

Design and Manufacture

OLHS Technical Department



Wood

Knowledge and Understanding Book

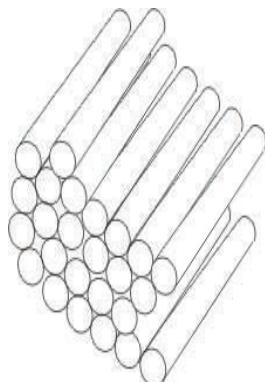
Knowledge and understanding of Wood

Throughout the world there are thousands of different species of tree, adding beauty and colour to our surroundings. They help keep the air fresh by taking in carbon dioxide and giving out oxygen. When cut or felled, and properly seasoned, the wood they provide has many uses including boat construction, house building, furniture and of course a wide variety of articles made in the school classroom.

Grain

All timber is composed of cells and wood fibres packed closely together. The term "grain" refers to the arrangement or direction of the cells and fibres in the timber. Try to imagine holding a bunch of drinking straws, this is basically very similar to how the grain of wood would look like if we looked at it through a microscope.

Grain



Classification of Wood

Trees are classified into two main groups, **Hardwoods** and **Softwoods**.

Hardwoods

This group of trees have broad flat leaves and seeds enclosed in a fruit or seed case. Hardwoods can be deciduous or evergreen. A tree which loses its leaves in the Autumn is called a deciduous tree. Examples of hardwoods are, Beech, Oak, Ash, Mahogany, Teak, Hickory.

Softwoods

This group of trees have long needle-like, shaped leaves and seeds exposed in cones and are known as conifers. Most softwood trees are evergreen (i.e. they keep their leaves all year round). Examples of softwood are, Red Pine, White Pine, Cedar, Douglas Fir.

Timber - Form of Supply

Timber is usually supplied in the following sections.

Planks Vary from 38mm to 100mm in thickness and over 100mm in width



Boards Less than 38mm in thickness and over 100mm in width.



Strips Less than 38mm in thickness and less than 100mm width.



Squares Square Section - thickness same as width.



Dowel Rods Dowel Rods, or cylindrical wooden pegs, are variable in sizes from 3mm to 50mm. Common timber used for dowel rods are Ramin or Beech.



Safety

Safety is of major importance in any craft room, it is imperative that safe working practices are observed at all times. Failure to observe safety rules will result in that individual losing the privilege to work in the craft room.

Some general safety precautions

1. Work benches and machines must always be swept clean after use. Think of the person who has to use them NEXT.
2. **ALWAYS** walk when in the workshop, running causes accidents.
3. If sharp tools must be carried in the work shop they must be carried facing downwards.
4. **ALWAYS** work with sharp tools, blunt tools cause accidents.
5. Before any work commences all jackets should be removed and hung up. All bags placed under the workbench. Any loose cloth or hair should be tucked in or tied back.
6. Pupils should be familiar with the position and operation of the emergency stop buttons in workshops. **ONLY** press if an **EMERGENCY** arises.
7. Eye protection must be worn if operating any machinery.
8. Report any damaged tools, equipment, etc. to the teacher.
9. **ALWAYS** store tools in the well of the bench when not in use.
10. **ALWAYS** keep both hands behind the cutting edge when working with a chisel.
11. **NEVER** strike two hammer faces together. Flying metal chips could cause serious injury.
12. **ALWAYS** use a file fitted with a handle, tangs are sharp and very dangerous if used without a handle. If you are unsure what a tang is, ask your teacher, after all that is why they are there.
13. **ALWAYS** check machines to ensure that any rotating parts are properly guarded and free to rotate without obstruction, e.g. ensure before switching on that the chuck key is removed from the Jacob's Chuck. Never use a machine without permission from the teacher.

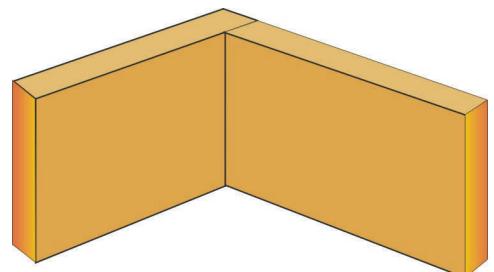
The Workshop is a Safety Zone

Timber Joints

The majority of joints used in woodcraft have been designed specifically to attain the maximum possible strength in the model they are holding together. The type of joint selected will depend on what is being constructed i.e. what forces are going to be exerted upon the artefact. The selection is also dictated by the final appearance. i.e. in furniture manufacture it is normally important to hide the joint as a piece of furniture which has a joint construction which is strong but showing will not be very pleasing to look at and ultimately potential customers would most likely avoid buying such furniture.

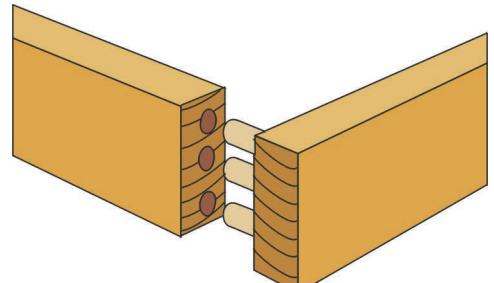
Butt Joint

Butt joints are the quickest and simplest to make but are not very strong. They generally need dovetail nailing to increase the overall strength of the joint.



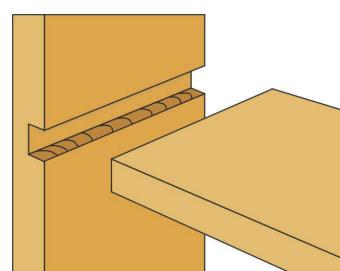
Dowelled Joint

These joints are both neat and strong. The holes must be lined up exactly but this can be done using a dowelling jig. The dowel will have a groove in the length so as to allow excess glue to escape.



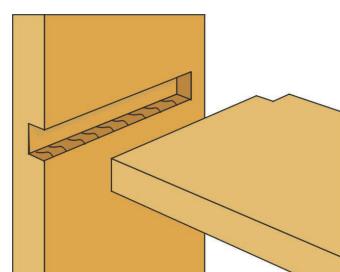
Through Housing

These joints are simple to make and are suitable where the two parts being joined together are the same width.



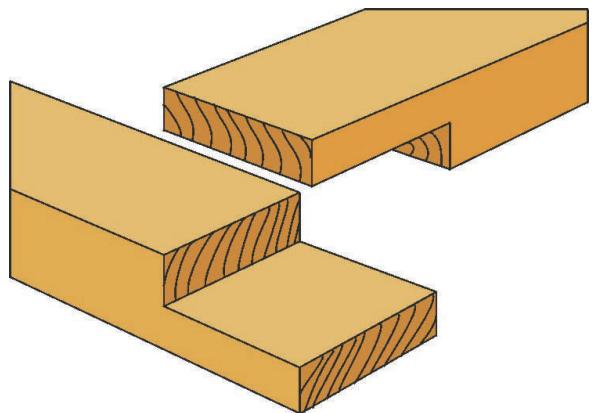
Stopped Housing

These are harder to make, but are neater because the joint does not show on the front edge.



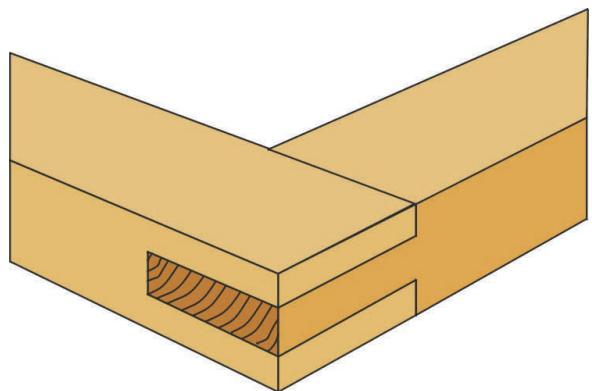
Corner Halving Joint

This joint is stronger than the butt joint and is also simple to make, but still needs strengthening with screws or dowels.



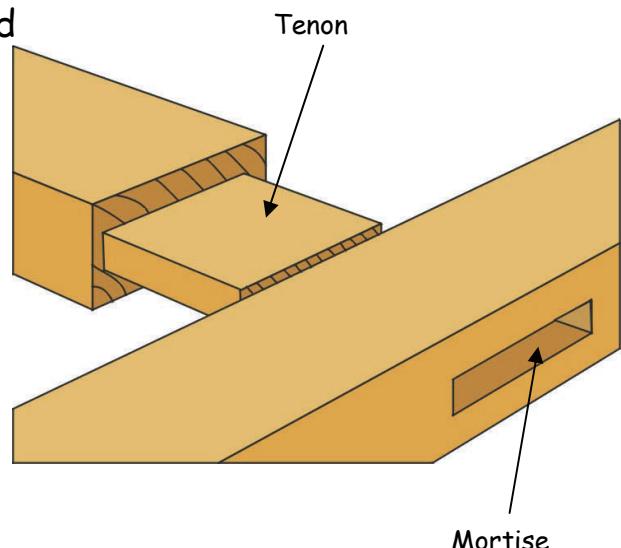
Corner Bridle

This joint is strong and fairly easy to make. They can be strengthened by dowels.



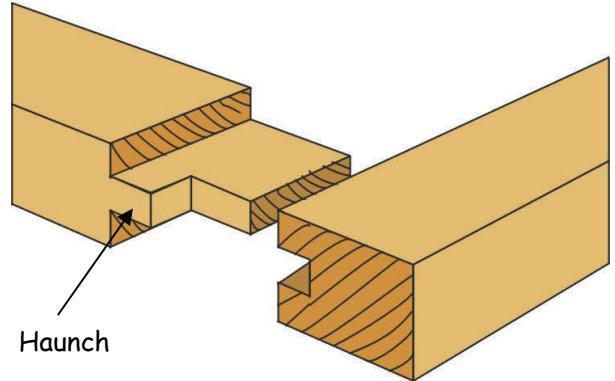
Mortise & Tenon Joint

The mortise & tenon joint is the strongest tee joint and can be further strengthened by wedging or dowelling.



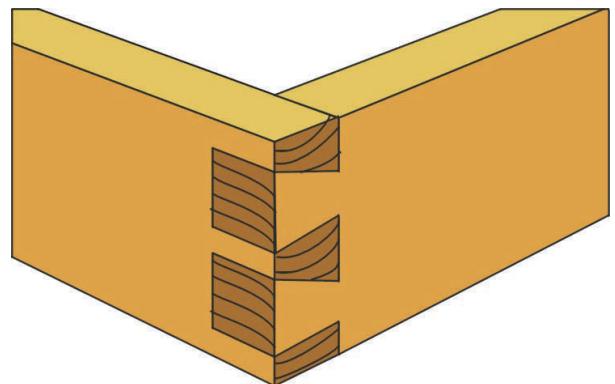
Haunched Mortise & Tenon Joint

This joint is used where the rail of a table join into the top leg of the table. This could be regarded as a hidden joint.



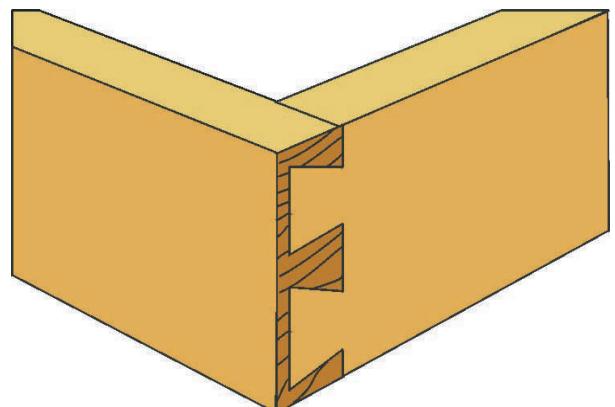
Dovetail Joint

This type of joint is very strong and can be only pulled apart in one direction. It is used to construct drawers.



Lapped Dovetail Joint

The Lapped Dovetail Joint is used in cabinet construction where the dovetail joint is used for strength but should not be seen from one side.

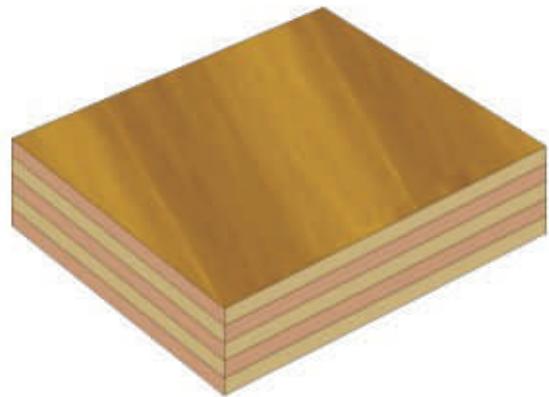


Man-made boards

Very wide boards (cut timber) made of hardwood or softwood are rare, expensive and liable to warping. They are in short supply because many of the world's rain forests are disappearing due to the over cutting of trees. Wide boards can be made by butt joining narrow boards together but this is time consuming and can also warp. One way which has overcome this problem is the development of man-made boards. These boards are generally very strong although some are stronger than others, depending on how they have been made. There are many different types of man-made board available and among the more common are PLYWOOD, BLOCKBOARD, CHIPBOARD, MDF and HARDBOARD

Plywood

This is made from layers or plies of wood glued together so that the grain of each layer of ply is at right angles to the next. There is always an odd number of plies (layers) so that the grain runs the same way on both sides of the board. Plywood can be finished with a decorative hardwood veneer or melamine (thin plastic coat)



Blockboard

These are made by sandwiching strips of softwood between two plies. As with the plywood the strips of softwood run at right angles to the top and bottom plies. It can also be finished with a hardwood veneer. It is only suitable for interior use.



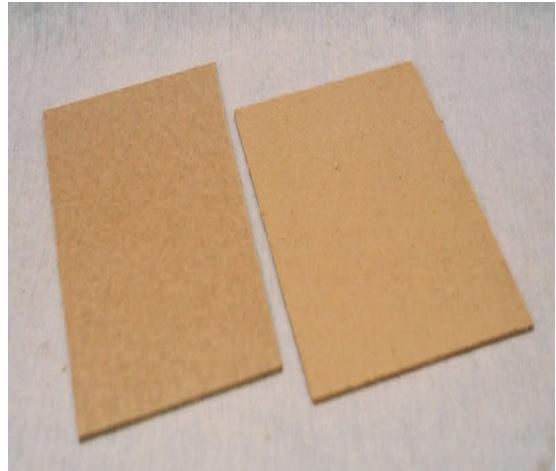
Chipboard

Chipboard is made by gluing small wood chips together under heat and pressure. As with blockboard it is only for interior use. Examples of chipboard use are kitchen work tops which generally have a melamine-faced finish.



Hardboard

This is made by mixing wood fibres with water and synthetic resin glue, hot pressing it into sheets and leaving to dry. It is not very strong and is generally only used internally.



MDF (Medium Density Fibreboard)

This is made in a similar way to hardboard but is much thicker. It has a smooth surface that takes paint and varnish very well and makes an excellent ground for veneers.



Finishing

Finishing is the name given to the process of coating or sealing wood. This is what gives the surface of the wood its final finished appearance. There are a wide variety of finishes available and depending on the final use of the wood will most likely determine what finish will be applied.

If a coffee table was made in the school workshop and a final finish was not applied to the surface, what do you think would happen to the wood if coffee or tea was spilt on it?

Firstly, the fluid would soak into the wood, staining it and most likely over time weakening the wood by swelling it.

Applying a Finish

Before applying a finish it is important to make sure that the surface is very smooth and free from blemishes (marks and scratches) by firstly using an appropriate plane or scraper and then different grades of abrasive paper in the direction of the grain.

Sequence to applying varnish to a piece of wood

1. The **Smoothing Plane** (Smaller brother of the Jack Plane) is used first to remove pencil lines and any major blemishes.
2. Next, use a **Medium grade** of glass paper sand all surfaces.
3. The next stage is to apply a fine sprinkle of water over the surface of the wood. This raises the grains in the wood which when dry will be sanded off using a **Fine Graded** glass paper. This technique gives a better overall finish.
4. Using a **Fine Graded** glass paper sand down all surfaces.
5. Apply first coat of varnish. Allow to dry.
6. Using a **Fine Graded** glass paper sand down all surfaces.
7. Apply second coat of varnish. Allow to dry.

Types of finish available

Water Based Varnish

Spirit Based Varnish

Wax Polish

Coloured Wax Polish

Danish Oil

Coloured Stains

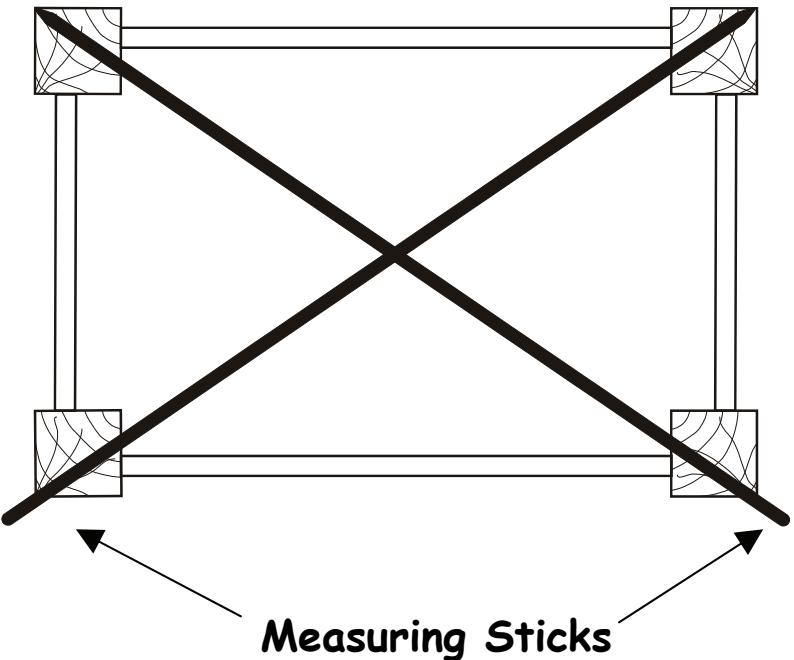
Paints

Gluing up Frames

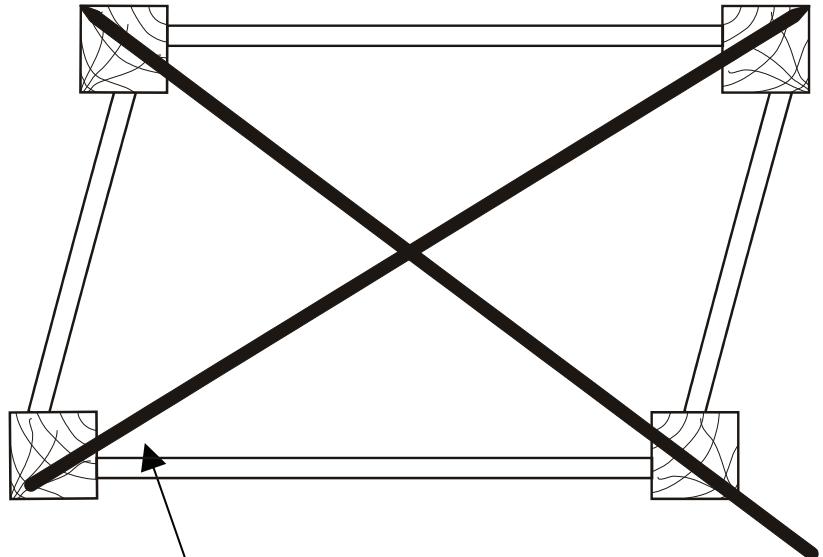
Before any gluing of frames can be carried out, the frame must be assembled **DRY**, i.e. it needs to be checked to ensure that it is **Square** and is not affected by Winding (Twisting of the frame). To check if the frame is square it is ideally done using long straight sticks to check the diagonals. See below.

Table Frame

As can be seen from the drawing opposite, if a frame construction is **Square**, the diagonal distance (Corner to Corner) between each corner will be the same distance.



If the frame is not square the diagonal distance from corner to corner will be greater for one of the corners as shown opposite. This is corrected simply by adjusting the sash cramps until a satisfactory squareness is achieved.



Diagonal much longer than opposite diagonal

Woodworking Tools

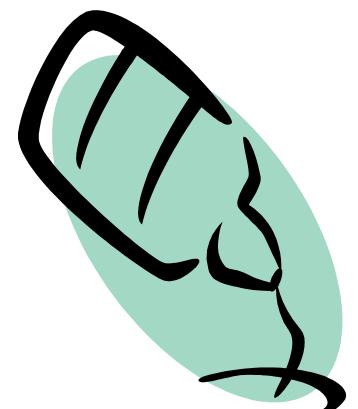
The Ratchet Brace

The ratchet brace is used to hold and turn various boring bits when cutting circular holes in timber. The head of the brace rotates on a ball bearing washer to reduce friction. The other end of the crank has a chuck containing "alligator" jaws which hold the bit. The chuck is attached to the brace by means of a threaded core at the end of the crank. The ratchet enables the brace to be used in a confined space where it would be impossible to make a complete revolution of the crank. The sweep of the crank is usually about 250mm.



PVA Glue

Polyvinyl acetate (PVA) is probably the most common type of wood glue used in the school workshop. It is a white water based liquid adhesive (i.e. it is mainly made of water). It is supplied to schools in plastic containers. It is easy to apply, non-staining (although excess glue should be wiped off with a damp paper towel) strong and attains its maximum strength usually after twelve hours. If a wood glue is required for external use a waterproof PVA glue must then be used.



Claw Hammer

This hammer is used for heavy nailing (i.e. used for hammering big nails). The claw part of the hammer is used to remove nails that have already been driven into the

Cross Pein Hammer

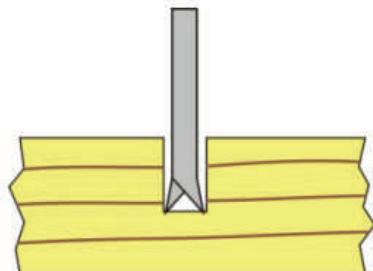
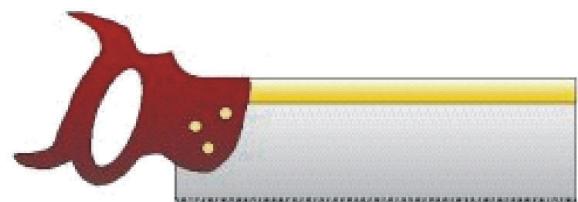
This is a very light weight hammer with a cross pein at one end. This hammer is used for light work with the cross Pein part being used to start driving short nails and panel pins into the wood. The shaft of the hammer is made from a special wood called Hickory. The reason for using hickory is because it is a very tough wood and therefore less likely to break when being used.

Cross Pein



Tenon Saw

The Tenon Saw is used for general sawing in wood. The fine teeth 12 - 14 per 25mm ensure a fine saw cut or KERF. To help prevent the saw blade jamming when sawing the teeth are SET, i.e. the first tooth is bent to the right and the second to the left and then right and so on. The purpose of this is to make a bigger gap than the thickness of the blade, this will allow the blade to cut without jamming. Your teacher will demonstrate what this means. The Tenon Saw has a brass or steel Stiffening Rib to strengthen the back of the blade and prevent it from being too flexible.



Kerf

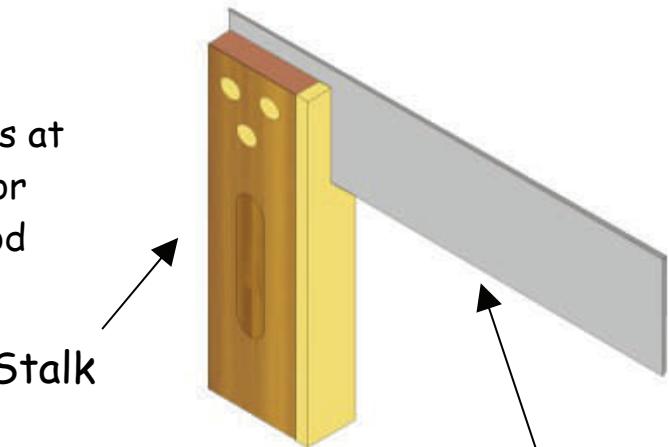
Hole Saw

This tool is used to drill big holes in wood and is generally fitted to an electric drill. The hole saw has a centre drill attached which is called the PILOT drill. It is called this because it ensures the hole saw makes a hole exactly where you want it.



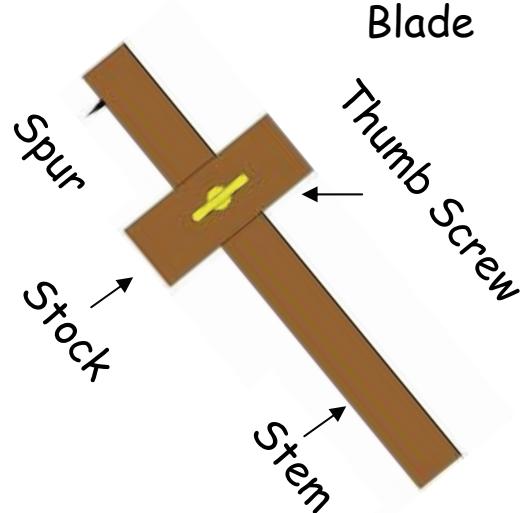
Try Square

The try square is used to test the squareness of material and mark out lines at **right angles** to a given surface on wood or plastic. The stock is made from rosewood with a tool steel blade.



Marking Gauge

The marking gauge is used for marking lines **parallel** to an edge on timber (cut wood). The stock and stem are made from beech because beech is a very hard wearing wood, whilst the spur is made from steel sharpened to a point. The thumbscrew is made from plastic or box wood and then threaded into the stock.



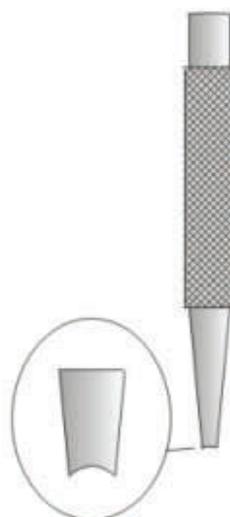
Pincers

Pincers pull out nails which the claw hammer cannot grip, either because they are too small or do not have a head. The small thin claw on the handle of the pincers will fit under the heads of small nails and lever them out far enough for the pincers to grip



Nail Punch

There are different sizes of nail punch to suit different sizes of nail. They are used to drive headless nails and panel pins below the surface, so that the hole can be filled with a suitable wood filler.



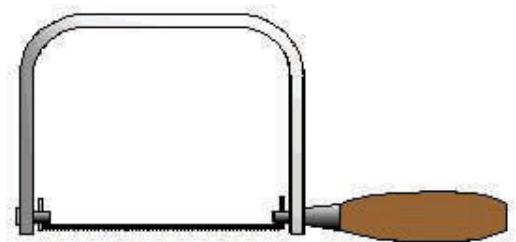
Woodworkers Bench Vice

This vice is fixed to the bench so that the top of the wooden jaw facing the bench is level with the top of the bench, it is used for holding wood.



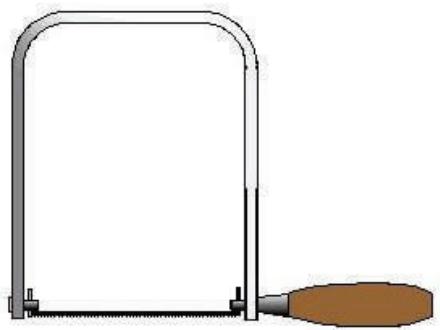
Coping Saw

The coping saw is used to cut curves and other awkward cuts in wood. It is also unique as it is one of only a few saws which has its teeth facing backwards. In normal sawing the cut is made in the forward stroke but with the coping saw the cut is made on the backward stroke.



Fret Saw

A Fret saw is very similar to the Coping saw except it can be used for even more intricate and deeper cuts than that of the coping saw.



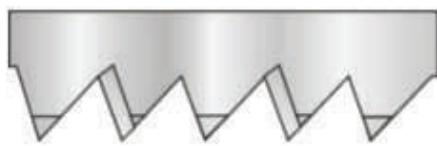
Panel Saw

The panel saw is a fine toothed crosscut for sawing plywood, thin wood and large joints.



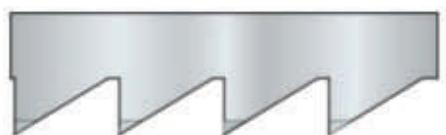
Cross-Cut Saw

This type of saw is used for cutting across the grain of large piece of wood. The sketch opposite shows the teeth of this type of saw.



Rip-Saw

The Rip saw is used for sawing along the grain of large pieces of wood.



Carpenters' Mallet

The carpenters' mallet is used in woodwork for hitting chisels or for assembling parts of wood together. The carpenters' mallet is made from a hardwood called beech as this wood is very hard wearing.



Mortise Chisel

As the name suggests this chisel is used to cut out the mortise in a Mortise and Tenon joint.

It is a stronger chisel than the bevel edged chisel. This allows it to be struck with a mallet and has a shock absorbing leather washer between the handle and the blade.

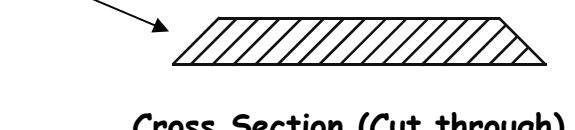


Bevel Edged Chisel

The bevel edged chisel is used for paring and general chiselling of wood. Two edges of the blade are bevelled along their length and this makes it suitable for accurate joint work. The size of the chisel is indicated by the width of the blade (3mm - 50mm)



Bevel Edge



Cross Section (Cut through)

Firmer Chisel

This type of chisel is used for general chiselling work. As its name implies, it is firmer than the bevel edge chisel.



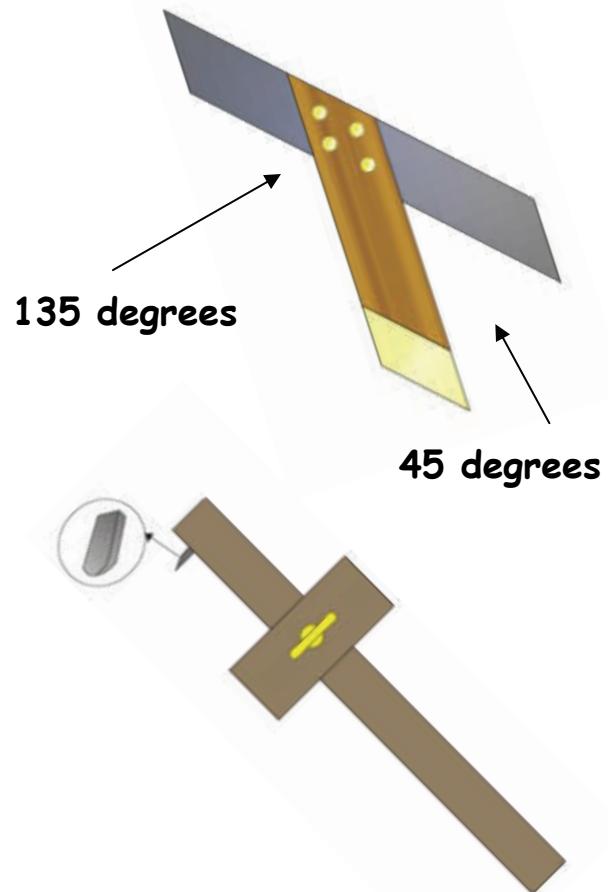
Cross Section (Cut through)

Safety Note

When working with the bevel edge chisel or any type of wood chisel **ALWAYS** keep both hands behind the cutting edge.

Mitre Square

This is used to mark out angles of 45 degrees and 135 degrees and for testing mitres. It is used the same way a Try Square is used except it checks different angles.



Cutting Gauge

This type of gauge is very similar to the marking gauge except it has a cutting blade instead if a spur. It is ideal for cutting end grain or veneers.



Dovetail Saw

A Dovetail saw is very similar to the Tenon saw except the teeth of this saw are much smaller allowing more accurate cuts. As the name implies it is an ideal saw for cutting dovetail joints.



Pad Saw

The Pad saw is used for cutting straight and curved cuts in the middle of a piece of wood. i.e. where other saws cannot reach.



Surform Tools

These are a type of file with large teeth. There is a hole behind each tooth which allows any filings to escape and thus reducing clogging. The most commonly use shape used are the flat and round surforms.

Panel Pin

This type of nail has a thin round shank and a small head which can be driven below the surface with a nail punch.

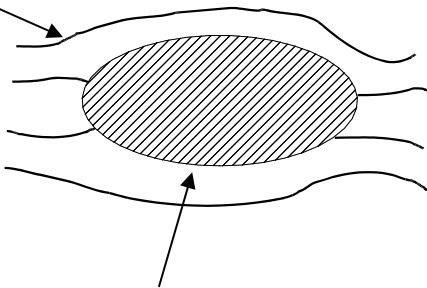


Oval Brad

This nail has an oval shaped shank (long part of the nail). It is shaped this way so as to allow it to be driven below the surface of the wood without splitting it. As can be seen in the sketch opposite the nail is positioned length ways along the grain

Wood Grain

Cross Section (Cut through)



Round Wire Nail

These nails have a flat head and are made from steel. They are sometimes Galvanised (Dipped in Zinc) to stop them from rusting. They are used for general joinery work and normally come in sizes ranging from 12mm to 150mm.



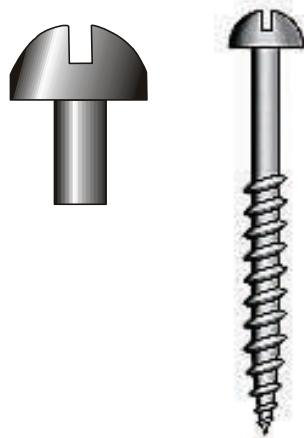
Raised Countersunk Head Screw

These screws are not very common but are used to screw fittings to wood. They are often made from chrome plated brass which gives an attractive finish.



Round Head Screw

These screws are used to screw thin metal fittings to wood e.g. Tee Hinges, etc. They are used for jobs which do not require the head to be flush. They are made of steel and usually come "Black Japaned". (A black coating to prevent rusting)



Countersink Screw

The main purpose of the countersink screw is that when fully engaged the head of the screw will sit flush with the surface of the material in which it has been used.

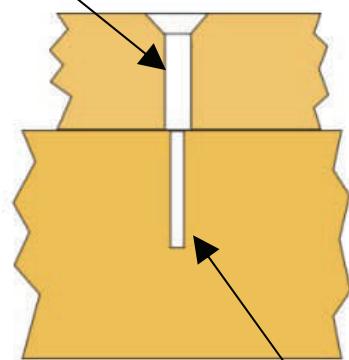
When joining two pieces of wood together the top piece of wood will have a clearance hole drilled first. This hole will be slightly larger than the actual diameter of the screw.

A countersink hole is then drilled as can be seen from the picture shown below. This is the hole in which the head of the screw will sit when fully engaged.

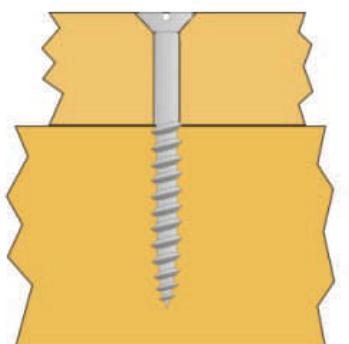
Finally, a pilot hole is drilled. This allows the screw threads to get started. In soft wood a Bradawl could be used.

Soap or wax can also be used on the threads as this will lubricate them allowing

Clearance Hole



Pilot Hole



Countersink screw head

Countersink Hole



"Rose Bit", used to make a countersink

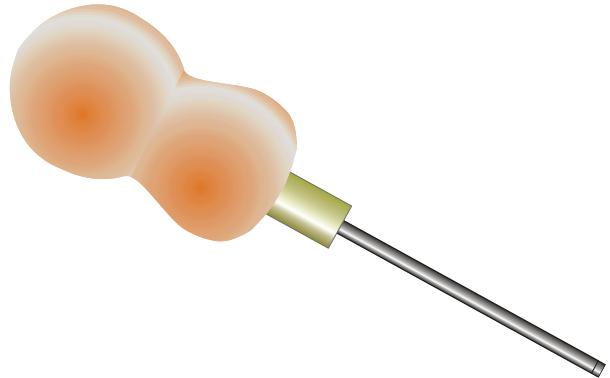
Hand Drill or Wheel Brace

The hand drill or as it otherwise known, the wheel brace is used to drill holes up to a diameter of 8mm. If the hole to be drilled is close to an edge the handle can be removed to allow the drill to get close in.



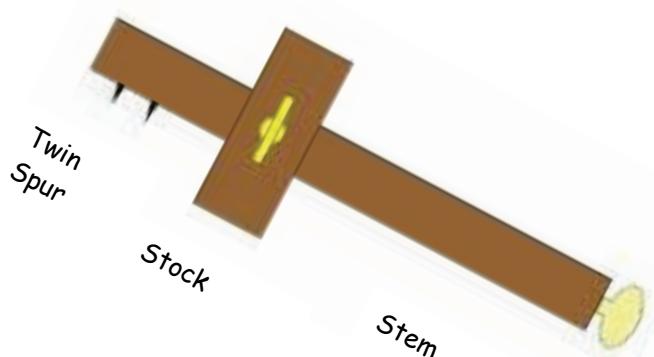
Bradawl

This is used for making small holes in wood prior to starting to insert a screw.



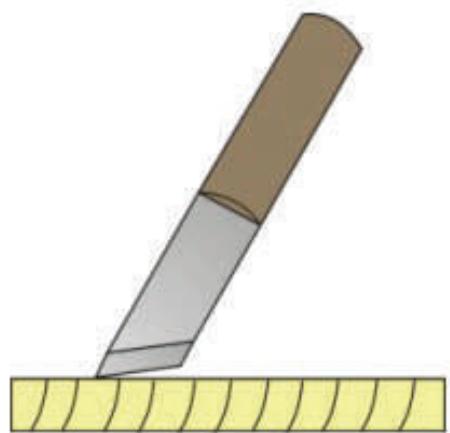
Mortise Gauge

This tool is very similar to the marking gauge but this gauge marks two parallel lines opposed to the marking gauges one line. It is ideal for the marking out of mortise and bridle joints.



Marking Knife

The marking knife is used to mark lines on wood, usually across the grain. A knife cuts a thinner more accurate line than a pencil. It is nearly always used with a try square.



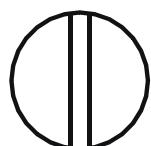
Rasps

A rasp is used for rough shaping of wood and other soft materials. The most commonly shaped rasp is the half round. As can be seen from the close up the teeth are much bigger than a file.



Sliding Bevel

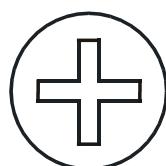
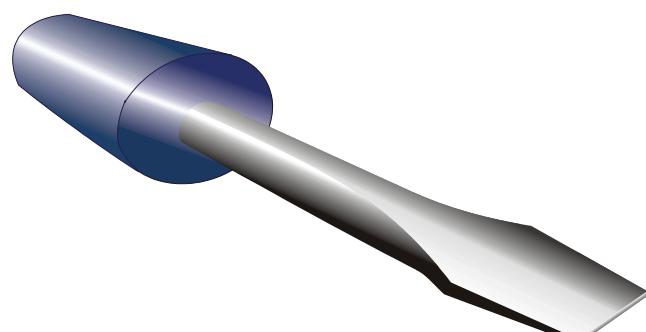
Used to mark out lines on wood at an angle to a given surface on wood.



Slotted Screw Head

Screwdriver (straight slot)

This type of screwdriver is used to drive slotted screws into wood. The main disadvantage of its use is that it can slip out of a straight slot and damage both the head of the screw and the wood.



Phillips Screw Head

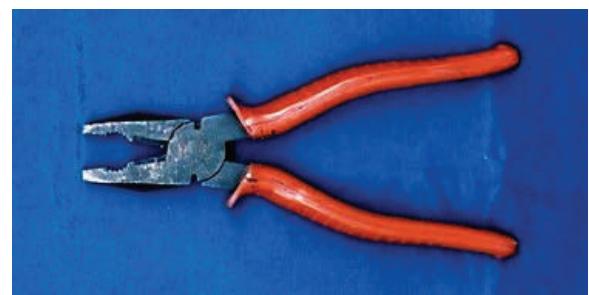
Phillips Screwdriver

The main advantage of the Phillips slot is that the screwdriver blades do not slip out of the slots so easily. A Pozidrive screwdriver is very similar to the Phillips screwdriver.



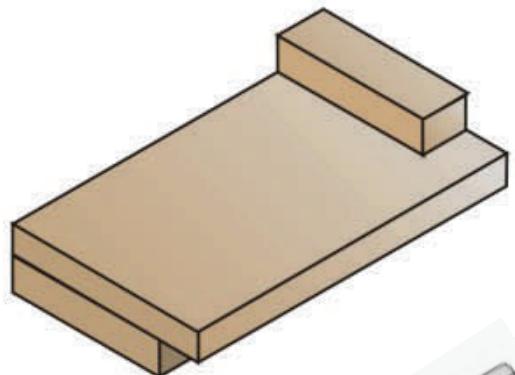
Pliers

This tool is mainly used to grip small items but can also cut wire.



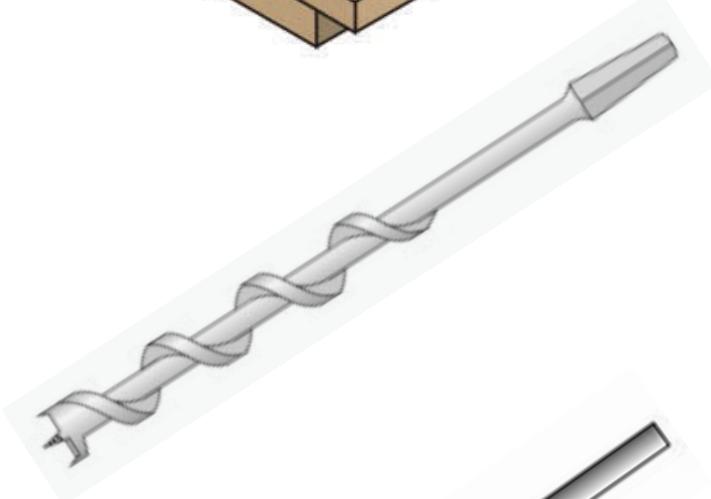
Saw Board

The use of the saw board prevents the workbench from being damaged by continual cutting. It also allows timber to be held in a steady position whilst cutting is taking place.



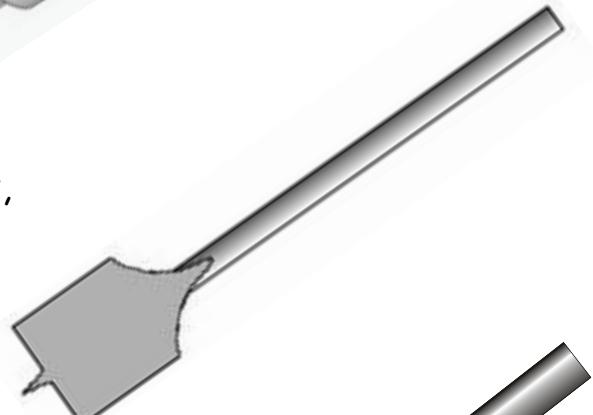
Auger Bit

For boring deep holes in wood. The tang of the bit is square to allow fitting into the ratchet brace.



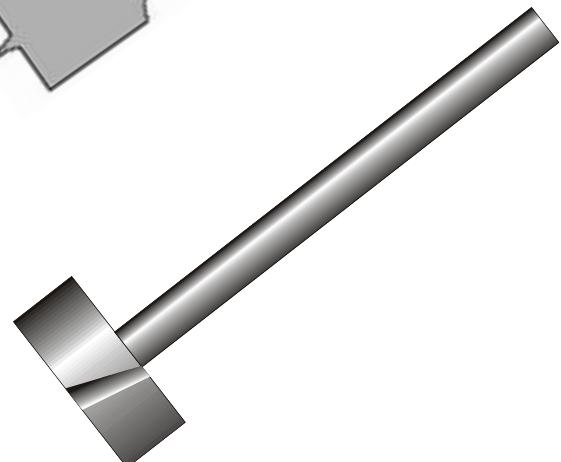
Flat Bit

These bits are used in electrical drills for fast, accurate drilling in both soft and hard woods.



Forstner Bit

This bit is used for drilling shallow, flat bottomed holes in wood. The bit is guided by its rim and not by a centre point as with the flat and auger bits.



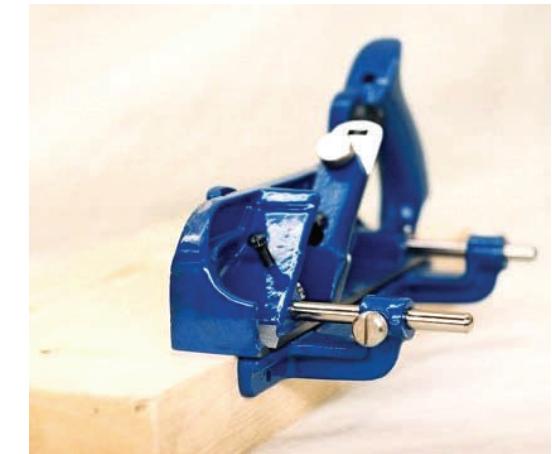
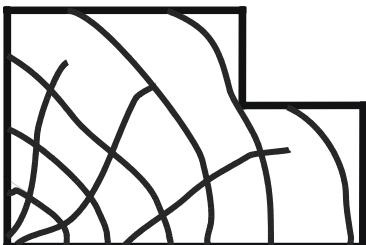
Twist Drill

This type of drill can drill holes in wood, plastics and metals. Common sizes are 1mm to 13mm.



Rebate Plane

This type of plane is generally used to make a REBATE on the edge of a piece of wood as can be seen from the picture opposite. It can use a number of different interchangeable blades which allow different types of cut to be made to the edge of the wood.



Cut made by
Rebate Plane

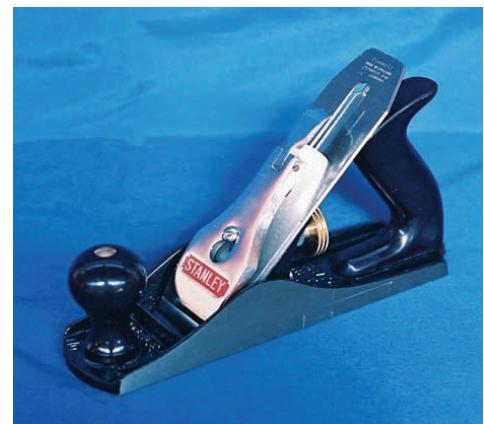
Jack Plane

The Jack Plane is used for producing smooth flat surfaces and edges on wood. The overall length of the jack plane is 250mm and the cutting iron (this is the blade that shaves the wood) is either 50mm or 60mm wide.



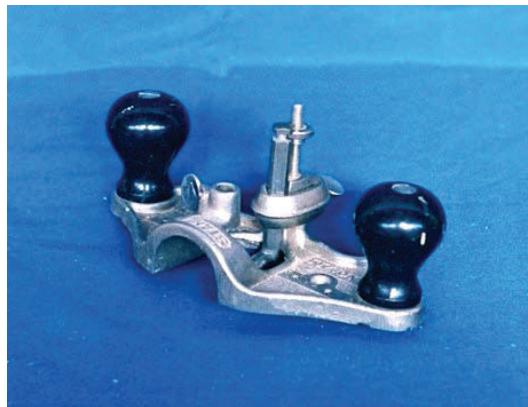
Smoothing Plane

This plane could be regarded as being the smaller brother of the Jack Plane. It is used for cleaning up and removing all tool marks on the work piece.



Router Plane (*Granny's Tooth*)

This plane is used for trimming the bottom of housing joints to the correct depth.



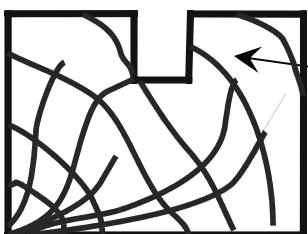
Block Plane

The block plane is used for trimming the end grain, mitres or interlocking grain. depths.

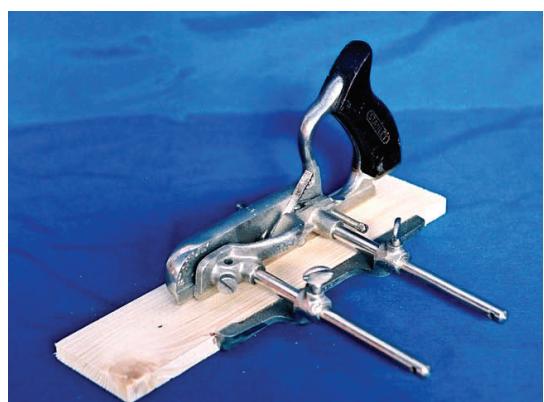


Plough Plane

The plough plane is used for ploughing grooves parallel to an edge. It must be used with the grain i.e. in the same direction in which the grain runs.

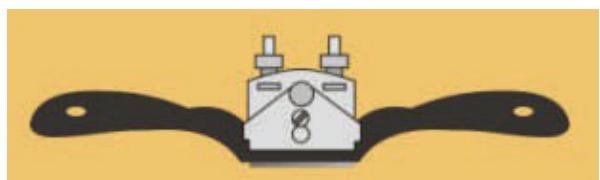


Cut made by
Plough Plane



Spoke Shave

This type of plane is used to smooth curves. There are two types available; one for concave surfaces and one for Convex surfaces.



Bullnose Rebate Plane

Used in forming stopped rebates and chamfers. It could be described as the smaller brother of the block plane.



The Pillar Drill

The pillar drill (or Vertical Drill) can either be bench mounted or floor mounted. The chuck (part which holds the twist drill) can hold drills up to a 13mm diameter. The adjustable table which holds the work piece can slide up or down and can be locked at a desirable height.

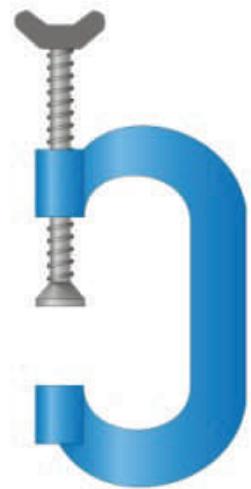
Safety Check

Before Drilling - ensure the drill is secure with the chuck key removed, eye protection on, guard in position and work piece securely held.



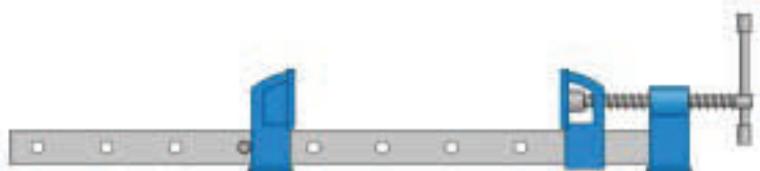
6 Cramp

This is used to hold work down onto a bench and to cramp small pieces of glued wood together.



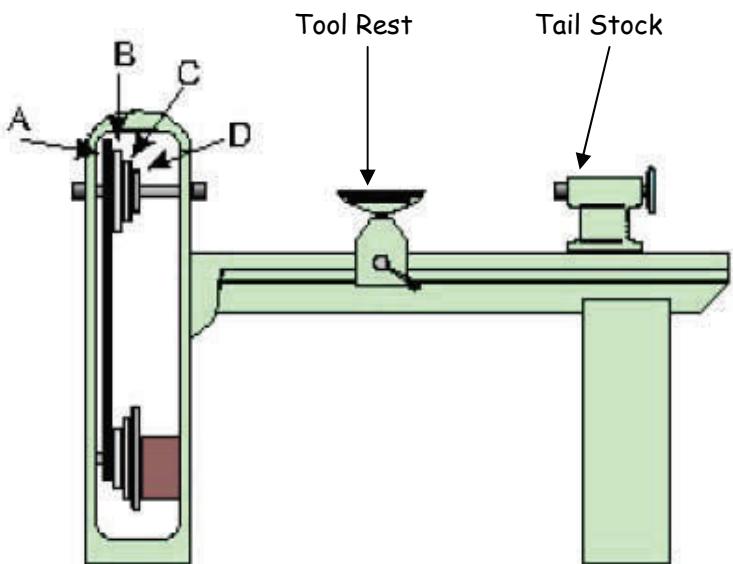
Sash Cramp

This cramp is used to hold frames, carcases and butt joints while the glue sets. Always ensure that the wood being cramped is protected from damage by using scrap pieces of wood between the cramp and the frame/carcase being cramped.



Wood Turning Lathe

The wood lathe is a machine used to create cylindrical objects in wood, i.e. wooden bowls, table legs, etc. A piece of wood is secured between two points called the HEADSTOCK and the TAILSTOCK. The HEADSTOCK has a motor enclosed and is therefore the end which actually turns the wood.



The surface finish of the wood being turned can be improved by increasing the speed of the lathe.

A-D change speed pulleys

Wood Turning Tools

Wood turning tools are used to shape the work piece. Depending on what shape is required will ultimately determine what type of tool will be used. The tool rest can be seen on the drawing above, this is used to support the tools while shaping is being carried out.

Revolving Centre

The Revolving Centre has bearings encompassed within the body of the tool. This allows the work piece to revolve without friction.



Dead Centre

The tailstock remains stationary while the work rotates. This causes friction and therefore the work piece has to be greased.



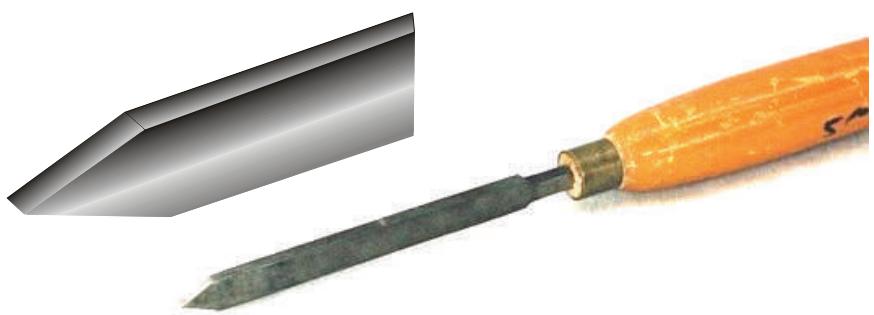
Centre Fork

The centre fork is secured in the revolving spindle (headstock). The fork is driven into the wood to be turned, the fork then turns the wood.



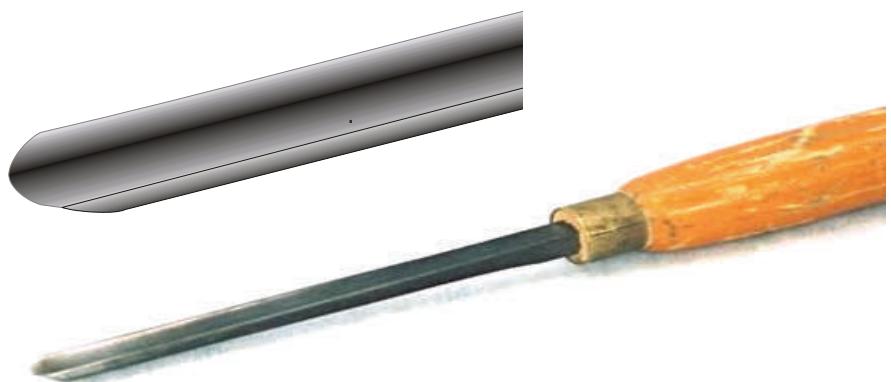
Parting Tool

The parting tool as it's name implies is used to part off the "turned wood" from the remaining wood at either end.



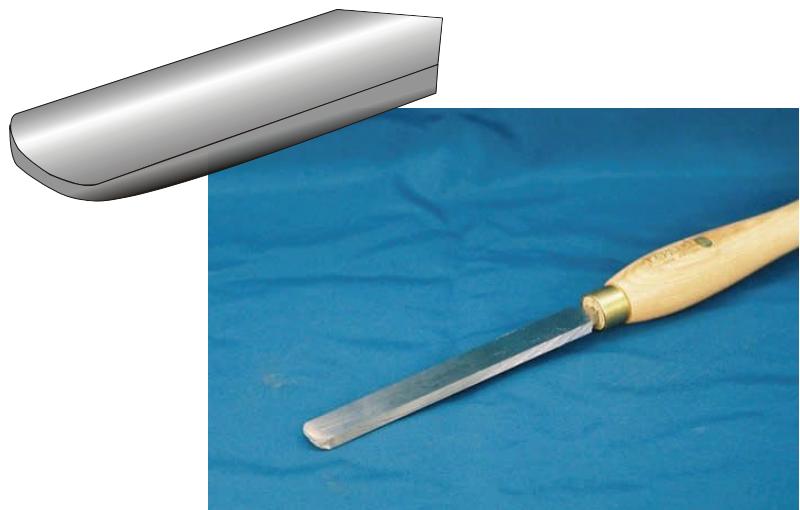
Spindle Gouge

This round nosed gouge takes over from the roughing-out gouge for



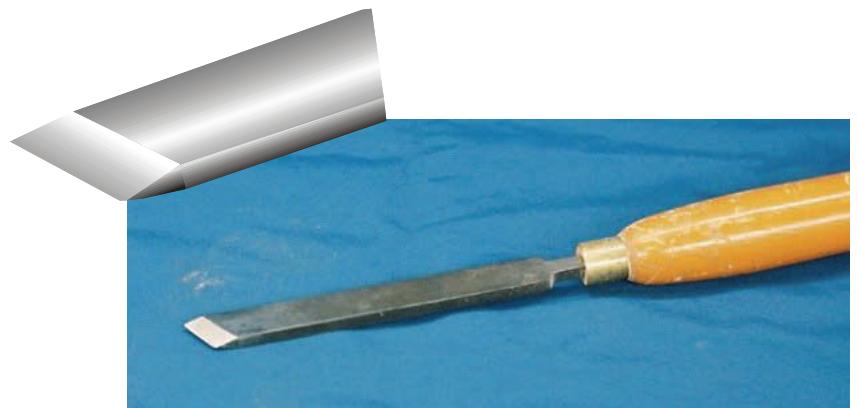
Round Scraper

These scrapers are used for working inside bowls and



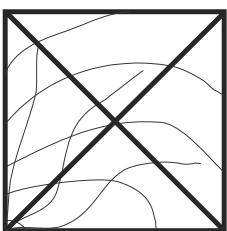
Skew Chisel

This chisel is used to give a good surface finish.



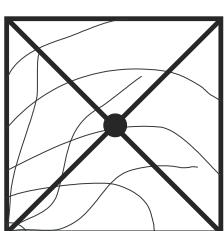
Stages in preparing a piece of wood for turning

Stage 1



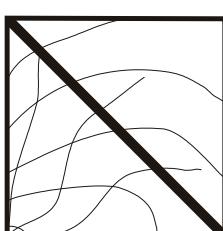
On both ends of wood mark a line from corner to corner to establish the centre.

Stage 2



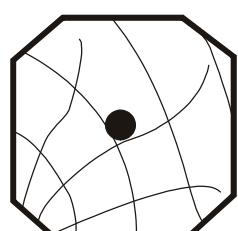
On one end of the wood, using a centre punch, make a hole. The Cone Centre will locate here.

Stage 3



On the other end cut a Kerf. The Centre Fork will locate here.

Stage 4



Now plane all four corners of the wood as can be seen from the sketch above.

Face Plates

Face plates are secured to the headstock of the lathe and are used to hold blank pieces of wood which can then be turned into wooden bowls.



Mortise Machine

A mortise machine appears to drill a square hole in wood. The machine actually drills a round hole but because the drill bit is surrounded by a hollow square chisel, while the drill is creating the hole, the chisel is cutting the edges away from the hole leaving the mortise. (square hole)

