



CLASS NOTES

## Wood 103: Millwork Clearance

### CLEARANCES

Drum Sander  
Dust Collection  
Jointer  
Planer  
Resaw Bandsaw  
Router Table



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# Welcome

Welcome to the Millwork and Joinery class at Protohaven!

## Shop Rules

### Be Safe

- Get safety clearances
- Wear protective equipment
- Watch and reset equipment after use
- Never use equipment that is red-tagged

### Take Care of Each Other

- Be aware of your surroundings
- Don't use a tool if it poses a danger to someone else

### Take Care of the Tools

- Get tool clearances
- Do not alter or use equipment beyond limits
- Notify staff when maintenance is needed

### Keep the Shop Clean

- Clean up after yourself
- Return tools to their original locations

## Tool Status Tags

Every tool at Protohaven has a status to let you know if the tool is safe to use.

If the tool status is *green*, the tool is safe to use. All features should be expected to work, and no extra care should need to be taken while using the tool.

If the tool status is *yellow*, the tool may still be used, but with extra caution. The information on the physical tag or in the online maintenance history will indicate what special care needs to be taken while using the tool. If the physical tag and the maintenance log disagree, alert a tech.



If the tool status is *red*: **DO NOT USE THE TOOL**. The tool is not safe to use. The information on the physical tag or in the online maintenance history will indicate what fixes are pending, and when a repair is expected.



Some tools in the shop are explicitly green tagged to let you know they are working. Other tools in the shop are not explicitly green tagged when they are working to reduce sign fatigue.

If you are in doubt about the status of a tool with no visible tag, check the tool status by following the link in the QR code attached to the tool, or check the Protohaven website for the tool status page:

<https://www.protohaven.org/equipment/>

## **Filing a Tool Report**

If you are using a tool, and the tool becomes unsafe, damaged, or is not working properly, you must notify a tech. The tech may instruct you to submit a tool report:

<https://airtable.com/appbIl0RlmbIxNU1L/shrluff2WSzy8c3xd>

Notifying the tech will help us keep signage up to date, and make sure the users who come in after you have all the information they need to use the tool safely, even if they don't use discord.

# Millwork and Joinery Safety

- Always use eye protection.

*The machines covered in this class can cause pieces of wood to move unpredictably, and at high speed.*

- Always use hearing protection.

*Power tools can be loud enough to permanently damage your hearing.*

- Do not wear loose clothing, long sleeves, jewelry, or gloves.

*They will get caught in moving parts and cause severe harm.*

- Wear closed-toe footwear.

- Clean as you go, and keep the floor clean of accumulated debris and sawdust.

- Use the appropriate dust collection.

- Maintain a balanced stance at all times.

*Do not lean into the cut, or overreach.*

- Disconnect the power before servicing a machine.

*Unplug any power tool before changing blades, bits, or abrasives.*

- Cuts should always be made **with the grain**.

*Cutting against the grain leads to tearout and chatter. Extreme cases may lead to kickback, or the tool may bind.*

- If any adjustment crank or knob feels stiff, **STOP**. Check the lock knobs and look for accumulated sawdust that is interfering with the movement.

If you feel unsure of something, feel free to ask!

# Introduction

## Learning Objectives

This class focuses on power tools used to preparing and shaping lumber.

After taking this class, you should be comfortable with:

- Preparing a square face and edge on the jointer.
- Cutting down stock to width on the resaw bandsaw.
- Thinning stock to parallel faces on the thickness planer.
- Smoothing stock with the drum sander.
- Shaping stock with the router table.

## Millwork and Joinery Terminology

<b>bow</b>	A warp along the length of the face of the wood.	
<b>cup</b>	A warp across the width of the face, in which the edges are higher or lower than the center of the wood.	
<b>twist</b>	A distortion in which the two ends do not lie on the same plane. Synonym: <i>wind</i> . Winding sticks assist in viewing this defect.	
<b>wind</b>	A distortion in which the two ends do not lie on the same plane. Synonym: <i>twist</i> . Winding sticks assist in viewing this defect.	
<b>crook</b>	A warp along the length of the edge of the wood.	
<b>check</b>	A crack in the interior of the wood running with the grain.	
<b>fence</b>	Vertical surface that supports the workpiece as it passes through the tool.	
<b>gullet</b>	Space in the saw blade between teeth.	
<b>kerf</b>	Width of the cut.	
<b>set</b>	Bend in the teeth to make kerf wider than the spine of the blade.	
<b>swarf</b>	Chips and dust carried away from the workpiece by the saw blade during the cut.	

<b>table</b>	Horizontal surface that supports the workpiece as it passes through the tool.
<b>square</b>	Two faces of a board meeting at 90°.
<b>flat</b>	When a surface has no high spots, low spots, or twist.
<b>push block</b>	A piece of wood or plastic notched to apply a mechanical pushing action on the workpiece.
<b>push pad</b>	Paddles with handles, with high friction surfaces to push the workpiece along a table or fence.

# Tools

## Woodshop Dust Collection

Dust collection is an important part of any shop. Dust is a health hazard: dust is an irritant, and specific sizes of dust particles (PM2.5) can lodge in the lungs and accumulate there, leading to long-term and possibly severe health issues. Dust is also hard on metal tools, and can encourage surface rust and pitting.

### Notes

Run the dust collection system when using any connected power tool.

Open the appropriate blast gates to insure air flow.

Keep unused blast gates closed to maximize airflow where it is needed.

The dust collection system also has three floor inlets, one next to the miter saw, and one behind the resaw bandsaw and one next to the drill press. These are useful for collecting floor sweepings.

Empty the dust collection bin when it becomes two-thirds full (at the seam). Running the dust collection system with an over-capacity bin will reduce system performance.

## Parts of the Dust Collection System

### Control panel

The control panel has power switches of the dust collection system.

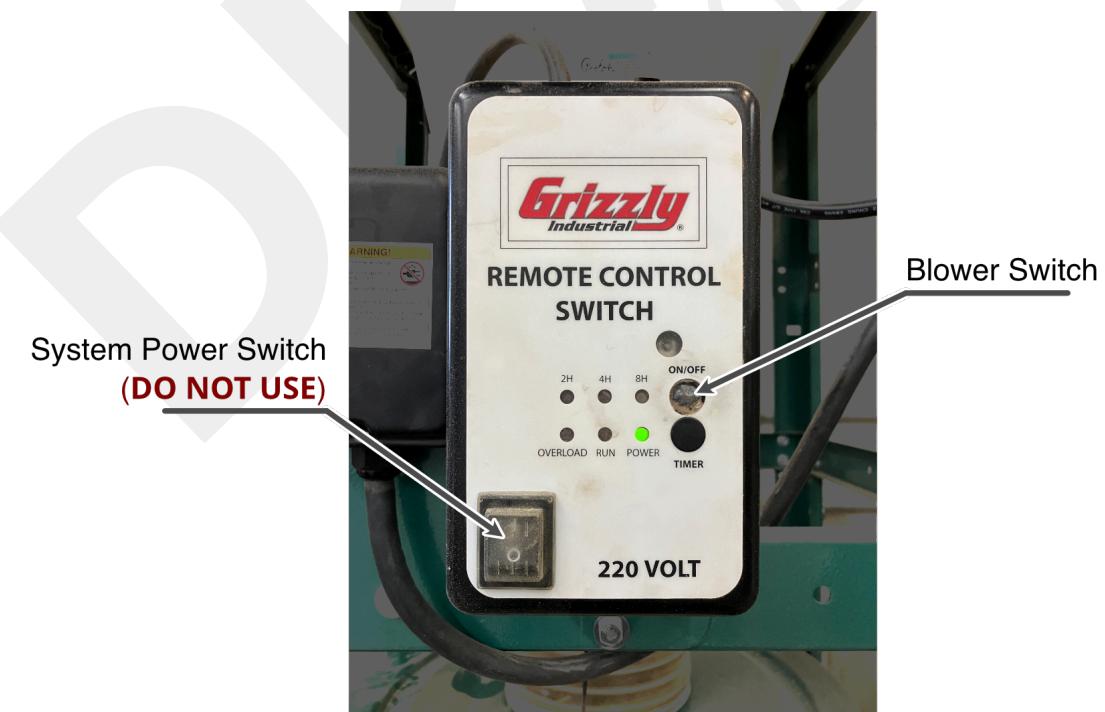


Figure 1: A close up of the dust collection control panel.

### System Power Switch

The system power switch turns power on and off to the entire dust collection system, including the control panel. **DO NOT USE THIS SWITCH.** This switch should remain on at all times during open shop hours.

### **Blower Switch**

The blower switch turns on the blowers that pull air through the system, collecting dust.

### **Dust Collection Bin**

The dust collection bin holds all of the sawdust and light chips pulled in by the dust collection system. The lid is held in place by clamps.

## **Basic Operation**

### **Turning On The Dust Collection**

Press the blower switch while the dust collection system is off.

### **Turning Off The Dust Collection**

Press the blower switch while the dust collection system is on.

## **Maintenance**

If the dust collection bin becomes full:

1. Stop the dust collection blowers with the blower switch.
2. Unclamp the lip of the dust collection bin.
3. Remove waste from the bin.

*Scoop out waste into a wood shop trash can, and then roll the trashcan out to the dumpster and tip it in. If you need help lifting the bin up to the mouth of the dumpster, please ask!*

4. Replace the dust collection bin lid, and secure the clamps.  
*Ensure the gasket is attached.*
5. If the wood shop is in use and dust collection is still needed, turn the blowers back on.

## **Jointer**

The *jointer* (or in some countries a *surface planer*) can flatten the face of a board. The newly flattened face can then be presented to the fence to create a board with an edge square to the face.

## **Notes**

### **Safety**

- Keep hands six inches from the cutter.
- Never push on the workpiece above the cutter.

### **Care**

- Do not adjust the outfeed table.**

*The machine will bind and kick back if it is not correctly adjusted to the height of the cutter.*

- Watch for excessive chip ejection around the cutter and machine base. If a lot of chips are getting ejected, check the dust collection boot for build up, and clean the chute when needed.
- Do not cut engineered materials, splintered wood, or wood with knots on the jointer. *These materials are prone to chipping, causing kickback and projectiles. Engineered materials are also particularly damaging to the cutters due to the staggered grain orientation.*

## Parts of the Jointer

### Full View



Figure 2: An annotated full view of the jointer.

### Fence Releases

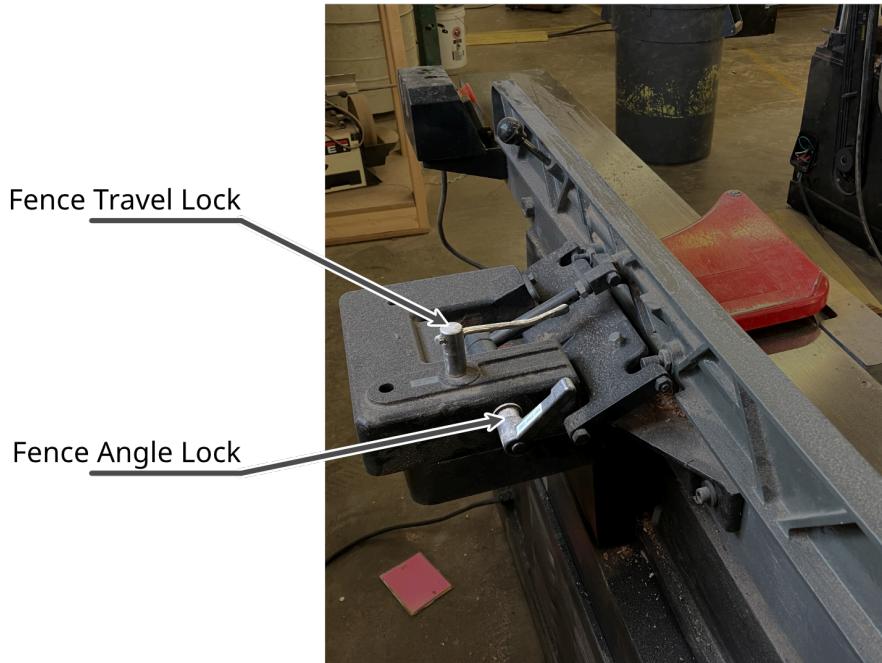


Figure 3: Handles on the back of the jointer to release the fence.

### On/Off/Emergency Buttons

Use the **green button** to turn on the machine.

Use the **red button** to turn off the machine.

The large red **emergency stop** button is designed to be easy to hit if you need to power off the machine quickly. If you use the emergency stop button, you must twist the emergency stop button to release it (the button is spring loaded, and will pop out when released). The machine will not run until the emergency stop button is released.

During normal usage it is better to use the stop button instead of the emergency stop button.

### Cutter

The cutter is a helical cutter head with many carbide inserts.

Always maintain a safe distance from the cutter. Never push down on a workpiece over the cutter head; the workpiece may be kicked out of the machine, exposing the cutter heads to your hands.

### Blade Guard

The blade guard covers the cutting head when there is no workpiece moving through the jointer. This style of guard is sometimes called a "pork chop" style guard due to its shape.

The guard should easily swing out of the way with the workpiece. If the guard does not easily move, **STOP**. Do not try to force the guard. Turn off the machine and alert a shop tech.

Do not try to prop the guard open or open the guard manually while the cutter is moving.

### Infeed Table

The infeed table holds the workpiece before it contacts the cutting head. Push the workpiece along the infeed table toward the cutting head to begin the cut.

The depth of cut is determined by how far the infeed table sits below the apex of the cutting head.

### Infeed Height Adjustment Crank

The infeed height adjustment crank raises and lowers the infeed table to adjust how much material is taken off on each pass. Taking multiple light cuts is recommended for better control and quality of cut.

In general, a cut depth greater than 1/8" is not recommended.

### Fence

The fence can be moved laterally to expose more or less of the cutting head, and angled with respect to the outfeed table.

Normally, the fence is set to be perpendicular to the plane of the outfeed table. Always check your desired angle with a quality square or gauge.

The fence does not need to be perpendicular to the rotational axis of the cutter, only to the plane of the outfeed table.

### Fence Position Lock

The fence position lock secures the fence's lateral position with respect to the cutting head.

**Do not move the fence without first unlocking it.** Always lock the fence after moving it to a new position.

### Fence Angle Lock

Secures the fence angle with respect to the tables.

### Fence Perpendicular Stop

Use this stop to quickly index the fence to the perpendicular.

### Outfeed Table

The outfeed table supports the workpiece after it has passed over the cutter. The height of the outfeed table should always match the apex of the cutting head.

### Outfeed Height Adjustment Crank

**Do not use the outfeed height adjustment crank.** This setting should *never* be used unless the jointer is out of calibration and you are trained and have permission to do so.

## Basic Operation

## Workholding

When face jointing, use pads to apply pressure straight down to keep the board in good contact with the table.

When edge jointing, use pads to apply pressure at a 45° angle to that the board is in good contact with both the table and the fence.

## Setting Up

1. Turn on the dust collection.
2. Open the blast gate.
3. Adjust the depth of cut.

*Maximum cut of 1/16" for faces and 1/8" for edges.*

4. Place the workpiece on the infeed table, with the widest, most stable surface facing the table.

*If the workpiece is cupped, place the cupped (concave) side facing down.*

5. Turn on the motor.

## Joint the Workpiece

1. Using a push block to gently keep the workpiece in contact with the infeed table and fence, begin pushing the workpiece across the cutter.

*Move the workpiece as smoothly as possible.*

2. **Do not push down on the workpiece over the cutter.**

*Pushing down on the workpiece over the cutter will flex the warped wood flat during cutting, preventing the workpiece from becoming flat when released.*

3. Once all of the workpiece is on the outfeed table, use a push pad to gently keep the workpiece in contact with the outfeed table and the fence. Use a push block on the tail end to gently push the work piece past the cutter with only light downward pressure.

*Keep your fingers free of the cutter.*

4. Repeat until the surface is flat.

*Check for flat by checking for light when placing the workpiece on a known flat surface, or checking with a rule. If multiple passes does not seem to make progress toward flatness, this indicates that the outfeed table is misadjusted.*

Flip the workpiece on its side so that the flat edge is against the fence, and repeat the jointing procedure to flatten the second edge. Test the corner with a square to make sure the corner is true. When edge jointing the fence is the most important reference surface.

## Cleaning Up

1. Turn off the motor.
2. Sweep up any dust and/or shavings.  
*There is a floor intake for the dust collection system on the wall behind the resaw bandsaw.*
3. Close the blast gate.

4. Turn off the dust collection.

*If other members are still using the dust collector, leave it on.*

## Resaw Band Saw

The *resaw band saw* takes off slices of a board. Slices can vary in width from thick planks to thin veneers. A workpiece should have at least one flat face on the table in order to be stable during the cut.

One common use of the resaw band saw is to create bookmatched panels from a board.

## Notes

### Safety

- Do not put round stock through the saw unsupported.  
*When cutting cylinders, use a jig to prevent the workpiece from spinning or twisting, and to keep the workpiece orientation straight and true as the cut is made.*
- Do not cut lumber that has nails or loose knots.

### Care

- Tension the blade before use, if needed.  
*The blade is under operating full tension at the 11 o'clock position.*

## Parts of the Resaw Band saw

### Full View

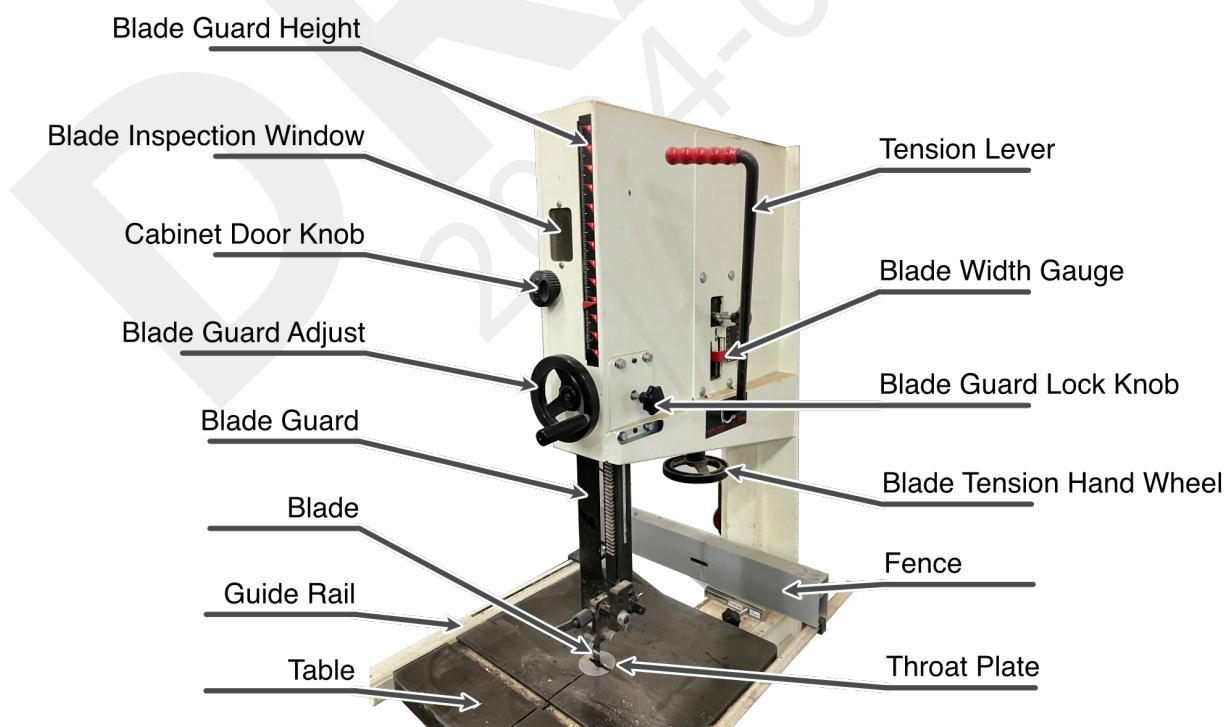


Figure 4: An annotated full view of the resaw band saw.

## Guides

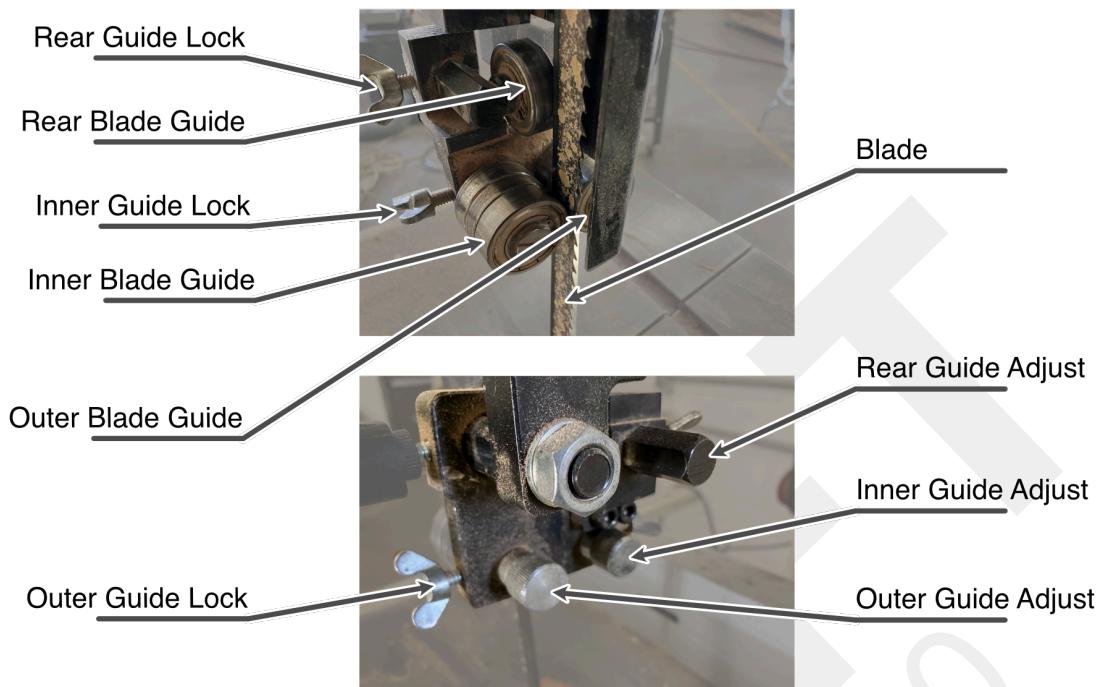


Figure 5: Blade guides and adjustments.

## On/Off/Emergency Buttons

Use the **green button** to turn on the machine.

Use the **red button** to turn off the machine.

The large red emergency stop button is designed to be easy to hit if you need to power off the machine quickly.



Figure 6: Resaw band saw power switch.

## Tension Lever

Use the tension lever to apply or release tension on the blade.

Before turning the saw on, always use the tension lever to put full tension on the blade.

## Cabinet Doors

The cabinet doors cover the upper and lower wheels of the saw.

Both the upper and the lower cabinet doors must be closed while operating the machine.

The doors are an important safety feature: they prevent accidental contact with the blade, and will contain the majority of the blade when it breaks.

## Blade Guard

The blade guard protects the blade, and can be adjusted to only expose enough of the blade to make the cut.

Unlock the blade guard to adjust the height. Set the guard at a height that will allow the workpiece to pass below it without making contact, but will prevent your hand from fitting between the bottom of the guard and the workpiece.

## Blade Guard Lock Knob

The blade guard lock knob engages the blade guard lock, keeping the blade guard from moving up and down.

Loosen the blade guard lock knob to adjust the blade guard. Turning the crank without unlocking the knob will damage the gears.

Always tighten the blade guard lock knob before using the machine, to keep the blade guard from falling into the workpiece during a cut.

## Thrust Guide

The thrust guide supports the back of the blade during the cut.

The thrust guide should be adjusted to create a gap of 1/64th of an inch (or less) behind the blade. The thrust guide should not make contact with the blade at idle. This gap provides a small amount of flex towards the rear, but prevents the blade from either rubbing against the guide when idling, or being pushed off the wheel during a cut.

### Blade Guides

The blade guides keep the blade in proper position laterally, just above the workpiece.

The blade guides should be positioned as close to the sides of the blade as possible without scraping the blade when idling.

The front edge of the guides should be just behind the tooth profile of the blade. The blade guides should never extend into the teeth; the teeth will damage the blade guides.

### Blade

The resaw blade is meant for straight cuts of large workpieces.

The blade has large tooth spacing, allowing thick stock to be cut without the swarf getting packed into the gullet.

The workpiece should be checked to make sure that at least two teeth will be buried in the material at all times during the cut. If the workpiece is thinner than two teeth, running the saw can result in individual teeth getting knocked off the blade, damaging it irreparably. If a tooth is broken, power off the saw immediately and report the issue.

### Table

The table supports the workpiece as it moves past the blade.

Anything put through the saw should have at least one flat surface that can be presented to the table. Any twisting of the material will result in the blade binding in the cut, breaking the blade, and possibly breaking critical parts of the machine.

**Any workpiece that does not have at least one flat edge must be secured in a jig or sled** to safely perform a cut. Once a single cut has been made, the fresh edge can be used against the table for subsequent cuts.

### Fence

Once a workpiece has two straight edges, use the fence to cut parallel slices off the workpiece. The fence supports and guides the workpiece past the blade.

Adjust the fence so that the cut is of an appropriate width by lifting the fence release lever and moving the fence. Once the fence is positioned, lock the fence in place by pushing down on the fence release lever.



Figure 7: Lift the fence release lever before adjusting the fence.

Often a dull or misaligned blade will cause the workpiece to wander away from the fence, causing a crooked cut. Watch your cut carefully and support your workpiece firmly against the fence to prevent this.

## Throat

The saw passes through the table via the throat.

Care should be taken to not push the blade laterally into the throat plate.

## Push Stick

Use push sticks to move the work past the saw blade.

As you approach the end of a cut, you do not want your fingers to get close to the blade. Use a push stick to push your workpiece all the way past the blade. They are often sacrificial, and you can push the tip of the stick straight into the blade.

## Adjusting the Blade Guides

The resaw band saw has six blade guides to support the blade during a cut.

Above the table, there are three blade guides: an inner guide, and outer guide, and a rear guide. The inner and outer guides keep the blade from moving left or right. The rear blade guide supports the back of the blade during a cut, to keep it from being pushed off the wheels.

An additional set of three blade guides in the same configuration support the blade below the table.

To adjust a blade guide:

1. Loosen the guide lock screw.
2. Turn the guide adjustment knob so that the guide spins freely when the blade turns.  
*Do not overtighten the guides so that they clamp the blade.*
3. Tighten the guide lock screw.

TODO: more notes on proper tolerances here. (check with Cord)

## Basic Operation

### Work Holding

Apply pressure to keep the board firmly against the table and the fence.

## Check the Blade

1. Put the blade in full tension.

## Prepare the Machine

1. Check the table angle.

*For most cases, the table should be 90° to the blade.*

2. Check the blade guides.

3. Loosen the blade guard lock knob.

4. Adjust the blade guard to just above the height of the workpiece.

5. Adjust the fence for the desired cut width.

6. Make sure there is sufficient support available on both the infeed and outfeed sides of the cut for the size of the workpiece.

7. Turn on dust collection.

8. Turn on the saw and let it spin up to full speed.

9. Check for blade drift.

*If the blade is drifting, stop the saw and alert a tech.*

## Making a Cut

### Safety Warning!

If the blade binds in the cut, **POWER THE MACHINE OFF IMMEDIATELY**. Keep the workpiece stable until the motor has been disconnected from the power and has stopped completely.

Under normal use the blade will eventually break. This will usually be preceded by a rhythmic pulsing as a developing crack in the blade passes through the workpiece. If you experience this pulsing, stop and inspect the blade for damage. Inform a tech that the cracked blade should be removed from service immediately.

Do not back out of a cut while the blade is running. The blade will be pulled off of the front edge of the wheels, creating a safety hazard and causing irreparable damage to the machine.

1. Holding the workpiece firmly against the table and the fence, feed the workpiece into the blade.
2. Feed slowly and consistently through the length of the cut.  
*Make sure the workpiece does not twist or wander away from the fence.*
3. As you reach the end of the cut, keep your fingers away from the blade.  
*Use a push stick to feed the trailing end of the workpiece past the blade.*

## Cleaning Up

1. Turn off the saw.
2. Wait for the saw to come to a complete stop before leaving the area.
3. Sweep up any dust.

*There is a floor intake for the dust collection system on the wall behind the resaw band saw.*

4. Turn off the dust collection system, if it is not otherwise in use.

## Planer

The *planer* (or *thickness planer*) removes material from the top face of a board to make it flat. The resulting surface will be parallel to the opposite face.

### Notes

#### Safety

- Never attempt to plane engineered products like MDF, plywood, particleboard or chipboard, or any workpieces with loose knots or splintered wood. They will splinter and the resulting shrapnel can injure you and damage the machine.
- Do not attempt to plane stock shorter in length than the distance between the feed rollers.

#### Care

- Do not over-tax the motor.
- Turn the crank no more than a quarter turn between cuts.
- If the table was lowered after stopping the motor, reset the cut depth for its thickest point and set the table height for that thickness.
- For flattening or reducing the thickness of thin stock, a drum sander may be a better choice.

## Parts of the Planer



Figure 8: An annotated front quarter view of the planer.

### On/Off Switches

Use the **green button** to turn on the machine.

Use the **red button** to turn off the machine.

There is no emergency stop button on the thickness planer.

### Bed

The bed of the planer supports the workpiece as it moves through the planer.

### **Lock Knobs**

The two lock knobs on the left side of the table lock the position of the bed on the screw posts.

The lock knobs must be loosened before adjusting the bed height, and should be tightened while cutting to keep the table from drifting during an operation and to help prevent chatter.

In daily use these are often not locked (against manufacturer's instructions) when making a series of cuts at different thicknesses to the same workpiece, but should definitely be locked if feeding multiple pieces through that should end up being the same size.

### **Height Adjustment Crank**

The height adjustment crank raises and lowers the bed.

A quarter of a crank is the maximum depth adjustment that should be made between cuts. Limiting the depth change will help prevent bogging.

### **Cutter Housing**

The cutter housing stays stationary over the bed. The cutter housing holds the cutter head, infeed and outfeed rollers, and kickback pawls.

### **Kickback Pawls**

The kickback pawls prevent the workpiece from being ejected backwards from the front of the machine.

Once they engage with the workpiece, the workpiece cannot be pulled out of the front of the planer without first lowering the table. Do not try to pull material back out of the planer against the kickback pawls.

In severe situations when the material has bound or failed in some fashion, the machine should be turned off, the table lowered, and the material manually pulled out the back of the machine.

### **Infeed Roller**

The infeed roller is a toothed roller powered by the motor that pulls the material toward the cutter head.

At no time should your hand be remotely close to the infeed roller. The roller will embed itself into the surface of the workpiece, so if the depth of cut is too shallow, perpendicular lines will be visibly imprinted in the surface of the workpiece when it exits the machine. When the infeed roller first grabs the workpiece, it can sometimes lift it off of the infeed table briefly, creating a pinching hazard. Keep your hands away from the bottom of the workpiece when feeding it.

The infeed roller should do the work of moving the workpiece through the machine. If you have to force the workpiece through manually, you are taking too deep a cut. It

may be necessary to push the work forward manually past a thin spot where the feed rollers are not able to touch the workpiece.

### Cut Depth Limiter

The cut depth limiter is a small piece of metal on the top edge of the mouth of the planer that prevents the user from running a wide board at the maximum depth of cut.

Narrower boards can be run through to one side or the other at a deeper cut, but it can be used as a good guide for determining a good height for your first cut. Do not crank the workpiece upward underneath this, potentially damaging the height screws or table. Instead, adjust the table height, then check to see if the workpiece fits under the limiter.

### Power Feed Handle

The power feed handle adjusts the speed at which material is fed past the cutter head.

Leave the power feed handle pulled out to the 16FPM position. It is less taxing on the motor and yields a better surface finish. The feed rate should only be changed when the machine is running.

### Support Rollers

The support rollers can easily return stock to the front of the machine for subsequent cuts.

### Digital scale

The digital scale measures the depth of cuts, keeping track of how much material should still be removed.

Take a skim cut and zero the scale. Measure the thickness of your workpiece and determine how much material you wish to remove. Take cuts and raise the bed until the scale indicates the appropriate distance has been moved.

## Basic Operation

### Setting Up

1. Place the workpiece on the infeed table.
2. Unlock both lock knobs.
3. Adjust the table height so that the thickest part of the workpiece barely fits under the cut depth limiter.
4. Lock the lock knobs.
5. Turn on dust collection.
6. Make sure the workpiece is not engaged with the kickback pawls or infeed roller.
7. Turn on the motor.

### Pass the Workpiece Through the Planer

1. Push the workpiece slowly into the machine until the infeed roller engages.
2. Allow the feed rollers to pull the workpiece completely through the machine.
3. Support the workpiece at the front and rear of the machine as necessary.

4. Remove the workpiece from the outfeed table once the outfeed roller has disengaged.

Adjust the planer height as needed and repeat to remove more material. Do not adjust the planer table height by more than a quarter crank between cuts.

### Cleaning Up

1. Turn off the motor.
2. Turn off the dust collection.  
*If other members are still using the dust collector, leave it on.*
3. Brush off any dust, and sweep any chips from the surrounding area.

## Drum Sander

The drum sander can be used to:

- Flatten a board face.
- Smooth a board face.
- Reduce the thickness of thin stock.

### Notes

Always feed stock against the rotation of the drum.

A planer may be a better choice if a lot of material needs to be removed from a thick workpiece.

## Parts of the Drum Sander

### Full View



Figure 9: An annotated full view of the drum sander.

### Sanding Drum Power Switch

The sanding drum power switch turns the sanding drum motor on and off.

### Sanding Drum

Rotates as the workpiece advanced through the machine. Wrapped with a strip of abrasive (usually 80 grit sand paper) which is held in place on both sides with clips embedded in the drum. The abrasive should be inspected before each use to ensure that it is not scorched, overloaded, or loose on the drum.

### **Feed Table Speed Knob**

The feed table speed knob acts as the power switch and speed control for the feed table. Rotate the speed knob clockwise past the click to turn on the feed table. Once the feed table is moving, rotate the speed knob to adjust the speed of the feed table. Turn off the feed table by rotating the knob counter clockwise past the click.

**Make sure the drum motor is turned on before feeding a workpiece into the machine.**

### **Height Adjustment Crank**

The height adjustment crank raises and lowers the sanding drum, adjusting the clearance between the sanding drum and the feed table.

### **Feed Table**

The feed table moves the workpiece past the bottom of the sanding drum. If the feed table is pulling your workpiece to the left or right, tell the tech on duty.

### **Replacing the Abrasive Strip on the Drum**

You may wish to replace the abrasive strip on the drum:

- The abrasive strip on the drum is worn.
- You want to use an abrasive strip with a specific grit.

### **Sourcing Abrasive Strips**

Abrasive strips are a consumable; you are welcome to use whatever is installed on the drum or left on the shelf beneath the drum sander.

Protohaven sells pre-cut abrasive strips for the drum sander in the Protohaven Shop by the front desk. Check with the tech on duty for pricing and availability.

You are welcome to bring your own abrasive strips, but you will need to cut the appropriate bevel in the strip for the strip to fit the drum.

### **Removing an Abrasive Strip From the Drum**

1. Start with the drum lid closed.



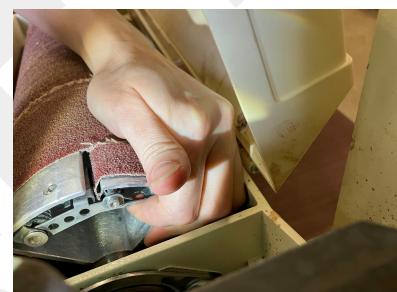
2. Open the drum lid.



3. Reach into the drum and find the lever for the right clamp.



4. Pull up on the lever for the right clamp.



5. Loosen the tapered end of the paper.



6. Pull the tapered end out of the drum.



7. Unwind the abrasive strip from the drum.



8. The left clamp.



9. Lift the left clamp to release the abrasive strip.



10. Pull the tapered end of the abrasive strip completely out of the drum.



11. The empty drum.



### Attaching an Abrasive Strip to the Drum

1. Start with an empty drum.



2. Lift the lever for the left clamp and insert a tapered end of the abrasive paper strip.



3. Wind the abrasive paper onto the drum.

*Leave a small gap between the edges of the paper as it winds on to the drum.*



4. The last wind of the paper around the roll should have an 1/8 inch gap.



5. Insert the hook tool into the right clamp lever.



6. Pull the hook up, and then turn the hook so that the shoulder rests on the drum.

*The shoulder should hold the paper in place.*



7. Feed the end of the taper into the right clamp.



8. Release the clamp and remove the tool.



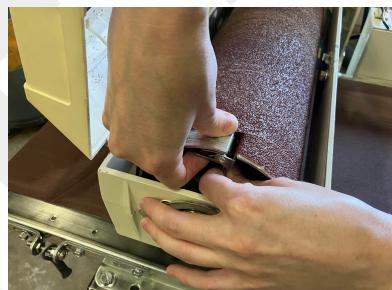
9. Check the winding of the abrasive paper.

*Retighten the strip as needed, making sure there is a gap between each winding of the abrasive strip.*



10. Pull the left clamp lever.

*Hold the paper to the drum to keep it from unspooling.*



11. Pull the taper into the drum to take up any slack in the abrasive paper.



12. The new abrasive strip is in place.

*Recheck the gaps between the windings to make sure the paper does not overlap.*



13. Close the lid.



## Basic Operation

### Setting Up

1. Open the cover.
2. Raise the drum using the Height Adjustment Crank.
3. Place the workpiece below the drum.
4. Lower the drum until the drum barely touches the top of the workpiece. Check this by rotating the drum by hand. **DO NOT TURN ON THE DRUM MOTOR.**  
*Turn the crank slowly as pushing the drum into the workpiece can bend the machine casting.*
5. Use the table feed to move the workpiece out from under the drum.
6. Close the cover.

### Sanding

1. Turn on dust collection.
2. Open the blast gate.
3. Turn on the drum motor.
4. Turn on the feed table and adjust the table speed.
5. Feed the workpiece once all the way through.
6. Adjust the drum height for the next pass and repeat as needed.

### Cleaning Up

1. Turn off the feed table.
2. Turn off the sanding drum.
3. Dust off and sweep up dust as needed.
4. Close the blast gate.
5. Turn off the dust collection.

*If other members are still using the dust collector, leave it on.*

## Router Table

The router table can be used to profile an edge of a workpiece, or cut a channel in the face of a board.

### Notes

#### Safety

Always pass the workpiece across the bit from the right to the left.

#### **Safety Warning!**

DO NOT let the workpiece pass between the fence and the bit.

If the workpiece passes between the fence and the bit, the workpiece is likely to catch on the bit and be kicked violently off of the table into the shop, possibly causing injury or damage.

## Parts of the Router Table

### Full View

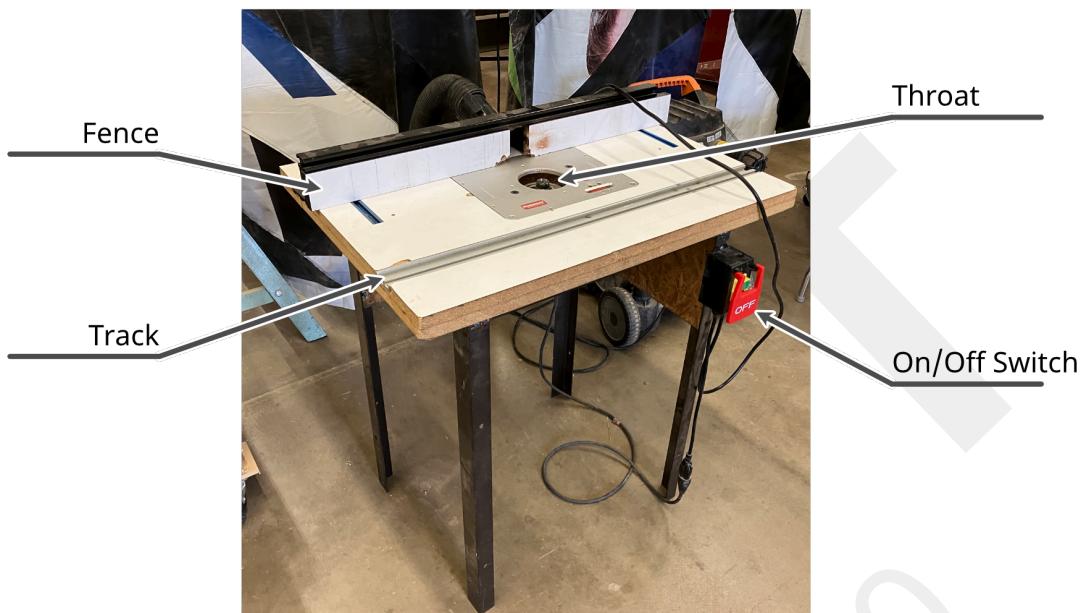


Figure 10: An annotated full view of the router table.

### Lift Assembly

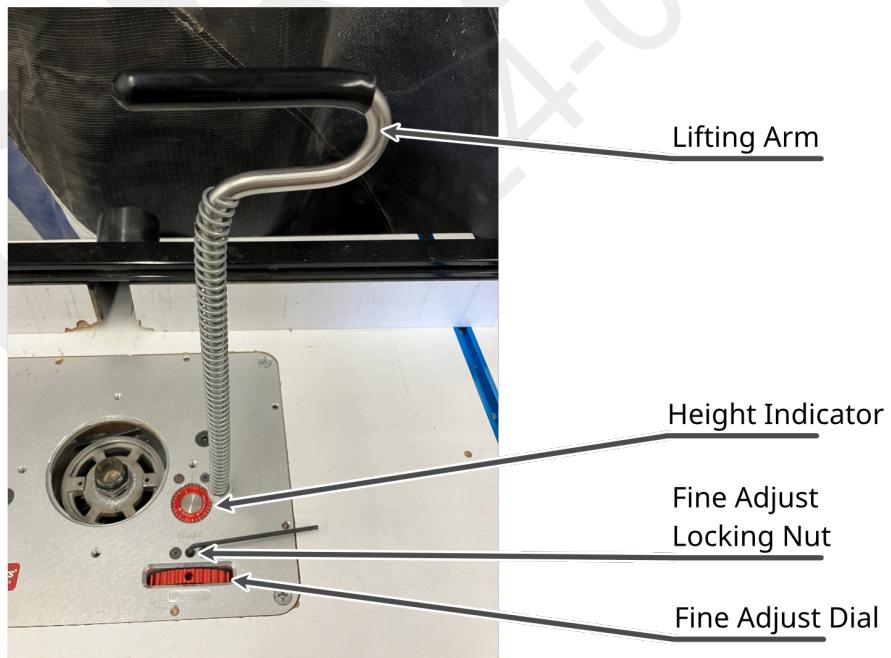


Figure 11: The router table lift assembly, with lifting arm inserted.

### On/Off Switch

Use the **green button** to turn on the machine.

Use the **red paddle** to turn off the machine.

The red paddle acts as the emergency stop button on the router table.

### **Throat Plate**

The through plate sits in the router opening in table, and supports the material as it gets close to the bit.

There are several throat plates available in the Router Table Kit that work with router bits of varying sizes. Use a throat plate that is as close to the size of the router bit as possible while allowing the router bit to freely turn within the throat plate.

### **Lifting Arm**

Use the router lifting arm for large adjustments in the height of the router.

The lifting arm is keyed to the lifting assembly within the table. See [Adjusting the Bit Height](#) for instructions on using the lifting arm.

### **Fine Height Adjustment Dial**

The fine height adjustment dial raises and lowers the router very slowly. Use the fine adjustment tool to dial in the router bit height for fine work.

### **Collet**

The collet accepts the shaft of the bit. Tightening the collet will lock the bit into place.

Always tighten the collet **very firmly** before turning on the router.

### **Bit**

The bit spins against the workpiece to remove material.

There are many kinds and shapes of bits for treating edges: bits are available to chamfer or round edges, cut rabbets, make ogee cuts, or even complicated geometries for sash work. Router bits are also available to cut channels (straight, sliding dovetails, etc.). A set of various router bits is available at the front desk for member use.

### **Bearing**

Some bits have a bearing at the top of the bit.

The bearing acts as a stop, and limits the depth of cut. Test the bit with scrap material to make sure that the workpiece properly engages with the bearing.

### **Fence**

The fence can be set as a reference surface on the router table.

The fence can be set in line with the bit to limit the depth of cut when using bits that do not have a bearing. The fence can also be set to precisely cut a channel in a workpiece.

### **Shop Vac**

The router table has a dedicated shop vac for dust collection.

In normal use, the shop vac hose is connected to the port on the back of the fence. The hose can be removed to help pick up chips and dust on the floor around the router table. Always reattach the shop vac hose to the router fence after cleaning the area.

## Basic Operation

### Setting Up

Checkout the Router Table Kit from the front desk.

If you do not have your own router bits, checkout the router bit set from the front desk.

Lift the router to its highest position:

1. Stand in front of the router table.

*Face the side of the table that has the power switch.*

2. Insert lifting arm.

*The lifting arm is stored in a tube attached to the top of the Router Table Kit.*

3. Rotate the lifting arm so that the black rubber handle is parallel to the track, pointing to the left, as shown in Figure 11.

4. Push down the lifting arm to engage it with the lifter.

5. Rotate the lifting arm 90° clockwise, so that the black rubber handle is pointing away from you.

6. Pull up on the lifting arm to raise the router to its highest position.

*The router may already be in its highest position.*

Secure the bit in the router:

1. Attach an appropriate collet (1/4" or 1/2") for the bit in use.

*Both collets should be in the Router Table Kit.*

2. Place bit in collet.

*If any coatings are present on the bit, ensure that the collet is not in contact with the coating. The collet should be making firm contact with only the metal shaft of the bit.*

3. Tighten the collet.

*Use the wrenches in the Router Table Kit.*

Insert the throat plate:

1. Lower the router using the lift arm.

2. Insert the appropriate throat plate for the bit in use.

*Various throat plates are available in the Router Table Kit.*

3. Raise the router such that the router bit is at an appropriate cutting height.

*Make sure there is clearance between the router bit and the throat plate.*

Release the lifting arm:

1. Rotate the lifting arm 90° counter-clockwise to release the lifting arm.

2. Remove the lifting arm from the router table.

Set up and clear the table:

- If using the fence to register your workpiece, securely lock the fence in place to make sure it does not move during a cut.
- Clear away any setup tools (lifting arm, Allen wrench, collet wrenches) off of the table and put them back in the kit.

## Adjusting the Bit Height

The lifting arm can be used for large adjustments of the bit height:

1. Stand in front of the router table.  
*Face the side of the table that has the power switch.*
2. Insert lifting arm.  
*The lifting arm is stored in a tube attached to the top of the Router Table Kit.*
3. Rotate the lifting arm so that the black rubber handle is parallel to the track, pointing to the left, as shown in Figure 11.
4. Push down the lifting arm to engage it with the lifter.
5. Rotate the lifting arm 90° clockwise, so that the black rubber handle is pointing away from you.
6. Pull up or push down on the lifting arm to change the router position.  
*This takes a good amount of force.*
7. Rotate the lifting arm 90° counter-clockwise to release the lifting arm.
8. Remove the lifting arm from the router table.

Make fine adjustments to the bit height with the fine adjustment dial:

1. Unlock the fine adjustment dial.  
*The appropriate Allen wrench is included in the Router Table Kit.*
2. Adjust the bit height.
3. Lock the fine adjustment dial.

## Workholding

The workpiece must be held down firmly against the table at all times.

The workpiece is held against the fence or a bearing on the bit.

Make sure the fence is firmly held down against the table.

Test fit the workpiece (or appropriate scrap) to make sure the workpiece will properly register against the bearing or the fence.

**DO NOT let the workpiece pass between the fence and the bit. The workpiece may catch on the bit and be violently ejected from the router table.**

## Making the Cut

1. Attach the shop vac to the router table fence, if needed.
2. Turn on the shop vac.
3. Make sure the router table is free of any loose materials: cut offs, tools, etc.
4. Using push pads to keep your hands clear of the bit, pass the workpiece across the bit, moving the workpiece from right to left.

- If you are profiling an edge, keep the working edge pressed firmly against either the bit bearing or the fence during the pass.
  - If you are making a channel cut, keep the workpiece pressed firmly against the fence during the pass.
5. Depending on the material and the depth of cut, adjust pressure and speed for a clean cut.

*Cutoffs and other waste scraps are good for testing router setups with specific materials.*

When finished cutting, turn off the router and the shop vac.

### **Cleaning Up**

1. Unplug the router table.
2. Remove throat plate and return it to the Router Table Box.
3. Raise the router to its highest position.
4. Loosen the collet with the wrenches in the Router Table Kit.
5. Return the wrenches to the Router Table Kit.
6. Remove the bit from the collet.

*If you are using a shop bit, return the bit to its case.*

7. Put the collet in the Router Table Kit.
8. Sweep up any dust and chips.

*Disconnect the shop vac to pickup floor sweepings and clean out the track and the fence.*

*Reconnect the shop vac to the fence when finished.*

9. Return the Router Table Kit to the front desk.

*If you borrowed shop router bits, bring them back, too!*

# Resources

*Additional resources go here:*

- Websites?
- Books/Magazines?
- YouTube Channels?

DRAFT  
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# Acknowledgments

Some definitions used in this document were sourced from the Wikipedia article *Wood Warping*:

[https://en.wikipedia.org/wiki/Wood\\_warping](https://en.wikipedia.org/wiki/Wood_warping)

The images of wood defects were sourced from Design and Technology Online:

<https://wiki.dtonline.org/index.php/File:DefectsLabelled.png>

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