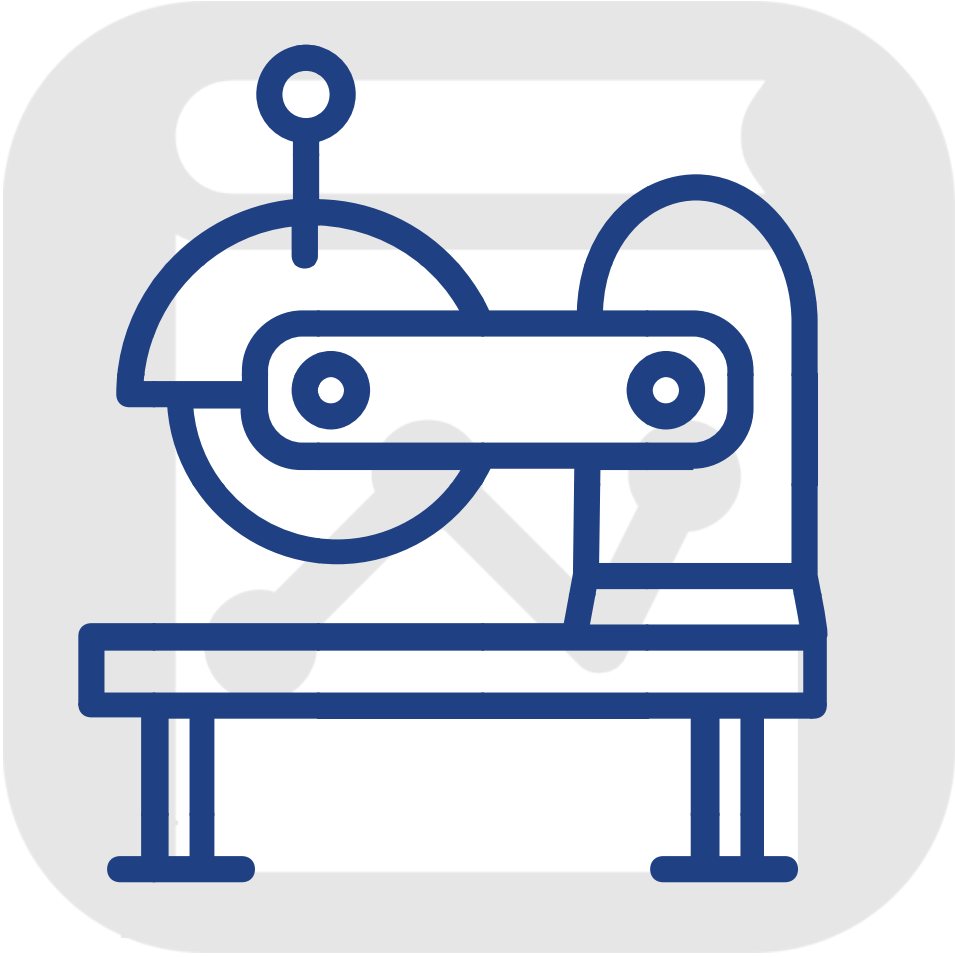
Fixed machinery

BCATS

BUILDING, CONSTRUCTION AND ALLIED TRADE SKILLS



Unit Standard 24351 (v3), **Level 2**

Demonstrate knowledge of and use fixed machinery in the construction of BCATS projects

6 CREDITS

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Introduction

This handbook is an introduction to a wide range of fixed machinery tools used for BCATS projects.

Most school and provider workshops have a range of fixed machinery designed for specific purposes. Most of these machines are similar to those used in industry. It is important for you to fully understand how they work, what they are designed to be used for, and how to use them correctly and safety.

To include and describe every fixed machine you could use for your BCATS projects would make this resource very long. Therefore, the main fixed machines used across a range of areas have been selected. Your teacher/tutor will teach you to identify, select, use, and maintain the fixed machines needed for your two BCATS projects.

L2 BCATS students from Awatapu College and Rotorua Boys' High School using fixed machinery to make their projects.

How you will be assessed

You will be assessed through a combination of practical and written work.

To achieve this unit standard, you need to demonstrate knowledge of setting up and operating fixed machinery and use fixed machinery to complete two BCATS projects. Your teacher/tutor will tell you which project(s) to complete.

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

- describe what six fixed machines can and cannot be used for
- describe how to use six fixed machines safely and how to maintain them
- choose the right Personal Protective Equipment (PPE) to use
- use four fixed machines correctly and safely
- keep fixed machinery and the work area clean and tidy.

Depending on your school's policy, you might not be able to use some machinery yourself.

If this is the case, you must still set up the machine and talk your teacher/tutor through how to use it as though you were using it yourself.

Your teacher/tutor might give you a work diary to help you record how you made your projects. If you can, take photos of you using and maintaining fixed machinery as your projects progress.

Note: Your teacher/tutor must also formally attest to observing behaviours such as using the machinery safely and reporting any damage or faulty machines.

Glossary of terms

Term	Meaning
Alternating current -AC	An electric current that reverses direction in a circuit at regular intervals.
Direct current -DC	An electric current that flows in one direction in a circuit.
Anticlockwise	Rotating in the opposite direction to the path of the hands of a clock. (Left to right).
Binding	To hold, restrain or cause to stick.
Bevel	Cut a slanting edge on a piece of timber.
Biscuit joiner	A woodworking power tool used to join two pieces of timber together. It cuts slots in the timber into which oval biscuits are glued, producing a very strong joint.
Chamfer	A flat surface made by removing the edge or corner of a piece of timber.
Chuck	A revolving clamp with adjustable jaws that holds a drill bit.
Cladding	The external wall covering material on a building or fence.
Clockwise	Rotating in the same direction as the path of the hands of a clock (Right to left)
Collet chuck	A holding device that forms a collar around the tool to be held and, when tightened, exerts a strong clamping force on the tool.
Collets or sleeves	A cone-shaped sleeve used for holding circular or rod-like machine pieces.
To 'earth'	A connection between an electrical tool, device or circuit and the earth.
Depth of cut	The distance that a cutting blade extends into material being cut.
Double-insulated	Two levels of protection built into power tools. The primary protection is afforded by the first layer. If that fails protection is provided by a second level.
Flutes	The helical grooves of a twist drill that provide the rapid removal of waste material from a cutting surface.
Hazard	Any activity that has the potential to cause harm. Anything that could hurt yourself or others.
Hazard	Anything that can cause harm, including a person's behaviour
Harm	Illness, injury, or both; includes physical or mental harm caused by work-related stress
Helical grooves	Spiral grooves

Term	Meaning
Kick back	A sharp and often dangerous reaction that can occur when the material being machined closes on a cutting blade. This closing can cause the material to be projected violently back toward the operator by the momentum of the blade.
Masonry	Building work block, stone or brick work.
Mode	The method of carrying out an operation or task.
Profile	A temporary wooden structure used to set out a construction area and establish levels. String lines are attached to the top to define the set out.
Residual current device (RCD)	A safety circuit-breaker that operates if there is a fault in electrical equipment.
Ripping	Cutting timber with the grain.
Revolutions per minute (RPM)	The rating which identifies the speed of a machine.
Side loaded	The application of pressure to the side of the disc when using a portable power tool.
Torque	The measure of a turning force around its axis.
Transformer	An electrical safety device which lowers the voltage of an electric current.
Tungsten carbide	An extremely hard composite steel used in tools and accessories that require high wear resistant qualities.

Masonry table saws can cut stone precisely and with little vibration.

Health and safety

The Health and Safety at Work Act 2015 is designed to:

- prevent harm to employees at work
- promote good practices in health and safety management.

The Act puts responsibilities on everyone to take all practicable steps to ensure your own safety and the safety of others.

Under the law you are **not allowed** to work with any machine or equipment until you have been instructed in the safe use of that machine or equipment.

- You must follow safety procedures, and use the safety guards.
- You can refuse to work on any machine or equipment if you have not been instructed in its safe use or do not feel confident to use the machine.
- If you are injured while using machinery before you are appropriately trained both you and your school/employer can be prosecuted.

Apart from using the correct PPE (personal protection equipment), one way you can help ensure your own safety is to select and use fixed machines correctly. Keep them well maintained and check them before using. Make sure all guards are fitted and all guides and clamping systems are functioning correctly before using the machine.

You **must** receive training in the use and maintenance of fixed machinery and apply it when you select and use them. You have a responsibility to ask your teacher/tutor for guidance if you are unsure of or have forgotten how to use a machine safely.

Always stop and think – if it doesn't look or feel right, don't do it!

Machine safety basics

All machines are dangerous. Each individual machine has operating procedures and safety rules that must be followed to reduce the danger to you and others.

Only a teacher or tutor can use some of the machinery included in this module. Your teacher or tutor will inform you of which machines these are. Take the opportunity to watch and learn how they use them. You might also be involved in setting up the machine or involved in 'tailing out'.

'Tailing out' from the thicknesser.

ALWAYS

- only use machines you have been taught how to use properly and safely
- ask your teacher/tutor/employer to talk you through how to use it properly and safely if you are even a little bit not confident using it
- know the capabilities and limitations of the machine
- select the right machine for the job
- strictly follow safe working practices
- select and use appropriate Personal Protection Equipment (PPE)
- before using, check the machine is well maintained and has all its safety guards and protections. Report any damage/concerns to your teacher/tutor immediately.

Personal safety

There are basic personal safety rules you must practice to help them become habits, even if you only need to use a machine to make one cut. Forgetting to do follow these basic rules only once could result in serious or even fatal injuries.

ACTION	HAZARDS AND RATIONALE
Tie back long hair back.	Long hair can get caught up in moving machinery. This can result in: → the operator's hair being ripped out and/or → the operator's face being dragged into the machine.
Wear snug fitting clothing.	Ties, scarves, or loose clothing can get caught up in machinery. This can result in: → the operator being dragged into the machine and/or → the wearer being choked.
Wear Personal Protective Equipment.	High velocity projectiles can be thrown off the blades. Dust can lead to respiratory problems. Noise can lead to deafness. Objects can be dropped on your feet.
Keep your fingers and hands away from moving blade at all times.	Moving blades can't tell the difference between timber and flesh. Always use push sticks and push plates to protect your hands and fingers from the blades.
Take any rings and/ or necklaces off.	Rings and necklaces can get caught in the blade or crushed in machinery. This usually results in a severe injury
Use bare hands when operating rotating machinery.	Gloves can easily get caught up and dragged into the machine. This will usually result in a mutilated hand and/or loss of fingers.
Ensure that all guards are correctly fastened in position.	Exposed belts, pulleys, blades and cutter heads can kill you.
Isolate the machine from the power supply when setting up or making adjustments.	The accidental starting of a machine can have fatal consequences for the person setting the blade or adjusting the cutter heads.

Operating fixed machinery safely

Follow these safety rules for any fixed machinery.

- Use only machines which you have been trained and have permission to use.
- Wear appropriate PPE.
- Always operate machines in well lit, clean areas.
- Read and follow the manufacturers' instructions before use.
- Check all safety guards are in the right condition, position and secured before starting work.
- Before starting the machine, isolate it and turn the blade or cutting head by hand to check for smooth operation.
- Check the electricity supply and that electrical leads have current inspection tags.
- Stand to one side of the machine when starting it.
- The stop button must work and be within easy reach of the operator. (The stop button must be a raised mushroom shape and coloured red to make it easier to see and use in an emergency.)
- If you need to force material through the machine, stop. Ask your teacher/tutor for help.
- Switch off machines before making any adjustments or to remove waste.
- Turn off a machine when you leave the workspace.
- Follow the manufacturers' instructions when changing blades or cutting knives.
- Keep the surrounding work area clear of scraps and off cuts.
- Give the machine your undivided attention at all times. Do not allow yourself to get distracted.

Fixed machinery hazards and controls

Every fixed machine has its own hazard, and every hazard is able to be controlled. Be aware of the hazard and use the appropriate control. An example of how to do this is below.

Before I use a band saw, I think about the hazards and make sure I can control each hazard.

1. *I think about what could/might happen.*
2. *Using the hierachy of controls as a guide, I take action to eliminate or reduce the likelihood of it happening*

HAZARD	POTENTIAL HARM	CONTROL(S)
Exposed blade.	Injury to hand, fingers, or other body parts.	Set the Upper Guide Assembly in the correct position. Wait for the blade to reach full speed before commencing the cut. Do not force the saw when completing the cut. Ease the pressure off the blade towards the end to remain in control when the blade exits the material.
Loud continuous noise.	Loss of hearing.	Wear ear muffs.
Material being cut is too small.	Cutting hand/fingers (or other body part) as a result of the fingers being too close to the blade.	Ensure the material being cut is big enough that fingers never come near the cutting edge of the blade. Use a guide stick if need be.
Blade breaking	Injury to one or more parts of the body	Reduce tension on the blade by cutting relief cuts before attempting to cut curves.
Using blunt or incorrect blades.	Excessive force required to complete the task, which could lead to slipping and resulting hand/finger injury.	Use the band saw as trained to. Make sure that the correct blade for the job is fitted and that it is in good condition
Distraction.	Losing or severely damaging body parts.	Focus on what you're doing. One person to operate the machine. Others must keep at least 1 metre away. Do not talk to others or allow them to talk to you.
Dull or blunt blade or incorrectly tensioned blades breaking.	Serious injury possible to hand, arms, and/or face and body.	Check blade is sharp and correctly tensioned and that it runs freely and accurately when wheel is turned by hand.

Care and maintenance basics

Keep fixed machines in good condition. Good-quality work is impossible to achieve with blunt, incorrectly sharpened, or damaged blades/grinding stones etc. fitted to the machine. They are also dangerous because you have to apply extra pressure to complete the task. This reduces your control which increases the likelihood of injury.

Your teacher/tutor will help you to learn how to care for and maintain machinery. If you are given the opportunity to do so, get involved in doing maintenance such as changing blades and lubricating moving parts.

Awatapu College students servicing fixed machinery.

Powering the machinery

Fixed machines in many workshops are hard wired. An example is a large band saw. If the machine is not plugged in to a power point on a semi-permanent basis, coil the power cords around the machine to prevent kinking when not in use.

The cords of non-hardwired fixed machines need regular voltage leaking testing. Check the condition of the cords regularly and that the compliance tags are current.

Classification

Fixed machinery can be classified according to their purpose. Some fixed machines will be used across a wide variety of projects. Others are specialist machines used for one specific job such as a concrete mixer to mix concrete.

DRILLING	GRINDING/ SHARPENING	SAWS
Vertical drill	Bench grinders]	Table saw
Horizontal borer	Whetstone	Mitre / compound saw
Mortiser		Scroll saw

SANDERS	SHAPING	OTHER
Vertical	Overhead router	There are specialist CNC (Computer numerically controlled) routers for different materials. For example, masonry table saws are for cutting stone precisely and bridge saws do the same with granite.
Flat-bed	Surface planer	
Bobbin		
Drum		

There are many other trades in the building and construction industry, all of which have their own specialist fixed machinery. Your teacher/tutor will introduce you to these and teach you how to use them if your project relates to one of them instead of those covered in this resource.

BCATS trades are listed below, most of which have specialities within them:

Architectural aluminium joinery		Brick and block laying	
Carpentry		Concrete	
Exterior plastering		Flooring	
Frame and truss fabrication		Glass and glazing	
Interior systems		Joinery	
Kitchen and bathroom design		Painting and decorating	
Stonemasonry		Tiling	

Saws

Bench saw

Bench saws are also known as **dimensional saws** or **table saws**. Some people also consider compound mitre saws within the category of bench saws.

One of the most useful machines in the workshop, these saws are used to make accurate straight cuts in various materials. It can be used for ripping and crosscutting, or cutting mitres, bevels, chamfers, trenches, grooves, tenons and compound cuts.

A bench saw should not be used:

- for machining short lengths of timber
- without the hood and belt guard
- without appropriate training
- without PPE.

Note: You need to know about bench saws but only your teacher/tutor may have your school's Board of Trustee's permission to use it.

Safety

- Make sure that all guards are set up correctly.
- Keep the fence parallel to the blade and secured in its correct position.
- Keep your fingers well away from the blade.
- Keep the saw bench clear of sawdust and off-cuts.
- Use a stick or wait until the machine is switched off before clearing off-cuts or scraps away.
- **Never** attempt freehand cuts.
- Make sure that there are no nails, screws or other hard materials in the material to be cut.
- Always stand to one side of the saw blade. Never stand in front of it.
- If you are not the machine operator, KEEP AWAY from the bench saw when it is in use. Take care to not distract the person using it.

Saws

Bench saw facts

An incorrectly set up saw can:

- propel pieces of timber off at high speed
- kick back when the saw kerf closes up and jams on the back of the blade. This often results in the piece of work being flung at the operator at high speed.

Cross cutting, using the ripping fence as a stop, can cause timber to jam between the fence and the blade, also resulting in the timber flying off the saw.

When the circular saw is switched on, the blade revolves so rapidly it appears as a blur that will remove a 4-5mm-wide section from anything it touches, including you.

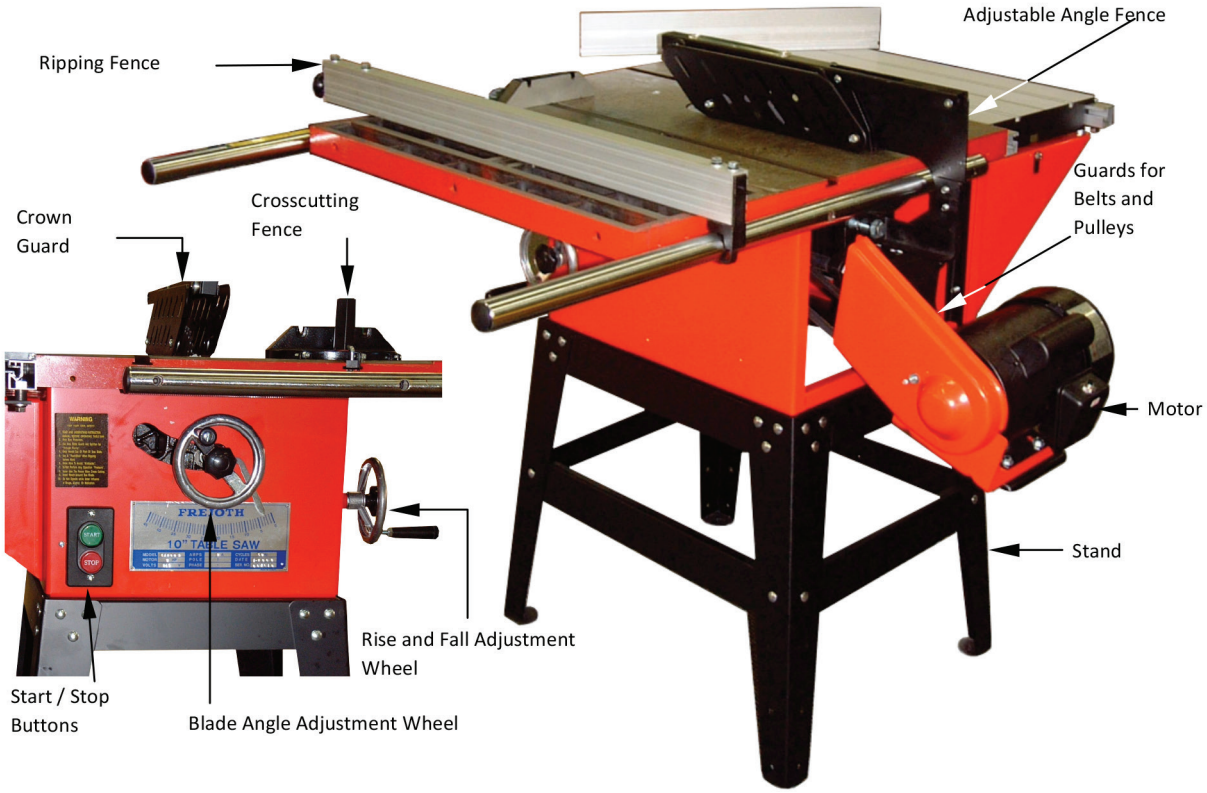
Parts of a bench saw

Adjustment wheels – Used to raise or lower the height of the blade and to tilt the angle of the blade from vertical up to 45 degrees.

Ripping fence – A guide fence that is positioned parallel to the blade and locked in place.

Mitre fence – A guide or fence that slides in a groove parallel to the blade. It is used for cross cutting timber from 90 degree to 45 degrees.

Sliding table – Used for crosscutting. Especially suited to wider material. The sliding table provides a smoother, more accurate cutting action.



Saws

Blades

Circular saw blades are available for various cutting operations. It is important that you use the correct blade for the task.

As a general rule, the more teeth the blade has, the smoother the cut it will produce.

- A ripping blade is designed to saw timber along the grain. It cuts with a chiselling action. The cut will be rough if it is used across the grain.
- Crosscut saw blade is designed for cutting manufactured boards and timber across the grain. The teeth are similar in appearance to the crosscut teeth on the hand saw.
- Combination blade has a combination of cross cut and ripping teeth.
- Tungsten carbide tipped blades have tungsten carbide inserts on the end of each tooth. These teeth will produce a very smooth cut and remain sharper for longer than conventional blades.

Blade safety features

Riving knife – also known as a fin or splitter. This is positioned directly behind the saw blade to prevent the timber closing up and being kicked back towards the operator.

Hood or cover guard - a metal cover that fits over the top of the saw blade. It should be adjusted close to the timber to provide protection from the blade, flying splinters or timber that may ride up on the blade.

SAFELY USING A BENCH SAW	
Ripping	
›	Set the fence to the required distance from the saw to ensure that the blade will cut on the waste wood side of the line.
›	Keep the face edge against the fence.
›	Carefully push the timber through.
›	For longer lengths of timber, another person should tail-out the timber from the back of the saw.

SAFELY USING A BENCH SAW *Continued*	
Cross cutting	
›	Move the ripping fence well out of the way.
›	Set the mitre fence to the angle required.
›	Place the timber firmly against the mitre gauge and push towards the blade.
›	Do not hold the off cut – doing so could cause it to jam on the blade.
Grooving (to cut a groove along the length of a piece of timber)	
›	Remove the hood if it is attached to the riving knife.
›	Lower or remove the riving knife.
›	Lower the blade to the depth of the groove.
›	Set the ripping fence in place.
›	Test and adjust for accuracy on a piece of scrap timber.
›	Cut the groove.
Trenching (similar operation to cutting a groove except that it is cut across the grain)	
›	Use the mitre gauge instead of the ripping fence.
Rebating (similar set up and operation to cutting a groove)	
›	Make the first cut in the narrower edge of the timber.
›	Make the second cut into the face of the timber. This will give the maximum amount of support to the material being cut.
Bevel (cutting a bevel is a ripping operation with the blade tilted to the required angle)	
›	Ensure that the blade is not going to come in contact with the fence.
›	Be aware of the position of your fingers in relation to the blade.

Bench saw maintenance

Blade maintenance	Regular maintenance
→ Keep blade sharp and free from rust.	→ Clean and lightly oil after each use.
→ Lightly oil after use.	→ Change blade when blunt.
	→ Oil adjusting screws and table slides.
	→ Apply grease to bearings if required.
	→ Check operation of the on/off and emergency buttons.
	→ Inspect electric cords and plugs for damage.

Band saw

The band saw can perform a wide range of cutting operations including straight or curved cuts in timber, plywood, hardboard, plastics, and other similar materials.w It can c¬ut timber of considerable thicknesses with minimal waste.

- → Most work is cut to pencil lines with the cut-taking place on the waste wood side of the line.
- → The band saw can also be set to make bevelled cuts of up to 45 degrees.

A band saw should not be used:

- → without the blade side guard
- → without the appropriate training
- → without PPE.

Band saw facts

Butchers use band saws because they cut through meat and large bones easily. You consist of meat and bones. Keep away from the blade!

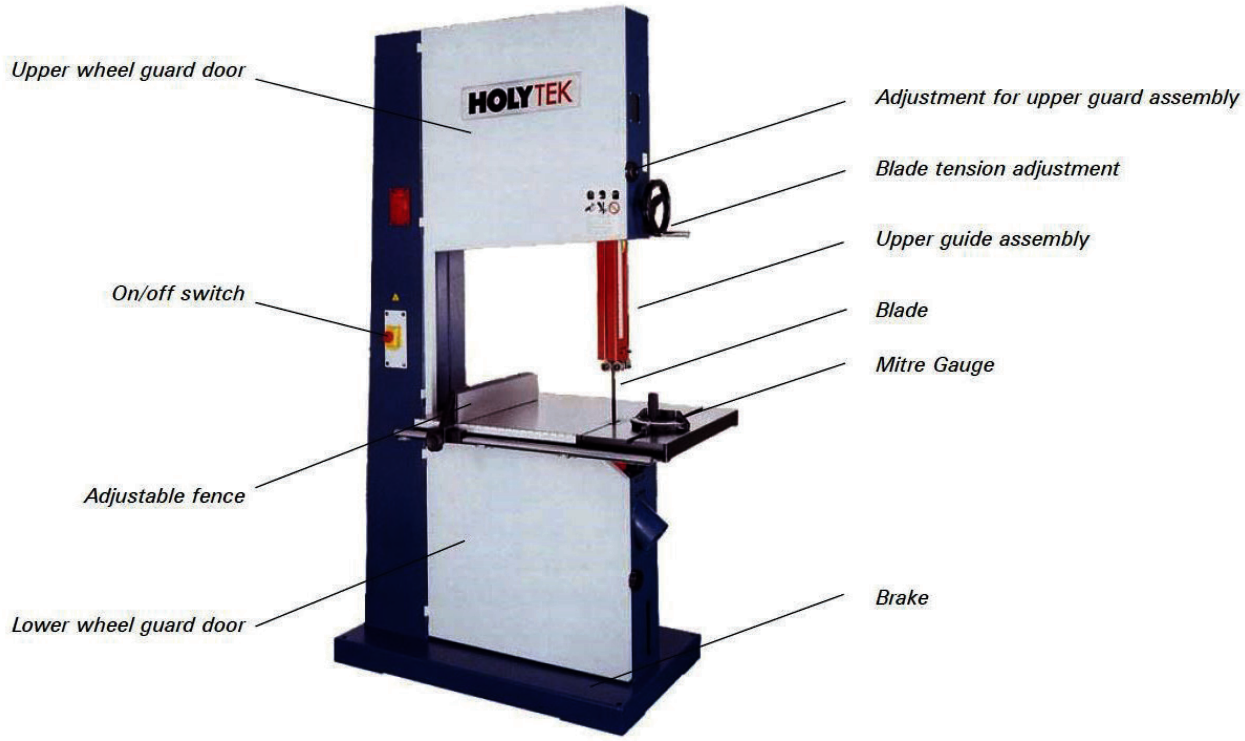
Band saw blades have the potential to break. When they do, fragments may fly off the machine, generally to the right of the saw, and can cause serious injury.

Safety

- → Clear the floor area around the band saw of all obstructions.
- → Ensure that all guards are in position and that guides are correctly set up.
- → Check that the blade is suitable for the job.
- → Check that the blade is tensioned correctly..
- → Wear your personal protective equipment (PPE).
- → Do not wear loose clothing or rings when using the saw.
- → Keep fingers clear of line of cut.
- → Do not force the timber into the blade.
- → Do not twist the blade by forcing the saw to cut tight curves.
- → Wait until the blade reaches operational speed before starting the cut. Only cut material when the blade is at full operational speed.
- → Clean the machine and clear up the work area after use.

Saws

Parts of a band saw

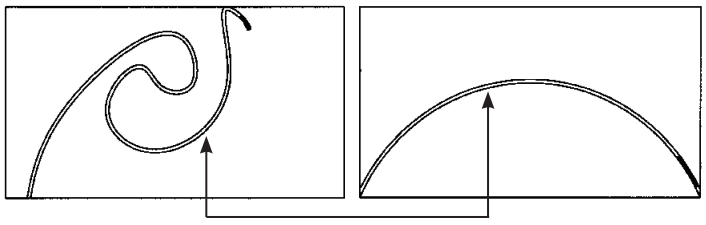


Blade

The blade is a continuous loop that revolves the two wheels. The bottom wheel is powered to drive the blade. The top wheel is free-spinning and adjustable so the tension and tracking of the blade can be controlled.

It is important to choose the correct blade for the job.

Narrow blades are suited for cutting tight curves and thin timber.



Thicker blades are suited to cutting straighter lines and thicker timber because they are stronger and less likely to break.

Path of cut

Blades that are regularly maintained and correctly used should wear out rather than break. Ensure that the blade is sharp, well set, and free from kinks and cracks.

Causes of blade breakages

- Blunt or dull blades.
- Cutting too sharp a curve or forcing the cut.
- Feeding too fast.
- Backing out of a cut.
- Upper guide set too high above the timber.
- Incorrect tensioning of the blade.
- Saws caked in gum and resins. This dulls the blade. Clean with kerosene.
- Incorrectly adjusted side guides and thrust wheel. The blade must not touch the guides and thrust wheel except when under load.

Using a band saw

First adjust the height of the upper guide to:

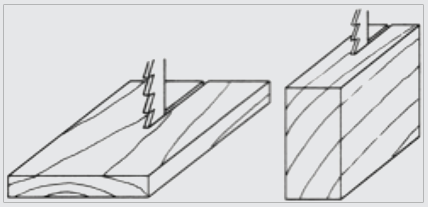
- support the blade to prevent twisting, and to help ensure an accurate cut
- protect the operator from the exposed blade
- keep the upper guide 10mm above the material.

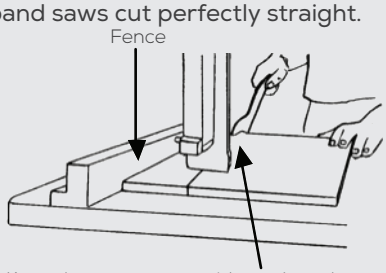
Ripping

- Ripping refers to cutting a board down to a narrower width.

Re-sawing

- Re-sawing is a term applied to the cutting of a board along its width while standing on its edge to make it thinner.
- You can re-saw using the ripping fence as a guide.
- To maintain a straight cut use a wide blade, with large teeth, that is in perfect order and tracking properly over the wheels.
- Be aware of the drift when ripping, as few band saws cut perfectly straight.





Keep the upper saw guide set just above the surface to be cut and use a push stick when working near the blade.

Bevels and angles

When ripping oblique cuts, such as bevels or large chamfers, tilt the table and use a fence on lower side of the cut.

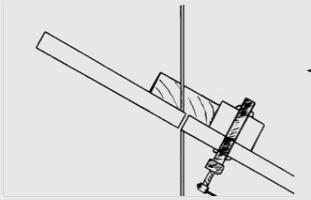
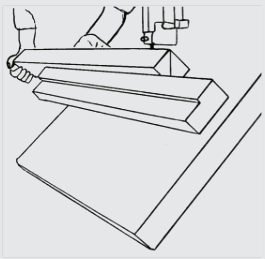


Table tilted with an improvised fence



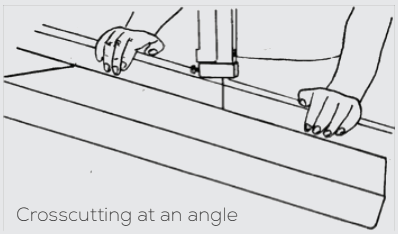
Saws

Crosscutting

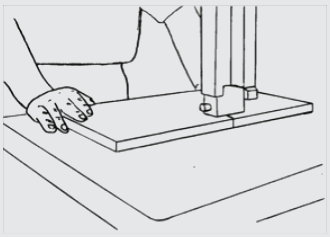
The distance from blade to band saw frame will restrict the width of timber that can be cut.

When cross cutting:

- feed the timber squarely onto the blade
- cut to the waste wood side of the line
- feed the work at a slow, even speed.



Crosscutting at an angle



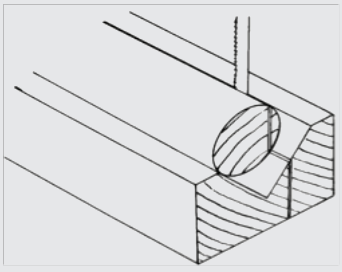
Cutting curves and circles

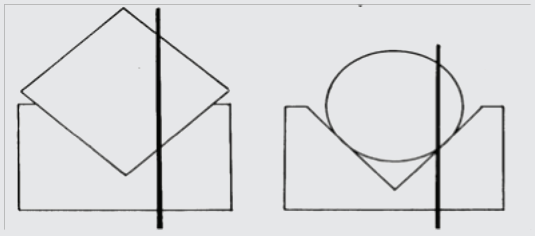
- Select the blade for the smallest curve.
- Drilling holes in the back of tight curves can help the cutting process for tight curves.
- A series of relief cuts can be made from the outside edge of the material to the curve. This method reduces tension on the blade.
- Always plan your cut so you don't have to back the blade out.

Let your teacher/tutor know if you need to back a blade out of a cut. It is unlikely you will have the expertise to do it safely.

Cutting angles and cylinders

Use vee blocks for cutting angled pieces and cylinders. This helps to keep the pieces being cut stable.





Saws

Band saw maintenance

Blade maintenance	Regular maintenance
→ Keep blade clean. → Maintain the correct blade tension. → Ensure that all the guides and thrust wheel are correctly adjusted. → Sharpen when dull or blunt.	→ Clean and lightly oil after each use. → Oil adjusting screws and table slides. → Apply grease to bearings if required. → Check operation of the on/off buttons. → Inspect electrical cords and plugs for damage.

Awatapu College student using the band saw to cut a macrocarpa slab.

Mitre and compound mitre saw

These are general purpose saws commonly used on worksites and in workshops. They are usually used for general crosscutting work. Some models have the ability to cut angles in two planes, making them an ideal saw for cutting operations and finishing work.

The saw base has a predetermined locking position at 90º and 15 steps both ways to 45º but can be locked at any position on this arc. The direction of the blade rotation is always down and away from the operator which will pull the timber hard up to the fence.

A transparent retractable lower guard encloses the lower portion of the blade. As the saw is lowered on to the work and the guard comes into contact with the timber, the guard retracts progressively allowing the blade to cut the timber.

Do not use mitre saws:

- without the appropriate training
- without PPE
- when the blade is starting up or slowing down.

Safety

- Keep the work area clean, tidy, and free of chips and off-cuts.
- Do not wear loose clothing or jewellery. Keep long hair tied back and out of the way
- Use PPE, including eye/face protection, hearing protection, dust mask, and heavy duty footwear.
- Check that the is free of nails, knots etc.
- Keep hands away from the path of the blade.
- Operate in a well lit area.

Saws

SAFELY USING A MITRE SAW	
›	Make sure that the saw is securely fixed in the correct position.
›	Make sure the table top is free of any chips and pieces of off-cut before setting up the saw.
›	Secure the work in position, make sure the material is hard up against the back fence.
	Switch on the saw, and when the blade has attained full speed, lower it onto the work.
›	When you finish the cut, release the trigger and wait for the blade to stop spinning. This will protect the cut surface from being caught by the saw teeth.
SAFELY USING THE SLIDE COMPOUND MITRE SAW	
›	Disengage the carriage securing screw and draw the saw blade fully along its slide.
›	Start the saw and wait until the blade attains full speed before fully pulling the blade along the slide.
›	When the cut is finished, release the trigger and wait for the saw to stop completely before returning it to the elevated position.

Bevel or compound cuts

A bevel cut is when the angle of the blade is other than 90° to the bed.

A compound cut is a combined mitre and bevel cut.

Mitre saw maintenance

Blade maintenance	Regular maintenance
→ Keep blade sharp and free from rust.	→ Clean and lightly oil after each use.
→ Replace blunt blades.	→ Oil adjusting screws and table slides.
→ Lightly oil after use.	→ Check operation of the on/off buttons.
	→ Inspect electric cords and plugs for damage.

Surface planer

Also known as a buzzer, this machinery is used to achieve a straight and flat surface. It performs the tasks of dressing, squaring and straightening timber.

This may include:

- straightening warped or bent timber
- planing square edges
- planing a bevelled edge
- chamfering, rebating and tapering.

Surface planers should not be used:

- for machining short lengths of timber
- without the bridge guard
- without the appropriate training
- without PPE.

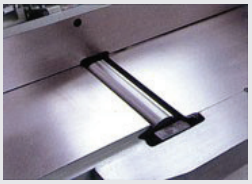
Surface planer facts

The cutter-heads and blades of this machine are exposed, which makes it potentially the most dangerous machine in the workshop.

It will plane fingers just as quickly and completely as any piece of timber.

If it is on and you are not using it **stay well away.**

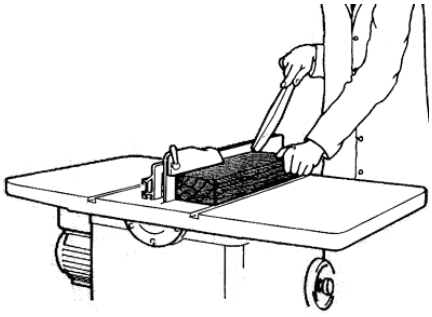
You need to know about surface planers but, in almost all cases, only your teacher/tutor can demonstrate its use.



The exposed cutter heads

Safety

- Ensure that all guards are used correctly and adjusted when necessary.
- Wear the appropriate personal protective equipment (PPE).
- Keep your hands clear of the cutter heads.
- Only plane timber longer than 300mm.
- Ensure that the timber is free from nails, screws, stones and other hard materials.
- Clean the machine and clear up the work area after use.



AND Always use a push stick

Machining technique tips

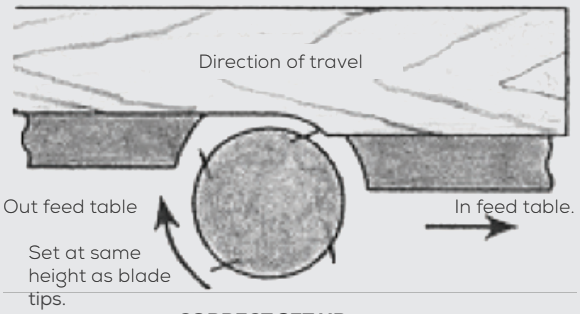
The operator feeding the material into the machine controls the rate of cut.

Machine marks or ripples occur because the timber is being fed into the machine too fast.

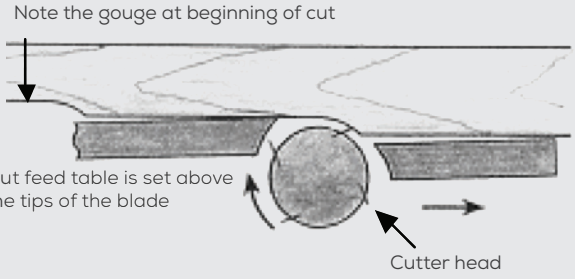
- → Use a push stick to keep hands clear of the blades.
- → Use a push plate when dressing the faces of timber near the blade.
- → Apply downward pressure over the out-feed table so that the in-feed table can control the depth of cut.

To achieve the smoothest finish possible:

- → ensure that the rear out feed table is exactly level with the tips of the blades
- → ensure that the blades are running at full speed before commencing the cut
- → work with the grain
- → take light cuts, i.e. thin shavings
- → maintain a steady feed rate.



CORRECT SET UP



INCORRECT SET UP

Using a surface planer

Surfacing or flattening – to dress a flat face on a board.

- → Position the fence to allow full width of timber to pass over cutter head.
- → Set the guard for the timber to pass underneath.
- → If the timber is warped, plane the hollow side first.

Surface planer

Edging – to square the edge of a board.

- → Set cover guard allowing clearance for the timber to pass between guard and fence.
- → Keep the flat face of the board firmly against the fence.
- → Keeping your hands well clear of the cutters, push the board over the cutter head.

Bevelling or chamfering – similar to edging but the cut is on an angle.

- → Set the fence to the required angle.
- → Ensure the work is held firmly against the fence.

Rebating

- → Lower in-feed (front) table to the required depth.
- → Set fence to required width of cut.
- → With large or deep rebates make several passes until the full depth has been cut.

Tapering – to make one end narrower than the other.

- → Lower in-feed table to depth required for the taper (i.e. lower by the amount of timber to be removed from the thin end).
- → Fix a stop to the in-feed table to help prevent kickback.
- → First place the timber against the stop, then lower onto the cutter head.
- → Hold the timber firmly and push forward using a push-block.

Maintenance

Surface planer maintenance
→ Regularly inspect the cutter head to check that the blades are sharp and secure. Replace blunt or damaged blades.
→ Clean and lightly oil after each use.
→ Oil adjusting screws and table slides.
→ Apply grease to bearings if required.
→ Check operation of the on/off and emergency buttons.
→ Inspect electric cords and plugs for damage.

Thicknesser

Also known as a panel planer, the thicknesser is used to reduce the thickness of timber and to plane wide panels to a uniform thickness.

It is designed to produce a parallel cut between two surfaces of the timber and, therefore, cannot be used to straighten a warped or twisted board. If the board is warped or twisted, first plane it to a flat, straight face on the surface planer.

Thicknessers should not be used:

- for machining short lengths of timber
- without the appropriate training
- without PPE.

Thicknesser facts

The thicknesser is a self-feeding machine with the potential to catch your clothing or fingers in the rollers and drag you into the rotating blades.

Always stand to the side of the machine. Use safety goggles and face protection. The blades can spit bits and pieces out at high speed.

You need to know about thicknessers but, in almost all cases, only your teacher/ tutor can demonstrate its use.

Safety

- Wear the appropriate personal protective equipment (PPE).
- Always keep your hands clear of the in-feed rollers.
- Keep your hands to the side of the board – never on top.
- Stand to one side of the timber being planed.
- Only feed into the machine timber that is at least the minimum length recommended by the machine's manufacturer. Check the manufacturer's instructions.
- Clean the machine and clear up the work area after use.

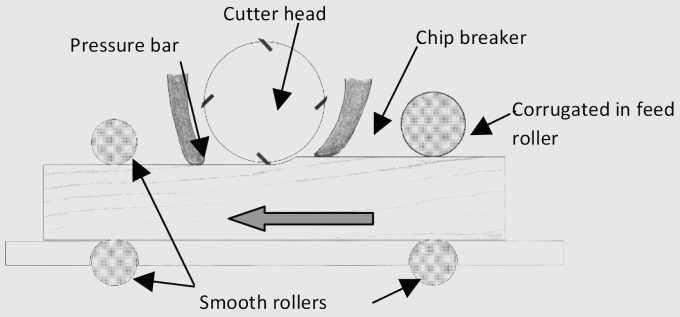
Thicknesser

How thicknessers work

The timber is gripped between an upper corrugated in-feed roller and a smooth lower in-feed roller and drawn into the machine at an even speed.

The timber passes under a cutter head, which planes the upper surface of the timber. A pressure bar and a chip breaker help to ensure that the cut is clean and parallel to the opposite side of the board.

The out feed rollers help to remove the timber from the machine. Anti-kickback devices prevent the work from being thrown back at the operator.



SAFELY USING A THICKNESSER	
›	Set the thicknesser to produce a fine cut, (1 to 2 mm less than the thickest portion of the timber).
›	Avoid thicker cuts that will place undue strain on the motor.
›	Feed the timber into the machine with the grain facing back towards the operator.

A combination of surface planer, thicknesser and circular saw can be required for square dressing. Square dressing is the process of dressing (planing) a flat face and square edges on the surface planer. The thicknesser is then used to create a parallel face. The circular saw may be required to create a parallel edge for wider timber.

Your teacher/tutor will talk you through how to do this if it's needed for your project.

Maintenance

Thicknesser maintenance

- Regularly inspect the cutter head to check that the blades are sharp and secure. Replace blunt or damaged blades.
- Clean and lightly oil after each use.
- Oil adjusting screws and table slides.
- Apply grease to bearings if required.
- Check operation of the on/off buttons.
- Inspect electric cords and plugs for damage.

Vertical drill press

The vertical drill press is used to accurately drill holes. It may be bench mounted or a freestanding pedestal type.

Safety

- Always wear eye protection when using the machine.
- Ensure that all guards are in place and that no pulley belts are exposed.
- Isolate the machine from the power supply before making any adjustments. This means turn the power off and unplug the machine.
- Never try to stop the machine by grabbing the spinning chuck.
- When drilling deep holes, back out often to clean out the hole.
- Never use a hand auger bit in a drill press – use round shank drill bits.
- Hold small pieces of work with a clamp.
- Make sure the bit is tight in the chuck.
- Always remove the chuck key before switching the drill on.

The drill press should not be used:

- without the appropriate training
- without PPE.

Preparing material for drilling

- Always put where the hole is to be drilled directly under the bit.
- Put a piece of waste wood under the piece being drilled to prevent the timber breaking out at the back.
- The depth stop can be set to regulate the depth of the hole. If no depth stop is fitted, lower the table to suit.
- Smaller objects and materials must be clamped to a stable platform.
- Longer objects must have their longest length to the left of the operator.
- Select and use the correct type of drill for the task.

Drill bits

There are several drill bits to choose from. Which one is best for your task depends on what material you're drilling and the type and size of hole you need.

Standard twist drill bit. These are usually made of high-speed steel (HSS). This type of drill is suited for use with steels and plastics. The smaller diameter drills are commonly used to drill fine holes in timber, such as pilot holes for screws. These drills are often reground to provide a sharper point.

Brad or spur bit. These are recommended for drilling holes in timber, e.g. dowelling. Brad bits improve accuracy because they are easy to establish in the start position, will self-centre, and do not wander when the drilling starts. The spurs will also scribe the timber around the outer edge of the hole ensuring a cleaner cut.

Combination auger bit. The screw point allows for an accurate start to drilling while the wide edge of this drill's twist helps to maintain direction, especially for deeper holes or holes at an angle. The open spiral allows the fast removal of shavings.

Flat or spade bit. These are commonly used to drill larger diameter holes. They are relatively inexpensive and quite versatile.

Forstner bits. Holes drilled with a forstner bit are clean, accurate and flat-bottomed. The drill is guided by its rim and can be used to bore half a hole, on the edge of a board, or overlapping holes. These bits are unaffected by grain, knots or defects in the timber. A saw tooth bit, with a cutting edge and saw teeth around the rim, are useful for drilling end-grain and thin timber.

Countersink/counter bore set. These bits are used to drill a pilot hole and countersink, or counter bore hole, in one operation. The adjustable stop collar allows for variation in the depth of the hole.

Hole saw. Used to drill holes through a range of materials, including plastics and steel. They are can be purchased individually or in sets. Care must be taken to prevent them from overheating during use.

Caring for drill bits

Remember to:

- keep them sharp and free from rust.
- store them separately in a rack or container.

Horizontal boring machine

Horizontal boring machines are sometimes called a dowel borer. They have a revolving chuck, which holds the drill bit, and an adjustable table.

The horizontal borer is used for boring holes for:

- dowelled joints, in carcass construction
- widening joints
- rails and stiles of doors and general framed joints.

The horizontal boring should not be used:

- without the appropriate training
- without PPE
- without guards.

Safety

- Always wear eye protection when operating the machine.
- Ensure that all guards are in place and that no pulley belts are exposed.
- Isolate the machine from the power supply before making any adjustments.
- Never try to stop the machine by grabbing the spinning chuck.
- On deep holes, back out often to clean out the hole.
- Never use a hand auger bit in a drill press – use round shank drill bits.
- Clamp small material firmly to the table.
- Make sure the bit is tight in the chuck.
- Always remove the chuck key before switching the machine on.
- Tie long hair back or use a hairnet. Don't let jewellery or hoodie strings dangle.
- If the machine is fitted with a hydraulic ram to hold the material in position, ensure the guard is fitted and adjusted to the correct height.

Using a horizontal boring machine

Make sure the drill bit is held firmly in the chuck and the chuck key is removed.

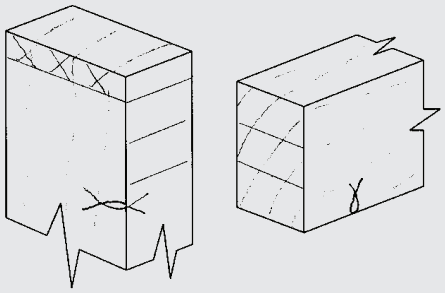
Check that chuck guards are in place.

To centre the bit:

1. Place the work face side down on the table.
2. Push work gently against the drill bit to make a small indentation.
3. Turn the work over and push the work gently against the drill bit to make a second indentation in line with the first. This will indicate the centre of the work.
4. Adjust the table until the drill bit is directly between the two marks.

To mark out and bore the work:

1. Identify and mark out the face side and face edge.
2. Mark position of dowel holes. Note: centre line for the dowel position is not required.
3. Place the work face down on the table and adjust the stop gauge to regulate the depth of the hole.
4. Check that the bit is centred on the work. Clamp small material firmly to the table.
5. Start the machine and bore the holes.



The correct marking out procedures for a dowelled joint between a stile and rail

Note: The timber must be held down firmly, face side down, for the entire drilling operation. Any movement will cause the hole to be bored off centre, resulting in an uneven joint. Remember to use cramps for smaller pieces.

Maintenance

Horizontal boring machine maintenance

- Keep bits sharp and free from rust.
- Store bits separately in a rack or container.
- Clean and lightly oil machine after each use.
- Oil adjusting screws and table slides.
- Apply grease to bearings if required.
- Check operation of the on/off and emergency buttons.
- Inspect electrical cords and plugs for damage regularly.

Sanders

Bench mounted disc or belt sanders are used for shaping components and sanding end grain. They can also assist with the finishing of small work pieces. Bobin sanders are suited for finishing curved and intricate surfaces.

Disc sander

Combination belt and disc sander

Bobbin sander

Belt sanders

Safety

Awatapu College student using a flat-bed sander.

- Adjust the work rests so there is minimum clearance between the belt and the rest.
- Secure the work rest properly.
- Install abrasive belts that are the same width as the pulley drum.
- Hold small or thin pieces of stock in a jig or holding device to prevent injuries to the fingers or hands.
- Use a suitable dust extraction system during the sanding process.
- Wear eye & respiratory protection during machine operation.
- Ensure that the work is securely positioned against the cross fence or table before the work comes in contact with the abrasive belt or disc.
- Make sure the bit is tight in the chuck.
- Always remove the chuck key before turning the machine on.
- If the machine is fitted with a hydraulic ram to hold the material in position, ensure the guard is fitted and adjusted to the correct height.
- Tie long hair back or use a hairnet. Don't let jewellery or hoodie strings dangle.

Grinders

Bench grinder

The bench grinder is used for grinding steel cutting tools to repair damaged cutting edges.

Bench grinders are usually double ended, with abrasive wheels fitted on both ends of the spindle. A coarse grit wheel for rough grinding is mounted on one end of the spindle and a fine grit wheel for finishing is mounted on the other.

They are used primarily for sharpening cutting tools such as:

- hand tools – planes, chisels etc.
- twist drills
- hand-held construction equipment.

They can also be used for removing excess metal or material and for rough shaping of parts.

The bench grinder should not be used:

- without the appropriate training
- without PPE
- when grinding wheel is starting up or slowing down.

SAFELY USING A BENCH GRINDER	
›	Always wear eye protection when working on or near a grinder.
›	Always allow the bench grinder to reach full operating speed before starting the grinding process.
›	Only use this machine as its manufacturer intended.
›	Do not wear jewellery, gloves, loose clothing or items that could catch on the wheel and cause injury to the operator. Tie long hair back and make sure hoodie strings are tucked away.
›	Before starting work, check that the grinder is firmly fixed to the bench, there are no chips or cracks in the wheels, and that the wheels are securely attached to the machine.
›	Ensure that all guards and guides are in place and the transparent safety shield is set in the correct position.
›	Only grind steel. Other materials will clog up the wheel, which can cause it to explode.
›	Do not use the side of the wheel. It could shatter.
›	Keep the adjustable work rest within 2mm of the wheel.
›	Make a habit of standing to one side of the grinder when starting the machine and until it has reached its full operating speed.

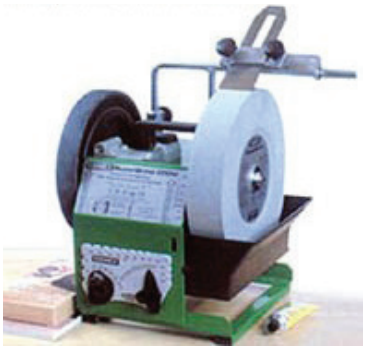
Bench grinder maintenance

- Regularly check the wheels for chips and cracks. Replace if damaged.
- Use a wheel dresser if the wheel becomes clogged or smooth.
- Check operation of the on/off buttons.
- Inspect electric cords and plugs for damage.

Motorised whetstone

This is a slow turning motorised stone that is lubricated by water to reduce overheating. The water also helps to maintain a clean cutting surface.

It is slower cutting than a bench grinder but safer and easier to use. Your teacher/tutor will talk you through how to use it safely if you have one in your workshop.



Wood lathe

The wood-turning lathe is a machine that provides excellent opportunities for the operator to craft a range of turned items.

The wood lathe can be used for:

- spindle turning, e.g. table legs turned between centres. The distance between the headstock and tailstock governs the maximum length that can be turned
- faceplate turning e.g. bowls. The distance between the centre of headstock spindle and the bed governs the maximum diameter that can be turned.

Lathe work requires tools specifically constructed to withstand vibration and the forces applied to them during turning operations. They come in a range of shapes to suit particular turning operations and have long handles and blades to give the operator leverage and control.

To gain maximum leverage when using a wood-turning chisel or gouge, hold the tool with one hand firmly at the end of the handle and the other just behind the blade while bracing it against your body for extra support.

Safety

- Never wear ties, rings, long hair or loose clothing when using a lathe.
- Isolate the machine from the power while setting it up.
- Clear the area around the lathe of hazards such as power leads, timber off-cuts, and excessive build-up of shavings.
- Maintain adequate ventilation around the work area.
- Turn on dust extraction fans to remove dust and waste.
- Only use materials that are straight grained, free from splits, cracks, knots and defects.
- Inspect turning tools for:
  - split handles
  - loose blades
  - blunt or chipped cutting edges.

Wood lathe

SAFELY USING A WOOD LATHE	
›	Select the correct speed for the work to be turned.
›	Ensure the work is fixed securely to the face plate or between centres.
›	Rotate the work slowly to ensure that it clears the lathe bed and the tool rest.
›	Regularly adjust the position of the tool rest as the timber is removed.
›	Use only the specially-designed gouges. They are fitted with extra-long handles designed to counteract the pull of the revolving timber.
›	Return tools to the tool tray.

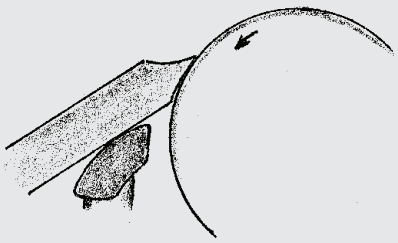
Turning methods

There are two methods for using wood lathes.

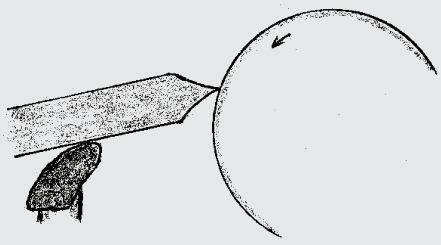
1. The 'cutting method' is a fast method that produces a clean, smooth surface but requires considerable practice and skill. Professional wood-turners use this method for most cuts.

   All flat and round surfaces are produced with the skew chisel and all hollows with the gouge. The resulting surfaces require little sanding as a slicing cut along the grain is used.
2. The 'scraping method' is slower than cutting, but easier to learn and carry out. Flat and round surfaces can be produced with a scraping action, but scraping will not give a smooth, clean finish and, therefore, requires more sanding.

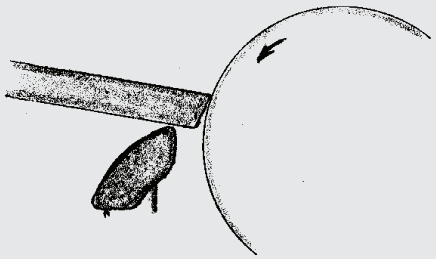
Cutting techniques



Chisel correctly set up for a clean **cutting** action. Note the bevel supporting the cutting edge. Tool rest is approximately 5mm from the work.



The tool rest is too far from the work for an effective cutting angle or control of the chisel. This is likely to cause a chattering effect on the cut surface, and increases the likelihood of a dig in occurring.



Scraping action – blade set just above centre line of work.

As the work progresses, move the tool-rest closer to the work.

Sanding the work

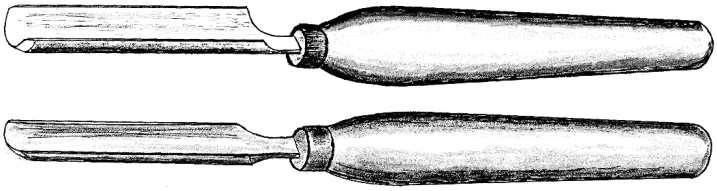
→ Set up and use the extraction system.

→ Remove the tool rest to avoid the possibility of fingers becoming jammed between the tool rest and the rotating timber.

Hand tools for use with the wood lathe

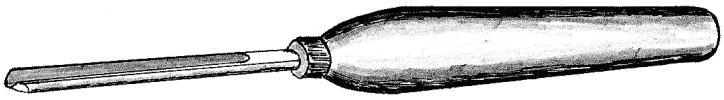
Roughing out gouge.

These are used for initial cuts to form a cylinder.



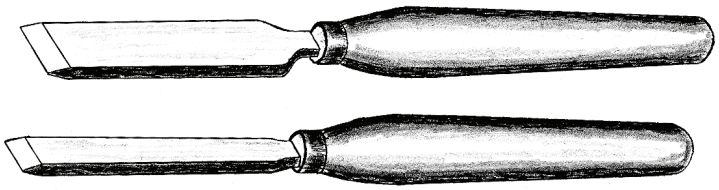
Spindle turning gouge.

This is used for turning knobs, coves and other rounded shapes.
They differ from bowl turning gouges in that they are less deeply fluted.



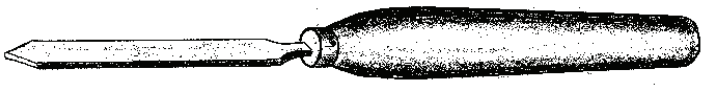
Bowl gouges

have a deep flute for easier cutting in confined spaces.



Skew chisels

have wider blades used for long, straight, flattening cuts. The narrower bladed chisel is used for shallow curves and fine beads.

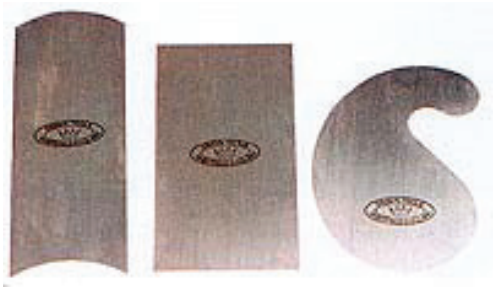


Parting tools

are used to square off the ends of turned work and for removing the work from the lathe (parting off).

Scrapers

are an easy tool to use allowing a high degree of accuracy. They give a slower and rougher cut than a gouge and more sanding is generally needed.



Maintenance

Wood lathe maintenance	Hand tools maintenance
→ Clean and lightly oil bed after each use. → Apply grease to bearings if required. → Check operation of the on/off buttons. → Inspect electrical cords and plugs for damage.	→ Regularly inspect handles for splits. → Regularly check for loose blades and blunt or chipped cutting edges. → Keep sharp and free of rust. → Clean and lightly oil after each use.

CNC machines

A CNC (computer numerically controlled) router is a computer-controlled router machine that is capable of cutting out, drilling, and carving/ etching objects or images into the face of a piece of material.

CNC routers are used to shape or grind a wide range of materials used in building and construction including, wood, plywood, MDF, aluminum, and composites.

They are mainly used to produce mass production items. Their main advantage is that, once programmed, they can produce as many items as required that are all dimensionally correct.

A stone CNC router is a type of CNC router machine designed for marble, granite, ceramic tiles, glass machining, and polishing. Because stone dust is very abrasive, these routers also have much better protection for the guide rails. With "wood" routers the guide rails are often visible from the outside and unprotected, while stone routers' guide rails are fully covered.

Unlike wood routers, stone routers also have a water recirculation system. A small jet of water is pointed at the router bit and this captures almost all fine stone dust in the water. This then flows to a collection reservoir where the stone particles settle on the bottom.

Other CNC machines include mills for finishing aluminium products, table saws and specialist water cooled bridge saw for cutting granite, marble and stone.

CNC milling machine (left)

CNC water cooled bridge saw (right)

CNC table saw (below)

CNC router bits

Specialised CNC router bits are available to cut and shape a wide range of materials such as marble, granite, stone and concrete. It is important to note these bits are only to be used in the CNC machined designed for the material. They should not be used on other materials as the router bit will be damaged.

The range is too extensive to include all examples of CNC router bits available. Below is a small selection of the type used in industry. You can find others by visiting a local supplier or searching on the internet.

Electroplated router bit for ceramics

Electroplated flat router bit for cutting marble

Incremental stepped bit for cutting granite

IMPORTANT

ONLY use a CNC router once a teacher/ tutor has instructed you in its safe use and operation and has given permission.

CNC machines

SAFELY USING A CNC ROUTER	
Pre-operational safety checks	
›	Ensure you are familiar with CNC 'nesting' and 'tool-pathing' software functionality.
›	Locate and ensure you are familiar with the operation of the ON/OFF and emergency stop controls.
›	Ensure that the guard door and safety devices are in position and secured.
›	Only machine materials that are suitable for the routing process.
›	Ensure that the router cutting bit size conforms to specifications.
›	Isolate the machine from its power source before making any adjustments to the cutter head or tool array.
›	Ensure all cutters are sharp and free of resin build-up or wear.
›	Adjust the waste collector shroud and coolant system correctly for maximum efficiency.
›	Be aware of anyone else in the immediate vicinity. Make sure no one else is near the machine before using it.
›	Familiarise yourself with all electrical and mechanical operations and controls, including any handheld keypad interface remote control.
Operational safety checks	
›	Wear PPE, including safety glasses and ear muffs.
›	Never attempt to program a CNC machine without proper training.
›	Never pre-program any CNC router to perform operations beyond the capacity of the machine.
›	Confirm all CNC programming instructions for the router. This may be completed as a free air run. A 'free air run' has no material placed on the bed to the router.
›	Ensure the work piece is securely held flat to the vacuum pads, glued, or clamped within the machine.
›	Ensure that the tool bit array tracking remains unobstructed during the routing operation.
›	Never leave the CNC router in operational mode while unattended.
›	Isolate the CNC router from the power source when the job's completed.

CNC router care and maintenance

- → Check CNC cutter tools are in good condition before and after cutting.
- → Ensure the water in the cooling system is kept clean and topped up.
- → Every time a job is completed, sweep and clean the table. Vacuum or blow away the dust on the machine with an air gun.
- → Regularly lubricate all moving parts to allow the machine to function properly and prevent premature wear.

Summary

Fixed machines are widely used in the construction industry. Use extreme care and appropriate PPE at all times to avoid injuring yourself or others.

Safe use of fixed machines

Always:

- Use only machines which you have been trained and have permission to use.
- Wear appropriate PPE.
- Always operate machines in well lit, clean areas.
- Read and follow the manufacturers' instructions before use.
- Check the position and secure all safety guards before starting work.
- Before starting the machine, isolate it and turn the blade or cutting head by hand to check for smooth operation.
- Check the electricity supply and that electrical leads have current inspection tags.
- Stand to one side of the machine when starting it.
- The stop button must work and be within easy reach of the operator. (The stop button must be a raised mushroom shape and coloured red to make it easier to see and use in an emergency.)
- If you feel you need to force material through the machine, stop. Ask your teacher/tutor for help.
- Switch off machines before making any adjustments or to remove waste.
- Switch the machine off before leaving the work station.
- Follow the manufacturers' instructions when changing blades or cutting knives.
- Keep the surrounding work area clear of scraps and off cuts.
- Give the machine your undivided attention at all times. Do not allow yourself to get distracted.

Summary

Tool care and maintenance

- Good workmanship is impossible with machine tools that are blunt, dirty or rusty, or have broken fittings and handles. If you find any damaged or faulty machinery, tell your teacher/tutor.
- Cutting blades must always be kept sharp and in good condition.
- Rub metal components with light machine oil to prevent rust.
- Ensure the material is free of any fasteners, such as nails, before machining.
- Make a habit of checking that all machines are cleaned down at the end of your lesson.