WORKSHEET 2

1. Whenever you see the word automatic or 'auto', connected with a product you know it's based upon a system that it can control.

2. Input - Process - Output.

3. A black box is a system that you know how to operate and you know what it does, but you don't know how it works.

4.

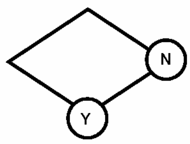
5. When a system can sense a change in the environment and use the data to control it's actions.

6. An open loop system includes feedback a closed loop does not.

7.

The beginning or end of the chart (start & stop)

The process



The decision box where the control works. Sensors are used to answer a question (e.g. is the room temperature hot enough?)

Y = Yes N = No (they can be the other way round)

8. Light	Heat	Sound
Pressure	Tension	Position
Movement	Vibration	Speed

9. In more complex systems such as those found in an automatic washing machine or a DVD player there are a number of linked systems called sub-systems that work together to make the product work correctly.

10. In a DVD player there are a number of sub-systems:

The disc feed sub-system
The disc spinning sub-system
The laser movement sub-system
The laser reading sub-system
The conversion for TV sub-system

They must all work together and feedback information to each other for the player to work well.

WORKSHEET 3b

1. Any mechanical system.

2. **Input** – the energy put in, e.g. the squeezing together of the handles of a pair of scissors.

Process – the movement of the mechanism, e.g. the movement of the scissors blades.

Output – the work done, e.g. the cutting of paper by the scissors.

3. Appropriate diagrams

linear 

reciprocating 

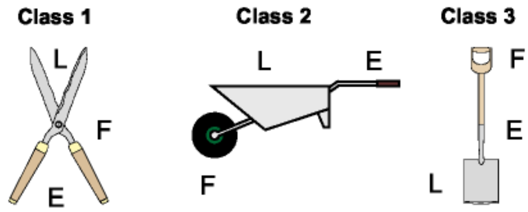
rotary 

oscillating 

4. To help you remember which is which, try to learn the rhyme **1 2 3 – F L E**

(F L E are the initial letters of what is in the middle)

5.



6. When a mechanism such as a lever improves the effect of an effort, the mechanism is said to have provided a **Mechanical Advantage (MA)**. To work out what this is, the following formula can be used

MA = Load ÷ Effort

7. MA = 5

8. Since the effort and the load started to move at the same time and stopped at the same time, but the effort moved twice as far, the effort moved faster than the load. The difference between the two speeds is known as the **Velocity Ratio**.

Velocity Ratio = Distance effort moves ÷ Distance load moves

9. VR = 3

10. Torque = 2 Nm

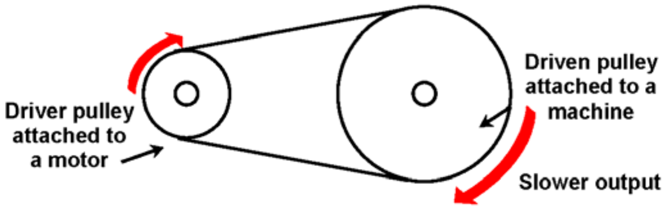
WORKSHEET 3d

1. The load moves 2M

2. The **Mechanical Advantage (MA)** of a pulley system is the same value as the number of pulley wheels.

3. Largest load = 60N

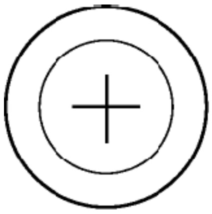
4.



5. Speed ratio is

Dia of driver pulley ÷ Dia of driven pulley

6.



7.

Gear ratio = Number of teeth on driver gear ÷ Number of teeth on driven gear

8. 300rpm

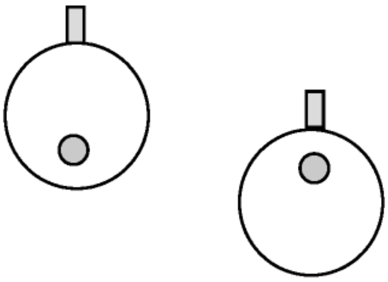
9. Two meshing gears turn in opposite directions. To get the driver and driven gears to turn in the same direction an idler gear needs to be added to the system.

10. 20rpm

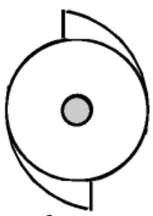
WORKSHEET 3e

1. Cams are used in mechanisms to change rotary motion to reciprocating (backwards and forwards) motion.

2.



3.



4. Four times faster.

WORKSHEET 4

1. Frame - made up of beams connected together, e.g. Electricity pylons, some bridges, etc.

Slab - made up of boards connected together, e.g. Boxes, chipboard based furniture, etc.

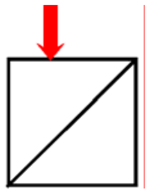
Monocoque or **Shell** - made from shaped sheets of rigid material, e.g. Car bodies, cans, etc.

Flexible - made from flexible sheets of material, e.g. Air beds, blow-up furniture, etc.

2. Note: Most rigid structures need to be able to flex a little without breaking up, e.g. the forks on a bicycle must flex when it ridden over bumps in the road and a skyscraper must sway in a high wind.

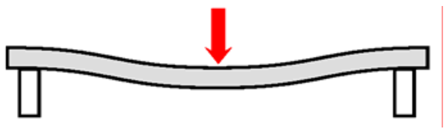
3. Tension, Compression, Bending, Torsion, Shear

4.



A rigid gate structure

5.



WORKSHEET 5b

1. Density Is the amount of matter (mass) in a material. A cube made form a high density material will be heavier than the same size cube made from a low density material.

Gold & Lead

2. Fusibility Is a measure of how easy it is to melt the material. The temperature at which the material normally melts is known as the **melting point**. **Note:** A highly fusible material has a low melting point.

Zinc & Lead

3. Wood & Polystyrene

4. Copper or Gold

5. There also materials like some plastics or frosted glass that let some light through, but detail of what is on the other side of the

WORKSHEET 5b (Cont.)

material cannot be seen, these are known as **Translucent** materials.

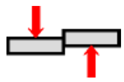
6. A force will **deform** a material. If the deformation is temporary and the material returns to its original state then it is said to be **elastic.**

7.

Tensile strength - resists stretching e.g. High tensile steel

Bending strength - resists bending - is **rigid**. E.g. woods

Shear strength - resists sliding forces such as those made by scissors e.g. Stainless steel



8. Ductility.

9. Malleability Is a measure of how easily a material can be permanently deformed by compressive forces. e.g. hammering, without cracking.

10. Toughness Is a measure of how well a material can stand up to sudden forces, e.g. A hammer blow, without cracking. A material that is not tough is called **Brittle**.

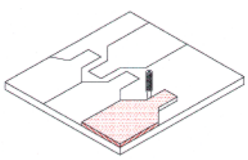
WORKSHEET 7b

1. When parts have to fit together.

2. Incorrect measuring when using a ruler.

3. A template is an accurately formed shape, made from a rigid material. The template can be drawn around or followed repeatedly without wearing away. These are particularly useful for irregular shapes.

4.



5. Guiding tools.

6. Jigs are used to ensure that dimensions are always accurate. They are particularly useful when the positioning of holes and bends are important.

7. Lining up holes, bending in the correct position, lining up saw cuts, etc.

8. The work piece can slip if it is not clamped in place.

9. To allow the rod to be passed over the pin position, so that a reverse curve can be bent afterwards with the pin back in position.

10. Mild steel.

WORKSHEET 8

1. Computer aided design / computer aided manufacture.

2. Dimensions added automatically, views can be twisted and turned and viewed from any angle.

3. Faster accurate drawing, common parts can be inserted from a drawings bank, changes can be made quickly and easily, dimensions can be added automatically, printouts can be too any scale, in 3D the object can be viewed from any angle.

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

5. 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.

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

7. Up to 500th of a millimetre.

8. 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.

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

10. The cost of the computers and programs. The high cost of the machine. The loss of jobs.

WORKSHEET 9a

1. One-off - Producing one product at a time. This method is often used by traditional craftsmen and artists, who work to order.

2. Advantages: The customer gets a product that is designed exactly as they want it. Quality checks can be made at every stage of manufacture. **Disadvantages:** The production process is slow and costly.

3. 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.

WORKSHEET 9a (Cont.)

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.

4. Advantages: Flow production methods lower the production cost. Model changes can be made regularly upon change over.

Disadvantages: No production occurs while the machines are being reset The products need to be stored until there is a demand for them.

5. 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.

6. Advantages: Low production costs if sufficient products are made.

Disadvantages: Models cannot be changed easily. If one machine breaks down the whole line is effected. The machines cannot be easily reset to make other models. The machine cost a lot to purchase.

7. Computer Integrated Manufacturing

8. Stock control, production planning, marketing, sales, research and development, CAM manufacturing, quality control.

9. Each department uses computers, the CIM system links all the computers, so that everyone involved can see what is happening, with regard to the product, in the other departments.

10. One-off.

WORKSHEET 9c

1. Do what it is meant to do excellently Last a long time. Need little maintenance.

2.

3. 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**.

4. To make sure the product meets the required safety standards and to maintain consumer confidence. Also to make sure that parts fit together and do not have to be rejected.

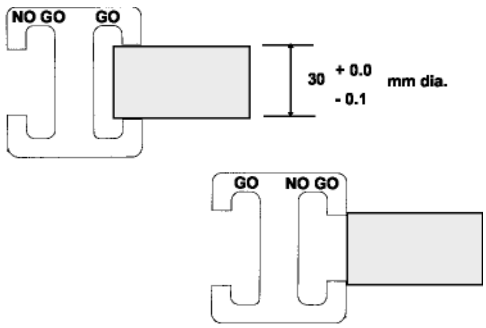
5. The amount that a dimension can vary without affecting performance is known as the **tolerance**.

6. Lengths, widths and depths. Positions of holes and their diameters. Angle measurement Surface flatness and smoothness.

7. 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.

8. By identifying a trend of a machine to produce out of tolerance parts, before the tolerance has been reached.

9.



10.

WORKSHEET 9d

1. 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. This data is about:

A) The cost of getting the raw material.

B) The cost of converting the raw material into a usable material.

C) The amount of recycled material used in the product.

D) How much time energy and waste is involved in the

E) How much material, time and energy used in packaging.

F) How easily it can be disposed of safely, or recycled.

2. The aims of responsible manufacturers are:

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

WORKSHEET 9d (Cont.)

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.

3. Recycling is processing old material to make it good enough to be used as new. Reused refers to materials that can be used for other purposes, or products that can be cleaned and used again.

4. Put in a bottle bank. Sorted for colour. Broken up. Melted down. Used as new glass or added to new glass.

5. 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.

WORKSHEET 10a

1. A new problem needs to be solved. New technology makes the old design obsolete. Fashion changes and old designs don't sell. Novelty, a manufacturer needs their product to be different from their rivals.

2. Often a company will carry out **market research** to see if there is a need for the product they intend to design and manufacture. One way of doing this, is by asking the general public to answer a questionnaire containing questions about the problem and what they see as a possible solution.

3. :

WHAT is the situation? E.g. What happens to the controllers without storage?

WHY does this cause a problem?

WHEN does this cause a problem? E.g. Is the user likely to be standing or sitting at the time?

WHO does the problem effect? E.g. who will want to find the controllers quickly?

WHERE will the solution be used? E.g. Which room and where in the room?

4. A brief is a short statement explaining the problem and suggesting a possible solution.

5. Analyse rival products. Investigate new technology and new materials. Check fixed data.

WORKSHEET 10h

1. The Designer Specification is a list of all the factors that must be right if the design is to be successful.

2. Four selected from: Function, Shape, Size, Aesthetics, Storage, Manufacture, Materials, Finish, Safety, Ergonomics, Cost, Pollution, Market.

3. Regularly throughout the rest of the design process.

4. Isometric and Oblique.

5. Crating the drawing first.

6. Add notes.

7. Trying out small changes to your chosen idea, to improve it. Researching possible materials to use, shaping methods, jointing methods and finishes, and then choosing which you are going to use.

8. Textbook or computer program.

9. Weight, rigidity, hardness, toughness, texture, colour, opacity, malleability, ductility, conductivity.

10. A **prototype** is the product made at the end of a project, using the correct sizes, materials, joints and finishes. The prototype should work. A **model** is often made to a proportional size, with cheaper materials. It doesn't always need to work.

11. Dimensions, proportions, colour schemes, mechanical systems, feature positions, shape, attractiveness, stability.

12. Paper, card, cardboard, MDF, plywood, balsa wood, rigid foam, polymorph plastic, wire, welding rod, match sticks, lollipop sticks, clear plastic sheet, drinking straws, clay.

13. Glue gun adhesive, double sided tape, split pins, blutack, PVA, velcro, pritt-stick.

14. Orthographic working drawing Rendered pictorial drawing

15. It should include all the information required to make the product.

16. Information table Flowchart.

17. The 'Quality Check' column is very important, because if the checks are not planned they will be forgotten and the product parts are unlikely to fit together well.

18. Drilling holes before the item is bent and difficult to hold.

WORKSHEET 10h (Cont.)

19. Designer specification.

20. Market Testing To support your own thoughts about the product, it is a good idea to create a questionnaire and ask your family and friends to give their opinions by testing your prototype.

WORKSHEET 11a

1. One year's growth of wood is shown as an annual ring.

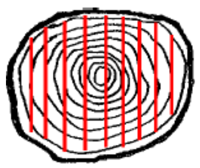
2. By counting the number of annual rings.

3. The five main features are: bark, growth cells, annual rings, heartwood, sapwood.

4. Harder, darker and drier, the best wood.

5. To be useful, the wood has to be converted from a tree trunk to planks. This is done by sawing through the tree trunk. There are two common methods of sawing.

6.



Through and through Conversion

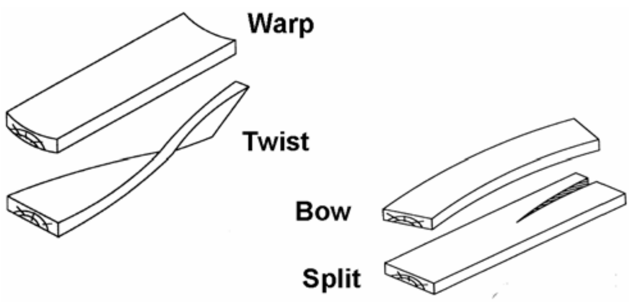
Quarter sawn Conversion

Through and through - a quick cheap method, but produces planks that are likely to warp.

Quarter Sawn - a more costly method that produces more waste, but the planks produced are less likely to warp.

7. When the wood is cut into planks it is still very wet from the water taking the minerals from the roots to the leaves. If the planks dry quickly the wood splits and warps and becomes useless. To dry the wood slowly it is stacked in large drying ovens called **kilns**. The drying programme takes four or five weeks.

8.



9. Less than 10%

10. It is best stored flat or vertically upright, so that it does not bend because of its own weight.

WORKSHEET 11c

1. Hardwoods - deciduous. Softwoods - coniferous.

2. Made from the waste wood left over from conversion.

3. Planed All Round, Planed Both Sides.

4. 47mm x 22mm

5. A plank is between 225 and 375mm wide and 50mm or more thick. A strip is between 25 and 100mm wide and between 9 and 25mm thick.

6. Cedar or protected Scots Pine.

7. Beech

8. It is made from thin sheets of wood (veneers), glued together with the grain direction at 90° to the one next to it. They always have an odd number of layers 3,5,7 etc. to reduce warping.

9. Blockboard

10. It is made from small chips of waste wood.

WORKSHEET 12

1.

1. Look along the length of the strip of wood and see if it is warped, bowed or twisted.

2. Check the ends to see if there are any splits.

3. Check for knot holes or loose knots.

4. Check to see if there are too many knots, because they may make the wood hard to plane smooth.

5. Check for small holes made by insects such as woodworm.

2. 3mm

3. Allow 1162mm or 1165mm (3mm added at one end or both ends).

4. Marking gauge.

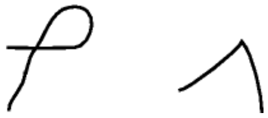
5. Check that the edge is at right angles with a try square.

WORKSHEET 13

1. Mark out the shape in a corner of the sheet.

2. By the loop mark on the face side and the tick mark on the face edge.

3.



WORKSHEET 13 (Cont.)

4. With the handle touching the face edge.

5. A marking gauge.

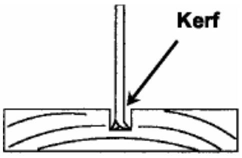
6. It cannot be rubbed out.

7. Dividers have points on both legs.

8. A marking knife.

WORKSHEET 14a

1. Each tooth of the saw is alternately bent to the right and the left of centre. This is to stop the blade from jamming in the cut. The width of the cut is called the **kerf**.



2. Diagram of a bench hook (sawing board).

3. Use trestles (sawing horses)

4. A Tenon Saw, it has a rigid blade designed for cutting joints.

5. A Panel Saw, because you can complete long straight cuts with it.

6. Coping Saw

7. Teeth per inch.

8. Set the frame at right angles to the blade.

WORKSHEET 14c

1. Jack plane and Smoothing plane.

2. So that the plane produces tissue thin shavings.

3. Height adjustment screw.

4. Level adjustment lever.

5. 0.5mm or less.

6.To check the direction, the **side** of the piece of wood should be looked at, not the top surface being planed. Look at the grain approaching the top surface. Plane in the same direction.

7. Either direction.

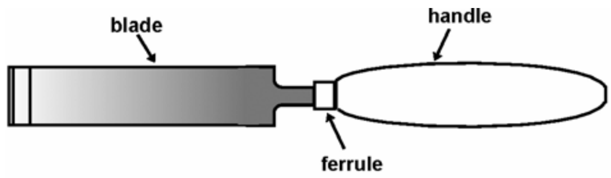
8. The wood splits.

9. Plane half way from both ends.

10. Clamp an extra piece of waste wood to the edge of the board or chamfer the corners of the board.

WORKSHEET 14d

1.



2. Ash or Polycarbonate

3. It stops the wooden handle from splitting.

4. They allow the chisel to get into corners.

5. Keep both hands behind the blade.

6. Tool steel

7. For cutting the mortise of a mortise and tenon joint.

8. To absorb some of the shock.

9. The gouge has a curved blade the firmer chisel has a flat blade.

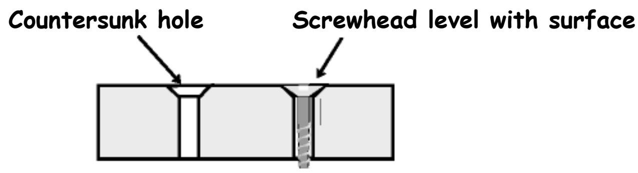
10. To cut shallow depressions in wood.

WORKSHEET 14e

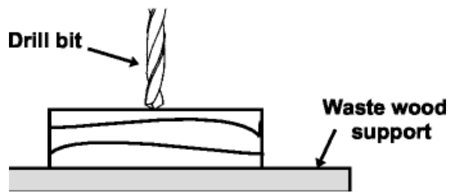
1. Holding the drill bit.

2. HSS High Speed Steel.

3.



4.



5. This drill is so named because the main parts can be made to slide up and down the central pillar.

6. When drilling a larger hole with a power drill.

7. When using a flatbit or hole saw, only cut the hole until the point of the flatbit, or the guide bit of the hole saw, break through the other side. Then turn the wood over and using the break-through hole as a guide, cut the second half of the hole.

8. Hole saw. Drill bits are not normally made that large.

WORKSHEET 14f

1. Never use a power tool until you have received instruction on how to use it safely.

2. If your finger touches the revolving disc you will receive a very painful graze.

3. A good rule is that when the wood is touching the disc it should be covering the slide slot in the table. If it doesn't, it is too short.

4. To stop the disc from clogging.

5. If a finger touches the blade lightly, the flesh tends to move up and down with the blade and is not cut by it.

6. Position the hold down bar no more than 0.5mm above the material being cut.

7. Stop the power lead from trailing across the floor of the workshop.

WORKSHEET 15c

1. Side grain to side grain.

2. A butt joint is end grain to side grain, a cut joint allows for side grain to side grain contact.

3. Two from: butt joint, lap joint, comb joint, mitre joint, dowel joint, dovetail joint. Both sketched.

4. Two from: through housing, dovetail housing, stopped housing. Both sketched.

5. A wooden strip glued on the inside or dovetail pinning. (Sketched)

6. Triangular pieces of thin wood glued into saw cuts across the joint. (Sketched)

7. Lining up the holes.

8. Dovetail joint. (Sketched)

9. Use a Cross halving.

10. One from through housing, dovetail housing, or stopped housing. (Sketched).

WORKSHEET 17

1. Permanent jointing.

2. The solvent needs to evaporate (dry) before the adhesive works. The time this takes is called the setting time.

3. Most wood adhesives are made up of solid particles of glue being dissolved in a solvent (water or spirit).

4. The glue soaks into the pores of the wood and then sets like lots of little fingers grabbing onto the wood on both sides.

5. It is very important that the surfaces to be glued are freshly cleaned with glass paper to remove any dirt or oily residue left by touching the surface with your fingers.

6. Using a cramp to hold the two halves of a joint together firmly, helps to force glue into the pores of the wood. Cramping also holds the joint still while the glue is setting.

7. Varnish the wood before you glue the parts together, the glue will not stain varnished wood.

8. After normal glueing, mix sawdust of the same wood with the glue to make a paste and use this to fill the gap.

9. Synthetic Resin (Cascamite) because it is waterproof.

10. Use it in a well ventilated area and do not sniff it.

WORKSHEET 18b

1. Friction between the nail shaft and the surrounding wood.

2. Galvanised mild steel.

3. A pin punch is used with a hammer to drive the head of the pin below the wood surface. The hole above the pin head can then be filled with a wood.

4. Place the nail at least nine times its diameter from the end of the wood.

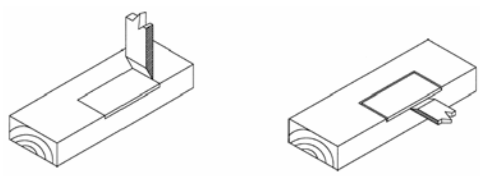
5. Sketch of claw hammer. Designed for hitting nails into wood and for removing bent nails from wood.

6. Hold the pin in a piece of card.

7. The chipboard screw has thread all the way up the shaft and it has two threads (spirals) wrapped around each other.

8.

9.



10. Knock down joint.

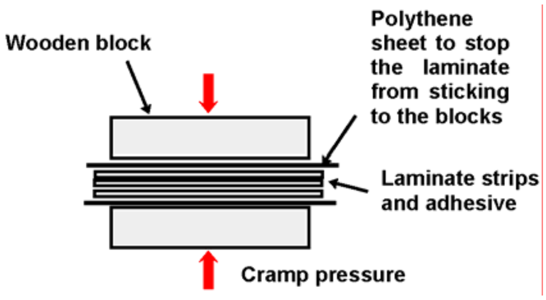
WORKSHEET 19

1. A laminate is made up of layers of veneers (thin sheets of natural wood) glued, one on top of another. Unlike plywood, the grain of each sheet is normally lined up in the same direction.

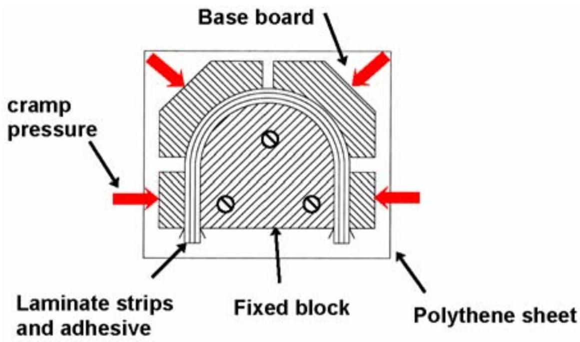
2. For laminated wood to bend the layers would need to slide over each other the adhesive prevents this from happening.

3. A laminated strip is tougher than solid wood because a crack that starts on one side of the strip is stopped by the glue line and does not go all the way through.

4.



5.



6. To stop the laminate from sticking to the blocks.

WORKSHEET 20b

1. To stop wood from absorbing moisture, so that it is less likely to become stained and warp. To protect against rot and insect attack. To improve the appearance of the wood's surface.

2. Planing with the blade set to provide tissue-thin shavings.

3. 00

4. Wrap the glasspaper around a sanding block. Always sand backwards and forwards in the direction of the grain.

5. Stain (colouring) is used to change the colour of light woods to make them more interesting or to blend in with darker woods.

6. Matt, satin and gloss.

7.

i) Apply the first coat thinly and let it set fully. This coat soaks into the pores of the wood and then sets. The wood is now sealed.

ii) Use a fine grade of glass paper to lightly sand the surface because the first coat tends to make the surface rough as it sets.

iii) Apply the second coat also thinly, check for any runs or drips and let it set to a smooth finish.

8. It does not crack or peel off.

9.

1. A primer coat. A primer is a paint that sets quickly and seals the pores in the wood.

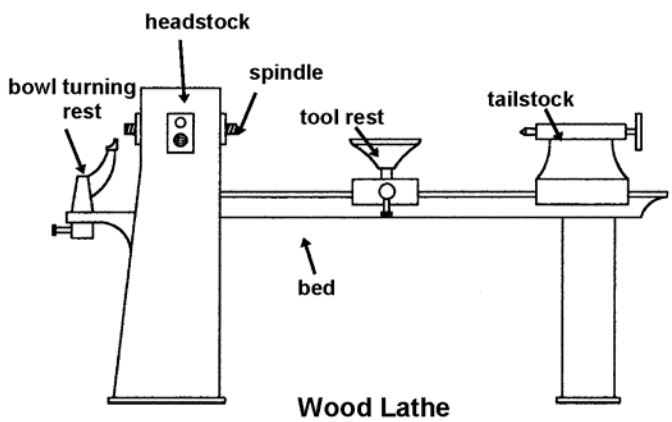
2. An undercoat coat. Undercoat paint contains a lot of pigment (colour) to stop the original surface showing through.

3. A gloss top coat. Gloss paint contains less pigment and more clear varnish to provide the shine. If the paint also contains polyurethane it will have a tough, scratch resistant finish.

10. Acrylic gloss. A water based paint that only requires a primer and top coat. The gloss is not as shiny, or the finish as scratch resistant as a polyurethane paint. Emulsion A water based paint that often contains vinyl to make it more water resistant and easier to wipe clean. Normally only two coats are required, the first coat seals the wood like a primer. The finish can be matt or satin only, gloss is not an option.

WORKSHEET 21

1.



2. So that they can be held safely and give good leverage.

3. It is cut into an octagonal shape.

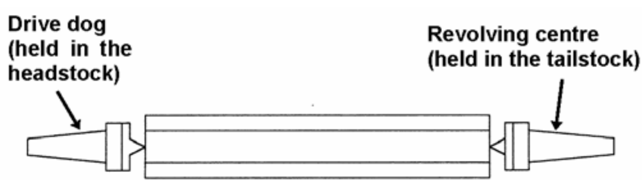
4. The outside shape before the hollowing.

5. The wood should be prepared by marking out

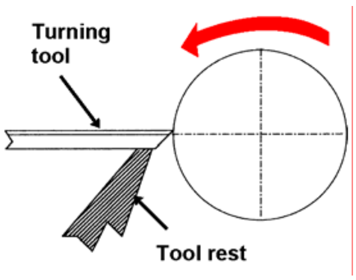
WORKSHEET 21 (Cont.)

an octagon on both ends and then planing the sides. At one end a saw cut should be made to allow the teeth of the drive dog to dig into the wood. (sketches req.).

6.



7.



8. Never attempt to use a lathe until you have received instruction from your teacher. Always wear goggles!

WORKSHEET 24b

1. Ferrous - metals that contain iron and are affected by magnetism (apart from stainless steel).

Non-ferrous - metals that do not contain iron and are not effected by magnetism.

2. Alloys - metals made up from a mixture of elements, e.g. Copper + zinc (brass) or lead + tin (solder)

3. In steel the rust layer is loose and can fall away; this exposes new atoms that will combine with oxygen to form new rust. In non-ferrous metals the oxide layer is dense and does not fall away; this creates a barrier to the oxygen in the air and new corrosion occurs very slowly. The layer is called tarnish.

4. Mild steel contains contains 0.15 - 0.35% carbon, and is ductile, malleable and tough. Tool steel contains 0.8 - 1.5% carbon, and is very hard, rather brittle and is difficult to cut.

5. It does not rust.

6. It is nearly as strong as mild steel but only only third the weight.

7. It is a good conductor of heat and has a high melting point.

8. It is not rigid enough to be used for taps.

9. It is wear resistant.

10. It is weak and soft.

WORKSHEET 25

1. Scribers, scribing blocks, dividers and odd-leg callipers.

2. Using Engineer's Blue

3. Use a centre punch to make an indent for the leg to sit in.

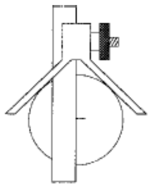
4. Odd-leg Callipers.

5. For running along the edge of the metal.

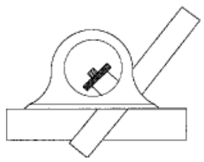
6. So lines can be scratched at different heights.

7. Because it can do at least three different jobs.

8.



9.



10. A sketch showing the combination square set up like an engineers square.

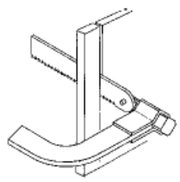
WORKSHEET 26a

1. To take different lengths of blade.

2. 32 TPI or 24 TPI

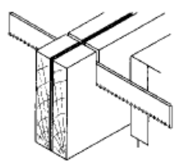
3. So that the teeth don't jam.

4.

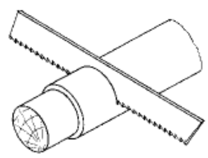


5. A Tension file.

6.



7.



8. To stop the saw blade from sliding over the metal when starting a cut, use a triangular file to file a groove on the waste side of the line. The saw teeth should fit into the groove.

WORKSHEET 26b

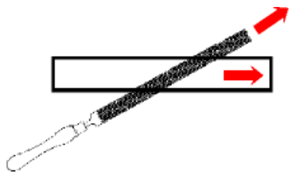
1. To push fit into the handle.

2. Sketches of cross sections of flat, square, triangular, round, half-round, knife.

3. Bastard to get rid of most of the waste quickly. Second cut to leave a reasonably smooth finish. Smooth or dead smooth to provide a very smooth finish.

4.

5. When filing a long edge, push the file forwards and slide it sideways at the same time.



6. Drawfiling (Sketched)

WORKSHEET 26c

1. To hold smaller diameter jobber drill bits.

2. The larger diameter bits have a tapered shank and are held directly in the pillar drill spindle. The thin part at the end locks into the spindle and cannot slip under pressure, like a straight shank could in a chuck.

3. For holes in metal of 8mm diameter or larger, it is better to use a smaller drill bit first (4 or 5mm dia.). The smaller drill is less likely to wander off the centre punch mark. It also provides a hole that can guide (pilot) the larger drill.

4. Set the pillar drill's depth stop, so that the drill cannot drill beyond a depth of 10mm.

5. Use cone bit.

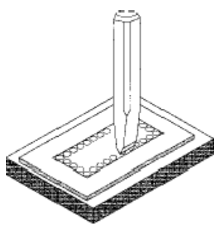
6. Illustration of a hand vice with the metal supported on a block of wood.

WORKSHEET 26d

1. High Carbon Steel

2. A sketch of chain drilled holes.

3. The chisel is hit with a hammer to cut between the holes until the inside is cut free. The edges are then filed with a safe-edge file.



4. Chiselling is faster than filing and the top of the vice can be used as a guide.

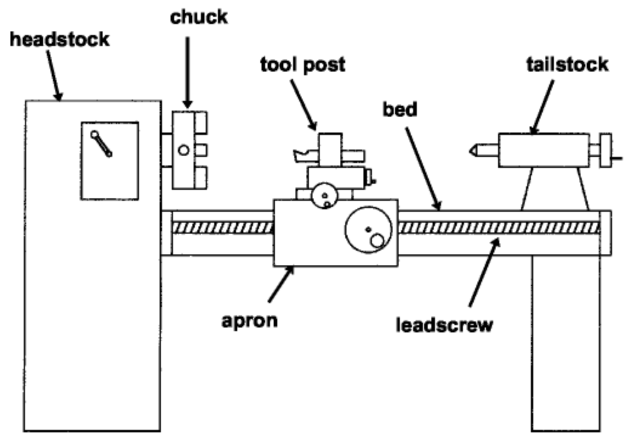
5. When cutting along a curved line.

6. One side of the cut curves away from the other side.

7. They can be used for both straight and curved cuts.

WORKSHEET 26e

1.



2. HSS or tool steel with a tungsten carbide tip.

3. To 100th of a millimetre.

4. Illustration of turning down, facing off, parting off, thread cutting.

5. Enlarging a hole by cutting away the inside wall.

6. The chuck revolves the work, while the drill bit is held still in the tailstock.

7. Use a centre drill.

WORKSHEET 27a

1. Annealing - by heating the metal to a dull red. The metal is now more malleable, so it will not split when it is hit with the mallet. The surface will now be black (burnt tarnish) and this needs to be cleaned off before hollowing. Either emery cloth can be used to clean it, or the still warm disc can be placed into a bath of dilute sulphuric acid.

2. Forming block or sandbag and a bossing mallet.

3.

4. Sinking gives a lip around the edge.

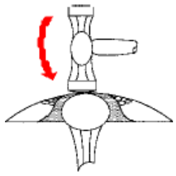
5. Sketches of a bowl without a lip and one with a lip.

WORKSHEET 27a (Cont.)

6. a) to remove any unwanted bumps and to correct the overall shape.

b) to harden the metal and make it more rigid.

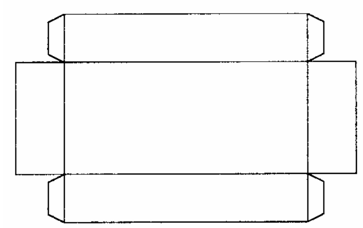
7. The bowl is placed over a **Mushroom Stake**. Starting in the centre, the bowl is revolved one space after each blow. The blows should spiral outwards to the edge.



WORKSHEET 27b

1. Up to 1.5 mm.

2. The net should be dimensioned for a box of 200x150x20mm.



3. It is less costly than metal if an error is made.

4. By folding over to make a safe edge.

5. Folding bars can handle sheet metal of larger size than a vice on its own.

6. By using a block of wood a folding jig. It has to be the same size as the base but thicker than the box height.

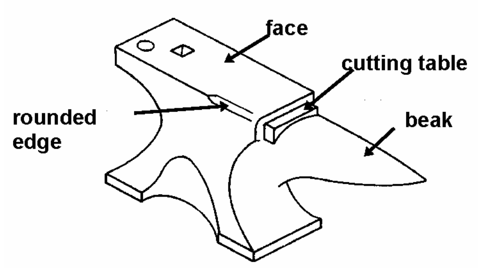
7. Use wooden striker, hit with a mallet.

8. For bending curves, a machine that has three adjustable rollers is used. The tightness of the curve can be controlled by altering the position of each roller.

WORKSHEET 27d

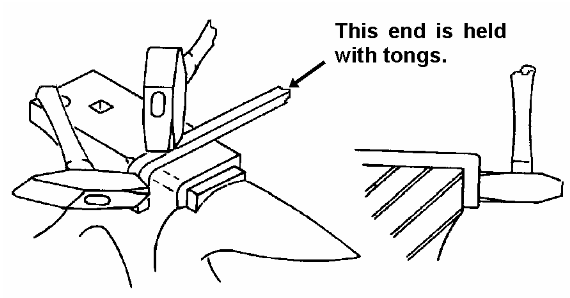
1. When it is hit it is squashed and becomes denser. Also, a shaped product will have the 'grain' (layers of crystals) flow around the shape.

2.



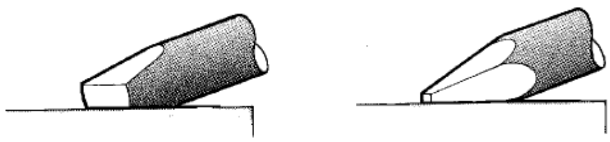
3. To grip the hot metal firmly.

4.



5. 1. Hold the bar at a slight angle to the anvil face and hit on one side, the anvil face flattens the other side at the same time.

2. Turn the bar 90° and hit again to make the point square in shape.



3. Hit each corner of the square shape to turn it into an octagonal shape

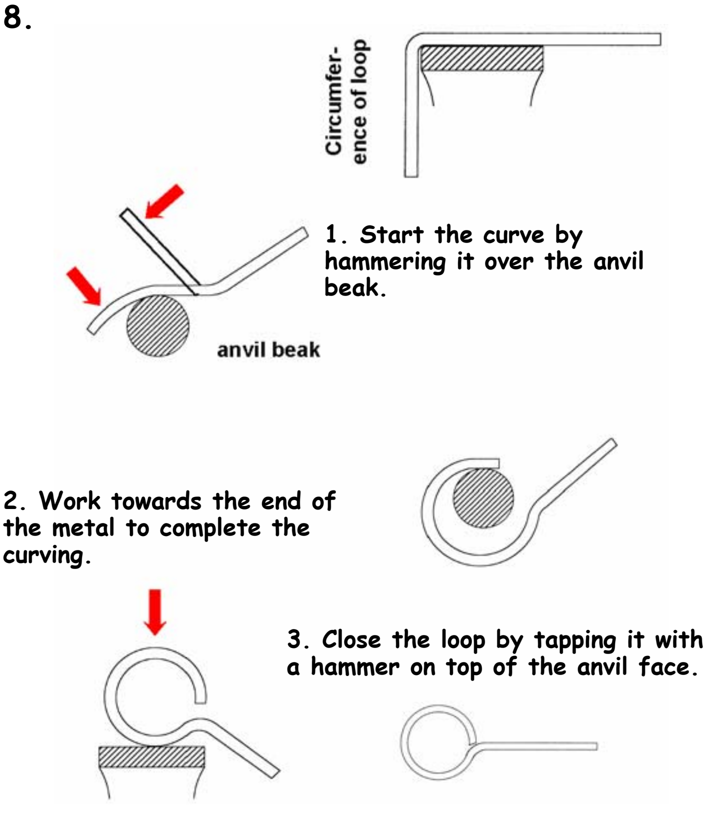
4. Continue turning the bar and hitting the corners until the point is round in shape.

6. Upsetting is the term given to the process of thickening the metal. This is useful for maintaining strength when drilling a hole.

7. Heat the bar to a bright red and then grip it the vice and slide on a special twisting tool, or use a large tap wrench. Twist the metal while it is still red hot. Twisting will only occur between the vice and the wrench.

WORKSHEET 27d (Cont.)

8.



9.

An 'S' scroll

10. The metal is heated to bright red in a forge.

WORKSHEET 28b

1. The pattern should be tapered so that it can be taken out of the sand without dislodging any sand grains. The taper is known as the Draft.

2. Internal corners need to have a fillet to stop cracks appearing during cooling.

3. A pattern that, because of its shape, would dislodge sand when it was removed needs to be split into two or more sections. The two halves are held together with dowels.

4. So that the halves can be separated when the pattern needs to be removed.

5. A) the drag is turned upside down and put on the base board. The pattern is placed in the middle. Moulding sand, made damp with oil or water is sieved over the pattern until the pattern is covered. B) The rest of the sand is then shovelled in and then rammed with a rammer until it is packed tightly. The surface is then levelled by scraping a metal strip across (strickling).

C) The drag is turned the right way up and the cope is then placed on top. The top half of the pattern is added and also the sprue pins are positioned. Sand is then added and rammed to fill the cope.

D) The cope is now lifted off and the top half of the pattern and the sprue pins are removed. Channels called gates are cut between the sprue pin holes and the pattern to allow the molten metal to flow into the mould cavity.

E) A wood screw is screwed into the pattern and it is tapped from side to side to release the pattern from the sides of the sand mould. The pattern is then carefully lifted vertically from the mould.

F) The cope is placed back on the drag. A hollow basin shape (pouring basin) is cut into the sprue hole that the metal will flow into (runner). A thin metal rod is pushed into the sand to create narrow holes that will allow air to escape when the metal is poured.

6. To allow trapped air to escape.

7. The casting will come free with its gates and sprues attached, these will have to be removed by sawing them off and filing down the stumps.

8. To provide a hole in the casting.

9. Extra pieces are added to provide hollows in the mould that will hold the core in place. These are called core prints.

10. The cores sit in the core prints.

WORKSHEET 29b

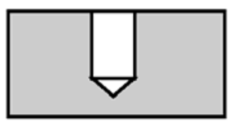
1. Cutting an internal thread into the side of a hole is known as 'tapping the hole'.

2. On a tap or die. The 'M' stands for metric. The 10 is the thread diameter in mm. The 1.5 is the size of the pitch in mm.

3. The pitch is the distance between the tip of one tooth and the tip of the next tooth, in mm.

4. This is a hole that is smaller in diameter than the thread diameter (nominal size), so that the thread can be cut into its side.

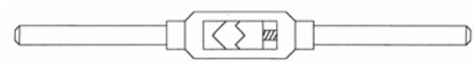
5. A blind hole.



6. Taper tap - tapers for ten threads. Second tap - tapers for five threads. Plug tap - tapers for 1.25 threads.

WORKSHEET 29b (Cont.)

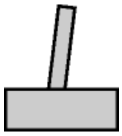
7.



8. A die held in a die stock.

9. The centre screw is tightened to open the die. The outer screws are tightened to close the die.

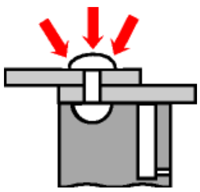
10. Make sure that the die stock is at right angles to the rod to stop a 'drunken' thread being cut.



Effect of drunken thread

WORKSHEET 29c

1. Hammer the rivet shank into a rough mushroom shape using the Ball Peen part of the hammer head.



2. The set part is used to go over the shank of the rivet and push the two pieces of metal to be joined together. The snap part is used to support the rivet head while the shank is being formed and also to round off and smooth the rough shaped head at the shank end.

3. To make sure the holes line up, mark out and drill one pair of holes only. Rivet them together and then line up the metal sheets. The remaining holes can then be marked out and drilled.

4. The pin is pulled by jaws in the gun. The pin head squeezes into the tube of the rivet. The pin then breaks away and leaves the head behind.

WORKSHEET 29d

1. Tin and Lead.

2. 183° to 250°C

3. Dirt and grease will stop the solder from soaking into the surface of the metals to be joined.

4. To stop the component form overheating. The heat goes into the sink to heat it up instead of travelling further up the wire and heating the component.

5. The solder remains liquid until the surface goes dull.

6.

1. When the metal is heated up for soldering it stops an oxide layer forming (tarnish). Molten solder must be able to soak into the surfaces of the metal sheets being joined, to make a strong joint.

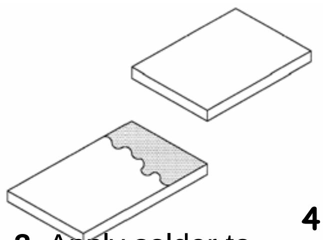
2. It breaks down the surface tension of the molten solder to allow it flow in between the metal sheets.

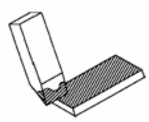
7. Acid - a clear liquid that when applied will clean the surface of the sheet metal by dissolving any oxide layer or grease, before soldering starts. This flux must be washed away with water as soon as the joint has been soldered, otherwise it will weaken the joint. Passive - a brown resin that looks like grease. This does not dissolve any old oxide layers, so surfaces need to be cleaned with emery cloth first. It does not need to be washed away at the end.

8.

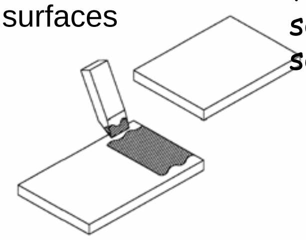
1. Apply flux to both the surfaces

2. Melt solder onto hot tip (tinning the iron)

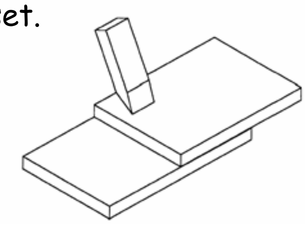




3. Apply solder to both fluxed surfaces



4. Place the parts together and rub the hot iron over the joint to re-melt the solder. Then let it cool and set.



WORKSHEET 29e

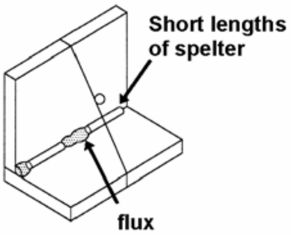
1. Spelter is brass (copper & zinc) and melts at 870°C.

2. The force of the blowtorch flame can move the metal parts to be soldered.

3. So that the loops can be twisted to tighten the wire.

4. Borax. The powder is mixed with water to make a paste.

5.



6. Copper, zinc and silver.

7. Easy flow - melts between 625°C and 690°C Medium - melts between 690°C and 725°C Hard - melts between 725°C and 800°C

8. If one type of solder only was used, then the solder put on the seam would re-melt and the joint would spring open when the base was being heated for joining. When the three grades are used, as shown in the diagram, each joint melts at a lower temperature than the last, so earlier joints stay set.

WORKSHEET 29f

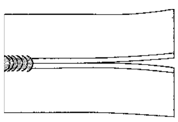
1. Gas - using an oxyacetylene gas flame Arc - using an electric spark Resistance - using an electric current.

2. Acetylene and Oxygen.

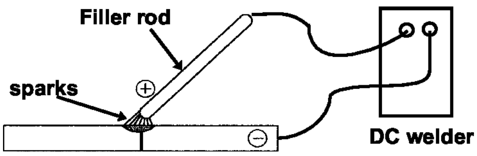
3. The filler rod is used to build up the joint and to replace the metal that has evaporated.

4. The flame is moved forward in a series of small circular movements to heat a wider area than the diameter of the flame.

5. If the ends are not tacked the pieces will warp in the heat and the joint will separate.



6. The joint metal and the filler rod are both connected to an electric circuit. When the rod is held a short distance away from the joint, sparks fly between the two. The temperature of the sparks is so high that both the end of the rod and the joint metal melt and form a weld pool.



7. A passing a current through the sheets of metal heats them up where they touch each other, because this is where there is most resistance.

8. Illustration of Squeeze time, Weld time, Hold time and Release.

WORKSHEET 30

1. Work Hardening When metal is bent or shaped by hitting with a mallet, the area being reshaped becomes harder and more brittle.

2. Annealing is the process of heating metal to soften it and remove the brittleness.

3. Put soap on the surface and heat with a blowtorch until the soap turns black.

4. Heat to cherry red and then let it cool slowly, buried in sand.

5. It is hardened by heating to bright red and then cooling it quickly by plunging it into room temperature water.

6. It is now very hard, but unfortunately also very brittle, too brittle to use without it breaking. It needs to be softened a little to reduce the brittleness, this is done by the process of tempering.

7. A) Clean the area to be tempered. B) Heat gently until the correct colour appears and moves to the blade. C) Plunge into room temperature water and swirl it around.

8. It is case hardened.

9. Any cracks that start in the hard, brittle outer case are stopped by the soft core.

10. At certain temperatures, colours appear on the surface that only appear at that particular temperature. So the type of colour showing tells you what the temperature of the surface is.

WORKSHEET 31

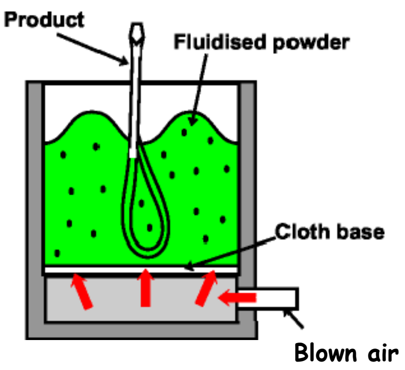
1. Wrap emery cloth around a file and rub it up and down in one direction.

2. It can catch your clothing or a rag if you are holding it and drag your hand into the machine.

3. It is less likely to flake off.

4. Lacquered.

5.

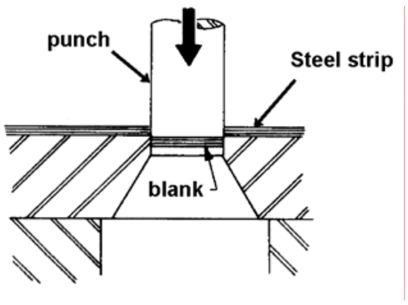


6. Enamelling.

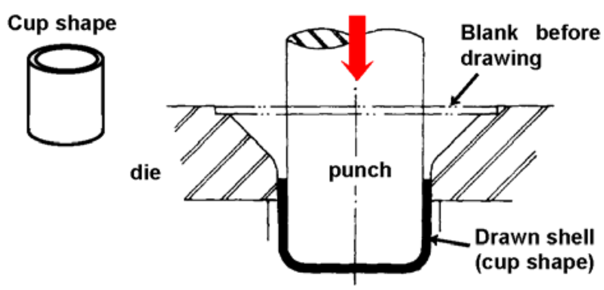
WORKSHEET 32b

1. Piercing is when a press is used to cut holes of any shape out of a sheet of metal. The part cut out is waste. Blanking is when a press is used to cut out a shape that is to be kept and used. The sheet of metal that it has been cut from is the waste.

2.



3.



4. Illustrations of extrusion and rolling.

5. An ingot of metal is heated until it is soft. A hydraulic ram then forces the metal through a shaped hole in a die.

6. Die casting. Because the moulds are permanent and do not need to be made each time.

7. Lost wax casting.

WORKSHEET 33

1. Thermoplastics - can be reshaped by heating. They will try and return to their original shape if re-heated. Thermosetting Plastics - cannot be reshaped by heating and can withstand higher temperatures than thermoplastics.

2. All modern plastics are made mainly from oil, coal and extracts from plants. They are **synthetic** (not natural - manmade) and come in hundreds of types, each with their own set of properties. Many have been made to order by materials scientists.

3. Most property changes are made by adding additives to the basic plastic.

4. To protect it from the effects of ultra violet light and stop it becoming brittle.

5. Polyvinyl chloride (PVC) because it is rigid, quite hard, has good chemical resistance and is tough.

6. Expanded polystyrene because it is very light in weight.

7. Acrylic, because it is rigid, hard, very durable outside and polishes to a high shine.

8. It is tough, resists wear, has good chemical resistance.

9. ABS because it is very tough, scratch resistant and has good chemical resistance.

10. Urea formaldehyde, because it is rigid, hard, strong, heat resistant, does not bend when heated.

WORKSHEET 34

1. To protect the surfaces from accidental scratching.

2. Spirit based markers.

3. By marking out the centre point on a double layer of masking tape stuck in the correct position.

4. To allow a pencil to be used for marking out a curved line and a marking gauge to scratch a line.

5. Show that there is less waste when a shape is marked out in a corner and not in the centre of a sheet.

WORKSHEET 35a

1.

1. Hard, rigid plastics such as Acrylic and Polystyrene can crack easily if they are not well supported.

2. Power saws tend to create so much

WORKSHEET 35a (Cont.)

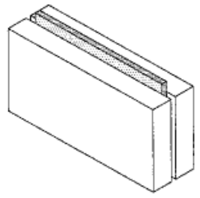
friction heat that the cut plastic softens and welds itself back together again behind the blade.

2. It provides support all around the saw blade.

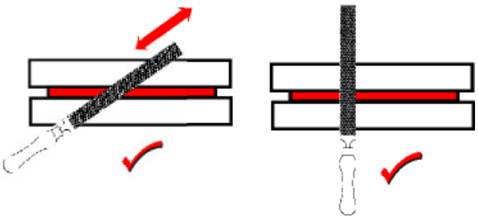
3. If the teeth pointed upwards the plastic would rise with saw with no support.

4. The tape takes away enough heat from the plastic to stop it welding together behind the blade.

5.



6.



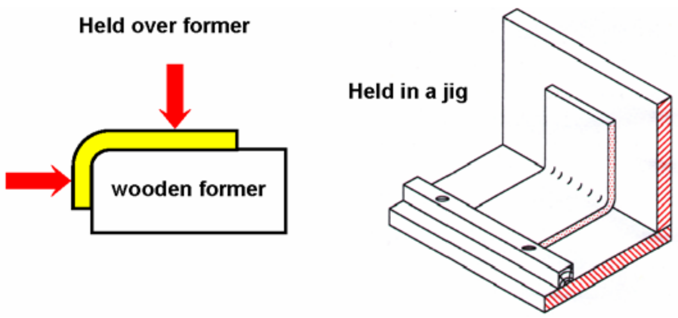
7. A standard drill will catch the plastic as it breaks through the bottom of the hole and cause cracking around the hole.

8. Use pilot holes. First drill the hole with a 4mm drill and then redrill with a 6mm drill and continue using drills that are 2 or 3mm larger in diameter until the correct size is reached.

WORKSHEET 35c

1. If the plastic sheet is re-heated then it will try to return to its original shape of a flat sheet. This property is known as plastic memory.

2.

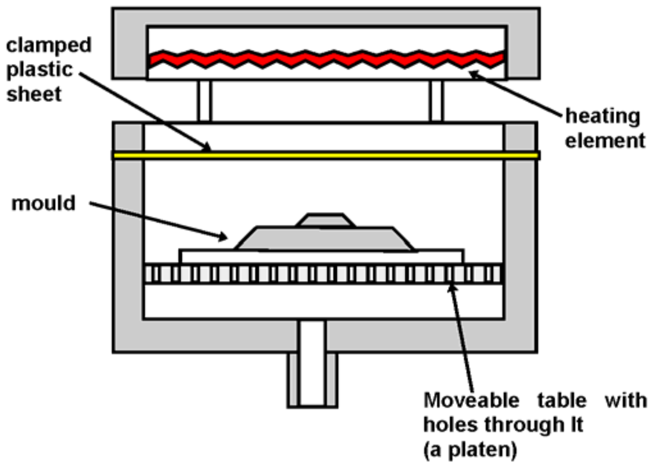


3. A) Placing a shape onto MDF. B) Clamp a sheet of soft heated acrylic between the shape and sheet of MDF. Let it cool. C) Remove the top surface to half the depth of the indent with a file. D) Re-heat in an oven until the acrylic returns to its original thickness.

4. A description of press forming.

5. So that the formed plastic can be removed from the mould easily.

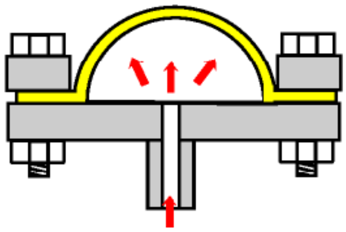
6.



7. Using a profile router.

8. Blow moulding, Vacuum forming, Press forming.

9. Blow moulding.

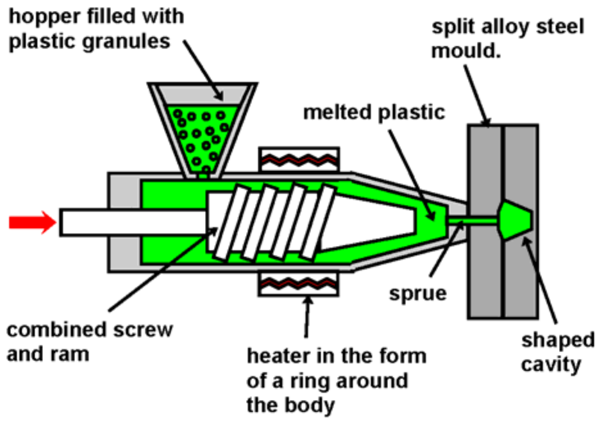


WORKSHEET 35d

1. Injection moulding (possible diagram)

2. Thermoset plastics cannot be softened by re-heating, so any plastic left in the machine would block the nozzle for good.

3.



4. A) A layer of release agent is applied to the

WORKSHEET 35d (Cont.)

inner surface to stop the new GRP from sticking to the mould. The release agent can be in wax form.

B) A thick layer of coloured gellcoat resin is painted over the release agent.

C) A sheet of glassfibre is laid by hand over the dry but sticky gell coat layer.

D) Polyester resin, the same colour as the geelcoat, is stippled onto the glassfibre until it is covered with resin. This is then allowed to set before the hull is taken out of the mould.

WORKSHEET 36

1. A diagram of an 'Octaclip' in use.

2. Any cement spillage or seepage from the joint will permanently mark the surface.

3. Cements are spirit based and can cause major problems if sniffed.

4. Where large areas of contact are involved.

5. A heated wheel, run over two sheets, one on top of the other, will heat-weld the two sheets together along the line of travel.

WORKSHEET 37

1. Ultra-violet light can cause some plastics to become brittle and shatter easily.

2. Rub the edge longways over a board covered with wet & dry paper.

3. Wrap wet & dry paper around a half round file and drawfile along the edge of the plastic.

4. To stop the plastic from over heating and burning, move the plastic towards you once and let it cool for a few seconds before making a second pass.

5. Scratches on the face of the plastic can be removed by rubbing the scratched area with metal polish and a rag.

WORKSHEET 39b

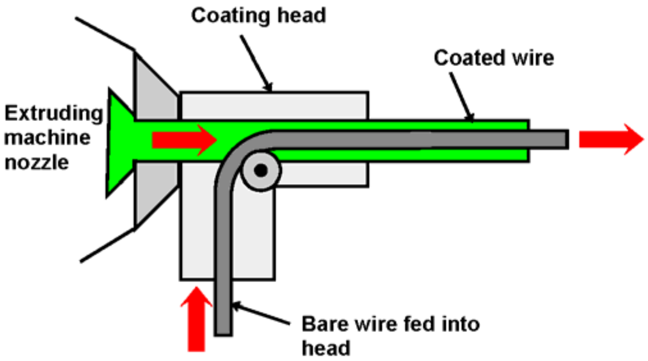
1. They do not rot or corrode. They are light in weight. They are easy to use in mass production. They come in a vast range of colours. They can be clear and transparent. Lubrication is not required for moving parts. Moving parts work quitly.

2. The exact amount of plastic powder or granules is put into the mould so that there is no waste to clog up the process.

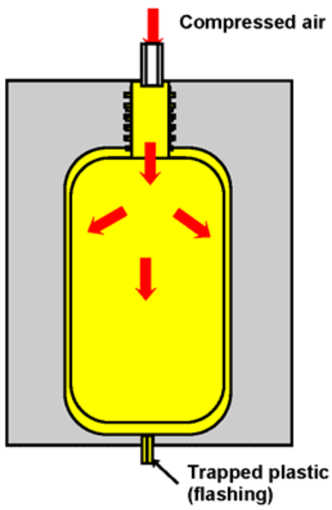
3. Ejector pins.

4. Extrusion, because long lengths can be made.

5.



6.



7. So that the inside walls of the mould are coated evenly.

WORKSHEET 40

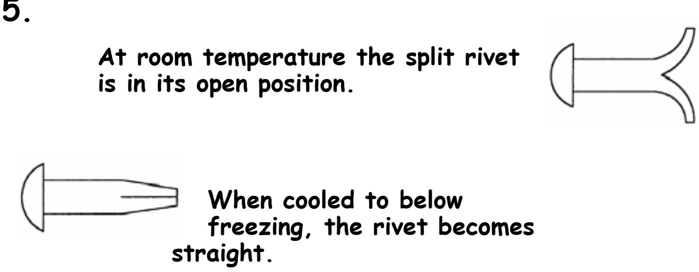
1. A smart material is a material that can be controlled. It can be made to change its colour, size or shape and be returned to its original form at will.

2. The control input can be changing the temperature of the material, applying an electric current through the material or by applying pressure to the material.

3. Shape Memory Alloys & Shape Memory Plastics.

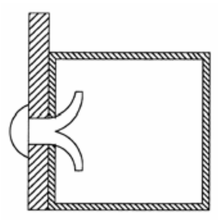
4. Nickel and Titanium.

5.

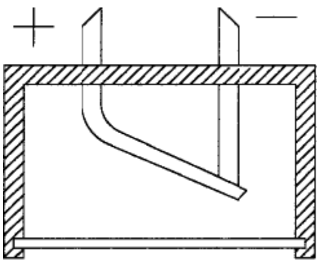


WORKSHEET 40 (Cont.)

When cold and straight the rivet is placed through the hole and is allowed to heat up to room temperature. The rivet then opens up inside the tube and holds the sheet and tube firmly together.

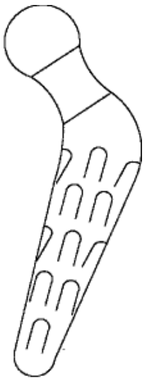


6.



The diagram shows a detector for a fire alarm sprinkler system. When a fire raises the temperature, the positive (+) contact straightens and breaks the circuit, this will trigger the sprinklers.

7.



The diagram shows an artificial hip joint. When it is cooled the teeth lie flat and allow it to be inserted into the top of the thighbone.

When the temperature of the joint rises to that of the body, the teeth curve out and grip the inside of the hole in the bone and stop the joint from moving.

8.

Glasses frames that remember their shape are made from a SMA. If the glasses are sat upon and the frames are twisted, the alloy remembers its room temperature shape and returns to it.