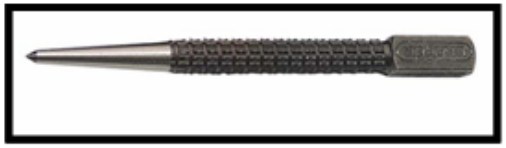
Craft & Design General Notes

Tools & Equipment

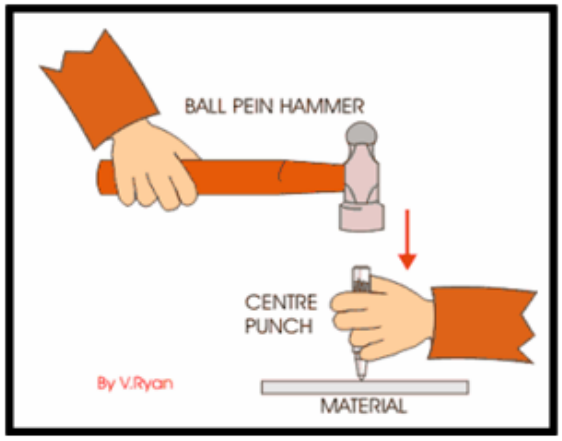
CENTRE PUNCH

WHAT IS IT ?

A centre punch is a metalworking tool which is used to produce a small dent in metal which acts as a starting point for any hole to be drilled.



Square section striking head with knurled body and polished ends. Manufactured from carbon steel hardened and tempered.



WHAT IS IT USED FOR ?

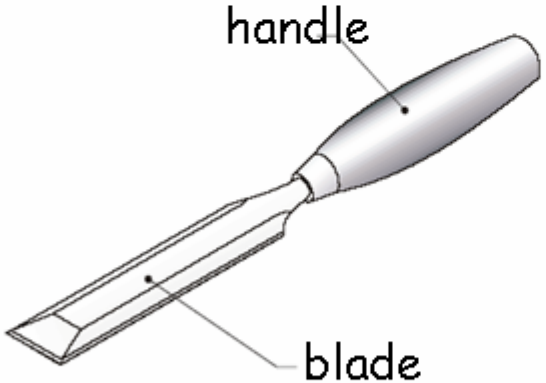
A ball-pein hammer is used to tap the head of the centre punch and this delivers enough force to the point of the punch to put a small dent into the surface of the material.
It is important to have the material supported underneath by a solid surface.

The centre punch shown above is an `Automatic` centre punch. A spring inside the punch means that when downward pressure is put on the punch by hand, it automatically `clicks`, producing the required dent without the need for a hammer.

CHISELS

WHAT IS IT ?

A chisel is a woodworking tool used to shape wood. It has a wooden or plastic handle and a metal body with a point which has been hardened and ground to a razor edge. There are many kinds of chisels. Two common ones are shown in the drawings below.



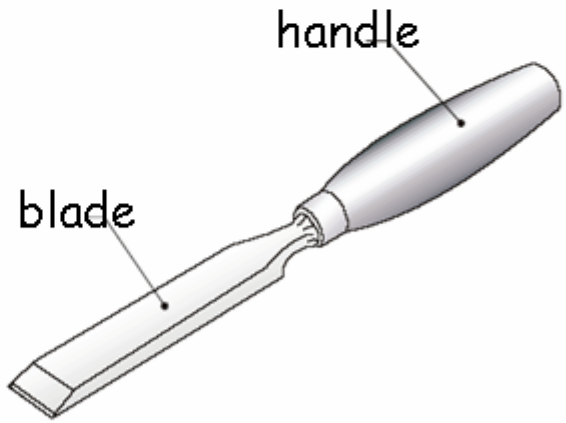
Bevel Edged Chisel - a light weight chisel which should be used mainly for hand driven work.

WHAT IS IT USED FOR ?

Chisels have many purposes, all to do with the shaping of pieces of wood.

When cutting joints, the shaping of the end of the piece of wood will often be done with a chisel.

Pressure can be applied to the handle either by hand or with a wooden mallet – depending on the type of work and kind of chisel being used.



Firmer Chisel - a basic general purpose chisel with a rectangular section blade.

CLAMPS etc.

WHAT ARE THEY ?

When working in the workshop, you will often have found that you did not have enough hands to do everything you wanted to do. Some operations require both hands which leaves you with the problem – how to secure the material while you are working on it.

There are a wide variety of clamps for a wide range of situations

WHAT ARE THEY USED FOR ?

1 ***METALWORK VICE*** – Very strong, used to hold metal while it is being cut at a workbench

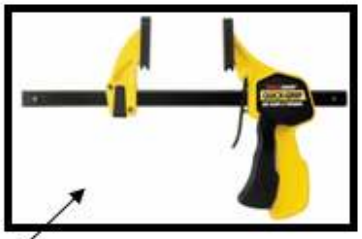
2 ***WOODWORK VICE*** – Mounted on a workbench, this vice holds wood in place when being cut

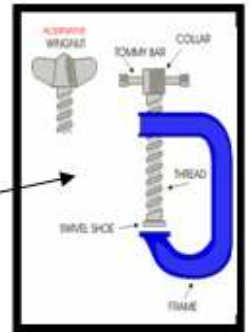
3 **SASH CRAMP** – These are used to hold furniture etc. together while being `glued up`

4 ***SPEED GRIP*** – Lightweight, these are used for convenience as an extra pair of hands for small jobs

5 ***MACHINE VICE*** – Used to hold pieces of wood and metal while they are drilled etc. Sits on the machine table

6 ***G CLAMP*** – General purpose clamp, mainly used for clamping items to the bench





COLD CHISEL

WHAT IS IT ?

A metalwork tool which is struck with a hammer. It has a tip which has been ground to a precise shape (see photo). The tip has been specially hardened so that it stays sharp longer.

WHAT IS IT USED FOR ?

In the same way that wood can be chiselled, metal can be also. It is a much tougher process but the idea is much the same. The metal to be chiselled is held in a vice securely and the chisel is struck with a heavy hammer. The removal of material is much slower when chiselling metal but it can still be done.

The metal being chiselled need not be heated up to soften it, hence the name – Cold Chisel.

CORDLESS DRILL

spare battery

WHAT IS IT ?

A power tool for drilling holes

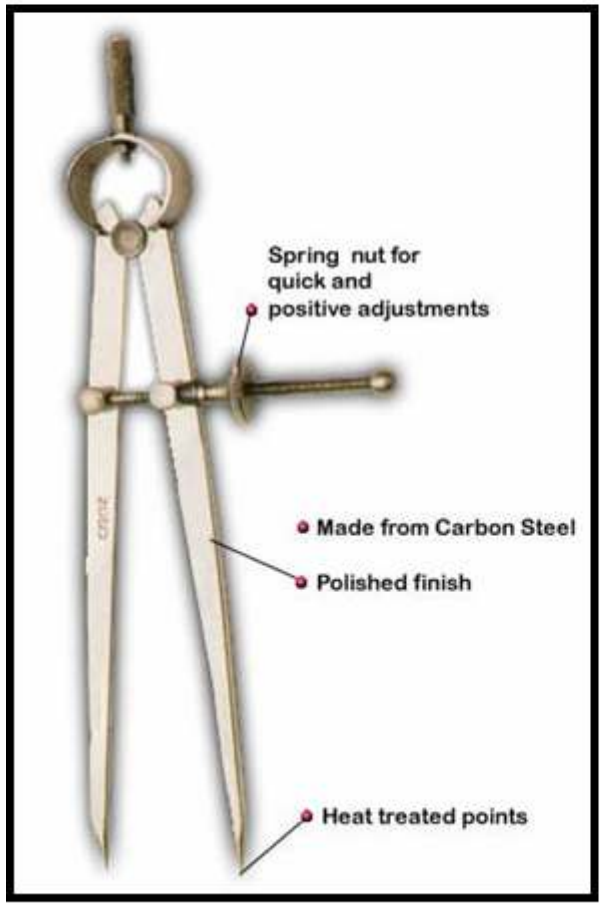
WHAT IS IT USED FOR ?

It can very often be awkward to drill holes in wood, metal or plastic using a pedestal drill. The shape or size of the material being drilled might mean you cannot use the standard workshop drilling machine.

A cordless drill can often be much more convenient in these situations although, because it is being held by hand, it might well not produce a hole which is as accurate as the one you would get using a pedestal drill.

Cordless drills are often supplied with an extra battery which allows on to be charged while the other is being used. The batteries generally clip into the base of the drill.

SPRING DIVIDERS



WHAT ARE THEY ?

Spring Dividers are a Metalwork marking out tool. They look and behave a lot like compasses. They have two legs which are hinged and can open and close by rotating a small nut. Instead of a point and a pencil, Dividers have two points. Both points are hardened to stay sharp for longer.

WHAT ARE THEY USED FOR ?

Dividers are used to mark out shapes onto sheet metal. They are used just like compasses to scrape circles and arcs onto the metal.

They work best if a small indent is placed on the sheet metal using a centre punch for one of the legs to rest in.

DRILLS & CENTRE DRILL

WHAT ARE THEY ?

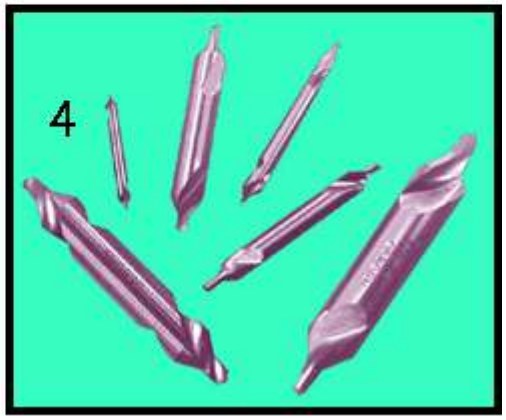
Sharpened steel devices for creating holes in solid objects

WHAT ARE THEY USED FOR ?

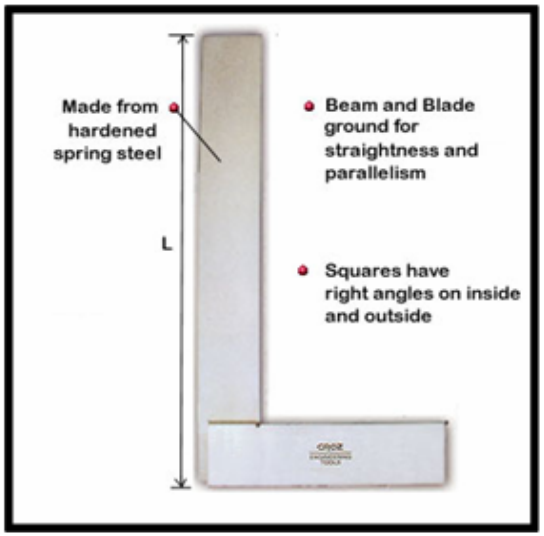
Drills are placed securely in the chuck of drilling machines and rotated at speed. Because of the hardness of their tip and the exact angles that the tips are ground at, the drill will begin to bore a hole into most materials. The type of drill shown in fig. 1 is designed to drill into wood and metal.

As you can see in fig. 2, drills come in a vast range of sizes. When the drill is being secured in the chuck of the drilling machine, it is tightened using a chuck key, usually like the one shown in fig. 3.

To ensure the hole starts at exactly the right place, a centre drill can be used – see fig. 4. These are more sturdy than ordinary drills and can start the hole without the need for a centre punch mark.



ENGINEERS` SQUARE

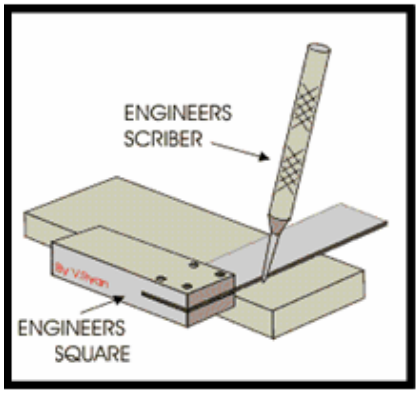


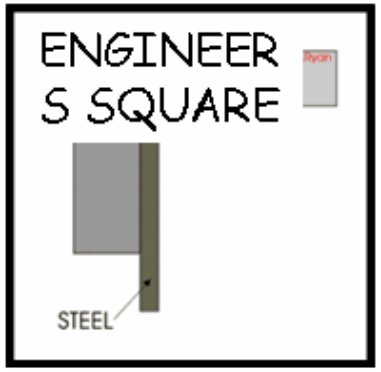
WHAT IS IT ?

An engineers` square is a metalwork tool used to mark out lines at right angles to an edge on metal.

WHAT IS IT USED FOR ?

The square is pushed against a straight side of the material (e.g. steel). An engineers scriber is then used to scratch a line onto the surface of the metal at right angles to the edge. Sometimes engineers blue (a dye/ink) is wiped onto the surface first so that the scratched line can be seen easily. The material is then cut down to this straight line.





Look closely at an engineers` square, you should see an interesting feature. There should be a small slot that has been cut into the stock. This prevents small burrs caused by filing from altering the try-squares accuracy. Dirt can also collect on metal surfaces, again the slot helps prevent measuring angles inaccurately.

In the example seen opposite, the engineers` square is used to test that a 90º angle exists across the edge of the steel. Although a burr exists on the edge of the steel it fits into the slot and does not affect the way the engineers` square is used.

FILES

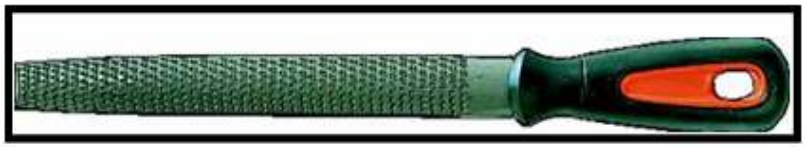
ROUND FILE

FLAT FILE

HALF ROUND FILE

THREE SQUARE FILE

RASP



WHAT ARE THEY ?

Files have wooden or plastic handles with a metal body. On the metal body are thousands of tiny teeth. In smooth files, these teeth are small. In rough files, these teeth are larger.

WHAT ARE THEY USED FOR ?

Files are used for removing material from either metal, wood or plastic. Sometimes the material is being removed to create a smooth edge. Sometimes to create a new profile (shape).

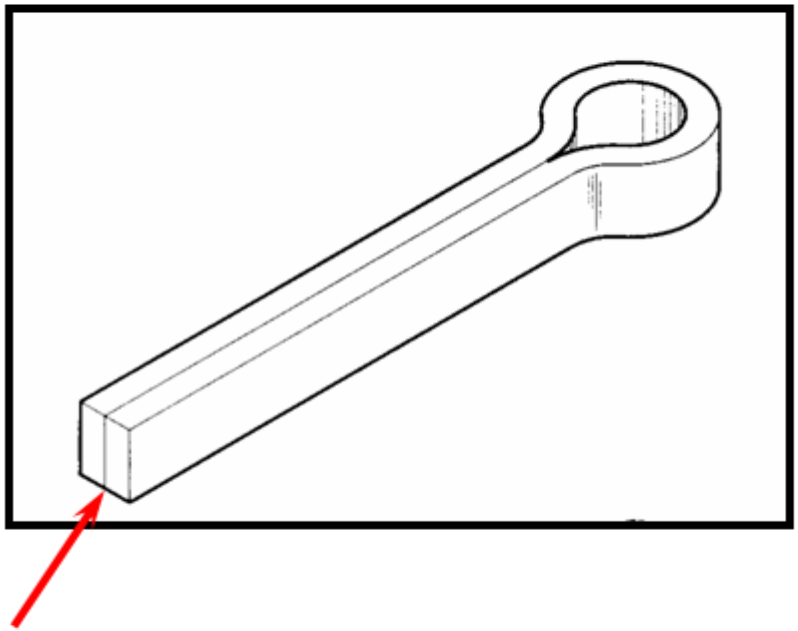
The material being filed should be secured in a vice.

Files come in a wide range from very rough (to remove a lot of material quickly but leave a rough finish) to very smooth files (to remove small amounts of material but leave a very smooth finish).

Files come in a range of cross sections for different jobs. Files can be Flat, Round, Half Round and Three Square.

A Rasp is used when a lot of material needs to be removed quickly but the quality of the finish is not important. Its' extremely large teeth achieve this.

FOLDING BARS



Jaws of the folding bars

WHAT ARE THEY USED FOR ?

When bending and folding sheet metal, very often the hardest part of the task is not the actual bending but how to hold the sheet metal while it is being bent.

Folding bars can often help here. The sheet metal is scored with a scriber along the bend line. The sheet metal is then sandwiched between the two jaws of the folding bars.

The bend line is then lined up with the top of the jaws and the whole arrangement is held in a vice while the sheet metal is bent.

HAMMERS & MALLETS

WHAT ARE THEY USED FOR ?

Obviously, hammers and mallets are used for hitting things but there are certain situations which demand a particular type of hammer or mallet be used.

CROSS PEIN HAMMER

HAMMERS

Inserting and shaping metal rivets is done using Cross Pein and Ball Pein hammers. A Claw hammer is a good general purpose hammer although it has a claw specifically designed for the removal of bent nails from wood.

NYLON MALLET

CLAW HAMMER

MALLETS

When materials need to be driven in or knocked together and they are soft enough to be easily damaged, the solution is usually to use a Mallet instead of a Hammer. There are a wide range of materials used to make the heads of Mallets ; Rubber, Plastic (Nylon), Wood, Copper etc. The most common type of Mallet found in the workshop is a Hide (Leather) Mallet.

RUBBER MALLET

JIGSAW

WHAT IS IT ?

A power tool for cutting out complex shapes out of large sheets of wood and plastic. It has a blade which moves at high speed up and down while the whole saw can be pushed along on two runners not unlike water skis.

WHAT IS IT USED FOR ?

Any time when a curved line needs to be produced in wood or plastic sheet, a jigsaw might be the very tool. Fist the required line is drawn on the sheet then the saw follows this lie cutting as it goes. The advantage of this saw over most others is that it can cut relatively tight bends and curves.

In the photo below however, the worker is using a straight edge to act as a guide to produce a long straight cut.

KNIVES & CUTTERS

WHAT ARE THEY USED FOR ?

The type of knife shown has a retractable blade. That means the blade can be slid back to a safe position inside its body when not being used.
The blade is razor sharp and can cut through light plastic and wood. It is commonly used for marking out the initial cuts in wood prior to cutting joints.
They are commonly made by the Stanley tool company and are therefore often known as Stanley Knives. More correctly, they should be called Craft Knives.

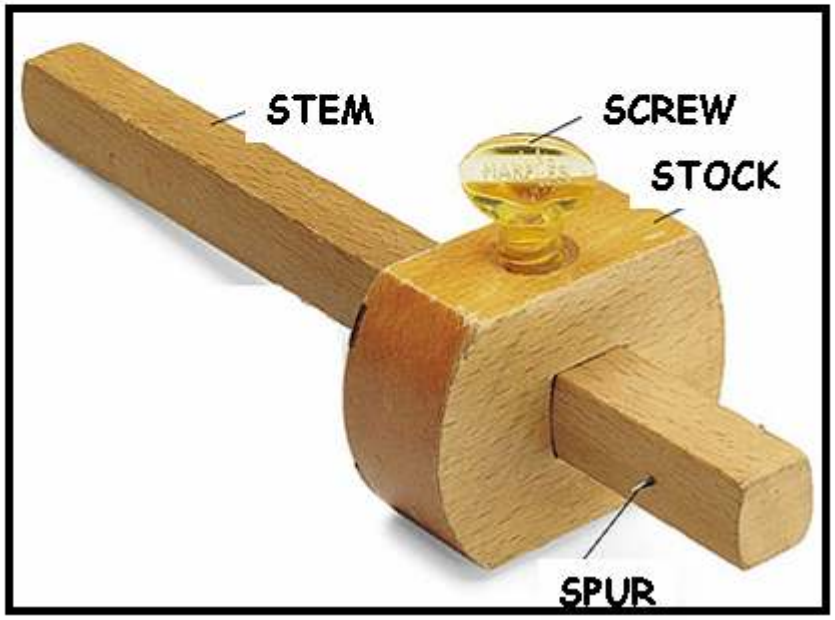
MARKING GAUGE

WHAT IS IT ?

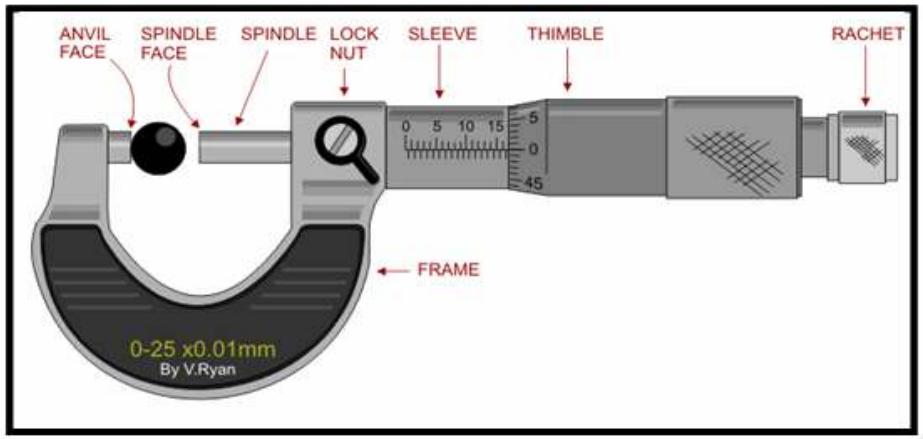
A marking gauge is a woodwork marking out tool.

WHAT IS IT USED FOR ?

When marking out a piece of wood, perhaps for a joint etc., you will often have to mark a line parallel to the edge of the wood. With the stock held firmly against the side of the wood, the spur is used to make a slight score in the wood. A pencil can then be used to make the score clearer to see.



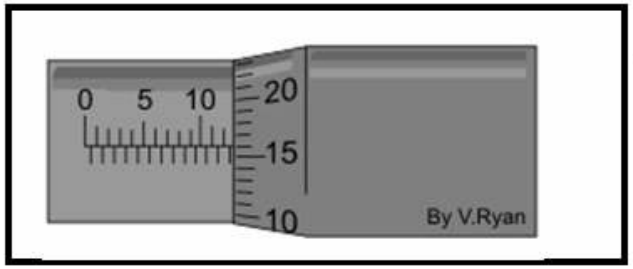
MICROMETER



The micrometer is a precision measuring instrument used by engineers. Each turn of the ratchet moves the spindle face 0.5mm towards the anvil face.

The object to be measured is placed between the anvil face and the spindle face.

The ratchet is turned clockwise until the object is 'trapped' between these two surfaces and the ratchet makes a 'clicking' noise. This means that the ratchet cannot be tightened any more and the measurement can be read.



Example 1

SLEEVE READS FULL mm	=	12.00
SLEEVE READS ½ mm	=	0.50
THIMBLE READS	=	0.16
TOTAL MEASUREMENT	=	12.66mm

Example 2

SLEEVE READS FULL mm	=	16.00
SLEEVE READS ½ mm	=	0
THIMBLE READS	=	0.355
TOTAL MEASUREMENT	=	16.355mm

MORTICING MACHINE

WHAT IS IT ?

A power tool for cutting square holes in wood.

WHAT IS IT USED FOR ?

There are various times when you would want to produce a square hole in a piece of wood rather than a round hole. The most common would be when you were making a mortise and tenon joint (look it up if you have to).

The mortising machine basically works like the pedestal drill that you will be familiar with using. The difference is in the cutter. The cutter has an auger bit surrounded by a square blade. The tip of the bit is very slightly lower than the end of the square cutter.

This means that, as the whole arrangement is driven into the wood, it cuts a round hole first then a fraction of a second later the square blade picks out the four corners to produce a square.

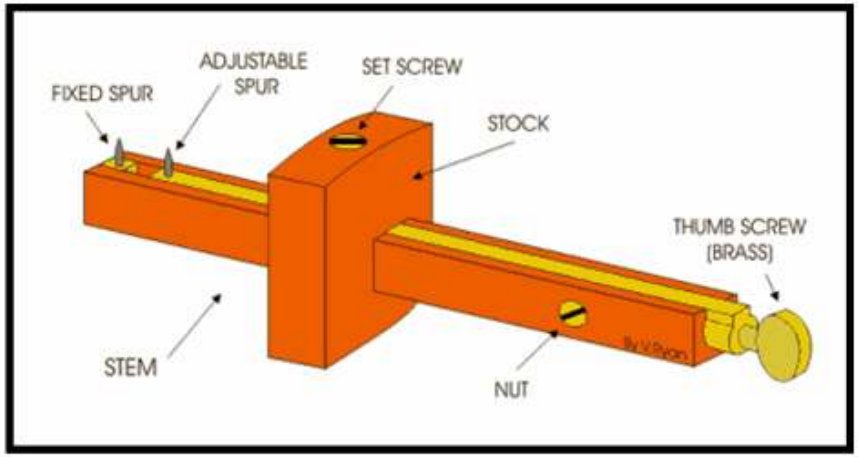
The whole table can be moved left and right and also in and out so that not only squares but rectangles can be cut.

cutter in the 'up' position

MORTISE GAUGE

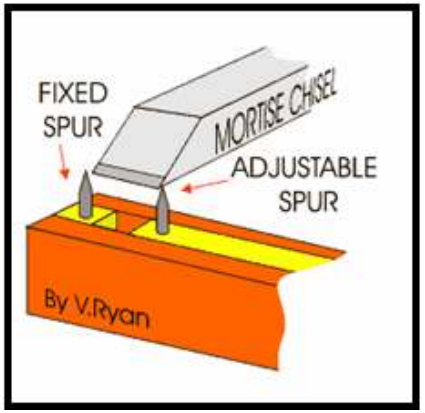
WHAT IS IT ?

A mortise gauge is a woodwork marking out tool.



WHAT IS IT USED FOR ?

When marking out the shape of a mortise and tenon joint on a piece of wood, you would often have to mark two parallel lines on the wood the width of the tenon apart. A mortise gauge can score two lines at the same time and their distance apart can be set by adjusting the thumb screw (see above).



NAIL PUNCH

WHAT IS IT ?

A woodwork tool, made from metal with a small dimple on the pointed end. It gets struck with a hammer.

WHAT IS IT USED FOR ?

In any finished model, you would want to hide the heads of any nails or pins which have been used to hold the parts in place while it is being glued.

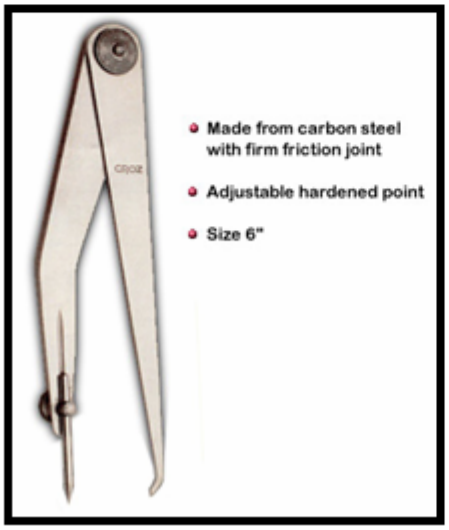
After the nails have been driven in, a nail punch is used to drive their heads a few millimetres under the surface. The hole that is left can then be filled with wood filler so that there is no evidence the nail is there.

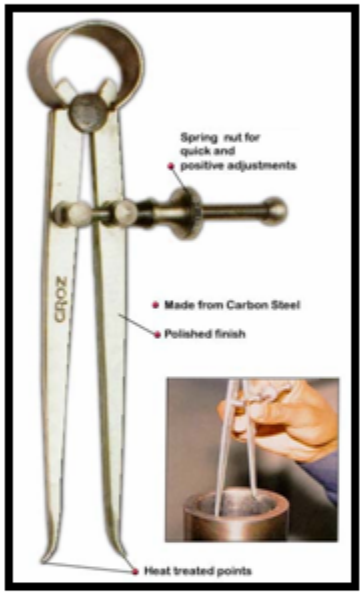
The small dimple on the end of the nail punch helps to avoid the punch slipping off the nail head when struck. This would damage the wood.

ODD LEG AND OTHER CALIPERS

ODD LEG CALIPERS

are used to draw lines on metal parallel to an edge. They do the same job in metalwork as a marking gauge does in wood. The bent leg runs along the side of the metal and the pointed leg scribes the line.



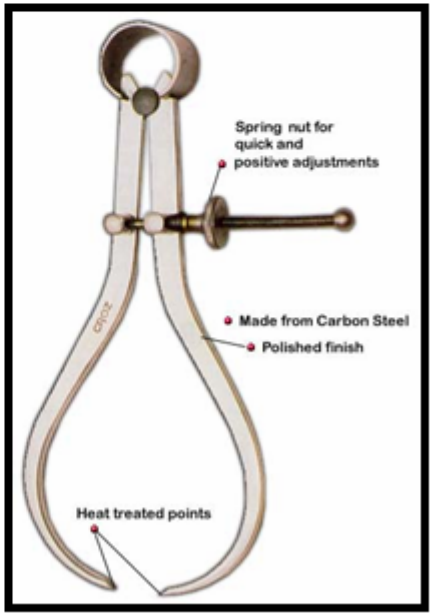


INSIDE CALIPERS

are used to measure the diameter of the inside of a hole in a piece of metal. You can see them being used in the photo above. Once the size is gauged, the distance between the points on the calipers is measured with a rule.

OUTSIDE CALIPERS

are used to measure the outside diameter of round objects. The points are opened and closed by turning the nut.

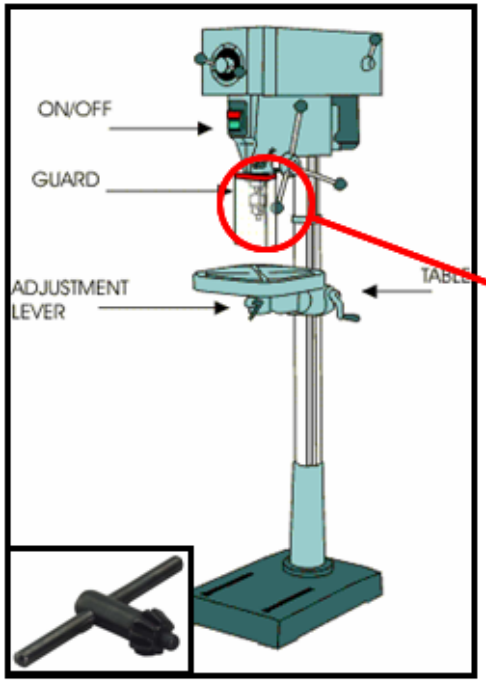


PEDESTAL DRILL

Shown below is a diagram of a pedestal drill, also known as a pillar drill. The pedestal drill has a long column which stands on the floor. This means it is capable of being used to drill large pieces of materials and produce larger holes. This is because the table can be lowered allowing long pieces of material to be positioned into the machine for drilling.

SAFETY

1. Always use the guard.
2. Wear goggles when drilling materials.
3. Clamp the materials down or use a machine vice.
4. If your hair is long enough for you to be able to tie it, it must be secured and tucked inside a collar.
5. Make sure loose or baggy clothing is held back securely.
6. Follow all teacher instructions carefully.

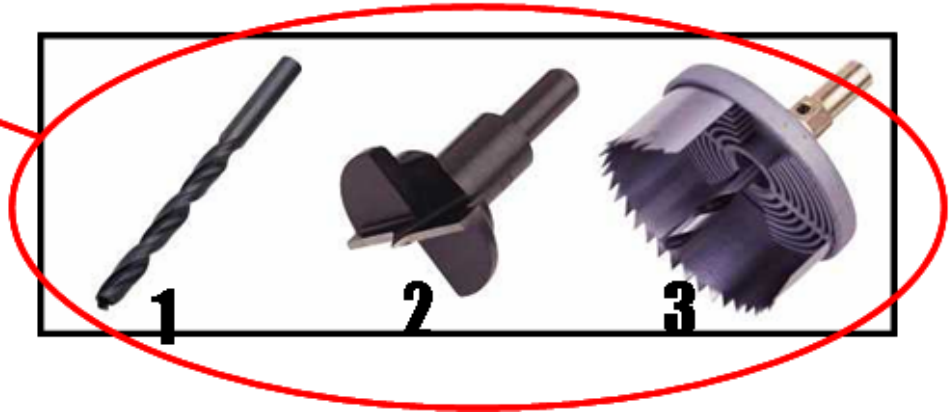


TYPES OF DRILL BIT

1 - Twist Drill - Used for drilling holes. A normal drill set will include sizes from 1mm to 14mm.

2 - Forstner Bit - Used for larger diameter holes. When using this bit the hole is drilled very slowly so that the bit does not 'jam' in the wood.

3 - Hole Saw - For large diameters a 'hole saw' can be used. The advantage of this type of drill bit is that the blade can be changed to give different sizes of diameter.



PINCERS

WHAT IS IT ?

A pair of Pincers, not unlike pliers, can be used in woodwork but are more often used in the metalwork room.

WHAT IS IT USED FOR ?

Pincers are used for gripping, snipping, grabbing and nipping a range of things.

They can be used to shorten a range of things such as nails and rivets and they are often used to remove pins and nails which get bent as they are being driven into a piece of wood.

Their jaws open and close and are hardened and sharpened to a point. They also have a rounded neck so that they do not dig into the wood as they remove nails.

PLANES

A large range of planes are available and they are used for different purposes. The body of a plane is made from high grade cast iron with the cutters being tungsten made from vanadium steel. The earliest known examples of planes are from the Roman era but even today they are used for the same purposes - to smooth rough surfaces or the plane down the thickness of a piece of wood to the required size.

WOOD BLOCK PLANE: Although this is a very old design they are still used today to remove a large amount of wood. This is due to the fact that they are lighter than steel planes and therefore they can be used comfortably for longer periods.

JACK PLANE: This is the steel equivalent of the wooden block plane. It has a steel body and because it is heavier than the wood block plane it is easier to hold down on the surface of the wood being planed. It is used to plane longer pieces of wood.

SMALL BLOCK PLANE: This is a small version of a wood block plane and it is used for light work such as producing 'chamfers'. It is normally held and used in one hand.

BULLNOSE PLANE: This is used to plain right into corners. The blade can be seen to go almost up to the end of the plane's body and consequently very little material is missed in a corner.

SMOOTHING PLANE: A shorter version of the steel jack plane. It is used for general work such as smoothing short pieces of wood. It is lighter and smaller than the jack plane.

MACHINE PLANE: This is favoured by DIY enthusiasts as it saves time. A blade revolves at high speed and as the machine plane is pushed across the surface of the wood - it is planed. A big disadvantage of these planes is that they are potentially very dangerous if misused. Also, sometimes the finish to the surface is not as smooth or precise as a hand held plane being carefully used.

POWER SCREWDRIVER

WHAT IS IT ?

A power tool for driving in screws.

WHAT IS IT USED FOR ?

It can be very time consuming if there are a lot of screws requiring to de driven in by hand. A power screwdriver can speed the process up considerably.

They come with a wide range of attachments which be fitted to accommodate a wide range of screw heads (slotted, phillips, pozidriv, allen etc.). In the photo shown, the screwdriver is fitted with a phillips attachment.

ROUTER

WHAT IS IT ?

A power tool for shaping the edges /corners of wood

WHAT IS IT USED FOR ?

You may well have seen coffee tables, window ledges, shelves etc. with fancy moulded edges. These would be almost impossible to achieve by hand. A router fitted with a shaped cutter can produce these edges quick and easily.

There is an element of danger with this tool and it must always be used as per the manufacturers instructions and with the proper guards in place. For this reason, pupils are not allowed to use this equipment.

SANDERS

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 which 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.

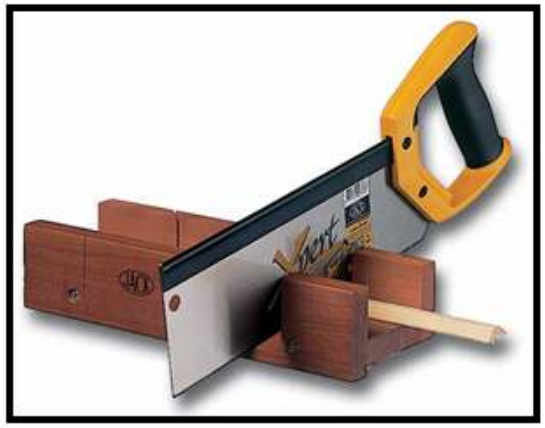
Know the safety precautions for this machine !

SAWS

COPING SAW: a coping saw is used to cut through thin pieces of wood and plastic. The thing that the coping saw can do better than most other saws is cut curves and corners.

JUNIOR HACKSAW: this saw is designed to cut through thin metal plate. The metal should be held in a vice and the line to be cut should be marked with a scriber.

HACKSAW: a much stronger, tougher version of the junior hacksaw, this saw can cut through much thicker metal and is designed to be used two handed.



TENON SAW: because of the stiffness of the blade, a tenon saw can only cut straight lines although it can do so very accurately if used properly. The wood should be held either in a vice, a sawing board or in a mitre box (as shown above).

SCRIBER

WHAT IS IT ?

It is a metalwork marking out tool used instead of a pencil. It can be double ended or single ended.

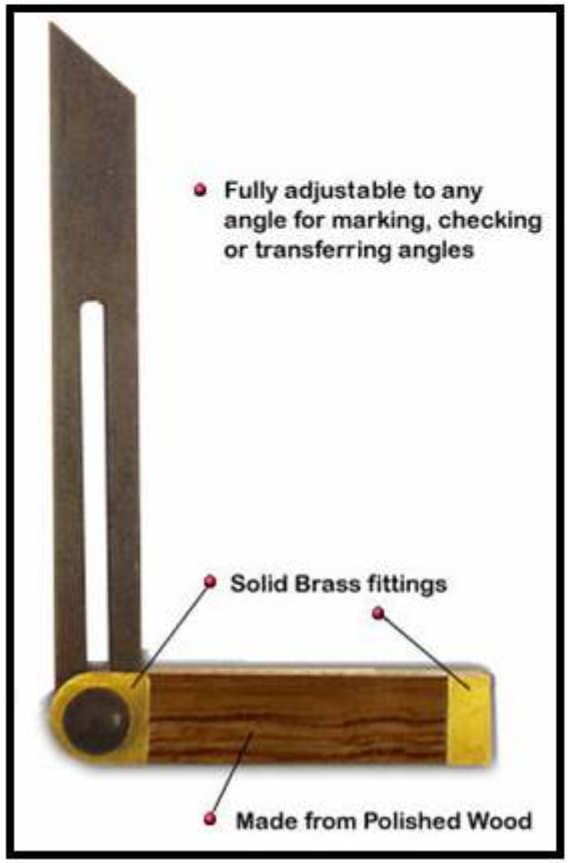
WHAT IS IT USED FOR ?

If a pencil or pen was used to mark out in metalwork, the lines would easily rub off. The scriber scores a more permanent line on the surface of the metal which is easier to work with.

SLIDING BEVEL

WHAT IS IT ?

A sliding bevel is a woodworking tool with a wooden body and a metal blade. The metal blade has a slot which allows it to rotate and to run along a slot. A brass wing nut acts as a clamp so that the metal blade can be set at a particular angle to the body then locked at that angle.



WHAT IS IT USED FOR ?

A sliding bevel has two main purposes.

Firstly it can be used to check if two surfaces are at a particular angle to each other. Secondly, when marking out a joint or a cut, a sliding bevel can be used to mark a line at a particular angle to an edge.

TINSNIPS

WHAT ARE THEY ?

A metalwork tool which basically behaves like a very tough pair of scissors.

WHAT ARE THEY USED FOR ?

Tinsnips are used to cut thin metal sheet into a variety of shapes. If you imagine drawing out a fancy shape in card then cutting it out using scissors, the process is much the same for sheet metal. This time though you would mark the shape with a scriber and cut the shape out with tinsnips.

The pair of tinsnips shown below right, have a slight bend in their jaws. This is to make the cutting out of round shapes slightly easier.

TONGS

WHAT ARE THEY ?

A metalwork tool used to allow you to handle hot things without putting your fingers at risk.

WHAT ARE THEY USED FOR ?

While using the forge, the metal which you are heating up will then be bent or hammered into shape. While shaping the metal, you will have to hold it securely.

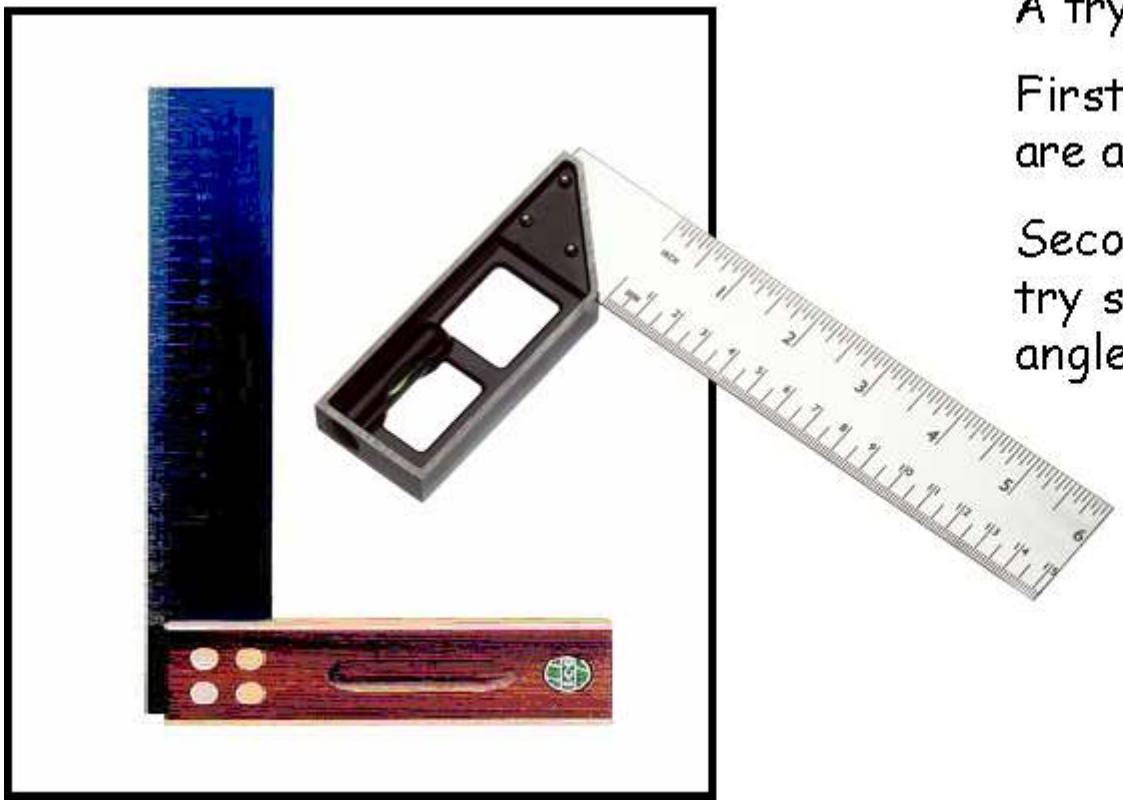
Clearly it is too hot to hold so tongs allow you to grip the metal tightly in one hand while hammering or bending or twisting with the other hand.

The very long handles make them safer to use as they allow you to keep your fingers well away from the heat and the hammering etc.

TRY SQUARE

WHAT IS IT ?

A try square is a woodworking tool with a wooden body and a metal blade. The blade is at right angles to the body and the tool is made to a high degree of precision. You can be sure the right angle is exactly 90^0.



WHAT IS IT USED FOR ?

A try square has two main purposes.

Firstly it can be used to check if two surfaces are at right angles to each other.

Secondly, when marking out a joint or a cut, a try square can be used to mark a line at right angles to an edge.

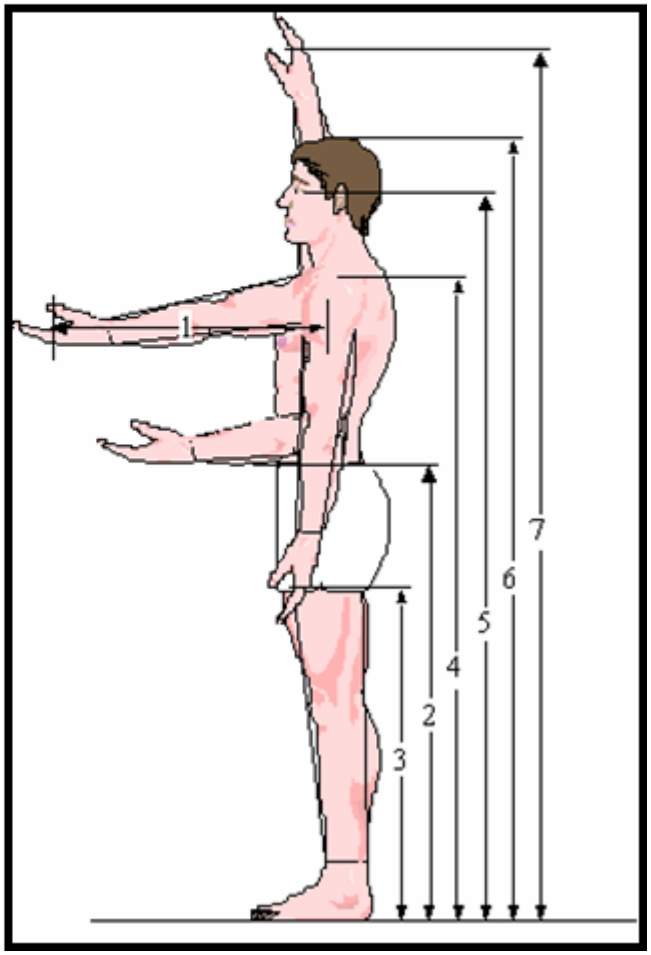
Design

5th & 95th PERCENTILE

WHAT IS IT ?

When any average size (male height, female reach etc.) is worked out, there are always some sizes at the extremes (max and min) which have a significant impact on the final value. To reduce this effect, the first and last 5% of any group are often ignored to give a more true average size. The first 5% and last 5% are called the 5th and 95th percentile.

	PERCENTILE			
	Male		Female	
Measurement - cm	95%	5%	95%	5%
1. Forward Reach	68.3	60.96	63.75	56.39
2. Elbow Height	113.3	100.33	105.41	91.7
3. Knuckle Height	78.74	69.1	72.64	62.99
4. Shoulder Height	152.7	135.13	141.73	123.95
5. Eye Height	173.73	154.69	161.8	142.24
6. Stature	185.9	163.58	171.96	137.16
7. Overhead Reach	215.4	191	177.8	170.18



AESTHETICS

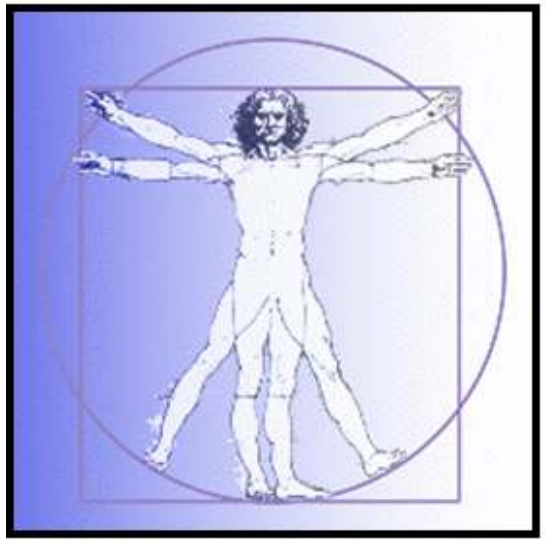
Aesthetics is concerned with appearance.

Trying to design something which will not only be comfortable to use (ergonomic) but also pleasant to look at (aesthetic). Often an in-between result is settled for since something which may be very good looking might be very uncomfortable to use.

When a design looks good and is said to be 'aesthetically pleasing', the designer has achieved just the right combination of . . .

SHAPE FORM STYLE COLOUR

ANTHROPOMETRICS



Anthropometrics means - man (anthrop) measurements (metric). It is the measurement of the size and proportions of the human body, as well as other stuff such as how far you can reach and so on. Accurate data on height, weight, limb, and body sizes are needed to design items ranging from clothing, furniture, cars tools and so on. Anthropometrics enables us to make sure that the objects we design take into account about 90% of the population.

Men and women are different. Women are usually smaller with finer body proportions

People of different ages are often different sizes

People from different parts of the world need to be considered when designing.

Anthropometric Data comes in the form of **charts and tables**. They may provide specific sizes such as **finger lengths** and **hand spans** but they also offer **average group sizes** for people of different age ranges. Other sizes to consider are **heights, reach, grip and sight lines**.

Game and toy designers need to use this information in order to design their products. They do understand that these sizes are constantly changing, as the **population grows bigger**.

DESIGN OBSOLESCENCE

Manufacturers design products to only have a certain 'lifespan' to encourage you to replace products you already own.

- **A phones' battery may only last 100 charges**
- **Computer software might need updating**
- **Bodywork on a car may rust even though the engine is OK**
- **A product may go out of fashion**

There are four types of obsolescence:

Functional Obsolescence

New technology replaces old (example: video tape replaced by DVD)
Obsolete products do not have the same functions or capabilities as new ones.

Style Obsolescence

Marketers change the styling of products so as to make owners of the old model feel 'out of date' (example: cars, clothing)

Intentional Physical Obsolescence

A product is designed to last for a specific lifetime (example: home entertainment electronics)
If a product will be technically or stylistically obsolete in five years, many marketers will design the product so it will only last for that time (this is done through a technical process called 'value' engineering)

Doing this will reduce the cost of making the product, and lower the price to consumers (unless there is a lack of competition in the industry, in which case the cost reduction will probably not be passed on to the consumer in the form of lower price)

Postponement Obsolescence

Technological improvements are not introduced even though they could be (example: a large software manufacturer that specialises in operating system - name withheld for legal reasons) .
The marketer feels either that consumers don't need the innovation or they are concerned that the new model will cannibalise the sales of their old model.

ERGONOMICS

Ergonomics is about ensuring a good fit between people, the things they do, the objects they use and the environments in which they work, travel and play.

Ergonomics needs to be considered in the design of virtually any product. Failure to do so may lead to designs which do not fit the needs of the users, leading to ineffective, inefficient or unsafe designs, which are unlikely to be commercially successful.

The human sciences of psychology, anatomy and physiology provide information about the abilities and limitations of people, and the wide differences that exist between individuals. People vary in many ways: body size and shape, strength, mobility, sensory acuity, cognition, experience, training, culture, emotions, etc.

Look at the two craft knives shown here. The plain handle shown in the first picture has been improved upon in the second picture. The second knife fits the users hand better – it is a more ERGONOMIC knife. This will make it more comfortable and safer to use.

What other everyday items can you think of that are obviously ERGONOMIC ?

FAULTY DESIGN

Attached is a picture of a laptop data port at LaGuardia Airport, NYC. Picture was taken in the Northwest terminal. Someone decided to replace one of the pay phones with some sort of laptop data port. However, they didn't install any sort of desk or ledge. In the hour I was waiting at the airport, I observed three people forced to sit on the floor while using this data port.

On the left is the elevator keypad from a luxury apartment. Can you see what's wrong? The numbers are listed right to left, instead of left to right.

All of the designs on this page have one thing in common – they all failed to properly consider their users when they were being created.

MARKETING

Most designers are designing for profit. That is, they intend to sell the items they design in the market place somehow. At some point in the design process, the designer will have to consider how the product is going to be marketed. It would normally be sensible to think of this early on in the design process. Marketing is a complex business but some of the important things to consider would be . . .

ECONOMICS

what will it cost to make ?

how much can you sell it for ?

how much profit ?

ADVERTISING

how will you publicise it ?

how much to spend on advertising ?

MARKET RESEARCH

who is likely to buy it ?

what are competitors doing ?

how many could you sell per year ?

CONSUMER ISSUES

any legal requirements ?

is a helpline required ?

THE DESIGN PROCESS

To get from the point where a need has been identified then it has been fulfilled takes a lot of designing skill. It is not a case though of sitting around waiting for a flash of brilliance from the Designer. The Designer follows a pretty well laid out series of steps to get from the beginning to the end of the process.

There are lots of different ways to get from the start to the finish of the design process but the one we have used during your Standard Grade is described on the left.

Try to remind yourself what each section was about. You might have used slightly differently worded headings from time to time but the basic idea was always the same ;

Identify a problem which needs solving **then**

Work out the limitations of time and materials and tools **then**

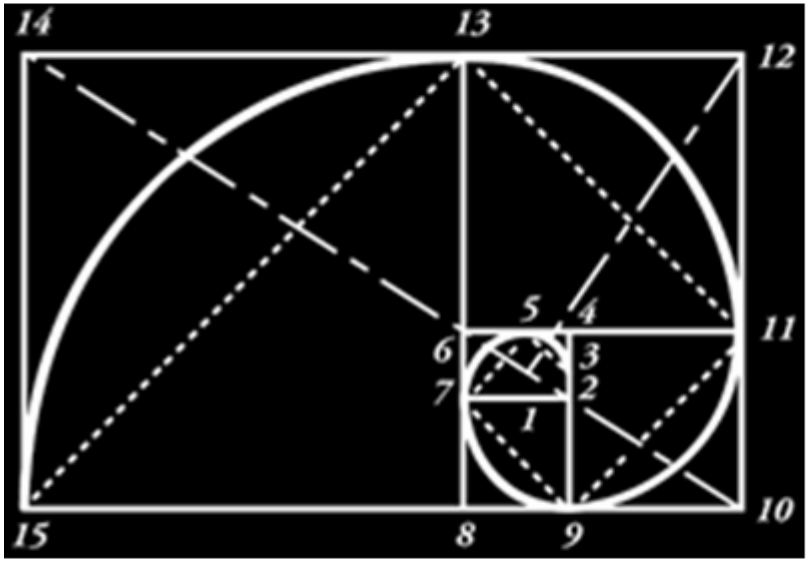
Investigate a range of possible answers to the various problems **then**

Decide on the best of all the identified solutions **then**

Think carefully how you are going to make your solution **then**

Ask yourself how good the finished article was

THE GOLDEN SECTION



There are some general rules for creating correct relationships and therefore aesthetically pleasing items of furniture.
The Golden Section involves mathematically proportioning space in a work of art.
This way of dividing space dates all the way back to the ancient Greeks designing the Parthenon. The Golden Section requires a particular ratio between height and width, which is about 13:8.
A rectangle constructed according to the Golden Section can be divided into a square and a smaller rectangle. The smaller rectangle has the same proportion as the original rectangle. Then the smaller rectangle can be divided into a square and even smaller rectangle. This method of divisions of the page can continue to infinity.
The pattern obtained by joining corresponding points on the rectangles is the same spiral found in seashells. Herein lies the reason for the Golden Section being aesthetically pleasing. It is a pattern found in nature; psychologically speaking, it makes sense that a figure of beauty in nature would be emulated in the world of design.

Materials

FERROUS & NON-FERROUS METALS

While preparing for the Standard Grade exam, you must get yourself familiar with the range of common metals to be found in a workshop. They fit in two categories, 'ferrous' and 'non-ferrous' metals. These metals can be used to build/manufacture a wide range of items. Study the properties of the materials below.

FERROUS METALS - Metals that contain iron.

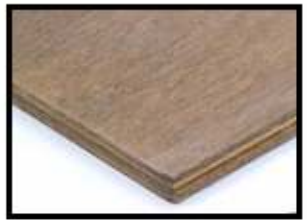
NAME	ALLOY OF	PROPERTIES	USES
Mild Steel	Carbon 0.1 - 0.3% Iron 99.9 - 99.7%	Tough. High tensile strength. Can be case hardened. Rusts very easily.	Most common metal used in school workshops. Used in widely in engineering.
Carbon Steel	Carbon 0.6 - 1.4% Iron 99.4 - 98.6%	Tough. Can be hardened and tempered.	Cutting tools such as drills.
Stainless steel	Iron, nickel and chromium.	Tough, resistant to rust and stains.	Cutlery, medical instruments.
Cast iron	Carbon 2 - 6% Iron 98 - 94%	Strong but brittle. Compressive strength very high.	Castings, manhole covers, engines.
Wrought iron	Almost 100% iron	Fibrous, tough, ductile, resistant to rusting.	Ornamental gates and railings.

NON-FERROUS METALS - Do not contain iron

NAME	COLOUR	ALLOY OF;	PROPERTIES	USES
Aluminium	Light grey	Aluminium 95% Copper 4% Manganese 1%	Ductile, soft, malleable, machines well. Very light.	Window frames, aircraft, kitchen ware.
Copper	Reddish brown	Not an alloy	Ductile, can be beaten into shape. Conducts electricity and heat.	Electrical wiring,tubing, kettles,bowls pipes.
Brass	Yellow	Mixture of copper and zinc 65% - 35% most common ratio.	Hard. Casts and machines well. Surface tarnishes. Conducts electricity.	Parts for electrical fittings, ornaments.
Silver	Whitish grey	Mainly silver but alloyed with copper to give sterling silver.	Ductile, Malleable, solders, resists corrosion.	Jewellery, solder, ornaments.
Lead	Bluish grey	Not an alloy.	Soft, heavy, ductile, loses its shape under pressure.	Solders,pipes batteries, roofing

MANUFACTURED BOARDS

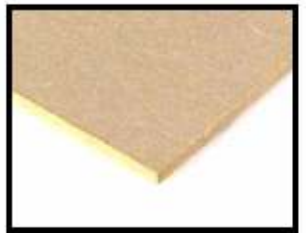
Where wood is required to cover a large surface, solid timber is usually not the solution. The widest solid planks are restricted by the maximum width of a tree. Where wide wooden objects are required (table tops, doors etc.), manufactured boards are often the solution. There are many types of board to consider.



PLYWOOD - Plywood is probably the most widely available manufactured board material. It is made by bonding together a number of thin veneers of softwood or hardwood - or a combination of each. There is always an odd number of veneers and the direction of the grain runs alternately to give the material strength; the more veneers used, the stronger the plywood. Both the type of glue and veneers determine the suitability of a sheet for a particular application. The finish quality of plywood varies enormously, some have attractive grains while others can have a large number of knots.

CHIPBOARD - Chipboard is made by bonding together wood particles with an adhesive under heat and pressure to form a rigid board with a relatively smooth surface. Chipboard is available in a number of densities; normal, medium and high-density. Normal density is fairly soft and 'flaky', high-density is very solid and hard (often used for worktops and fire doors) - medium density is somewhere in between.

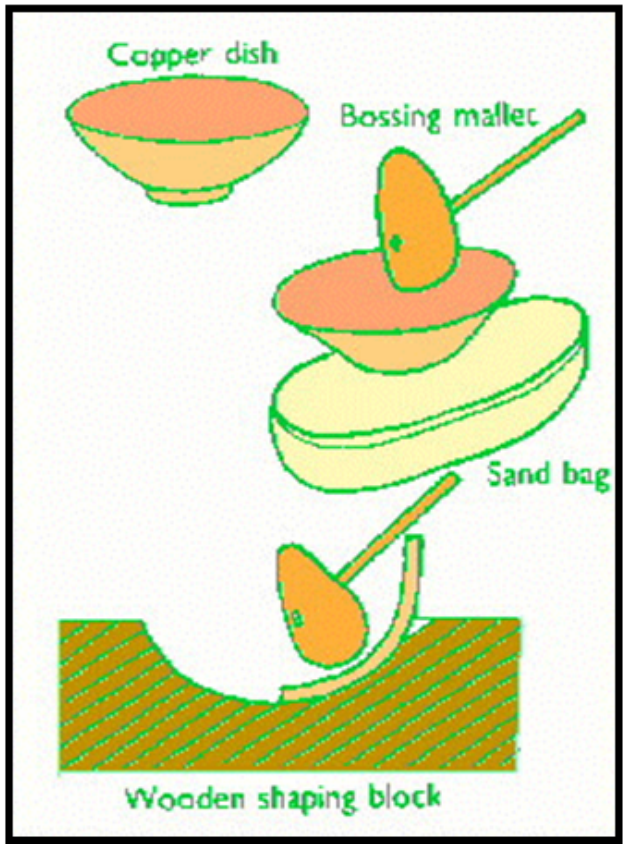
BLOCKBOARD - Blockboard is composed of a core of softwood strips (up to about 25mm wide) placed edge to edge and sandwiched between veneers of hardwood, the 'sandwich' is then bonded under high pressure.



MEDIUM DENSITY FIBREBOARD - MDF is made from wood fibres glued under heat and pressure. MDF has many qualities that make it an ideal alternative to plywood or chipboard. It is dense, flat, stiff, has no knots and is easily machined. Its fine particles provide a material without a recognisable "grain". Unlike plywood and blockboard, MDF contains no internal voids (small holes), and will produce better edges providing it is correctly machined.

MATERIAL PROPERTIES

MALLEABILITY - if a material can be deformed in all directions by such as hammering and pressing without it cracking or splitting it is said to be malleable. These materials need not be strong but they need to be 'plastic'. That is they need to be able to be bent often without breaking. Copper is a good example of a metal which is malleable.



TOUGHNESS
The ability to withstand sudden shocks or blows without it fracturing. It can also be applied to the ability of a material to withstand cracking if it is subjected to bending forces or shear forces.

BRITTLENESS
This is the opposite of toughness. Materials that are brittle cannot withstand any strain before they crack or break. Two good examples of this type of material would be acrylic and glass.

STABILITY
Materials which are stable resist changes in size and shape, which can often be caused by weather, particularly wet or dry conditions. Wood tends to warp and twist if it gets too wet or dry. Plastic tends to bend and stay bent if it is subject to constant force. This stretching due to force is called 'creep'. It is most important that certain objects such as turbine blades resist 'creep' because they are subjected to a lot of rotational force and high temperatures which are known to cause 'creep'.

DUCTILITY - usually means the ability of a material to be stretched twisted or bent without breaking. All ductile materials are malleable but all malleable materials are not necessarily ductile. For example clay can be easily shaped but when you try to stretch it, it breaks.

ELASTICITY - the ability to flex and bend when forces are applied and then return to normal when the forces are removed (e.g.. an elastic band).

HARDNESS
Any material which can resist wear and tear, denting and twisting and bending is said to have the quality of hardness. Drills, files emery cloth and glasspaper have these qualities.

SOLID TIMBER

Woods are classified into two main groups, softwoods and hardwoods. You should try to understand the main differences between softwood and hardwood and be able to give a couple of examples of each.

Click to see some examples . . .

SOFTWOODS

HARDWOODS

It would also be useful for you to know about seasoning of timber and to know about some of the defects which commonly occur in trees.

Click to find out . . .

click SEASONING

click DEFECTS

SOFTWOOD

- Usually evergreen trees (Don't lose their leaves)
- Grow fast therefore cheaper.
- Often used as construction material as trees grow tall and straight giving long planks

European redwood		Quite strong, Lots of knots, durable when preserved. cheap		General woodwork, cupboards, shelves, roofs.
Sitka Spruce		Tough, easily worked, straight grain. cheap		Indoor work only, low cost furniture
Parana pine		Tough with fine grain, prone to twisting		General woodwork, fitted furniture
Douglas fir		Strong, needs protection outdoors		Furniture, plywood, doors, windows. (Xmas trees)
Red cedar		Soft and weak.Very durable against weather, insects and rot		Weather boarding

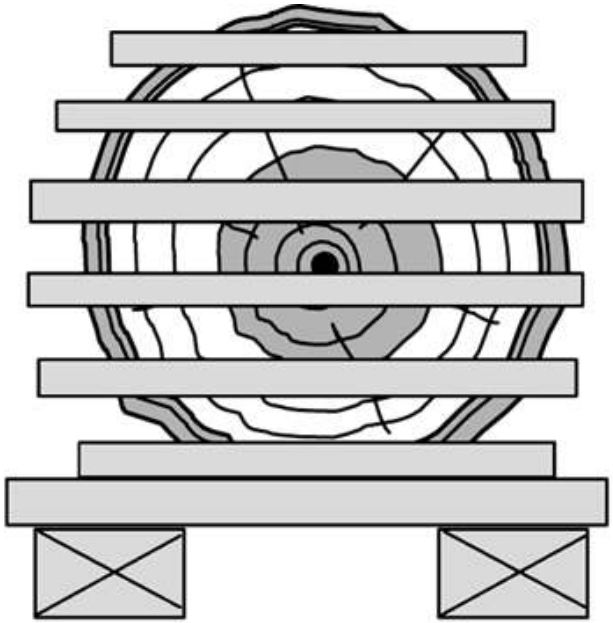
HARDWOOD

- Hardwoods usually have broad leaves and are deciduous (lose their leaves)
- Distinguished from softwoods by the structure of the grain
- They are generally more expensive than softwoods as they take longer to grow

Oak		Very strong,tough, durable.		Furniture, veneers, doors, fences
Beech		Close grain works and finishes well, Hard and strong but not durable outdoors		Wood floor in your house Functional furniture, tools, toys
Mahogany		Hard and Strong but not easy to finish. Expensive Indoor work only		Expensive furniture, veneers
Teak		Very durable, Fire resistant, but quickly blunts tools		Fine furniture, chairs, tables, shop fronts
Balsa		Very light and very soft, but strong for its weight		Model making, life belts, rafts

SOLID TIMBER

SEASONING



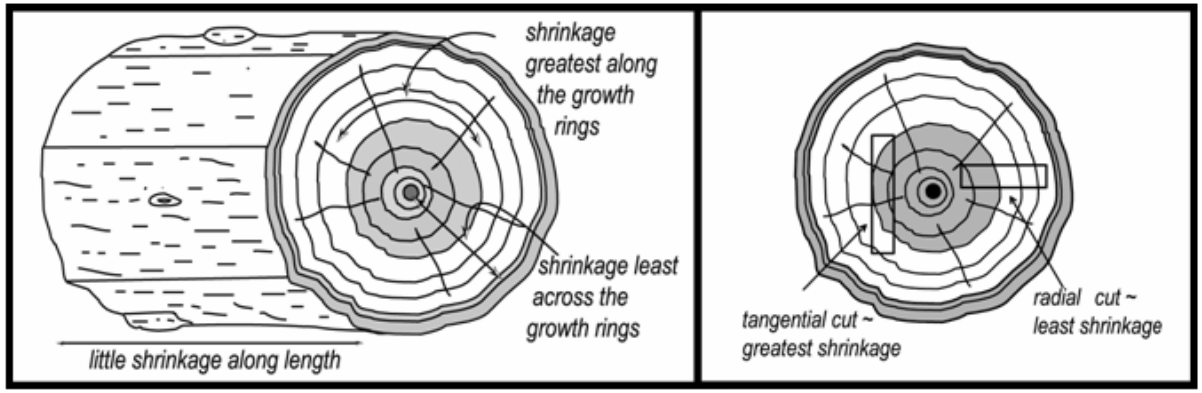
Seasoning is the controlled process of reducing the moisture content of the timber so that it is suitable for the environment and intended use. We need to reduce the moisture content of timber for the following reasons:

- Every time the moisture content reduces the timber shrinks.
- Consequently it will show fewer tendencies to warp, split or shake.
- Seasoned timber although lighter will be stronger and more reliable.
- The sap in timber is a food for fungi and wood parasites. Remove the sap and the wood will be less attractive to these dangers.
- Dry well seasoned timber is stronger.
- Dry well seasoned timber is easier to work with and consequently safer especially machine working.
- Timber with higher moisture content is difficult to finish i.e. paint, varnish, etc.

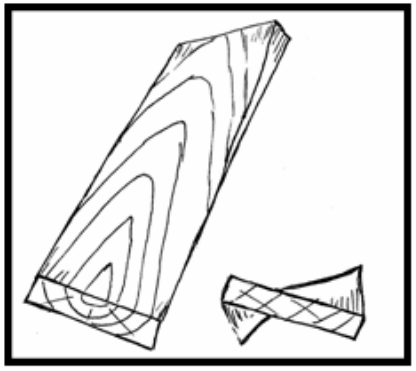
There are two main ways of seasoning timber, Natural (Air) and Artificial (Oven) drying. Both methods require the timber be stacked and separated to allow the full circulation flow of air, etc. around the stack.

DEFECTS

Because wood is a natural material, we have to put up with the fact that it will not be perfect and will come with some flaws (defects). Here are some of the most common defects found in timber.



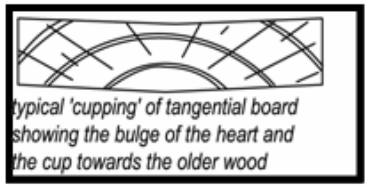
SHRINKAGE - When timber is seasoning and it's moisture content (MC) is reduced below the Fibre Saturated Point (FSP) continued drying will cause dramatic change such as increase in strength but also distortion and shrinkage.



TWISTING - This happens due to the board being cut close to the centre of the tree which has spiral grain.

The board is not of much use but small cuttings may be obtained from it with careful selection.

CUPPING - Depending on which way a board is cut out of a tree, more or less 'cupping' will result. Some rings are much longer than the others close to the heart therefore there will be more shrinkage at these parts than the others therefore cupping is the result.



BOW

Bow is a seasoning and/or storage defect caused by the failure to support the board with stickers at sufficient intervals. The boards own weight and probably those above it bears down and the resultant bow is inevitable.

THERMO PLASTICS & THERMOSETTING PLASTICS

Plastics are to be seen all around us and there are two main groups:

THERMOPLASTICS ➡ These plastics can be re-heated and therefore shaped in various ways.

THERMOSETTING PLASTICS ➡ Once 'set' these plastics cannot be reheated to soften, shape and mould.

EXAMPLES - THERMOPLASTICS

These plastics possess a common property, they soften when heated and are often used in schools to vacuum form shapes. Usually, when heated and formed into a shape - if reheated they return to their original shape.

Acrylic. (Known also as PERSPEX) This is the most common plastic in a school workshop. It is purchased usually in the form of sheets and comes in a range of colours. It can be translucent (e.g. smoked), transparent or opaque. It is resistant to most acids and weather conditions.

Polythene. Can be moulded into almost any form due to its excellent moulding qualities. Used for the production of bottles, bowls, toys, tube etc... It is available in large sheets. There are two types: High density which is rigid and hard, and low density which is tough and flexible. Machine parts are generally made from high density polystyrene whilst bottles are made from the low density polystyrene.

Polyvinyl Chloride. Better known as PVC. It is a tough material which can be purchased as a hard material or alternatively a flexible form. It can be welded or bonded with an adhesive. It has a range of uses including water pipes, raincoats, long play records, coating on electrical wires and many more.

EXAMPLES - THERMOSETTING PLASTICS

Many **adhesives (glues)** are thermosetting plastics. A good example is 'Araldite' which is an epoxy resin that hardens when a second chemical is added (a catalyst). It will bond most materials including woods and metals as well as some plastics.

Polyurethane. This forms the basis of many paints and varnishes because it is very tough and has water resistant qualities.

Melamine Formaldehyde. Used in the production of plastic laminates because of its smooth surface and hygienic qualities. It is also used in electrical plugs and sockets because it can be cast and it is an excellent insulator.

Polyester resins. If resins are combined with a material such as fibre glass the result is a very tough material that can resist impact. This type of material is known as a *glass reinforced plastic* (GRP) and is used in car body repairs, sailing boats, corrugated sheet because of its lightness, toughness and resistance to water.

Joining Methods

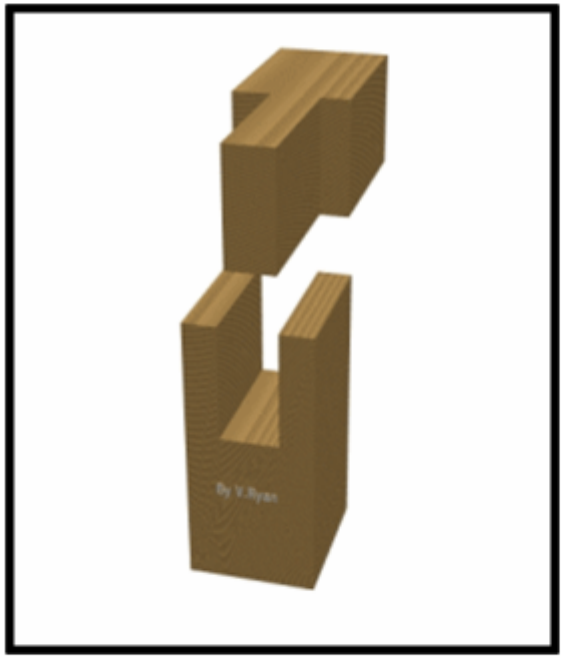
BRIDLE JOINTS

These joints are used when a light frame is needed and strength is not the main requirement. For example, a picture frame. One part of the joint fits into the other part and is glued permanently in position. The angled bridle joint can be used a a substitute for a mortise and tenon joint, again if strength is not important.

PLAIN BRIDLE JOINT

Using this wood joint would create a 'T' shape with two pieces of wood.

ANGLED BRIDLE JOINT

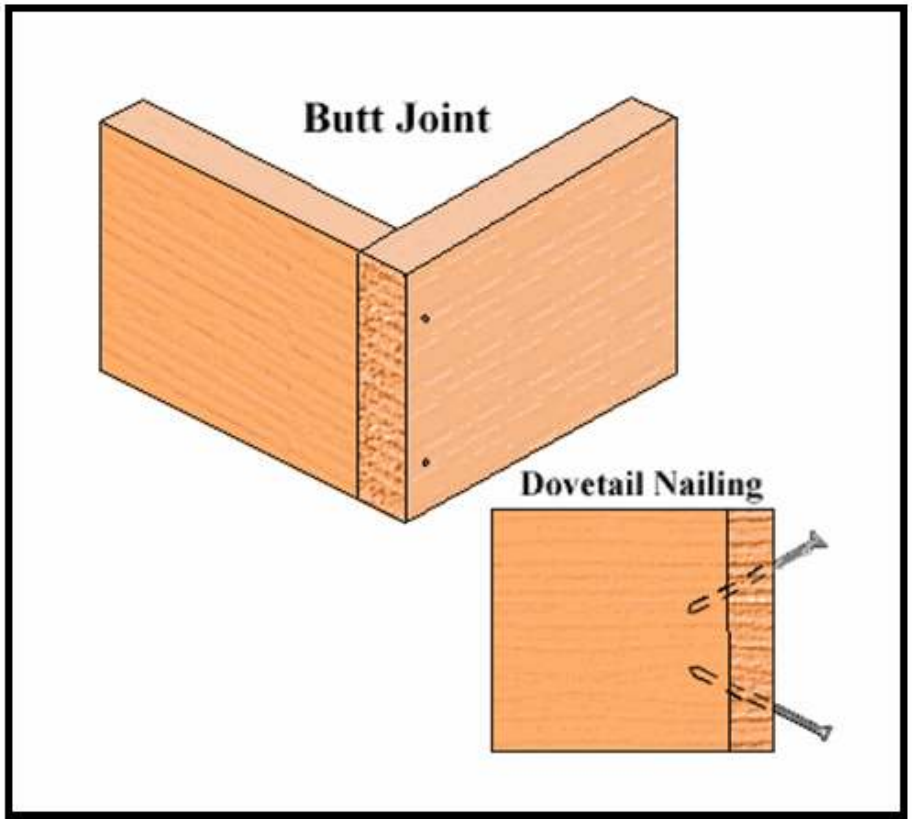


Using this wood joint would create an 'L' shape with two pieces of wood.

BUTT JOINTS

These joints are the most straightforward of all of the wood joints simply because they require no cutting out. All you need to do is ensure both ends are square and bring them up to each other at right angles as shown below and nail (and glue) the faces together.

BUTT JOINT



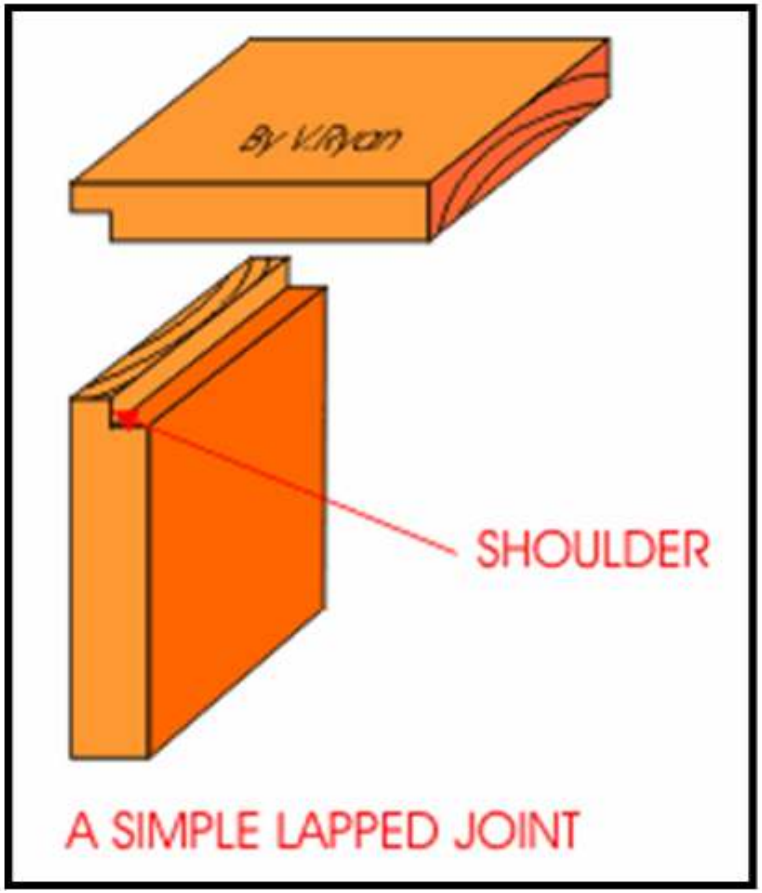
Notice that the nails have been driven in at an angle in a process called Dovetail Nailing.

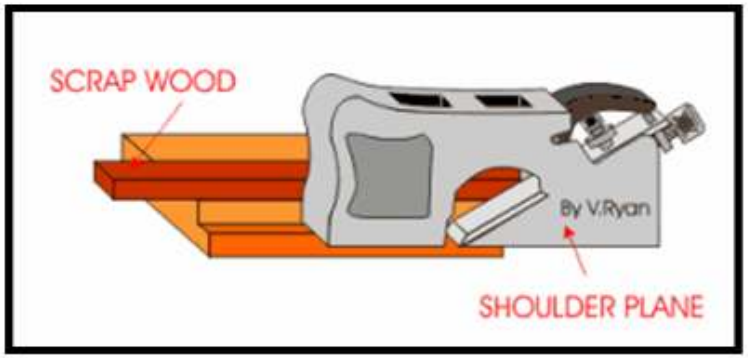
This is to give both parts more of a grip and help prevent the pieces from being pulled apart too easily.

CORNER REBATE JOINTS

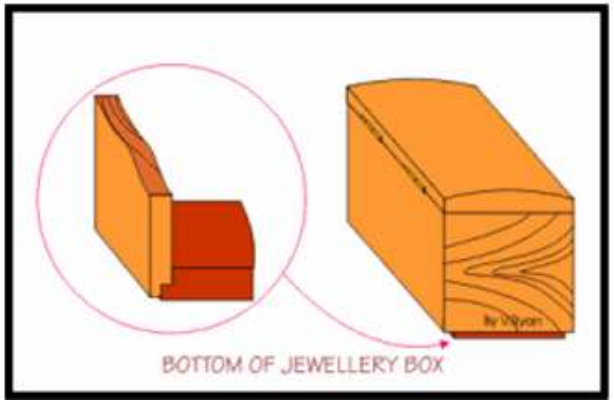
The shoulder or lapped joint is very common and is used for furniture and box constructions such as jewellery boxes. The joint below is a simple lapped joint. The shoulder can be seen clearly, this is usually planed using a rebate/shoulder plane or combination plane. This type of joint is often seen as a corner joint.

CORNER REBATE JOINT





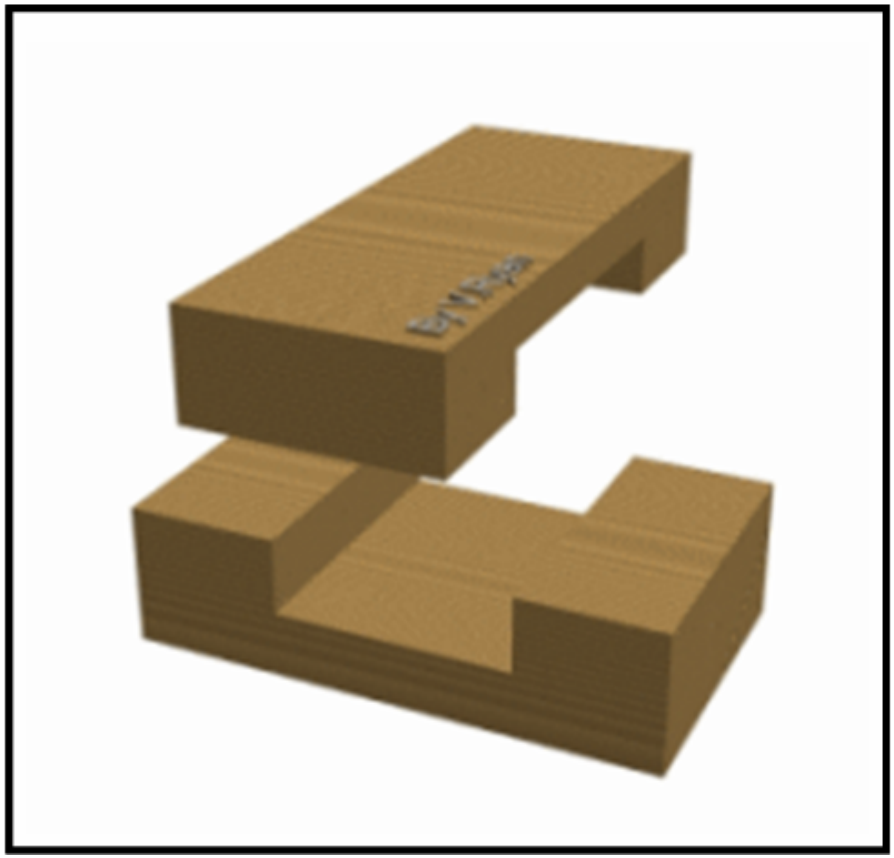
Here is a shoulder plane taking the rebate out with the help of a piece of scrap wood clamped in place. There are a few other ways of creating a rebate.



CROSS HALVING JOINTS

Cross halving joints are probably the most simple of joints to mark out and cut. They are used whenever it is necessary to join two pieces of wood that cross over each other. Sometimes these joints can be seen on the strengthening rails of tables and chairs.

CROSS HALVING JOINT

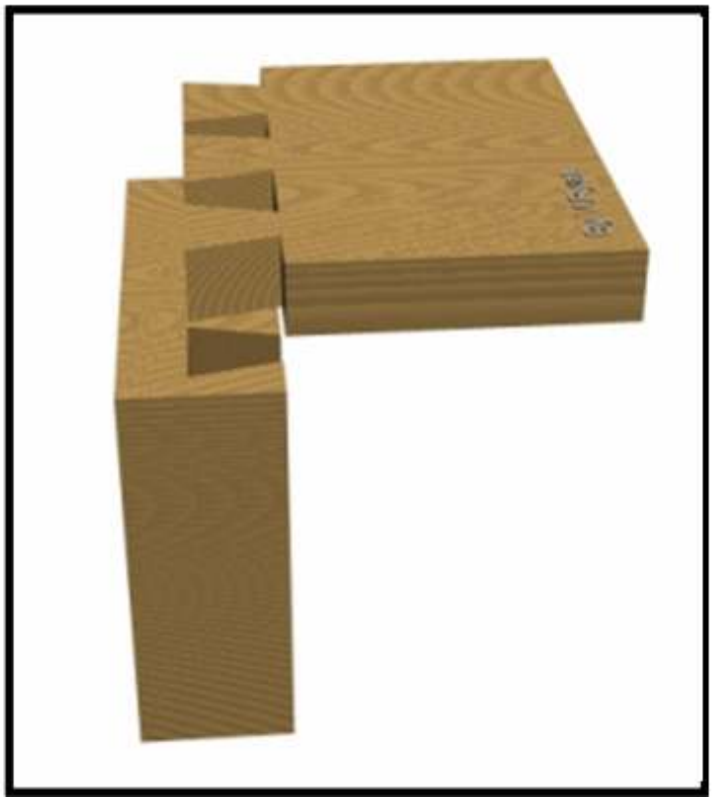


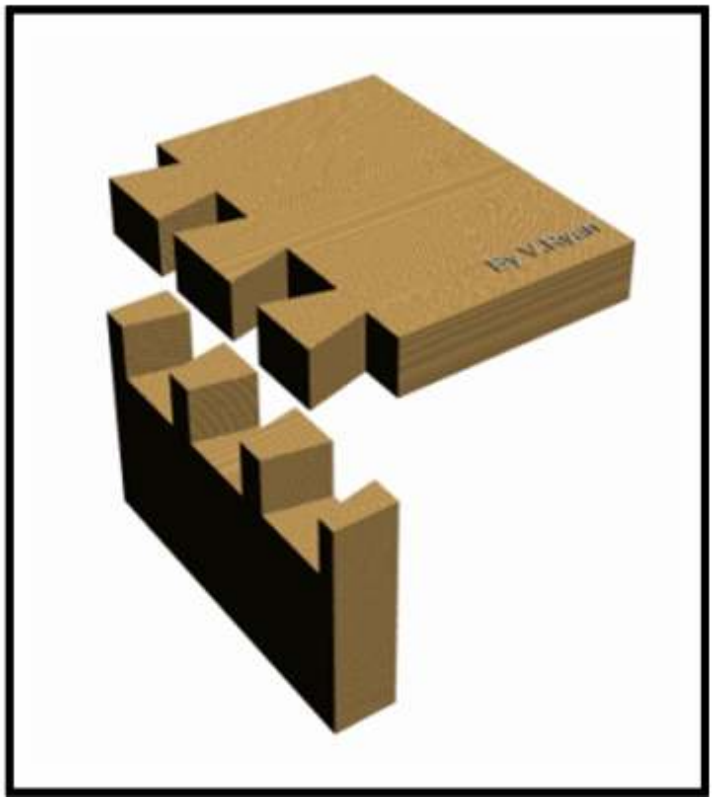
Using this wood joint would create a '+' or a 'X' shape with two pieces of wood.

DOVETAIL JOINT

The 'DOVETAIL JOINT' is very strong because of the way the 'tails' and 'pins' are shaped. This makes it difficult to pull the joint apart and virtually impossible when glue is added. This type of joint is used in box constructions such as drawers, jewellery boxes, cabinets and other pieces of furniture where strength is required. It is a difficult joint which requires practice. There are different types of dovetail joint and when cut accurately they can be very impressive.

DOVETAIL JOINT



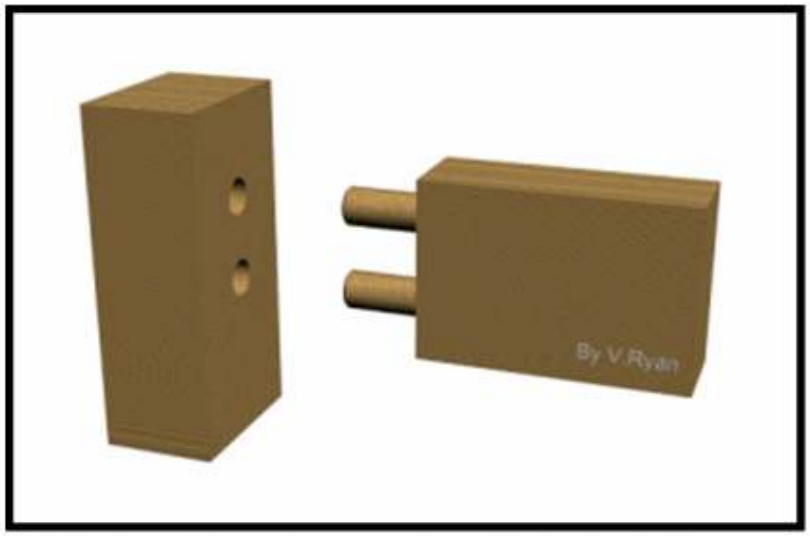


The box shown here is particularly strong due to the dovetail joints at its' sides.

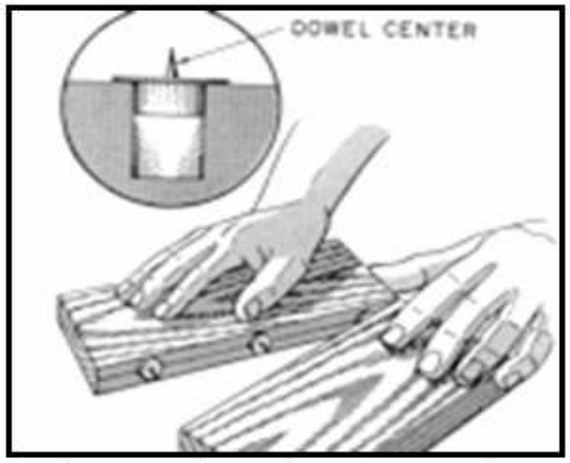
DOWEL JOINTS

Here is another way to create a joint in wood. It is a permanent method but it is not the strongest joint as the parts can eventually pull apart, especially as the joint becomes old. Modern glues that are very strong have meant that this joint is often used to quickly fix parts together.

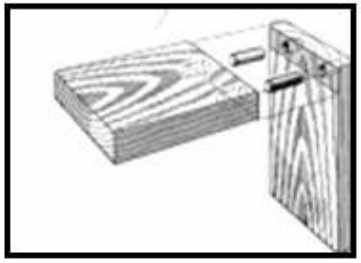
DOWEL JOINT



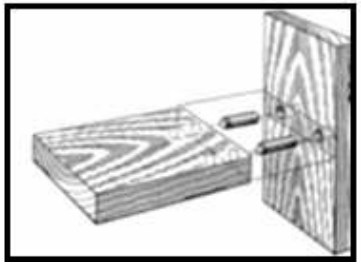
Obviously when using this jointing method, you have to make sure the distance between the holes is exactly the same as the distance between the dowels.



These dowel pins can be used to mark the wood to help ensure the distance between the holes is a good match.



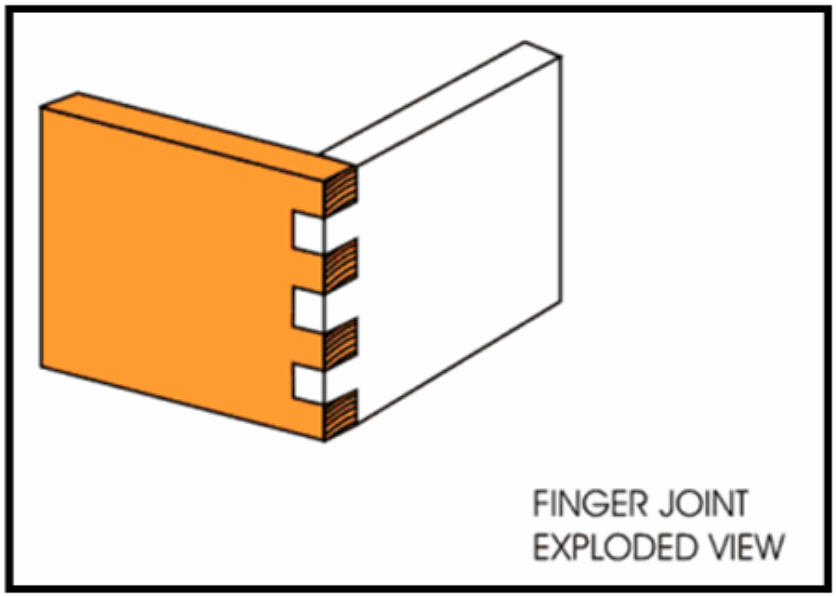
Some other dowelled joints in use.

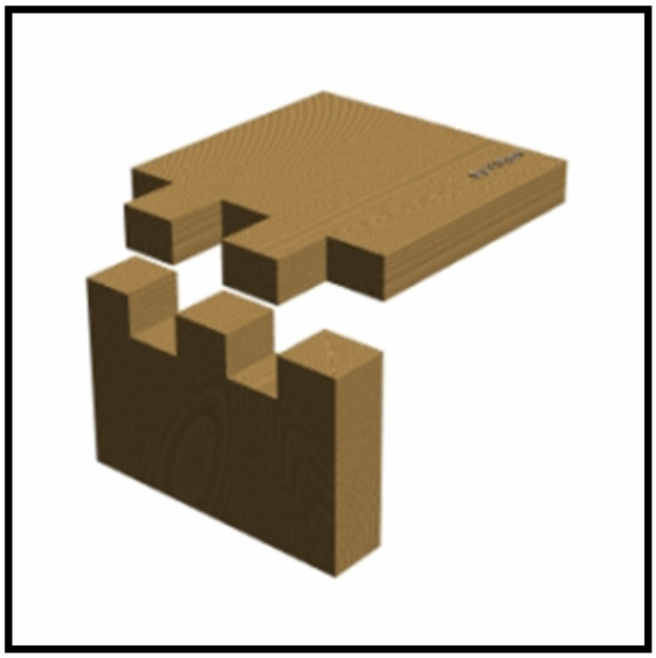


FINGER JOINT

This a good example of a 'finger' or 'comb' joint. It is ideal for box construction and is suitable for use with natural woods such as pine and mahogany or even manufactured boards such as plywood and MDF. The joint is strong especially when used with a good quality glue such as PVA (woodworkers adhesive) or cascamite.

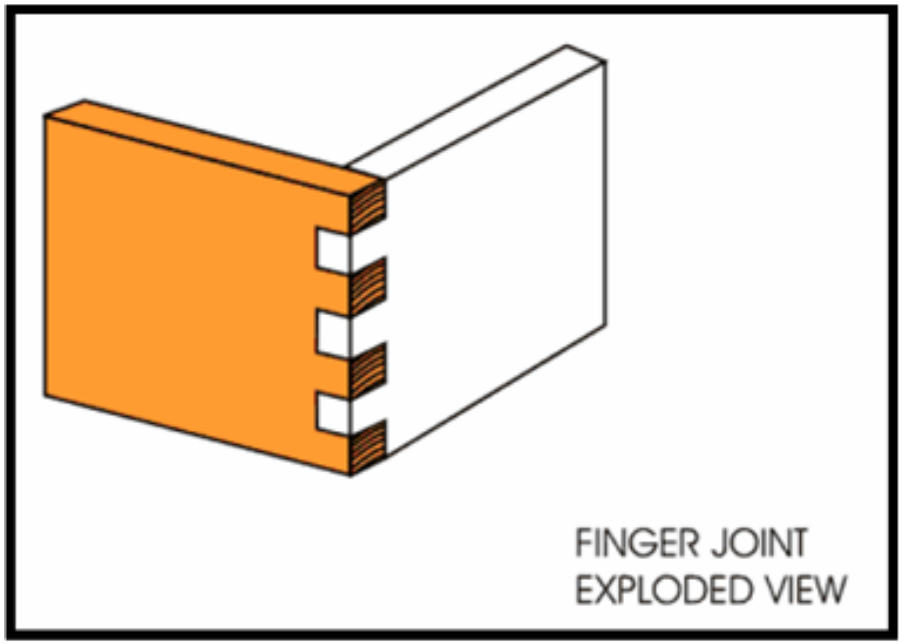
FINGER JOINT





The number of fingers on each end will vary depending on the size of the box being made.

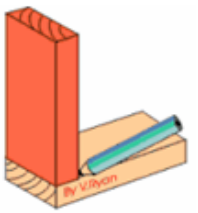
FINGER JOINT



A Finger Joint (sometimes called a comb joint), is created by accurately cutting out a series of steps on the ends of two pieces of wood. Alternate sections are then removed so that the two pieces fit together as shown here.

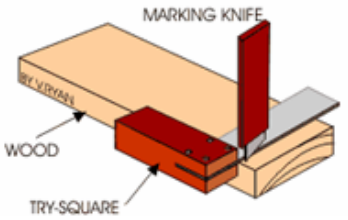
The number of fingers and the size of the fingers can vary greatly in any joint. The following slides will take you through the steps required to construct a simple, basic finger joint.

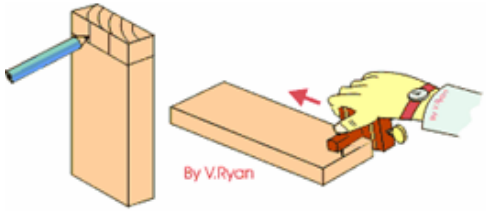
MARKING OUT A FINGER JOINT – on the first piece of wood



1. The two sides to be jointed are arranged as shown in the diagram. A pencil is used to mark the thickness of the material.

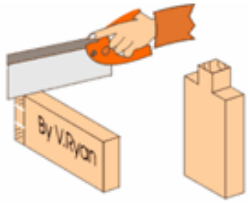
2. A marking knife and a tri square are used to mark all the way round the material. It is possible to use only a pencil but a marking knife is more precise and it has the advantage of cutting the wood fibres. This means when a saw is used to cut the joint the surface of the wood is less likely to split.





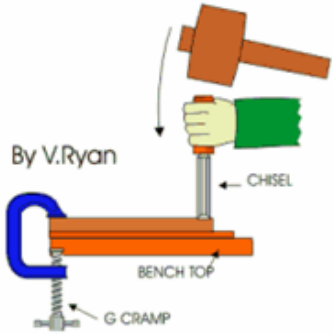
3. The fingers of the first joint are marked out using a pencil and a tri square/steel rule. The traditional way of marking the fingers involves the use of a marking gauge. Using a marking gauge to mark the fingers is difficult especially if you have not used this type of tool before. The waste wood should be shaded with a pencil. This will help you avoid cutting away the wrong part of the joint.

4. The wood is placed in a vice. It must be vertical so that the tenon saw is always cutting down in a straight line. Avoid putting the wood in the vice at an angle as it will be virtually impossible to use the saw accurately. When cutting, it is important to cut on the waste wood side of the line. It should still be possible to see the marking out lines after the saw has been used.

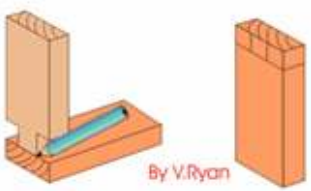


5. The wood is then turned sideways in a vice and the waste material is finally removed using a tenon saw.

6. If the joint is slightly inaccurate a firmer or bevel edged chisel can be used to correct it. A G cramp is used to hold the wood firmly. Scrap wood is placed underneath to protect the surface of the bench from the chisel. The first side of the joint should now be complete.

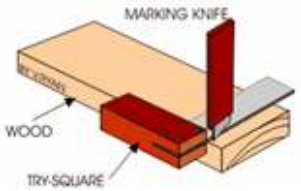


MARKING OUT A FINGER JOINT – on the second piece of wood



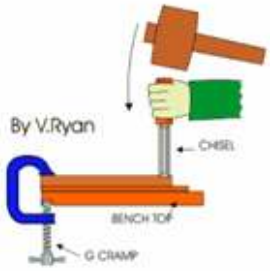
7. The first side is placed above the second side of the joint and the joint is marked out. Again a pencil is used although the traditional tool would be a marking knife.

8. Marking out the joint when both pieces are together can be difficult but a steel rule or a tri square can be used to straighten any lines. Again, the waste wood must be clearly identified.



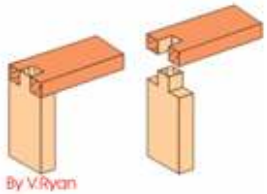
9. The tenon saw is used to cut down the lines marking the middle section of the joint. The wood must be secured in the vice in the same way as before. Remember, the saw is used to cut straight down the joint, on the waste side of the pencil line.

10. A coping saw is used to remove the waste wood. Again the wood is secured in the vice.



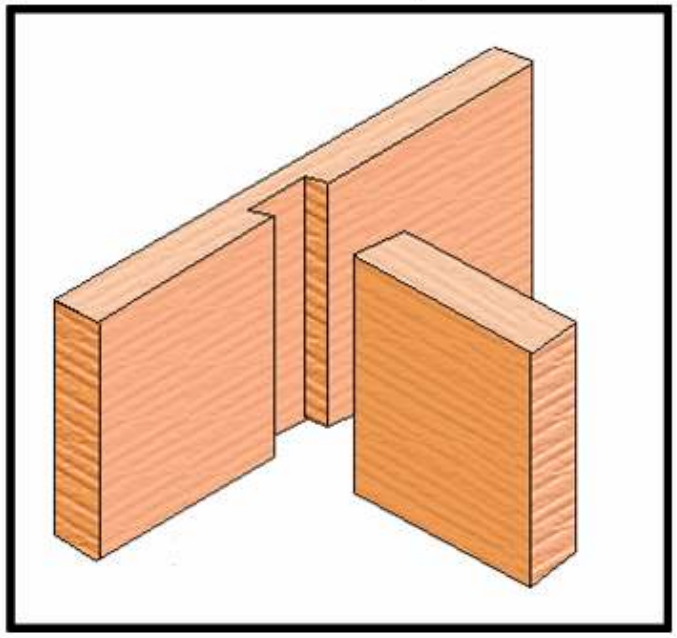
11. If the joint is slightly inaccurate a firmer or bevel edged chisel can be used to correct it. A G cramp is used to hold the wood firmly. Scrap wood is placed underneath to protect the surface of the bench from the chisel. The second side of the joint should now be complete.

12. The joint should fit together accurately. If the stages outlined above have been carried out carefully.



HOUSING JOINT

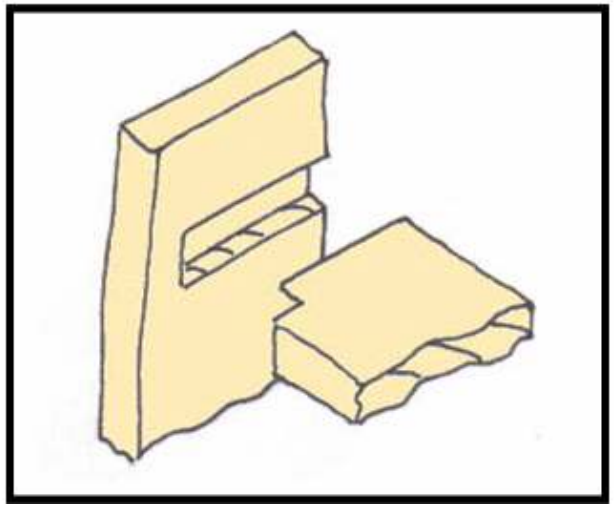
HOUSING JOINT



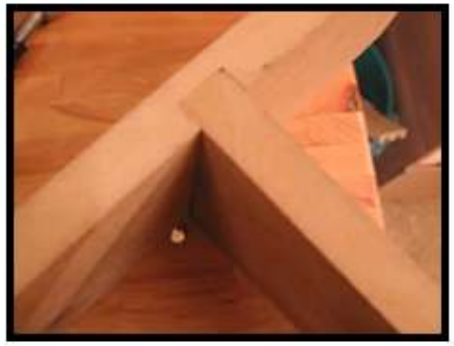
Housing Joints are most commonly used when a shelf is being fitted within a model. A groove is cut out of the side pieces at a certain height, wide enough for the shelf material to fit into. The shelf can then be glued and/or nailed in place.

A neater finish can be achieved by using a Stopped Housing Joint, as shown. You could imagine that this joint would be slightly trickier to cut out neatly although the joint will look better from the front of the model.

STOPPED HOUSING JOINT

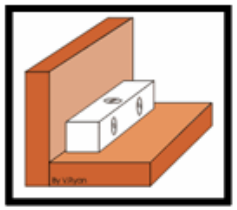


Notice how the photo on the left of the Housing Joint shows the cut out in the end piece but the photo on the right shows a neater finish because a Stopped Housing was used.



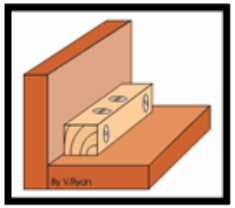
KNOCK DOWN FITTINGS

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



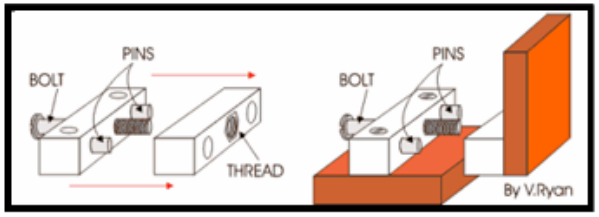
PLASTIC CORNER BLOCK (FIXIT BLOCKS)

The corner block is pressed against the two pieces of material (normally wood based). Screws are used to fix the block into position. This type of joint is used to fit modern cabinets such as those found in a kitchen. It is a relatively strong joint although it has the advantage that it can be dismantled using a screwdriver.



NATURAL WOOD FITTING (SQUARE SECTION BATTEN)

A piece of material such as pine can be drilled and screws can be passed through these holes. This gives a cheap and effective knock-down joint. The screws are normally countersunk into the knock-down fitting.



TWO BLOCK FITTING (LOK-JOINTS)

These are made from plastic. A bolt passes through the first fitting into the thread of the second. As the bolt is tightened it draws the two fittings together. The pins help keep the fitting straight. This gives a very strong joint and it can be dismantled using a screwdriver.

RIGID JOINT

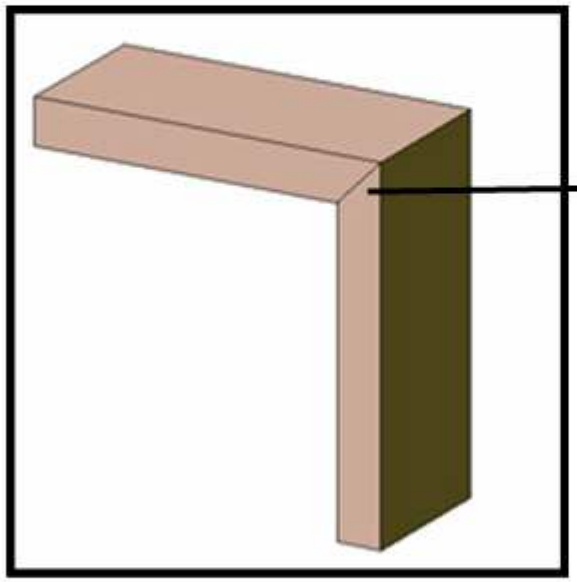
These are normally moulded in plastic which makes them strong. Screws pass through the four holes which hold the sides at each corner firmly together.

MITRE JOINTS

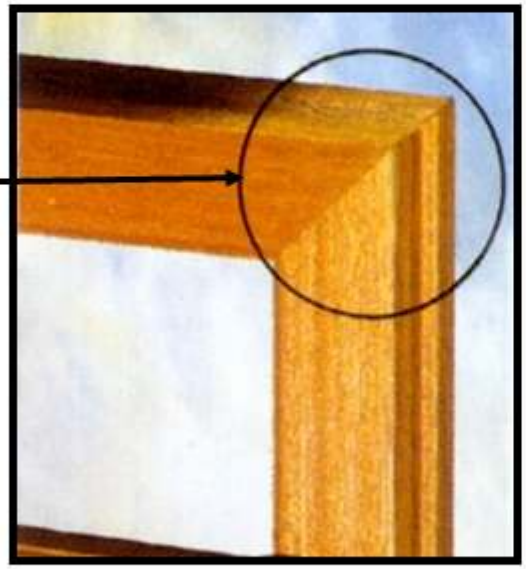
A Mitre Joint is used where two pieces of wood need to be positioned next to each other at exactly 90°.

A 45° cut is made on either end and when they are placed against each other, a 90° corner is achieved.

MITRE JOINT



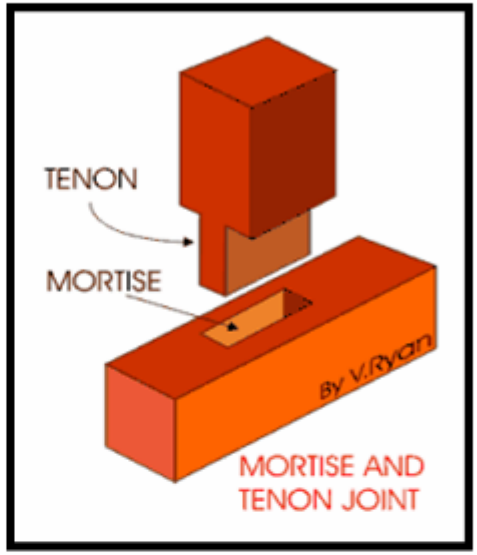
Using this wood joint would create an 'L' shape with two pieces of wood.



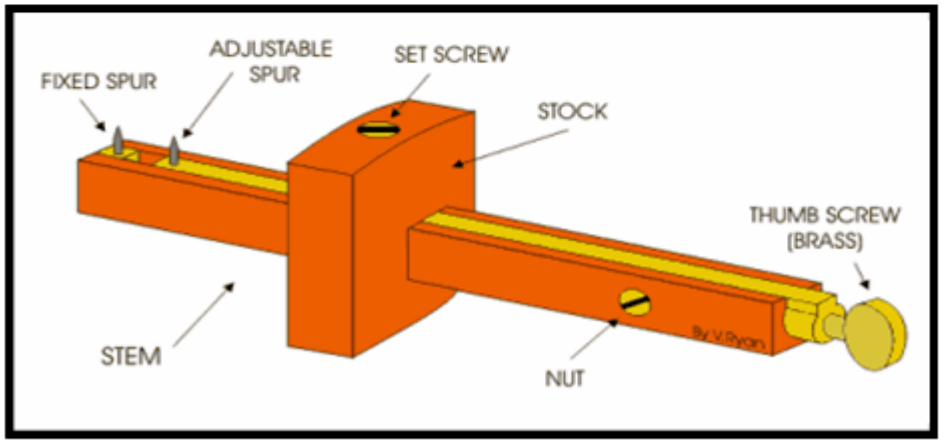
The most common use for Mitre Joints is in the construction of wooden picture frames. They are often made up of four pieces of wood with Mitres cut on both ends of each.

MORTISE & TENON JOINT

An animation of a Mortise and Tenon joint is shown opposite. This type of joint has a wide range of uses and is particularly useful when manufacturing furniture. The marking out and cutting of Mortise and Tenon joints are described in this presentation.



INTRODUCING THE MORTISE GAUGE

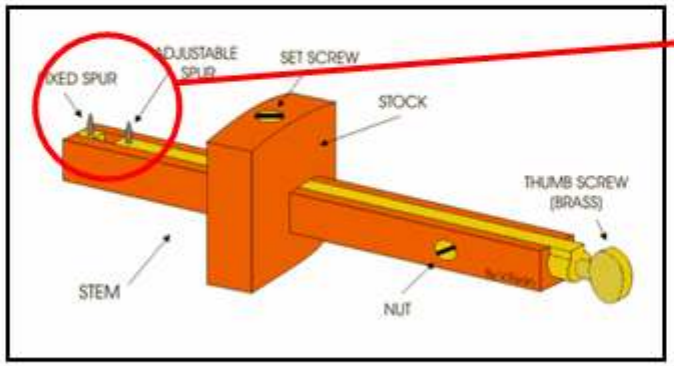


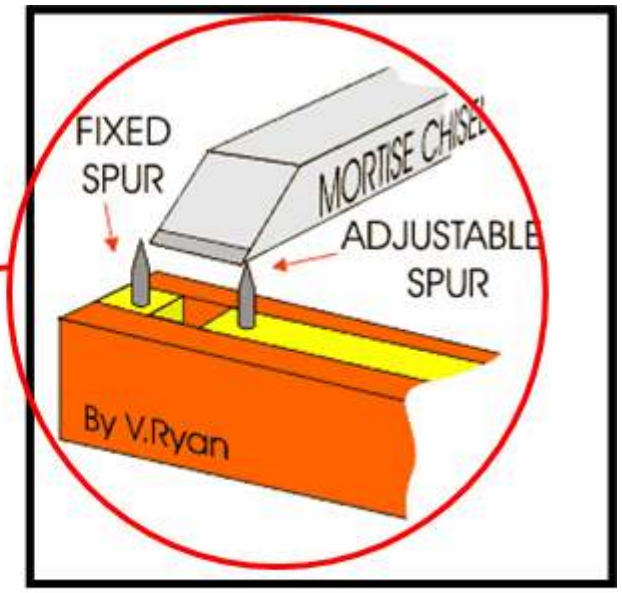
The mortise gauge is a special type of marking gauge. It is used to mark wood so that a mortise can be cut into it. It is crucial that it is set to the correct size of mortise chisel. The mortise chisel is then used to remove the waste wood.

The mortise gauge is normally made from a hardwood such as Rosewood with Brass being used for the parts that slide along the stem.

SETTING THE MORTISE GAUGE

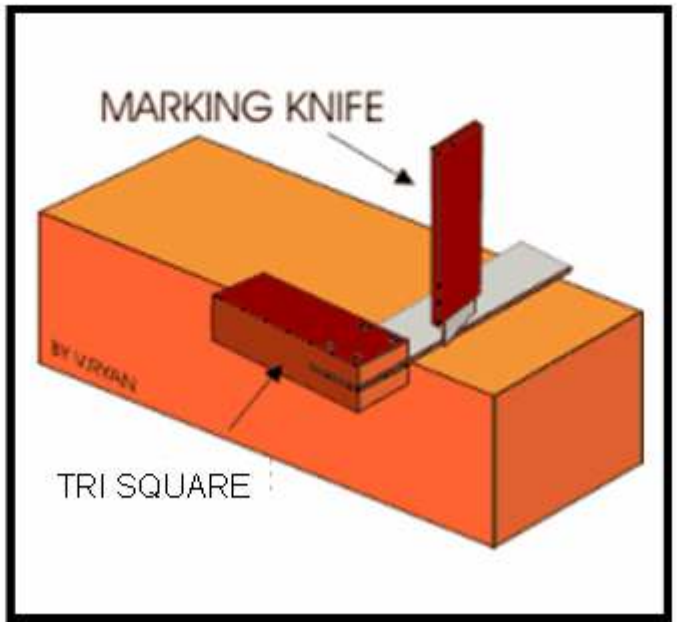
1. The distance between the fixed spur and the adjustable spur is set so that it matches the width of the mortise chisel. The width of the mortise chisel should match the width of the mortise to be cut in the wood.





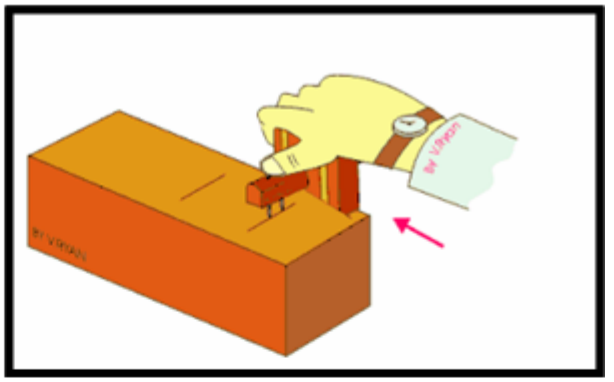
MARKING OUT THE MORTISE

2. A TRI SQUARE and a marking knife are used to mark the lines at the ends of the mortise.



MARKING OUT THE MORTISE – cont.

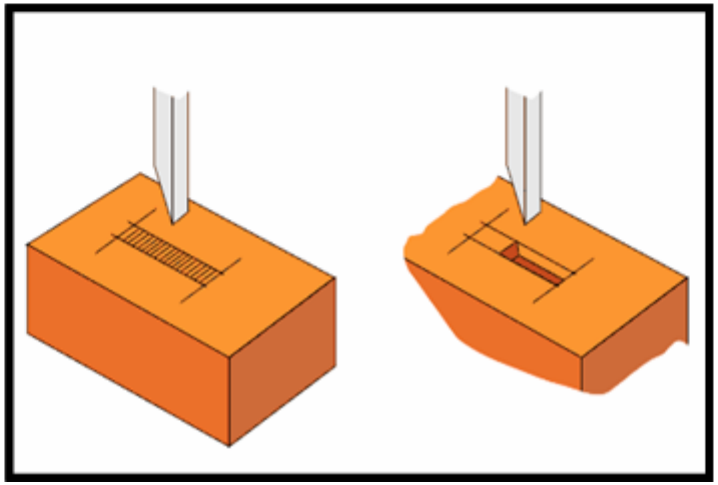
3. The stock of the mortise gauge is pressed against the side of the wood. It is then pushed along the wood until the mortise is marked out correctly.

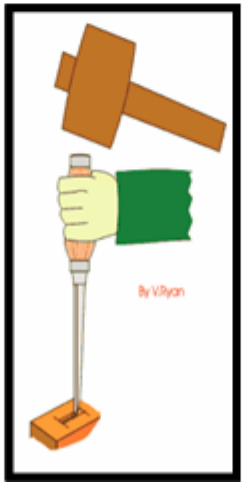


CUTTING OUT THE MORTISE

4. The Mortise Chisel is then used to break the surface of the waste wood by gently tapping the handle with a Mallet.

5. The waste wood is then slowly removed, this time, by applying more force to the handle of the Chisel with the Mallet. The waste is removed until the entire Mortise hole has been cut to the correct depth.

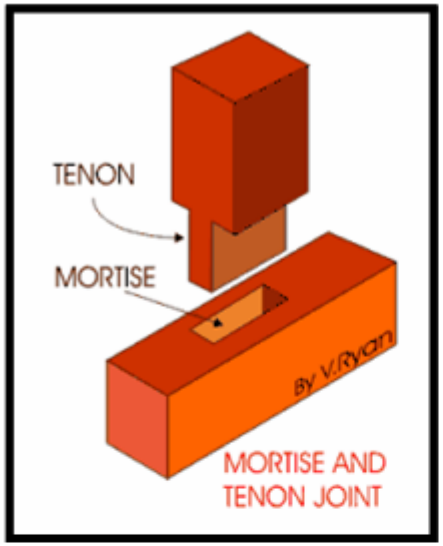




MARKING OUT THE TENON

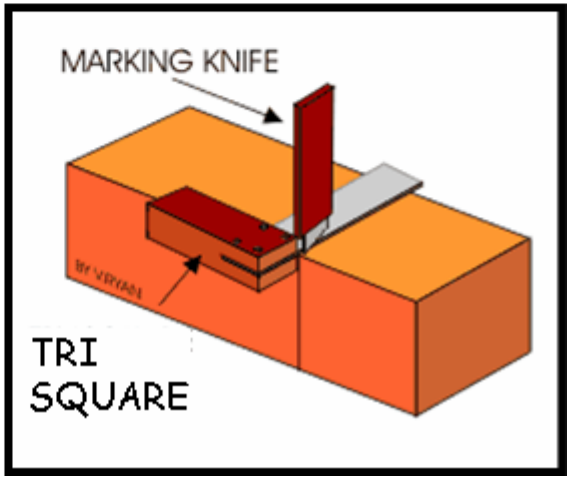
The Tenon part of a Mortise and Tenon joint is marked out and cut with the same tools as are used for the Mortise part of the joint.

Here is how it is done :



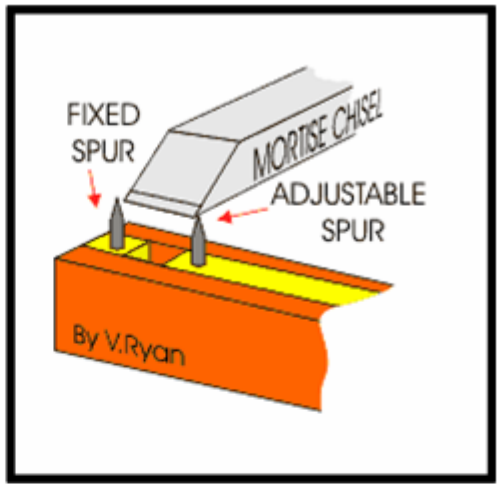
MARKING OUT THE TENON cont.

The width of the Tenon is marked all the way round the wood. Normally a marking knife is used to produce a precise line, with the aid of a TRI SQUARE. A pencil can then be used make the line stand out.

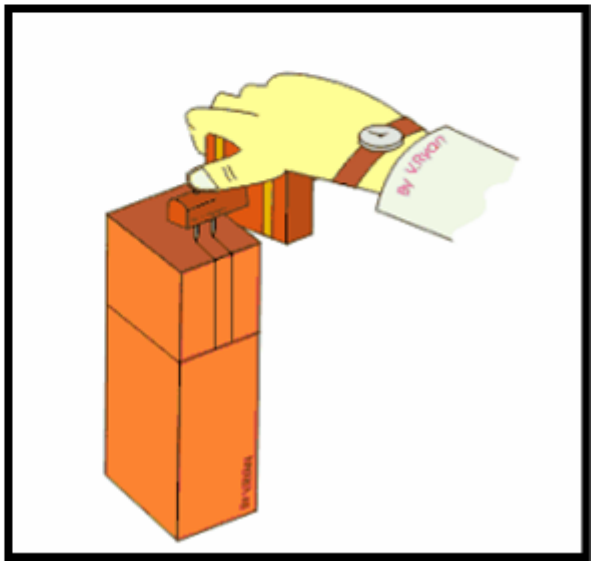


SETTING THE MORTISE GAUGE - again

The MORTISE GAUGE is now used to mark out the width of the tenon. It should be the same width as the mortise which has just been cut into the wood. The fixed spur and the adjustable spur of the gauge are set to the width of the mortise chisel.

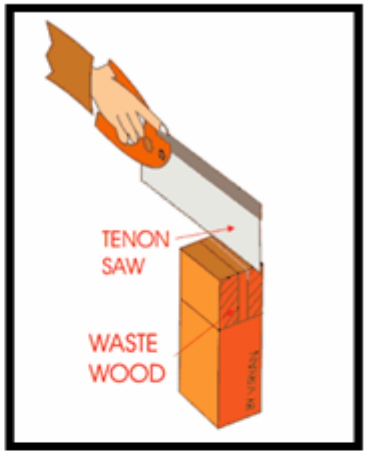


The MORTISE GAUGE is used to mark the size of the Tenon. The stock of the marking gauge must be held firmly against the side of the wood as it will have a tendency to follow the grain of the wood rather than a straight line.



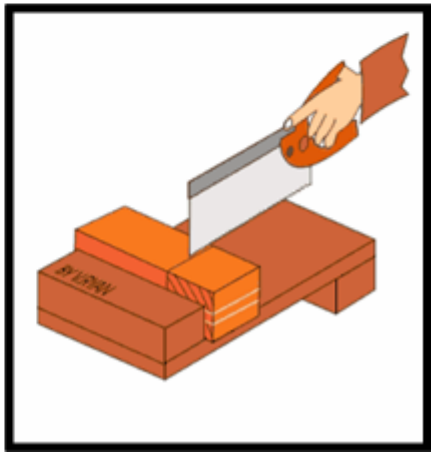
CUTTING THE TENON

A TENON SAW is used to saw down the gauged lines of the Tenon. The wood is normally held firmly in a woodworkers VICE. When sawing, take time to check that the saw is cutting straight down and that it is on the waste wood side of the Tenon.



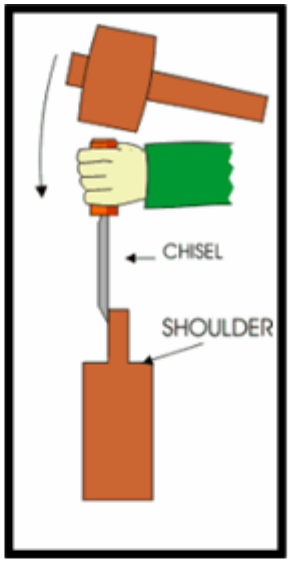
CUTTING THE TENON – cont.

The wood is then supported by a Bench Hook and a TENON SAW is used to finally remove the waste wood. This leaves the shoulder of the joint.



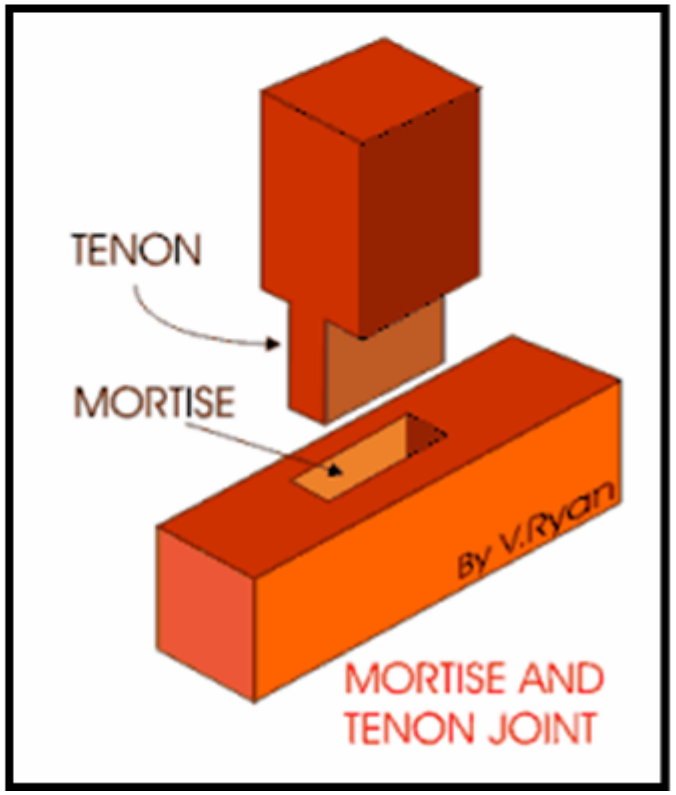
CUTTING THE TENON – cont.

A FIRMER CHISEL or BEVEL EDGED CHISEL can be used to remove rough edges and to straighten the Tenon. The wood must always be held in a woodworking VICE as a chisel my slip if the wood moves. If the marking out and cutting have been carried out accurately the Mortise and Tenon should fit together forming a firm joint.



MORTISE & TENON

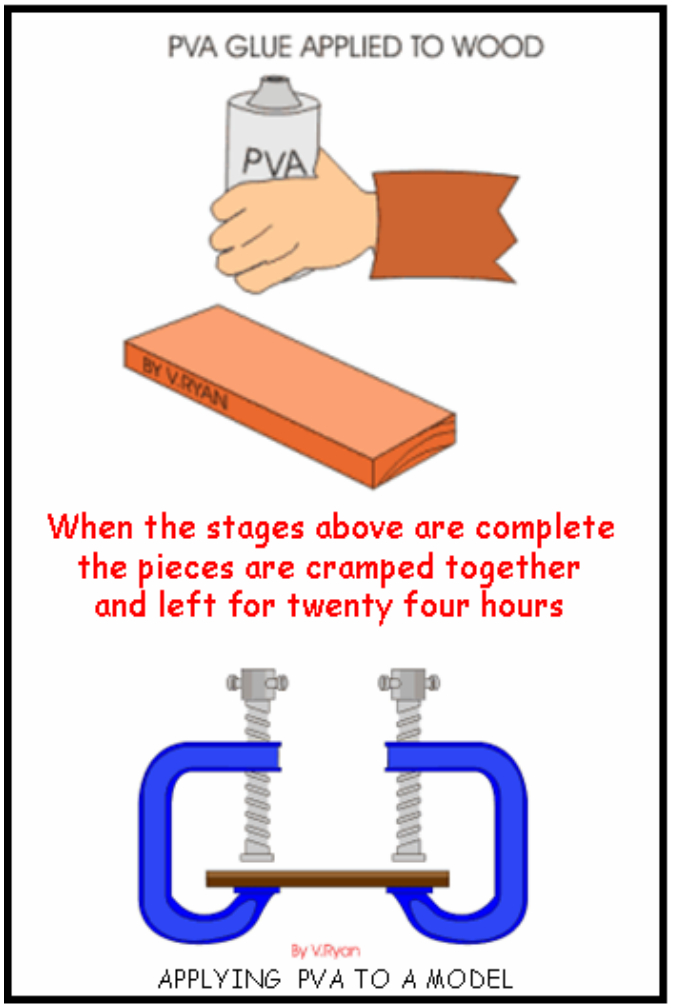
finished



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 all over 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.

Processes

ABRASIVES (sand paper etc.)

sanding block made from cork

rubber sanding block

sheets of glasspaper

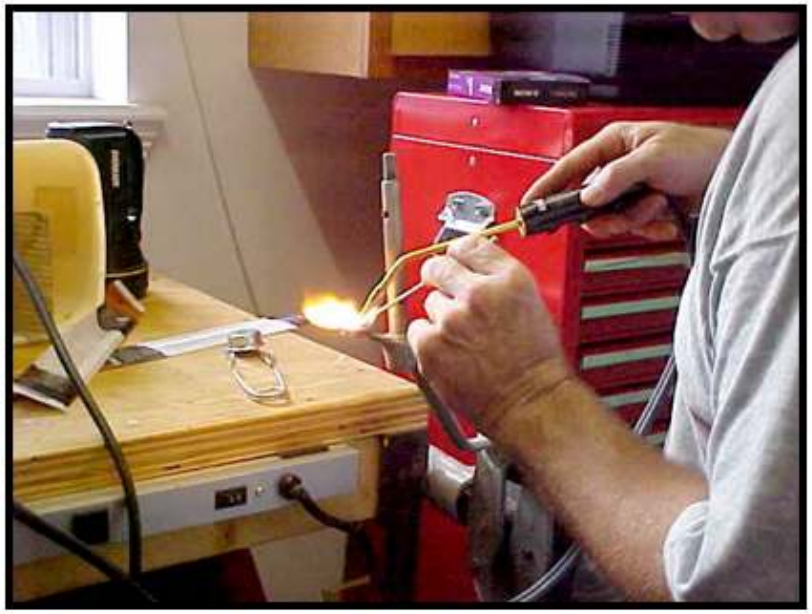
After any wooden model has been assembled and before a finish can be applied, it must be sanded down to remove any pencil marks, excess glue, roughness or dirt.

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.

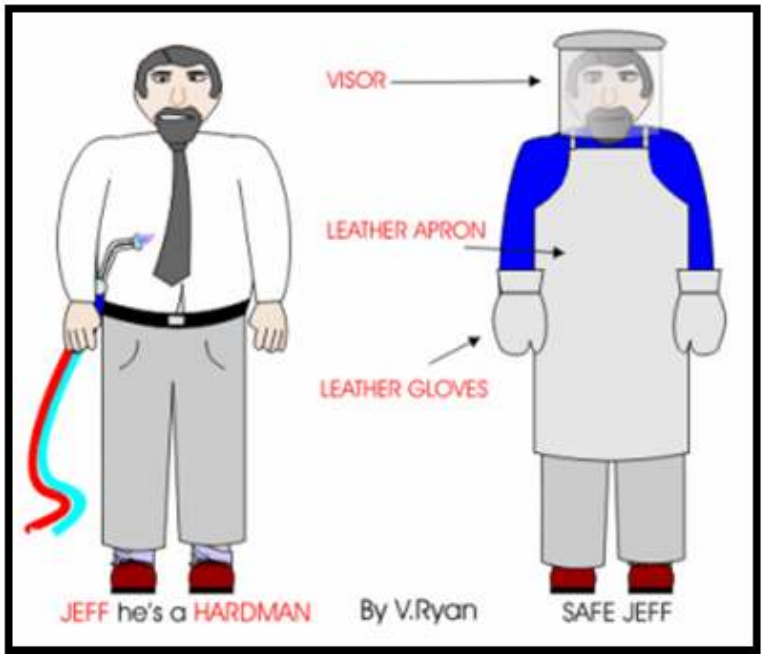
BRAZING

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.

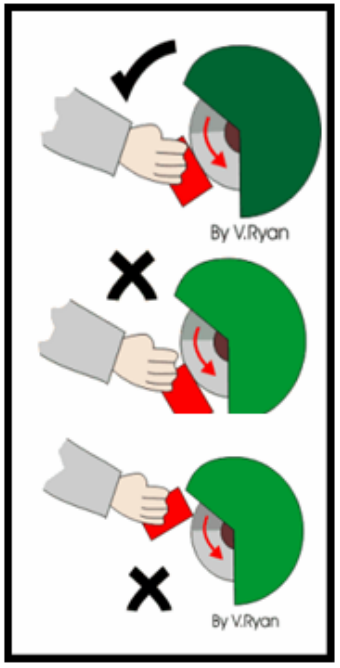


BUFF / POLISHER

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.

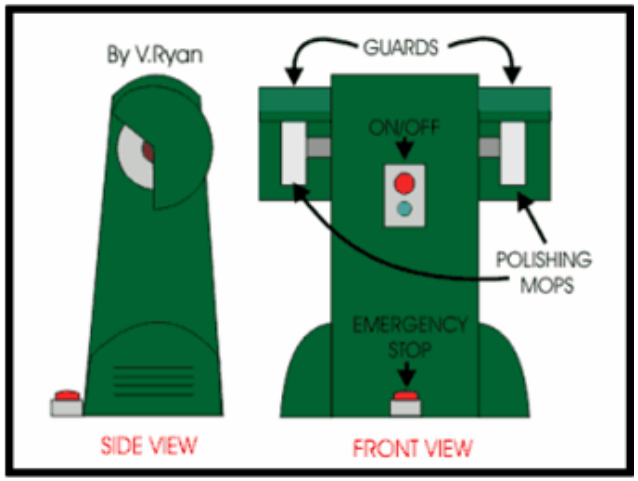
If the material is carefully pressed against the mop and moved backwards and forwards it will be polished.

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.



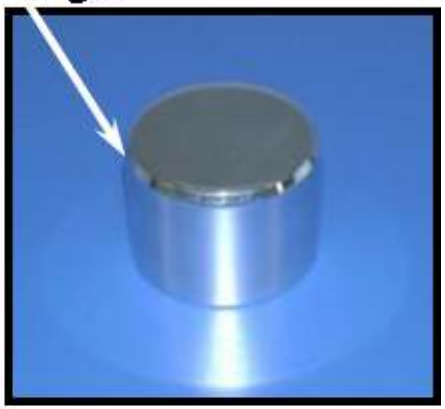
The second example is clearly a dangerous way to hold the work as the top corner is about to be caught by the rotating mop.

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.

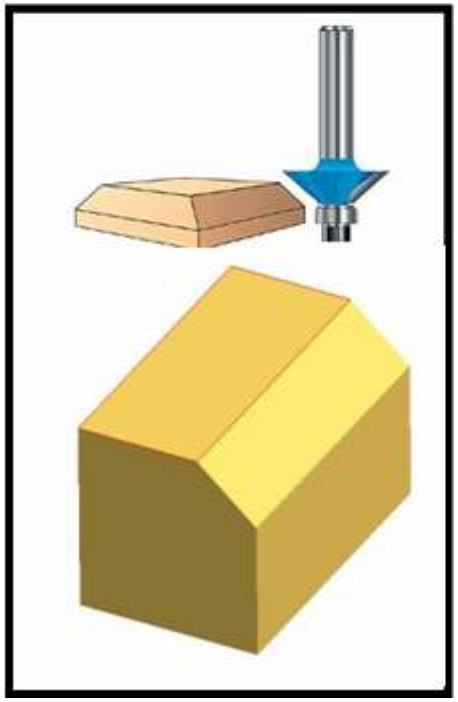
CHAMFERING

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, 90° corners are taken away from models where possible.

chamfered edge



The process of removing the point of a 90° 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 below right.

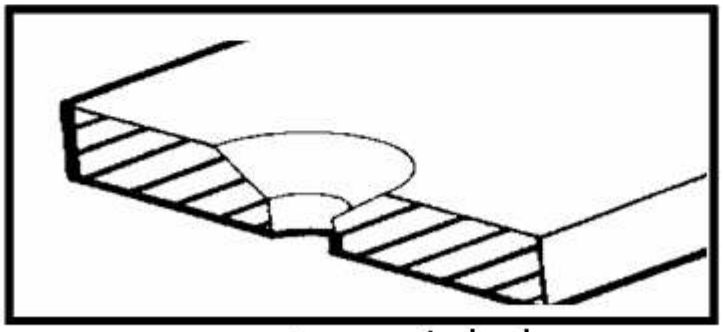


COUNTERSINKING

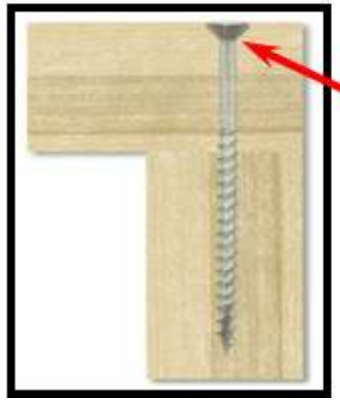
When a screw is driven into a piece of wood, it sometimes doesn't matter that the head of the screw is sticking up out of the wood. Sometimes it matters a lot and it has to be avoided.

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.

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.



a countersunk hole



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

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 300° C and 450° 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.

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°) 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.

FINISHES

PAINT

VARNISH

WOOD DYE / STAIN

WAX

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

VARNISH

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

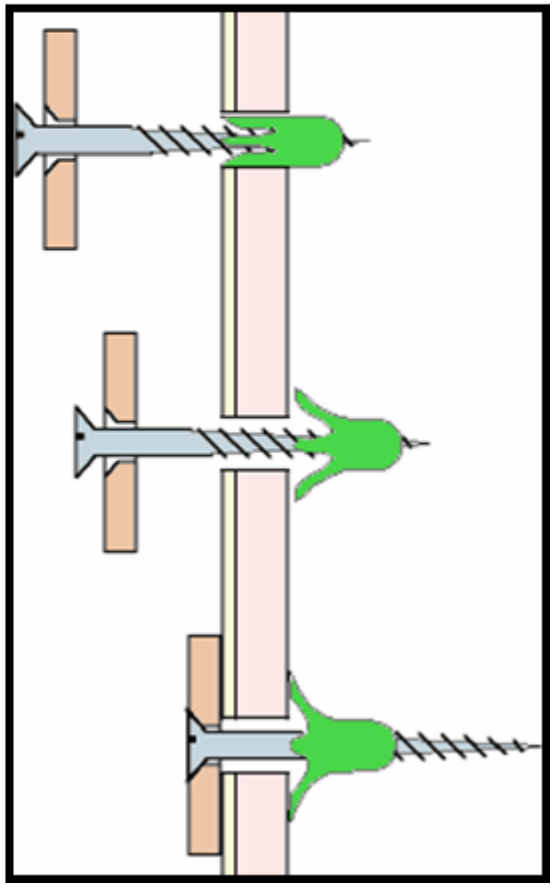
After the colour of the finish has been decided by either varnish or stain, wax can be applied to give the finished model a really smooth silky feel to it. The wax is applied by a soft cloth and is rubbed in to the wood in circular strokes.

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.



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.

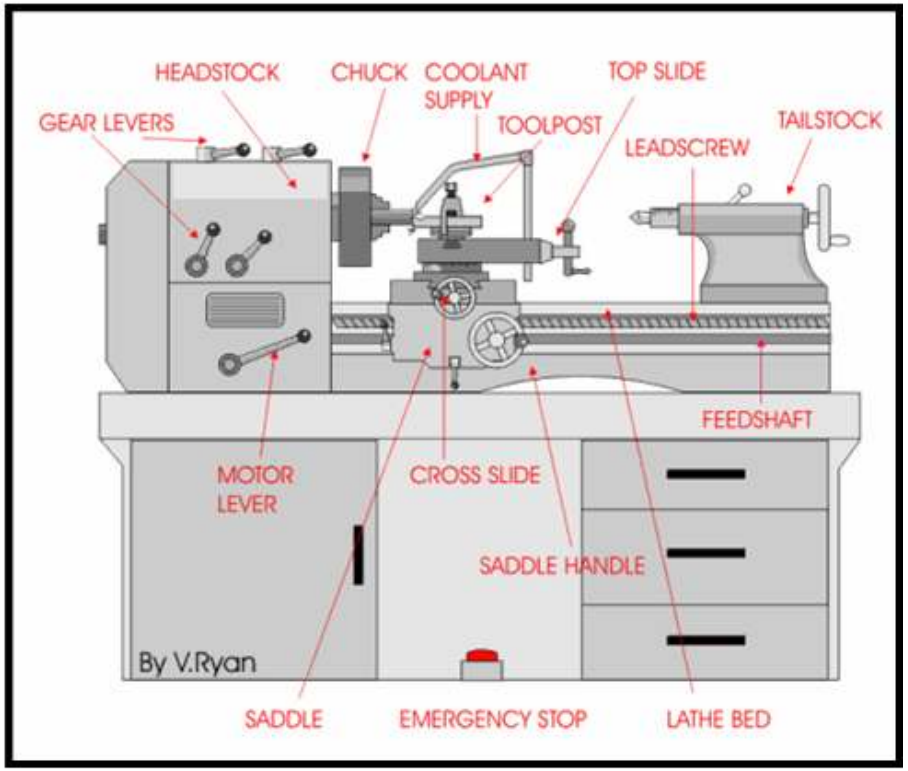
Tempering - The hardened steel is first cleaned to make it bright in appearance. It is then gently heated until it starts to change colour. first it goes to a pale straw colour, then straw, dark straw, brown, brown/purple, purple, dark purple then blue. The paler the metal the harder and more brittle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

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 to the right. 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

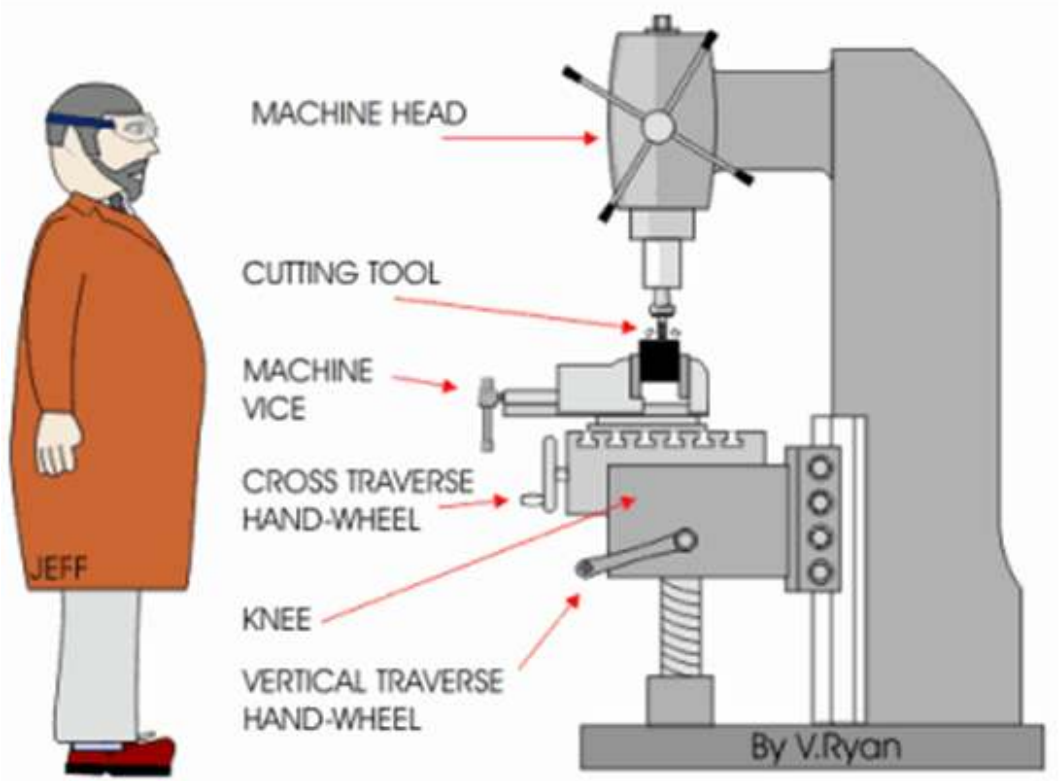
Used to remove the workpiece at the end of the turning process by 'parting off'

TURNING TOOLS

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

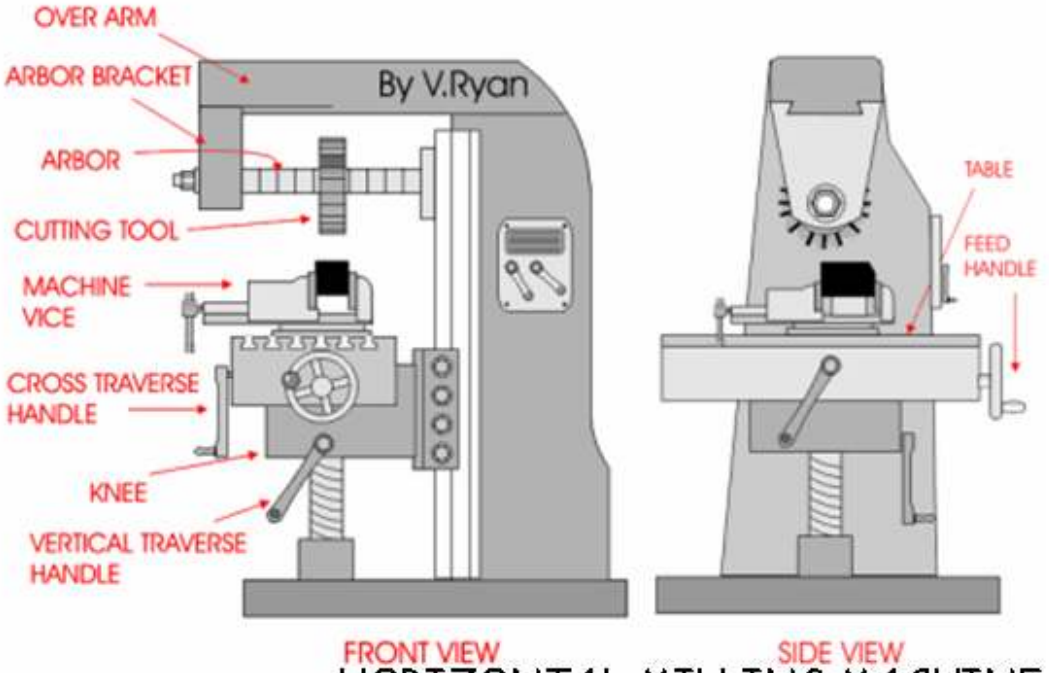
MILLING

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.

SANDERS

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 which 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 ?

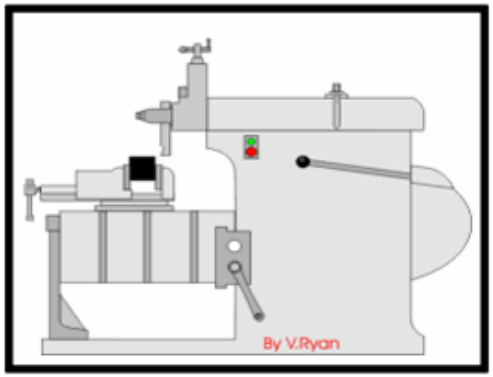
A woodwork machine tool.

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



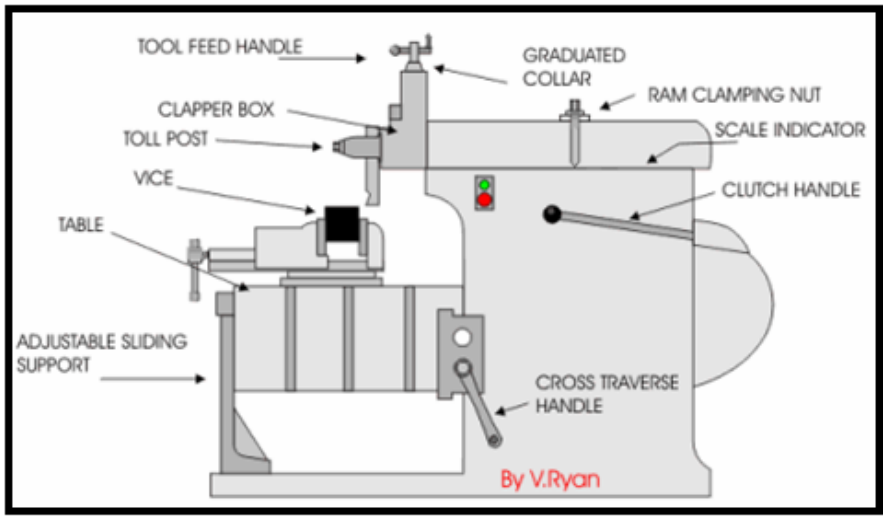
A shaping machine is used to machine surfaces. It can cut curves, angles and many other shapes. It is a popular machine in a factory workshop because its movement is very simple although it can produce a variety of work. They are less common in school workshops, perhaps because of their moving parts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

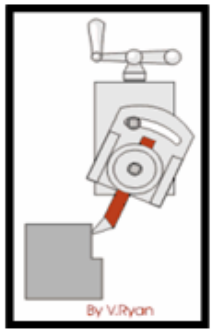
The main parts are indicated right:

The tool feed handle can be turned to slowly feed the cutting tool into the material as the 'ram' moves forwards and backwards.

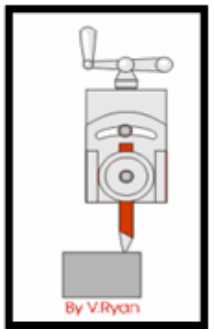
The strong machine vice holds the material securely. A small vice would not be suitable as the work could quite easily be pulled out of position and be damaged.

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.



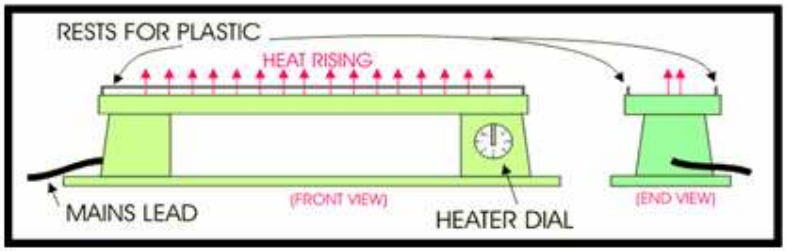


The tool post has been turned at an angle so that side of the material can be machined



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

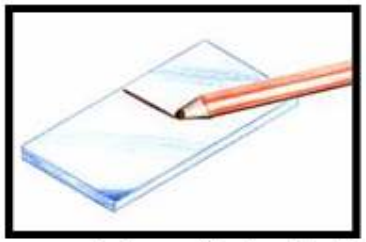
STRIP HEATER



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

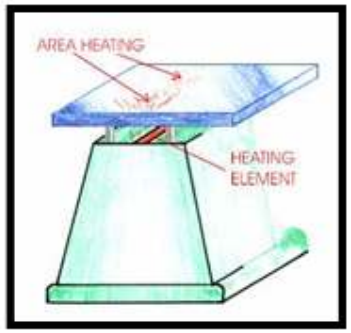


The position of the fold is marked with a *china-graph* pencil. With this type of pencil the line can be removed easily later.

STEP 2

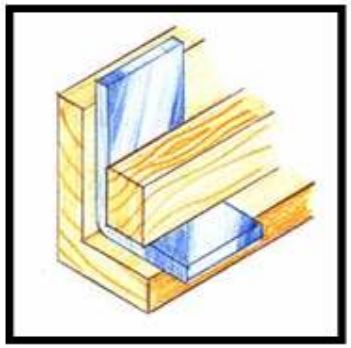
The strip heater is turned on and set at the correct temperature.

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.

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.

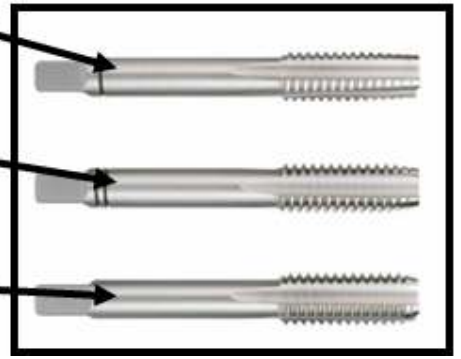

SET OF TAPS AND DIES

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.

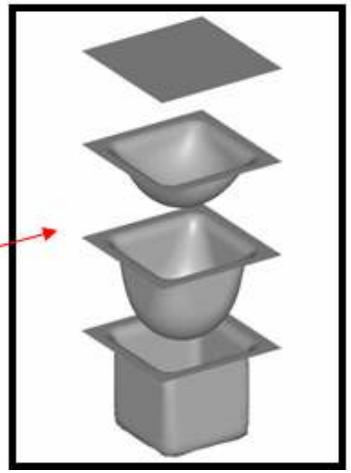
The Intermediate tap would go second.

You would finish with the Plug tap. This would allow you to get the thread right down to the bottom of the hole.

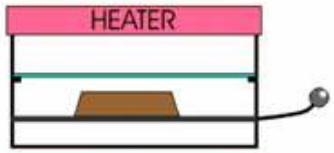


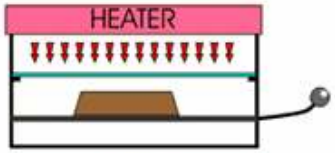
VACUUM FORMING

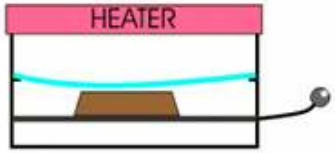
Vacuum Forming is a technique that is used to shape a variety of plastics. In school it is used to form/shape thin plastic, usually plastics such as; polythene and perspex. Vacuum forming is used when an unusual shape like a 'dish' or a box-like shape is needed. To the right you can see the stages involved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

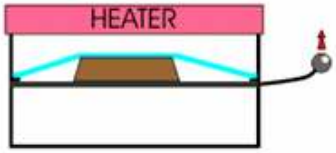


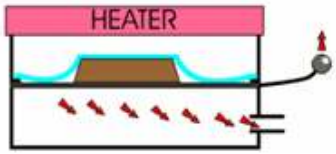
A flat plastic sheet goes through the vacuum forming process from start to finish.

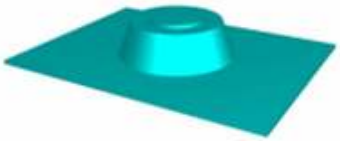












STEP 1
First, a former is made from a material such as a soft wood.

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.

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.

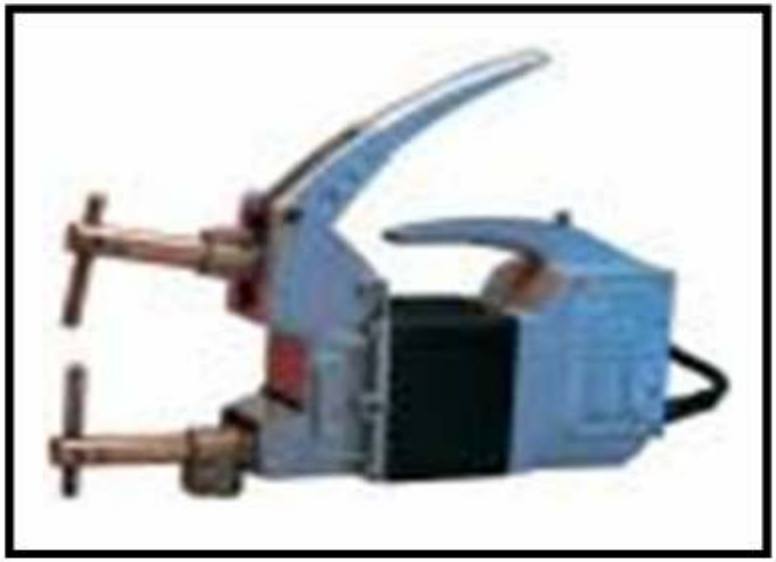
The heat is produced by the resistance of the material to carry a high electrical current.

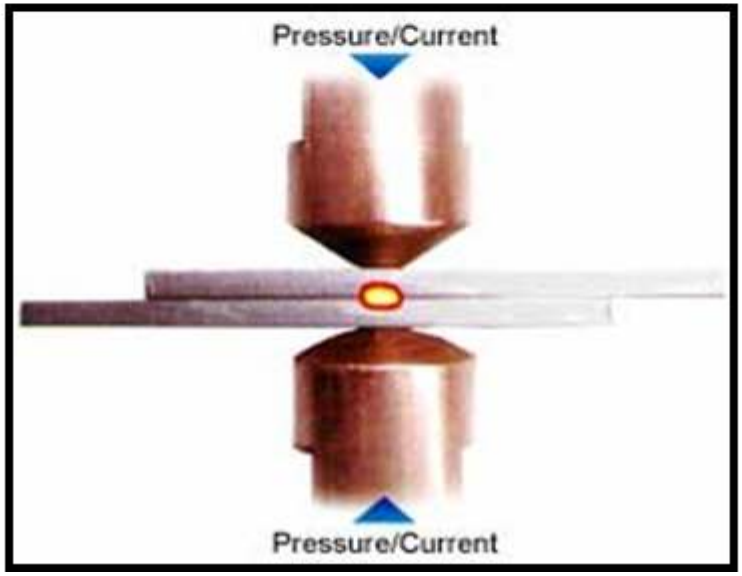
The greater the path of resistance is, the higher the heat intensity.

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.





WOOD TURNING

The woodwork lathe is a piece of equipment used to turn timber into round shapes.
The timber is held in the machine and a cutting tool is brought into contact with the revolving wood gradually cutting a cylindrical shape.
It is a relatively simple machine consisting of two stands, a bed, a headstock, a tailstock, toolrests and an electric motor providing the drive through a system of pulleys and a belt.

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.

WORKSHOP SAFETY

ALWAYS PROTECT YOUR EYES
you won't get another pair

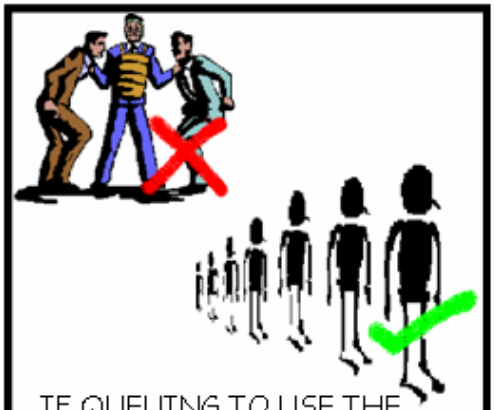
IF YOUR HAIR IS LONG ENOUGH
tie it back

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

PLEASE SWEEP THE MACHINE DOWN
as soon as you are finished

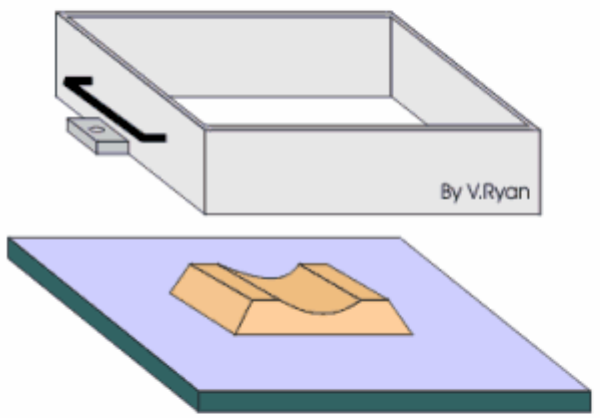
Click here to see the Safety Unit first years get when they first come to the Department

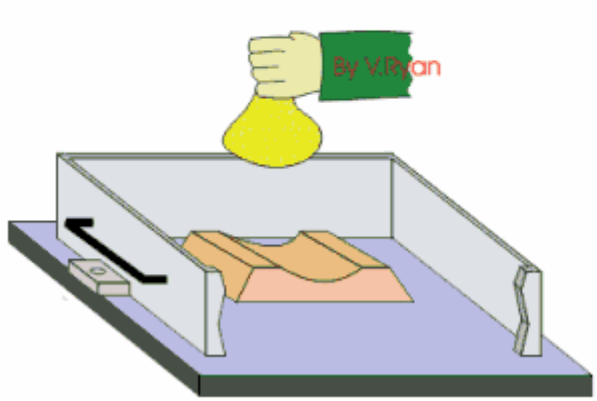
Here are a selection of some of the safety notices you will see around the various workshops in the Department. They will give you good general safety advice. Mostly you should find that they are all describing simple good behaviour which, in itself, will help you avoid most dangerous situations.



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

Casting allows us to shape molten metal for a desired purpose. It is a specialised part of the manufacturing/engineering world and it is properly called foundry work. In schools and colleges this usually involves casting molten aluminium. Before any casting can take place a wooden pattern is made precisely. This is called pattern making and in industry this is a very skilful job. Any inaccuracy at this stage will result in the final cast being wrong or even failing. In schools the pattern is usually made from a softwood and its sides are given a draft (an angle) so that it can be removed from the sand easily.

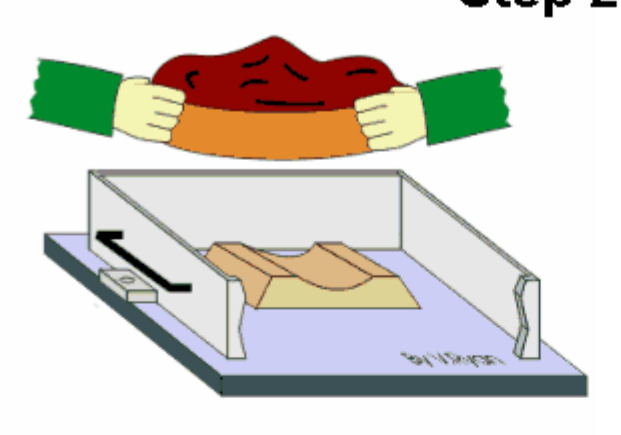




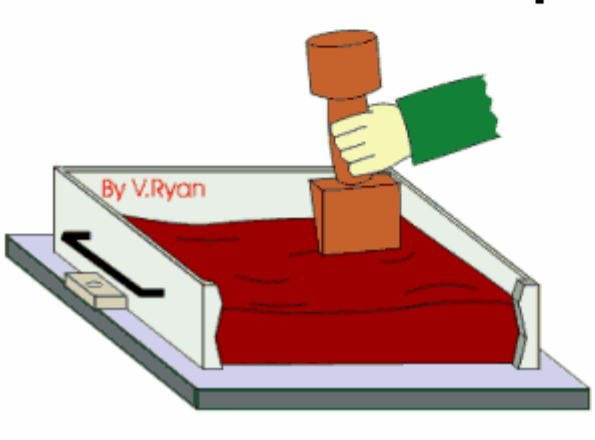
Step 1:

The diagrams to the left shows the pattern on a flat board and a casting box called a 'drag' being placed over it.

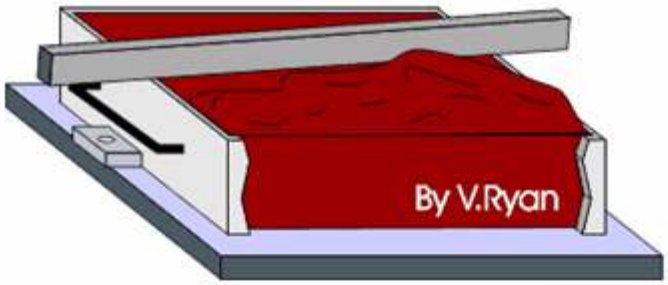
Special casting sand will soon be packed around the pattern but to ensure to can be removed easily from the sand, parting powder is sprinkled over and around it. (parting powder is similar to talcum powder). It stops the casting sand sticking to the pattern and pulling away with it when the pattern is finally removed from the sand.



Step 2: Casting sand is then shaken through a sieve (called riddled sand) so that only fine particles fall around the pattern. This is called facing sand and it must be fine so that detail on the pattern shows up on the final casting.
Different types of sand are available. The safest is called petro-bond. This is a mixture of quality sand and oil. The cheapest is called green sand and this is mixed with water. Green sand must be mixed carefully as if too much water is added - when molten aluminium is poured into the mould an explosion can result.



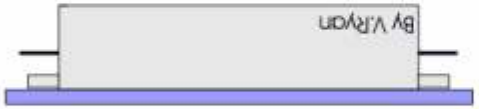
Step 3: The drag is then packed with more casting sand. It is a good idea to sieve all the sand being placed above the pattern and then ram it down firmly using a ramming tool. The tool has two ends, one is cylindrical and is used for general packing down of the sand. The other end is quite pointed and this can be used for packing sand close up to the pattern.

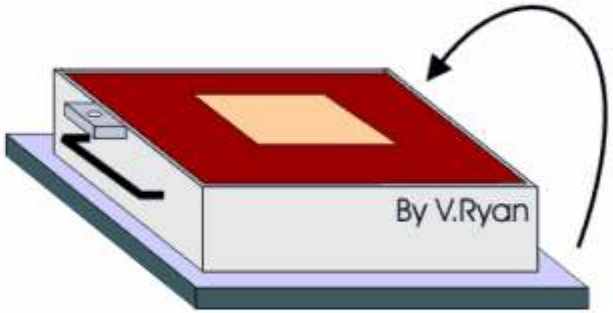


Step 4:

When the drag is packed fully it is levelled off (called 'strickled off') using a straight steel bar.

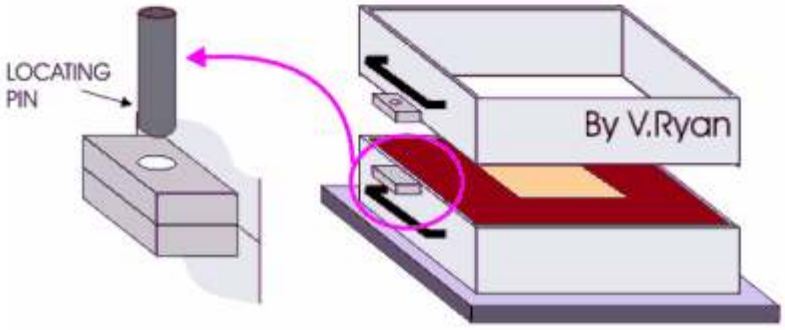
START





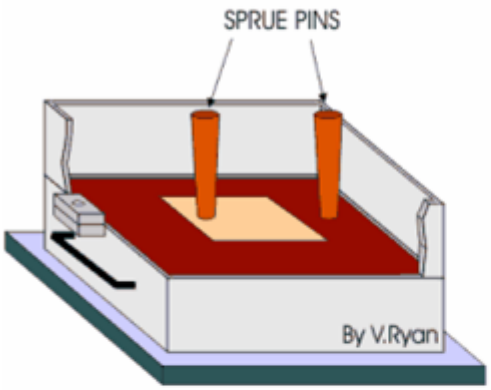
Step 5:

The entire drag and its contents are then turned over so that the base of the pattern can be seen.



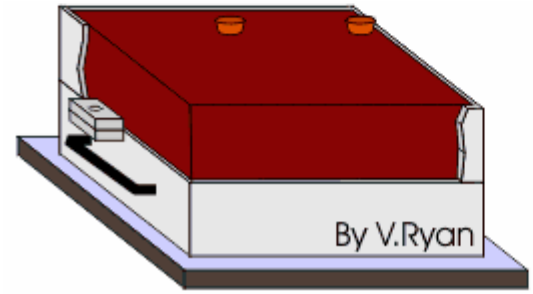
Step 6:

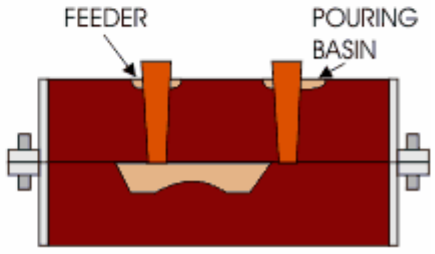
A top box called a 'cope' is then placed on top of the drag and locating pins are put in position so that the casting boxes cannot move sideways.



Step 7:

Sprue pins are positioned. One usually on the back of the pattern and the other to the side. These will eventually provide an entrance and exit for the molten aluminium when it is poured into the sand.
The sand is packed into the cope in the same way as the drag. Parting powder is first applied, followed by facing sand. The sprue pins should be taller than the box and stand out from the sand when it is levelled with a strickling bar.



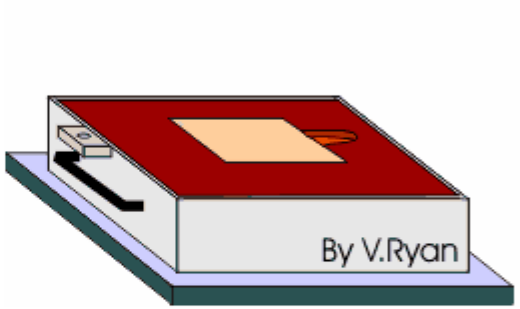


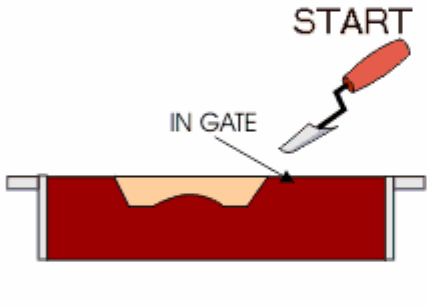
Step 8:

Small depressions are dug into the sand at the top of the two sprue pins. These are useful when the aluminium is poured. The depressions are called the pouring basin and feeder.

Step 9:

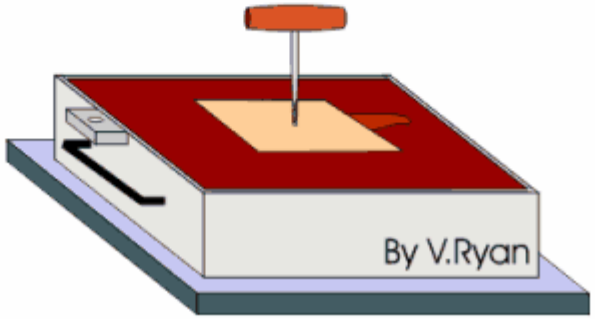
The top box (the cope) is then removed and if all is well the cope with the sand inside should lift off the drag (bottom box) without the sand falling out. A small ‘gate’ is cut below the position of one of the sprue pins. This will help the molten aluminium flow into the cavity left by the mould. Small tools are available or can easily be made to dig a variety of shapes in the casting sand. They are similar to small trowels.





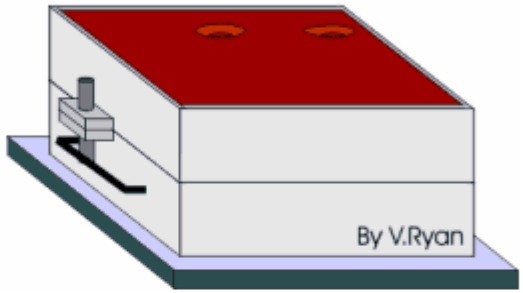
Step 10:

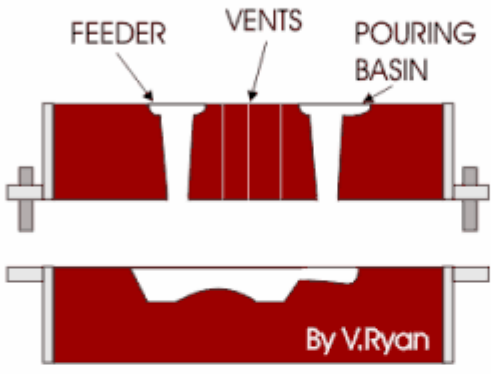
The pattern is removed using a ‘spike’. The end of the spike can be threaded and so it can be screwed into the softwood pattern. Before removing the pattern it is a good idea to gently tap the spike so that it loosens the pattern from the sand. It can then be lifted away from the casting box (drag).



Step 11:

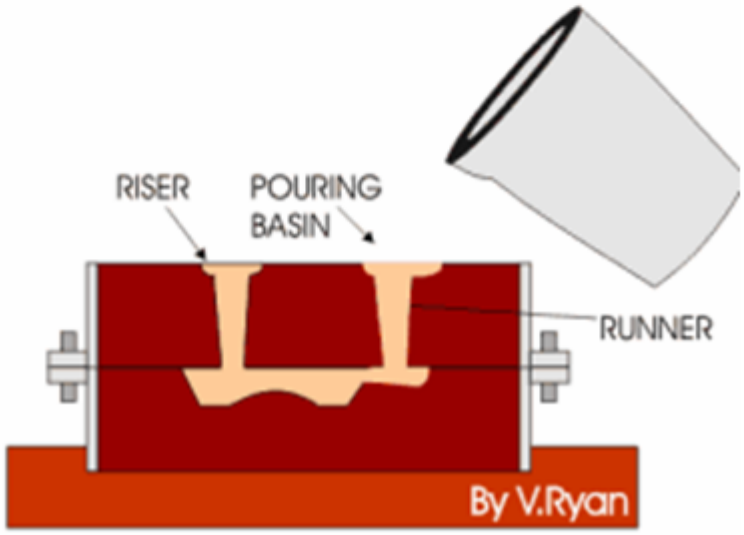
The cope (top casting box) is placed back on top of the drag and the locating pins put in position. Before this is done vents can be created using a thin piece of welding rod, pushing it through the sand . This allows gases to escape once the aluminium is poured.





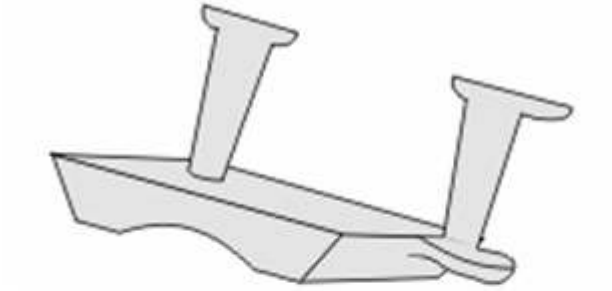
Step 12:

The aluminium is poured with great care, down the hole left by the first sprue pin (now called the 'runner'). As it runs down the runner it flows through the 'gate' cut by the trowel, into the cavity left by the pattern and up the riser (the hole left by the second sprue pin).
The casting should be left for at least an hour before removal from the sand.

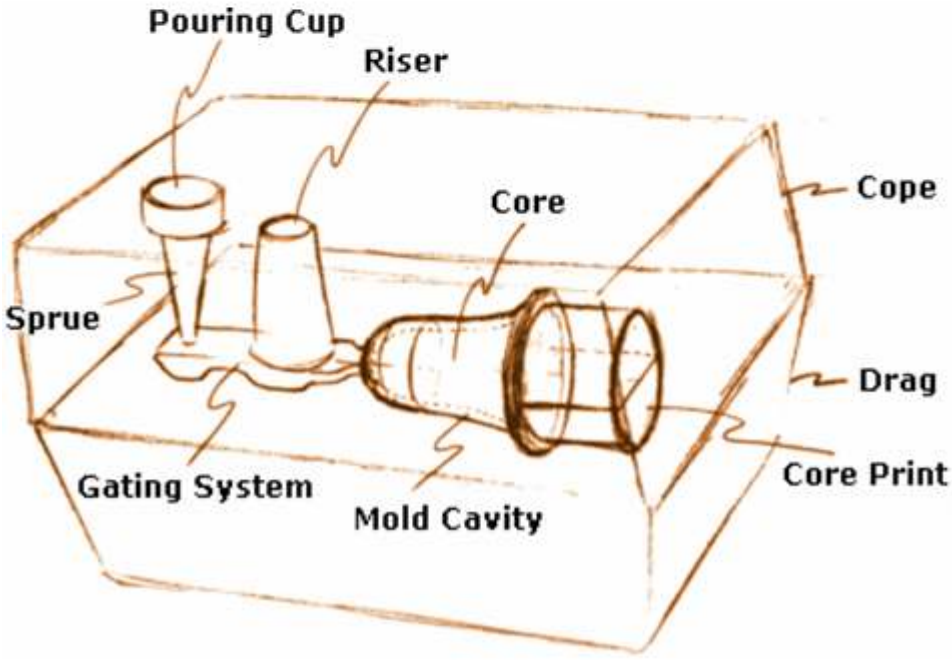


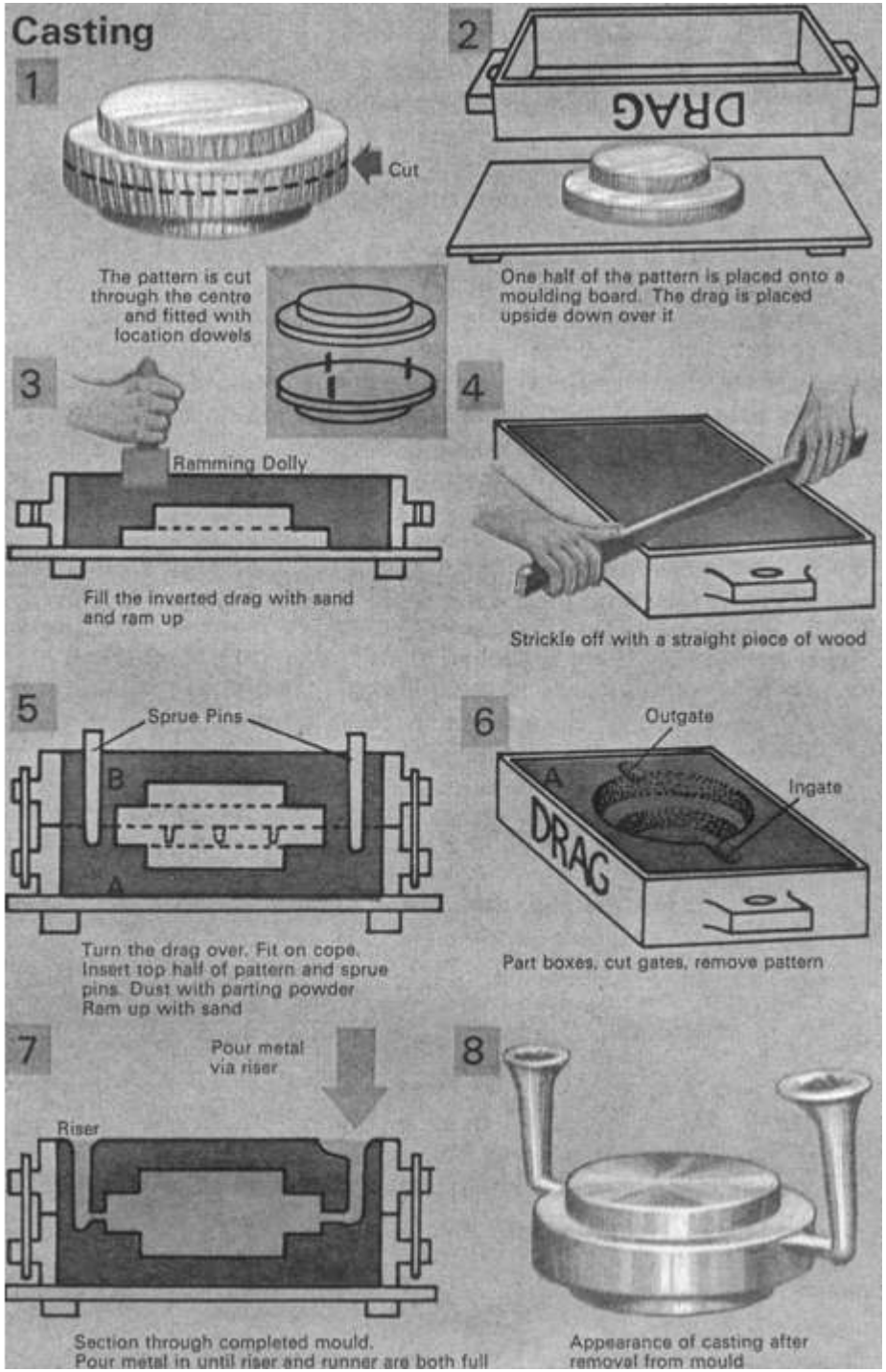
Step 13:

When removed from the sand, the runner and riser are cut away and the casting is ready for machining.



Inside the Cope and Drag…

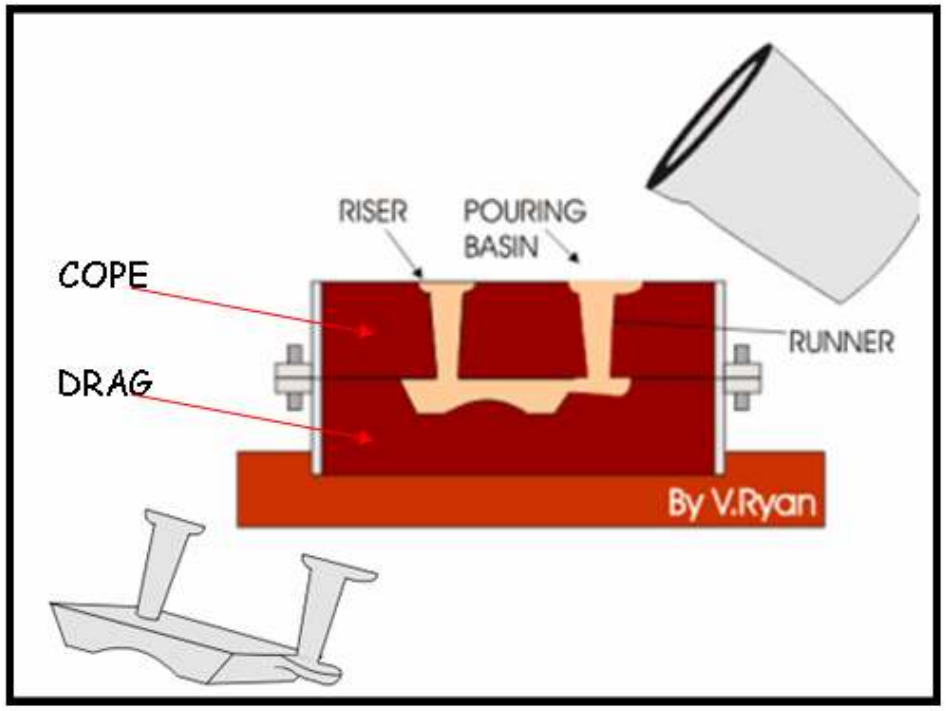




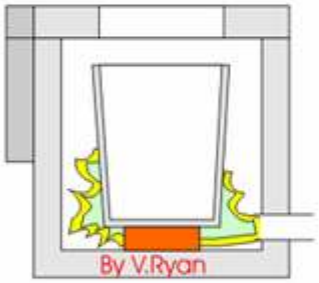
CASTING

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.

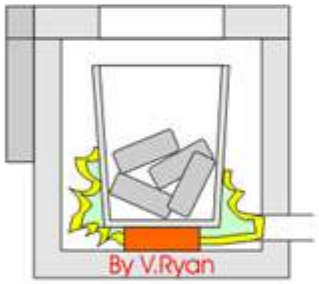
Aluminium is often used as it has a pretty low melting point. The box is split into two parts – the top half is called the **COPE** and the bottom half is called the **DRAG**. While pouring, the molten metal enters through a hole that has been created in the sand called a **RUNNER** and as the space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



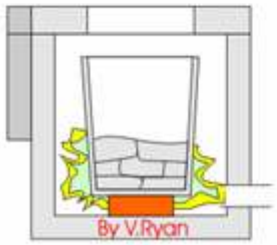
CASTING



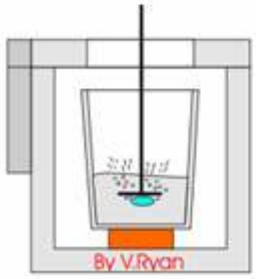
PREHEATING - The crucible is first preheated. This removes any moisture from the furnace and crucible. Usually the gas is turned half on in order to avoid rapid heating. The aluminium ingots to be used are placed on top of the furnace so that they warm up.



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.



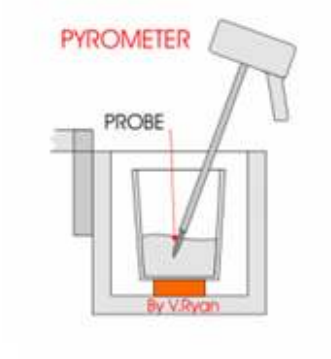
ADDING FLUX - As the aluminium begins to melt a small amount of 'flux' is sprinkled over the aluminium. A spoon can be used to sprinkle the flux powder. The flux prevents oxidisation (oxygen entering the molten aluminium). If oxygen enters the molten aluminium, when it is poured into the mould the final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



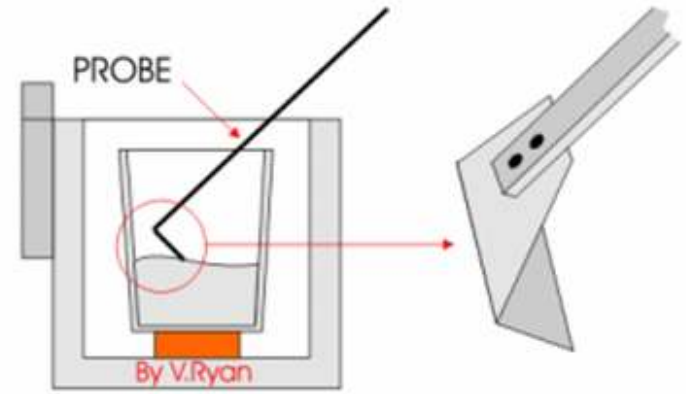
ADDING A DEGASSING TABLET - When the aluminium has melted fully and is approximately 700 degrees centigrade the gas is turned off and a degassing tablet is added. This removes any impurities, in the form of gas. It is important that a good extraction system is used to remove the fumes caused by the tablet.

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.



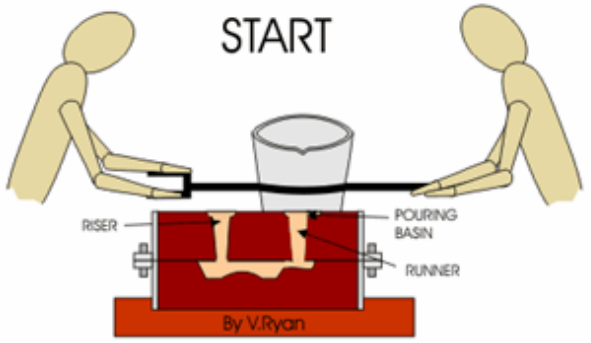
CRUCIBLE LIFTED OUT OF FURNACE - The sliding lid/top of the furnace is pulled back using a steel hook. This allows special lifting tongs to be placed around the crucible which can then be lifted up and away from the furnace. The crucible is set to rest in a bed of sand which surrounds the furnace. The 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

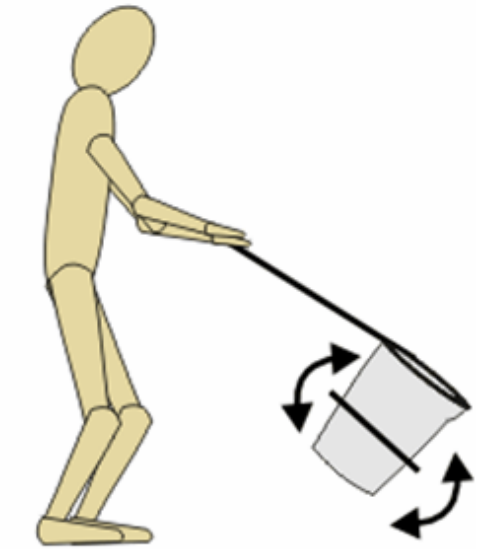
POURING THE ALUMINIUM - The two man ladle is then lifted which raises the crucible from the floor. The teacher must always control the pouring of the molten metal and so holds the two handles. The second person (possibly a pupil) holds the single handle allowing it to revolve when the ladle is turned 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 it 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.

20 Questions…

1. What is Casting?
2. What is a Pattern?
3. Why must a Pattern be accurately made?
4. What is a Drag?
5. Why do we use Parting Powder?
6. Why do we sieve the Casting Sand before it touches the Pattern?
7. What do we call this sieved sand which covers the face of the Pattern?
8. What is the name of the safest type of Casting Sand?
9. What is Green Sand?
10. Why must you make sure that the correct amount of water is added to Green Sand?

11. What is used to level off the Casting Sand once it has been packed around the Pattern?

12. Why is the Drag turned upside-down?

13. What is a Cope?

14. What do the locating pins do?

15. How do we allow gases to escape from the casting Sand?

16. Molten Aluminium is poured down the hole left by the first Sprue Pin. What is this hole now called?

17. What s the name given to the hole left by the second Sprue Pin?

18. What is the purpose of the Riser?

19. How long should the molten metal be allowed to set for before being removed from the Casting sand?

20. What must be removed from the metal before it can be machined?

20 Answers…

1. Casting is a way of shaping molten metal.

2. A Pattern is a block of wood made in the same shape of the final cast. It leaves an impression in the casting sand into which the molten metal will be poured.

3. If the Pattern is not accurately made it resulting cast may fail.

4. The Drag is the box which is placed over the Pattern.

5. Parting Powder allows the Pattern to be extracted easily form the Casting Sand.

6. We sieve the Casting Sand so that it is fine enough to pick up any details on the surface of the Pattern.

7. The sieved casting sand is known as Facing Sand.

8. The safest type of Casting Sand is called Petro-bond.

9. Green Sand is a cheap Casting Sand mixed with water.

10. If you add too much water to Green Sand it could explode when casting.

11. A steel bar is used to strickle off the sand once it has been packed.

12. The Drag turned upside-down so that the pattern faces upwards towards the Cope.

13. The Cope is a second box which is placed on top of the Drag and packed with more Casting Sand.

14. Locating pins stop the boxes from slipping sideways, away from each other.

15. Holes are made in the sand to allow any gases to escape.

16. The hole left by the first Sprue Pin (where the metal is poured in) is called the Runner.

17. The name given to the hole left by the second Sprue Pin is the Riser.

18. The Riser allows excess molten metal to escape.

19. Molten metal should be allowed to set for at least an hour before being removed from the Casting sand.

20. The excess metal left in the Runner and Riser must be removed from the metal before it can be machined.