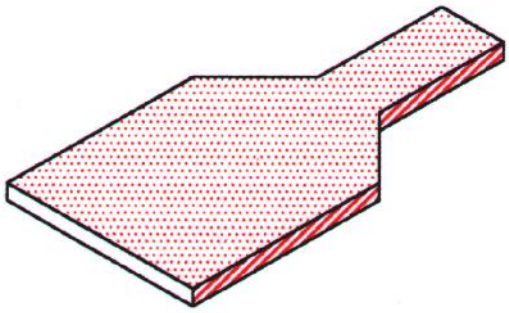
COMMERCIAL PRODUCTION

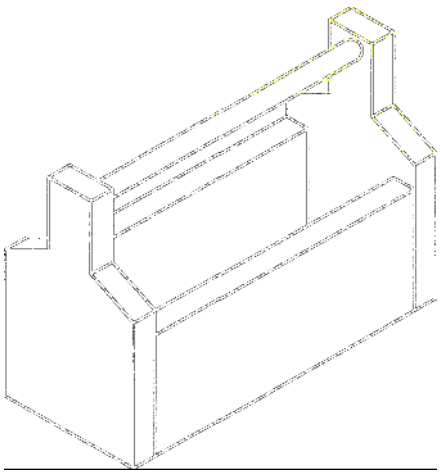
Most products are produced in large numbers, each being identical to the planned design. Dimensional accuracy is very important, especially when parts have to fit together. When a product is being handmade as a one-off, a common cause of error is incorrectly measuring when using a ruler. When a product is produced by mass or batch production methods, the need to measure using a ruler is removed by the use of **Templates** and **Jigs.**

TEMPLATES

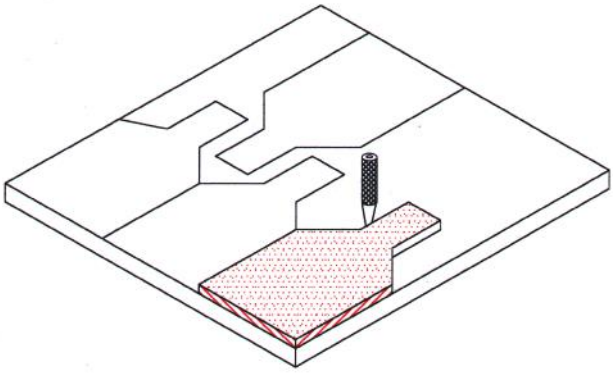
A template is an accurately formed shape, made from a rigid material. The template can be drawn around or followed repeatedly without wearing.



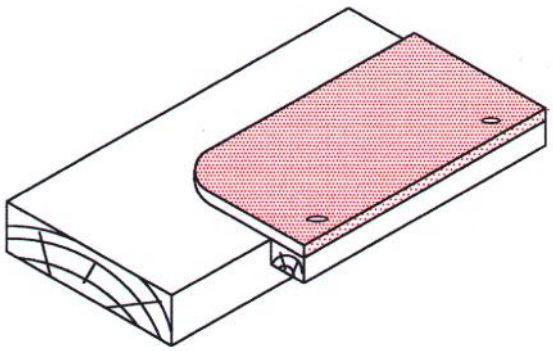
A template made from hardboard, used to mark out the ends of a bottle carrier.



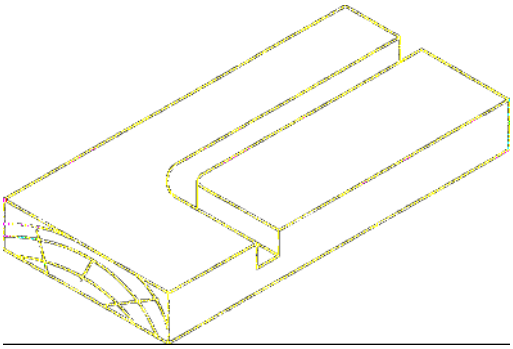
The template can also be used to save on waste when marking out a number of identical shapes on a sheet of material. When the shapes are drawn linked together, they are said to be **tessellated**.



Templates can also be used during the production process to guide a cutting tool.

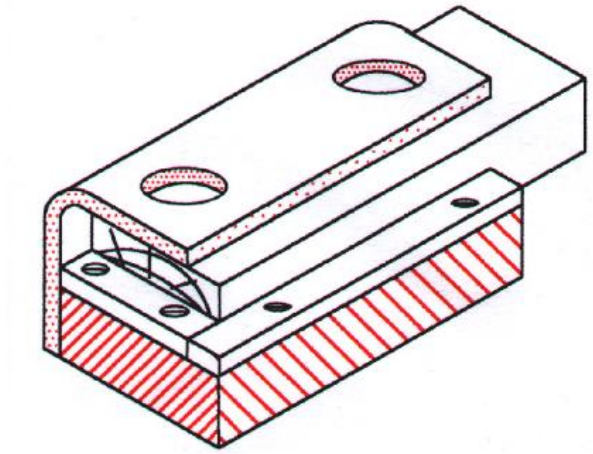


A plywood template can be used to guide the cutting of a groove, using a router.

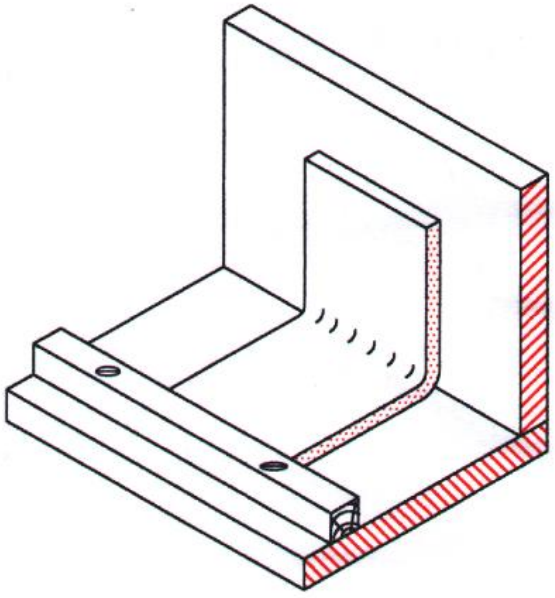


JIGS

Jigs are used to ensure that dimensions are always accurate. They are particularly useful when the positioning of holes and bends are important. They are designed so that they either hold the workpiece in the correct position or guide the cutting tool into the correct position. It should be possible to line up the jig with the workpiece and clamp them together to stop slippage.



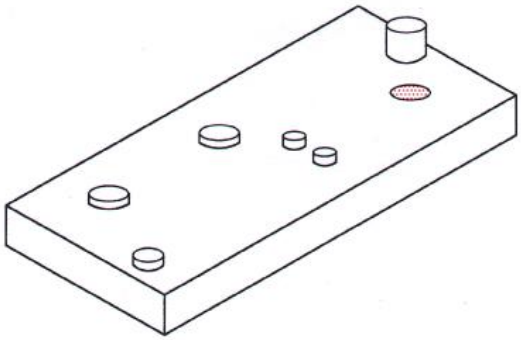
A school-made jig for lining up holes when making dowel joints.

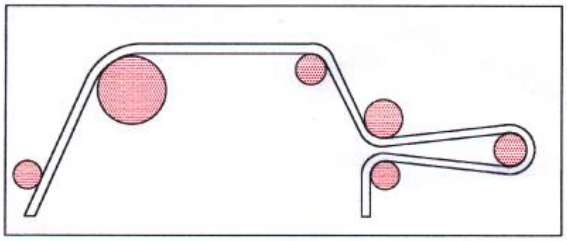


A jig for bending heated plastic sheet in the correct position every time.

KEY WORDS Template: Tessellation: Jig:

Below is a jig used for bending steel rod to make junior hacksaw frames. The jig is made from mild steel. The pins are removable to allow the rod to be bent into position. The pin for the end of the handle is shown removed from its locating hole.





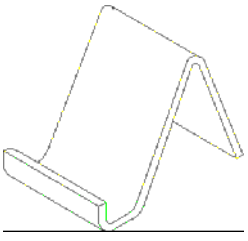
The completed frame

1. Give an example of when dimensional accuracy is important.
2. What is a common cause of error when products are handmade?
3. Describe a template.
4. Show a template being used to draw tessellations (draw your own example).
5. Apart from drawing shapes, what else can a template be used for?
6. Why is a jig used?
7. Give two examples of what a jig can be used for.
8. What can happen that stops a jig being an accurate guide?
9. Why are some pins removable in the junior hacksaw frame bending jig?
10. What material is the hacksaw frame bending jig made from?

A. Design a jig to line up the hole used to locate the handle in the ends of the bottle carrier. (shown in the first column). Show how the jig will locate with the end piece and be held in place. Name the materials used for the jig.

B. Design a jig, or jigs to allow the correct bending of sheet acrylic to produce the recipe holder shown.

Height 200mm
Width 180mm
Depth 200mm



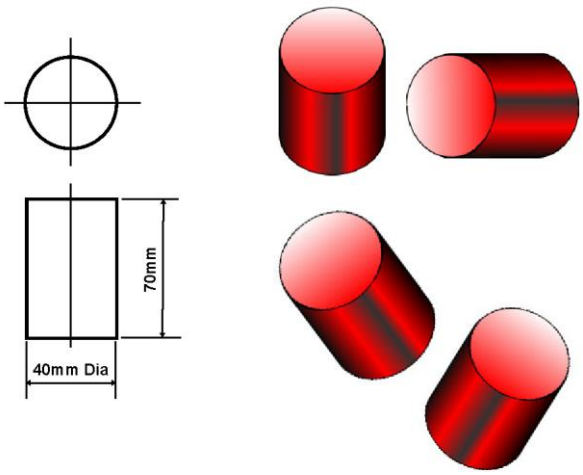
CAD/CAM

CAD/CAM stands for **Computer Aided Design / Computer Aided Manufacture**. This is the process whereby the product is designed using a computer, and the machines used to make it are controlled by a computer. Drawings and instructions written on pieces of paper are not required.

Computer Aided Design

Computer programs can be used to draw accurate, scaled drawings of the design of a product in both 2D and 3D.

In 2D, dimensions can be added automatically and drawings of parts that are used a lot, such as nuts & bolts can be inserted like clip-art, from a drawings bank. In 3D, rendering (colour & texture) can be added as well as highlighting and shading. The view can be made to twist and turn so that it can be viewed from any angle.



In industry, powerful programs can be made to animate moving parts and to work out the forces that the part will have to stand up to, so that it does not break in use. This can save hours of testing prototypes.

Advantages

Some of the advantages of using CAD are:

- Faster accurate drawing
- Drawings of common parts can be inserted from a drawings bank
- Changes can be made quickly and easily
- Dimensions can be added automatically
- Printouts can be to any scale In 3D, the object can be viewed from any angle

Disadvantages

Some disadvantages of using CAD are:

- The cost of the computer and programs
- Early ideas are recorded faster by sketching
- A pad of paper and a pencil can be used anywhere

Computer Aided Manufacture

Computers can control cutting machines such as drilling machines, lathes, milling machines etc. The computer controls the movement of the cutter very accurately (accuracy to 500th of a millimetre is possible).

In the CAD/CAM system, data from the CAD drawing is downloaded to the CAM program which is then used to control the cutting machine.

A computer can also be used to control the handling of the parts to be cut from one machine to another.

Computer controlled fabrication (joining parts together) is also possible. Parts can be automatically held together in the right positions, while they are welded, riveted or glued by computer controlled equipment.

Injection moulding, compression moulding, vacuum forming and extrusion of plastics can all be done by computer controlled machines.

Advantages

Some of the advantages of using CAM are:

- Very accurate work
- The machine does not need breaks
- The machine does not get tired and inaccurate
- Changes of design can be made quickly

Disadvantages

Some disadvantages of using CAM are:

- The cost of the computers and programs
- The high cost of the machines
- The loss of jobs

KEY WORDS **CAD: CAM: 3D: 2D: Animate: Commercial Production**

1. What does the term ‘CAD/CAM’ stand for?
2. State **two** things that can be done when drawing with a CAD program that cannot be achieved when drawing on paper.
3. List **three** advantages of using CAD.
4. List **two** disadvantages of using CAD.
5. What else can an industrial CAD program do as well as draw?
6. Name **four** machines that a CAM program can control
7. How accurate can a computer controlled cutting machine be?
8. Name **two** processes other than cutting, that can be carried out by computer controlled machines.
9. List **three** advantages of using CAM, rather than human controlled machines for manufacture.
10. List **two** disadvantages of using CAM.

A. Manufacturers of DVD systems, computers and TVs, etc. can change their models every month. Explain what part CAD/CAM plays in this rapid turnover.

MANUFACTURING SYSTEMS

There are **three** main production systems:

Mass Production - is used where there is a continuous demand for large quantities of a product. e.g. tin cans for food, cars, etc. Sometimes called **flow production**, this system is organised so that specially designed machines carry out one operation on the product, that is continuously passed from one different machine to the next, until at the end of the line it is complete and finished.

Advantages:

- Low production costs, if sufficient products are made.

Disadvantages:

- Models cannot be changed easily. If one machine breaks down the whole line Is affected.
- The machines cannot be easily reset to make other models.
- The machines cost a lot to purchase when the line is being set up.

Batch Production - is used where the need for a product is not continuous, or not enough are sold to make mass production worthwhile e.g. room heaters, and one style of calculator. Batch production often looks like mass production, but it uses machines that can be altered to make another model, or something completely different. e.g. The machines may be set up to make one model of heater for one month and then production is stopped while the machines are reset to make a different model for the next month.

Advantages:

- Flow production methods lower the production costs.
- Model changes can be made regularly, upon change over.

Disadvantages:

- No production occurs while machines are being reset, this adds to the cost.
- The products need to be stored until there is a demand for them.

One-off - Producing one product at a time. This method is often used by traditional craftsmen and artists, who work to order, e.g. high quality musical instruments and sculptures are made this way. **Advantages:**

- The customer gets a product that is designed exactly as they wanted it.
- Quality checks can be made at every stage of manufacture.

Disadvantages:

- The production method is slow and very costly.

KEY WORDS Mass: Batch: One-off: Commercial Production

1. Explain the term ‘one-off’ production.
2. List the advantages and disadvantages of one-off production.
3. Explain the term ‘ batch’ production.
4. What are the advantages and disadvantages of batch production?
5. Explain the term ‘mass’ production.
6. What are the advantages and disadvantages of mass production?

QUALITY

When a product is described as a high quality product it means that it is designed:

- to do what it is meant to do excellently
- to last a long time
- to need little maintenance.

High quality products normally cost more, one reason for this is that more money is spent in inspecting every part as it is being made and put together. The purchaser is willing to pay more to be sure that the product will not fail early on in its life.

Consumer Confidence

To help a consumer be sure that what they are buying is of good quality, independent standards organisations publish lists of standards of quality that the product must meet. If a product fully meets the standards, then the manufacturer can apply to the organisation to be allowed to have the organisations logo (known as a **kite-mark**) displayed on the product. If a consumer sees the kite mark on the product then they can be sure that it is safe to use and should work for a reasonable length of time.

The two most common kite-marks found on products in Britain are those of:

The **British Standards Institute**

The **European Commission**

Quality Assurance

Many companies want to get a reputation for high quality and wish to keep it. To help do this, the company can organise itself so that every employee tries to work with quality in mind, including those not directly involved in the making of the product, such as managers and office staff. When a company has done this, they can apply to be inspected to see if they are good enough to be awarded the **ISO 9001**. This is given by the International Standards Organisation to companies with a high standard of **Total Quality Management (TQM)**. These companies often organise their employees into small groups called **Quality Circles**, who meet regularly to discuss how the quality of what they do can be improved.

Quality Control

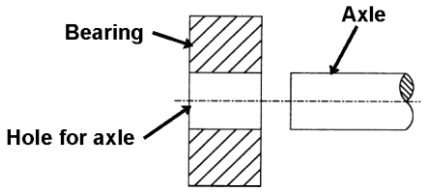
Even if every employee is working to a high quality standard, the machines making the product can go wrong and produce a poor quality output. To guard against this, computer controlled inspection equipment can inspect each part as it comes off the machine. This is called **Process Control**. The inspection equipment can warn the machine operator as soon as the quality of the parts begins to fall. Process control is costly, so many manufacturers rely upon inspecting the parts manually at regular intervals. For example, every 100th part can be removed for inspection.

Inspection

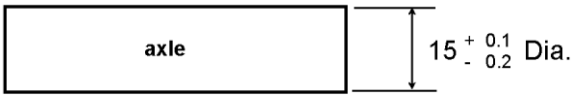
- A part needs to be inspected for:
- Accuracy of its dimensions
- Faults in the material (cracks, splits etc.)
- Its surface finish (e.g. rough instead of smooth)
- Its appearance (e.g. is the colour the correct shade?)

Dimensional Accuracy

Although Computer Aided Manufacture can produce parts very accurately, there will still be small variations in the dimensions. Problems arise when one part has to fit into another part. For example, the wheel of a shopping trolley has to fit onto an axle. If the axle diameter is too large, the wheel will stick and not turn easily; if it is too small then the wheel will lean over and the hole in the middle of the wheel, known as the 'bearing', will wear away quickly.



The dimensions do not have to be exact however, if the axle is just a little large or small, then the wheel bearing will still work perfectly. The amount that a dimension can vary without affecting performance is known as the **tolerance**. A dimension showing tolerances normally shows how much larger it can be by using a '+' sign and how much smaller it can be by using a '-' sign. If an axle should be 15mm diameter if perfect (this is known as the **nominal** size) but could be 0.1mm larger or 0.2mm smaller and still work well, then the dimension will be written in the following way.



Any axle that is too large or too small will be scrapped and hopefully recycled.

Tolerances can also be given for:

- Lengths, widths and depths.
- Positions of holes and their diameters.
- Angle measurements (in degrees).
- Surface flatness and smoothness.

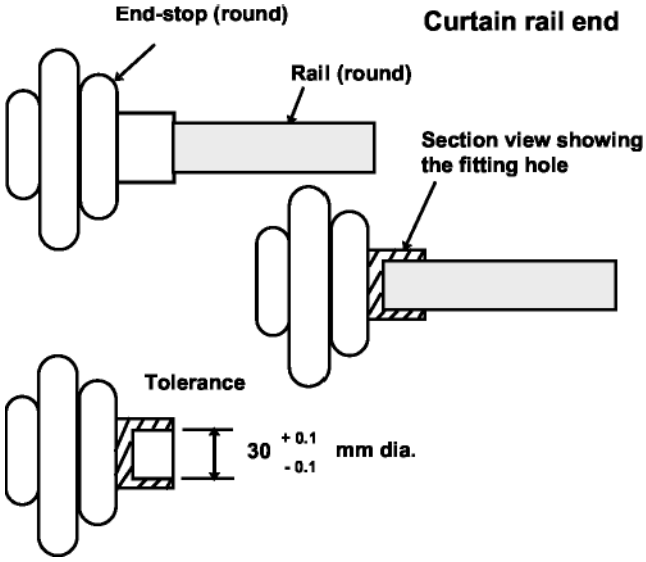
KEY WORDS Kite-mark: Quality control: Nominal: Tolerance

STATISTICAL QUALITY CONTROL

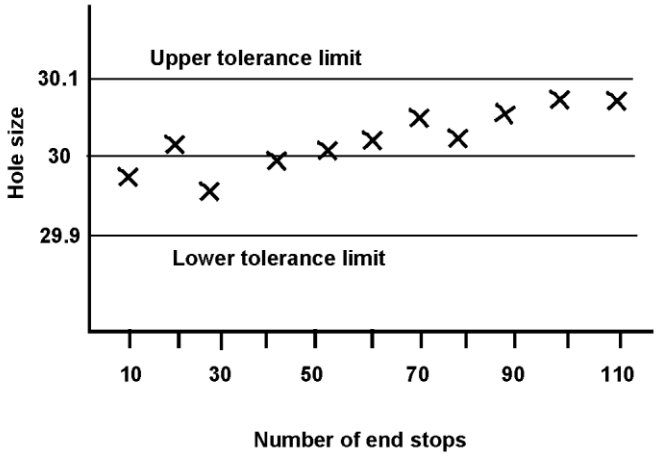
Checking each part of a product every time it is manufactured costs a lot of money and is normally only considered for the most expensive, top of the range products.

Normally, only a selection of parts are tested and the results are added to a graph to see if there is a trend showing that will eventually lead to the part being too large or too small.

e.g. The diagrams below show one end of a wooden curtain rail. The end-stop slides onto a round wooden rail. The hole that the rail fits into must be a tight fit and within diameter tolerances. The end-stop is turned on a computer controlled lathe.



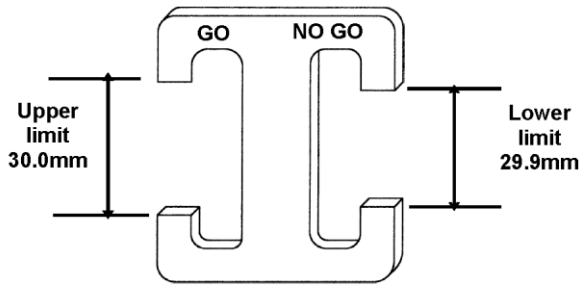
The production manager decides to check every tenth end-stop and plots the data on a graph.



It can be seen from the graph that there is a trend for the hole to get larger, so it would be a good idea to reset the machine before the hole gets too large and the end-stops have to be rejected.

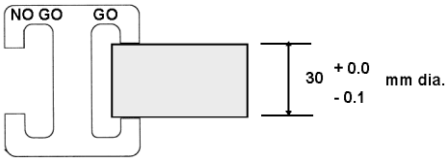
INSPECTION GAUGES

A quick and accurate method of checking to see if a component (part) is too large or too small is to use a 'GO - NO GO' Gauge

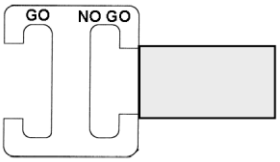


To use the gauge - On the rail

1. Check the the 'GO' side to see that it slides over the rail. If it doesn't, then the rail's diameter is too large.



2. Turn the gauge round and check that the 'NO GO' side will **not** slide over the rail. If it does, then the rail's diameter is too small.



For checking the hole in the end-stop, a **Plug Gauge** can be used in the same way.

1. What qualities must a high quality product have?
2. Sketch two examples of a quality kite-mark.
3. Explain the term 'Total Quality Management'. What will a successful company be awarded?
4. Why do manufacturers need quality control procedures?
5. Explain fully what is meant by the term 'tolerance' in manufacturing.
6. Name **four** things that tolerances can be applied to.
7. Why isn't every part of every product tested before it is assembled together?
8. How can statistics help reduce the number of reject parts?
9. Sketch a 'GO - NO GO' gauge and show how it is used.
10. Sketch a Plug gauge and show how it is used.

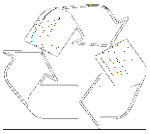
RECYCLING

Recycling is processing old material to make it good enough to be used as new, e.g. melting down used aluminium drinks cans so that new cans can be made without using fresh aluminium. Sometimes the old material is added to the new. Most 'new' steel contains up to 40% melted scrap steel.

Plastics - most thermoplastics can be recycled, e.g. 'PET' used for fizzy drinks bottles is recyclable. Thermoset plastics are not recyclable.

Metals- Pure metals can be recycled. Alloys can only be effectively recycled if all the scrap is the same alloy.

Wood & Ceramics- are not recyclable.



Products that are made of material that can be recycled will normally display the three arrow symbol on the label.

Recycling is part of the government's drive to reduce the amount of waste in this country. The aim is to reclaim and re-use as much material as possible. However, this is not always possible, some materials e.g. ceramics, cannot be recycled, but can be used for other purposes, e.g. old ceramic products are used as hard-core, a layer of broken ceramics and bricks, onto which concrete is poured to make pathways, etc.

The government's policy can be called the '4Rs' policy.

Reduction - Reduce the production of waste in the first place.

Re-use - Clean and re-use products, e.g. bottles.

Recover - Recycle paper, glass, cloth, steel and aluminium, etc.

Remove - Remove as little as possible and try and gain energy from burning the waste or collecting methane gas from a landfill site.

Life Cycle Analysis (LCA) This analysis process involves collecting data at each stage of the manufacture and use of a product, from the extraction of the raw materials, to the problems it produces when it is thrown away at the end of its life. The data is about:

1. The cost of getting the raw material e.g. digging metal ore from the ground.

2. The cost of converting the raw material into a usable material, especially how much energy was used (electricity, coal, gas or oil).

3. How much recycled material was used in making the product.

4. How much time, energy and waste was involved in each making process.

5. How much material, time and energy was used in packaging the product and

distributing it to the shops.

6. How easily it can be disposed of safely, or used for recycling at the end of its useful life.

LCA can be applied to the manufacture and use of a computer.

The aims of responsible manufacturers are:

A) To reduce the amount of energy used in manufacturing the product.

B) To make a product that lasts a reasonably long time.

C) To make it as recyclable as possible when it is worn out, or out of date.

Recyclable packaging

1. What do you understand by the term 'Life Cycle Analysis'?
2. How would you identify a responsible manufacturer?
3. What is the difference between the terms 'recycled' and 're-used'?
4. A clear glass jam jar is to be recycled. What would you expect to happen to it?
5. What is the government's policy about reducing waste and energy use?