

National Certificate in Building, Construction and Allied Trades Skills (BCATS)

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

Unit Standard – 24351

Level 2, Credit 6

Name: _____





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What you need to do

By the end of this module, you should be able to:

- describe how to safely set up and operate the following fixed machinery – thicknesser (panel planer), band saw, bench grinder, drill press, horizontal borer, compound mitre saw, wood lathe, surface planer (buzzer), bench saw,;
- set up and use **four** types of fixed machinery; and
- describe how to maintain fixed machinery.

How you will be assessed

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

To achieve this unit standard, you need to complete 2 BCATS projects where you can set up and use four types of fixed machinery. Your teacher/tutor will tell you which projects to complete.

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

- describe what machinery can and cannot be used for;
- describe how to set up and use machinery and how to do this safely;
- set up and use the machinery correctly and safely to produce accurate work;
- clean and clear the machines and work area after use;
- describe how to maintain cutting edges, saw teeth or grinder wheels; and
- describe how fixed machinery should be maintained.

Your teacher/tutor will give you an Assessment Record Sheet for Fixed Machinery so you can record the machinery you use on your projects, how you use it correctly, safely and how you maintain it. Photographs may be taken to verify your learning.

Your teacher/tutor will also give you a worksheet that you need to complete, which your teacher/tutor will mark.



Important note: Failure to handle, use or care for fixed machinery in a safe and proper manner will result in not achieving this unit.:

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
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.

Term	Meaning
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.

Safety

Responsibilities and the Health & Safety Act

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 employer can be prosecuted.

Personal protective equipment and clothing

Personal protective equipment (PPE) and clothing will vary greatly from job to job. It is often dependent upon the types of hazards that will be encountered.

Whatever the type of PPE and clothing required:

- keep it readily available;
- wear it whenever necessary; and
- keep it in good order and condition.

Today's standards for PPE and clothing are high. Responsible manufacturers usually meet specifications issued by Standards New Zealand. Where Standards New Zealand has approved the product, it will be identified with the standards certification mark.

Employers should provide (or ensure the employee has) the right PPE and clothing necessary for each job. An employee is obliged to wear the PPE and clothing that are provided, when necessary.

Hearing protection

High noise levels for even a short period can damage hearing, as can long exposure to moderate noise levels.

There are different grades of hearing protection available for a different noise level. Use the grade suitable for the work and wear it whenever the noise level requires it.



Eye protection

It can take just one eye injury to blind a person for life.

Welding flash, flying sparks, wood dust and splinters, chemical splashes, dust, concrete chips and steel splinters, are some of the common causes of eye injury.

The need to wear eye protection may not always seem obvious. For example a person grinding steel would know to wear eye protection. However, anyone working near the grinder should also wear eye protection because it is impossible to predict where projectiles will hit.



Respiratory protection

The inhalation of fumes, vapours and dust can be avoided with an appropriate respirator or dust mask.

The type of protection required depends on the type of work being undertaken.

For simple tasks of short duration a dust mask may be suitable. However, for toxic vapours or long exposures to high dust levels, an air supplied breathing apparatus should be used.



It is important to remember that the lungs and respiratory system can be damage equally by long exposure to seemingly harmless dust or by short exposure to a chemical.

Working outside does not lower the risk.

Safety footwear

Suitable footwear for the type of work is necessary when working with machinery. In most situations, this means safety boots or shoes (steel caps). Good robust footwear will provide a good footing and save possible slipping injuries. It will also protect the feet from falling objects and objects penetrating through the sole of the shoe.



Fixed machinery

Most school and provider workshops have a range of fixed machinery for cutting and shaping operations. The majority of these machines are similar to those in current use in industry. It is important for students and trainees to fully understand how they work, their use, and how to operate them correctly and safely.



All machines are potentially hazardous:

Each individual machine has operating procedures and safety practices that must be followed.

*In some cases the safety requirements are such that **only a teacher or tutor can use some of the machinery addressed in this module.***

Machine safety

Action	Hazards and rationale
Tie back long hair back	Long hair can get caught up in moving machinery. This can result in: <ul style="list-style-type: none"> the operator's hair being ripped out; or the operator's face being dragged into the machine.
Do not wear loose clothing, scarves, ties, etc.	Ties, scarves, or loose clothing can get caught up in machinery. This can result in: <ul style="list-style-type: none"> the operator being dragged into the machine; 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.
Do not wear rings	Rings can get caught in the blade or crushed in machinery. This usually results in the loss of the operator's finger.
Do not wear gloves 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 be lethal.
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.

Safe machine operation

High-speed machinery can cause serious injury if incorrectly used. The following safety rules must be observed for safe machine operation:

- Always operate machines in well lit, clean areas.
- Use only machines which you have been trained and authorised to use.
- Read and follow the manufacturers' instructions before use.
- Check the position and secure all safety guards before starting work.
- Before starting the machine, turn the blade or cutting head by hand to check for smooth operation.
- Check the electricity supply. (Use an isolating transformer or residual current device (RCD). Check electrical leads have current inspection tags.)
- Stand to one side of the machine when starting it.
- The stop button must operate efficiently and be within easy reach of the operator. (The stop button must be a raised mushroom shape and coloured red, to allow quick recognition and access in the case of an emergency.)
- Switch off machine to make any adjustments or to remove waste.
- Do not leave any machine running while unattended.
- 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.

Bench Saw

Also known as circular saw, dimensional saw and saw bench.

The circular saw bench is one of the most useful machines in the workshop. It is 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.

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

Safe use

- Make sure that all guards are set up in the correct manner.
- Make sure that the fence is parallel to the blade and correctly secured in position.
- Watch your fingers. Keep them away from the blade.
- Keep the saw bench clear of sawdust and off-cuts.
- Never attempt freehand cuts on the circular saw.
- 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.
- Never clear scraps of timber off the saw table with your fingers, use a stick.

Bench saw facts

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 fingers.

Statistically, more people are hurt by timber flying off the circular saw than by being cut by the blade.

An incorrectly set up saw can:

propel pieces of timber off at high speed; or

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, resulting in the timber flying off the saw.

If the revolving blade catches on clothing or hair, the person can be instantly dragged into the blade resulting in serious injuries.

However, if you are aware of the hazards and use the correct operating procedures, it is a convenient and safe machine to operate.

If you are not the machine operator, KEEP AWAY from the bench saw when it is in use.

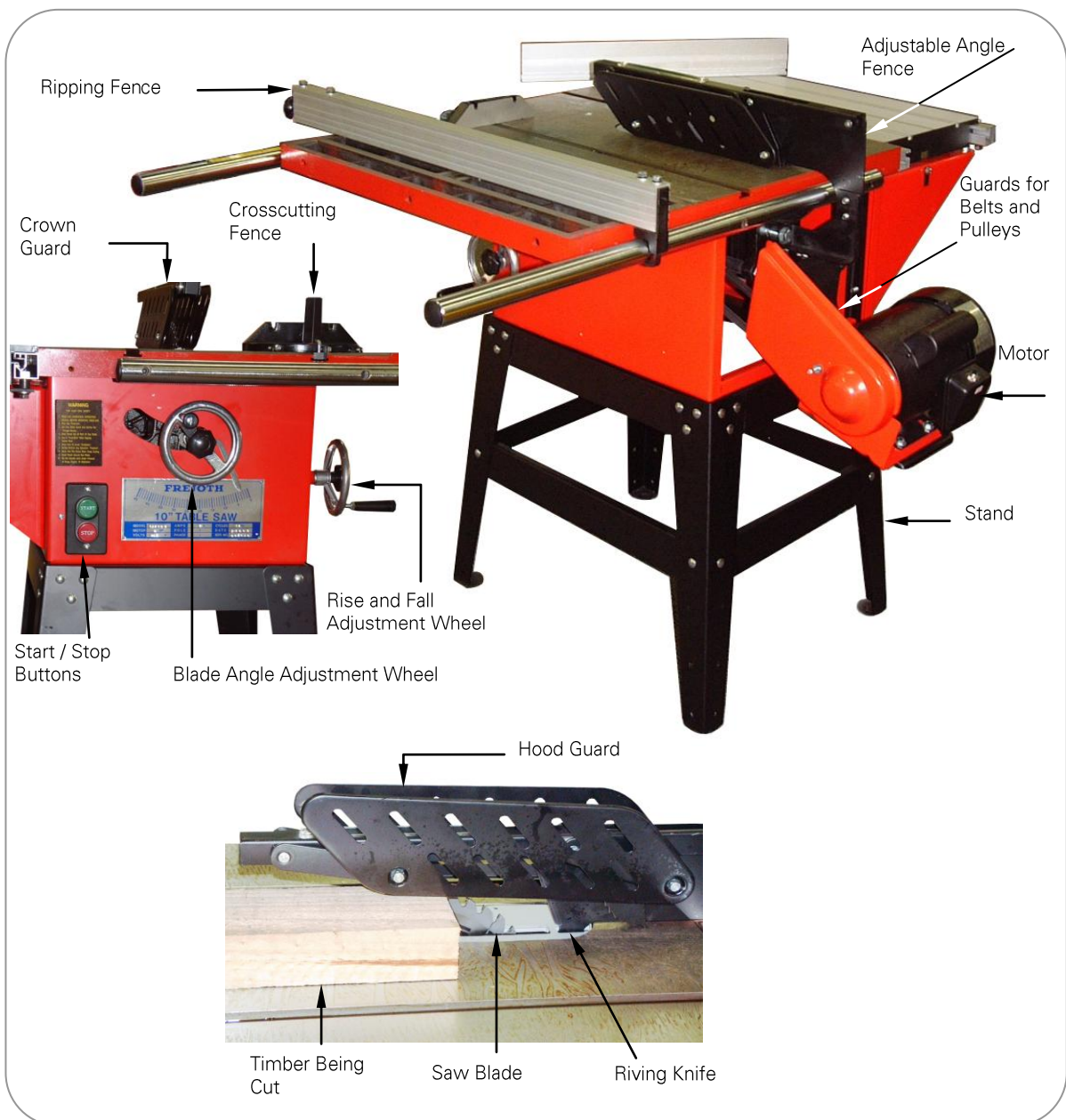
Parts of a circular saw bench

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.



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.

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.

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.

Operations

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.

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, as this may 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.

The second cut is made 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 over 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.

When a bench saw should not be used

Surface planers should not be used:

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

Blade maintenance

- Keep blade sharp and free from rust.
- Lightly oil after use.

Regular maintenance

- Clean and lightly oil after each use.
- Change blade when blunt.
- 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.



Activity 1

Identify the parts of the saw:

- Mitre fence
- Ripping fence
- On/off switch
- Blade
- Hood guard



The machine is to be isolated from the mains power supply before making any alterations.

Working in small groups and using the machine in the school workshop, complete the following activities:

1. Identify and describe function of the parts from question 1.
2. Set the ripping fence to rip a 60mm strip of wood. (Accurate to +/- 1mm.)
3. Set the saw to rip a 60 degree bevel.
4. Set the saw to cut a 45 degree mitre using the mitre fence.
5. Set the saw to cut a 6mm deep groove for a drawer bottom.
6. Demonstrate the safe set up of how to use the ripping fence as a guide when crosscutting a number of pieces to the same length.
7. Demonstrate the changing of a circular saw blade (refer to picture below).



Surface Planer

Also known as a buzzer and 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; and
- chamfering, rebating and tapering.



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**.*

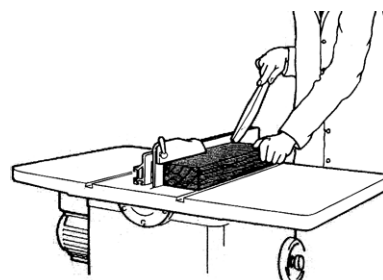
You need to know about surface planers but, in almost all cases, only your teacher/tutor can demonstrate its use.



The exposed cutter heads

Safety

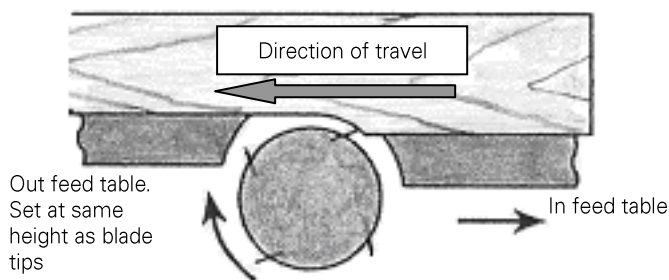
- Ensure that all guards are used correctly and adjusted when necessary.
- Wear the appropriate personal protective equipment (PPE).
- Keep your hands clear of the cutter heads.
- Do not plane short lengths of timber, less than 300mm.
- Do not plane thin timber.
- Do not make deep cuts.
- Ensure that the timber is free from nails, screws, stones and other hard materials.
- Always use a push stick.
- Clean the machine and clear up the work area after use.



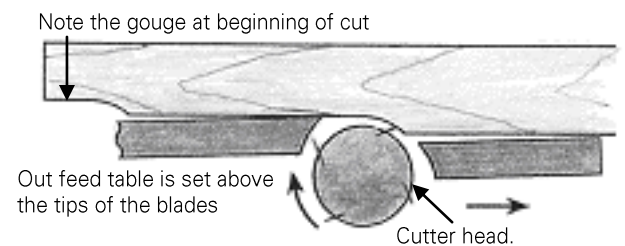
Using the surface planer

To achieve a smoother finish:

- 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; and
- maintain a steady feed rate.



Correct set up



Incorrect set up

Machining techniques

- 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.
- 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.

When surface planer should not be used

Surface planers should not be used:

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

Surface planer operations

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.



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.

Cutter head maintenance

Regularly inspect the cutter head to check that the blades are sharp and secure. Replace blunt or damaged blades.

Regular maintenance

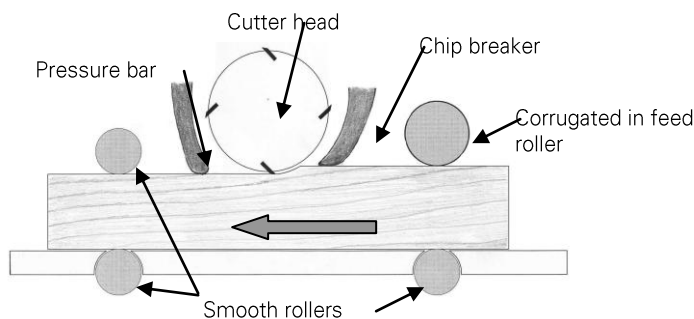
- Clean and lightly oil after each use.
- Oil adjusting screws and table slides.
- Apply grease to bearings if required.
- Check operation of the on/off buttons.
- Inspect electric cords and plugs for damage.

Thickener

Also known as a panel planer, the thickener 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.



Thickener facts

The thickener 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 and never look directly into it when it is being used. The blades can spit bits and pieces out at high speed.

You need to know about bench saws 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.
- Do not feed into the machine timber shorter than the minimum length recommended by the machine's manufacturer.
- Clean the machine and clear up the work area after use.

Thicknesser operation

- 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.

Using the thicknesser

- Set 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, which 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.

When thicknessers should not be used

Thicknessers should not be used:

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

Cutter head maintenance

Regularly inspect the cutter head to check that the blades are sharp and secure. Replace blunt or damaged blades.

Regular maintenance

- 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.



Band Saw

The band saw is a versatile machine that will perform a wide range of cutting operations including: straight or curved cuts in timber, plywood, hardboard, plastics, or other similar materials. It can cut 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.



Band saw facts

Butchers use band saws to easily cut through meat and large bones. It will work just as well on your fingers.

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 may 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 and the guides are correctly set up.
- Wear your personal protective equipment (PPE).
- Do not wear loose clothing or rings when using the saw.
- Keep fingers clear of line of cut and use a push stick whenever possible.
- 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.
- Do not cut timber when the machine is slowing down or stopping.
- Clean the machine and clear up the work area after use.

Using the band saw

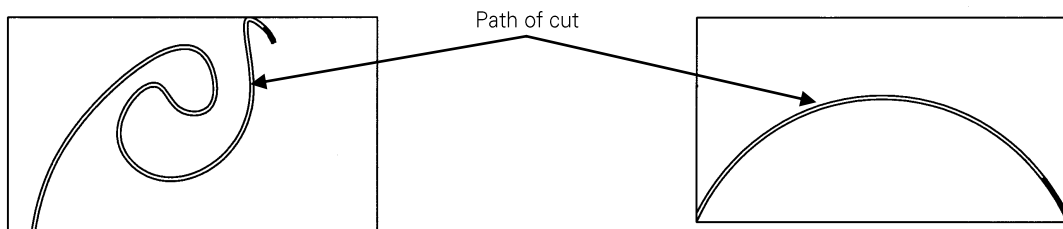
The adjustable upper guide:

- supports the blade, to prevent twisting, and helps to ensure an accurate cut;
- protects the operator from the exposed blade; and
- should be set up to 10mm above the work.

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.

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

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.

Band saw operations

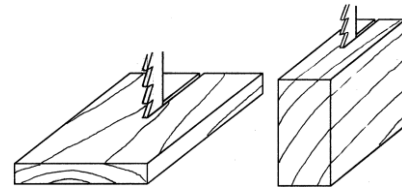
Ripping

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

Re-sawing

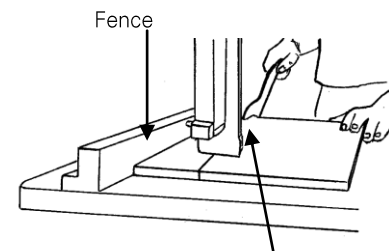
Re-sawing is a term applied to the cutting of a board along its width while standing on its edge to make it thinner.

These operations may be carried out 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.

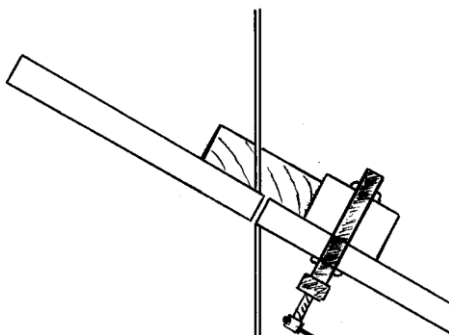
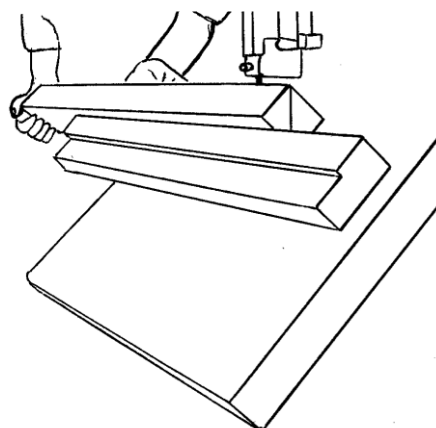


Table tilted with an improvised fence



When band saws should not be used

Band saws should not be used:

- without the blade side guard;
- without the appropriate training; and
- without PPE.

Blade 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.

Regular maintenance

- 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.



Activity 2

1. What advantage do we gain by placing the fence on the lower side of the cut?

2. If your blade is blunt, what will happen to your cut?

3. What advantage does a well set up band saw have over a circular saw when ripping or crosscutting?

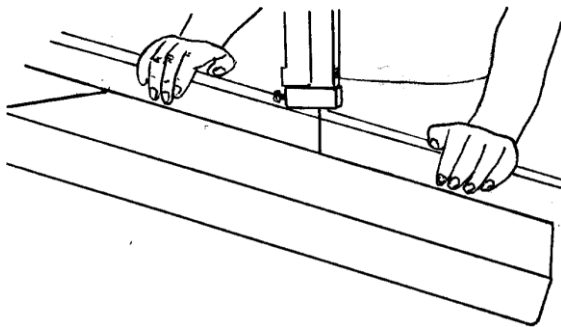
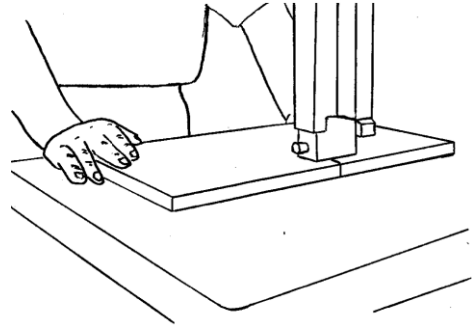
Tilt the band saw table to an angle, e.g. 30 degrees

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; and
- feed the work at a slow, even speed.



Using the band saw to crosscut at an angle

Cutting curves

- Select the blade for the smallest curve.
- Always plan your cut so you don't have to back the blade out.

If you must back a blade out of a cut, it should be done very slowly and carefully following the path of the kerf. Sometimes it is necessary to stop the machine and wedge the cut open.

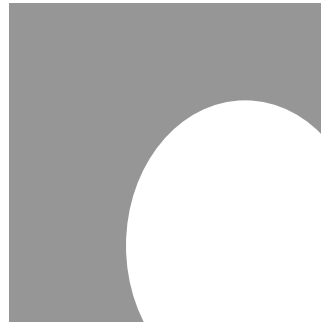
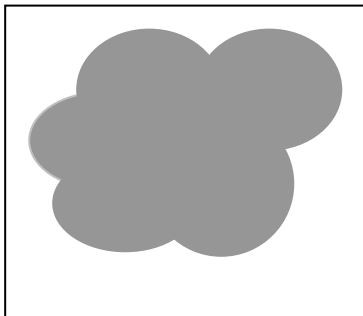


Activity 3

1. What is the risk of backing the blade out of a cut (Particularly a curved cut)?

2. When cutting tight curves or angles, what can be done to free the blade up and prevent binding on the corners?

3. The shaded areas shown below indicate the panels that are required. Show the release cuts required to achieve an efficient, smooth and flowing cut.



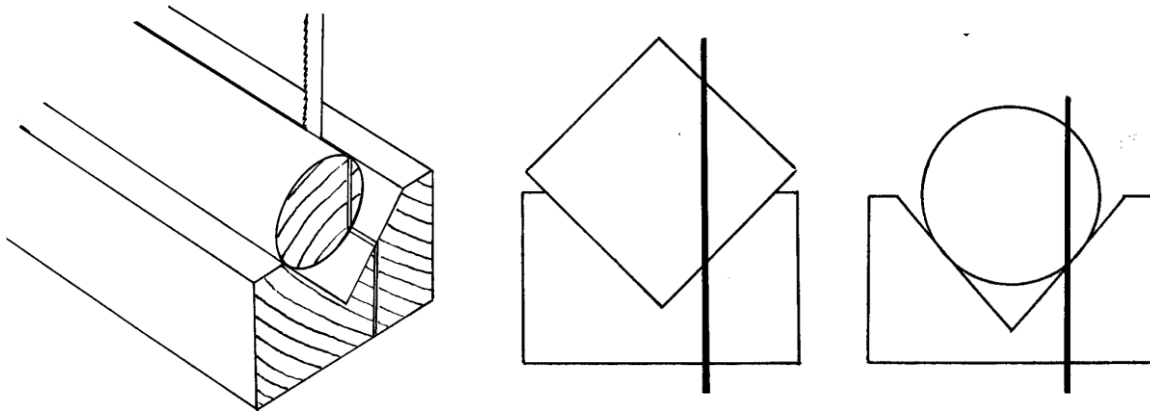
Cutting circles

Circles may be cut freehand, in the same manner as cutting curves.

A jig may be used to cut a number of similar circular discs.

Cutting angles and cylinders

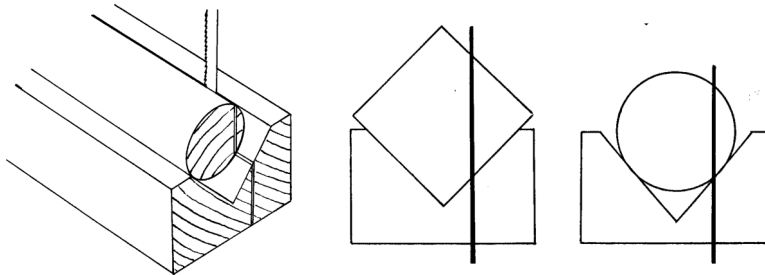
Use vee blocks for cutting angled pieces and cylinders.





Activity 4

1. What would happen if you tried to carry out the cuts shown below without the vee blocks?



2. What is the risk involved in not using a push stick?

3. What is the hazard of wearing gloves or rings when using the band saw?

4. What does a clicking noise as the blade rotates indicate?

5. What is the hazard of standing to the right of the blade?

Mitre and Compound Mitre Saw

These are general purpose saws which are now in common use on worksites and in workshops. They are used for general crosscutting work however some models have the ability to cut angles in two planes making it an ideal saw for cutting operations and finishing work.

The saw base has a predetermined locking position at 90° and 15 steps both ways to 45° 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.

Use of the mitre saw

- Make sure that the saw is securely fixed in the correct position.
- Remove chips and pieces of off-cut from the table top before setting up the saw.
- Secure the work in position.
- 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.

Use of the slide compound saw

- Disengaged the carriage securing screw and draw the saw blade fully along its slide.
- Start the saw and, when the blade attains full speed, lower it completely 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 occurs when the angle of the blade is other than 90° to the bed.
- A compound cut is a combined mitre and bevel cut.

Safety

- Clean work area.
- No loose clothing.
- Use PPE – eye/face protection, hearing protection, dust mask and heavy duty footwear.
- Timber must be free of nails, knots etc.
- Keep hands away from the path of the blade.
- Operate in a well lit area.

When not to use

Mitre saws should not be used:

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

Blade maintenance

- Keep blade sharp and free from rust.
- Replace blunt blades.
- Lightly oil after use.

Regular maintenance

- Clean and lightly oil after each use.
- Oil adjusting screws and table slides.
- Check operation of the on/off buttons.
- Inspect electric cords and plugs for damage.



Activity 5

1. Set up the mitre saw to cut a 45-degree angle.
2. Set up the slide compound saw to make a compound cut

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 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.
- 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; and

Prepare the material for drilling

- Always locate the hole to be drilled directly under the bit.
- Place a piece of waste wood under the piece being bored to prevent the timber breaking out at the back.
- The depth stop can be set to regulate the depth of the hole.
- Smaller objects and materials should be clamped to a stable platform.
- Select and use the correct type of drill for the task.

Drill Bits

Standard twist drill – Usually constructed out 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 - The recommended bit 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 thin materials, including plastics and steel. They can be purchased individually or in sets. Care must be taken to prevent them from overheating during use.



Maintenance

- Keep sharp and free from rust.
- Store separately in a rack or container.



Activity 6

1. There are several faults in the picture below. Identify 3 faults and the potential consequences.



Fault 1

Potential consequence

Fault 2

Potential consequence

Fault 3

Potential consequence

2. From the list of drill bits below, identify the most appropriate drill bit for each of the given tasks.

- Standard twist drill
- Brad bit
- Spade bit
- Forstner bit
- Combination auger bit
- Hole saw bit
- Countersink/counter-bore combination set

Task		Appropriate bit
1	Drill a 25 mm hole through 150mm thick timber.	
2	Drill a 10mm dowel hole.	
3	Drill two overlapping holes.	
4	Drill a 6mm hole through a steel bar.	
5	Prepare the pilot, clearance and countersink holes for 25 individual screws.	
6	Drill a 75mm hole through a fibreglass panel.	
7	Drill a 25mm hole through 50mm thick timber.	
8	Drill a 30mm hole through 10mm plywood.	

To bore holes at any angle, the table can be tilted and set to the desired angle.

To bore holes in round stock, use a vee-block.

3. What does a vee-block do?

4. What are the potential consequences to the work if you force the drill to cut straight through the work in a single action?

5. Describe the possible consequences of holding small objects in your hands when drilling.

6. What are the advantages of using a drill press over a hand held electric drill?

7. Why should large diameter drills, such as hole saws, be used at low speeds?

8. Describe the possible consequences if your hair got tangled in the moving drill bit.

9. Explain the purpose of the depth stop.

Horizontal Boring Machine

Sometimes called a dowel borer.

This machine includes 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; and
- rails and stiles of doors and general framed joints.

In many workshops the increasing use of biscuit jointers means that the traditional dowel joint is rapidly becoming redundant.



Safety

- Always wear eye protection when operating the machine.
- If they are fitted, 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.
- 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 machine on.
- Make sure that long hair is tied back or secured under a hairnet.

The horizontal boring should not be used:

- without the appropriate training;
- without PPE; and

Set up and use

- Clamp small material firmly to the table.
- Make sure the drill bit is held firmly in the chuck and the chuck key is removed.
- Chuck guards, if fitted, are in place.

Maintenance of bits

- Keep sharp and free from rust.
- Store separately in a rack or container.

Regular maintenance

- 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.



Activity 7

1. Describe the potential consequences if the operator places his/her hands in line with the drill bit when drilling the holes.

2. Why is the wearing of loose clothing or necklaces particularly dangerous when using this machine?

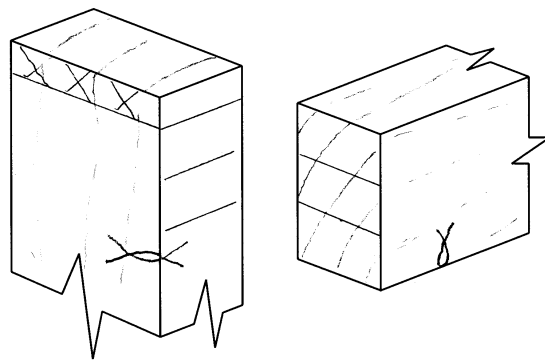
Set-up and use

Centring the bit:

- Place the work face side down on the table.
- Push work gently against the drill bit to make a small indentation.
- 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.
- Adjust the table until the drill bit is directly between the two marks.

Marking out and boring the work:

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



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



Note:

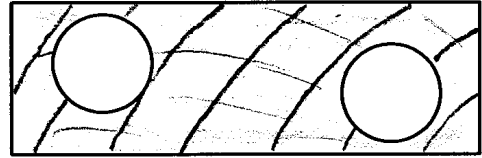
The timber must be held down firmly, face side down, for the entire drilling operation. Any movement will cause the hole to be bored off centre, resulting in an uneven joint.



Activity 8

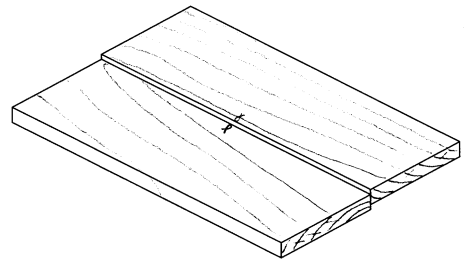
Describe the cause of each of the following faults.

1. **Fault:** Holes are out of alignment. The rails will be assembled in a twisted position.



Cause:

2. **Fault:** Surfaces not even after joining.



Cause:

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. Bobbin sanders are suited for finishing curved and intricate surfaces.



Disc sander



Combination belt and disk sander



Bobbin sander



Belt sanders

Safety

- 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.
- Keep hands away from the abrasive surface – a moving belt can easily and quickly remove the ends off fingers.
- 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 and respiratory protection when operating machine.
- 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.

Grinding Equipment

Bench grinder

The bench grinder is used for grinding steel cutting tools, e.g. to repair a cutting edge that has been damaged.

It is usually double ended, i.e. abrasive wheels are fitted directly to 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.

A portable bench grinder is used primarily for sharpening cutting tools such as:

- hand tools – planes, chisels etc.;
- twist drills;
- hand-held construction equipment; and
- can also be used for removing excess metal or material, and the rough shaping of parts.



Set up and use

- Check that it is firmly fixed to the bench.
- Check that all guards are in place.
- Check that the transparent safety shields are in place.
- Set the adjustable rest to within 2mm of the wheel.
- Stand to one side when first starting the machine until it has reached its full operating speed.
- Do not use once the power has been switched off.

Safety

- 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.
- Always use this machine as its manufacturer intended – with the power turned on.
- Do not wear gloves, loose clothing or items that could catch on the wheel and cause injury to the operator.

- Before starting work, check that the grinder is firmly fixed to the bench, there are no chips or cracks in the wheels and they are securely attached to the grinder.
- Ensure that all guards and guides are in place and the transparent safety shield is set in the correct position.
- Grind only steel. Other materials will clog up the wheel, potentially causing 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.

The bench grinder should not be used:

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

Grinding wheel maintenance

- Regularly check for chips and cracks. Replace if damaged.
- Use a wheel dresser if the wheel becomes clogged or smooth.

Regular maintenance

- Check operation of the on/off buttons.
- Inspect electric cords and plugs for damage.

Motorised whetstone

- A slow turning motorised stone that is lubricated by water, to reduce overheating.
- It is slower cutting than a bench grinder but safer and easier to use.
- The water also helps to maintain a clean cutting surface.



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; and
- **faceplate turning** e.g. bowls. The distance between the centre of headstock spindle and the bed governs the maximum diameter.



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.

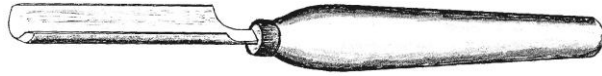
To gain maximum leverage when using a wood-turning chisel or gouge, hold the tool with one hand firmly at the end of the handle and the other just behind the blade while bracing it against your body for extra support.

Set up and use

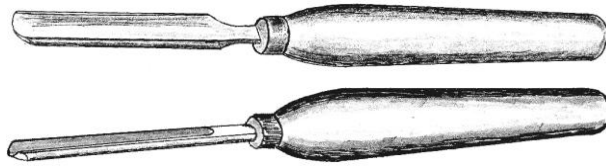
- Select the correct speed for the work to be turned.
- Ensure the work is fixed securely to the face plate or between centres.
- Rotate the work slowly to ensure that it clears the lathe bed and the tool rest.
- As the timber is removed, regularly adjust the position of the tool rest.
- Use only the 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.

Gouges

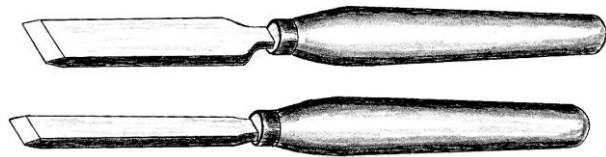
Roughing out gouge - used for initial cuts to form a cylinder.



Spindle turning gouge - used for turning knobs, coves and other rounded shapes. These chisels 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 generally require more sanding.

Safety

- Inspect turning tools for:
 - split handles;
 - loose blades; and
 - blunt or chipped cutting edges.
- 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 e.g. power leads, timber off-cuts, 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.

Gouge maintenance

- 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.

Machine 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.



Activity 9

Preparing stock for between centre turning.

Find centres by marking diagonals at both ends.

Cut down diagonal lines to a depth of approximately 3mm to support the spurs of the spur centre.

Remove corners by planing where possible.

1. What advantage is gained by removing the corners?

Preparing lathe for turning.

Remove the spur centre from lathe and tap into the end of the timber using a mallet.

2. Why should the centre be removed from the lathe before fitting it to the stock?

3. What could happen if the centre was driven into the stock while it is still mounted on the lathe?

4. Why should a steel hammer never be used to drive the centre in?

Position work on lathe and adjust tailstock to fit.

5. What does a high-pitched squealing noise coming from the tailstock indicate and how can it be stopped?

Check operating speeds are correctly set for the size of stock.**Set tool-rest in position approximately 5mm away from work and lock in place.**

6. What will tend to happen if it is set with a large gap between the tool rest and the work?

Rotate work by hand to ensure that it clears the tool rest.

7. What can happen if the tool rest is not properly locked in place?

Set dust extraction in the correct position and turn it on.**Put on your personal safety equipment and commence turning.**

Turning methods

Cutting method

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.

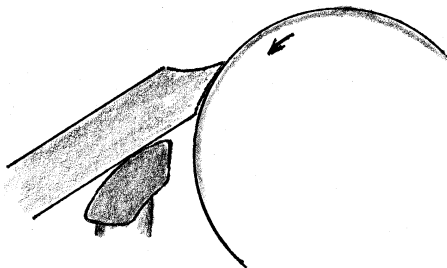
All flat and round surfaces are produced with the skew chisel and all hollows with the gouge. The resulting surfaces require little sanding as a slicing cut along the grain is used.

Scraping method

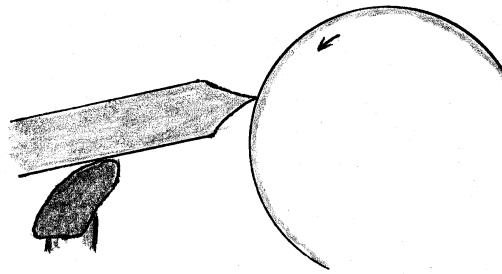
Scraping is slower than cutting, but easier to learn and carry out.

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.

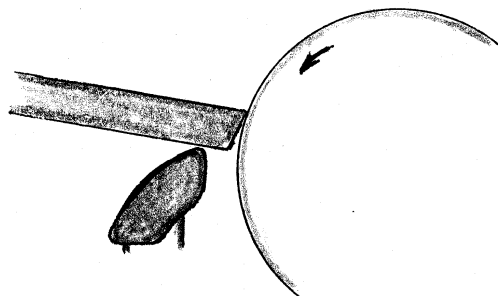
Cutting techniques



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.



Activity 10

1. What are the main advantages of cutting techniques over scraping?

2. What are the advantages of wearing a full-face shield compared with safety glasses?

3. What could happen if, when setting up a wood lathe to turn a large piece of timber (e.g. 300mm in diameter), the top speed was incorrectly selected?

4. Using the given sketch indicating the head of a wood lathe, show the position of the pulley belt needed to give the fastest speed.

