



BCATS

BUILDING, CONSTRUCTION
AND ALLIED TRADE SKILLS

Workshop processes



Unit Standard 24356 (v3), Level 1

Apply elementary workshop
procedures and processes
for a BCATS project **8** CREDITS

BCITO
buildingpeople

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(BCITO)**

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Introduction

This handbook provides an introduction to essential workshop skills. You will apply these as you complete and document a construction project where you can safely:

- establish the job requirements
- get the materials ready (timber and at least three other materials)
- mark out, cut, and shape the materials
- join materials and assemble the components (parts)
- finish the project.

Your teacher/tutor will guide you on which project to construct and on the processes and methods appropriate to your project.

How you will be assessed

You will be assessed through a combination of practical and written work. If you can, take photos of your project, including a photo of it completed.

Your project must include timber and at least three other materials, such as manufactured board, metal, plastic, glass, concrete, mechanical fasteners, adhesives, finishing materials, upholstery (fabric or leather).

You need to show your teacher/tutor that you can:

- read and listen to the instructions for a job and check anything you are not sure about
- get the right materials for the job
- mark out the materials using the correct tools and methods
- cut and shape the materials using the correct tools and methods
- join and assemble the materials using the correct tools and methods
- finish the project correctly
- complete everything safely
- keep your work area, tools, and equipment tidy.

Your teacher/tutor will give you an Assessment Record Sheet for you to document the workshop processes used during your project. They will also verify they observed your correct processes and behaviours.

Glossary of terms

Term	Meaning
Brittle	Material with a tendency to break or fracture.
Compressive strength	The ability of a material to resist a force that when applied will tend to decrease its volume.
Corrosion	The gradual deterioration of a material, e.g. ferrous metals will rust.
Corrosion-resistant	The ability of a material to avoid decay in adverse conditions.
Ductility	The capability of a material to be easily hammered, shaped, moulded or drawn into wire..
Electrical conductivity	The ease that electricity can travel through a material.
Electrical insulation	The resistance of a material to electricity.
Ferrous	Metals containing iron.
Hardness	The ability to withstand scratching and indentation.
Heat conductivity	The measure of how heat can travel through a material.
Magnetism	The ability of a material to attract iron.
Malleability	The ability of a material to be reshaped.
Non-ferrous	Metals that do not contain iron.
Non-metallic	Materials that contain no metals.
Non-magnetic	Materials that do not attract iron.
Oxidisation	The gradual deterioration of a material, e.g. non-ferrous metals such as aluminium will oxidise.
Porous	The ability of a material to absorb air, water and other liquids.
Tension	A force tending to produce elongation or extension.
Thermoplastic	The ability of a material to be remoulded over and over again.
Thermosetting plastic	A plastic that undergoes a chemical change when heated and cannot be reshaped.
Toughness	Strength, resistance to fracturing.

Health and safety

You will more than likely work towards achieving unit standard 24352, *Demonstrate and apply knowledge of safe working practices and use PPE during the construction of a BCATS project*, while you are preparing for and making your project. The information below is a summary of basic health and safety for easy reference.

The school workshop is a potentially dangerous environment.

Most of the equipment you will use is designed to hit, cut or shape wood and other materials. Hand tools, such as chisels, can cut you and hammers can injure your hands. Portable power tools and fixed machinery have the power to permanently maim or even kill you. Different materials have different risks if not cut or used correctly and/or without appropriate safeguards and Personal Protective Equipment (PPE).

Your teacher/tutor will explain the correct way to use the materials, tools, and equipment needed for your project. It is important that you follow instructions, apply some common sense, and ask questions if you are even a little bit unsure about the safest way to do things.



You will likely need to use at least these items of personal protection equipment (PPE):

- hearing protection
- safety boots or covered shoes
- gloves when handling treated timber
- dust masks
- safety glasses (even if you wear prescription glasses, you must still use safety glasses)
- apron or overalls.

Health and safety

Keep yourself and your classmates safe by also:

- carrying out instructions properly
- asking for advice when in doubt
- reporting any unsafe conditions
- using the correct tools and equipment
- making sure that tools and equipment won't trip anyone over or fall on them by keeping the workplace clean and tidy
- reporting any injury (however small) and having it attended to promptly
- not distracting others or fooling around
- wearing or using the personal protective equipment and clothing provided
- using only tools, machinery and equipment that you have been trained to use
- not starting machinery without all the guards in place
- only using machinery under supervision.



Working safely under supervision

Job specifications

Project specifications help everyone have a clear idea about the finished product by what goes into making it.

Job specifications are instructions about:

- what the project is
- how the project is to be done:
 - materials
 - finishes, etc.

Job specifications are made available before the project begins.

JOB SPECIFICATIONS CAN BE:		
DRAWN	WRITTEN	VERBAL
→ detailed plans, drawings and elevations	→ handwritten instructions and explanations	→ face-to-face conversations/ instructions
→ quick sketches or diagrams	→ typed instructions and explanations	→ phone conversations/ instructions
	→ emailed or mailed instructions	→ verbal messages
	→ cutting lists	

Job specifications

Using the job specifications

1. Read through the written specifications with the person providing the information. Ask questions to check your understanding of what is required.
2. Check that the working drawings and written specifications provide all the required information.
3. Listen to the oral instructions and check that:
 - they match the written specifications
 - you understand them
 - you can visualise the finished product
 - the materials to be used are clearly identified and appropriate
 - they include health and safety requirements
 - the required equipment is all included
 - any additional instructions or training requirements have been identified
 - any additional help, information or supervision requirements have been identified
 - you are in agreement about how long it will take to make the project and when it must be finished by.
4. Do a final check with the person who provided the information that all the information needed to complete the task is available and understood.

Materials

The job specifications will identify the materials that are to be used including:

- material type – e.g. plaster board
- material brand – Winstone Gibraltar board
- material size – 16mm.

Detailed information about materials is not included in this handbook because it is likely that your teacher/tutor will help you to understand different materials through getting you to also do unit standard 24355: *Demonstrate knowledge of construction and manufacturing materials used in BCATS projects*. Even if they don't, the student resource for that unit standard will be worth reading to familiarize yourself with different materials and their uses.

Marking out tools

Marking out tools

The correct tools and careful measurement are needed to accurately mark materials.

You will need a work bench, saw horse or other stable surface to support the material that is to be marked out. You will also need to be able to keep the materials steady with vises, cramps, or other adjustable work holders.

The marking out surface needs to be at a height and angle to suit the work and the worker.

Marking-out tools include:

- steel rule
- folding rule
- carpenter's pencil
- measuring tape
- tri square
- combination square
- sliding bevel
- marking gauge
- cutting gauge
- mortise gauge.



Steel rule

Stainless steel rule – common size 300mm long.



Use

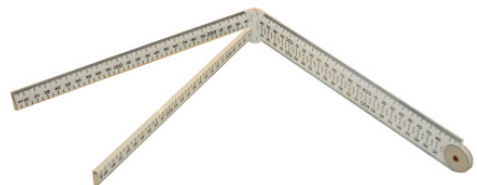
- For accurate measuring and marking out, particularly for bench work and setting up machines.
- Maximum accuracy is achieved when used with a sharp marking knife or sharp pencil.

Care and maintenance

- Protect the edges and ends from damage.
- Keep clean.

Folding rule

A folding, 1-metre rule graduated in millimetres.



Use

- For accurate measuring and marking out.
- Use flat for an approximate reading, use on its edge to accurately mark measurements with a sharp pencil.

Care and maintenance

- Easily broken.
- Lubricate hinges and keep the ruler clean.

Marking out tools

Carpenters pencil

The carpenter's pencil has a rectangular shaped lead and comes in hard, medium or soft grades.



Use

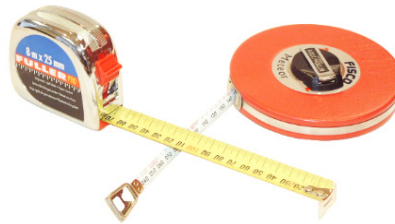
- For marking and recording measurements.
- Use as a finger gauge for drawing lines parallel to an edge.

Care and maintenance

- Keep the point sharp and chisel shaped.

Measuring tape

A flexible strip of steel divided into millimetres, centimetres and metres. Common lengths used by carpenters are 5m and 8m.



Use

- To accurately measure lengths.
- When measuring, hold the tape tight and support it to prevent sagging.
- Rewind after use.

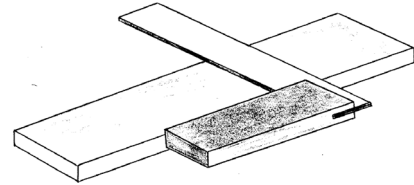
Care and maintenance

- Avoid loops in the tape as they may cause it to snap when it is pulled tight.
- It's important to keep the tape dry, lightly oiled, and free from grit that may scratch the enamel surface and make reading and rewinding difficult.
- Avoid retracting the tape hard onto the stop end.

Marking out tools

Try square

A blade fixed at 90 degrees to the stock.



Use	Care and maintenance
<ul style="list-style-type: none">→ For marking angles of 90°.→ To test (try) if edges and corners are square.	<ul style="list-style-type: none">→ Keep clean and free of rust.→ Ensure that squares are not knocked or damaged.

Combination square

The stock is adjustable and can be fixed by a thumb screw in any position along the blade.



Use	Care and maintenance
<ul style="list-style-type: none">→ For marking angles of 45° and 90°.→ Use as a gauge in awkward places and for measuring the depths of rebates.	<ul style="list-style-type: none">→ Keep clean and free of rust.→ Lightly oil the thread screw so the stock moves easily on the blade.

Sliding bevel

The blade is held in position on the stock by a thumb screw. The blade of the bevel can be adjusted to any desired angle.

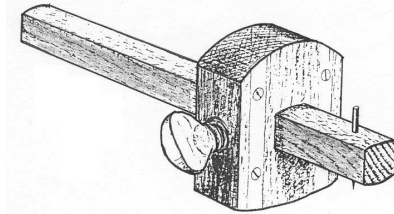


Use	Care and maintenance
<ul style="list-style-type: none">→ For marking odd angles and testing bevel cuts and mitres.	<ul style="list-style-type: none">→ Keep clean.→ Lightly oil thread at thumb screw to keep moving parts in operating order.→ Retract blade when storing.

Marking out tools

Marking gauge

The spur scribes the line and is mounted in the stem. Move the position of the stock on the stem to adjust. The thumb screw locks the gauge in a set position.



Use

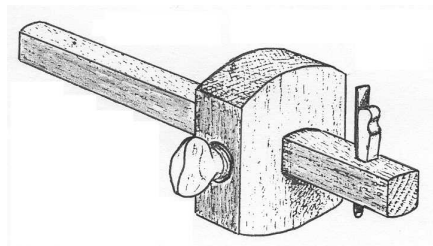
- For scribing lines parallel to an edge.

Care and maintenance

- Keep the spur sharp.
- Release the tension on the thumb screw when not in use.
- Store in a clean and dry environment.

Cutting gauge

Similar to the marking gauge but with a cutter or blade instead of a spur.



Use

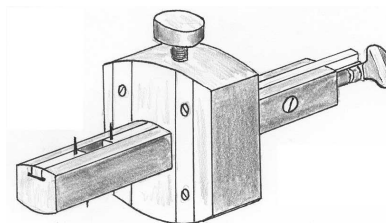
- For cutting or marking out across the grain.
- Used for cutting veneer or thin timber into strips.

Care and maintenance

- Keep the cutter sharp.
- Release the tension on the thumb screw when not in use.
- Store in a clean and dry environment.

Mortise gauge

The mortise gauge has two spurs, one of which is adjustable and used to mark two lines parallel to a face or an edge. This gauge is particularly useful for marking out mortise and tenon joints as well as positioning for dowel joints.



Cutting and shaping processes and tools

Tools for cutting and shaping include:

- Tenon saw
- Panel saw
- Rip saw
- Hack saw
- Planes
- Scraper
- Rasps and files
- Dovetail saw
- Cross cut saw
- Coping saw
- Chisels
- Spokeshaves
- Oilstone or diamond stone
- Sanding block

Safety when using tools

You will use hand and power tools to make your project. The following sections cover some basics about a selection of common hand tools.

Most hand tool accidents arise from one or more of the following:

- using the wrong tool for the job
- the tool not being properly used
- using blunt or defective tools.

To avoid having an accident when using hand tools, always:

- use the right tool for the job
- use the tool correctly
- repair or replace defective or faulty tools.

Hand tools that are used for cutting must be kept sharp. You're more likely to be injured with a blunt tool than a sharp one.

Saws

A well-balanced handsaw is essential. While portable circular saws have, in many cases, superseded hand saws, a properly sharpened and set saw can produce a smooth, straight cut with greater accuracy than a power saw.

Handsaws vary in size and shape to suit particular jobs. The three main groups are:

- backed saws, such as tenon saws and dovetail saws
- rip, crosscut and panel saws
- curve cutting saws, such as coping saws.

The number of teeth per 25mm gives the size of the saw.

Cutting and shaping

Tenon saw

The tenon saw has a brass or steel ridge on the top edge to strengthen and stiffen the blade. Blade lengths vary from 300 to 400mm, with 13 points per 25mm.



Use	Care and maintenance
<ul style="list-style-type: none">→ For general bench work, e.g. when a fine cut is required on small items, such as mouldings.→ Can also be used in a mitre box for consistency and improved accuracy.	<ul style="list-style-type: none">→ Store in a rack or hang by the handle or blade,→ Keep clean and free of rust.→ Maintain the saw in a sharp condition.

Dovetail saws are smaller versions of the tenon saw, with 18 to 22 teeth per 25mm. The dovetail saw is used for cutting dovetails and other fine work.

Panel saw

Panel saws are normally 600mm long or shorter, with 10 to 12 points per 25mm.



Use	Care and maintenance
<ul style="list-style-type: none">→ For fine crosscutting on finishing timber and panels.	<ul style="list-style-type: none">→ Store in a rack or hang by the handle or blade.→ Keep clean and free of rust.

Crosscut saw

Crosscut saws are normally 700mm long, with 5 to 10 points per 25mm.

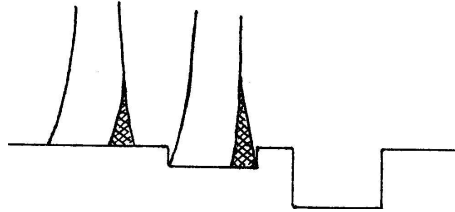


Use	Care and maintenance
<ul style="list-style-type: none">→ For general-purpose cutting across the grain of timber.	<ul style="list-style-type: none">→ Hang by the handle or blade.→ Keep clean and free of rust.→ Send to saw doctor for sharpening and setting when required.

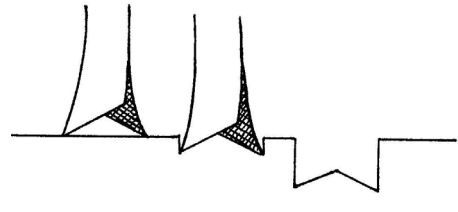
Cutting and shaping

Rip saw

Normally 700 to 800mm long, with 3 to 6 points per 25mm.



→ Rip saws cut along the grain with a chiselling action.

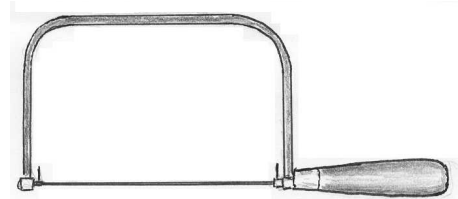


→ Crosscut cuts the wood fibres with a slicing cut.

Note: Ripping timber along the grain is usually done either with a portable power saw or on a saw bench. It's still handy to know how and when to use it even if these are available.

Coping saw

Coping saws have a fine blade held in tension in an adjustable steel frame. Two adjustable levers alter the blade position.



Use

- For cutting sharp curves in thin timber.
- Scribing the ends of mouldings at internal angles.

Care and maintenance

- Replace the blade when necessary.
- Keep clean and free of rust.
- Align the adjustable pins to ensure that the blade is straight within the frame. A twisted blade will produce a rough, inaccurate cut and is more likely to break.

Hack saw

Blade lengths vary from 225 to 305mm, with 18, 24 or 32 teeth per 25mm. Hack saws have a detachable blade held in a heavy duty metal frame. The blade is held under tension to help prevent it twisting and bending.



Use

- For cutting metal or plastic.
- For softer material, generally use a coarser blade.

Care and maintenance

- Release blade tension when storing.
- Keep clean and free of rust.

Cutting and shaping

Chisels

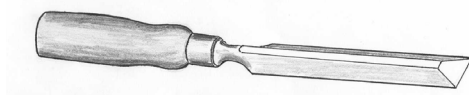
A metal tool with a sharp bevelled edge, chisels are used to cut and shape stone, wood or metal. High quality forged steel blades help to ensure a fine cutting edge.

Chisels used to be able to be used only with a wooden mallet. Steel hammers can be used on newer versions if they have shatter resistant handles. If in doubt about what to use with your chisel, check with your teacher/tutor.

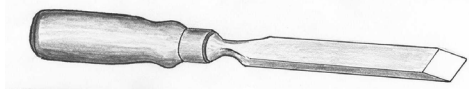
Chisels are mainly used for:

- fine, delicate cutting, such as removing waste from dovetail joints
- heavier chopping work such as checking in hinges, or halving joints
- shaping and trimming timber.

Chisel widths vary from 6 to 50mm. The beveled-edge and firmer chisels are most commonly used.



Bevelled-edge chisel

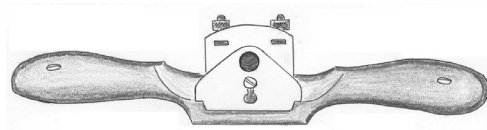


Firmer Chisel

Other chisels available include butt, registered firmer, paring, and carving chisels.

Spokeshaves

A spokeshave is used for smoothing surfaces on internal or external curves. The cutting action is similar to that of a plane but the sole is short so that it will follow the curve of the component.



The sole face can either be flat or curved, with the curved sole being better for concave curves. Care and maintenance are the same as for planes. Make sure your spokeshave is always placed where it can't fall - they break if dropped.

Cutting and shaping

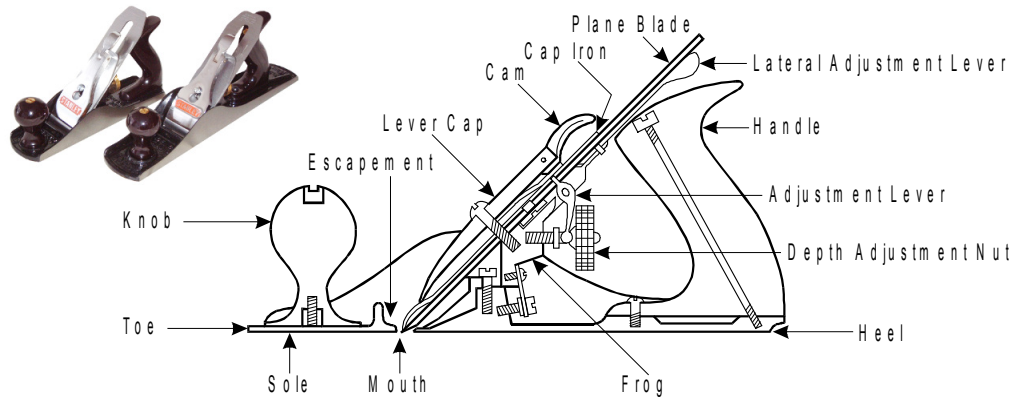
Planes

Planes are a tool used to take shavings off timber to produce smooth timber surfaces, straighten timber, and reduce timber to a required width.

Planes and chisels must have a very sharp blade. Your teacher/tutor will show you how to test if they are sharp enough before you use them.

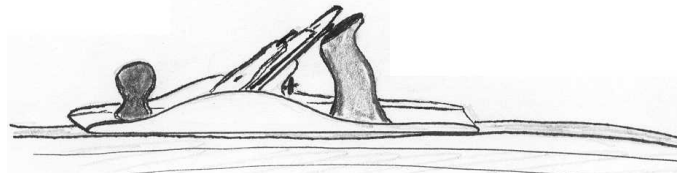
Metal planes have a cast steel body and a steel blade (of back or cap iron) that can be adjusted in two directions using a lever and a wheel adjustment.

Metal planes vary in size, with the most common being 245 x 50mm (No 4).



A jackplane has a longer sole and is more suited to straightening long lengths of timber.

Jointer or try planes have a very long sole and were used for planing long straight edges or surfaces.



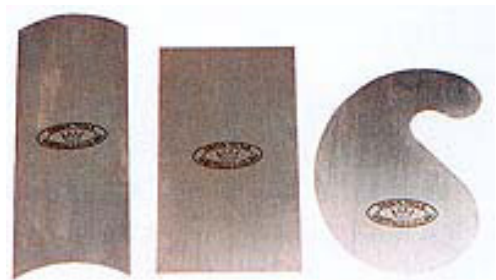
Portable electric planers are commonly used for this task now.

Block planes are used for fine chamfers and end grain.

Scraper

The hand scraper is usually a flat piece of steel with a cutting edge formed by burring over the long edges of the scraper.

They are used to remove marks and defects on planed surfaces and are particularly good on irregular or opposing grains. Scrapers can also be shaped up for use on curved surfaces.



Joining materials and assembly products

Wood joints are used to join pieces of timber together. Their use increases the strength of the joint and/or improves its appearance, adding value to the finished product.

Wood joints can be made either by hand or by machine. Which method is used will often depend on the project and the equipment available. Similar construction principles apply regardless - accurate marking out and careful cutting and shaping create quality workmanship.

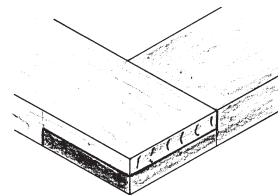
Brief descriptions of wood joints commonly used in joinery, boat building, and furniture making are below. Following this is an example of how to mark out, cut, and shape a halving joint.

It is likely that your teacher/tutor will help you to learn about joining materials and techniques through getting you to also do unit standard 25920, *Use joints for a BCATS project*. This section is therefore only a summary of different techniques to join wood. Please see the student resource for the Joints unit standard for greater detail, and for how to join metal.

Halving and corner joints

ANGLE HALVING JOINTS

Used for corner joints in framing construction. It is a quick and easy joint to construct and is relatively strong.

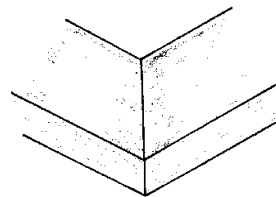


MITRE JOINT

In its most basic form it is a butt joint that has had a 45 degree angle cut on the ends of each piece.

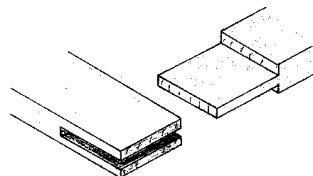
It is often used for decorative work because no end grain is exposed.

The joint is not very strong but can be strengthened by inserting wooden tongues.



BRIDLE JOINT

This is a strong and attractive wood joint. The joint is usually glued together and is often pinned with a dowel through the side of the joint.



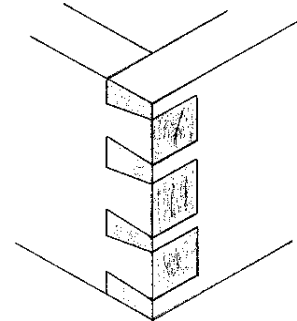
Joints

DOVETAIL JOINTS

Dovetails are one of the strongest forms of angle joints. The strength in this joint is obtained through:

- extra gluing surfaces of the dovetails
- the angle of the dovetails.

The dovetail joint is used where strength and an attractive appearance are required, such as in the construction of strong boxes, chests and drawers.

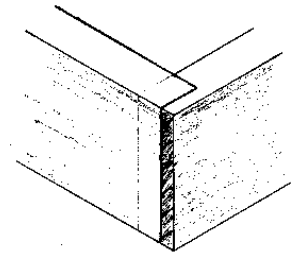


REBATE/SHOULDERED BUTT

This joint is a simple form of construction that provides greater strength than a basic butt joint.

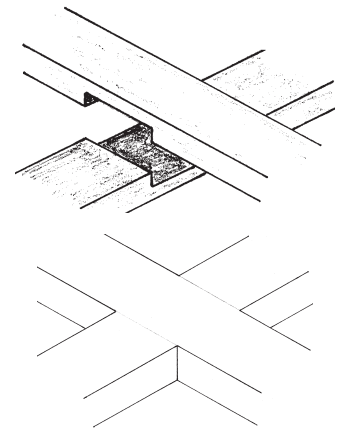
The shoulder helps support the joint as well as offering additional gluing surface.

It is used for boxes, plinths and cheap drawers



CROSS HALVING

This joint is similar to the angle halving joint and is used where two pieces cross one another. It is a strong joint with the advantage of maintaining a flush surface finish.

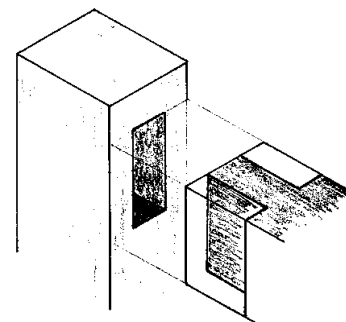


Rail to stile joints

THROUGH MORTISE AND TENON JOINTS

This is the simplest form of the mortise and tenon joint. It is used where a rail meets a stile. The mortise is cut right through the stile. The tenon runs through it and is finished flush with the outside edge.

This joint can be strengthened with the use of wedges. It is a strong joint that is far superior to a dowel joint.

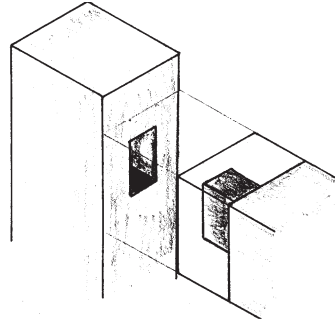


Joints

STUB MORTISE AND TENON JOINTS

This is a very similar type of joint to the through mortise and tenon. Its difference is that the tenon is 'stopped', which means it does not pass through the stile.

This joint is used on high quality work to prevent the end grain from being seen on the outside edge.

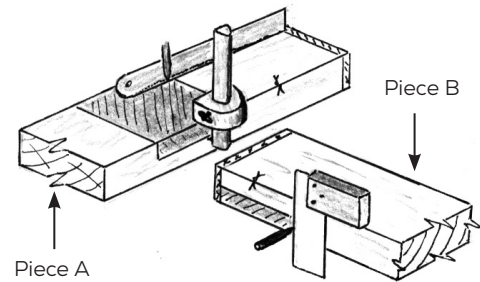


Dovetail and biscuit joints made by a Rotorua Boys' High School student for his bedside cabinet.

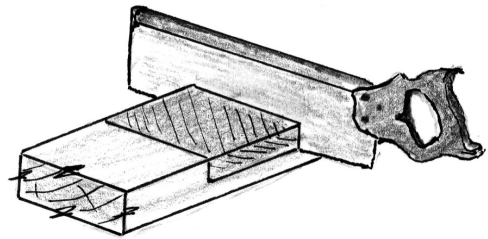
Joints

Preparing a halving joint

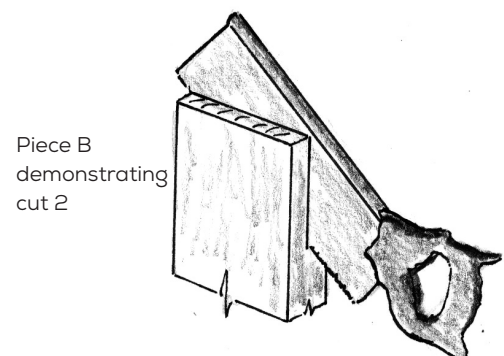
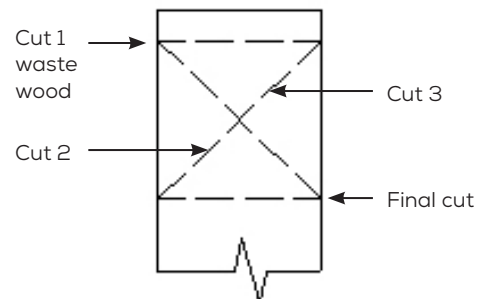
1. Prepare the timber, identifying face side and face edge. Mark out the timber joint. Ensure that an allowance is made for final dressing of the timber.



2. Saw across the grain down to the gauge line on Pieces A and B. Check first that you are cutting on the waste wood side of the line.



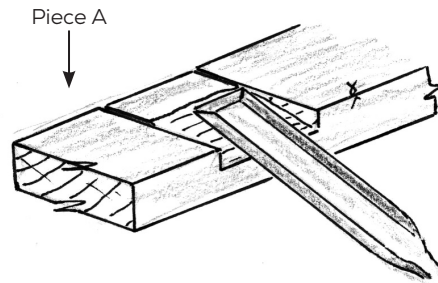
3. Remove waste wood on Piece B using a tenon saw. Follow the cutting plan to provide the straightest cut. Clean up cut surface using a wide chisel.



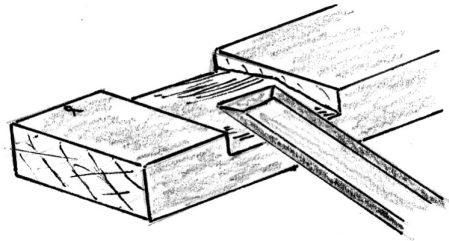
Joints

4. Ensure that work is clamped securely. Remove waste wood from Piece A. Chisel up on a slope, towards the centre of the work.

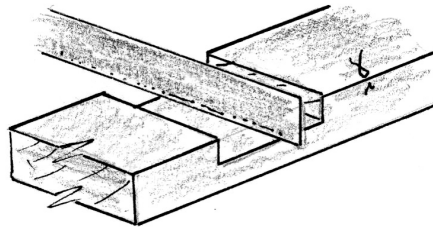
Never place your hand or any part of your body in front of the chisel.



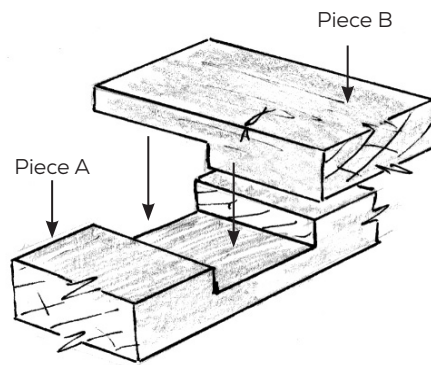
5. Repeat the chiselling process from the other side.



6. Chisel bottom flat (test for flatness with a ruler).



7. Fit the parts together and clean up your work area.



Surface finishes

Surface finishes are a design element that must be appropriate to the specific project and how it is going to be used. There is a wide range of surface finish materials available that can be applied with a brush or roller, or sprayed on.



Paint finish coats ready for application

Paint

Paints cover and add colour to an object or surface by covering it in a pigmented coating. Paints are available in gloss, satin and matt finishes.

There are three main coats of paint that are normally required to complete a quality job.

1. **Primer** is a preparatory coating put on materials before painting. Priming ensures better adhesion of paint to the surface. It increases paint durability and provides additional protection for the material being painted.
2. **Undercoat** has opacity to cover any blemishes. It provides a base for the finish coat.
3. **Finish Coat** provides the final hardwearing surface with gloss and colour pigments. A finish coat will not cover blemishes and will not stick to a surface for long without an undercoat.

The two main types of paint are enamel (oil-based) and acrylic (water-based).

- **Acrylic** paint. This is a fast-drying paint that can be diluted with water. It becomes water-resistant when dry. Acrylic-based paints are regularly used for house painting and interior decorating. Brushes are washed in water.
- **Oil-based** paints. These are slower drying but produce a harder-wearing paint finish. Brushes are washed in mineral turpentine.

Surface finishes

Varnish

Varnishes provide a protective coating without changing the colour. They are paints without pigment. Like paints they are available in gloss, satin and matt finishes.

- **Acrylic varnish.** Quick drying and non-toxic. Brushes can be rinsed out in water.
- **Polyurethane.** Commonly used for a wide range of applications. Coats can be applied by brush, roller or spray painted depending on the job and the availability of equipment. Once fully hardened, the surface should provide a hardwearing, resilient surface. Clean brushes in mineral turpentine.
- **Sanding sealer.** A clear-finish primer formulated for application over bare wood. It is designed to "raise the grain", which is then sanded to provide a smooth surface under oil-based polyurethane topcoats. Its quick-dry feature allows you to seal and topcoat your project in one day. Clean brushes in mineral turpentine.
- **Lacquer.** A fast-drying solvent-based paint or varnish that produces an especially hard, durable finish. Clean brushes in mineral turpentine.

Oil

Oils provide a quick and easy finish to most timber surfaces. There is a wide range of oil types. Which one to select depends on the finish you want. The main problem with oils is that they take a lot longer to dry than varnish and can fade over time. An advantage is they don't produce toxic fumes. Examples of oils are:

- **Danish oil.** This is a blended oil that is excellent on pine. It gives a natural low-lustre finish.
- **Lemon oil.** This provides a suitable finish for teak and matt finished woods where a wax finish is not desired. It has the aroma of fresh lemons.
- **Linseed oil:** A natural product available in natural and boiled form. A traditional wood finish, although it does tend to go gummy if applied too heavily. As linseed oil dries it generates heat. Rags used to apply linseed oil can spontaneously combust if left scrunched up. Lay them flat on concrete to dry completely, well away from anything else that could catch fire.
- **Teak oil.** A quick-drying penetrating seal for teak and similar woods. It leaves a slight sheen when dry.
- **Tung oil.** This oil gives a superior finish to that of linseed oil, and is water-resistant. It can be easily applied using a rag.
- **Vegetable oil.** Commonly used on surfaces that are in contact with food, e.g. salad bowls. The oil is non-toxic and will not taint the food.

Clean brushes in mineral turpentine.

Surface finishes

Polish

Polishes help to seal the timber and provide a harder wearing surface than a stand alone oil finish. As with oil finishes, there is a wide variety of polishes available. The two most common are:

- **French polish.** This is made from pure shellac and alcohol. It provides a high-quality finish for furniture. Applying French polish uses a traditional polishing method that often needs 20 to 30 coats.
- **Wax polish.** A good-quality wax polish, with added beeswax, will provide a hard, protective coating with a natural sheen. Wax polishes are available in a number of forms including liquid, paste, a special brushing wax, coloured waxes and staining waxes.



Painstaking and careful application of one of many coats for a strong and glossy french polish finish

