ABRASIVES (sand paper etc.)

sanding block made from cork

rubber sanding block

sheets of glasspaper

After any wooden model has been assembled and before a finish can be applied, it must be sanded down to remove any pencil marks, excess glue, roughness or dirt.

Abrasive sheets can be wrapped around cork or rubber blocks to give a flat even rubbing surface. Cork and rubber are used to ensure the corners do not dig in to your finished model and spoil the smooth surface.

The abrasive sheets come in a wide range of grades from very rough to very smooth. You should start with rough abrasive and work towards very smooth.

SANDING

ORBITAL SANDER

WHAT IS IT ?

A power tool used in the woodwork room

WHAT IS IT USED FOR ?

An orbital sander can take the boredom out of sanding large flat surfaces in woodwork. A sheet of abrasive paper is fixed to the base and the base rotates at high speed in very small circles. This movement produces the rubbing required to remove the top surface of the wood.

BELT & DISC SANDER

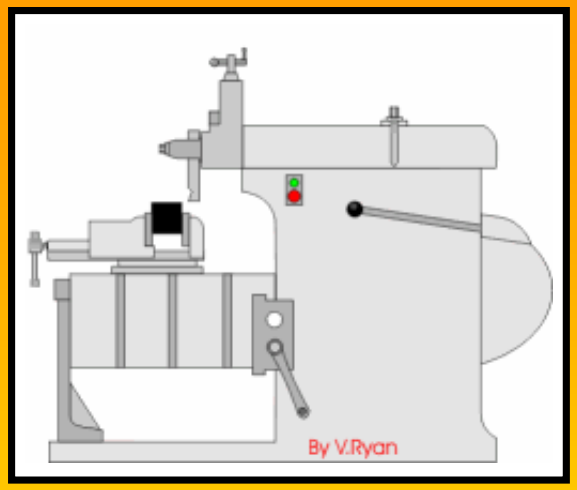
WHAT IS IT ?

A woodwork machine tool

WHAT IS IT USED FOR ?

The belt sander and disc sander is used to produce flat smooth faces on pieces of timber. It is particularly good at achieving smooth faces on the end of a piece of timber. If you have ever tried this by hand you will have found it very difficult to smooth the end grain of a piece of timber by hand.

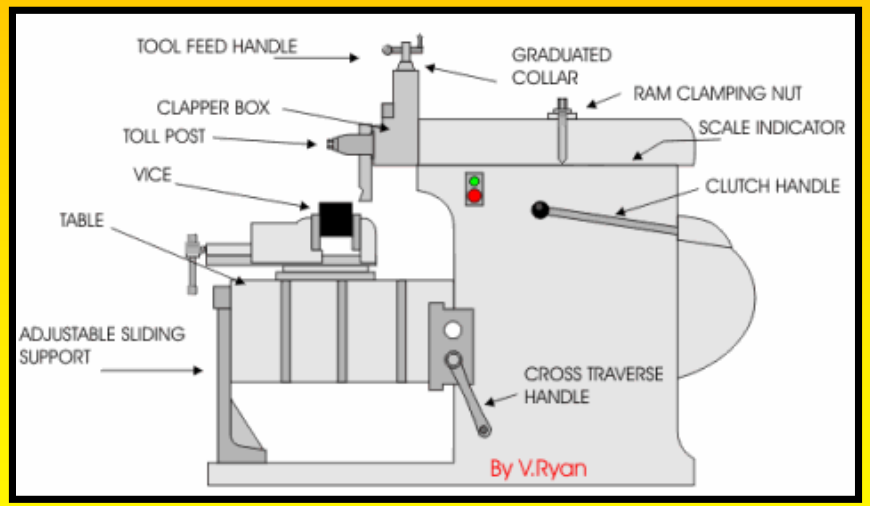
Know the safety precautions for this machine !



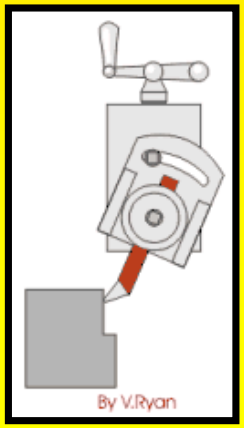
SHAPING

A shaping machine is used to machine surfaces. It can cut curves, angles and many other shapes. It is a popular machine in a factory workshop because its movement is very simple although it can produce a variety of work. They are less common in school workshops, perhaps because of their moving parts which present a high risk.

The main parts are indicated right:

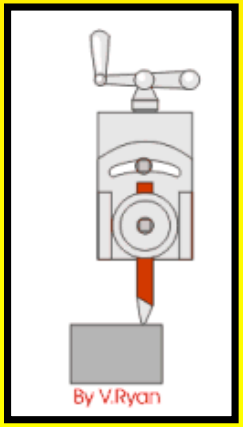


The tool feed handle can be turned to slowly feed the cutting tool into the material as the 'ram' moves forwards and backwards. The strong machine vice holds the material securely. A small vice would not be suitable as the work could quite easily be pulled out of position and be damaged. The vice rests on a steel table which can be adjusted so that it can be moved up and down and then locked in position. Pulling back on the clutch handle starts the 'ram' moving forwards and backwards.



The tool post has been turned at an angle so that side of the material can be machined

The tool post is not angled so that the tool can be used to level a surface.



ADHESIVES (glues)

When putting a wooden model together at the assembly stage, it is important to consider what would be the best adhesive (glue) to use.

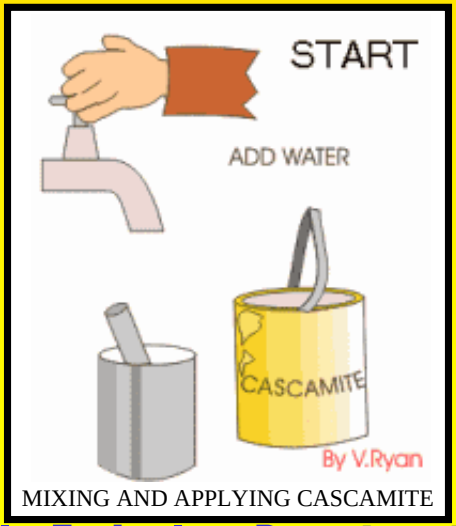
The thing that will determine which is best is where your model is going to be situated when in use. If, for example,you have made a model which will be placed indoors in a dry environment, PVA will almost certainly do the job.If on the other hand,your model will be outdoors or in a bathroom which is liable to get steamed up a lot, you will have to consider using a glue such as cascamite which is waterproof.

PVA – Poly Vinyl Acetate

This glue looks white and creamy and runs reasonably freely. It should be applied <u>all over</u> the joining surfaces in a thin even film. The excess should be wiped away immediately once the joint has been secured.

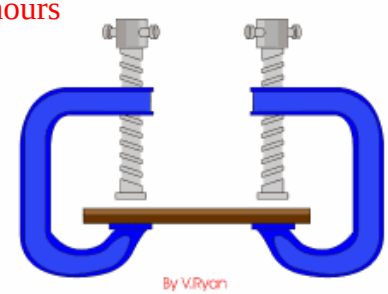
CASCAMITE

This waterproof glue which comes as a powder and has to be mixed with water into a paste. It is then applied in the same manner as with the PVA, clamped and left to set. The finished result is a joint which will hold even when wet.



MIXING AND APPLYING CASCAMITE

When the stages above are complete the pieces are cramped together and left for twenty four hours



APPLYING PVA TO A MODEL

PAINT

VARNISH

WOOD DYE / STAIN

WAX

FINISHES

The choice of finish you put on your model will depend on a lot of things – mainly the material your model is made from though. There are no good and bad finishes, only finishes that are suitable or unsuitable. You should try to understand which finishes to use when.

PAINT

Comes in a huge range of colours, good for indoors and outdoors, gloss paint gives a high shine, some paints are specifically for wood and some for metal, a lot of care has to be taken to achieve a smooth finish.

VARINSH

Designed specifically for wood. It goes on like paint but it lets the grain of the wood come through which some people find attractive. Can have a shiny finish or a more dull finish. It can be waterproof or for indoor work.

WOOD DYE / STAIN

Much the same as varnish except that it is much more ‘runny’ and is applied with a cloth. This has the advantage that you can get a very smooth finish. No brush strokes. It always leaves a dull matt finish though, not shiny.

WAX

After the colour of the finish has been decided by either varnish or stain, wax can be applied to give the finished model a really smooth silky feel to it. The wax is applied by a soft cloth and is rubbed in to the wood in circular strokes.

DRAW FILING

The normal filing technique is fine for the quick removal of a lot of material. You will probably have noticed though, that it tends to leave a pretty rough surface. When you are trying to achieve a highly polished surface with a file you should ‘DRAW FILE’.

Draw filing is shown in the photo here, the important points to note are the angle between the work and the file (around 90^{o}) and how the file is held in both hands without using the handle. So long as the file stays flat against the metal, this should produce a very smooth surface finish.

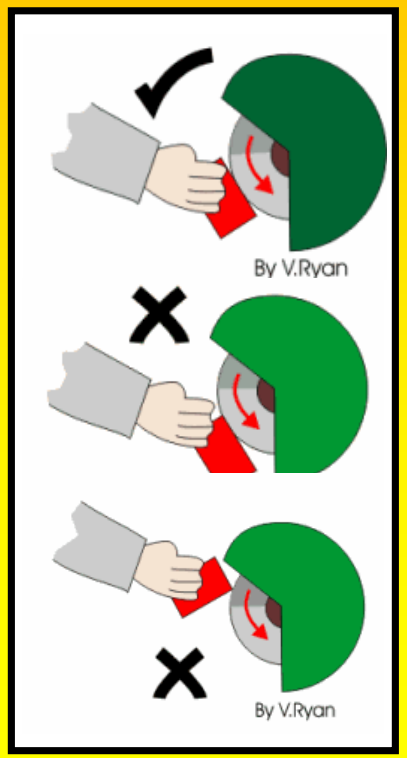
This technique is most often used to polish the edges of acrylic (plastic) sheet but it works equally well on metal.

BUFF / POLISHER

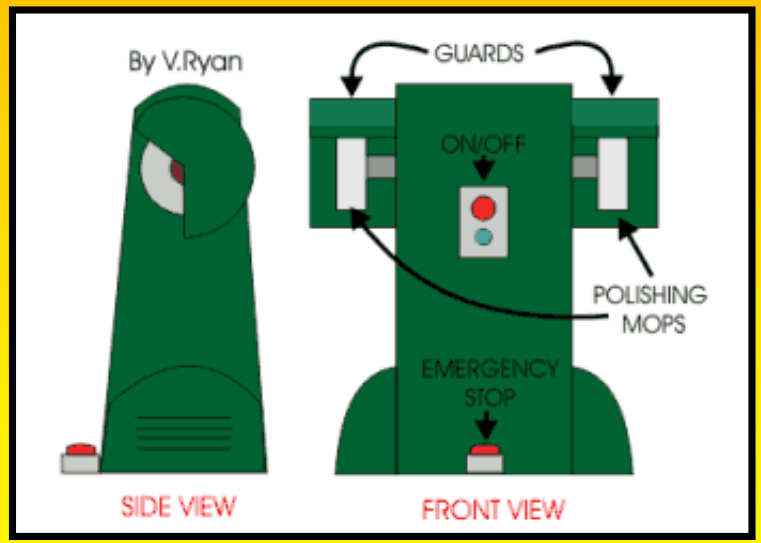
The Polishing Machine (also called the Buffing Machine) is used to polish soft metals including copper and brass as well as plastics such as perspex. The two ‘mops’ spin at high speed when the ‘on’ switch is pressed.

If the material is carefully pressed against the mop and moved backwards and forwards it will be polished.

The material must be filed to removed scratches and then wet and dry paper or emery cloth is used to further smooth the surfaces. Only then can it be polished on the buffing machine.



The diagram on the left shows the correct way to hold the work and how it should be pushed gently against the rotating mop. The work should be held firmly in both hands and moved backwards and forwards against the lower part of the mop. If the work is held in one place the mop will wear quickly making it difficult to polish materials. Use the full width of the mop. Great care must be taken so that the top corner of the work is not caught by the rotating mop. If this happens the work will be ripped from both hands and it will fly at high speed into the guard. When this happens it can be quite frightening.



The second example is clearly a dangerous way to hold the work as the top corner is about to be caught by the rotating mop.

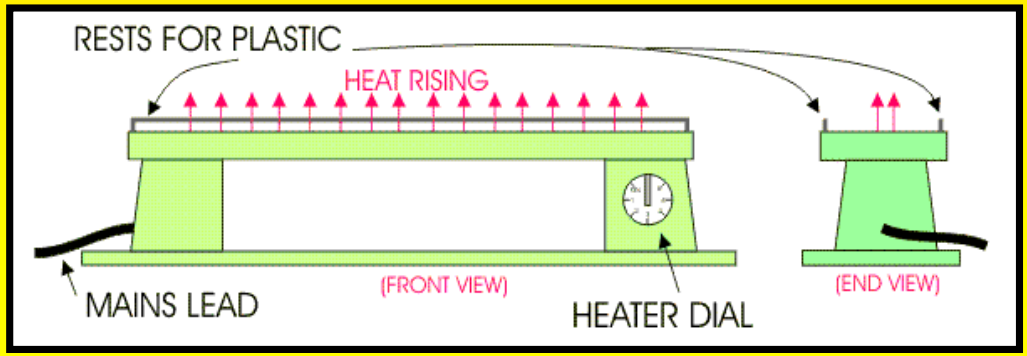
In the third example, another dangerous accident is about to take place. The work is about to be pressed against the top part of the mop. This should be avoided as the work will be ripped out of the machinists hands and it will fly out at high speed towards him/her.

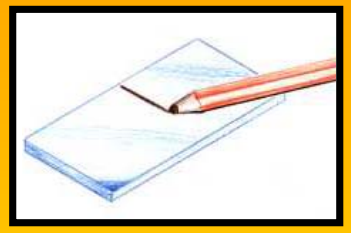
CRAFT & DESIGN

STRIP HEATER

Plastics such as *acrylic* can be formed (shaped) in different ways. One of the most popular methods of shaping plastic materials like acrylic is to fold (bend) it on a 'strip heater', at different angles. A photograph of a strip heater is shown above along with a simplified diagram below.

A heating element extends along the length of the strip heater and gives off intense heat when it is turned on.



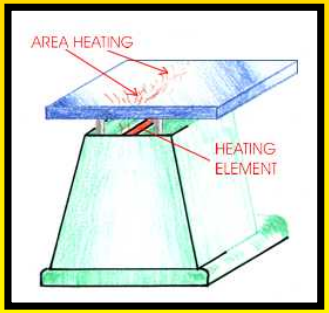


STEP 1

The position of the fold is marked with a *china-graph* pencil. With this type of pencil the line can be removed easily later.

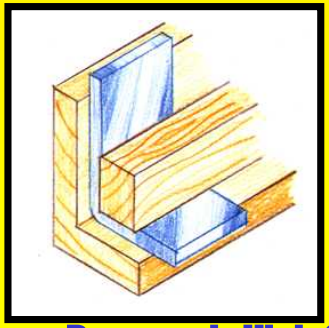
STEP 2

The strip heater is turned on and set at the correct temperature.



STEP 3

The plastic is placed across the rests, above the heating element turning the plastic over every 30 seconds. This stops the heat from the element damaging the surface of the plastic.



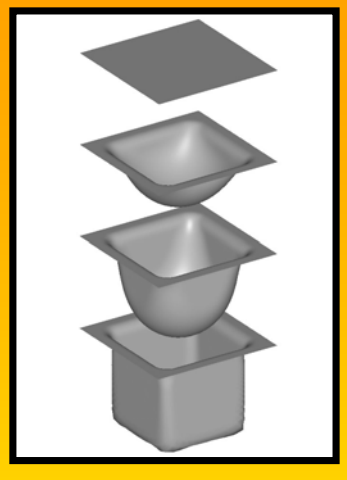
STEP 4

When the plastic becomes flexible it is placed in a 'jig'. The jig is made to the correct angle, in the example opposite – 90°. A square section block is then pressed against the plastic to hold it as it cools.

CRAFT & DESIGN

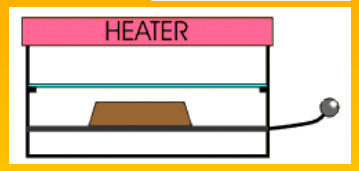
VACUUM FORMING

Vacuum Forming is a technique that is used to shape a variety of plastics. In school it is used to form/shape thin plastic, usually plastics such as; polythene and perspex. Vacuum forming is used when an unusual shape like a ‘dish’ or a box-like shape is needed. To the right you can see the stages involved in vacuum forming.

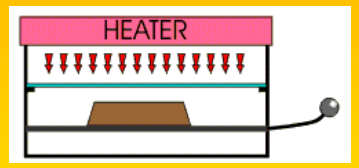


A flat plastic sheet goes through the vacuum forming process from start to finish.

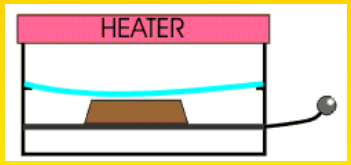
STEP 1
First, a former is made from a material such as a soft wood.



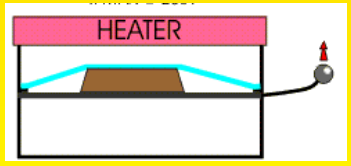
STEP 2
The former is placed in the oven and a sheet of plastic (for example, compressed polystyrene) is clamped in position above the mould.



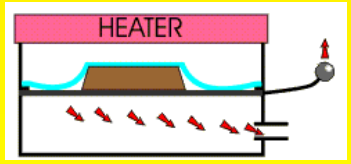
STEP 3
The heater is then turned on and the plastic slowly becomes soft and pliable as it heats up. The plastic can be seen to 'warp' and 'distort' as the surface expands.



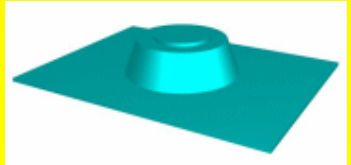
STEP 4
After a few minutes the plastic is ready for ‘forming’ as it becomes very flexible.



STEP 5
The heater is turned off and the mould is moved upwards by lifting the lever until it locks in position.



STEP 6
The 'vacuum' is turned on. This pumps out all the air beneath the plastic sheet. Atmospheric pressure above the plastic sheet pushes it down on the mould. When the plastic has cooled sufficiently the vacuum pump is switched off.



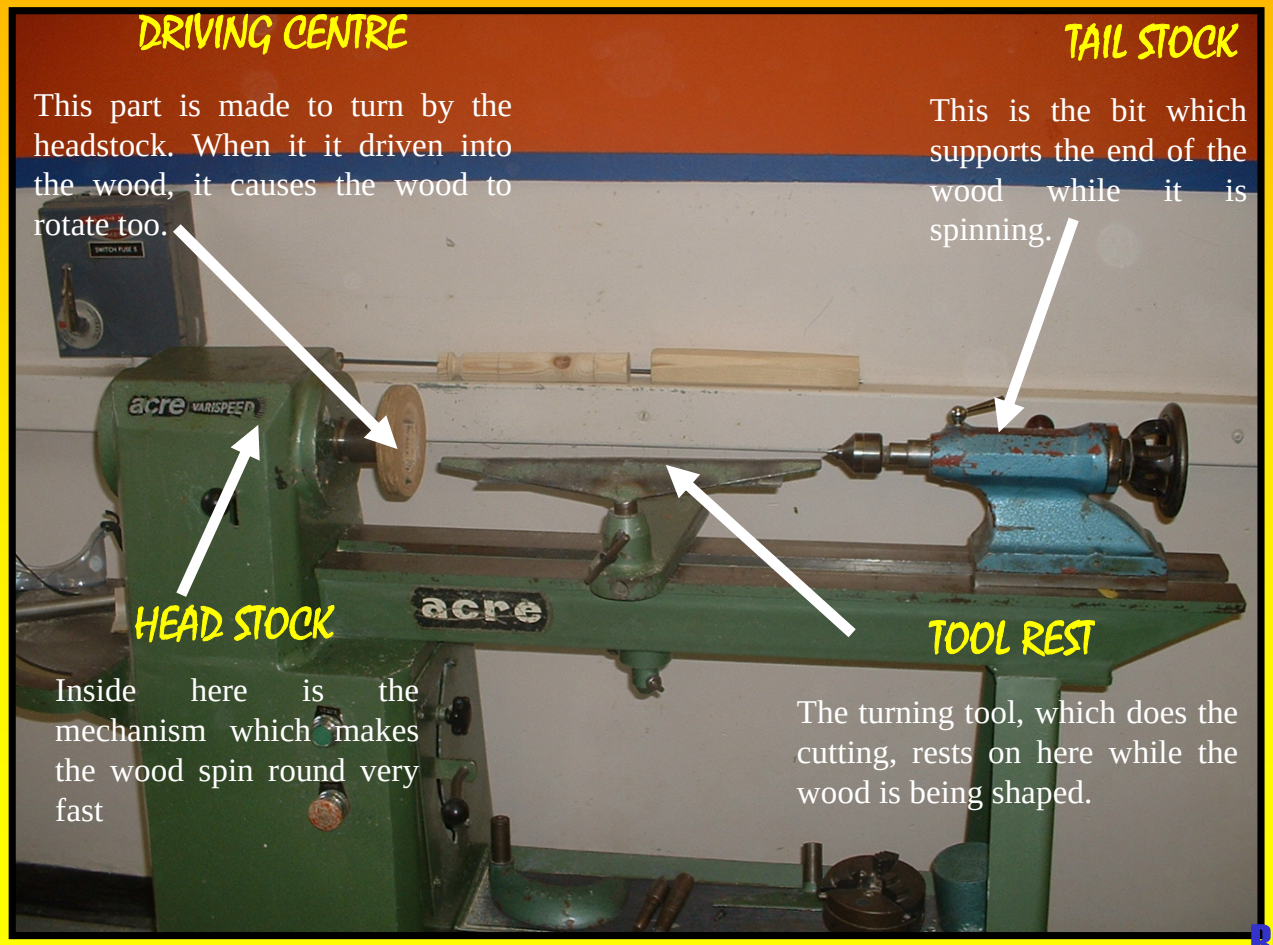
STEP 7
The plastic sheet is removed from the vacuum former. The sheet has the shape of the former pressed into its surface.

CRAFT & DESIGN

WOOD TURNING

Take a look at this photo of our wood lathe. Get to know the names of the important parts of the lathe, you might be asked to name and describe them in the exam.

It might be useful also to know the names of the most common turning tools and be able to describe what they do.



SKEW CHISEL

Skews are the basic chisels used in spindle turning for cutting beads, shearing the ends of boxes or cylinders and smoothing cylinder edges.

ROUGHING GOUGE

Designed for taking a square piece of wood down to round.

PARTING TOOL

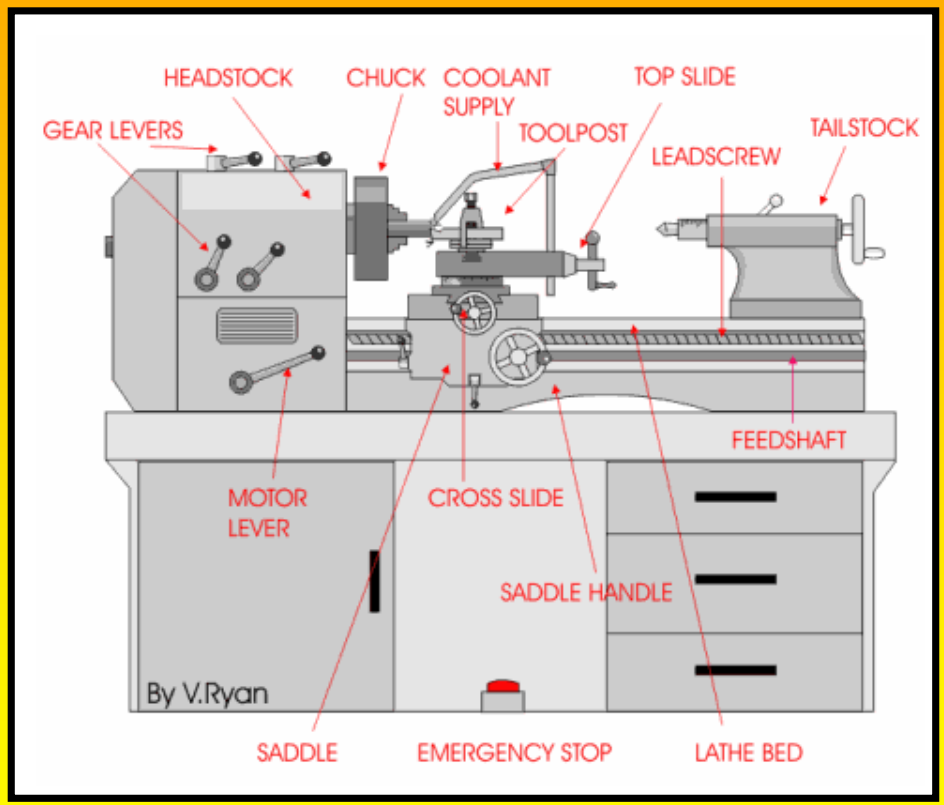
Creates a gap in the wood and is used to cut off a section of the wood to an exact length (part off).

ROUND NOSED SCRAPER

Perfect for achieving a smooth finish after shaping has been completed by other tools.

METAL TURNING

The Centre Lathe is used to manufacture cylindrical shapes from a range of materials including; steels and plastics. These may be lathes operated directly by people (manual lathes) or computer controlled lathes (CNC machines) that have been programmed to carry out a particular task. A basic manual centre lathe is shown below. This type of lathe is controlled by a person turning the various handles on the top slide and cross slide in order to make a product / part.



The tools that do the cutting all have specific jobs and they are named below ;

KNURLING TOOL

Used to produce the diamond pattern on metal objects which is often used to give them 'grip'

PARTING TOOL

Used to remove the workpiece at the end of the turning process by 'parting off'

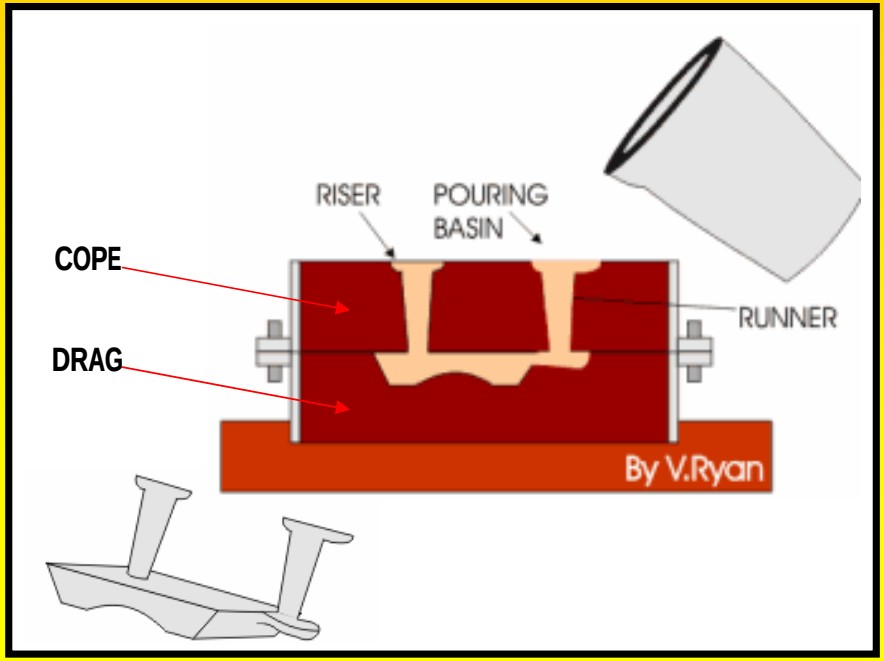
TURNING TOOLS

Left and right facing tools used to turn the metal down in cuts in both directions.

CASTING

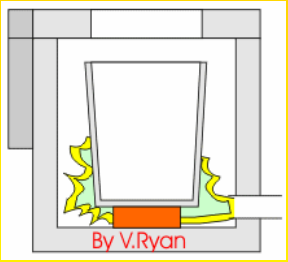
The process of sand casting involves taking a wooden pattern of the thing you want to create in metal, placing it in a box of sand,splitting the box and removing the pattern, pouring molten metal into the space where the pattern used to be then removing the metal once it has cooled down and hardened. That is the basic idea although there is a lot more to it and great care has to be taken as the molten metal is extremely hot.

Aluminium is often used as it has a pretty low melting point. The box is split into two parts – the top half is called the **COPE** and the bottom half is called the **DRAG**. While pouring, the molten metal enters through a hole that has been created in the sand called a **RUNNER** and as the space fills up, air escapes out of another hole called the **RISER**.

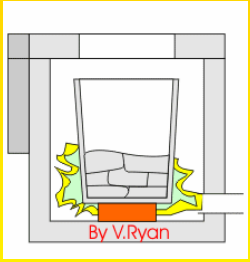


CRAFT & DESIGN

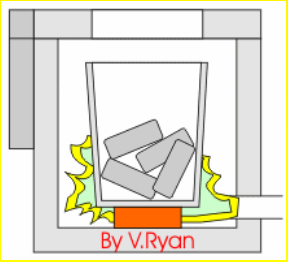
CASTING



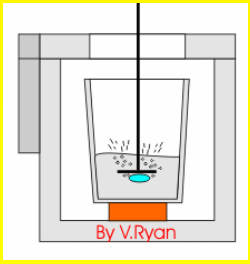
PREHEATING - The crucible is first preheated. This removes any moisture from the furnace and crucible. Usually the gas is turned half on in order to avoid rapid heating. The aluminium ingots to be used are placed on top of the furnace so that they warm up.



ADDING FLUX - As the aluminium begins to melt a small amount of 'flux' is sprinkled over the aluminium. A spoon can be used to sprinkle the flux powder. The flux prevents oxidisation (oxygen entering the molten aluminium). If oxygen enters the molten aluminium, when it is poured into the mould the final casting can have bubbles which can ruin the finish of the cast shape.



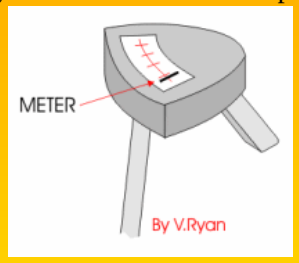
CHARGING WITH ALUMINIUM - once the crucible and furnace have been preheated the lid/top is pulled to one side with a steel hook. Aluminium ingots are then placed into the crucible with steel tongs. All steel tools such as tongs are pre-warmed. The gas pressure is turned up to full.



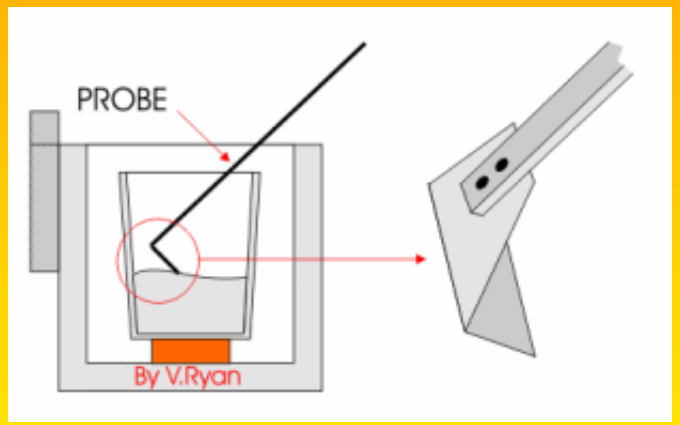
ADDING A DEGASSING TABLET - When the aluminium has melted fully and is approximately 700 degrees centigrade the gas is turned off and a degassing tablet is added. This removes any impurities, in the form of gas. It is important that a good extraction system is used to remove the fumes caused by the tablet.

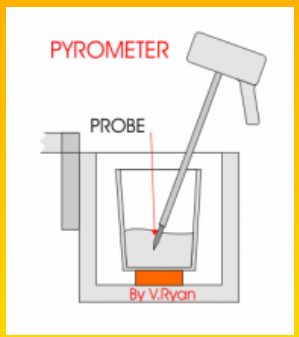
CASTING

TEMPERATURE CONTROL - Judging the temperature of the molten aluminium is sometimes difficult. Using a pyrometer, the instrument used for testing temperature, allows accurate measurement. The pyrometer is first warmed over the furnace to evaporate any moisture and then it is placed into the molten metal The temperature can be read on the meter, near the handle.



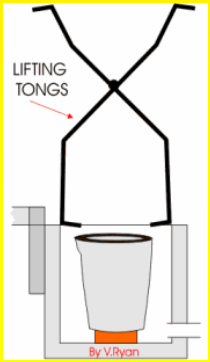
When the temperature reaches 650 degrees it is ready for pouring but first the 'dross' (waste that collects on the surface of the aluminium) must be removed with a special tool.

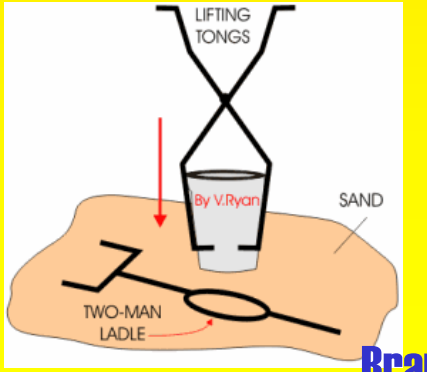




CRUCIBLE LIFTED OUT OF FURNACE - The sliding lid/top of the furnace is pulled back using a steel hook. This allows special lifting tongs to be placed around the crucible which can then be lifted up and away from the furnace. The crucible is set to rest in a bed of sand which surrounds the furnace. The crucible should never be allowed to rest directly on a the cold concrete floor as this could cause an explosion.

This process should never be carried out by a pupil. Great care is needed as the molten aluminium is at a very high temperature.



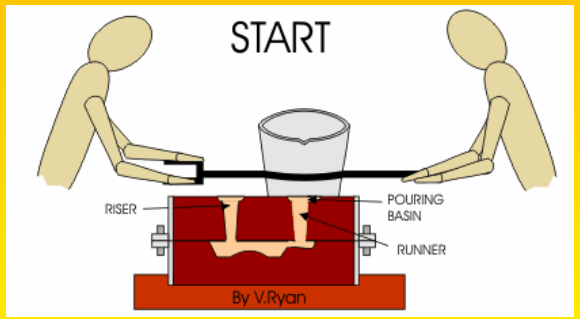


CASTING

POURING THE ALUMINIUM - The two man ladle is then lifted which raises the crucible from the floor. The teacher must always control the pouring of the molten metal and so holds the two handles. The second person (possibly a pupil) holds the single handle allowing it to revolve when the ladle is turned for pouring by the teacher. A third person stands behind the crucible and uses a steel steady to prevent the crucible from falling out of the ladle.

The aluminium is poured into the runner and when the cavity is full is rises up the riser. The flow of aluminium should be constant, if there is even a short break in pouring the cast aluminium it may cool and the cast may be imperfect.

SAFETY CLOTHING MUST BE WORN !!



The third person stands behind the crucible and uses a steel steady to prevent the crucible falling forward and out of the ladle.

QUESTIONS:

1. Sketch the stages involved in the use of a furnace to prepare aluminium ingots for casting.
2. Explain the need for safety clothing / equipment when casting.

CRAFT & DESIGN

FORGING

Hardening – Some steels, usually those with a greater percentage of carbon in them, can be hardened by heating and cooling rapidly. The metal is heated to above its upper critical temperature and cooled rapidly and evenly in water. This makes the metal so hard that it is very brittle and because it breaks so easily is not much use for many purposes. The very hard steel can further be heat treated to make it softer by stages to make it more useful. This process is called TEMPERING.

Tempering - The hardened steel is first cleaned to make it bright in appearance. It is then gently heated until it starts to change colour. first it goes to a pale straw colour, then straw, dark straw, brown, brown/purple, purple, dark purple then blue. The paler the metal the harder and more brittle it is. The darker the metal the springier and tougher it is.

This list gives an idea what types of uses may be given to steels tempered at different stages. The list is merely a sample and many other objects which are required to be harder than the normal are first hardened and then tempered in this way.

COLOUR	HARDEST	APPROXIMATE TEMPERATURE (°C)	USES
Pale straw		230	Lathe tools, scrapers, scribers
Straw		240	Drills, milling cutters
Dark straw		250	Taps & dies, punches, reamers
Brown		260	Plane blades, shears, lathe centres
Brown/purple		270	Scissors, press tools , knives
Purple		280	Cold chisels, axes, saws
Dark purple		290	Screwdrivers, chuck keys
Blue	TOUGHEST	300	Springs, spanners, needles

DIP COATING

When making models in metal, they may be painted at the end but they may also be coated in a thin plastic film by a process known as DIP COATING. This has a few advantages over painting in that it can be quicker, achieve a more even covering and the plastic coating can be more hard wearing than paint. It does however require a fair bit of specialist equipment and takes a bit of setting up but the results can often make it well worthwhile.

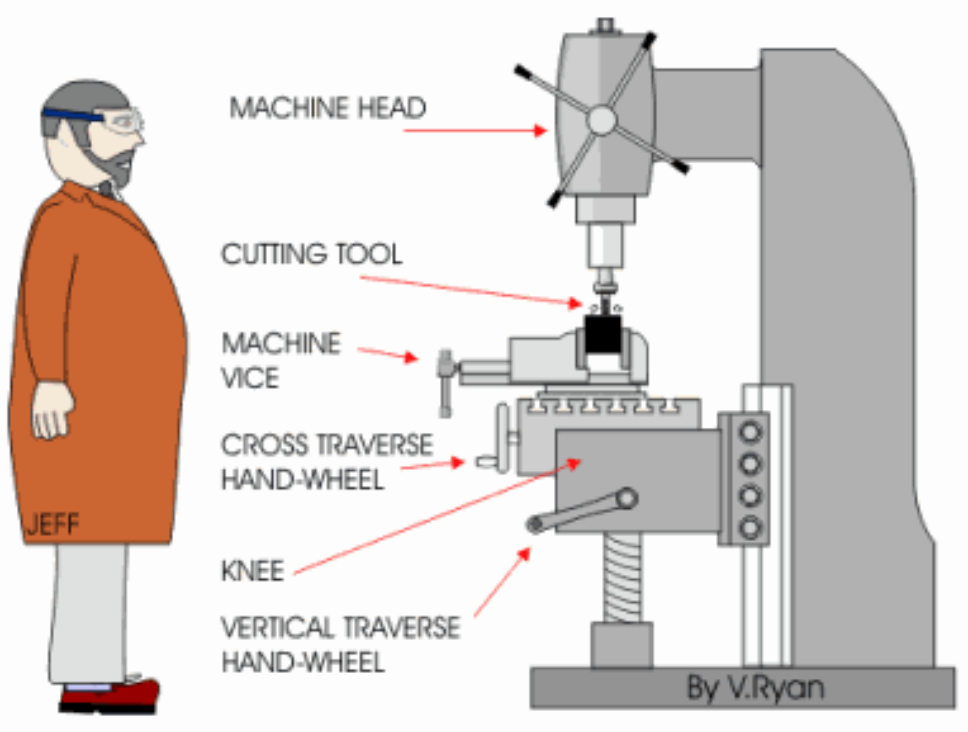
HERE IS HOW IT IS DONE :

The FLUIDISER is basically a big drum full of plastic granules. Air is blown into the drum from the bottom and this causes the granules to float around in the drum like a cloud.

The previously prepared metal part is heated in an oven at a constant temperature ranging between 300º C and 450º C, depending mainly on the size of the model. As soon as it is removed from the oven, it is placed for three or four seconds in the powder floating around in the fluidiser. When the powder comes into contact with the hot metallic surface it melts and coats the metal part evenly. The part is removed from the fluidiser and hung to cool down.

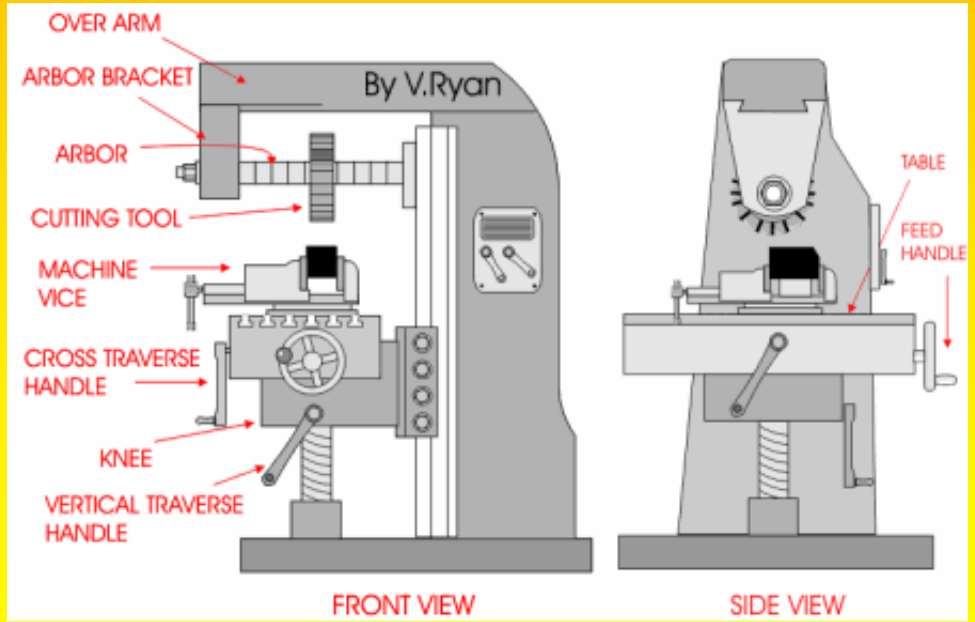
MILLING

A Vertical Miller is used to shape metals such as mild steel and aluminium. It can also be used to shape plastics such as perspex and nylon. Full size milling machines such as the one shown below are powerful but also very accurate/precise. The cutting tools are very expensive and are broken easily if the machine operator tries to take too deep a cut, in one go.



VERTICAL MILLING MACHINE

The Horizontal Milling Machine is a very robust and sturdy machine. A variety of cutters are available to removed/shape material that is normally held in a strong machine vice. This horizontal miller is used when a vertical miller is less suitable. For instance, if a lot of material has to be removed by the cutters or there is less of a need for accuracy - a horizontal milling machine is chosen.



HORIZONTAL MILLING MACHINE

OVEN

The oven you may well have at home might look a lot like the one which gets used in the workshop. There is nothing fancy in either – a metal box with a heating element and a thermostat to allow us to set the temperature at the level we need.

In the workshop we would tend to use the oven for heating things such as small-ish metal objects that are going to be dip coated.

Also, if we had acrylic (plastic) which we wanted to shape, we could heat it in the oven first. If we wanted to put a bend or corner in the acrylic then obviously a strip heater would be best. However, if we wanted to heat the acrylic all over the oven would give us the best result.

TAPPING A HOLE

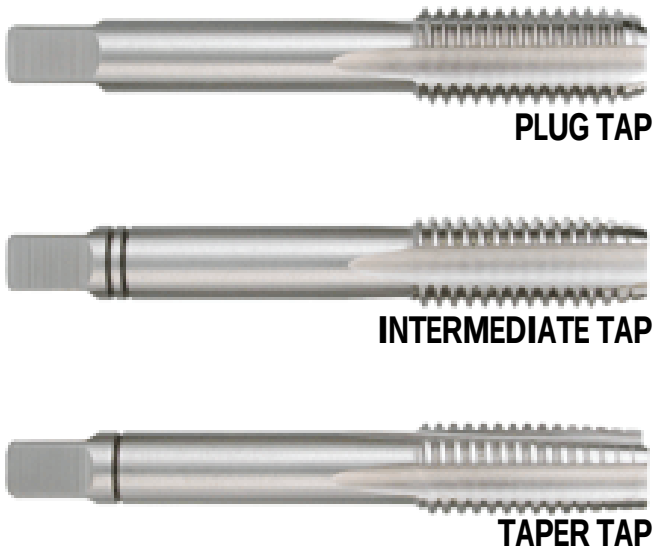
HOLE BEING TAPPED

Putting a thread into a hole in metal requires a cutting tool which is both very hard and very sharp.

Taps are made in a wide variety of sizes and are designed to fit into holes drilled in metal so that when they are spun around, they cut into the metal leaving a thread after they have been removed.

The tool which makes the taps turn around is called a tap wrench.

SET OF TAPS AND DIES



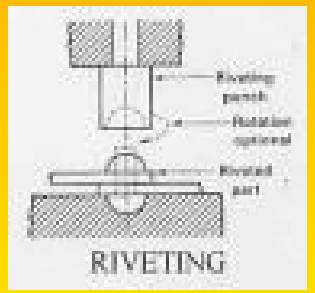
PLUG TAP

INTERMEDIATE TAP

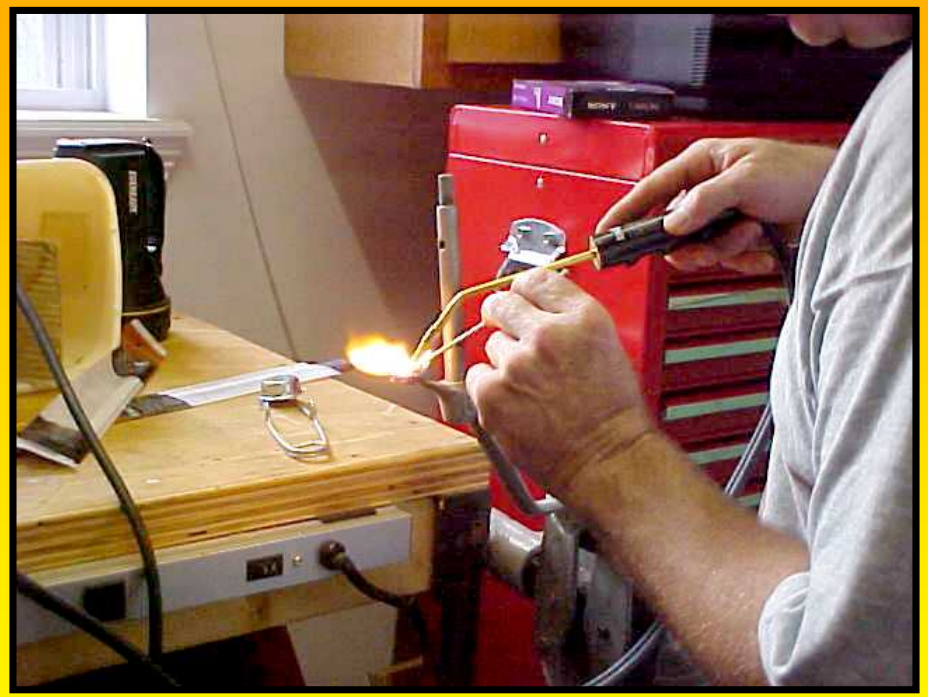
TAPER TAP

Notice how the three taps in the set are very slightly different. The Taper tap is the one you would start with – it is slightly more pointed to give a gradual, easier start. You would finish with the Plug tap. This would allow you to get the thread right down to the bottom of the hole. The Intermediate tap would go second.

RIVETING

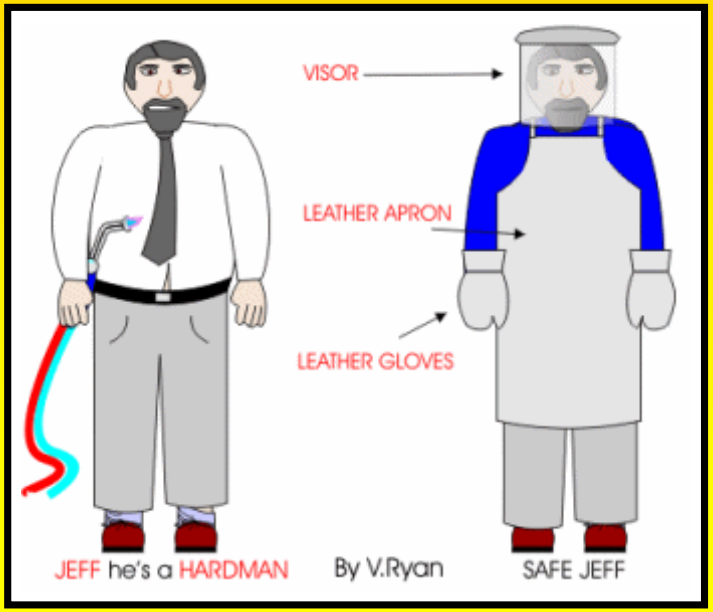


BRAZING



Brazing is a welding process which basically takes two pieces of metal which require to be joined together, heats them up using a gas torch and applies glue to them in the form of molten metal.

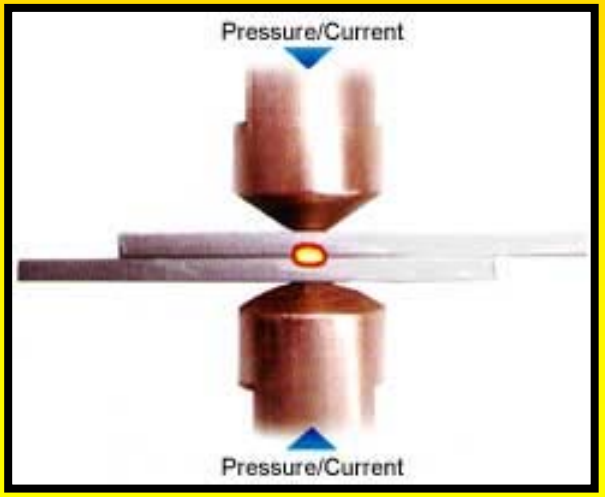
First the metal to be joined is thoroughly cleaned. Then heat is applied very evenly around the joining area. A soft metal brazing rod is then introduced to the flame and allowed to heat up. As it heats up it melts and runs into the joining area. When it cools down the molten metal from the rod hardens and acts like a glue holding everything together.



The equipment used in brazing could be extremely dangerous if not used with great care and with the correct safety equipment. Take a look at the animation on the right to find out what you should be wearing when you are brazing.

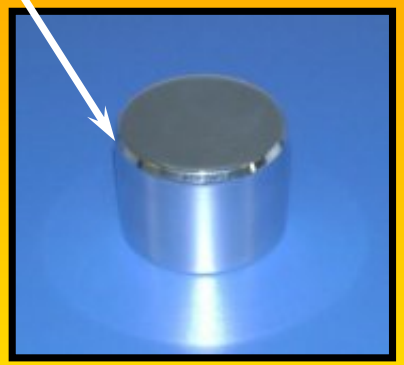
SPOT WELDING

Spot welding is the process of joining two or more metal parts together in a localised area by the application of heat and pressure. The heat is produced by the resistance of the material to carry a high electrical current. The greater the path of resistance is, the higher the heat intensity. This heat is controlled via time application and level of current applied. The pressure is applied to forge the joint and consolidate the nugget to provide the weld strength. No other materials such as rods, fluxes, inert gasses, oxygen, or acetylene are required.



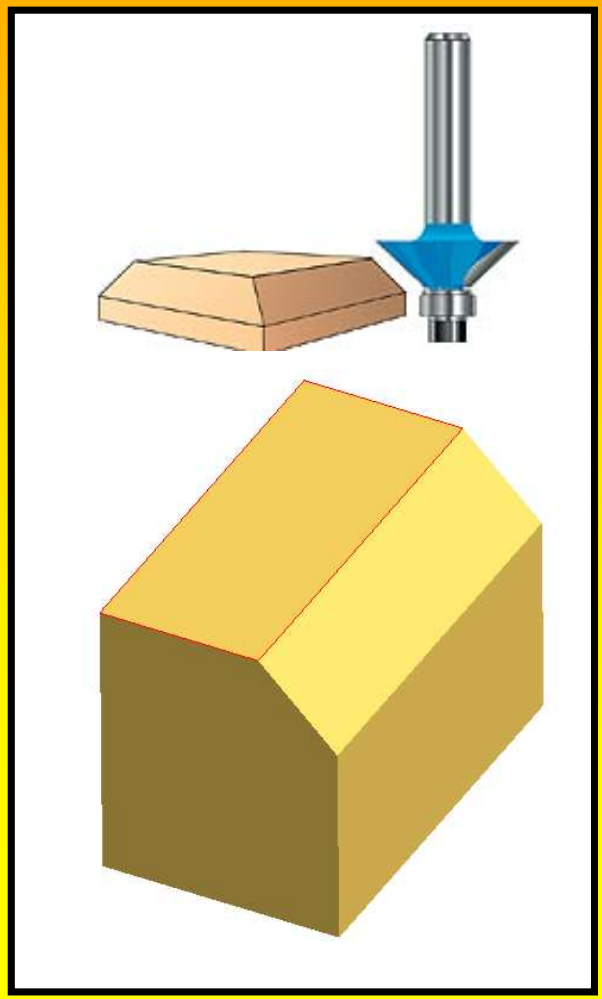
CHAMFERING

chamfered edge



There are many situations in the design of models and everyday objects where sharp corners have to be avoided. Sometimes because of looks but more often for safety reasons, 90º corners are taken away from models where possible.

The process of removing the point of a 90º corner is called chamfering. A corner can be chamfered with a file, with a plane, with a sander or with a specialist tool as shown on the right.

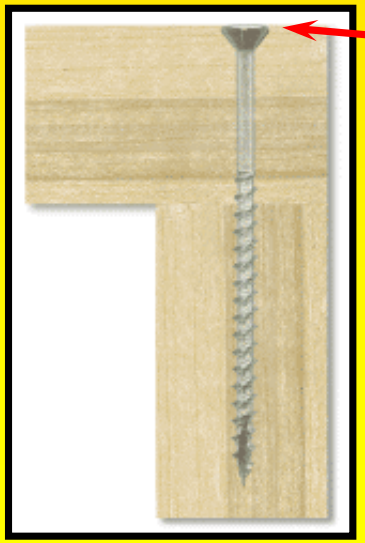


COUNTERSINKING

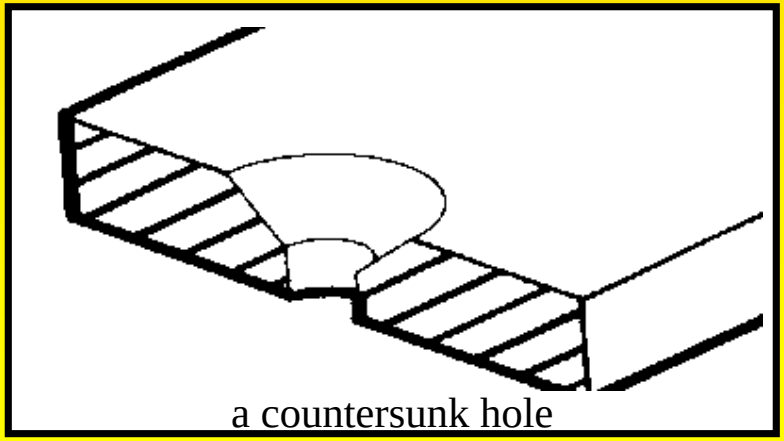
This is the countersink drill bit which is placed in the chuck of the drilling machine and produces the angled hole which makes the countersink.

When a screw is driven into a piece of wood, it sometimes doesn't matter that the head of the screw is sticking up out of the wood. Sometimes it matters a lot and it has to be avoided.

When this is the case, a countersunk screw is used. The special shape of the head allows it to go 'flush' with the surface of the wood. To work best of all, the hole should be prepared for the screwhead to fit into it. It is prepared using a countersink drill bit in the manner shown below. The head of the countersunk screw will now fit snugly into the prepared hole



Notice how the head of the countersunk screw is 'flush' with the surface of the wood.

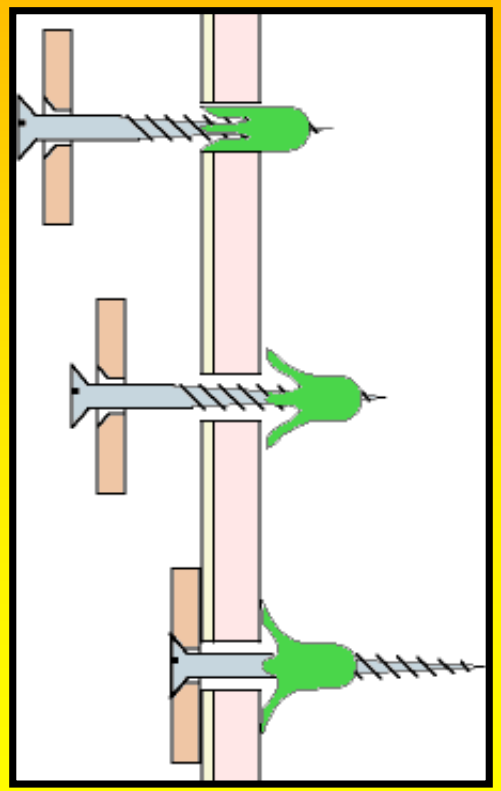


a countersunk hole

FIXING TO A WALL

To fix items to a wall, you have to pay particular attention to what the wall is made from. After you go under the surface of most walls, you quickly meet the kind of material which a screw would find it difficult to really ‘bite’ into. Materials such as plaster or brick would simply crumble when the screw was tightened.

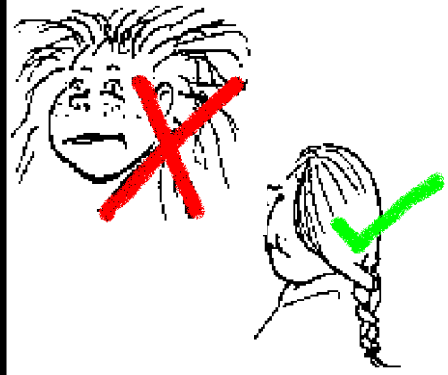
To get round this problem, a hole is drilled deep enough for the screw. A small plastic insert (shown green) is placed in the hole and this acts as a grip for the screw.



CRAFT & DESIGN

WORKSHOP SAFETY

ALWAYS PROTECT YOUR EYES
you won't get another pair

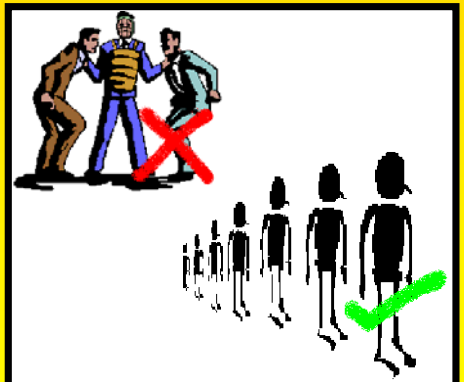


IF YOUR HAIR IS LONG ENOUGH
tie it back

LOOSE CLOTHING AND
JEWELLRY IS DANGEROUS
make sure nothing is hanging loose

Click here to see the Safety Unit first years get when they first come to the Department

Here are a selection of some of the safety notices you will see around the various workshops in the Department. They will give you good general safety advice. Mostly you should find that they are all describing simple good behaviour which, in itself, will help you avoid most dangerous situations.



IF QUEUING TO USE THE MACHINE
don't distract the current user or fool around

PLEASE SWEEP THE MACHINE DOWN
as soon as you are finished