Focus on Timber

Manilla Central School

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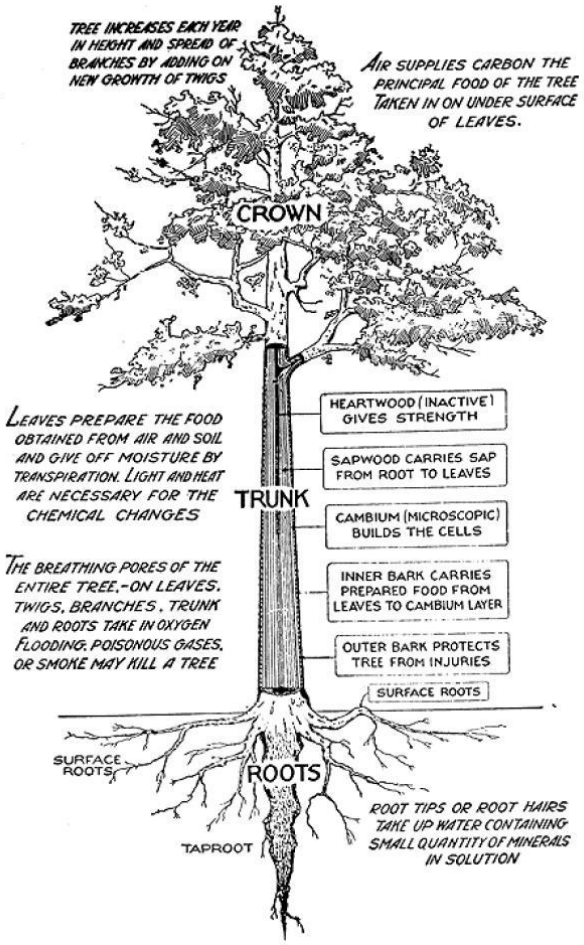
The Main Parts of a Tree and Their Functions

Trees come in various shapes and sizes but all have the same basic parts and structure. They have a network of leaf bearing branches and twigs called the crown. This is supported by the bark covered trunk. Below the ground is a network of roots which anchor the tree to the ground and the root system usually occupies a similar area as the crown of the tree.

In a mature tree, most of the cells of the trunk, roots and branches are dead or inactive. Any actual growth of new cells only takes place in three areas of the tree, by specialised cells. These are found in the tips of the branches and roots, and in a thin layer just inside the bark.

Lastly, trees have reproductive structures; either cones or flowers.



Crown

The crown, consisting of leaves, twigs and branches, plays a vital role in exchanging carbon dioxide for oxygen as well as filtering dust and particles from the air. The crown also reduces the temperature of the soil around the tree by creating shade and minimises the impact of raindrops.

The leaves are where the tree makes the energy needed to grow. They contain a green chemical called chlorophyll which uses the sun's energy to change carbon dioxide and water into sugar and oxygen. The tree releases the oxygen into the atmosphere and it either uses the sugar as food or stores the sugar in its branches, trunk or roots.

Trunk

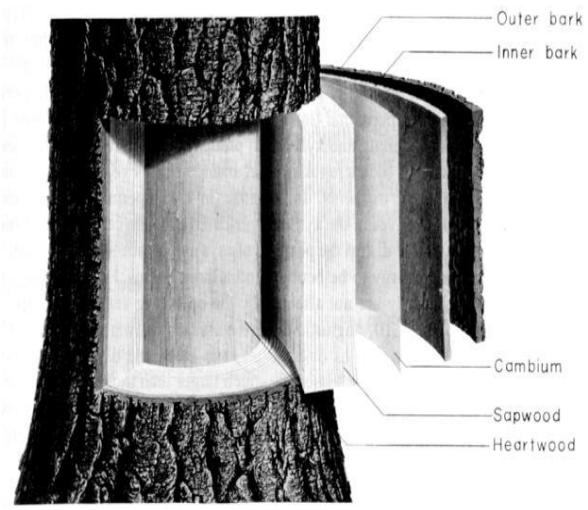
The trunk gives the tree its strength and shape as well as supporting the crown. The trunk is made of tubes that run between the roots and the leaves and act as a conduit for water and minerals travelling up from the roots and sugar travelling down from the leaves

Bark

The bark protects the tree and covers all of its trunk, branches and twigs. The bark creates a physical barrier against birds, animals and insects. Some barks also

contain chemicals that do the same thing, and in some species the bark is also reasonably fire proof/resistant.

Inner Bark (Phloem)



The inner bark or phloem is where most of the sugar travels from the leaves to the cambium layer. The phloem is found between the outer bark and the cambium layers.

Cambium

The cambium is a very thin layer of growing tissues that produces the cells that become sapwood, bark or more cambium. The cambium layer is what makes a branches, roots and the trunk grow in diameter.

Sapwood (Xylem)

The xylem is the newest layer of true wood. It is a network of thick walled cells which transport water and dissolved minerals from the roots to the leaves. As these xylem cells become inactive, they die, dry out and transform into heartwood.

Heartwood

The heartwood of a tree is comprised of dead cells. The heartwood provides the trunk with its strength because the dead cells are more rigid than those of the sapwood because they shrink and become tighter as the dry out. Heartwood is usually filled with sugar, oils and dyes and is normally darker than the sapwood.

Roots

A tree's roots absorb water and nutrients from the soil, store sugar and anchor the tree to the ground. All trees have lateral roots that branch into smaller and smaller roots. These lateral roots usually extend below ground, easily as far as the tips of the branches in the crown. Some trees have a tap root which drills down into the ground as far as 4-5 metres but the majority of the root system doesn't grow deeper than 30 – 45 centimetres because the oxygen needed for the roots to work properly is most abundant at this level. Most of the roots are covered in thousands of root hairs which absorb water and water soluble minerals from the soil.

Properties of Timber

The properties of timber are those aspects of appearance, strength and durability that the user needs to consider that are the most appropriate for the end product and its usage. Timber comes in a bewildering variety of colours, grain patterns and densities. Add to these choices resins and oils that can repel insects, create pleasing aromas, making one timber extremely flammable and another waterproof or resistant to fungal attack – and you can begin to appreciate the many choices ahead when choosing timber for a project.

Aesthetic properties; a timber's appearance due to colour, grain and features

Aesthetics are those features of a design that deal with what a particular person likes rather than what the design needs need. Colour preference, aroma and surface texture are all personal likes and not necessary for a timber product, like a chair to function properly.

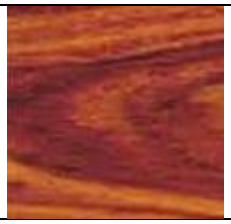
Timber is valued for its appearance when it is used to make items like jewellery boxes, fine furniture and musical instruments. Different species of trees produce timbers of many colours, shades and grain patterns. From almost white to yellow, orange, red, brown, purple and through to black – the variety of colours available with timber can cater for every palette.

Different tree species, as well as naturally occurring faults can produce amazingly complex patterns within the grain structure. Gum tree burls for tables, tightly curling decorative patterns for musical instruments and the knots of cypress pine flooring – there are colours and features for everybody's tastes and budgets.

A timber's appearance is a combination of its colour, grain, features and surface smoothness.

Functionality; a timber's structure and durability

The size and direction of the timber's grain, naturally occurring features such as knots and the types of oils and resins that naturally occur within the timber can all impact on how suited a timber is for a project in regards to the environment it will be used in and for how long it is intended to last.

Zebrawood		Birdseye Maple	
Canarywood		Tulipwood	

Strength, stiffness and density are all properties to consider when choosing timbers for building housing, boats or bridges.

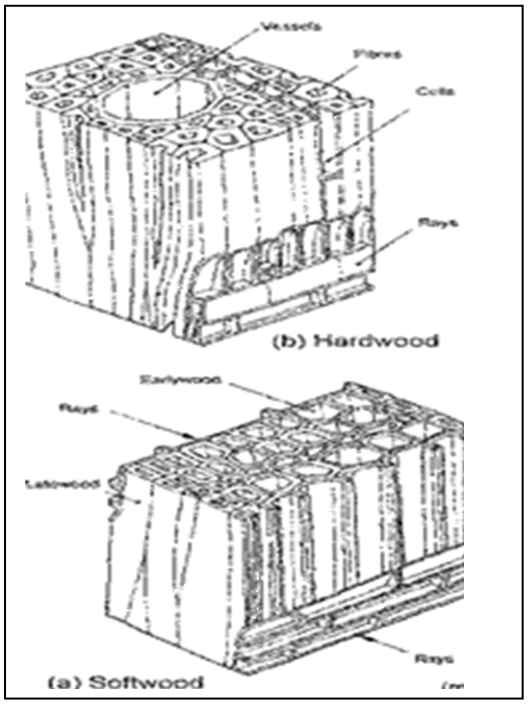
Camphor wood is naturally antibacterial and repels moths. Cypress pine contains phenol which has antifungal properties and termites don't like to eat it. Both timbers have similar antibacterial/antifungal properties and repel insects but due to their densities are used in very different projects. Camphor wood is light and easily worked. It can be used for timber cutting boards and other kitchen utensils as well as the lining for blanket boxes and wardrobes. Cypress pine is very dense and hard and is used in building and flooring.

A timber's functionality must meet the needs of both the environment in which the product will be used and the product's purpose. Functionality is therefore a combination of dimensional stability, surface hardness, strength (compressional, tensional and shear), stiffness and durability - the timber's ability to resist the impacts of environment (including insect and fungal attack) and usage.

Microstructure of Timber

Cell Structure of both softwood and hardwood timbers

The essential difference between hardwoods and softwoods is the presence of vessels in hardwoods. These are continuous pipes running the length of the tree and serve as conduits for water and nutrients in the outer layers of wood in a growing tree. The actual cells in the softwood species have the same function as the vessels in hardwoods.



The cells constitute fibres and have the main direction of orientation in the longitudinal direction (parallel to the trunk of the tree). The individual cells are stuck together rather weakly but parcels of longitudinal cells are bound together with a few cells that run across to the longitudinal axis of the wood. These are called rays.

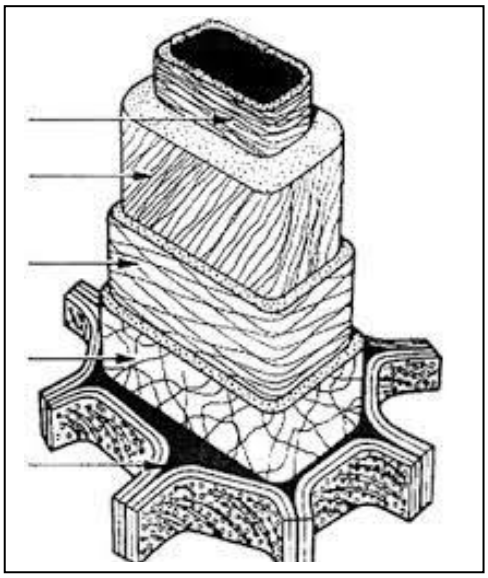
Chemical Components

Cells are composed of three main chemicals;

Cellulose - a long chain polymer with the chains principally aligned with the long axis of the cell. In some parts of the cell wall, the cellulose is spirally wound.

Lignin - glass-like substance that serves as the filler - like the resin in fibreglass. It is a brown colour.

Hemicellulose is a cellulose-type molecule, but not as long as the main cellulose. It is a more mat-like molecule that is used to wrap up the cell.



The main structural element is the cellulose which is very effective in transmitting tension or compression. The spiral winding of the cell gives buckling resistance to the cellulose that is parallel to the cell axis. Cells are hollow tubes, so liquids can be taken into the wood along the cells much more easily than across the cells.

Moisture in Wood

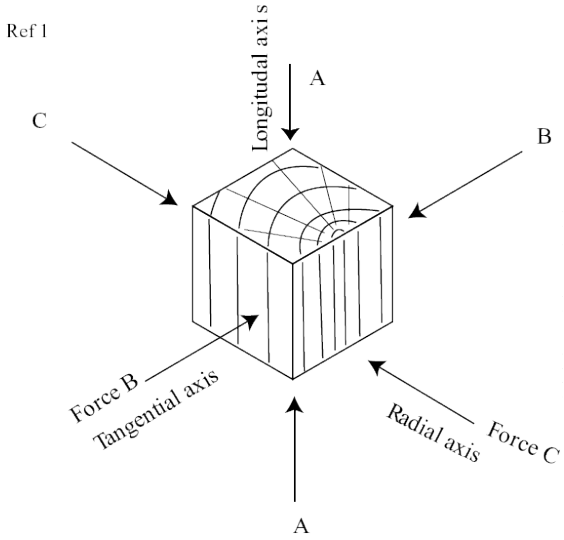
Moisture Content (MC)

When a tree is first cut down, up to 90% of the timber's weight is water. When the timber is seasoned (a process of drying timber), the water content usually drops to about 15% of the timber's weight, depending on the local climate of the area in which the timber is being dried. The aim of seasoning timber is to remove the water content at a uniform rate. Drying it out too fast can damage the cell structure of the timber or causes the timber to shrink in unpredictable ways. Drying too slowly leaves the timber vulnerable to rot and fungal attack. Modern timber seasoning methods often combine traditional air drying as well as more modern techniques such as kiln or microwave driers and even chemical treatments.

However, pieces of timber hundreds of years old will continue to react to the humidity of the air around them unless it is completely sealed with some type of protective coating such as paint or lacquer. This process is called *Equilibrium Moisture Content (EMC).* As the surrounding air dries out a piece of timber, it will give up some of the moisture held within the timber's cell walls, and start to shrink. Similarly as the humidity increases, this same piece of timber will absorb water back into its cell walls and expand. Old furniture is often damaged because it was not sealed properly and hundreds of years of expanding and contracting cause joints to loosen and boards to crack.

Shrinkage

Shrinkage is the reduction in the dimensions of the timber due to the timber's cell walls loosing moisture. Shrinkage occurs in three different directions in relation to the grain of the timber.



1. Longitudinal shrinkage is shrinkage along the length of the growth rings or grain. Shrinkage along the length of the timber is usually the smallest.
2. Radial shrinkage occurs across or perpendicular to the growth rings.
3. Tangential shrinkage occurs parallel to the growth rings. This is usually the direction along which most shrinkage occurs and is always more significant than that of radial shrinkage.

When timber is seasoning and its MC is reduced below the Fibre Saturation Point (FSP), continued drying will cause dramatic changes in strength and weight but can also cause distortion and shrinkage.

Faults in Timber

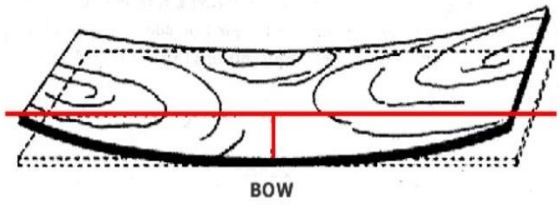
As trees grow, the trees must contend with naturally occurring problems as they grow and adapt or die. The strength needed to support the crown or to resist storms always produces some stresses in the tree. This stress is like an internal spring and allows the tree to push back against the forces of wind and gravity. When trees are converted into timber, the saw miller must remember:

- All trees are 'prestressed'.
- Cutting boards from tree trunks causes stress relief which can change the shape of the board.

Bent trees present special problems for the woodworker as the milled timber from bent trunks can cause 'slope of grain', the direction of the grain radically changes and is not along the length of the board which increases the chances of the timber cleaving under stress, similar to that which occurs in timber with large knots.

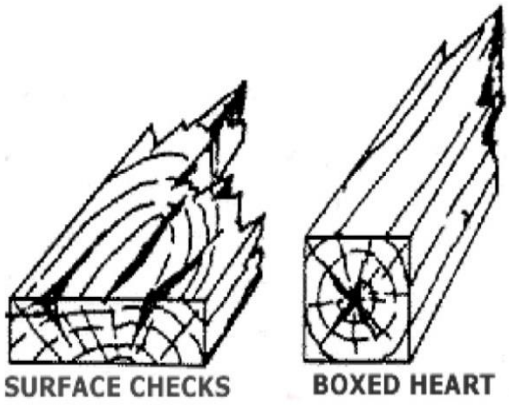
Wood Defects

Timber is far from being a stable and consistent material. One of the biggest challenges of working with timber is learning to work within the constraints of a timber's defects. The following are a list of the most common wood defects.



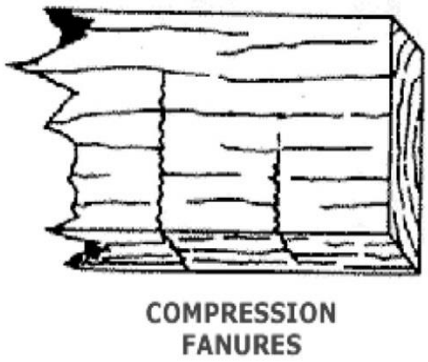
Bow (Bowing)

The curvature of a piece of sawn timber in the direction of its length.



Boxed Heart

A term used when the heart is enclosed within the four surfaces of a piece of sawn timber. Well Boxed Heart means that the heart is enclosed within the four surfaces of a piece of sawn or hewn timber throughout its entire length, and is reasonably well centered at both ends.



Checks

Are small separations of the wood fibers in a longitudinal Wood Defects direction, not penetrating as far as the opposite or adjoining side of a piece of sawn timber; they usually result from strains developing during seasoning; Surface (or Seasoning) Checks, and End (or Heart) Checks are distinguished.

Compression Fanures

Are fractures across the grain in which the fibers are broken transversely or are crushed by compression. Various causes are suggested, such as felling across obstructions, and failure inside the growing tree caused by high winds, growth stresses, etc. Is also known as Felling Shakes, Thunder, Rupture, Lightning, and Transverse Shakes, Upsets, Cross Breaks, or Cross Fractures. Very often they are difficult to detect until the timber is dressed.

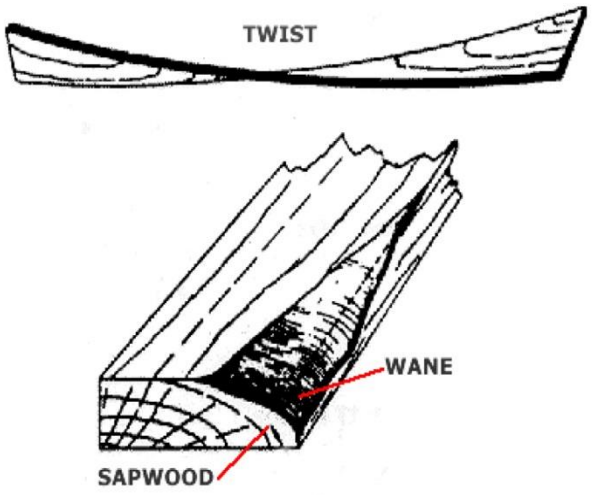
Cup (Cupping)

The curvature of a piece of sawn timber across its width.

Diamond (Diamonding)

A distortion due to differential shrinkage in drying that causes a piece of timber originally square (or rectangular) in cross section to become diamond shaped. This defect occurs when the rays pass through diagonal corners of the square (or rectangle) and is caused by the difference between tangential and radial shrinkage which in many timbers is in the proportion of about 2:1.

Honeycomb



(Internal Checks) The development of checks in the interior of a piece of wood due to drying stresses, usually along the wood rays, often not visible at the surface. This defect occurs when thick timber is dried too quickly in a seasoning-kiln.

Split (also known as a Shake)

Is a longitudinal separation of the fibers which extends to the opposite face or adjoining edge of a piece of sawn timber.

Spring

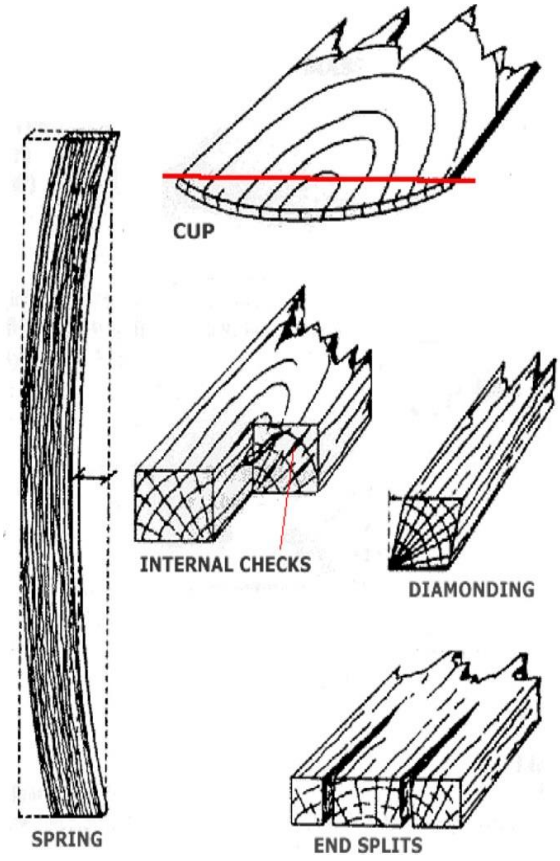
The curvature of a piece of sawn timber in the plane of its wide face: known as Crook or Free Side Bend.

Twisting

Is the spiral distortion of a piece of sawn timber; it may be accompanied by either bowing or spring, or both.

Wane (Want)

Is the lack of wood on any face or edge of a piece of sawn timber, usually caused by a portion of the original rounded surface of a log remaining on the piece; bark may or may not be present.



Slope of Grain

Localised slope of grain can be caused by knots. Slope of grain can also be caused by a slight bend in the tree, which means that when a straight board is cut out of it, there is a bend in the grain. This tends to be a longer feature and may go unnoticed in an appearance product.

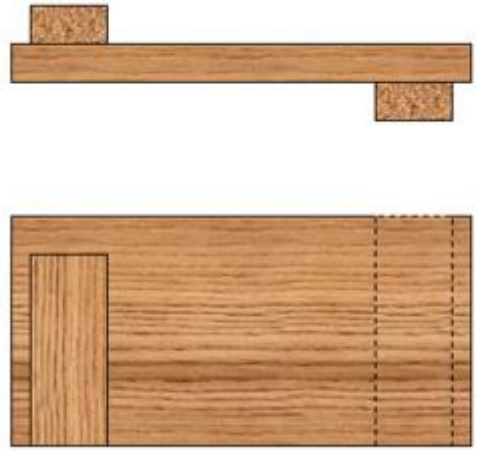
Each defect presents its own challenge to the woodworker and can be viewed as either a ‘good’ or ‘bad’ depending on whether the defect can be included as a ‘feature’ or whether the defect will negatively impact either the project’s appearance or strength/functionality.

Woodwork Hand Tools

The following tools are some of the basic tools found in woodwork rooms. Most students need to be able to recognise each tool, what it is used for and how to use it correctly.

Bench Hook

A **bench hook** is a workbench accessory used in woodworking. The purpose of the bench hook is to provide a stop which a piece of wood being worked can be placed against to hold it steady whilst cutting, planing, or chiseling that piece of wood. Bench hooks make your hand sawing safer and more accurate. This simple hand-tool appliance (three sticks of wood) uses the force of the tool and gravity to hold your work as you saw. And it acts as guide for your tool so your cuts are right on the line.



Saws

Backsaw

A **backsaw** is any hand saw which has a stiffening rib on the edge opposite the cutting edge, allowing for better control and more precise cutting than with other types of saws. Backsaws are normally used in woodworking for precise work, such as cutting dovetails, mitres, or tenons in cabinetry and joinery. Because of the stiffening rib, backsaws are limited in the depth to which they can cut. Backsaws usually have relatively closely spaced teeth, often with little or no set.

The type of backsaw found in this workshop is a **Tenon** saw.

Coping Saw

A **coping saw** is a type of hand saw used to cut intricate external shapes and interior cutouts in woodworking or carpentry.

Squares

A **try square** is a woodworking or a metal working tool used for marking and measuring a piece of wood. The *square* refers to the tool's primary use of measuring the accuracy of a right angle (90 degrees). A piece of wood that is rectangular, flat, and has all edges (faces, sides, and ends) 90 degrees is called four square. A board is often milled four square in preparation for using it in building furniture.

Try Square

A traditional try square has a broad blade made of steel that is riveted to a wooden handle or 'stock'. The inside of the wooden stock usually has a brass strip fixed to it to reduce wear. Some blades also have graduations for measurement. Modern try squares may be all-metal, with stocks that are either die-cast or extruded.

'Try square' is so called because it is used to "try" the squareness.

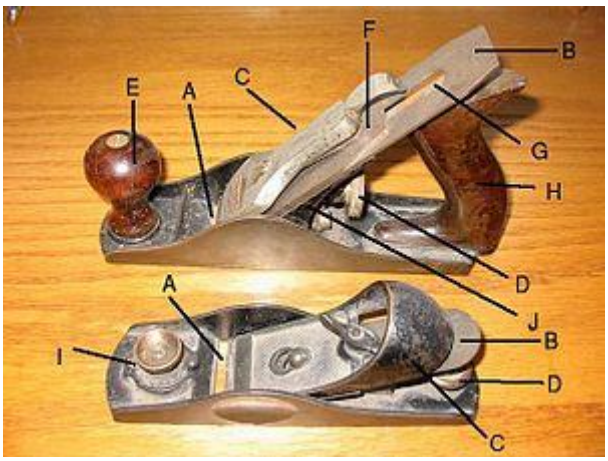
Sanding Block

A **sanding block** is a block used to hold sandpaper. In its simplest form, it is a block of wood or cork with one smooth flat side. The user wraps the sandpaper around the block, and holds it in place (by inserting a fitted piece of cardboard under the sandpaper, one can soften the impact on the wood and protect against tears or uneven wear on the sandpaper). Sanding blocks are helpful because they prevent the "waves" created by plain sandpaper.

Hand Plane

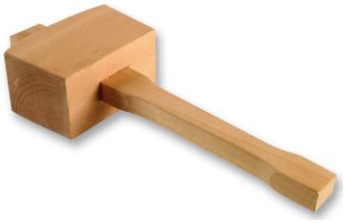
A **hand plane** is a tool for shaping wood. Planes are used to flatten, reduce the thickness of, and impart a smooth surface to a rough piece of lumber or timber. Planing is used to produce horizontal, vertical, or inclined flat surfaces on workpieces usually too large for shaping. Special types of planes are designed to cut joints or decorative moldings.

Hand planes are generally the combination of a cutting edge, such as a sharpened metal plate, attached to a firm body, that when moved over a wood surface, take up relatively uniform shavings, by nature of the body riding on the 'high spots' in the wood, and also by providing a relatively constant angle to the cutting edge, render the planed surface very smooth. A cutter which extends below the bottom surface, or sole, of the plane slices off shavings of wood. A large, flat sole on a plane guides the cutter to remove only the highest parts of an imperfect surface, until, after several passes, the surface is flat and smooth. When used for flattening, bench planes with longer soles are preferred for boards with longer longitudinal dimensions. A longer sole registers against a greater portion of the board's face or edge surface which leads to a more consistently flat surface or straighter edge. Conversely, using a smaller plane allows for more localized low or high spots to remain.



Hammers & Mallets

Wooden mallets are usually used in carpentry to knock wooden pieces together, or to drive in dowels or chisels. A wooden mallet will not deform the striking end of a metal tool, as most metal hammers would. It also is used to reduce the force needed for driving the cutting edge of a chisel, giving better control.



Warrington Hammer

A **Warrington Hammer** is a specialised cross-peen hammer. It has a normal face on one side of the head and a narrow face on the other. The narrow face is used to start smaller nails such as panel pin because it will pass between the fingers holding the panel pin.

Claw Hammer

A **Claw Hammer** is the 'normal' hammer most people have in their garage at home. It is a carpenter's or builder's hammer with a normal face on one side of the head and a claw for removing nails on the other side. This type of hammer is not usually found in the school's workshop as it is typically used for larger nails than those used in most school projects.

Bradawl

A **bradawl** is a woodworking hand tool with a blade similar to a spike and a handle made from wood or plastic. A bradawl is used to make an indentation in wood or other materials in order to ease the insertion of a nail or screw.

Chisel

A **chisel** is a tool with a characteristically shaped cutting edge (such that wood chisels have lent part of their name to a particular grind) or blade on its end, for carving or cutting a hard material such as wood, stone, or metal by hand, struck with a mallet, or mechanical power. Chisel use involves forcing the blade into some material to cut it. The driving force may be applied by pushing by hand, or by using a mallet or hammer.

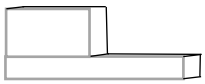
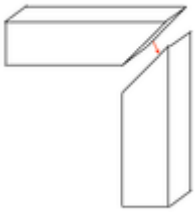
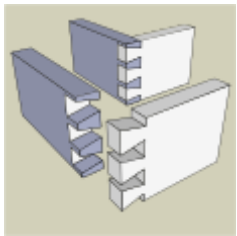
Joinery

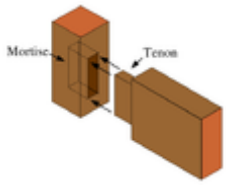
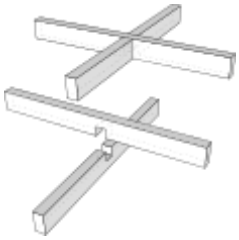
Joinery is a part of woodworking that involves joining together pieces of timber or lumber, to produce more complex items. Some wood joints employ fasteners, bindings, or adhesives, while others use only wood elements. The characteristics of wooden joints - strength, flexibility, toughness, appearance, etc. - derive from the properties of the materials involved and the purpose of the joint. Therefore, different joinery techniques are used to meet differing requirements. For example, the joinery used to construct a house can be different from that used to make puzzle toys, although some concepts overlap.

Joints can be designed to hold without the use of glue or fasteners; a pinned mortise and tenon is an example of this.

Glue is highly effective for joining timber when both surfaces of the joint are edge grain. A properly glued joint may be even stronger than a single piece of wood. However, glue is notably less effective on end-grain surfaces. Animal glue is soluble in water, producing joints that can be disassembled using steam to soften the glue.

Various mechanical fasteners may be used, the simplest being nails and screws. Glue and fasteners can be used together.

Joint	joint	Description
Butt joint		The end of a piece of wood is butted against another piece of wood. This is the simplest and weakest joint.
Dowel joint		The end of a piece of wood is butted against another piece of wood. This is reinforced with dowel pins. This joint is quick to make with production line machinery and so is a very common joint in factory-made furniture.
Mitre joint		Similar to a butt joint, but both pieces have been bevelled (usually at a 45 degree angle).
Dovetail joint		A form of box joint where the fingers are locked together by diagonal cuts. More secure than a finger joint.

Tongue and groove		Each piece has a groove cut all along one edge, and a thin, deep ridge (the tongue) on the opposite edge. If the tongue is unattached, it is considered a spline joint.
Mortise and tenon		A stub (the tenon) will fit tightly into a hole cut for it (the mortise). This is the traditional method of jointing frame and panel members in doors, windows, and cabinets. This joint is a good strong joint to use.
Cross Lap		A joint in which the two members are joined by removing material from each at the point of intersection so that they overlap.