost to manufacture your product? How much will it cost consumer?
Environment- What impact will the product have on the environment? How can it be designed and be made to be more sustainable?
Safety- How will product be designed to be safe to use?
Size- What will the dimensions be in millimetres of the finished product? This should include Height, Length and Depth.
Function- What will the product do and how will it work?
Materials- What materials/components will be used to make the product

Design Specification

Definition/purpose:
A design specification is a list of measurable criteria that the product must meet. Each point must be concise and be justified.
It provides detail on the specific requirements of the product.
A good specification will include; aesthetics, function, ergonomics, components and materials, sustainable issues and social issues.

Design Specification	Justify my choice
1. I want my design to be simple so that it can be made very well and work well, but very good to look at as this will make my father happy to see a good and creative picture everyday	Since the card is to make someone happy it should have a good and creative design but it also shouldn't be too complicated as this will mean that it will be difficult to make sure the circuit works well
2. My design must have an electrical circuit that works well.	The electrical circuit cannot have any gaps or parts that don't work as then the led lights will not work
3. My design must have a good battery holder	This is important so that the battery does not fall out and then the lights in the card will not work.
4. My design should be colourful and attractive	This is so that the person recieving this card will be pleased and think that i tis a good design.
5. My design should be cost effective and not too expensive to make	It would be a good idea to keep the costs down wherever possible and avoid unnecessary spending so that the card is good value for money.
6. It should be made using the following materials: grafite pencil or copper tape, card, paint or colour pencils, a battery and led lights.	These are the materials I have chosen for my design because it is the simplest and most cost effective way to make a card with an electrical circuit (because grafite is conductive)
7. It should look neat professional and well presented.	This is important because the card should appear like it has been carefully made and not messy or badly made.
8. My card should have a switch so that the Light turns on when I tis pressed	I think that this is important because it will make the card more fun and interactive

Manufacturing Specification

Definition/purpose:
A manufacturing Specification should contain information needed to make the design.
It should include the following information:
The scale of production to be used:. Is the product to be batch or mass produced or made as a one off item?
A drawing of the final design. This should include assembly and construction details.
Details of components and materials needed & any standard components. This could be a cutting list
Details of how quality will be ensured, such as quality control and quality assurance. This can be a flow diagram or visual making diary

Key Words
You must know the meanings of the key words below:
Design brief
Design specification
End user
Manufacturing specification
Key points
ACCESSFM is a tool used to help designers write a specification
You must be able to:
Explain what is a design brief
Explain what is a design specification?
Explain what should be included in a manufacturing specification
Write a design brief and design specification for a product
Modify a design brief as a result of user feedback
Produce a manufacturing specification for a product

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Push & Pull

Market forces

Marketing strategies
Analysing existing products:

Research unfamiliar technologies/materials/consult experts/testing & disassembling products

Questionnaires
Identify needs of target group, social & economic background
of users, features target group want in a product.

Focus groups
Cross section of users in a controlled environment

Field testing
Testing of a product against a rival company to stay ahead of the competition

Technology Push

Technology push is when products are **re-designed because of changes in materials or manufacturing methods**. This might mean that new materials have become available, with improved properties or that improvements in manufacturing processes mean a **manufacturer can make the product cheaper or more efficiently**, which reduces manufacturing costs. Technology Push usually **does not involve market research**. It tends to start with a **company developing an innovative technology and applying it to a product**. The company then markets the product.

Market Pull

Market pull is when product ideas are produced in **response to market forces**. Examples of market influences include: **A demand from consumers for new or improved products**. **Another manufacturer launches a competing product**. A manufacturer wants to increase their share of the market. The need is identified by potential customers or **market research**. A product or a range of products are developed, to solve the original need. Market pull sometimes starts with **potential customers asking for improvements to existing products**. **Focus groups** are often central to this, when testing a concept design or an existing product.

Improving manufacturing efficiency

Lean manufacturing *aims to make products in the most effective and efficient way possible. It is where possible waste are eliminated during manufacturing.*

This includes:
Moving products unnecessarily around a factory.
Making too many products
Time workers spend looking for tools
Doing just what the customer wants. (no extras!)

(JIT) JUST IN TIME *production deliver materials only when needed. Less money is tied up in materials. Could be delivery problems if suppliers don't deliver on time thus slowing manufacture. Could stop manufacturing leaving equipment unused and customers waiting.*

(FMS) FLEXIBLE MANUFACTURING SYSTEMS *react to unpredicted change. They change systems or the order of making components to help make the end product. They might even redesign the product.*

Increased automation is improving manufacturing efficiency but can mean fewer jobs for people.

Key Words

You must know the meanings of the key words below:

Marketing Strategies

Analysing products

Lean manufacturing

Just in time

Technology push

Market pull

Key points
Different production systems/techniques improve efficiency

You must be able to describe a product that has developed As a result of market pull and technological push

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Inspirational design and new technologies

Name of Company

Apple

Braun

Dyson

Under armour

Key facts about the company

Company founded by Steve jobs, Steve Wozniak and Ronald Wayne in 1976. Famous for selling Macintosh personal computers. Later designed Imac G3, the ipod a portable music player and very popular Iphone. The first phone combined elements of the G3 and Ipod with a touch screen mobile phone.

German company founded by Max Braun in 1921. Well known for its popular shaving and grooming products and functional approach to design

British design engineering company formed by James Dyson in 1991 as a way of bringing his bagless vacuum cleaner ideas to market. By 2001 47% of all vacuum cleaners sold in UK were the Dyson brand.
Dyson vacuums are known for not loosing suction as they don't have bags and use cyclone dust separation.
Dyson now makes many different products including heaters, fans and hairdryers.

American sportswear company founded in 1996 by Kevin Plank, a former American footballer
They developed moisture wicking clothing that uses micro fibres to keep athletes cool/dry
They sell wide range of accessories/clothing

Iconic Design

An iconic design is usually a design that is 'ground breaking' and one that sets new standards in its field. It is a design that other designers and manufacturers follow, as it becomes a bench mark for other similar products. Furthermore, an iconic design is one that stands up to the test of time, remaining a good design, despite the passing of years, decades and even centuries.up to the test of time, remaining a good design, despite the passing of years, decades and even centuries.

Some examples of iconic designs include;
Red telephone boxes, red double decker buses, the Spitfire, Concorde, the Mini car, and the London Underground map.

Criteria for an iconic design

A design that sets a bench mark for others to follow.
A ground breaking design, in terms of its technology or manufacturing techniques used during its production.
A design that improves on the past.
A design that sets new standards in terms of quality, functions/features or style.
A design that stands the test of time, remaining popular despite the passing of years.
A design that stays in the memory of those who see/use it.
A design that is often recognised immediately by consumers.
A design that inspires other designers.
Sets a trend.
A design that is innovative.
A design that is aesthetically pleasing.
A design that is often emulated/copied by other designers.
A design that has its place in history, or even helps change history.

Key Words
You must know the meanings of the key words below:
Iconic Design
Key points
An iconic design is usually a design that is 'ground breaking' and one that sets new standards in its field.
You must be able to:
Explain why a product is iconic
Explain what was special abut the first iphone
Explain what James Dyson invented and what made It unique.
Explain what Under Armour sports wear is designed to do.

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Social issues in the Design & Manufacture of Products

Ecological, environmental & Social issues

Effects of the use of raw materials

Deforestation. Trees removed and land converted to other uses. Loss of animal habitats & impact on climate change

Mining can cause erosion and contamination of soil. Sinkholes can be traced back to mining.

Oil is needed for plastics. Oil spills can have devastating effect on environment, killing wildlife.

Some raw materials used in bio fuels are farmed. Over farming and use of pesticides can contaminate land and kill wildlife

Carbon released from manufacturing can cause global warming

Designers must consider the distance their product travels from source to manufacture, distribution and final disposal.

Ethical design is the practice of designing and making products with moral purpose in mind. It considers the impact that a product may have on the lives and well-being of those affected by its creation, through manufacture and use. For example, a product may be manufactured in a factory with terrible working conditions, such as extremely long hours for low pay, where profits are not used to help change those conditions. Designers can make moral decisions about how and where products are manufactured to avoid this. Consideration of how the product affects the environment can also be classed as ethical design, for example, contributing to deforestation (which will also affect local people, who may rely on the natural resources). Minimising the disruption to the natural world and local communities should be at the heart of ethical design.

Fairtrade

This helps people in developing countries get a fair deal for their product/produce.

Workers get paid a minimum rate even if global prices fall.

Receive a fairtrade premium that can be invested in education and health care.

People buy fairtrade because of its values

The Fairtrade Certification Mark show that it meets fair trade standards

FAIRTRADE

Key Words

You must know the meanings of the key words below:

Reuse
Recycle
Repair
Refuse
Reduce
Rethink

Key points

Fair trade help people in developing countries get a fair deal for the products that they produce

You must be able to:

Explain how the 6 R's can be used by designers to evaluate the impact of their products on the environment

Explain the benefits of fair trade for the producers and consumers of products

Explain what the potential impacts of oceanic pollution are.

What ethical design is about

The 6 R's

Reduce

How can the amount of materials and components used be reduced? Is the product really necessary?

Rethink

How can the design of the product be changed so its less harmful to the environment? Can a better way be found?

Refuse

Should the product be manufactured if it is not sustainably designed?
Is packaging necessary? Can it be removed?

Recycle

Is the product made using recycled materials? Could the materials be recycled once the no longer of use.

Reuse

Could the product be used in a different way once it no longer functions? Could it be taken apart and used to repair other products?

Repair

Is the product easy to repair?
Are replacement components readily available in case of failure?

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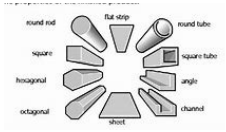
Materials & Their Properties

Standard Components

Stock Forms: *These are standard shapes/sizes in which material are available. To minimise effort designers try to use stock form or closet size that is required for their product that requires smallest amount of processing/changes.*



Reasons for using standard components:

They can be used in many different products.
Materials can be purchased in bulk reducing cost.
Processes can be automated speeding up the process.
Efficient use of labour
Consistency in quality of manufacture produced
Parts can be made in range of standard size.

Used with paper & board:

Clips 

Fasteners 

Rivets 

Sticky tape 

Bindings 

Used with timber:

Hinges 

Screws 

Handles, draw runners
Knock down fittings 

Brackets 

Nails 

Used with Polymers:

Caps 

Fasteners 

Nuts and bolts 

Used with Textiles:

Zips 

Sequins

Buttons 

Beads 

Poppers and studs 

Velcro 

Used with Metals:

Nuts, bolts, washers 

Hinges 

Rivets 

Electrical components:

Resistors 

Capacitors 

Diodes 

Switches 

LEDs 

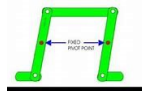
Transistors 

Motors 

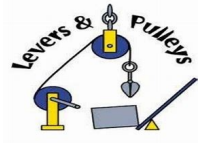
Micro controllers 

Mechanical components:

Levers
Pulleys

Linkages 

Gears 



Cams 

Belts 

Key Words
You must know the meanings of the key words below:
Standard component

Key points
Standard components are parts that are used in many different products
It is much cheaper to buy a standard component
You must be able to:
Explain why standard components are used
List standard components used with a variety of materials

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TEMPORARY FIXINGS

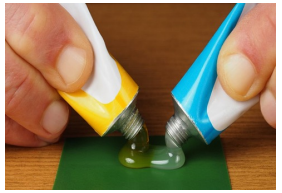
TEMPORAY FIXINGS:
Temporary fixings are commonly things such as screws or knock-down fittings, which are most commonly used in joining flat-pack furniture. These types of fittings can easily be put together, or removed if needed, using basic tools such as a screwdriver.

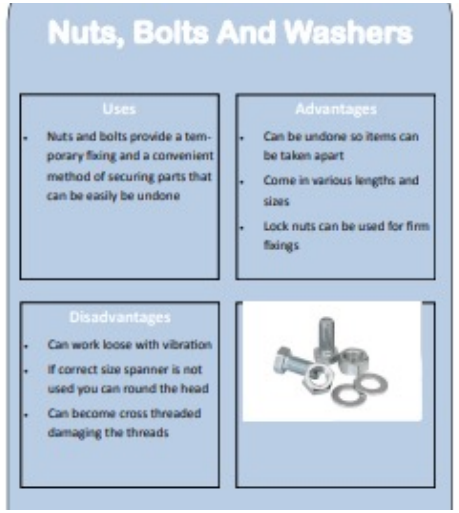


WHAT DO DESIGNERS CONSIDER WHEN DESIGNING FOR DISASSEMBLY?
The fewer parts you use, the fewer parts there are to take apart.
As with parts, the fewer fasteners (e.g. glue, screws, etc.) used, the better.
Common and similar fasteners that require only a few standard tools will help to simplify and speed disassembly.
Screws are faster to unfasten than nuts and bolts.
Glues should be avoided.
Disassembly instructions into the product will help users understand how to take it apart.

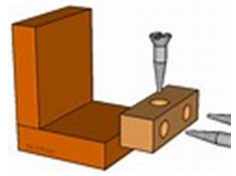
Key Words
You must know the meanings of the key words below:
Temporary fixings
Permanent fixings
Knock down fixiings
Key points
Temporary fixings are used to make disassembly easy.
Designers consider disassembly and how it might extend the lifetime of a product
It can be better for the environment to use temporary fixings
You must be able to:
Explain why temporary fixings are used and be able to name different types of fixings and their benefits to the consumer

PERMANENT FIXINGS:
Materials joined permanently by using **adhesives**, a substance that bonds surfaces together. Adhesives can range in bonding strength and types depending on the materials that need joining. You can also permanently join materials through welding.

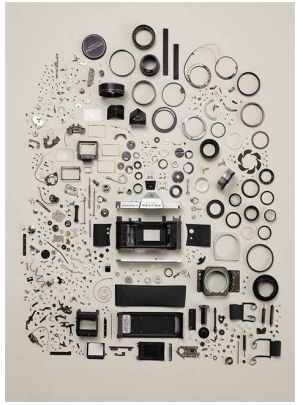


KNOCK DOWN FITTINGS
Knock-down fittings are those that can be put together easily, normally using only a screw driver, a drill, a mallet/hammer and other basic tools. They are temporary joints although many are used to permanently join together items such as cabinets and other pieces of furniture that are purchased in a flat pack



HOW CAN TEMPORARY FIXING BE GOOD FOR THE ENVIRONMENT ?
•Ease of disassembly
•Limit use of adhesives
•Limit or eliminate hazardous materials and waste

- **WHAT ARE THE BENEFITS TO THE CONSUMER OF TEMPORARY FIXINGS**
- Extending product useful lifetime.
- Parts standardization and replacement
- Modular components and parts
- Accessibility, safety and disassembly
- Affordability



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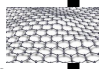
Materials & Their Properties

New Materials

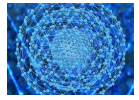
Modern materials: New processes have led to the development of titanium alloys with improved properties. (Metal foams and Graphene)
One way of altering a material to perform a new function is coating the material in nano material. Materials coated in metals can improve surface quality to improve hardness and prevent corrosion. Changing physical state of material. E.g. LCDs Liquid crystal display



Metal Foams: *Metal foams are made from metal with gas pores They look like metal sponges.*
They have properties of metal but are much lighter. (75-95% lighter)
They are used for crash resistant vehicles.

Graphene: *Graphene is a form of Carbon. Atoms are arranged hexagonally. It is 200 times stronger than Steel. It is flexible, transparent and conducts heat and electricity well. Used in smart phone windows and touch panels.*

Nanomaterials: *Made of tiny particles less than 100 nanometres in size. Nano coatings can repel dirt, water with self cleaning properties*



Smart materials: *Change property in response to external stimulus. This is reversible if the stimulus changes. A smart material seems to think.*
Stimulus that might cause changes to a smart material could be: light, heat, cold, moisture, stress or even PH levels.
Shape memory allows respond to heat. They can used in spectacle frames and heated if bent to return to original shape.
Thermochromic pigments change colour in response to temperature. These pigments can be used for thermometers and food packaging.
Photochromic pigment change colour in response to light changes. E.g in transition lenses

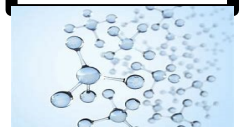
Composites: *Combine 2 or more materials to get a better property. E.g. Carbon fibre has six times strength of concrete.*
The materials in a composite are not mixed at chemical level.
Common composites include: Glass reinforced polyester. (GRP) used in body building and boat hulls.
Carbon reinforced polyester (CRP) used to make tent poles, bikes and sports equipment.
Composites cannot be recycled and are disposed of in la

Technical Textiles: *Manufactured for properties rather then looks. Their fibres are spun and then woven into fabric. Examples include Kevlar in body armour and fire resistant clothing worn by firefighters. Conductive fibres allow circuits to be incorporated into fabrics. They can control things such as light and temperature. Micro fibres incorporate tiny capsules that reduce body odour and can be medical textiles.*

Key Words
You must know the meanings of the key words below:
Metal foam
Graphene
Nanomaterials
Composite
Technical textiles

Key points
Composite combine 2 or more properties.
Smart materials change in response to external stimulus

You must be able to:
Describe characteristics of new materials
Explain what is a smart material and a composite material
List technical textiles, smart and composite materials.
You must be able to give examples of typical uses.



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FINISHING PROCESSES

Polymers

Plastic can become rough or scratched when processed and can become weathered or faded if left outside
The main reasons for finishing materials are:**Protection** - To make the plastic last longer (more durable). **Aesthetics** - To make the plastic more appealing. **Functionality** - To improve its properties e.g. grip
POLISHING:Polishing techniques are used to restore a high quality finish. Brasso® is often used to give a lustrous shine to plastics
ELECTROPLATING: Used predominantly in the automotive industry (car trims), in electronics, bathroom fixtures and various household goods
TRANSFER PRINTING: Image is printed onto special transfer paper and bonded onto the surface with a heat press. This is commonly used to personalise mugs and clothing
ETCHING AND FROSTING: Image is printed onto special transfer paper and bonded onto the surface with a heat press. Laser-etched surfaces can reflect light effectively. Frosting covers larger areas to make plastic opaque
FLOCKING: Polymer flocking fibres are bonded to statically charged materials with adhesive
Polymer flocking fibres are bonded to statically charged materials with adhesive
DECALS: Printed and cut self-adhesive vinyl can be attached to most surfaces
SPRAYING:Plastics are primed and sprayed with paints for aesthetics and protection from UV degradation. Quick to apply but contain VOCs (volatile organic compounds) which are hazardous fumes




Timber

Finishes can be applied by brushing, rubbing or spraying.
Basic preparation is needed before any finish can be applied. This is referred to as **cleaning up**.
STAINS: Softwood is sometimes stained to make it look like other types of woods such as hardwoods. This may enhance its appearance.
It is not a good idea to stain after filling because the filler will show up as a darker colour than the wood.
Stains can be water-based, or spirit based. These types of stains dry far more quickly. Oil based stains last the longest
OILS: Produce a natural finish. This type of finish suits oily woods such as teak and iroko. Examples of oil finishes are teak oil and linseed oil. This form of treatment is suitable for inside and outdoor purposes but if used outside needs regular recoating. Oils are applied with a clean cloth with the surplus oil wiped off. This is a traditional wood finish, which produces a dull gloss finish.
WAX: The wax should be the last finish to be applied. The wood should be sealed with French polish (shellac wood sealer) then lightly rubbed down with fine glass paper when dry. The wax should be rubbed into the surface of the wood, allowed to dry and finally polished with a soft cloth or brush.
VARNISHES: These are normally referred to as plastic finishes and are made from polyurethane.This gives a tough surface, which is resistant to heat, water and spirits. It also provides resistance to knocks. Some varnishes can be used for outside purposes.
It is available in clear, translucent, and coloured shades.
It provides either a matt, eggshell or gloss finish.
It is applied in thin coats using a brush and rubbed down in between each coat with wire wool.
PAINTS: Paints provide a colourful and protective finish for woods. It may be used outside or inside.When painting a product it should be sealed with a **primer.** Secondly **undercoats** should be applied, sanding down between each coat with a fine glass paper. There are lots of different types of paints available in many different colours from matt, eggshell to gloss. Emulsion paints, vinyl or acrylic resin are all water based paints. They are not waterproof or very durable.
Oil based paints some of which are non-drip are more durable and waterproof.
Polyurethane paints go hard when exposed to air. They provide a scratch resistant, tough surface suitable for toys and some furniture.





Timber Preparation

Basic preparation is needed before any finish can be applied. This is referred to as **cleaning up**.

A **smoothing plane** is used is used to provide a smooth surface to the wood. This hand tool removes any surface blemishes or marks

GLASS PAPER

- A smooth surface can be achieved with the use of glass paper.
- Glass paper is an abrasive paper made from **ground glass glued to paper**.
- Glass paper smoothes away small faults by rubbing back and forth along the direction of the wood grain. The glass paper should always be wrapped around a cork block to prevent any damage to the wood. You should be careful not to round off edges or sand hollows into the materials.

- Glass paper comes in a variety of grades. Some are very coarse and are used to remove rough surfaces. Some are fine and are used to produce a very smooth surface. There are ten grades and each sheet comes in sizes 280mm x 230mm.
- Glass paper comes in **extra fine, fine, medium** and **coarse**.

Metal

PLASTIC DIP COATING
A metal workpiece is heated and dipped into powdered plastic that bonds to the surface to protect it. This also provides insulation, It improves ergonomics, and changes the functionality and aesthetics
GALVANISING: Galvanizing gives a product a coating of zinc. The process is low maintenance, creates a resistance to corrosion and is relatively inexpensive
ELECTRO PLATING: Electro-plating uses an electric current to add a thin layer of another metal to its surface. This can add protection. It often improves aesthetics and can add value.



Key Words
You must know the meanings of the key words below:
Protection
Electro plating
Galvanising
Polyurethane paint
Polishing
Key Point
Basic preparation is needed before any finish can be added
Different finishes are used with different materials.
Different finishes are applied for indoor and outdoor use
You must be able to:
Identify different finishes applied to materials and describe the process involved.
Main reasons for applying a finish to a m,aterial

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Materials & Their Properties

Metals

Making Metal: *Metal ore is extracted from the ground by mining/quarrying. The metal is refined from ore by using heat and a lot of energy. This can happen through electrolysis or using chemicals to remove unwanted elements.*
After refining metals are melted and cast into products and shaped into stock forms. They can be treated to soften metal by annealing which softens the metal and improves its malleability. Metals can be recycled by melting.

Ferrous Metals: *Contain iron. They are commonly used with other metals. They have a melting point of 1600 C or higher. Most ferrous metals are prone to rust and corrosion and can be picked up by a magnet.*

Cast Iron: *Hard & compressive strength. Engine mounts, pipes, cookware*
Low carbon steel: *Tough, easy to machine. Nuts and bolts, car body panels*
High carbon steel: *Strong & hard. Springs, high tension wires*

Non – Ferrous Metals: *Do not contain iron. They have good resistance to corrosion and do not tarnish. They are not magnetic.*
Aluminium: *Light weight, strong. Drinks cans, cooking pans*
Copper: Conducts heat/electricity. Wiring & water pipes
Tin: *Soft & malleable, corrosion resistant. Tin cans, solder*
Zinc: *Hard & brittle. Low melting point. Coating for Steel*

Common Alloys

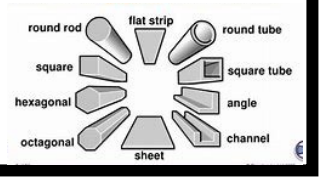
An alloy is a mixture of 2 or more metals. They can be ferrous or non ferrous. They have better properties than a pure metal.
Brass: *Copper and Zinc. Low friction, corrosion resistant, malleable. Used in locks & musical instruments*

Stainless Steel: *Iron & Chromium with small amount of Carbon. Tough , strong, corrosion resistant, difficult to machine. Used in kitchen equipment & medical instruments.*

High Speed Steel: *Iron with small amounts of carbon, tungsten, Molybdenum, Vanadium and Chromium. Very hard even at high temperatures. Used for saw blades, drill bits, files & wood turning tools.*

Stock Forms

Metals come in standard shapes including, sheet, rod, square bar and tube.
They come in standard sizes , lengths, thicknesses.
Metal Ingots can be melted into standard shapes.



Key Words
You must know the meanings of the key words below:
Ferrous metal
Non – ferrous metal
Alloy
Key Point
Alloys are designed to have better properties for an application than just using a pure metal.
You must be able to:
The difference between ferrous and non ferrous metals.
Describe the characteristic properties and common uses of a variety of metals.
Explain how metal ore is converted into usable material

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Materials & Their Properties

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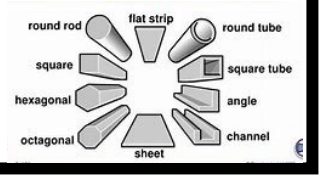

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Tools Equipment & processes Pages

Manufacturing Processes: Polymers

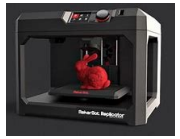
Wasting Processes:
Thin sheets of Polymers can be sawn using coping saws , fret saws and band saws.

Holes can be drilled using power drills or pillar(pedestal) drills

Addition processes:
Solvent cement is an adhesive. It can bond (join polymers). It dissolves the surface to mix/join them so they solidify together.

Thermoplastics can be welded . The faces can be heated using an electrical welding gun or hot plate. On melting of the surfaces they are pushed together forming a joint as they cool.

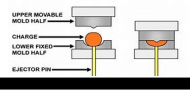
3d printing involves printing out a CAD(computer aided design model). A complex Shape can be made in a single operation. Instead of using numerous machines. The 3d printer deposits material one layer at a time until the item is finished.



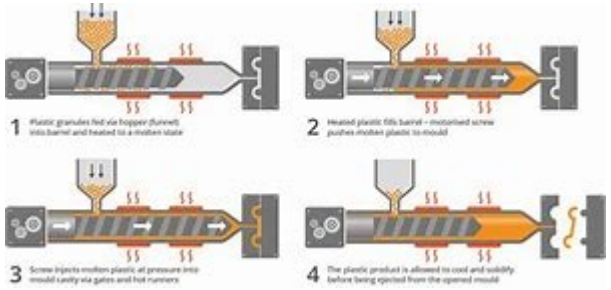
Deforming and Reforming:
Bends can be made in thermo plastics using a line bender. This heats just the area where the plastic is needed to be bent. The plastic once hot can be bent against a former or jig until it cools and goes rigid.

3D products can be made using a vacuum former where the plastic is heated around a mould and then the air around the mould is sucked out of the former.

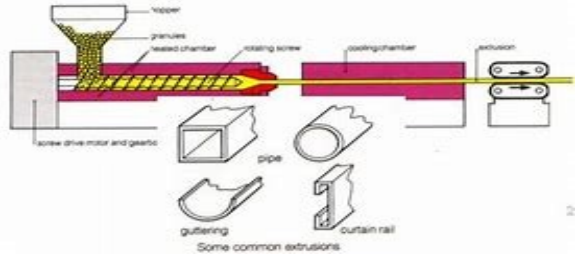
Yoke/Press moulding heats plastic sheet until it is flexible. It is then pressed between a mould and yoke. Once cool it retains the shape of the mould.



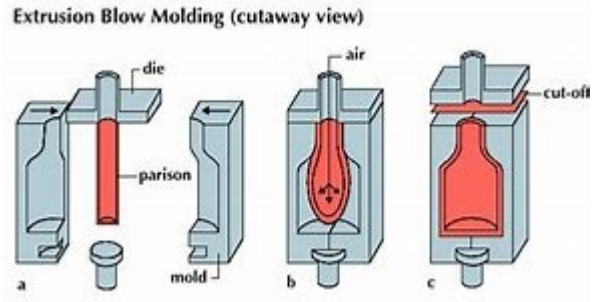
Injection moulding:
Plastic powder/granules are fed into a hopper. Heaters melt the plastic as a screw moves it towards a mould. This is forced into the mould and pressure maintained until cooled.



Extrusion:
Similar to injection moulding without using a mould. The plastic is forced through a die in a continuous stream to create long tubes/sections.



Blow moulding:
Similar to extrusion. An air supply and split mould are used to make hollow products such as bottles.



Key Words
You must know the meanings of the key words below:
Line bending
Moulding
Vacuum forming
Injection moulding
Extrusion
Blow moulding

Key points
Most industrial polymer moulding processes use reusable metal moulds and are designed to make large quantities

You must be able to:
Identify the processes and equipment used to manufacture products from polymers
Select an appropriate tool to carry out a process needed on a polymer and justify your choice

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Manufacturing considerations

Scales of Manufacture

Scales of manufacture: *This is about making identical products. As the quantity increases the processes used may be the same but tolls and equipment may be different*

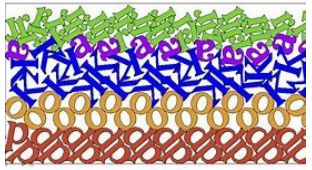
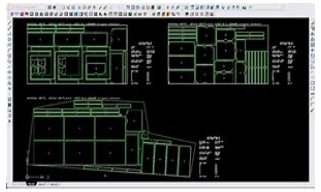



Type :	Characteristics:	Example:
One off/ bespoke production	*One product made for a specific customer. Usually takes a long time to make and high level of skill. High cost! £££££££££*	*A wedding dress, Wedding cake* 
Batch production:	*A group of identical products. Processes could be automated. Jigs might be used. Equipment set up costs are high.*	*Chairs, clothing from high street store* 
Mass production:	*Large quantities of identical products. Use of production line. Automated processes and dedicated jigs. Cost per product lower than batch manufacturing*	*Cars, Nuts & Bolts* 
Continuous production:	*Extremely large quantities 24/7. Typically used for chemicals or materials. Equipment and processes are fully automated with dedicated jigs and fixtures. Set up costs are very high. Cost per product low compared to other methods*	*Petrol, Steel* 

Influences of Quantity on Selection of Equipment:

ECONOMIES OF SCALE:
As quantities increase there are opportunities for getting bigger discounts, buying materials in larger quantities and reducing labour cots by using automated machines.
E.G If one person cuts one shape from card with scissors. A laser cutter/die cutter might be used instead to speed up manufacturing. Equipment costs more initially but is faster and labour is reduced so less money needed to pay workers. This has effect of reducing overall cost for products/companies

Material management:
Material used in manufacturing was be done so efficiently.
Most materials come in wide variety of shapes/sizes & different stock forms.
Designers use stock from to reduce machining/waste.
Designers tessellate shapes nested together using computers to reduce waste.

Key Words
You must know the meanings of the key words below:
One off/bespoke production
Batch production
Mass production
Continuous production
Economies of scale
Stock form
Key points
If a large quantity I manufactured total sot can be reduced by using automated equipment and less labour.
The quantity of products manufactured has a significant effect on equipment selection & manufacturing methods
You must be able to:
Describe different scales of production and give examples.
Explain why equipment changes with scales of production

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DFMA

DFMA: Design for Manufacture and Assembly

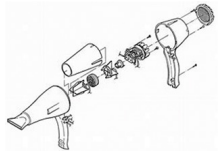
Is a design approach that focuses on ease of manufacture and efficiency of assembly. By simplifying the design of a product it is possible to manufacture and assemble it more efficiently, in the minimum time and at a lower cost.

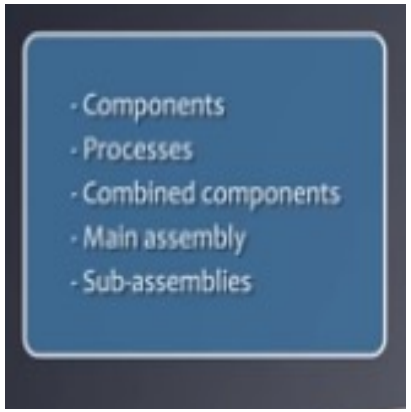
CONCEPTULIZATION STAGE
"The act or process of forming an idea". In this stage we review user requirements of product.

E.G **What are the user requirements of the hairdryer**

Blows hot air over damp hair to **speed the evaporation of water to dry the hair**.
Enable control over the shape and style of hair, by accelerating and controlling the formation of temporary hydrogen bonds within each strand.
Affordable
Looks good

ANALYSIS STAGE
A paper assembly diagram is completed to check if there are there are excess **components & processes** in use. The analysis stage consists of 5 parts.





SUB ASSEMBLY
2 or more components, treatments or processes that must happen before being assembled in main assembly

COMBINED COMPONENT
Consists of several components and **cannot be easily dismantled!**

PROCESS STAGE?
Checks are made to see if there are excess processes in the assembly diagram?

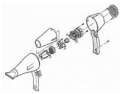
Checks are made to see if processes can be removed or altered to make manufacture more stream lined?

DFMA REPORT
Details of participants
Date of location
Key user requirements
Outcome of analysis
Alternative designs
Evaluation of key issues and action points

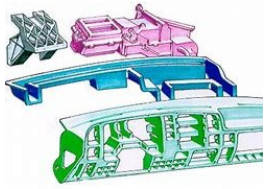
REDESIGN
This could happen by elimination and removal of a component or process?

Finding another way of making it?

Finding a solution where things can be combined together?



MAIN ASSEMBLY
Product for which the assembly diagram is made.
Consists of components, combined components and sub assemblies



1) Should the component move or be able to move in relation to the preceding component in the assembly diagram ?

3) Should the component be fitted or removed separately because otherwise assembly or disassembly of other theoretically essential components would be impossible ?

3 Elimination Questions

2) Are there fundamental reasons for the component being made of a different material which does not otherwise occur in the product ?

Key Words
You must know the meanings of the key words below:
DFMA, components, analysis, main assembly, sub assemblies, redesign, conceptualization stage
Key points
There are 5 stages in the analysis stage
DFMA focuses on simplifying a product for manufacture.
The use of elimination questions helps decide the need for a redesign of a component
You must be able to:
Describe the concept of DFMA
Consider how a design can be adapted to make it easier and manufacture

COMBINED COMPONENT
Consists of several components and **cannot be easily dismantled!**

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Intellectual Property

INTELLECTUAL PROPERTY

Typically the rights will be sold or licensed to others

The Patent Office is responsible for granting patents, registered designs and registered trade marks

The Rights are effective in UK only

COPYRIGHT

Issued on musical work, artists, literature, films, ensures that the artist can gain financially.

Can be drawn on paper, filmed or sound recorded on tape disc or electronic file.

Happens automatically when you compose a piece of work, essay, book or music.

Lasts for the life of the creator + **70 years** after his death

Sound recordings are protected for 50 years

PATENTS

Patents are for new inventions. A new invention is a product or process that can be used or made.

Patents are concerned with how things work

To be patented idea must:-

· Be new and have an inventive step that is not obvious to someone with knowledge and experience in the subject

· Be capable of being made or used in some kind of industry.

· Can sell the invention and all the intellectual property (IP) rights

· Can license the invention to someone else but retain all the IP rights

DESIGN RIGHTS

Protects the appearance of a product. In particular shape, lines and forms, colour, texture or material of the product.

A registered design can last for 25 years, and in that time can be bought, sold or licensed. You can license your design to other manufacturers so that they can manufacture your product.[the designer would be paid for this]

You can also stop others from manufacturing your product.

•Lasts for an initial period of 5 years.

•Can be extended in four 5-year terms to give protection for a maximum of 25 years.

•Becomes a property which can be bought, sold, hired or licensed.

REGISTERED TRADE MARKS

Trade marks are used for brand recognition. Badge, Name or Logo, Words picture or a combination. Eg. Nike, Macdonalds, Unauthorised use of a company trade mark means the rightful owner may lose business and the trust of their customers.

A sign which may be represented graphically.

•Distinguishes the goods or services of one company from another.

•May include words, designs, letters and the shape of goods or their packaging.

•Provides legal protection.

•Application fee of £200 and a further £50 for each other class.

•Lasts indefinitely, lasts 10 years and can be renewed every 10 years.

Key Words

You must know the meanings of the key words below:

Patent
Design Right
Copyright
Registered trade mark

Key points

Registered designs which give stronger protection but require registration at the Patent Office

Design right gives weaker, but automatic protection without the need for registration

Intellectual property rights are effective in UK only

It offers protection to the designer so people do not make money out of your idea

You must be able to:

Explain what intellectual property is?
Explain the difference between the 4 types of intellectual property?
Explain the length of time each intellectual property lasts

Be able to give examples of each type of intellectual property.

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STANDARDS
A Standard is a guide that companies, that design and make things, need to follow.
They tell manufacturers how their products and services can be safe and of a certain quality.
Standards may state:

maximum sizes . thicknesses of certain parts of an object.
certain colours that need to be used for things to be safe and ensure that they are seen at night.
a specific way of making a product well in the factory.

Standards

Standards affect our daily lives in many ways, making life easier, safer and healthier.
Without Standards for people to follow, then all our products would behave slightly differently, making them hard to operate, to fix or to programme.

BRITISH STANDARDS

The British Standards Institution (BSI) brings together experts from across the designing and manufacturing industries to help devise Standards by which products are measured.

They were the first Standards organisation in the world with its history dating back to 1901.

It is independent from government and trade and industry associations and is a non-profit distributing organisation. This means that all the profit it makes goes back into the service it provides.

BRITISH STANDARDS

BSI has thousands of current standards; this equals one for every 59 businesses in the UK.

BSI standards cover everything from accounting to zoom lenses. There are approximately 6,000 standards in development at any one time.

Over 130,000 BSI standards are sold each year in hard copy alone. Standards contribute £2.5bn to the UK economy -

BSI's oldest standard still in use today is from 1927 - BS 275 Dimensions of rivets - while some of its most recent are for biometrics and business continuity.

STANDARDC MARKS
A product passes all of the specified independent tests that make up a particular Standard, manufacturers can indicate this by displaying a certification mark on its surface. Products that have not undergone the standardization process are not allowed to do so.

When you see a product with a Kitemark this means BSI has independently tested it and has confirmed that the product conforms to the relevant British Standard, and has issued a BSI license to the company to use the Kitemark

Many products such as new toys must meet legal requirements before they can be sold within the European Community, and must carry CE marking. CE marking attached to a product is a manufacturer's claim that it meets all the requirements of the European legislation.

Key Words
You must know the meanings of the key words below:
Standard
Kitemark
British Standard

Key points
Standards make life safer and easier
Kite marks, The CE mark and Lion mark show that the product has been thoroughly tested
Over 130,000 standards are sold each year

You must be able to:
Explain why people use standards?

What a standard is?

The purpose of symbols on products

Recognise and identify different symbols

Be able to discuss the benefits to the consumer of having Standards on products

Explain why product regulations and safeguards are important