The Essential Woodworking Class

Learn the basics of woodworking with simple hands-on projects to build your confidence and skills. Each lesson in this class explores an area of woodworking that will form the building blocks of all future woodworking projects you undertake. Keeping the average DIY'er in mind, this entire class is conducted using basic handheld power tools, with *no fancy fixed tools like table saws, lathes, planers, or drill presses*.

This class will cover the fundamentals from making straight cuts and perfect holes to mastering the router and making mitres. Whether you're new to woodworking or just want to solidify your understanding of the woodworking basics, this class is definitely one you'll love!

Lessons

Lesson 1: Tools + Supplies

The basic tools to get you started in your woodworking. With the beginner in mind, this tool list is meant to be inexpensive and approachable - with no expensive fixed power tools.

Lesson 2: Making Perfectly Straight Cuts

The most fundamental skill that you will use over and over is cutting wood. Learn how to make those cuts perfect and square every time. Put this core concept into practice by making fun and easy Yard Dice with straight cuts.

Lesson 3: All About Glue

Glue is indispensable for a woodworker. This class explores types of glue, application, and cleanup. Put the knowledge into action by making a custom House Numbers using concepts from this class.

Lesson 4: Drilling Perfect Holes

Not every woodworking project can be solved with glue. Discover tips and tricks for making drilled openings perfect every time. This lesson puts drilling skills to use by making an Upcycled Bottle Vase.

Lesson 5: Sanding

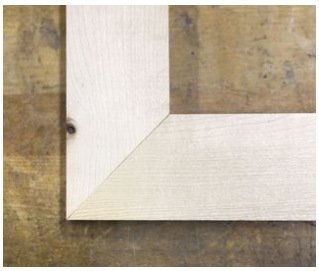
Sanding your work is a cornerstone of any woodworking project. This short lesson looks into the details of how and why to sand your work.

Lesson 6: Wood Shaping

There's no substitute to learning the age-old craft of shaping wood by hand. This lesson explores the basic techniques and processes for shaping wood by hand. This lesson explores these techniques by making a Salad Servers as part of the lesson.

Lesson 7: Hand Router

Arguably the most versatile hand tool in the woodworker's arsenal, the router can preform a variety of duties with ease. Learn all the tricks and the core types of router bits you need in this lesson, then finish up by making a Magnetic Knife Rack.



Lesson 8: Bevels and Mitres

Bevels, mitres, what's the difference? Learn all about these angled mysteries and learn how and why they are used. We'll make a picture frame that uses both bevels and mitres. You'll be a mitre master before you know it!

Lesson 9: Color + Finishes

Seal and protect your work with color and finish. Dive into the different types of finishes your work can have, and what makes some sealants food safe in this lesson.

LESSON 1: TOOLS + SUPPLIES

Chances are that you, or someone you know, already own some basic tools that you can get started with. It really doesn't take many tools to accomplish a wide variety of everyday projects. Some tools are basic and shouldn't cost a lot, some tools are used loads and may require a higher quality so you're satisfied, and some tools you won't need at all!

The barrier to learning about woodworking shouldn't be behind having the biggest shop with the best tools, there's lots of people who live in apartments without shop access or who don't have the money for fixed machines like table saws. *With this in mind every lesson in this class uses basic hand power tools to teach the skills and make the projects.*

As a general rule, I like using corded power tools as they perform better since they don't run out of juice, and you don't have to mess with batteries - a power drill is my exception, but you'll find your own personal favorites as you progress.

Here's all the tools I use in this woodworking class:

- Power Drill
- Circular saw (or hand saw)
- Hand router
- Jigsaw
- Random orbital sander
- Tape measure
- Clamps, clamps, clamps
- Speed square
- Wood glue
- Hot Glue
- Double-sided tape
- 4-way rasp

- Hammer
- Sandpaper
- Screwdrivers
- Miter box

Personal Protective Equipment

- Eye protection
- Hearing protection (I like the over-ear style)
- Dust mask
- Fire extinguisher (a shop necessity)
- First aid kit (just in case)

Workshop Tools

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Drill

Corded drills have more power but are tethered by the cord and may lack some of the features that cordless drills have, like torque control. If you're serious about woodworking, or looking to up your game, a quality drill like the Milwaukee M18 I use in this class is about $75 by itself, but you can usually find it bundled with some other goodies which helps justify the purchase.

Circular Saw

I recommend a corded 7-1/4" blade circular saw. Since circular saws use lots of power (and you don't want to be changing out batteries partway through your build) get a corded saw. Look for a circular saw with a controllable blade depth, and one with a tilting base that allow bevels - both standard features. Look to spend $50 - $80 on a quality saw.

Hand Router

A hand router is one of my favorite woodworking tools and has many of uses besides providing a decorative edge profile. A small palm router like the one shown here is usually more than enough for most woodworking jobs, but there's also a larger plunge routers which have a spring-loaded base that allows the router to dip into the wood.

I use a Bosch 1HP palm router for almost every project; it's got good power, it's easy to handle, and has excellent build quality.

Jigsaw

Jigsaws are great for curved cuts that have a tight radius. There's interchangeable blades that can be used for fine cuts or faster coarse cuts, and different lengths of blades. Your jigsaw will have a adjustable base that lets the angle of the cut be set - a standard feature. I like corded jigsaws as they have the power for a consistent cut, unlike battery power which can make the action sluggish when they run out of juice. As with circular saws, try your hand at a few and see which one feels good to you. There's not much to a jigsaw, so don't spend more than $60 on one.

Orbital Sander

An orbital sander has an adhesive base that sanding pads can be easily and quickly interchanged. Look for a sander that has a variable speed which will allow you to refine your sanding and can provide less fatigue, and pick up a few extra sanding pads of different grits.
Go with a corded sander over the cordless, since you'll be sanding for a while you'll want all the power you can get without changing batteries. Plan to spend $50 - $80 on an orbital sander that feels good in your hand, and has a variable speed.

Aside from power tools there's a few more tools to have on hand that you're going to need.

Clamps

You really can't have enough clamps. I'd recommend a few different types, and different sizes, so you've got a clamp for all occasions. When you're doing a big glue-up you'll be surprised by how many clamps you end up using, and the clamp you wish you had on hand.
The quick-release clamps are handy to have, but I wouldn't rely on them under stress as they aren't as secure as bar clamps with a twisting handle. Clamps can cost anywhere from $10 - $50 depending on the type. A few bar clamps and spring A-Clamps to get you started should be good.

Square

Shown here is a speed square (or carpenter's square), which is great because it combines a few functions like protractor, a square edge, a 45 degree edge, and even has rafter/stair calculations on it...all in one!
The square also has some thickness to it, so it can easily be used as a saw guide. Though plastic squares are available, look for the aluminum one as it's more robust.

Adhesives

Along with clamps, holding wood down while your working can be a challenge. For the times when a clamp is too large, or just gets in the way, double sided tape and a hot glue gun are great alternatives. Double sided tape goes for about $10 a roll, and any type of hot

glue will work so shop thrifty. Of course, we're also going to need lots and lots of wood glue. There's even an entire lesson in this class dedicated to glue.

Measuring

Of course, every woodworker is going to need a good tape measure. Avoid the fancy tape measures with frills and go for something simple. Also, chose a tape measure that has both metric and imperial units. Even if you don't use one of the units, you'll be glad you have it for the once in a lifetime project where you need it.

Of course, there's the workshop staples of a **hand saw**, **hammer**, **4-way rasp**, **sandpaper** , and **hand screwdrivers**. If you plan on making lots of handsaw cuts, you'll probably want a **miter box**.

Outside of this woodworking class you're likely to use these tools for everyday projects, too. Think of it as an investment. You don't have to buy expensive tools to achieve great results, but avoid buying cheap tools as they usually don't hold up to much use. It's best to buy standard tools and then upgrade later if you want special features.

Personal Protective Equipment (PPE)

Think back to your high school shop teacher, do you remember how many fingers they had? No matter if they were missing any, the answer is always safety.

All power tools pose a *serious safety hazard*, and this will never be more evident until it's too late. Tools spin very fast and have more than enough torque to cause some very serious damage to your body, and in extreme cases even death. Keep this sobering reminder in the front of your mind before you start any work, as the smallest mistake can have some serious consequences.

PPE - Personal Protective Equipment (shown above)

Eye Protection*is a requirement!* The smallest speck in your eye, no matter the severity, can take you out of commission for the rest of the day. I don't even enter the shop without having eye protection on, and you shouldn't either. Your eyes are much too valuable to not protect, and eye protection is cheap.

Hearing Protection, either over-ear or in-ear, provide relief when using any power tools. Hearing loss is measured by duration of exposure, so while it might not seem too loud at the moment by the end of the day you've been exposed for a long time and have caused damage to your hearing.

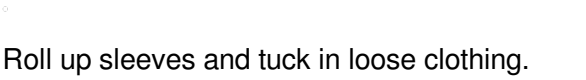
Dust Masks are great to prevent inhalation of wood dust. It might seem benign, but wood dust is listed as a hazard by safety organizations. Also, picking out weird dust-boogers after a long day of woodworking is kinda gross.

Gloves might seem to be missing from this list, but they're actually not. While gloves are great for a variety of uses, working with woodworking machines is not one of them. If your glove gets caught in a machine while running it can suck your hand in with it, but if you were wearing no gloves you stand a better chance of damaging a smaller portion of your body.

Aside from PPE, you should also limit your exposure to equipment entanglement by tying back long hair, removing jewelry, tucking in loose clothing.

Tie back long hair

Remove jewellery



Roll up sleeves and tuck in loose clothing.

While many wounds in the shop are cuts caused by sharp blades, there's the real risk of avulsion (skin being ripped off) from many of the fixed power tools, such as the lathe or drill press, where the tool catches a ring or watch and pulls it into the machine. Even though we're not working with fixed power tools in this class, there's always a risk when working with any tools.


INSTRUCTIONS
A
B
C
AMEREX

Shop Safety

Fire Extinguisher

Wood is flammable, and wood dust is extremely flammable. Keeping a fire extinguisher easily accessible in your shop is smart and super easy. Locate your fire extinguisher somewhere visible, easily accessible, and preferably near your exit.

Egress

This might seem like a no-brainer, but keeping your exit path clear is something easily forgotten. Shops are busy places and can be cluttered up with raw materials and half-built projects. Take the time to organize your shop so that you always have a clear path in an out of your shop.

First Aid

Accidents happen, let's hope it was minor and you can get back to work. Keep a first aid kit in your shop and keep it stocked. At a minimum you should have bandages, a tourniquet, antiseptic, and eye drops. A more comprehensive first aid kit is never a bad thing, so go crazy making sure you've got the best first aid possible, your injuries will thank you later for it.

Now that we have the boring safety stuff out of the way...

Before We Start...

Keep these things in mind as you progress through the class:

- **We all make mistakes.**
  Learn from what happened and change your approach next time. Also, try not to obsess about small imperfections in your work, chances are you're the only one who will notice them!

- **Take your time.**
  Woodworking is incredibly satisfying, so enjoy the process - the smells, how the wood feels, and how it reacts while you are making. I learn new things about wood all the time, and taking your time with projects allows the journey to be just as enjoyable as the destination.

- **Have fun!**
  There can be frustrating times when something is not working. Remember that you're learning something new and that's to be expected, most times you can start over or fix a piece and you'll realize it not a big deal. Take breaks and examine your work objectively, and remember that with practice things get easier; You'll be a pro in no time!

- **Ask for help.**
  We're all learning new things, so talking about your project to another hobbyist or expert can be a very rewarding exchange. There's an entire community at Instructables with knowledge to share that would love to be part of your project, and that includes me! Ask for help if you need it, you'll be happy you did!

Ready to get started? Let's go to the shop!

LESSON 2: MAKING PERFECTLY STRAIGHT CUTS

One of the first things any woodworker is going to be faced with is making cuts, either by hand or with a power tool. It might seem like just diving in is the way to go, but there's some finesse in how to make your cuts accurate, square, and as clean as possible.

Before we start cutting wood to the right size, let's learn a very misleading thing about wood dimensions.


SIERRA PACIFIC INDUSTRIES
2" X 4" X 8'
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ft
25ft
2
STANLEY
3
4
in


SIERRA PACIFIC INDUSTRIES
2" X 4" X 8'
1
ft
25ft
2
STANLEY
3
4
in

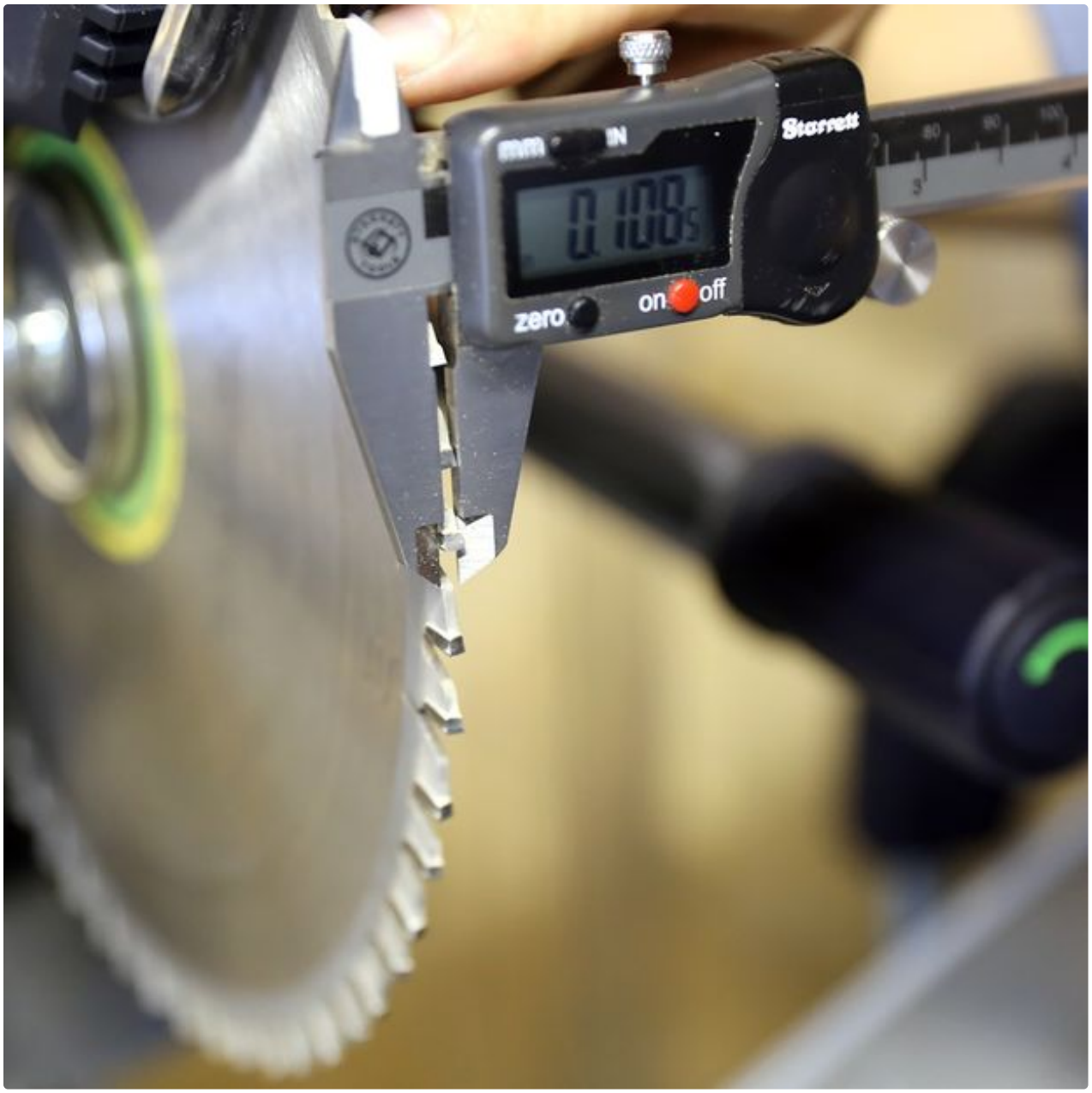
Nominal Vs. Actual Dimensions

The wood dimensions listed on lumber are a big fat lie. It's not really a secret, as every carpenter knows this, but it's something you should be aware of before buying the wrong size for a project.

We've all seen lumber dimensions in the home stores, like 2x4's, which is indicating the cross section dimension of the lumber - in this example 2" by 4". However, if you take a tape measure to the wood you'll notice that it's not really 2" by 4" at all, it's about a ½" shorter on both measurements giving you a 1-½" by 3-½".

Part of the reason is that when a tree is felled and chopped up into boards it has a lot of moisture still inside, when the wood is kiln dried it shrinks and warps after losing the moisture. To account for this the mills then process the wood through a plane to smooth down the surfaces and clean up the edges, ideally giving you a straight and smooth board, at the expense of some lumber dimension. This is true for lots of dimensioned lumber, so be aware and always double check the dimensions at the store before buying.

Knowing this will help you plan for your projects and account for the actual dimensions you need, and what you should be shopping for when you pick up lumber.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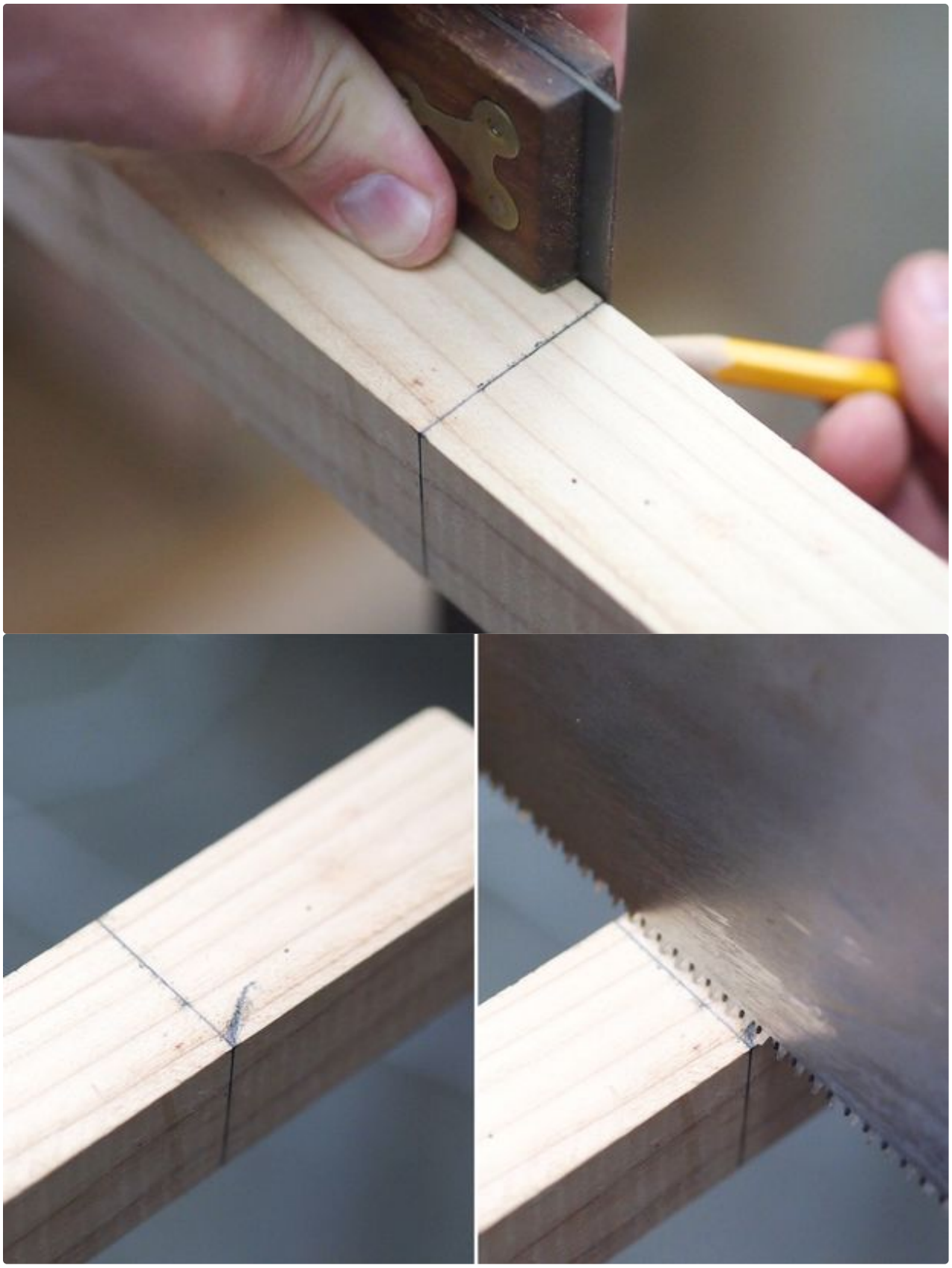
Kerf

Once you know your lumber size you're going to want to cut it to size. Any cutting will result in some loss of wood that is turned into sawdust, this is called the **kerf**. The kerf is the divergence between the left and right sides of the saw teeth, and since the teeth of any saw is larger than the blade thickness **you'll want to measure kerf from the teeth and not the blade**.

When you are cutting you typically want to cut on one side of your marking line so the **kerf** doesn't cut into your piece and remove some of your measured material.

On a circular saw there's a small indent on the plate, this indent represents the blade kerf. Knowing about kerf will help us work out how we measure and layout or material before cutting. **Your saw marking will likely be different!** And, the type of blade you're using might have a different kerf. Always make a few tests cuts to see where your notch/marking end up with your blade setup.



Layout + Cutting

Cutting wood is easy, but takes a little skill to make sure your cuts are straight and square.

To cut square (at a 90° angle to the length of the wood) you'll need to make a square marking, align the edge of your square along an edge of the wood where you want to make a cut and draw a line with a pencil. Rotate the square and make corresponding lines along the sides of your cut line, these side cuts will help guide your cut to ensure that your blade isn't wandering off the cut line.

When marking I use a little **check mark** that tells me on which side to cut on, if I line the **kerf** up to the checked side of the line I know that the piece I cut will be exactly the right size. If I cut directly on top of the marked line the **kerf** would eat into a small portion of the measurement. This might not seem like a big deal, but when your entire project doesn't fit by 1/8" it can be very frustrating.

Of course, you can always use a mitre box with your handsaw to keep things nice and straight if the marking technique doesn't work for you.


IRWIN
QUICK-GRIP

Straight Cuts in Plywood

Cutting straight in plywood is a little easier, since the blade doesn't wander as much during a cut.

Measure and mark where you want to make a cut, remember to add a check mark on your line to determine which side you're cutting on. Secure your wood to a workbench or other stable surface with clamps.

You can make a cut without any guides by carefully following the line with your cut notch on your circular saw, but an easy way to get perfectly straight cuts it to set up a fence. A fence is a straight member used to guide the plate of the circular saw. Setting up a fence is easy, you just need to measure the distance from the teeth of the saw blade to the edge of the plate and then set your fence to this distance away from your cut.

Plywood cut set up with fence

Clamp the straight edge to either the wood or the workbench to ensure it doesn't move. Be mindful when cutting that you want to set up your work so that any cuts fall away safely.

The extra setup may take a little longer than just eyeballing the cut. Straight edges on your cuts are the hallmark of a pro.

Plunge Cut

A plunge cut is where a cut starts in the middle of the board as opposed to the ends. Plunge cuts can be a little tricky, but get easier with a little practice.

Before cutting carefully line up your circular saw above where you want to cut, making sure to account for the kerf and which side of your mark the blade is on. Rest the front of the base on the board and lift the back of the saw up so the blade is not touching the wood, start the blade spinning and slowly lower the blade into the wood using the front of the base as a hinge.

As with all cuts, make sure your piece is securely fixed to your workbench and always be aware of what's underneath your cut.

Tearout

You may have noticed when cutting wood that there's a ragged edge to your cuts, this is called tearout. Tearout is the ragged edge cause after cutting wood, there's a few reasons why this happens and luckily a few ways to prevent it.

Tearout occurs only on one side of your work piece, the side where the blade exits the cut, for circular saws this will be the side of your wood that is facing up when you cut. Consider flipping your wood to have the best (or "show") side facing down and the ugly (or "hide") side facing up, that way any tearout will be on the less nice side of your wood.

There's a few things you can do to prevent tear out: using a zero clearance board, making a scoring cut, and slowing down your cutting rate / using a different blade.

Zero Clearance

Zero clearance sacrificial board on top

The best way to avoid tear out is to use a sacrificial board to support the wood while the blade exits the cut, this sacrificial board is called zero clearance - meaning there is no clearance between your work piece and the sacrificial board that is abutting your wood. This sacrificial board supports the wood fibres as the tool exits your work and allows a clean cut all the way through.

Scoring Cut

Shallow scoring cut before making deeper cut

Another method of preventing tearout is to make a shallow cut along your cut line to make a groove in the wood. This shallow cut usually doesn't cause any tearout and will prevent the following cuts from creating any tearout on the surface of your work piece.

The plate of a circular saw can be raised and lowered to expose more or less of the blade. The plate height can be adjusted by releasing a tension lever on the back of the saw near the blade and pulling the plate downwards. To make a scoring cut the plate should only expose 1/16" to 1/8" (2-4mm).

Feed Rate + Blade

Different blades have different feed rates

Tearout can also be caused by the type of blade you're using. A large toothed blade will have fewer teeth and will cut wood much faster and aggressively, but can leave a splintered edge from cutting too fast. Switching to a blade that has more teeth will cut less aggressively, will cut slower, and leave less tearout. Slowing down the feed rate (how fast you cut through wood) can also give better results.

Project to Try + Next Lesson

Making straight cuts with your hand or power saw is a cornerstone of almost every woodworking project. As with any skill, practice makes perfect and you'll gain more confidence with each cut you make.

An easy project to make while practicing your straight cuts are **yard dice.** This lawn game is a great way to hone your straight cuts, and then gave a fun project to show off and play with outside. Why not try it out and see what your yard dice come out like?

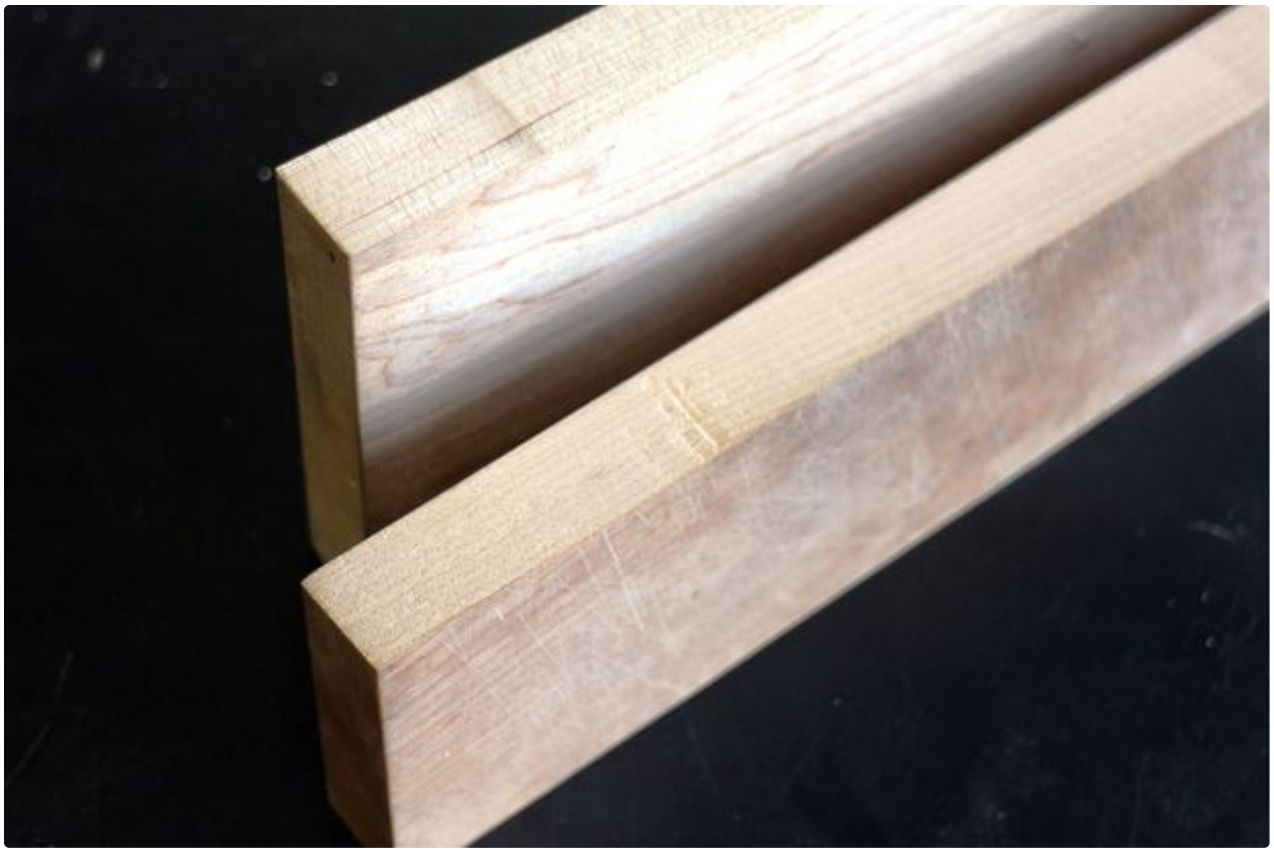
Now, let's move onto the most helpful tool in the woodworker's arsenal: **glue**.

LESSON 3: ALL ABOUT GLUE

For woodworking there's a few types of glue that are used, but by far the most common is carpenter's glue. This type of glue is called polyvinyl acetate adhesive, or PVA for short. PVA glues are inexpensive and have great holding ability, making it an ideal woodworking adhesive.

There's lots of different types of PVA glue to chose from, but I like to use Titebond III which is waterproof, has great adhesion, and accepts paints and finishes.

Some other choices for woodworking glue include CA glue (cyanoacrylate or Super Glue), hot glue, or polyurethane construction adhesive (used with a caulking gun); each has its own performance abilities and limitations, but for the scope of this course we're going to cover common carpenter's glue (PVA).



Glues and Grains

Gluing two pieces of wood together is fairly straightforward, but you do have to pay attention to the pieces you are gluing.

You'll hear the term "wood grain" used in the workshop. Wood grain is the longitudinal arrangement of the wood fibers and is an important attribute to understand for woodworking. Different types of wood have different grain structure, but all wood has a "direction", this can be categorized as **straight grain** (parallel along the direction of the grain) or **cross grain** (perpendicular to the direction of the grain).

When gluing it's important to know that the two aspects that make a good joint are surface area, and grain direction. Surface area is the amount of surface that will be glued together, so a butt joint connection will have less surface area than a finger joint connection.

The grain direction means that a joint along the direction (straight grain) of the grain will be stronger than one that is against the grain (cross grain).

This is easily seen if you look at the end grain if a piece of wood, the porous end grain doesn't have the same strength as gluing along the grain. While end grain glue joints can work, they will probably fail eventually or will require some other method to help support the joint. A good everyday example of this is a picture frame, which has mitred corners which are end grain - if you look you'll probably see a nail or some other supporting joinery which holds the joint together. We'll tackle this exact problem in **Lesson 8 - Bevels and Mitres** when we build our own custom picture frame.

Clamps

With almost every woodworking project you make you're going to need a clamp somewhere along the way. Clamps allow you to hold things together while glue dries, or just hold a piece in place temporarily while you work on another part. There's loads of different types of clamps out there, and you can never have too many of them!

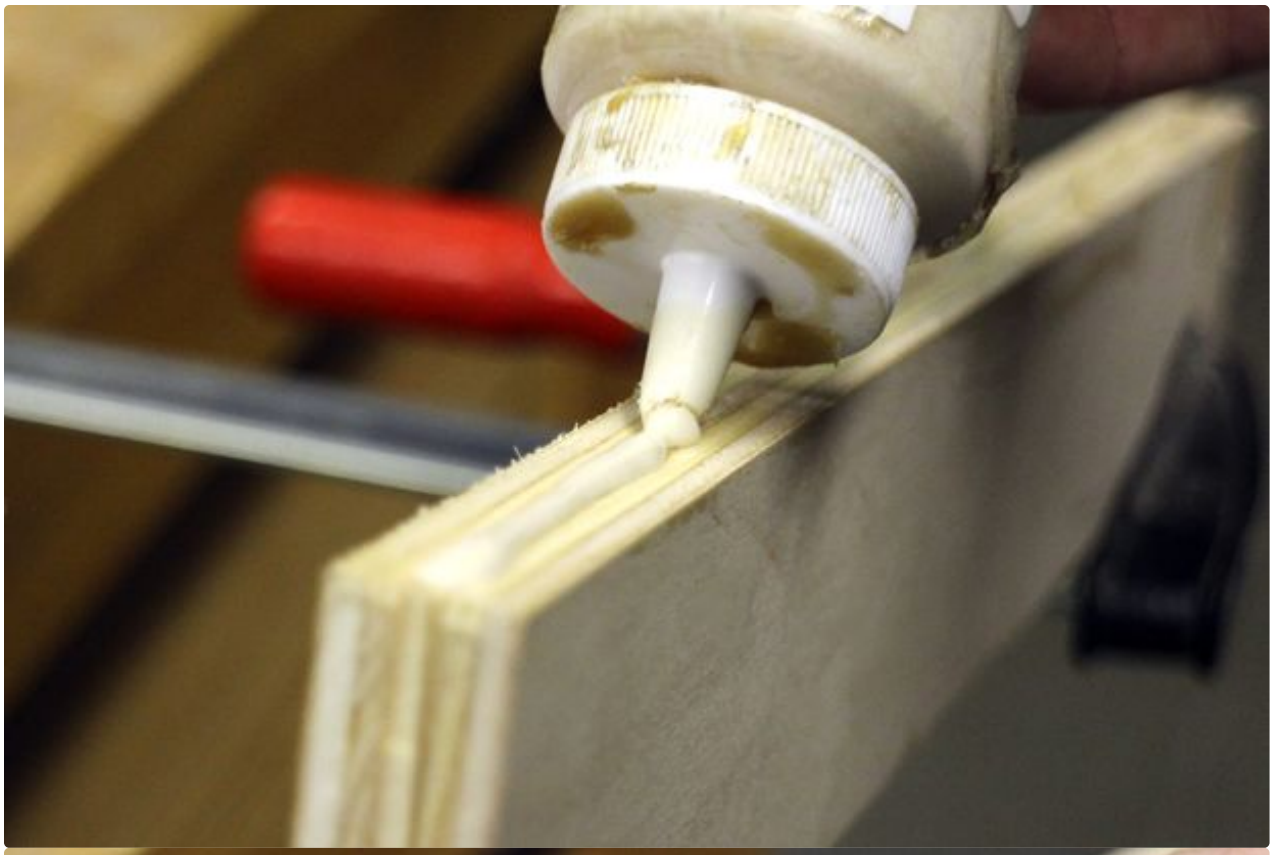
Shown above there's a band clamp, a bar clamp, a spring clamp (also called an A-clamp), and a ratcheting bar clamp. There's plenty more types of clamps out there, and they all have a variety of uses.

When using glue you're going to want to use clamps to keep your work securely in place while the glue dries. Invest in a few clamps of different types and sizes to start off to find the type that works best for you, it's one of the best tools in the shop.

Cover Work Area Before Gluing

A common mistake is to start a glue up without covering your work area before you start, at best this makes a big mess to clean up but at worst it can result in gluing your project to your workbench! Rolls of "builder's paper" are inexpensive, but old newspapers serve the same function and are free.

When your glue dries to the paper it'll be much easier to remove with a knife, scraper, or sanding than trying to repair damage from having it stuck to your workbench.



Glue Application

There's nothing special about applying carpenter's glue, but it's important to take care when applying and to use the right amount.

Before starting any glue up consider first what you're going to need to hold your piece together, maybe it's a few clamps, or maybe it's tape. Make sure you have your supplies close at hand before starting anything, it's a real pain to scramble afterwards for that last clamp.

When you're ready to glue apply a bead along your work surface, then drag your finger along the bead to evenly spread out the glue.

Since glue can cause wood to swell where it's applied it's important to joint the pieces quickly after glue application, this is especially true for joints that have tight tolerances.

Clamping + Cauls

Once the surfaces are glued together you can clamp your work until the glue has set. When clamping it's good to apply pressure to the pieces being glued, but over-tightening can cause too much glue to squeeze out the pieces may not bond.

For some pieces you may need clamping pressure on the top and bottom to keep your pieces level or aligned. Adding straight scrap pieces to the top and bottom of your glue up, and then clamping them in place, can help keep your work stable and level. These wood pieces that transverse the glue-up on the top and bottom are called cauls.

Cauls added to top and bottom of clamped piece

To make things even easier for cleanup you can add a barrier of paper between the cauls and your work so you don't accidentally glue them together.

When tightening your clamps make sure not to over-tighten, which not only squeezes out all the glue, but can also dent and damage your work.

Dent in wood caused from over-tightening

Glue Cleanup From Wood

One of the best methods to remove excess glue from your work piece is to rub sawdust all over the joint. The sawdust will mix with the glue and clump together, making cleanup a breeze. You should avoid using a wet towel or sponge as moisture causes wood to swell and too much might deform your work. Sawdust is an easy and readily available solution to glue cleanup.

It is important to clean up the extra glue as soon as possible since wood that absorbs glue will stain differently than the rest of the wood.

A putty knife makes a great tool for both glue application and clean up

Another great method for applying and cleaning glue is a putty knife, the flat surface does a great job of evenly spreading glue over your surface and the sharp edge makes cleaning up excess glue easy.

Glue Cleanup From Hands

If you get any glue on your hands after your piece is secure you can easily remove it by just rubbing your hands together. Wet or still damp glue should just flake off.

Wrap Up

PVA glue is invaluable to a woodworker, and can offer much more strength to wood when bonding along the grain than mechanical fasteners.

However, glue is not the solution to ever problem a woodworker will face. In the next lessons we'll learn about drilling openings, which then can be used for mechanical fasteners like screws; perfect for applications where you don't want to rely on glue.

LESSON 4: DRILLING PERFECT HOLES

Drilling holes in things isn't difficult, but knowing a few tricks can improve your projects dramatically. In this lesson the basics of power drills will be covered, as well as techniques for drilling small and large holes.

It seems simple, but there's lots that can go wrong when drilling from wandering drill bits, holes that don't line up, and tear out. Understanding the tool limitations and how the bits work is the best place to start, at the end of this lesson you'll be a pro in drilling.

This fundamental skill in woodworking will be used in almost every project you make, and with a little practice will become second nature. Most of this lesson can apply to both corded and cordless power drills, but for this lesson I'll be exclusively using a cordless drill.

Torque and Speed

Most of today's power drills do double duty and can be used to drill openings and drive screws. You may not have noticed but most drills actually have settings on them which you can dial in for different applications - some fancier models even have a speed control which you can change from low to high, giving your drill an ever wider range of settings.

Torque Selection (Clutch)

The business end of the drill is called the chuck, this is where you insert drill bits. Most drills have a ring of numbers around the chuck, this is the clutch that lets you select the torque for driving screws. You can rotate the ring to choose the torque value of your drill, which will stop the drill from spinning when it reaches a certain amount of resistance: higher the torque value the higher the resistance threshold. This is great when you don't want to over tighten a screw and risk it snapping or boring too far into the wood.

At the end of the torque selector is a drill icon, this tells the drill that you are drilling and have no need to limit the torque (maximum torque).

Speed Selection

With most drills the rotational speed can be controlled by how much pressure is applied to the trigger, but many drills will also have a speed selector. This allows you to switch from high speed to low, perfect for driving screws (low speed) to drilling (high speed)

Drilling Vs. Driving Bits

Most drills can handle the double duty of drilling holes and driving screws. There's a few different types of drill bits used to make openings and choosing the right bit is important since different drill bits excel at different things.

Countersink - Used to create a conical hole in your work so when a screw is placed inside the hole to sit flush with the surface of the surrounding wood.

Driving bits are used to drive screws into wood. There's many shapes that correspond to the head shape of the screw you are using. For clarity, "*cam out*" is when you are driving a screw and the head slips out of the screw head, this can cause the head of the screw to "*strip"*, meaning deform the shape of the head making the screw unusable.

Driving Bits:

Slot - Common style of driver. Advantage is less rotational force needed due to the leverage of the head width, disadvantage is cam out and the driver does not automatically center to the screw.

Robertson - Also called square drive. Advantages are ease of use since screws stay on drive and virtually no cam out, disadvantage is they are not common in some areas (mostly America).

Phillips - Widely used and versatile screw. Advantages are that even incorrect size drive can fit into screws, disadvantage is moderate cam out (though some screws are designed to induce cam out to prevent over tightening).

Torx - Advantages include high torquing and very low cam out, disadvantages are availability to consumer and the accessibility to the right bit when disassembling your work.

Allen - A relative to Torx and can sometimes be used interchangeably. Advantages are low cam out and high torquing ability, disadvantages are that it's uncommon for wood screws (mostly used for machine screws). You probably have a bunch of Allen drivers from IKEA furniture.

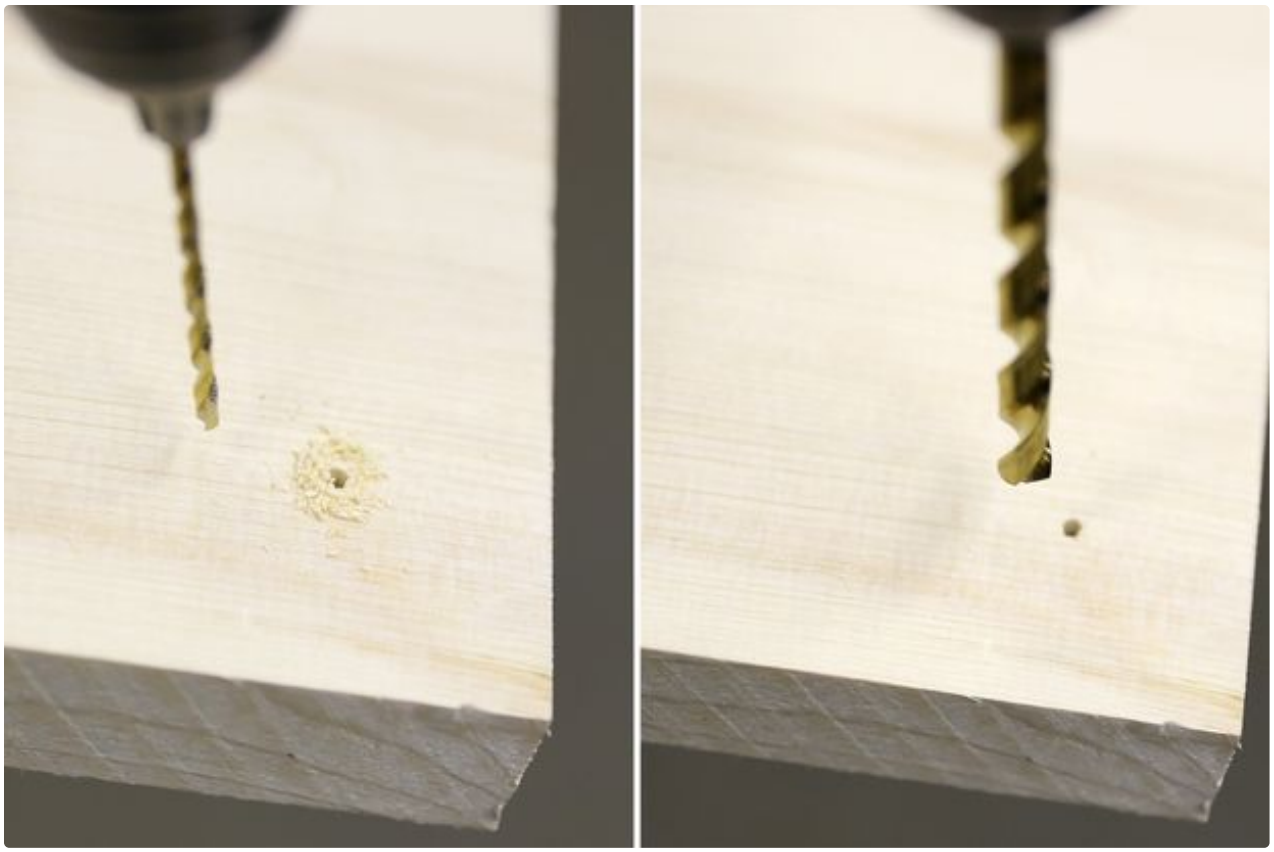
This is just a sampling for the many types of screws you're likely to run into. For most projects you'll probably use the most common screw which is the Phillips screw, possibly the Robertson. Start with getting a small selection of each and you'll have most of your options covered for almost all your projects.

Tear Out

While drilling openings into wood you may notice a ragged exit hole, this is called tear out and it can ruin an otherwise nice piece of wood.

The easiest way to prevent tear out is to support your work at the exit point of the tool. Tear out happens because the wood fibers get caught on the drill bit and pushed out the wood, with a sacrificial board supporting the wood fibers at the exit point of the tool you can prevent tear out - this is called **zero clearance**. To make a zero clearance drill support all you need to do is sandwich another wood board underneath your work, then clamp them together. Zero clearance was explored in previously in **Lesson 1 - Tear-out**.

If you don't want to use a zero clearance board another trick is if you have a concealed side to your work you can make that side the "exit" side of your drilled opening, leaving the starting point of your drilled opening the "show" side.



Pilot Holes

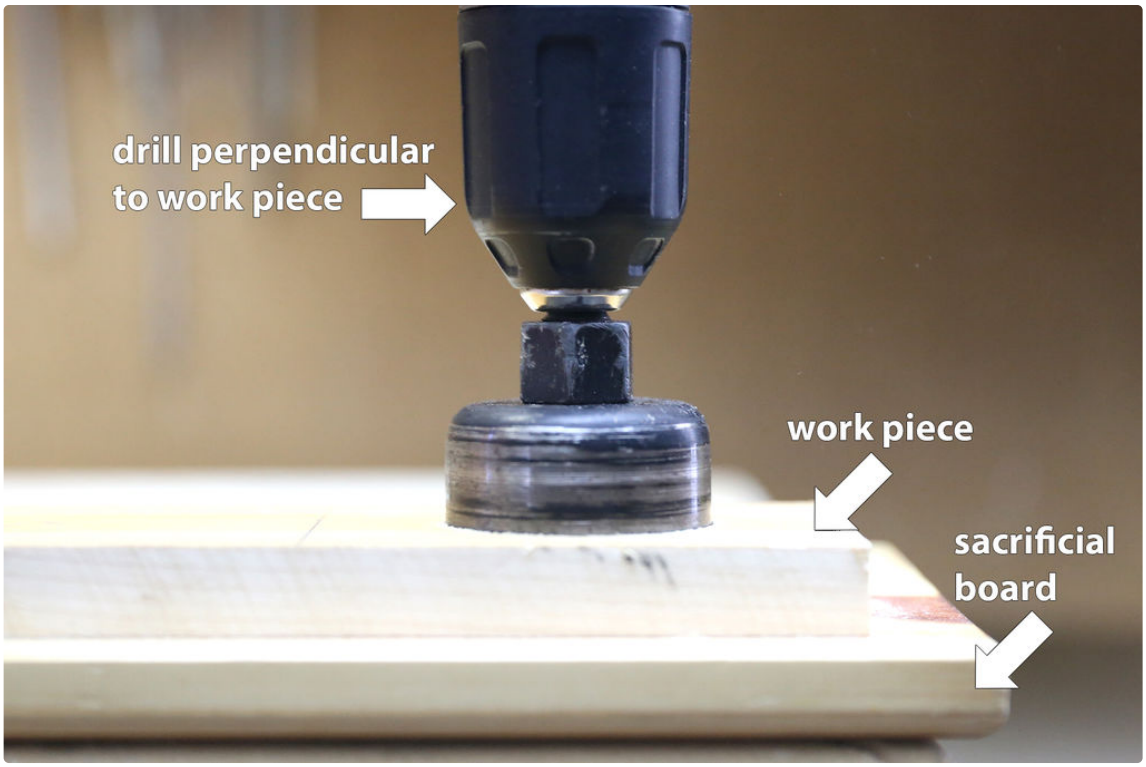
To make drilling easier and more precise, especially in dense hardwoods, drill a pilot hole. A pilot hole is a hole with a smaller drill bit than your final size.

This smaller hole will help guide the larger bit for the final size of the opening, and also has the benefit of allowing you to see and correct any minor drilling mistakes before committing to the larger bit.

Hole Saws

Hole saws are used to drill out large diameter openings in wood. They come in a variety of sizes, usually stepping up in diameter by " or ¼" increments, but there are specialty hole saw sizes for any diameter if you're willing to pay for an unusual size.

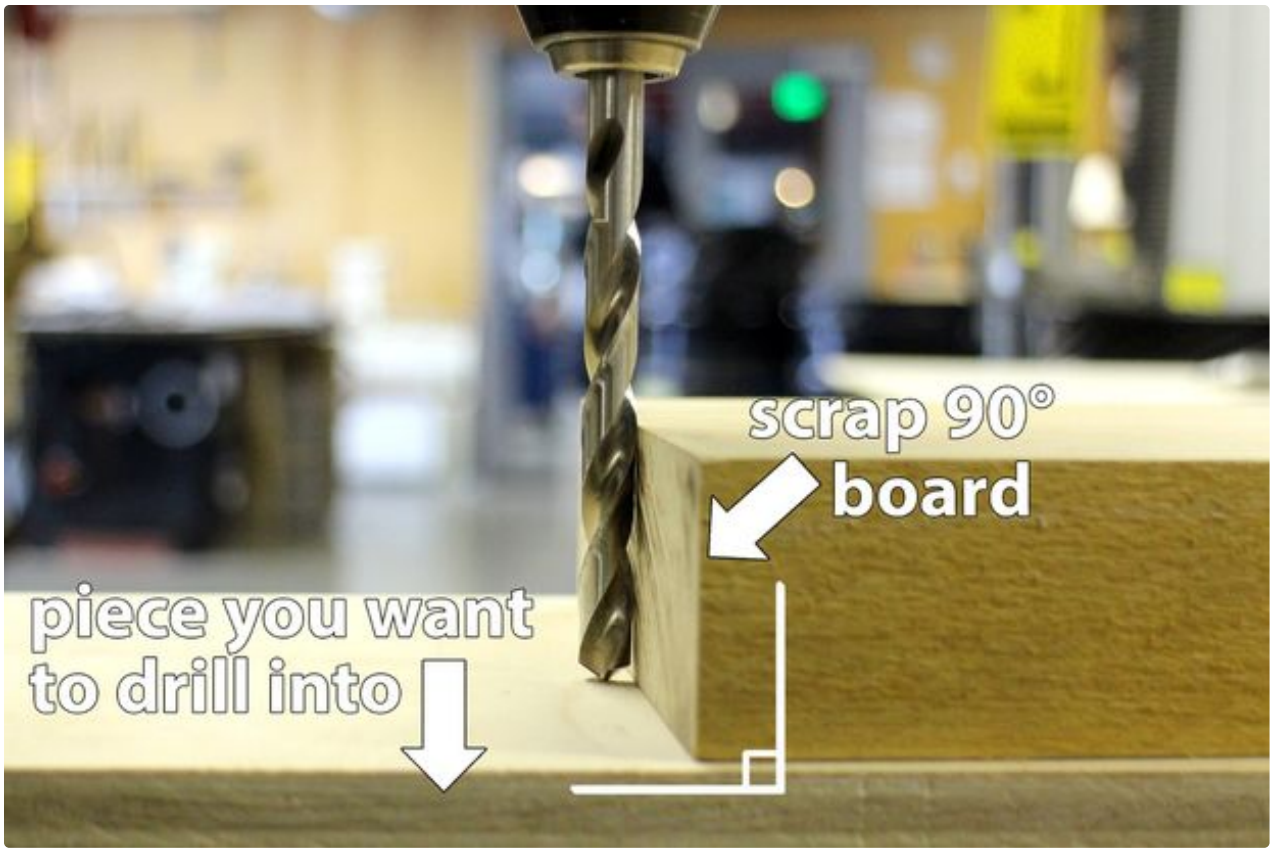
To prevent tearout, use a sacrificial piece of wood under the wood you are drilling a hole through.



Even though hole saws are removing the perimeter of your hole and will create a plug when finished drilling all the way through, they are covering a lot of surface area and can get bogged down easily. Go slow with the hole saw and push gently, allowing the hole saw teeth to do the work.

After drilling you should have a plug inside your hole saw from the wood you just cut, this plug can be easily removed by inserting a screwdriver through one of the openings in the side of the hole saw and working it out.

If your work was clamped properly, and you used a sacrificial board underneath, you should have clean holes in your wood.



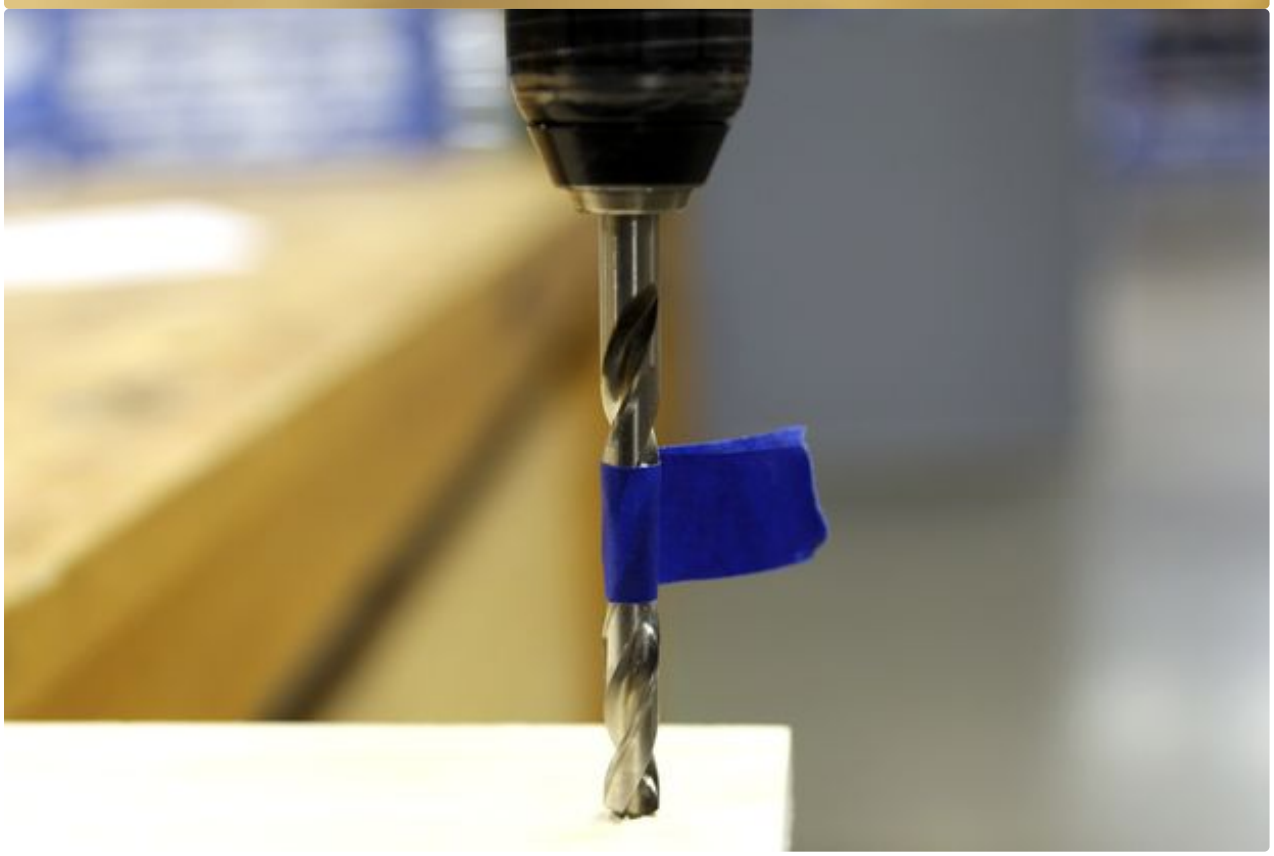
Drilling Straight

Drilling an opening into wood isn't difficult, but you may notice that even the slightest tilt can make your exit hole somewhere you didn't mean to. Some of this can be corrected by using a pilot hole, but you can get consistently straight holes by using a scrap piece of wood that has a squared end.

Honing our skills from **Lesson 1 - Making Perfectly Straight Cuts**, we can easily make a straight square cut on a scrap piece of wood and then use this as our reference piece to drill straight holes.

Mark where you want to drill a hole, then place your drill bit on the point. Next bring up your squared scrap against your drill bit until the drill bit sits flush against the squared end. You can move the scrap piece around to the perpendicular side of the dill to check both directions for squareness.

A drill press is a fixed tool that is set up just for drilling straight holes perpendicular to the work piece. The next step if you find yourself doing lots of drilling would be to invest in a drill press, it can save a lot of setup time.



Simple Depth Guide

There's going to be some occasions where you'll only want to drill into wood a certain distance and not all the way though. A very easy way to manage drilling depth is to measure from the tip of the drill bit the depth you wish to go, then mark that length with a small piece of tape. Drill down into wood until you reach the tape touches the surface of the wood.

A fun and easy project to hone your drill skills is an **upcycled bottle vase**, which uses all the skills taught in this lesson to make something functional and chic.

now that we've covered the basics on woodworking construction: cutting straight, drilling openings, and using glue. It's time to turn our attention to finishing wood by learning about **sanding**.

LESSON 5: SANDING

Before we go too much further into woodworking we should talk about sanding. In the previous three lessons, any sanding you did on the class projects was probably more than adequate, but with some very basic techniques you can greatly improve the quality and time it takes to make your projects beautiful.

Sanding is done to create an even surface and enhance the look of wood. It can take time to do a good job of sanding, but every project benefits from sanding.

Sanding is the action of removing small amounts of material from the surface of wood with an abrasive. Sandpaper comes in different coarseness levels, called grit. Coarse grit sandpaper is used to quickly remove lots of material, while fine grit sandpaper is used to smooth out an already mostly smooth surface and make it even smoother.

Grit Sizes

Sandpaper comes in different grit sizes.

Coarse grit (40-50) are great for rapidly removing material to shape wood, or to rough up a surface in preparation for gluing.

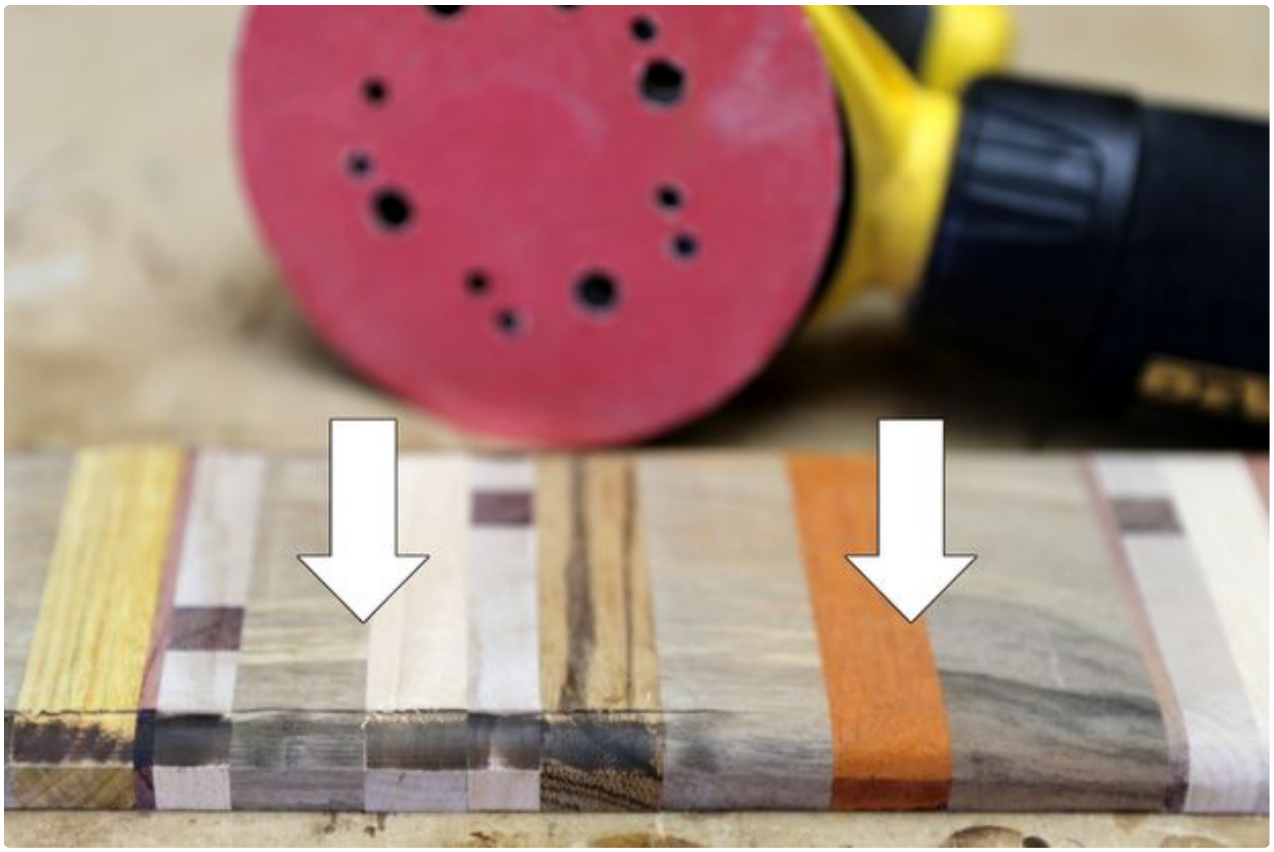
Medium grit (60-80) are for sanding smooth a surface after it's roughly the shape you want. These grits will remove tooling or abrasion marks from coarser sandpaper grits.

Fine grit (80-120) are for bringing a nice smooth finish to an already relatively smooth surface, can increase the sheen and will remove abrasion marks from medium grit sandpaper - great for preparing a surface for finishes.

Very fine grit (150-220) an even finer sanding finish - perfect for preparing a surface for finishes.

Micro grits (240-3000) are used either as a sanding in between coats of finishes or paints, or used progressively stepping up the grits to polish wood.

I like grabbing the assorted pack, which usually covers a few different grit sizes. Here's medium, fine, very fine, and micro mesh assortments.



Coarse to Fine

It might seem obvious, but it bears stating. Always start with a lower grit sandpaper and work the area of interest on your wood before moving up to a higher grit. Taking your time with the lower grits where a lot of material can be removed quickly will save you loads of work down the road.

Skipping grits can sometimes be okay, but skipping ahead to a high grit with a rough surface to sand will make long and tedious work - and may not even be that effective at smoothing. When stepping up to higher grits each grit corresponds to different depth of wood scratches in the wood, slowly smoothing out the surface. Spending the time in the early stages of sanding make the finishing work much more enjoyable.

Area to Sand

With coarse grits it's easy to see what area has been sanded, but this gets harder to notice as you step up to the higher grits. A great trick to help you visually is to scribble a pencil over the area you're working before you start sanding, as you start sanding you'll be removing a small amount of wood and removing the pencil marks.

Keep applying pencil to your work piece as you step up the grits to keep track of where you've sanded and what spots need more attention.

Working With Mixed Densities

Wood comes in all kinds of densities and each of these densities sand down differently. When working with mixed wood types be mindful that less dense woods will abrade faster than denser woods.

In the picture sown here there's an example of two woods that sanded at different amounts on the left side near the bottom.

Sanding Between Coats of Finishes

Painting over smooth work produces great results, but sometimes the paint can dry with small debris or rough patches. Sanding with a micro grit in between coats when the finish is completely cured and dried can produce very smooth results.

Make sure to clean the surface with a lint-free or tack cloth to remove any fine dust or debris.

Cleaning

After sanding it's good practice to clean up the mess that comes with sanding and take a moment to examine your work.

When working with fine sanding avoid the temptation to rub a damp cloth over your work to clean it, as water can cause wood to swell and deform. Use a lint-free cloth or even a tack cloth, which is a semi-sticky cloth used for removing fine particles from surfaces - works great for preparing a surface for finishes.

Take your time when sanding, and spend the few extra minutes with the coarse grit to really get your wood project in the best possible place before moving up to the next grit.

Sanding can be time consuming, but taking the time at every step of the way will give you immense satisfaction when your work is finished and looks amazing.

LESSON 6: WOOD SHAPING

Of course not all woodworking involves perfect cuts and power tools. A great attribute of wood is that it's an easy medium to work with and can be tooled easily by hand, taking shape in almost any way you can image. Wood carving is not quick, but can be very relaxing. A good way to think of wood carving is in stages, or layers. You'll start with roughing out a very general shape, then progressively step through stages to refine the shape into something more detailed.

Tools

Shaping wood doesn't require much in the way of tools, mostly a method of cutting your stock down to size, some finer instruments to make details, and a method to smooth it all out after shaping.

To cut the basic shape of your wood stock a pull saw or a jigsaw are great for removing excess material.

To shape the wood and give it a smoother appearance a 4-way rasp is vital, as is an assortment of sandpaper.

A 4-way rasp has a flat side and a half-round side, each end will have a coarse and fine. the half-round side is great for contoured surfaces, and the dual roughness provides a great combination of removing or smoothing material.

Wood Selection

Any wood can be carved and shaped by hand, however some types are easier to work with than others (especially when starting out).

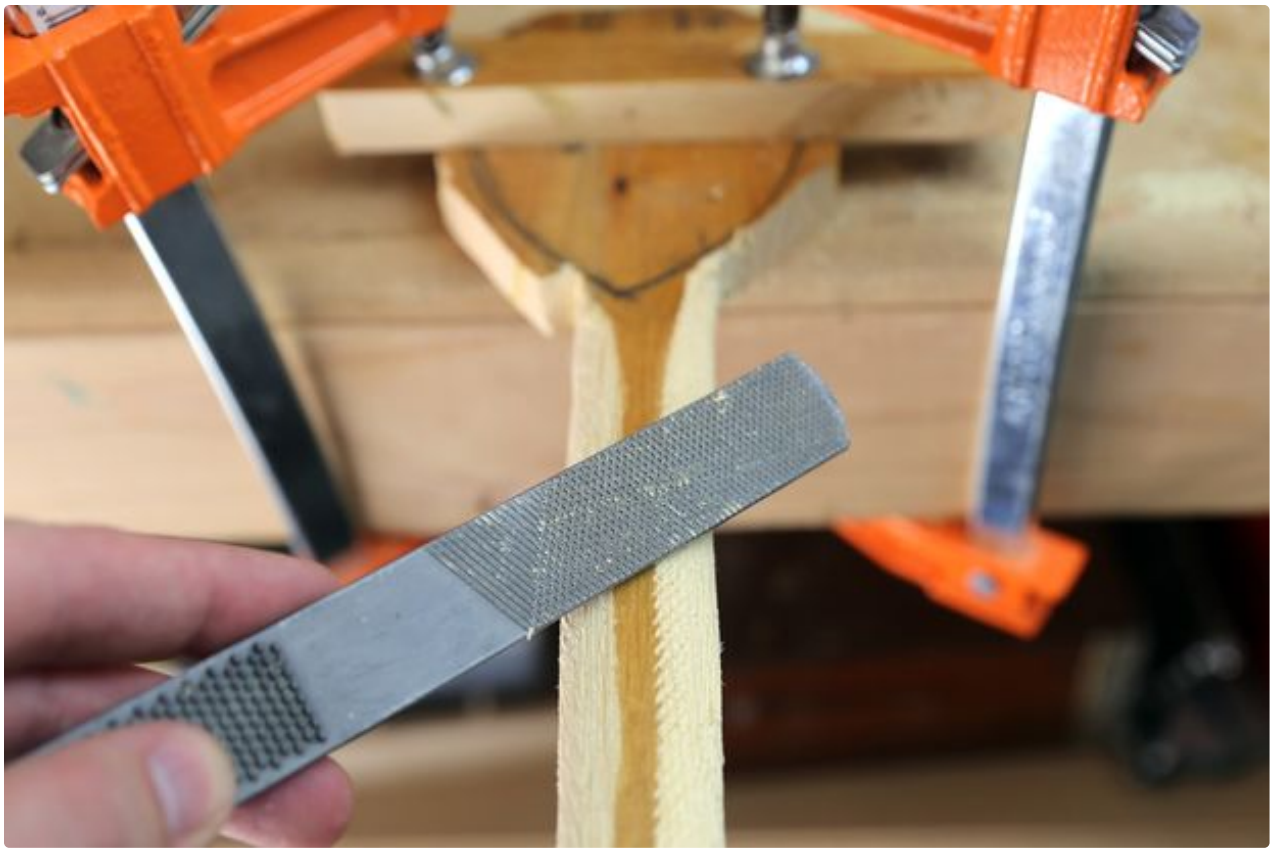
Wood hardness is measured by the Janka scale, which is how resistant wood is to a denting test. While the test is fun to try on your own the real take away is to know that different wood can have different densities and something to keep in mind when selecting wood to shape.

Luckily there's a plentiful supply of soft wood that's perfect for shaping in every hardware store: pine. Almost all wood framing studs in North America are either **s**pruce, **p**ine, or **f**ir (SPF). SPF framing studs are inexpensive, and perfect for hand shaping. Outside of the hardware store you can find pine (or other softer wood) from all sorts of places like old dressers, desks, or project boards. An easy test to see how soft wood is, try pressing your fingernail into the wood and make a dent - if your nail sinks into the wood easy and makes a mark then it's probably easy to shape.

Clamp Your Work

Hand shaping is very relaxing, but will become frustrating quickly if you don't have your work piece clamped down.

Use care when clamping your work, since clamping directly to soft wood would cause an indent in your piece. Use a sacrificial piece of wood was put between the clamps and the blank which distributes the load from the clamps across the wood and doesn't leave indents in the blank.



Rough Shaping With Rasp - Flat Side

A 4-way rasp has a flat side with coarse surface end and a fine surface end, and a convex curved side with rough and fine surface on the other.

For shaping on straight areas I use the flat side and start with the rough surface. The rough surface will remove more material but leave a very rough finish. This is perfect for getting the rough shape right.

Hold the rasp firmly in both hands with the rough surface over the wood, and then make a drawing motion diagonally to the wood.

Take time to make as many drawing motions to get the shape you desire. It makes more sense to do lighter passes and remove less material than to try and remove lots of material and go fast. Hand shaping takes time, but the results are worth it.

Rough Shaping With Rasp - Curved Side

The 4-way rasp has a curved side to get into areas where there's geometry that won't allow you to use the flat side. There is a rough end and a fine end to the rasp, depending on how much material you want to remove and how you want the finish to look.

In this serving spoon example the dish of the spoon head needs to have an indentation carved. To achieve this the wood was fist clamped securely, and then the curved rough end of the rasp was drawn over the deepest area of the indentation to start the gentle curve needed to dish the wood - this part can take a while as there's a lot of material to be removed to make the dishing shape.

Here's results after about 20 minutes. Take the time with the rough side to get the shape you want before moving onto the fine side and cleaning up the rough surface.

Sanding Smooth

Using the fine end of the rasp the head shape can be smoothed out, removing the tooling left from the coarse end of the rasp and filing down any rough or ragged edges. After learning about **sanding** we're ready to start sanding the rough shape smooth.

After some time with the fine end of the rasp the surface can be smoothed out more with coarse grit sandpaper, the grit of the sandpaper should be finer than the rasp - most fine rasps are equivalent to about 60-80 grit, so moving to 100 grit is a good choice.

Move your way up the sandpaper from 100 grit to 200 grit to smooth out the surface of your hand carving.

Hand carving is an art and takes practice and patience to get good results. There's a charm that comes from hand carved items, so never discount the aesthetic, sometimes perfection is not desired!

On the other end of the spectrum from hand carving is making curved edges and a power **router**. We'll learn all about this versatile tool in the next lesson.

LESSON 7: HAND ROUTER

A hand router is one of the most versatile tools in woodworking. More than just a way to bevel an edge, a router can create all kinds of edge profiles, be used to square wood edges, and even used as a thickness planer to level uneven wood. In this lesson we'll be covering all those uses as well as breaking down the router to understand just how handy this humble tool can be.

First we need to understand what a good router looks like. A router's power is measured in horsepower, with more horsepower allowing faster work as the motor can power through jobs without getting bogged down. For a lot of woodworking projects a simple handheld router is perfect, I use a 1hp Bosch palm router which is more than enough for the average woodworker.

Safety:

As with all tools, safety is very important. This is doubly so with a tool like the router. Sharp router bits spinning at very high speeds can pose a very serious safety risk if you're not careful. Whereas some power tools can take a finger off, the router basically chews up whatever it touches and can leave you with nothing to reattach. Always exercise caution when using the router and never put your hands anywhere near the blade during operation.

Router Anatomy

Whether you have a palm router (shown on the left), or a plunge router (shown on the right), or a big table router, they all work the same and will have many of the same features. Whichever router you have will require wrenches to undo the collet that holds the router bit, will have a flat surface to rest the router on and reference your work on, and be able to set the depth of the router bit. Let's take a look at the anatomy of a handheld router in detail:

Removable base

All handheld routers will have method to set the router depth, continuing to extend the router beyond the minimum depth of the tip will allow the base to slide off completely. Removing the base will allow you easier access to the collet to change the router bit, and allow you to change the fixed base for a tilting one (as seen below).

Removing collet and bit

Routers have a threaded neck close to the router body that the collet and nut fit onto, the way the bits are are inserted the nut will tighten onto the threaded bolt when it's spinning. Changing router bits is easy, but should only be attempted when the router is unplugged. Using two wrenches one wrench will fit into the keyway on the threaded neck and another fit onto the hex nut, twisting counterclockwise the nut and collet will come undone from the threaded neck.

Flat fixed or tilting base

All hand routers (palm and plunge) will come with a base that fits onto the router body and will have a base that is perpendicular to the router bit. There's an option to have a removable router base that can be tilted, meaning you have have your router bit placed at an angle to the piece you are working on. The angle of the tilting router base can be set with a thumb screw on the side, which will also have an angle indicator so you can set it to the correct degrees.

Bit depth

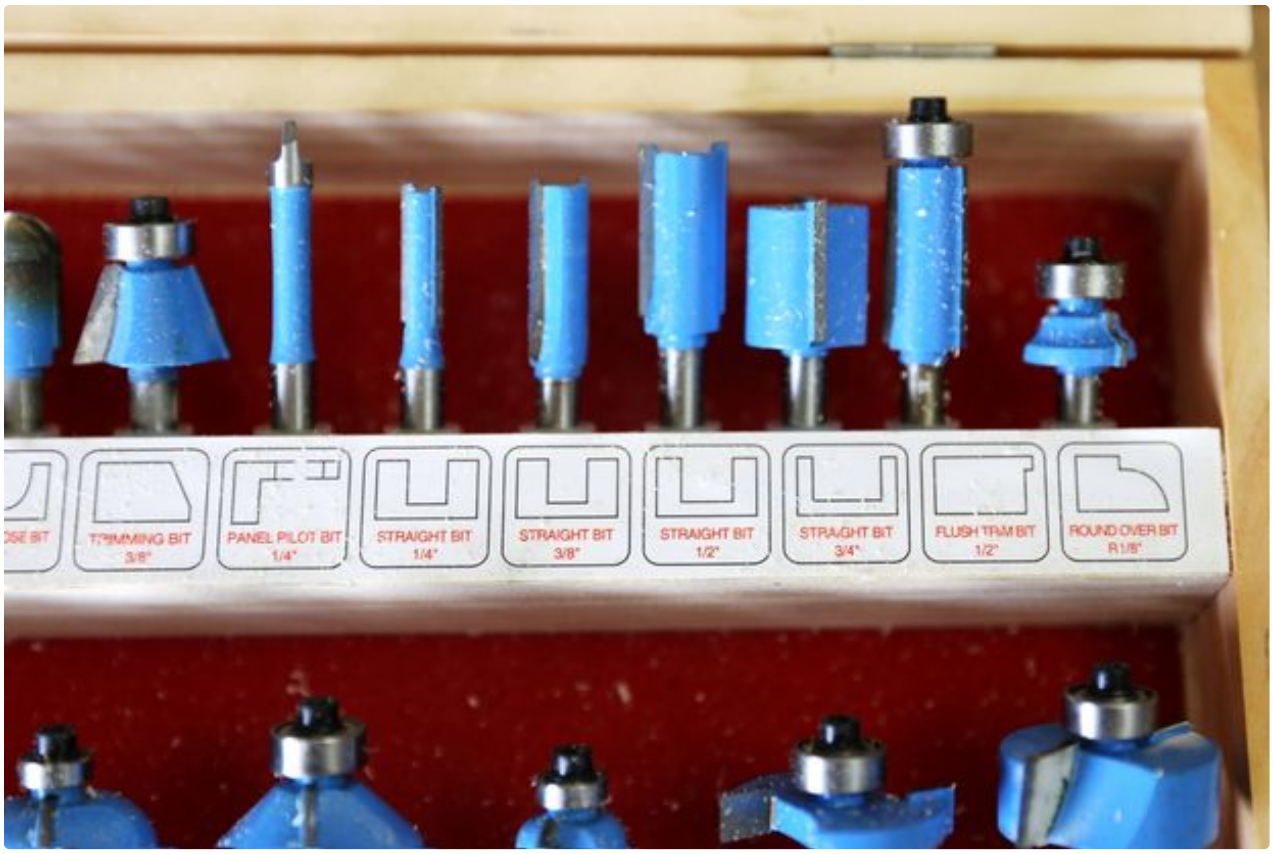
Some routers have a plunge feature, which allows the router to be dipped into the work piece and will spring back to a preset distance. This simple router doesn't have a plunge feature but does allow you to set your bit depth by unbuckling the hasp and setting the depth of the fixed base.

The measurement notches are measured from the collet and are meant to be an estimate, since the height of the collet can vary slightly based on how tight your bit is screwed in, and how much of your router bit shank is revealed.

Router Attachment - Edge Guide

Some routers come with attachments that serve a function to help you with your work, such as a straight edge guide. Edge guides are able to be attached to the router base by a hand screw and will allow you to set the distance of the guide to act as a fence.

The edge guide travels over your work piece and along a straight edge, this will guide the router bit to trim a straight edge on the opposite side of the work. Either measure the distance from the edge of the router bit to the inside edge of the fence, or set the fence distance by hand by placing the fence over the piece you wish to cut. The fence distance can be set with a thumb screw.


TRIMMING BIT
3/8"
PANEL PILOT BIT
1/4"
STRAIGHT BIT
1/4"
STRAIGHT BIT
3/8"
STRAIGHT BIT
1/2"
STRAIGHT BIT
3/4"
FLUSH TRIM BIT
1/2"
ROUND OVER BIT
R1/8"

Router Bits

There are hundreds of types of router bits designed to give you any profile you could want

It helps to have a variety of router bits on hand so you have options, like with a router bit set. The most common (and helpful) bits are the rabbit, flush trim, roundover, and straight cut.

Shank Size

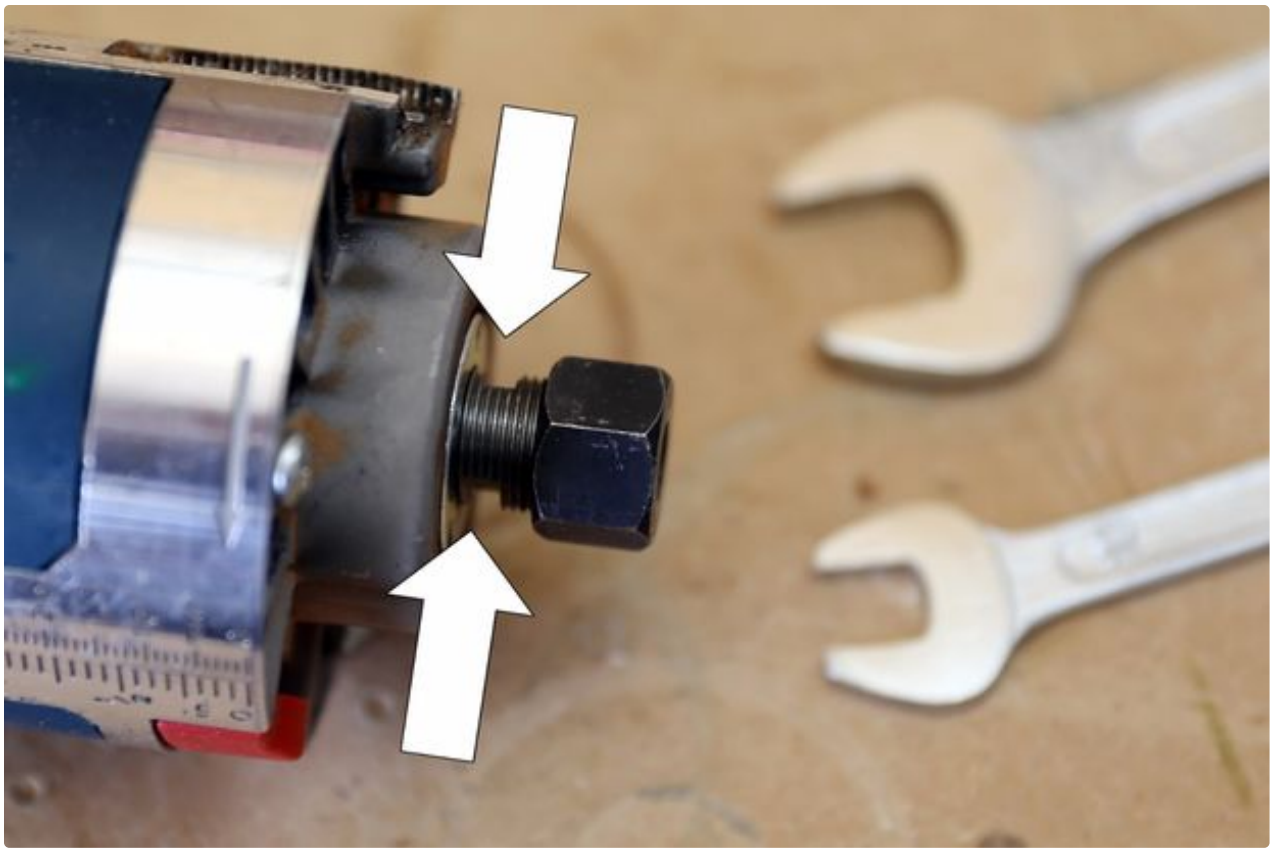
The shank of the router bits that fit into the collet are usually in either 1/4" or 1/2", so know the size of your collet before buying a router bit (or buy a secondary collet so you can switch).

To make things easy on myself, I just stick with one size of router bit shank, but your needs may vary.

Top vs Bottom Bearing

Some router bits have a steel bearing on the axis, this bearing allows the bit to ride up along your work and use it as a reference.

The bearing can be located at the **top** of the bit, close to the router body, or **bottom** which will ride against a smooth surface and trim everything between the bearing and the shank. With the bit inserted into the router and held in your hand, the bottom bearing is at the bottom, and the top bearing is at the top.



Attaching Router Bits

Routers have a threaded neck that the collet and nut fit onto, the way the bits are are inserted the unit will tighten onto the bot when it's spinning. Changing router bits is easy, but should only be attempted when the router is unplugged.

If you look below the nut you can see a keyway on the threaded neck that a wrench can be fitted into, with a wrench on the top nut you can hole the threaded neck and turn the nut counterclockwise to undo and remove the nut and collet.

Some routers have a momentary lock on the side which locks the threaded neck in place, eliminating a wrench needed for the threaded neck.

The lock button needs to be held in to engage the lock, and will disengage when released. The lock will only fully press into the router when the threaded neck is in a particular part if the rotation, so the threaded neck may need to be rotated slightly for the lock to engage.

When tightening the nut only use enough force to snugly hold the router bit, overtightening will make the bit very difficult to remove later.

Amount To Insert

It might seem that when inserting a router bit into the collet that it should be seated in as far in as it can go, however that's not always the best option.

Some routers have a shallow arbor that can prevent long shaft router bits from being inserted this far, but from a safety stance having the bit slightly set out from the threaded nut means that the collet is just grabbing onto the bare shank of the router and not the painted portion. On the other end, obviously extending the router bit far from the collet can produce a speed wobble that is very unsafe.

Of course, all routers are different and you will need to determine the best for your router and bit set.

Conventional Vs Climbing Cut

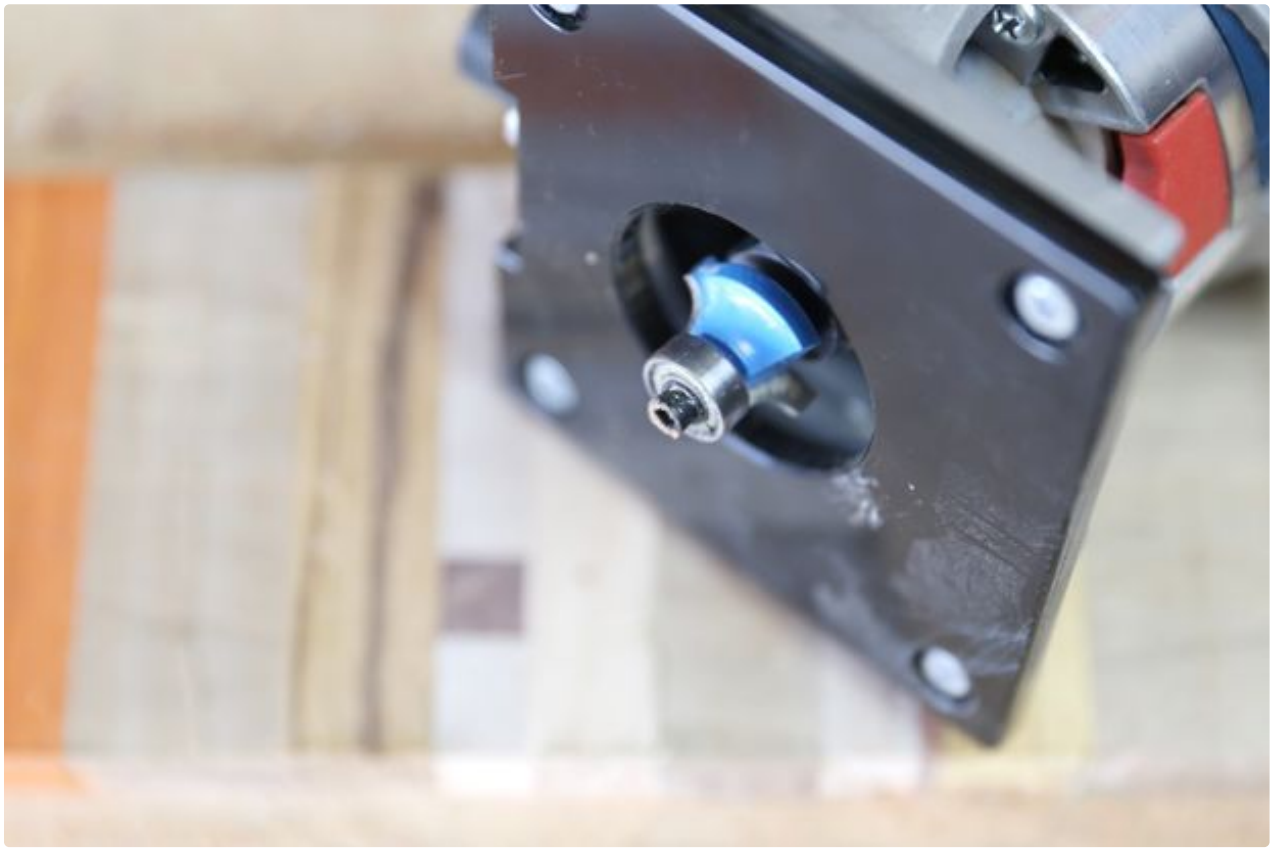
A milling cutter can cut in two directions, sometimes known as conventional (or up) and climb (or down). For almost all cutting with a palm router a conventional cut is recommended, but know that it can cause tear out when reaching the end of a cut.

Conventional milling : The chip thickness starts at zero thickness, and increases up to the maximum. The cut is so light at the beginning that the tool does not cut, but slides across the surface of the material, until sufficient pressure is built up and the tooth suddenly bites and begins to cut. This deforms the material (at point A on the diagram, left), work hardening it, and dulling the tool. The sliding and biting behaviour leaves a poor finish on the material.

Climb milling: Each tooth engages the material at a definite point, and the width of the cut starts at the maximum and decreases to zero. The chips are disposed behind the cutter, leading to easier swarf removal. The tooth does not rub on the material, and so tool life may be longer. However, climb milling can apply larger loads to the machine, and so is not recommended for older milling machines, or machines which are not in good condition. This type of milling is used predominantly on mills with a backlash eliminator. [source]

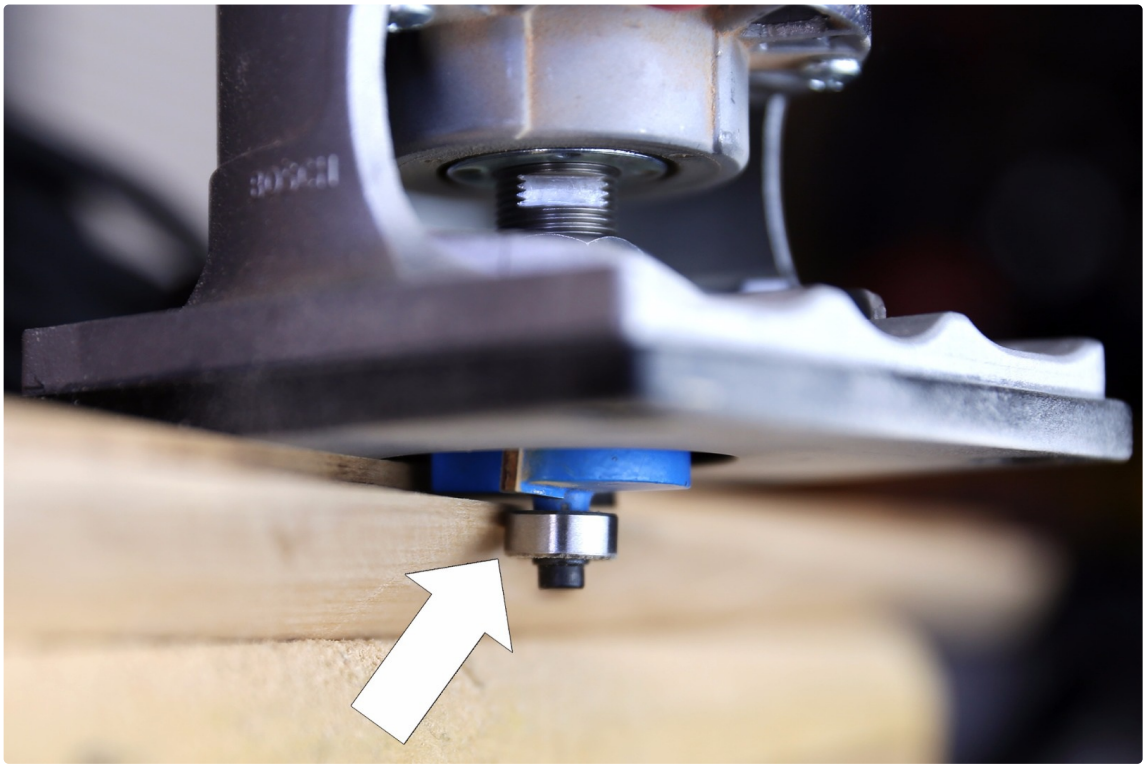
For hand routing, it's advised to only use **conventional milling**, this will prevent grabbing and kickback.

*conventional and climbing cut images used are public domain.



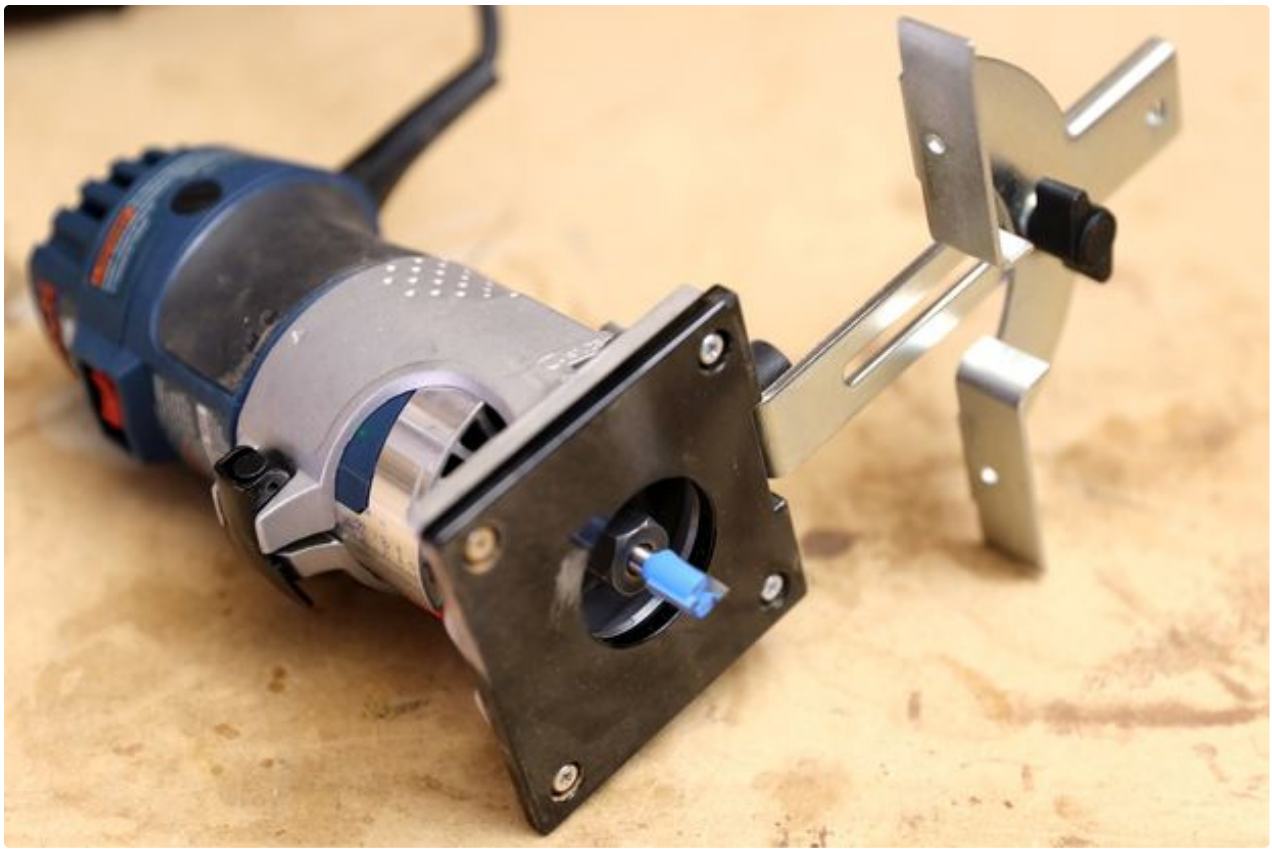
Router Edges

By far the most common application for the router is to tackle edges. There's a wide assortment of router bits that can achieve all kinds of edge profiles. Here's an example or a roundover with the bearing using the work piece as a reference.



Set the router base to the depth desired, its always a good idea to run the router on a test piece of wood before committing to the project - that way you can make multiple adjustments if necessary. Carefully router every side until the edge profile desired is achieved.

In the above example you can see the depth was set a little too low, leaving a small ledge from the to of the router blade profile. Most times ledges like this can be fixed with sanding.



Router Fence

Although the bearing on some router bits helps guide the blade based on a reference, sometimes you may want to make a cut with the router where there is no existing reference. This is where a fence comes in handy.

Most router bases will allow for some kind of attachment for a fence to be installed.

The edge guide can also be used to make channel cuts, using a flat reference edge

Remember, for cuts that remove a lot of material use shallow passes to achieve the depth desired, rather than making one pass. This will prevent your router from getting bogged down, will result in a better cut, and will make your router much easier to handle.

Surface Planing With Router - Setup

A great application for the router is surface planing. Using a flat bottom router bit to plane down irregular height of wood. To perform this action there's a little setup required.

SECURE WOOD TO BE PLANED

There will need to be clear and unobstructed access to the entire top of the piece to be planed. I use hot glue most times, as the work piece can be easily removed from the workbench and the hot glue doesn't leave much residue to be removed after the surface has been leveled.

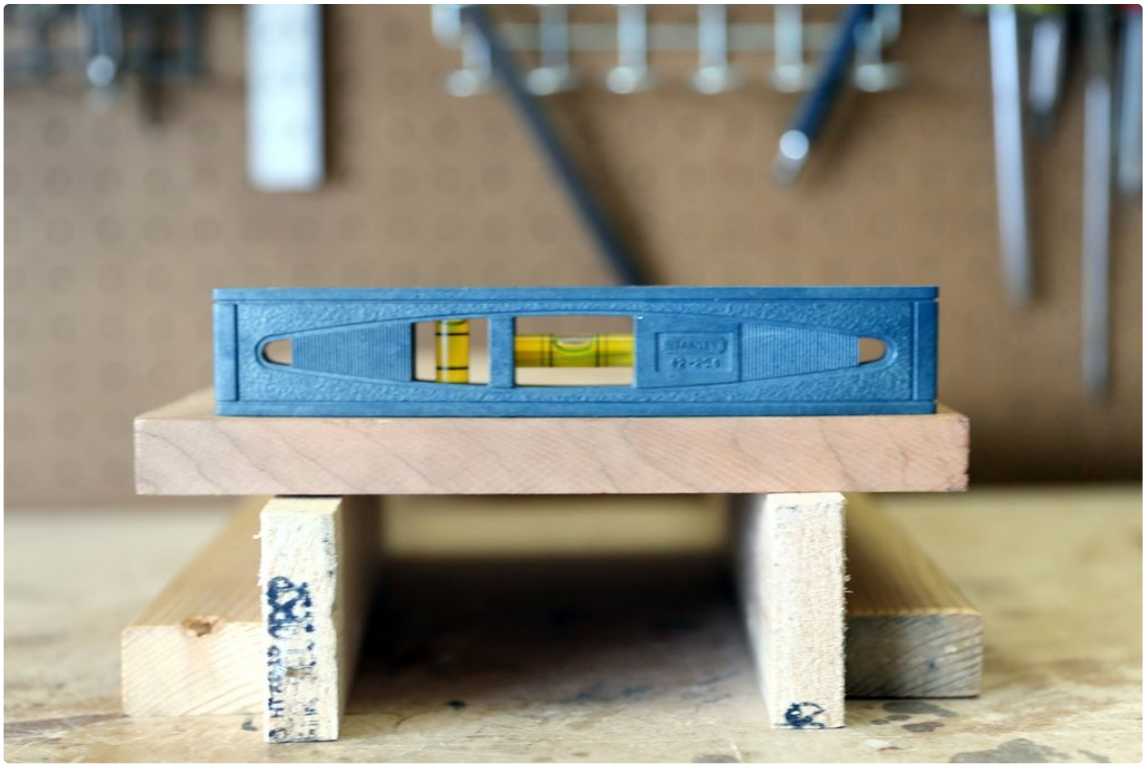
Add a small dab of hot glue to the backside of the glued up work piece and then firmly press the work piece down to the workbench in between the rails.

RAILS

The router will need a flat reference to glide across in order to surface plane. Setting up a temporary fence or rail is a great way to quickly get a flat reference that can be taken down or modified for future planing operations.

Find flat sections of wood to make 2 rails that will be used as the reference rails for the router to glide on.

With 2 rails we can attach them to the workbench and use them to plane down the glue up to a uniform height.



With both rails set up on your workbech a plank can be laid across the top of the rails to check if they are level. If there's any discrepancy check the workbench for levelness first, then check the rails to ensure they are symmetrical.

Having level rails means that when the router is riding on top the router bit will carve a level surface.

ROUTER SLED

To level the top of our work piece a sled will need to ride along the rails. The sled needs to be long enough to pass over the entire spacing of the rails, and wide enough to accommodate the router base. It's also important to make sure the sled is thick enough not to deflect when the router is placed on top, which can cause the routing to not be level and dish.

Find the center of your wood that will be your sled and drill an opening with a hole saw large enough for the router bit to pass without interference.

Router bases have a removable plate held on with 4 small screws. Remove the plate and center the router base over the drilled opening, then use a pencil to mark the screw holes from the base plate onto the sled. A drill bit the same size as the screws was used at each of the four pencil marks.

Once the holes are drilled a countersink was used so the base plate screws will sit inside the sled. Use the same screws that were in the removable plate to attach the sled to the removable router base.

Surface Planing With Router - Planing

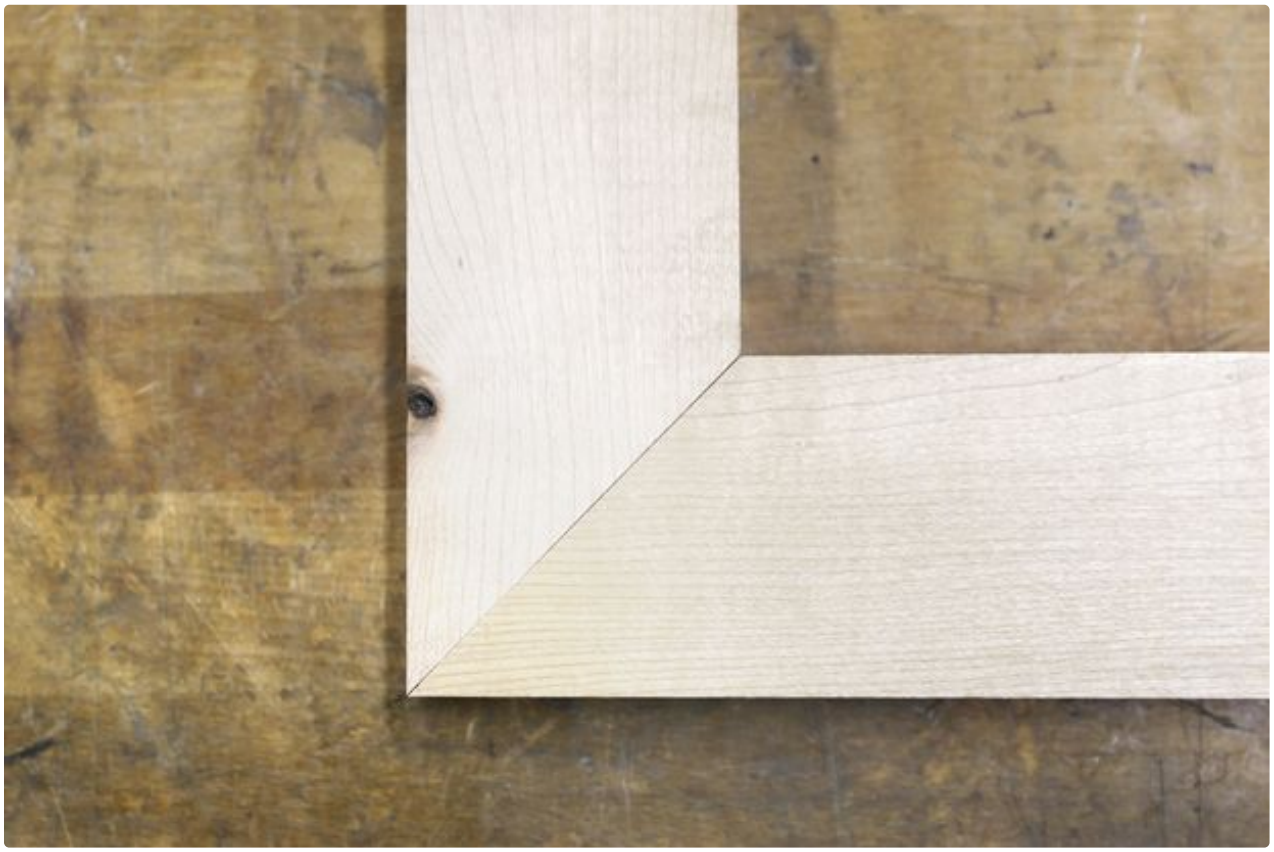
Insert the router bit into the collet and screw the nut into the threaded neck until it's snug. Set the router into the sled and put the sled in the rails, then set the router depth to about 1/4" lower than the highest point of the glue up. Starting with the router away from the glue up, power up the router and slowly move towards the glue up and gently eat away at the highest points from the glueup.

Continue routing at 1/4" depth increments until the lowest point of the glue up is reached. This may be several passes as minimal amount of material removal is desired. To plane down this piece of glue up took about 30 minutes.

It may happen that you will see striations and burn marks (indicated with arrows below) from the router achieving different depth cuts along the same path, or if the router is left too long in one area the bit can make a burn mark in the wood.

These striations and burns aren't a big deal as long as they aren't deep or too different from the adjacent wood, these imperfections can easily be accounted for when sanding with rough sandpaper after routing.

LESSON 8: BEVELS AND MITRES



Up to now we've been focused on right angles with our wood projects, but there's going to be times when you're going to want more complex shapes to your woodworking. The next step to adding interesting details to your work is with angled cuts, in woodworking terms angled cuts are called either bevels or mitres.

This begs the question: *what's the difference between a bevel and a mitre?*

Bevel

A bevel is an angled cut relative to the face of the material. This can be an angled cut along the entire side of a plank of wood, or cut at the end of the wood. The picture above is a bevel cut into the end of a piece of wood.

Mitre

A mitre is an angled cut cut relative to the square side of the material. This is most typically seen on wood picture frames. The image shown above is a typical mitre.

Both a bevel and a mitre are types of angled cuts, and both are easy to make without a compound mitre saw. However, bevels and mitres are also easy to cut with the humble circular saw. Almost all circular saws have a pivoting base that will allow a bevel cut, and a mitre cut is just an angled variation of the straight cuts we learned in the Making Perfectly Straight Cuts Lesson.

As you'll see, angled edges are tricky as the cut surfaces don't line up as perfect as you expect - this problem is multiplied when you try and create a squared box with mitred edges. We'll look at techniques to minimize these errors and make clean cuts.

Bevel Without a Table Saw

Making a bevel with a circular saw is just as easy. Almost every circular saw has a tilting baseplate that allows the angle to be set. The thumb screw or catch to loosen the tilt will be in front or behind the blade and off to the side, usually in line with the trigger.

The base can be tiled with a rough degree of accuracy, which is usually enough as most bevels are used for trim work and not intended for joining where precision would be needed.

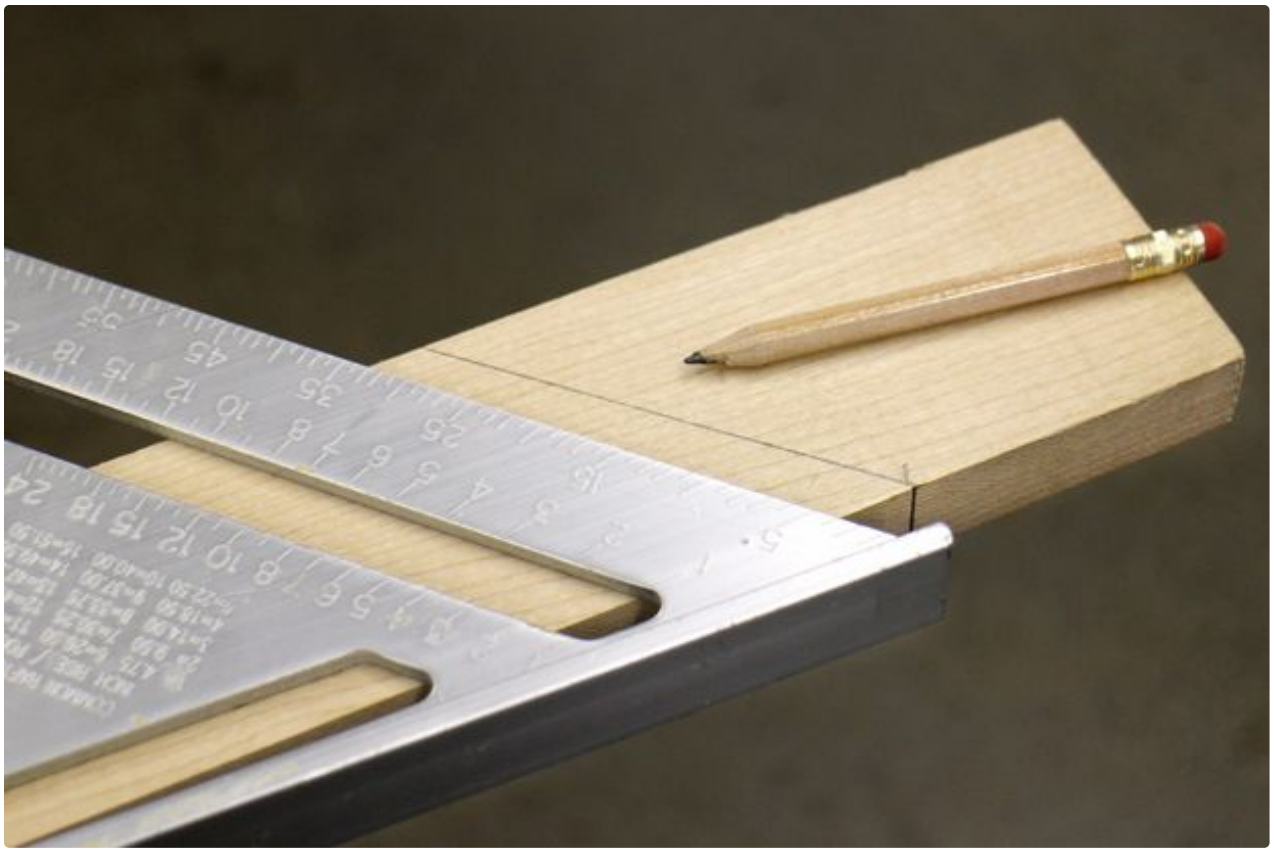
After getting the angle right the blade depth will need to be changed to only a little deeper than the thickness of the cut to be made. Blade height can be changed by a catch that will move the baseplate up or down and expose more or less of the blade.

It's important to not extend the entire blade when cutting for safety reasons, any more blade exposed than what you need can be a hazard as the exposed blade will be under the work piece and outside your view - making it very easy to accidentally cut into your workbench, the power cable, or yourself (yikes!).

To cut a straight and even bevel without the aid of a table saw and fence, you'll need to make your own fence. Accounting for the width of the baseplate and the blade kerf, a fence can be set up along side the wood to be cut, either by clamping (more stable but longer setup) or with heavy-duty double-sided tape (easier but less stable)

With everything set up the circular saw can be run along the wood to create the bevel. As with other cuts, it's advisable to position your work so that the cut off portion falls away from the wood. In the video example below I was cutting directly on top of my workbench, which has the potential for the blade to cut through the wood and into the bench.

As seen in the next picture below, I had the blade set slightly less than the full thickness of the piece, leaving a ridged profile.



Mitre Without a Table Saw

Cutting a mitre with a circular saw is almost the same as making a straight cut as learned in Making Perfectly Straight Cuts, only we're cutting at an angle. Measure and then mark your mitre with a pencil on the face of your wood, continue the mark from the face over the edge and onto the side of the piece - this will help keep reference when you're cutting.

If you're cutting a 45° angle the measurement is easy with a speed square, just line the flange edge of the speed square on the side of your wood with the flat side of the square on the face of your materials and scribe the angle with a pencil. If you're doing an angle other the 45° then the speed square has you covered with the markings on it, or you can use a protractor and a straight edge to achieve the angle you want.

As with the Making Perfectly Straight Cuts Lesson, set up a fence along the angled cut line, remembering to offset the distance of your circular saw base plate and blade kerf and to set the fence on the side of the wood you wish to keep so the cut off portion falls away. Then, clamp your wood to a stable workbench and cut your mitre.

With the fence set up correctly, your cut should be clean, accurate, and have minimal tear out.

Cleaning Bevels

Sometimes, even when you double check everything, bevels can come out irregular. Most of the time the result are thin fins of wood where the saw blade didn't cut, these can be easily resolved with a small trimming plane.

The plane works by having a flat and level bottom with a small notch cut out from which a sharp blade protrudes, it works much like a shaving razor except with this razor you can control how much of the blade is exposed. It's best to start with very little blade, then work your way up exposing more blade as required.

With the base positioned flat against the wood, run the planer in the direction of the wood grain with the blade facing forwards in one smooth motion. If done correctly the wood will curl as it's shaved (planed). Hand planes aren't just for corners, they're also commonly used on relatively flat surfaces to help level any high spots - look for another lesson on planes in a future class.

Truing Up Mitres

After a few cuts, something you're sure to notice is that the mitres don't line up, even when you're checking with a square and sure you cut everything as precise as possible - this is where an ugly truth emerges about mitres: **they're really hard to get right!**

The good news is there's some things we can do to try and make the mitres fit better. Clamp your sander into a bench vise so that you're got a sturdy station to sand at, put a 150 grit sandpaper on the sander and gently press the mitre onto the sander making sure the contact is as level as possible.

The idea here to to try and even out any small variations from the mitres and get a better fit. Go slow and check your work for squareness often, using a carpenter's or speed square. Eventually you will get to a place where your frame will be mostly square and the mitres tight (this is a Sisyphean task, as getting perfect mitres can be tough even for seasoned woodworkers).

Filling Mitre Gaps

Flip the frame over so the front is facing upwards. If your frame has any gaps that couldn't be trued up by sanding they should be apparent now with the corrugated fasteners installed.

In a similar way to when we learned that sawdust can be used to clean up excess glue in the All About Glue Lesson, we can also use glue and sawdust to act as a filler for small gaps.

Apply glue on top of the gap and use a toothpick or sheet of stiff card to force glue into the gap, push sawdust from the same same wood as the frame into the gap. Since sawdust is a great at absorbing moisture you can apply another layer of glue on top (if needed) and then another layer of sawdust to fill the gap.

A clamp was used to keep the wood tight. Allow the glue to dry overnight before sanding.

Sanding + Finishing Mitres

From the Sanding Lesson we know to start with a coarse sandpaper of about 100 grit, paying special attention to the transition between joined pieces and the corners, and working our way up to higher grits. If sanding reveals any more voids at the mitres then reapply the glue and sawdust trick again, wait until dry and then continue sanding.

Work up the sandpaper to about a 220 grit for your finish sanding. Clean off the frame after sanding to remove any dust or debris with a tack cloth or lint-free rag.

Mitres might be challenging at first, but they add great dimension to woodworking projects, as they don't leave unsightly end grain. With practice, you'll be a master of bevels and mitres in no time.

In the next lesson we'll learn about **stains and finishes** that will help make our work really shine.

LESSON 9: COLOR + FINISHES

For almost all my woodworking projects, I prefer to accent the grain of the wood rather than cover it up by painting. When I do paint, it's with a water based paint as it's easier to clean up (mistakes and after painting), and doesn't off-gas.

We've waited until the end of the class to talk about finishes, partly because there's no "right" answer when it comes to finishes, and everyone will have an opinion about how they want their piece to look. The aim here is to arm you with the knowledge of a few different types, and applications, then allow you to make your own mind up about what looks best on your woodworking project.

Protection

Shop safety should be observed when using any stains or paint, even if the stain or paint isn't harmful to your skin the solvents used for cleanup might be. The easiest solution is to use protection in the form of disposable gloves.

There's the standard natural rubber latex gloves, the more durable and latex-free nitrile gloves, and the loose fitting and economical vinyl gloves (also latex-free). You'll find a glove to fit your preference, budget, and one that suits the application. Wearing something is better than nothing, and makes cleanup a breeze.

Unless you want to have a multicolored workbench, it's usually a good idea to cover your work area with some kind of paper to catch any drips. Don't forget to put on some eye protection, too. Stain or solvent in the eye is no fun.

Application

Chip brush

These brushes have natural bristles set in a wood handle with epoxy. With a sturdy handle and rough bristles they can stand up to most solvents and are great for applying stains, epoxy, glue, or cleaning parts. They're more expensive than foam brushes but much less than paint brushes, so they're great for sticky applications where you'd want to dispose of the brush after.

Foam brush

Inexpensive and available in loads of sizes, these brushes apply a smooth and even coat, great for painting and finish coats. The head inside the foam is a plastic fin attached to a wood dowel, with repeated use the fin can warp or snap off the handle, the foam can also degrade after repeated use. These foam brushes are synthetic and may melt when used with solvents.

Lint-free rag

The same type of material used for T-shirts can be cut up into rags and used as a lint free rag. Lint free is important otherwise you'll be picking debris off the surface of your work with every wipe. Very inexpensive (free if you have old T-shirts!) these rags are great for applying stain, oils, or used for cleaning with a solvent. Rags can leave a "rustic" finish when used to apply (or wipe off) paint and may not be ideal for paint application.

Types

If you've ever wandered into the paint and finishes section of a hardware store you'll know there's a very large selection out there to chose from. Here's a few of the most popular choices of topical treatments for wood, broken down loosely into colorants and clear finishes:

COLOR

Stains:

Wood stain is a colorant mixed suspended in a solvent - since stains are solvent-based they cure. The colorant can be a dye or pigment.

> Pigments and dyes are largely used as colorants. The difference between the two is in the size of the particles. Dyes are microscopic crystals that dissolve in the vehicle and pigments are suspended in the vehicle and are much larger. Dyes will color very fine grained wood, like cherry or maple, which pigments will not. Those fine-grained woods have pores too small for pigments to attach themselves to. Pigments contain a binder to help attach themselves to the wood.
> The type of stain will either accentuate or obscure the wood grain. Most commercial stains contain both dye and pigment and the degree to which they stain the appropriate wood is mostly dependent on the length of time they are left on the wood. Pigments, regardless of the suspension agent, will not give much color to very dense woods but will deeply color woods with large pores (e.g. pine). Dyes are translucent and pigments are opaque.

-source

Shellac:

An older type of stain and high-gloss finish, mostly been replaced with newer synthetics but plenty of older furniture have a shellac finish that should only be touched-up with

shellac. Usually sold as dry flakes which is dissolved in ethanol to make liquid shellac. Oh! It's also made from a Lac bug that's been ground up.

Paint:

Paint is an application that will mostly obscure the grain of the wood when applied. Available in almost any color imaginable and can be applied with a roller, paintbrush, rag, or spray. Paints come either as a latex paint (acrylic), or oil. Latex paints are easier to clean up as they are water soluble and have a low odor. Oil paints are more durable and great for resisting water, but will require a solvent for clean up.

FINISHES

Varnish:
A hard and protective finish that is transparent, made from a drying oil, a resin, and a solvent. Typically glossy, but available as semi-gloss, varnish is applied over stains for a protective finish. Stain varnish is also available, which is a varnish with a dye added.

Polyurethane:

A type of synthetic abrasion-resistant and durable coating. This clear protective finish is great for protecting your wood from moisture and wear, and comes in different glossiness like matte, semi-gloss, and gloss. Some polyurethanes break down with UV exposure, so be mindful of what type you select.

Finishing Oils:

Oils can be synthetic or natural, the two most popular are both vegetable oils: linseed oil and Tung oil. However, Tung oil has a tendency to yellow over time, which can make for an attractive finish if desired. Danish oil is another popular type of oil that's been mixed with a varnish.

Epoxy

A thick and sticky 2-part solution that finish that cures to a clear, very hard, and waterproof finish. Epoxy coatings are either sold as a 1:1 ratio where the resin and catalyst are poured together in equal parts, or in unequal portions that need to be measured or weighed before combining.

All epoxies have a "pot life" which the epoxy has to be used by before the curing process begins and the epoxy cannot be handled any longer and must be left to cure.

Test

You may have found a color of stain or oil you like in the store but it can look very different depending on what wood it's applied to, sometimes there's a sample stick in the stain aisle to help you out and give you an idea.

Once you have a collection of colors in your own shop you can start your own stain stick (as seen above). Remember to number your samples to correspond with each can. Remember that stains will look different on different types of wood.

When you have a color you like, before you commit to covering your work test your finish on a hidden area of your work, like the back, underside, or inside. These "hidden" areas won't be seen by anyone and will give you an idea of the look of the stain. Allow the stain to dry before making the call, also try applying a second coat in the hidden area.

If there's no hidden area to your work you just need a scrap of the same type of wood (ideally a cut-off from the same section).

Cure Vs Dry

Cured Finish

A cured finish is not the same as a dried finish, as a finish takes longer to cure and can continue to do so even after the top of the finish seems dry.

> "[curing is] a chemical process that takes significantly longer than drying. Some kinds of finish cure by evaporation of their solvent, and some cure by reacting with oxygen. Either way, the process continues after a film has formed on top." -source

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Dried Finish

A dry finish is exactly what you think it means, dry. Something to keep in mind is that some woods are more porous than others and the surface might be dry but there's small pools of the finish deep in the wood that's not yet dry. Most times it's not a big deal, but something to be mindful of if you're looking for a particular tint to your wood finish. Also, some thicker finishes take longer to dry than thinner ones.

Food Safe?

Commercial Finishes

All commercial finishes are food safe **after they are cured**. I'll amend this by saying that if you're planning on storing something very acidic perhaps try something other than your coated woodworking project. Also, coated finishes like polyurethane or epoxy aren't suitable for cutting boards as the finish can chip off and end up in your food, best to use an oil instead.

Though any commercial finish is fine, sometimes it's easier to just buy the stuff that says right on the can "food safe".

Natural Finishes

If you want to keep things all natural there's loads of options like beeswax and mineral oil. Be mindful that most of the natural options will require frequent reapplication in order to keep protecting your work as it will rub off over time and with use.

It may be tempting to use a grocery store oil but I'd advise against this as cooking oils can go rancid over time, having rancid oil impregnated in your wood creation would be heartbreaking (and really gross). Best to opt for mineral oil, which is available everywhere, inexpensive, and as neutral as it comes.

Standoffs + Drying

After applying your finish you'll need to let it dry (or cure). It's best to leave your work undisturbed in a constant temperature, as cold can prolong drying time and humid heat can make the finish go weird.

To allow air around all areas where finish is applied upturned screws make for great standoffs, the tip leaves minimal marking and finding matching screws is plentiful in most workshops.

Follow the directions of your finish when observing drying times, and in between coats. Typically, thicker finishes take longer to dry than thinner ones. When in doubt, wait overnight.

Experimentation

Finishes can be a lot like alchemy, there's a few combinations that are known but through experimentation you'll find all kinds of combinations that work well together.

Though there's nothing wrong with store bought finishes many woodworkers mix their own "special sauce" for finishes that they've found over years of experimenting, so after you have a few types of stains and finishes try experimenting with different application methods, wait times, combinations of ingredients (be smart and safe, some chemicals don't work well together), and what sealer to use after a stain.

Next Steps

Now that you're done with some of the fundamentals, keep your skills sharp by getting started on your next project!

Big or small, there's something you've probably been dying to make.