Topic 1: Motion and Mechanisms

Not all systems are electrical. You can also make **mechanical systems**.

They have an input, process and output. They are used to change the type or size of a motion and force.

- 1. Linear motion—moving in a straight le e.g. a rocket
- 2. Rotary motion—moving in a circle e.g. a drill
- 3. Oscillating motion—moving back and forth in an arc, e.g a swing
- 4. **Reciprocating motion**—moving backwards and forwards in a straight line, e.g. a bicycle pump.



Input motion can be turned into output motion.

- 1. **Mechanical systems** change an input motion and force into an output motion and force.
- 2. They are designed to make thing easier for you to do—they give you 'mechanical advantage'.
- 3. The **process** part of a mechanical system uses **one or more mechanisms**. **Simple mechanisms** you might use in your design include:
- Gears
- Linkages
- Levers
- Cams
- Cranks
- Pulleys

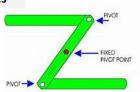
Topic 2: Motion and Mechanisms continued..

Gears



Gears are toothed wheels which interlock. They transfer rotary motion.

Linkages



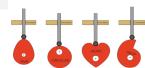
Linkages connect different parts of a mechanism. They can transfer forces and change the direction of motion

Levers



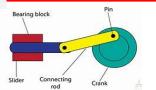
Levers enable an object to be lifted with less effort. As you move the pivot closer to the load it becomes easier to lift.

Cams



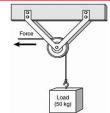
Cams change rotary motion into repeating motion. The cam is made up of a rotating shape and the 'follower' which follows the shape f the cam.

Cranks



Cranks can be as simple as a handle on a shaft. They turn rotary movement into reciprocating motion and vice versa.

Pulleys



Pulleys change the direction of the force needed to lift the load—you can lift the load by pulling, rather than pushing.

Topic 3: More mechanical Systems

Mechanical systems are really important and very common.

These are some examples:

Pulleys can reduce the force you need.

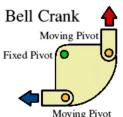
A pulley changes the direction of force needed to lift a load.

Using two or more pulleys together makes things feel lighter than

they actually are.

Bell cranks are a type of linkage.

Linkages change the direction of motion. A bell crank changes the direction of motion through 90 degrees.



Pneumatic cylinders use compressed air

Compressed air is used to push a piston down a cylinder—air pressure is converted into movement.



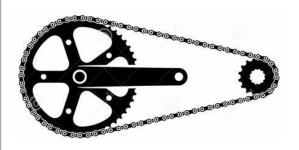
Topic 4: More mechanical Systems

Mechanical systems are really important and very common.

These are more examples:

Chain and sprocket mechanisms transfer movement.

These are found on bikes. Two sprockets (toothed wheels) are linked with a chain (made up from lots of links)



Mechanical components can be combined in systems.

Cranes are **systems** that **lift** and **move** heavy loads. They use **pulleys** to lift the load. The top part of a crane **rotates** using **gears**. The arm of the crane is a **lever**—the load is balanced with a concrete block.



Topic 5 & 6: Joining

You can join wood with joints

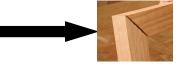
There are lots of **different types** of joints. **Marking out** and **cutting** them takes a lot of **skill**. **Accuracy** is vital to make them fit well and look good.

Butt joints are simple but not very strong. Used for cheap tables.

- A simple joint commonly used for boxes.
- A butt joint can be strengthened by fasteners such as: dowels, nails, screws etc...



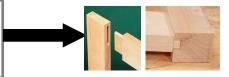
Mitre joints are used for picture frames.



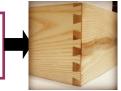
Lap joints are used for boxes and drawers.



Mortise and tenon joints are very strong and used for tables and chairs.



Dovetail joints are strong and look attractive. Often used for drawers.



Joints are often **glued** or **nailed** together to make them more permanent.

<u>Examples of glue</u>: PVA wood glue, cascamite (stronger than PVA and waterproof) tensol cement (used for acrylic)

Screws, nails, nuts and bolts also hold joints together.

Rivets, soldering and welding are for joining metal.

Topic 7: Quality and accuracy

- Quality control (or QC) happens on the product during, or after it
 has been made. It is the checking process that goes on to make sure
 the quality assurance standards are met and the final product is up
 to scratch.
- Quality control involves inspection, sampling and testing.
- Inspections are made for variations from standard size, colour, surface characteristics and to make sure the product works properly.
- 4. Part of the system is **feedback** so that the people responsible are told so they can fix the problem.

Manufacturing aids ensure repetitive quality

Manufacturing aids like jigs, moulds and templates **ensure accuracy** when producing a batch of **identical products**.

- 1. **Jigs** are used to position materials and give you a guide for where you should saw or drill.
- 2. **Templates** allow you to draw or cut around to get the same shape and size each time.
- 3. **Moulds** (also called formers and dies) can be used to create several copies of a 3D shape, e.g when vacuum forming.

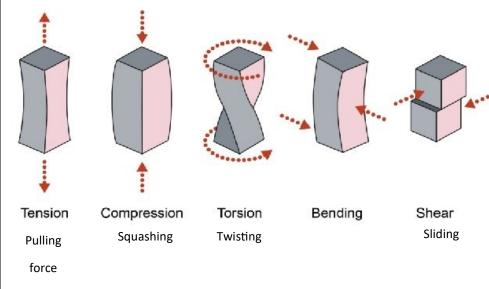
CAD/CAM improves accuracy

- 1. **CAD/CAM** is very accurate
- The same information can be sent repetitively to the machine, guaranteeing identical results.
- CAD/CAM is often used in industry to mass produce products.

Topic 8: Strong structures

Structures are designed to **carry loads** and **withstand forces** without collapsing or falling over. Structures include anything from electricity pylons to buildings, cars, lamp-posts and bridges.

Strong structures have to resist forces.



There are two types of structure—sheet and frame.

<u>Frame structures</u> are made in a **network** of ties and struts joined together e.g. **electricity pylons**. The frames is often made up of **triangular shapes** because they are strong. This is called **triangulation**.

<u>Sheet structures</u> (also called shell structures) are made up of flat or curved pieces joined together to make strong and stable 3D shapes. E.g car bodies are made of metal panels or moulded plastic traffic cones.

Topic 9: Computer controlled systems

Some systems are computer controlled.

Robots are a good example of a computer controlled system.

- 1. Robots are **automated** pieces of equipment which carry out a **range** of **tasks**.
- They are used to assemble products. They use a 'pick and place' system picking up components in a set order and placing them together in a set pattern.
- Feedback from sensors in the component trays or on the robot stops the assembly process if a component is missing,
- 4. The pressure of the robot's 'jaws', which it uses to pick up and move components, is controlled by **pressure sensors**. If the pressure is too high or too low, a signal is sent to a **micro-controller**, which in turn sends an **output signal** to the **robot's jaws**.



Topic 10: Security control

- Security systems protect people and property from criminals or mis-use.
- 2. There are a wide variety of security systems with **several different control mechanisms** e.g electrical, mechanical or computer controlled)
- Common security systems include: smoke alarms, burglar alarms, keypad (coded) door locks. There are some legal constraints on security systems so they shouldn't harm people, prevent authorised public access or infringe on people's civil rights and liberties e.g. hidden cameras.
- 4. Security systems can be linked to form a more **complex system** e.g some security systems have a direct link with the local **police station** so that the police are informed straight away if there is a break in.

<u>Electric locks</u> are often used as **safety** locks on machinery so the machine stops working if part of the machine is faulty.

Pneumatic locks use compressed air.

E.g. Automatic train doors use pneumatic locking systems. They make it very difficult for someone to open a door while the train is moving.

<u>Mechanical locks</u> are operated by hand or with a key. They form a physical barrier.

E.g. Hand operated bolts are placed at the top an bottom of a door to make it more secure.

Topic 11: Monitoring and display systems

Control systems can monitor the surroundings.

- Monitoring systems can be automated—controlled by automatic equipment.
- 2. Monitoring systems have **sensor inputs**, a **central processing circuit** and an **output**.
- Automated monitoring systems can be used to control an environment, e.g whether a place is light/dark, warm/cold, dry/wet, noisy/quiet.
- 4. Monitoring systems can be used for **care** e.g monitoring the environment of a plant or pet to make sure the conditions are right. E.g. the **temperature** of a **tropical fish tank** can be controlled by computer by using a **heat sensor**. If the water is too hot, the heat sensor will turn off the heater.

Control systems can be used in Point of sale displays

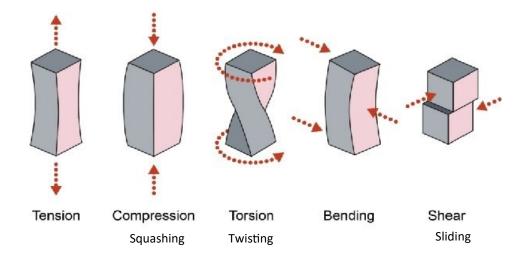
1. To capture the customers' attention. You will see these in shop windows, displays and in the cinema.

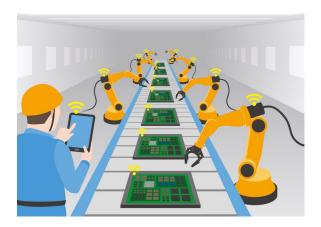
An **advantage** of using control systems in a display is that they **attract attention**.

A **disadvantage** of using control systems is that they are quite **expensive** to produce and have higher **maintenance costs** than a standard display.

Topic 12: Keywords, terms and definitions

Keyword	Definition
Automation	The use of machines to do something automatically.
Linear	Moving in a straight line.
Rotary	Moving in a circle.
Oscillating	Moving back and forth in an arc.
Reciprocating	Moving back and forth in a straight line.
Cascamite	Similar to PVA wood glue but stronger and water-
Gears	Toothed wheels which interlock.
levers	Enable an object to be lifted with less effort.
Cams	Change rotary motion into repeating motion.
Mechanical system	Mechanical systems incorporate more than one mechanism and movement,
Shear force	Sliding
Torsion force	Twisting
Compression	Squashing
Tension force	Pulling apart













Linear

Rotary

Oscillating

Reciprocal

Topic 1: Inspiration for Design

Designers generate ideas with a variety of methods.

- 1. Making an **ideas board** by coming up with lots of different ideas, in a group or individually.
- 2. Finding out about **current trends** by looking at magazines and website, visiting exhibitions.
- 3. **Disassembling** (taking apart similar products to find out how they are made.
- 4. **Creating a mood boards** to show **aesthetics** (visual/feel) wanted for the product.
- 5. Talking to **consumers** to find out what they like in that type of product.
- 6. **Adapting** and extending **existing products** e.g. creating a new look.

Creativity is important in Design

1. products that are innovative (new, different) will appeal to consumers and sell better than products that are not.

Example—you could make your product more innovative by changing the **shape**, adding **decoration**, **adapting** a current design, combining **materials**, combining **features** or **filing a gap** in the market.

You can get inspiration from patterns e.g. using grids, repeating shapes.

Nature can be a design inspiration for the **structure**, **function** or **aes-thetics** of a product. When human creations copy designs from nature, it is called **biomimicry**.

Ergonomics means making the product fit the user.

Topic 2: Analysing products & technology

Product analysis can give you **ideas** for your design to see what is **already** on the market, and what's **not** (**gaps** in the market)

Once you have a **design brief**, you can analyse a variety of **similar products** to help you with your own designs.

Product analysis can help you understand a product by looking at the **outside** as well as **taking it apart** and looking at what is going on **inside**.

You can draw inspiration from the products and techniques of past and present producers.

New technology impacts designs.

- 1. When coming up with new design ideas, you also need to look at **current** and **emerging technology**.
- 2. Advancing technology can **make products viable** that would have been too expensive or **big** before.
- It also means certain products are no longer needed—your design idea could be great but there might be no market for it because it used old technology.

Topic 3: Research and the Internet

Research what people want and need.

There are lots of sources you could use to gain information:

- Books and fashion magazines
- Analysing existing products
- The internet (manufacturers websites)
- Phone apps
- Surveys of shoppers

The point of research is to:

- 1. Check that people will actually want your product.
- 2. Find **similar products** are on sale, and what people like/dislike about them.
- Find out what materials and techniques would be suitable for making your product.
- 4. Find out how much the product is likely to **cost to make** and **how much** you think it will **sell for**.

Using the **internet** is a good method of **research** for finding information about materials, processes and inspiration for designs. Be careful of websites that seem **biased** (only give one side of an **argument**) or that don't give any evidence to back up what they say. Always check that it is **accurate** before using it in your work.

Product analysis can give you **ideas** for your design and help you **understand** a product. We use **ACCESS FM** and **FACE** when analysing a product.

Topic 4: Understanding user needs

Once you have identified your target group, you also need to think about their **specific needs**. The **disabilities, culture** or **religion** of users may have an impact on how you **design** a product.

Products need to be accessible to everyone.

- 1. Lots of product are specifically designed to help people with **disabilities**. Some packaging (e.g. for medication) has **Braille** labelling to give blind people information.
- 2. Control buttons can be made brightly coloured and extra large, so they're easy to find and press. E.g. tv remotes, calculators.
- 3. Products such as smoke alarms can be designed with **visible** signals as well as audible ones so that deaf people can be alerted to fires.
- 4. **Instructions** can be given in **picture** or **diagram** form so that people who have difficulty reading text can still use the product.
- 5. Designers also have to think about **wheelchair users**. E.g. trains and buses need to be designed to have wheelchair access.

People have different cultural and religious values.

Designers need to cater for people with different customs and beliefs and must consider; **Dietary needs, clothing styles, symbols** and **colours**.

Designers need to think about age groups.

People in different **age groups** have different **physical limitations**. Small children and elderly people may not be able to use **small parts** and might struggle undoing **fastenings** and opening **packaging**. Small parts can also be a **choking hazard** for children. Elderly people might have difficulty **holding** and **using** products. Designers can thik about putting large, easy to grip handles on, say, cutlery. Age groups also need to be considered in the **aesthetics** of a product. Adults might not want something that's too **brightly coloured** and childish.

Topic 5: Design specifications

- A design specification is a list of product features, also known as design criteria.
- 2. When you are writing up the design specification, think about how the finished product will affect the target consumers.

Questions to ask when writing a design specification.

- How can you ensure it matches the design brief?
- Can you make the product safe, so it won't harm the consumers?
- Can you make the product **cheap** enough for the consumers to afford?
- What shape, textures, colours will the consumer prefer?

Manufacturing specifications—How to make your product

A manufacturing specification must explain the design, materials and method for making your product. Include enough information for somebody else to make your product and include the following:

- 1 Details of the **processes** that will be used to put the product together.
- A list of the **materials** that will make up the product.
- 3 Measurements—the sizes and quantities of each part of the product.
- 4 **Tolerances**—the maximum and minimum variations from the standard size or weight.
- 5 **Finish**—e.g. how the materials are protected and what the required colours are.
- 6 **Quality control**—the checks neeed to make sure the product fits together and works.
- 7 **Costing** -the cost of materials, tools, machinery and workers' time.

Topic 6: Evaluating and adapting designs

The purpose of writing an **evaluation** is to **identify** the **good and bad points** and make sure it does everything you need it to. Write your evaluation up as a report. It could include:

- Whether is satisfies all the points of your **design brief** and **specification**.
- The result of prototype testing (how it functions, looks and feels)
- The **comments** of people in your target group.
- Description of any chances you have made to your design and why you made them.
- Any ways you can think of **improving** the product in the future which you have not been able to do due to cosy, time or not the right machinery.
- A discussion on whether your **timings** are still accurate after other changes are taken into account.

Products evolve and improve over time

- Products are always changing—this is known as product evolution
- Manufacturers are always looking for ways to make more money. One
 way to do this is by improving how they make their products to manufacture them more easily and cheaply. This is called continuous
 improvement.
- Designers often adapt products to satisfy te wants and needs of consumers—consumer demand.
- Technology is always changing so something that wasn't possible 10
 years ago might now be used to make a product better. Customers also
 often want the latest version of a product e.g mobile phones.

Topic 7: Modern materials

New materials have been made with new properties.

- 1. New textiles have been developed with modern technology.
- 2. Modern textiles are designed to have useful properties and characteristics. **E.g. TENCEL** is a relatively environmentally friendly modern fabric which has the following combination of properties:

Feels similar to silk
Breathes like cotton
Cheap
Machine washable
Holds dye well

Smart fabrics and microfibres are modern materials

- 1. **Smart fabrics** change their properties in response to changes in their environment. E.g they change **shape** or **colour** in response to changes in **temperature** or **light**.
- 2. **Microfibres** were developed in the 1980s. They are very **thin**, fine fibres. They are made from other ma made fibres like rayon and nylon. Because they are so **thin**, they can be woven into fabric very **tightly**. This close weave is very **resistant** to **rain** and **wind**—so microfibre fabric is often used for waterproof coats.

Topic 8: Processing materials

Processes are all the thigs you can do to a material to **change it** in some way. Anything from cutting and shaping to beetling and brushing to combining and strengthening.

<u>Process</u>	What it does
Beetling	Polishes and flattens the fabric by pressing it with rollers.
Brushing	Fabric is passed through a large rotating brush that raise the surface of the fabric. Brushing is used to make cotton softer for childrenswear.
Milling	Thickening and matting fabric by pressing an grinding it together.
Heat treatment	Synthetic fibres can be given 3D texture with heat treatment.
Chemical treatment	Chemicals can make fabrics resistant to creasing, fire, shrinking and water. They can also strengthen stiffen, permanently crease or create other interesting effects e.g devore is created by acid dissolving away bits of fabric.

Combing fibres can be a cheap way to improve a fabric's properties e.g expensive fibre and a cheap fibre can be mixed together to create an affordable fabric with an expensive texture.

- A mixture fabric is made from two or more types of fibres. If the fabric is woven, the warp is one fibre and the weft is a different fibre.
- A blended fabric is made from fibres which have been blended together before spinning into a thread. E.g. wool and cotton are blended to make Viyella, which can be made into a fabric.

Topic 9: Techniques

Patterns help you cut fabric accurately.

You attach the to material with **pins**. A **seam allowance** is added to patterns to there is room to make a seam. It is the gap between the **cutting line** and the **sewing line** and is normally **1.5cm**.

Decorating techniques personalise products.

Examples of decorating include:

- 1. Tie dye
- 2. Batik
- 3. Fabric pens
- 4. Block printing
- 5. Applique
- 6. Stencilling

Using CAD/CAM helps with designing and making.

It is fast, accurate and can manufacture identical products from one file.

Sewing machines vary but the basics are all the same.

Tips for using a sewing machine:

- 1. **Before starting** on your main product, do some lines of stitching on a **small sample** of fabric. Check stitch type, length and tension are right.
- 2. **Tack fabric together** using a simple hand stitch to hold a seam in place. This temporary stitch can be removed after using the sewing machine.
- 3. When you have reached the **end of a line** of stitching, **reverse** the direction and sew **back over** the last 1cm. This strengthens its.

Topic 10: Tools and equipment.

Measuring tape for accuracy and tailor's chalk to transfer mark-
ings that can be removed later.
Dress-makers scissors to cut fabric.
Embroidery scissors for more delicate cutting.
Pinking shears to cut with a zigzag edge.
Craft knives to cut stencils
Seam rippers or un-pickers to unpick seams
Pins to hold the fabric together before stitching
Needles for hand stitching e.g. embroidery, attaching beads to
fabric or tacking. Use a needle that is the right size for the thick-
Dry irons use heat and pressure to press creases out of fabric and
flatten seams.
Steam irons are more effective—they use water and steam as well as heat and pressure.
Cool iron (1 dot) —for silk
Warm iron (2 dots) —for mixed fabrics
Hot iron (3 dots) —for cotton and linen
Iron, low temp. Iron, medium temp. Iron, high temp. Do not iron

Topic 11: Computer aided manufacture

CAM—Computer aided manufacture

- 1. It is the process of **manufacturing products** with the help of computers.
- 2. CAM is linked to **CAD (computer aided design)**. Products are designed with CAD software. Then data from CAD software is downloaded into the control unit of a manufacturing machine which makes each component or product.

CAM is great for mass production.

They are used as part of the production line to do repetitive tasks o a reliable standard of accuracy.

Advantages:

- CAM makes production quicker and more efficient. Machines do not need to rest.
- 2. CAM is very accurate
- 3. It can be used to process materials and chemicals which are hazardous to humans.

Disadvantages:

- The initial cost of computer hardware and software and CNC machines is high.
- 2. Training programmers and operators is expensive.
- 3. The use of computers and automated machines means fewer workers (and fewer skilled workers) are needed. Some people have been made unemployed because of this.

Disassembling	To take something apart for the purpose of analysing how it has been made and what it looks like inside.
Bias	To favour a certain direction /opinion/thing or be against it.
Bias cut	The technique of cutting on a diagonal grain (at 45 degrees) rather than straight.
Manufacturing specification	A series of written statements or working drawings and sequence diagrams, that tells the manufacturer exactly how to make the product.
Tolerances	The margin of error allowed for a measurement of part of a product. Tolerances have an upper and lower limit
Automation	The use of computers and machines instead of people to do a job.
CAD/CAM	Computer aided design and computer aided manufacture.
Obsolete	No longer produced or used
Tacking	A temporary stitch to hold seams/fabrics together.
Viyella	Modern material: A mixed wool and cotton fabric with a diagonal weave like twill
CNC machine	The machines used in CAM are CNC (computer numerically controlled). Data is sent to the machine in the form of numbers
Legislation	A law or set of laws
Seam allowance	The distance from the edge to the stitching line on fabric. It is usually 1.5cm.
Biomimicry	Copying nature to come up with designs.
Kevlar	Modern material: Very strong, heat resistant synthetic fibre. Typically used for bullet proof vests
Nomex	Modern material: Nomex—Flame resistant material typically used for firefighters uniforms.
	for firefighters uniforms.

Year 9 Food Technology Knowledge Organiser

Topic 1: Manufacturer's specification & planning production

A manufacturer's specification can be a written **series of statements**, or **working drawings** and **sequence diagrams**. It has to explain exactly how the product will be made, and it should include:

- 1. Clear **construction** details explaining **exactly** how each bit is going to be made.
- 2. Sizes—precise measurements of each part
- 3. **Tolerances** The maximum and minimum sizes each part should be.
- 4. Finishing—details—any special sequences for finishing.
- 5. **Quality control** instructions—where, when and how the manufacturing process should be checked.
- 6. **Costings**—How much each part costs, and details of any other costs involved.

Plan how long the production process should take:

When you get to this stage of the product development, you also need to plan:

- 1. How your methods might have to **change** now you're producing the product **in volume**.
- 2. Each stage of the process in great deal of detail.
- 3. **How long** each stage will take.
- 4. What needs to be **prepared** before you can start each stage.

Topic 2: Food contamination and bacteria

Food manufacturers **have** to produce food that's **safe** to eat. When you're **buying**, **preparing**, **cooking**, **serving** or **storing** food, you also need to make sure it's done in the safest way possible.

There are certain **high risk foods**. Bacteria really like foods which are moist and high in protein.

High risk foods include:

Bacteria are the main source of food poisoning

- 1. **Meat, fish** and **poultry**
- 2. **Dairy products** and **eggs**
- 3. **Gravies, stocks** and **sauces**
- Shellfish and other seafood
- Cooked rice

When working with food you must be careful not to pass bacteria from one

Take simple steps to avoid cross contamination

food to another. Bacteria can be easily **transferred** to surfaces, equipment and hands, which in turn can 'pass on' the bacteria to other foods.

Use **separate knives** and **chopping boards** for preparing raw meat and **wash your hands** after handling **raw meat**.

Never sit **raw meat** and **cooked meat together.** Don't allow the **blood and juices** of raw foods to drip onto cooked foods e.g. during storage in refrigerators.

Year 9 Food Technology Knowledge Organiser

Topic 3: Different target groups

The target group are the consumers a product is made for.

A target group might have different nutritional and dietary needs, for example:

- 1. Babies and toddlers need nutrients for growth and development.
- 2. Pregnant and/or breastfeeding women need extra protein, calcium and iron.
- 3. Elderly people may need to cut down on fats and carbohydrates.
- 4. Diabetics need a healthy diet and have to control carbohydrates and sugar.
- 5. Vegetarians, particularly vegans, may need extra vitamin B12.
- 6. Athletes and people with active jobs want foods that provide energy .
- 7. Slimmers and people with inactive jobs need to eat low-fat foods.

Manufacturers also target specific preferences.

Not all target groups are defined by nutritional needs—manufacturers also target people's preferences. People buy products for a variety of the following reasons:

- They look good
- They are environmentally friendly
- They taste good
- They are trendy
- The packaging is appealing
- They are posh/quality food
- They are easy to eat.
- They can be cooked quickly.

Topic 4: Evaluation and development

Evaluation is an important part of any product development process, and needs to be done at **various stages** along the way.

- Does the product work well?
- Does the product work well as similar products on the market?
- Does the product look good? Is it well styled and modern looking?
- Are you unsure about any of the features? If so, which ones and why?
- If this product were on the market, would you consider buying it?
- If you were buying it, which price range do you think it would fall into?
- Do you prefer another similar product to this one?

This type of evaluation is called **formative** evaluation—its being used to help form the final design. Based on the answers of the questions above, you can **develop** and make **changes** to your design of the flavour, aesthetics and **requirements** of your target user.

Year 9 Food Technology Knowledge Organiser

Topic 5: Keywords, terms and definitions

Cross contamination	When bacteria is passed from one food to another
Design brief	The design brief explains why the product is needed, outlining the problem and how you intend to solve it.
НАССР	Stands for 'hazard analysis critical control point'
Biological hazard	This relates to bacterial contamination or the possibility of bacterial contamination.
Chemical contamination	Foods becoming contaminated by cleaning fluids during processing or storage.
Specification	A list of conditions that the product must meet.
Organic	Foods that do not contain additives or genetically modified ingredients and haven't been grown using pesticides or artificial fertilisers.
Preservation	Preservation destroys bacteria in food so it can be kept for a long time.
Salmonella	A type of food poisoning found in poultry, especially chicken.
Quality control	When you check that you are meeting standards through inspection, sampling and testing.
Target groups	The target group are the consumers a product is made for.
Marinating	A method for adding flavour which can be done using a mixture of oil, wine, vinegar and herbs.
Tolerances	The maximum and minimum size each part should be.