Build Your Own
Woodworker's Workbench

Intro: Building a real woodworker's workbench

Learn how to build a true woodworker's workbench.

What is a workbench?

A woodworker's workbench isn't a table, it's a work-holding system. It's not something you set things on top of, it's a tool that holds your work. Where a worktable might have a machinist's vise bolted to its top, a woodworker's bench is built to accommodate a number of different workholding mechanisms, such as bench dogs, planing stops, hold fasts, or board jacks, and will usually have one more woodworker's vises integrated into its structure.

A workbench needs to be heavy enough that it doesn't move under you while you're working, and stiff enough that it doesn't rack itself to pieces under the forces that will be placed upon it. It doesn't take many hours of planing a board or hammering a chisel for a worktable made of nailed 2x4s to come apart. Traditional bench designs use mortise-and-tenon joinery, which is strong and rigid, but not really suited for a novice woodworker who doesn't already have a bench.

The design

Learn how to build, with basic tools and readily-available lumber, a bench that provides most of the function of a traditional woodworker's workbench.

My bench top is two layers of 3/4" MDF edged with 1/2" oak and topped by a 1-1/2" thick edge-glued oak Ikea countertop.

The essence of the design is a joinery system using threaded rod that provides a great deal of strength and rigidity. The base is formed with 4x4 legs and 2x4 stretchers, connected with dowels and threaded truss rods. As screws are tightened down at each end of the rods, the structure is pulled together forming a rigid unit.

On the range from slap-dash to deliberate, my method is definitely on the deliberate side. If you have enough experience to be confident in using techniques that are more time-efficient, go for it. The techniques I'm using are those I thought least likely to go wrong, not those that would produce a product in the shortest time or at the lowest cost. You'll notice that I made a number of mistakes, spent considerable time on work I later determined to be unnecessary, and in a number of cases I used different techniques at the end than I did at the beginning. These are all the result of learning. I thought it would be better to demonstrate how I made errors, and how I corrected them, than to provide a set of instructions that presented the false impression that everything went together perfectly.

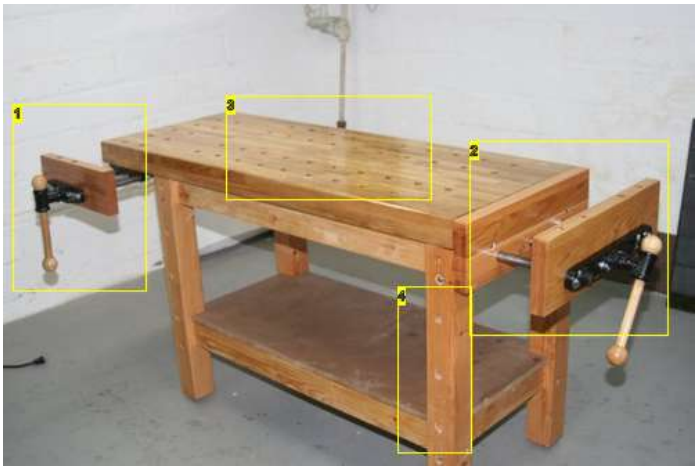
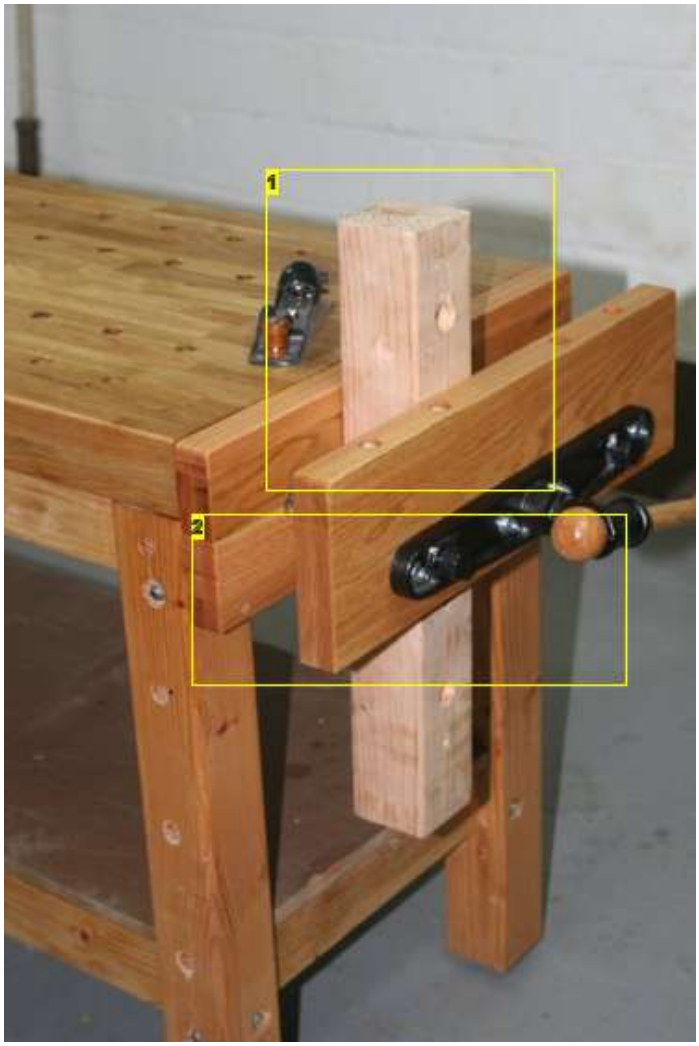


Image Notes
1. Front vise - with benchdog holes in outer jaw
2. End vise - with benchdog holes in outer jaw
3. Benchdog holes in top
4. Board-jack holes in front legs



1. Holding a piece vertically, for planing endgrain
2. Vise allows pieces up to six inches wide to be held between the screw and the guide rods, which avoids racking

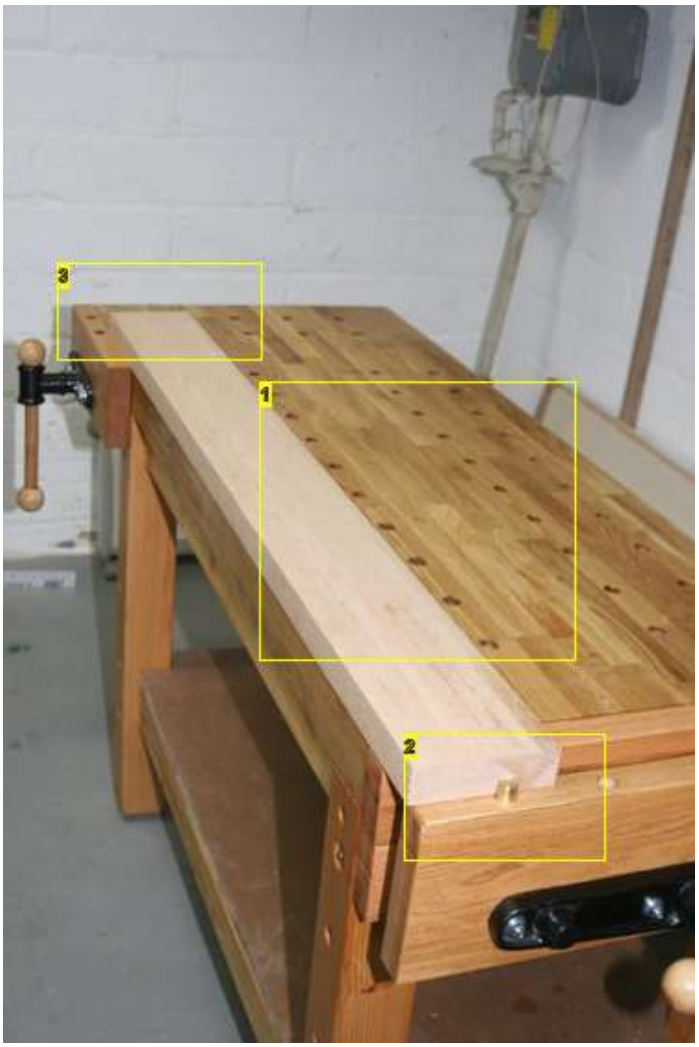


Image Notes
1. A board held flat, between two benchdogs (perhaps for face planing)
2. Benchdog in the vise jaw
3. There's a benchdog in the top, down here

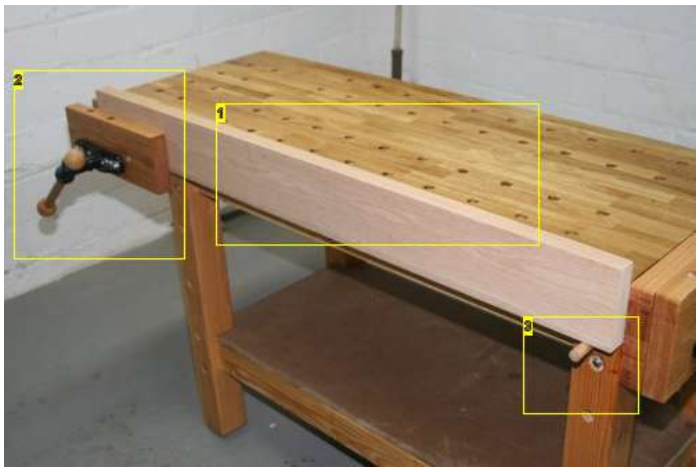


Image Notes
1. Holding a board horizontally, for planing the edge
2. Vise holds one end
3. Board jack supports the other end

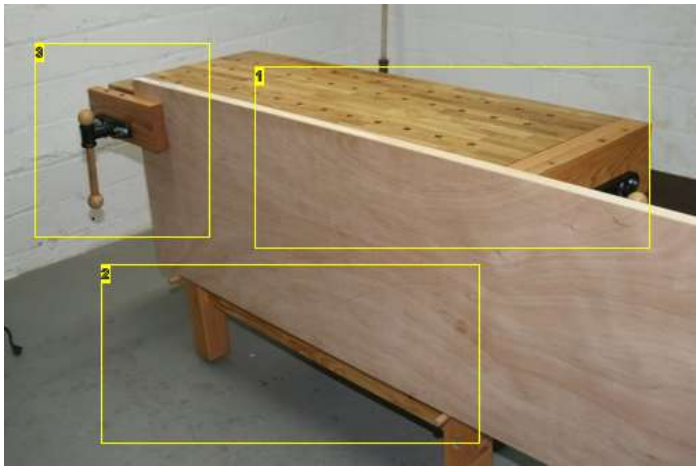
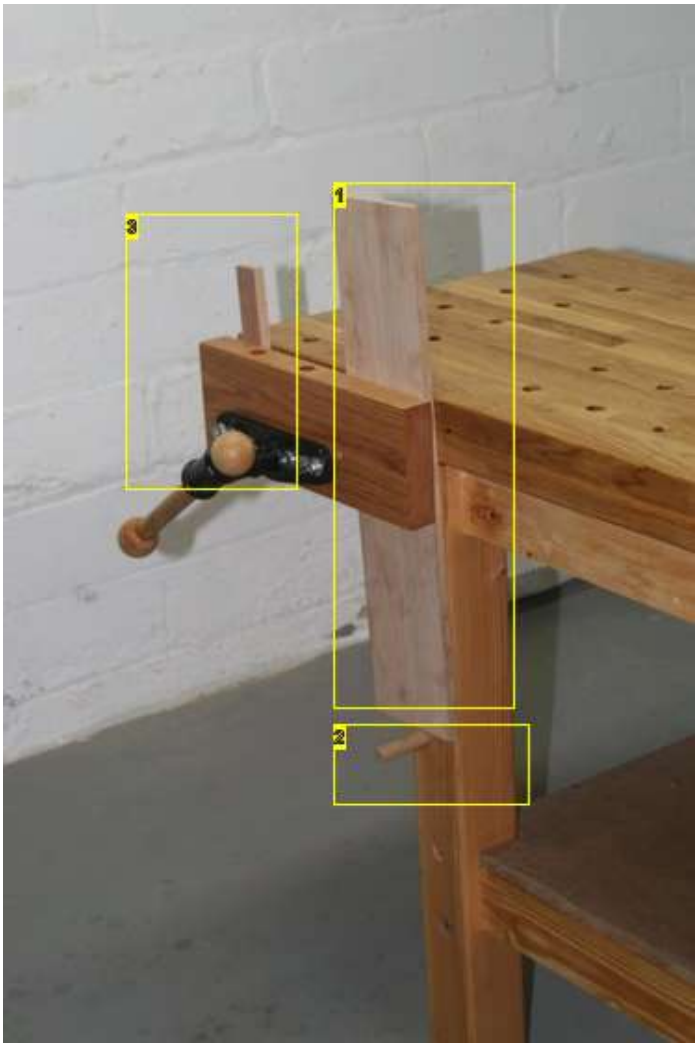


Image Notes
1. Holding a door for mortising hinges
2. Supported by board jacks
3. Held by the front vise



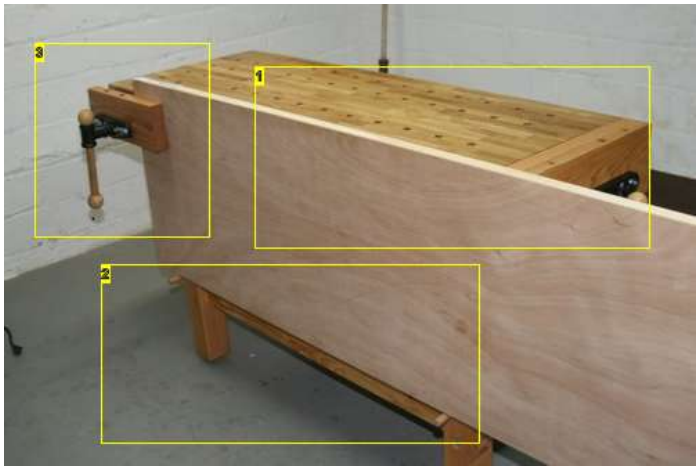


Image Notes
1. Holding a board vertically, for cutting dovetails
2. Using a board-jack here isn't necessary, but it can help hold the board in place while you clamp it
3. When clamping a board at the edge of the vise, you need a piece of similar width at the other edge, to keep the vise from racking

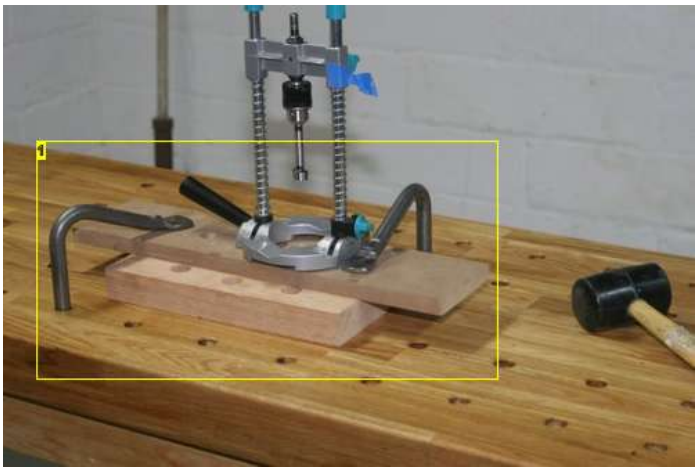


Image Notes
1. Holdfasts can clamp pieces in the middle of the bench

Step 1: The materials

The bench is built from construction-grade lumber, of the sort you can buy at any home center or lumber yard. I built mine from the same. There is nothing that says you can't use better material. Better wood costs more, but you don't need all that much of it.

If you decide upon construction lumber, you want kiln dry lumber. Green lumber will warp on you as it drys. Dig through the stacks and pick out the straightest, cleanest pieces. Generally, the boards that are sitting loose on the stack are those that other people left behind, as they sorted through looking for better. Be prepared to move them out of the way, and to dig down to the better stock. Be nice, though, and put everything back when you're done.

For the base:

The base is made of four legs, four short stretchers, and four long stretchers. The legs are 4x4's, roughly three feet long, the stretchers are made of 2x4's, the short are two feet long and the long are four feet long. You can cut two legs and a short and a long stretcher out of standard length stock, so you need:

Two 4x4's
Four 2x4's

In addition, you will need four pieces of 3/8" all-threaded rod, two feet long, and four pieces of 3/8" all-threaded rod, four feet long. I bought four pieces of six-foot length, and cut them down.

For the top:

Christiana's design uses three pieces of MDF - one two-feet by four-feet for the shelf, and two two-feet by five-feet to laminate the top. These can be cut from a single 49x97" panel. Allen's top was three layers of 3/4" MDF topped and edged with 1/4" hardboard.

I made my top from two layers of 3/4" MDF and an edge-glued oak Ikea Numerär countertop.

One 49x97" panel of 3/4" MDF
One 25x73" panel of 1-1/2" edge-glued oak
One 1/2x1-1/2" oak board, six feet long
One 1/2x1-1/2" oak board, five feet long
One 1/2x1-1/2" oak board, two feet long

For the vise:

If you're installing a vise, you'll need hardwood for the jaws and you may need some scrap MDF or plywood to make up the proper mounting thickness. For the vises I chose:

Two 24" lengths of 2x8 oak
One 13" length of 2x6 oak

Hardware:

4 - 3/8" all-threaded rod, 48" long
4 - 3/8" all-threaded rod, 24" long
32 - 3/8" dowels
16 - 3/8" nuts
16 - 3/8" washers
30 - 1-1/2" drywall screws
30 - 2" drywall screws
30 - s-clips
4 - levelers

Plus whatever you need to attach the vise or vises

Note: I've photographed the lumber lumber leaning against the wall, but storing it that way can cause it to warp. Stack it flat, and leave it for a week or so to adjust to the shop's temperature and humidity.

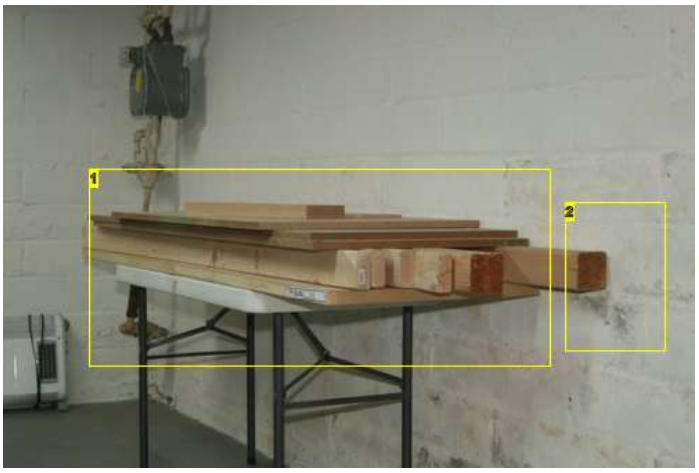


Image Notes
1. Stacked flat on a hollow-core door.
2. 1" away from the wall

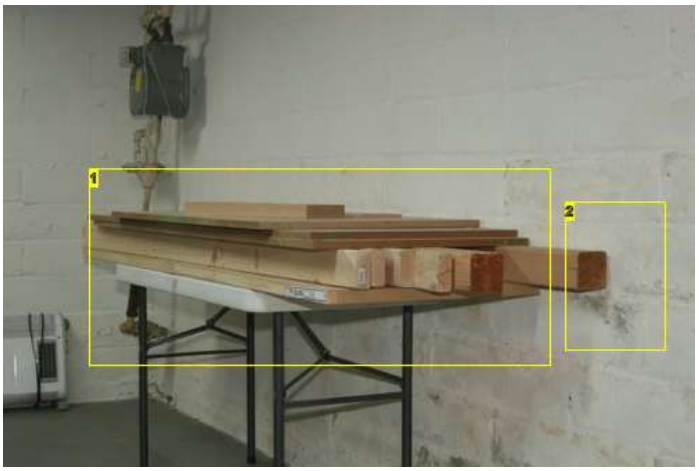


Image Notes
1. 4 ea. 2x4" 84" long
2. 2 ea. 4x4" 96" long
3. 1 ea. 49x97" 3/4" MDF, rough cut into: 1 ea. 26x49" and 2 ea. 24.5x71"

Step 2: The tools

According to the "Getting Started in Woodworking" video, you can build this bench with only a few basic tools - a drill, a circular saw, and a hand-held router. This isn't quite true.

First, there are a number of tasks involved in building this workbench that can be done faster, easier, and with more precision, on more sophisticated tools. If you have a miter saw, a table saw, a drill press, or a router table, you will definitely want to use them.

Second, if you do build this with a drill, a circular saw, and a hand-held router, you will need a few jigs and fixtures, and some specialized bits. And there are some places where other hand tools would make things easier.

In addition to the drill, circ-saw, and router, I used a belt sander, a random orbital palm sander, and a jig saw. Plus a screwdriver, a wrench, a hacksaw, and other miscellany.

For the drill, I ended up purchasing a Wolfcraft drill guide. If you think you can free-hand drill a hole through 3-1/2" of wood, and have the exit hole appear within 1/16" of where you intended, go for it. I cannot.

For the saw you'll need a crosscut blade and a plywood blade.

For the router you'll need a a 3/8" straight bit, an edge guide, 1/4"- and 1/8"-radius roundover bits, and a flush-trim bit with at least a 1-1/2" cutting length. Bits of this size are available only for a 1/2" collet. Some routers are capable of using multiple collet sizes. I was fool enough to buy a router that only had a 1/4" collet. More on that, later.

For the drill, other than normal twist bits, you'll need a 3/8" brad-point bit, a 1" Forstner bit, a 3/4" Forstner bit, most likely several 3/4" spade bits - or you can resharpen the one if you like, and a 3/8" counter-sink bit.

And you'll need a workbench.

I know, if you had a workbench, you wouldn't be building a workbench. Even so, you'll need some sort of work surface, even if it isn't as stable or capable as a proper bench. The traditional solution is to throw a hollow-core door over a couple of saw horses. The advantage of hollow core doors is that they're flat, stiff, and cheap. I used a folding table and a hollow core door I had bought for a future project.

Image Notes
1. The tools
2. hollow-core door as temporary work surface

Image Notes
1. Circular saw
2. Crosscut blade
3. Plywood blade

Image Notes
1. Handheld router
2. Edge guide for router
3. 3/8" straight bit
4. Ratchet with 7/16" and 9/16" sockets
5. soft mallet

Image Notes
1. Drill
2. Phillips screw bits
3. pencil and sharpener

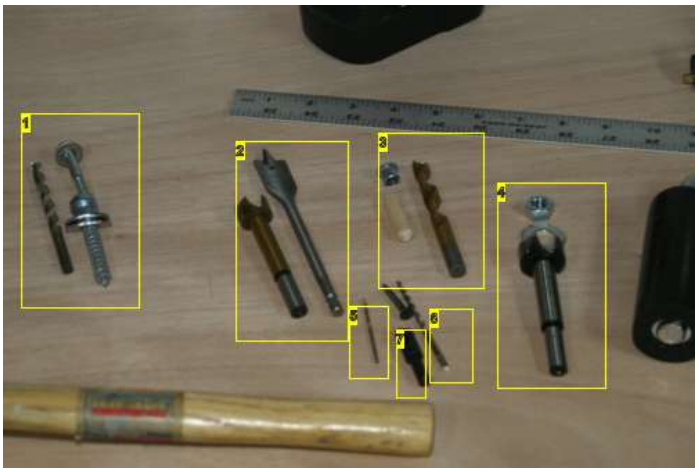


Image Notes
1. 1/4" bit for 1/4" through hole and 3/8" pilot
2. 3/4" forstner for 1/4" countersink and benchdogs, 3/4" spade bit for vise benchdogs
3. 3/8" brad-point bit, and 3/8" dowel center
4. 1" forstner bit for 3/8" countersinks
5. 3/32" bit for drywall screw pilot holes
6. 5/32" bit for drywall screw through-holes
7. 3/8" countersink bit for drywall screws

Image Notes
1. combination-square
2. Straight rule
3. Laminate/glue roller

Image Notes
1. Hand screws
2. You never have enough clamps

Step 3: Cutting guides

If the table is to be square and flat, the cuts must be straight and square. A table saw would be ideal. I don't have a table saw, so I need a cutting guide for my circular saw. And since I didn't have one of those, either, I made one. Or rather, three.

These guides are like every pretty much every other one anyone has made - two pieces of whatever flat panel material is convenient -- a thin one that the shoe of the saw rides on, and one that provides the edge that guides the saw.

My first attempt at making a cutting guide didn't work. What I ended up with worked fine for cutting panels, but the guide-strip was too narrow, and when the saw was extended fully for rough-cutting the 4x4's the clamp heads got in the way. So I made another. Actually, I made two more, so that I could cut one into shorter pieces that would be easier to handle.

Making the cutting guide:

Use whatever panel goods are convenient. You want the base to be thin, and the guide strip to be straight. I used 3/16" hardboard for the base and 1/4" ply for the guide strip.

There are two critical dimensions. The guide strip needs to be at least as wide as the distance the saw motor overhangs from the edge of the saw's shoe, plus a couple of inches for the clamps. This is where I made the mistake in my first attempt.

The base needs to be as wide as the sum of width of the guide strip and the distance from the edge of the shoe, plus a bit extra, With my saw, the overhang is 3-1/2", so I made my guide strip 5-1/2" wide. The distance between from the edge of the shoe to the blade is about 4-1/2", so the base needs to be at least 10" wide. Since I was working with a 24" wide sheet, I just sliced it down the middle.

I used the factory edge of the half-panel of hardboard as a guide for cutting the ply. I wanted to cut a 5-1/2" strip, and my saw cuts 4-1/2" from the edge of the shoe, so I wanted the edge of the hardboard 10" from the edge of the ply. So I set my combination square to 10", and used it to mechanically set the distance. Hint - if you need two things to be precisely the same length, try to avoid measuring them separately. Use some mechanical mechanism for setting the distance.

These sorts of things are usually glued and screwed, but it's actually the glue that holds them together - the screws just hold everything tight while the glue cures. Screwing into hardboard or 1/4" ply is an exercise in futility, so I just used glue, and used my two 4x4's as long clamps. It would have been a bit easier, if I'd done this before I'd rough-cut the 4x4's, but it worked out.

The next day, I used the 4x4s, again, to support them along their length, then ran the saw down them to cut them to match the width of the shoe. Then I cut one of them into shorter pieces, and I had a workable set of edge guides.

Because my base was originally 12" wide, after I'd trimmed it to match the saw, I ended up with a strip of hardboard roughly 2" wide - which proved useful in making a number of pads for keeping my clamps from denting my work pieces.

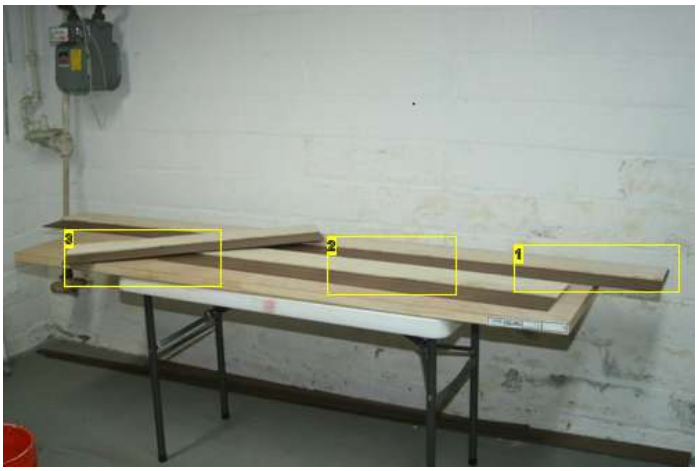


Image Notes
1. A long guide for ripping panels
2. A medium guide for cross-cutting panels
3. A short guide for cross-cutting boards

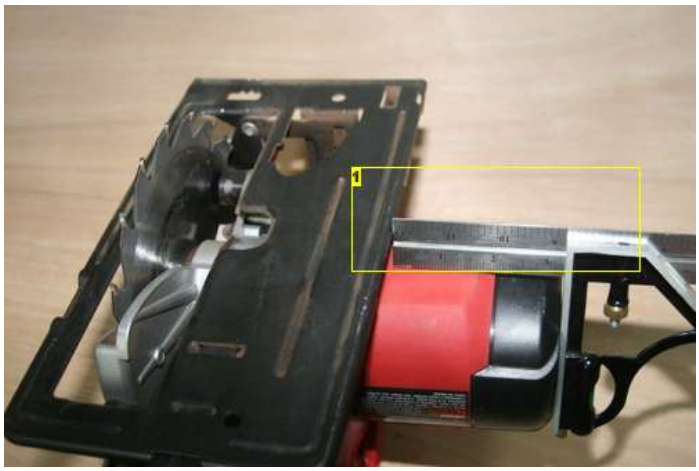


Image Notes
1. The saw motor overhangs the shoe by 3-1/2"

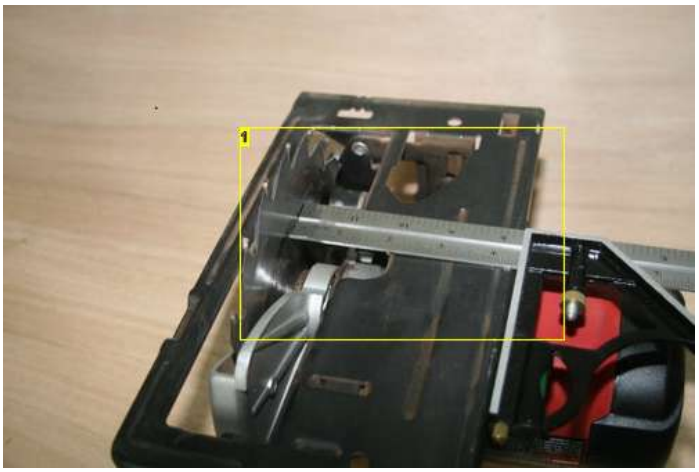


Image Notes
1. The saw blade is about 4-1/2" from the edge of the shoe.

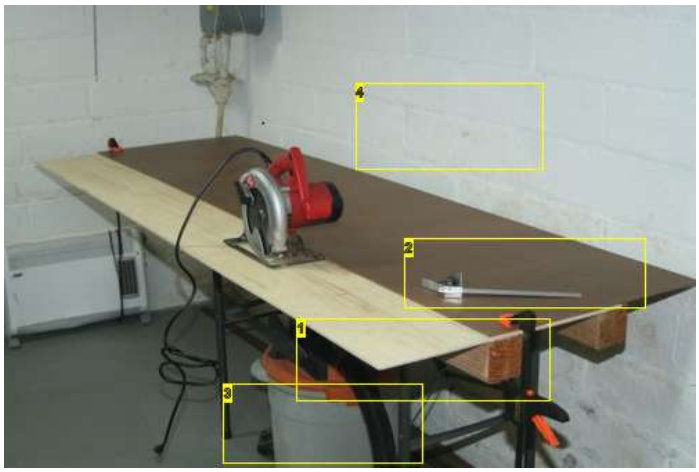


Image Notes
1. We want a 5-1/2" width (3-1/2" overhang + 2" for the clamps), so we set the guide edge 10" back (5-1/2" + 4-1/2" for the shoe)
2. Combination square set at 10"
3. Shop vacuum - an essential tool
4. Cutting the guide edge

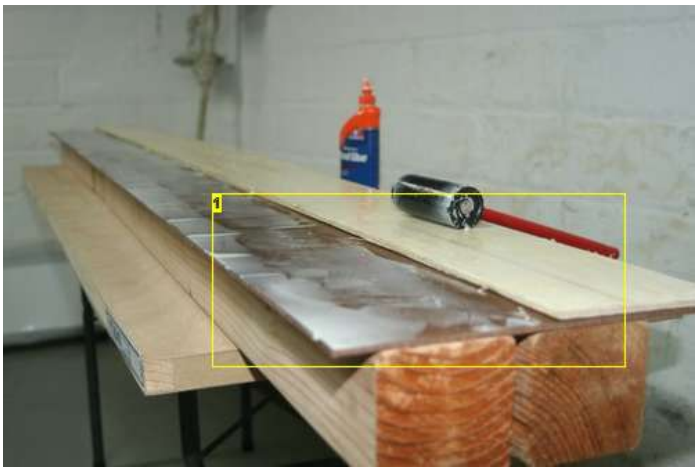


Image Notes
1. Spread the glue thinly but evenly over both surfaces

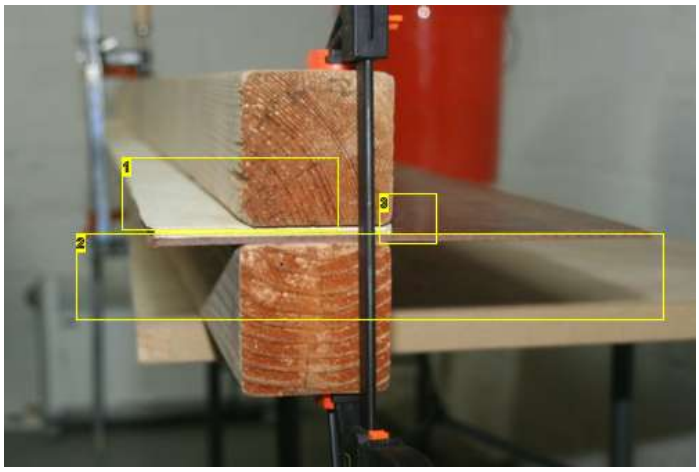


Image Notes
1. 5-1/2" wide 1/4" ply
2. 12"-wide strip of hardboard
3. This is the factory edge of the plywood panel

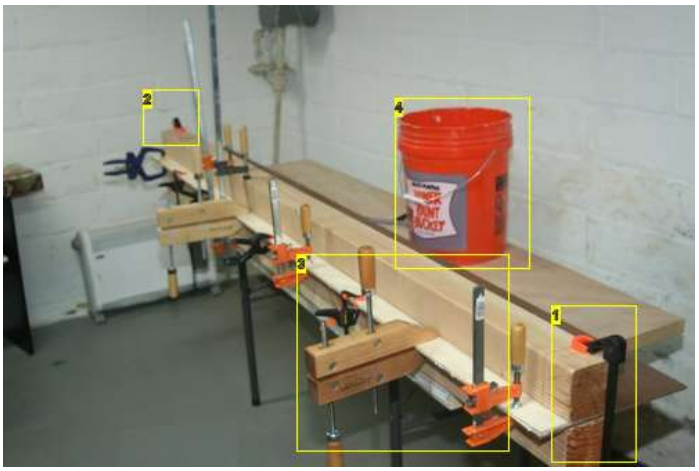


Image Notes
1. Clamp both ends of the 4x4s
2. Clamp both ends of the 4x4s
3. Clamp the edge that isn't clamped by the 4x4's
4. A couple of gallons of water to keep the table from tipping, since all the weight is on one edge.

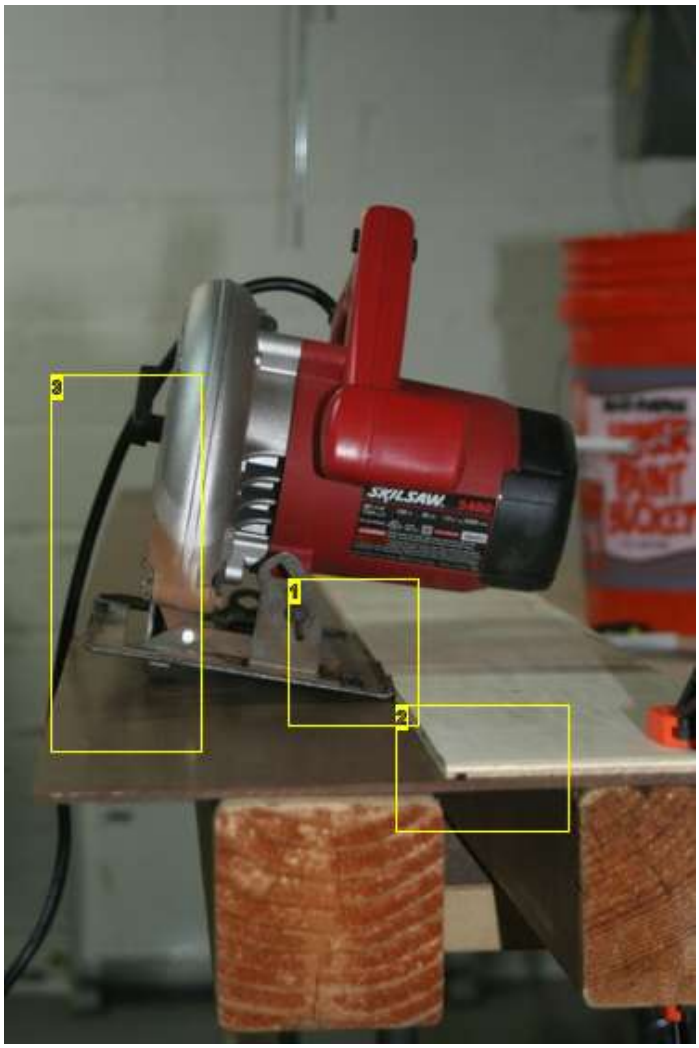


Image Notes
1. Using the guide edge as a guide, cut the base sheet to the cutting width of the saw
2. The guide edge
3. Plywood blade

Step 4: The Base, step one - Cutting the parts to length

The first step of actually building the workbench is to cut to length the lumber for the base.

The original design used a base that was 24" wide and 48" long. To go larger than that you need a second sheet of MDF. I ended up building mine 23x48".

The original design had a height of 35-1/8". Their two-layer top was 1-1/2" thick, so their legs were 33-5/8" long. I want a height of 35", but I'm using a top that's 3" thick. My basement floor is anything but level, so I'm using levelers that are adjustable from 3/4" to 1-1/2". In other words, I want legs that are around 31-3/4" long. (If you're not using levelers, your legs need precise lengths. The levelers give about 3/4" of adjustment, so precision is less necessary.

The parts:

four short stretchers - 2x4, length 16" (23" - 2 x 3-1/2")
four long stretchers -2x4, length 41" (48" - 2 x 3-1/2")
four legs - 4x4, length 31-3/4" (35 - 3 x 3/4" - 1")

Mark out on each 4x4 exactly which part of them will form the two legs. With a 96" long piece of lumber, there is some leeway as to exactly where the two 33-5/8" legs will be. Layout the legs so as to minimize the number of knots, splits, or other flaws. Pencil the cut lines, and mark which side of the cut line is to be scrap.

We want to make these pieces square, and of identical length. Square is a matter of making sure the saw blade is square and that the cutting guide is square. The trick to getting the pieces of the same length is to clamp them together and to cut them all at once. For the 4x4's, that means making a rough cut in each first, so we have four pieces, each 3-4" longer than we need, from which we'll get our four legs.

The rough cuts:

There's no real need to make these rough cuts with the cutting guide on the 4x4's clamped together, but I did so anyway, just for practice. This revealed that with my first attempt at edge guides, the clamps would get in the way of the saw motor, when making a deep cut.

That's why we make practice cuts. In all, it wasn't until my fourth cut that I was satisfied.

With my second attempt at edge guides, I made the other rough-cut. On this, the edge guide worked fine, but the end of the cuts revealed that the saw blade wasn't quite square. So I adjusted the blade, clamped all four legs together, and made what would be the first final cut, if it came out clean enough. It didn't. I'd let the saw drift a bit away from the guide edge. So I adjusted the saw, moving the guide back half an inch, and tried again. the rough-cut parts were a couple of inches longer than they

needed to be, so I had room to work with,. It's only the final cut at the other end that you only have one chance at.

How clean and how square these cuts need to be is entirely up to you. The cleaner the cut, the tighter the joints will hold together, and the squarer the cuts the squarer the entire bench will be.

The final cuts:

When you are satisfied with the cut on one end, flip all four legs -- still clamped together -- and measure and cut the other end. If you support them on the scrap pieces of 4x4, you can do this without moving the clamps.

With the 2x4's. you won't need to turn and cut from both sides, but you will need to make sure that there is clearance so the saw doesn't cut your table.

Layout on each 2x4 the best location for a 16" short stretchers and a 41" long stretcher. Line up the marks for outside end of the short stretcher, clamp the 2x4's together, clamp the assembly to the table, clamp your edge guide, and cut. If the cut is clean, reposition the edge guide to 16" and cut again.

Cut the long stretchers the same way.

Image Notes
1. Cut to length

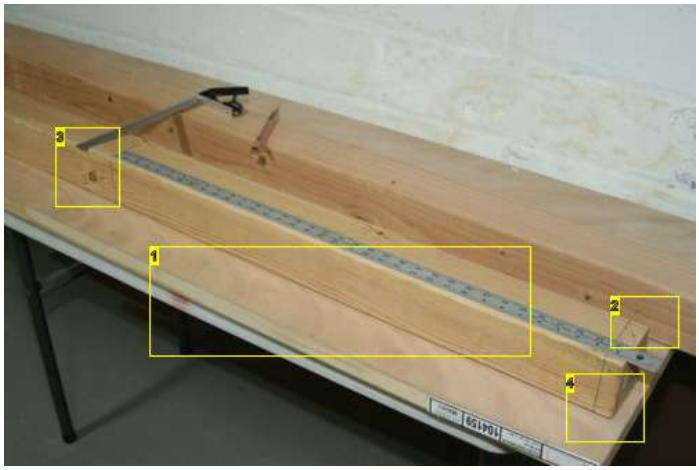


Image Notes
1. Laying out the length
2. Mark the side of the cut that is scrap
3. Avoiding the knot
4. Cutting off the splits and dents on the end

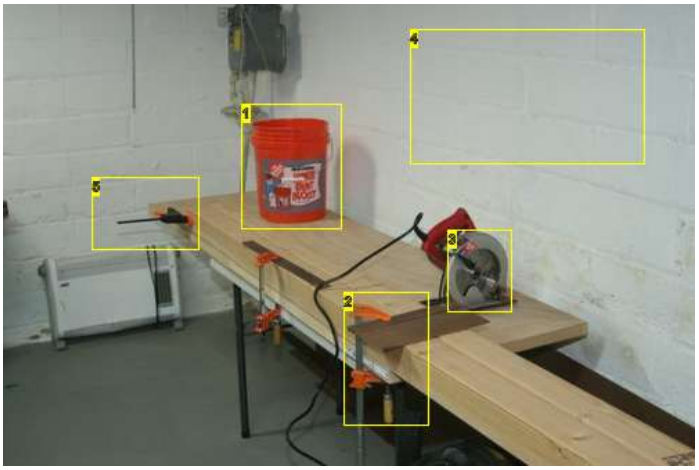


Image Notes
1. Counterweight, to keep the table from tipping.
2. My first edge guide, and the clamp that got in the way of the saw
3. cross-cut blade
4. Rough-cut the 4x4's - first try
5. 4x4's clamped together

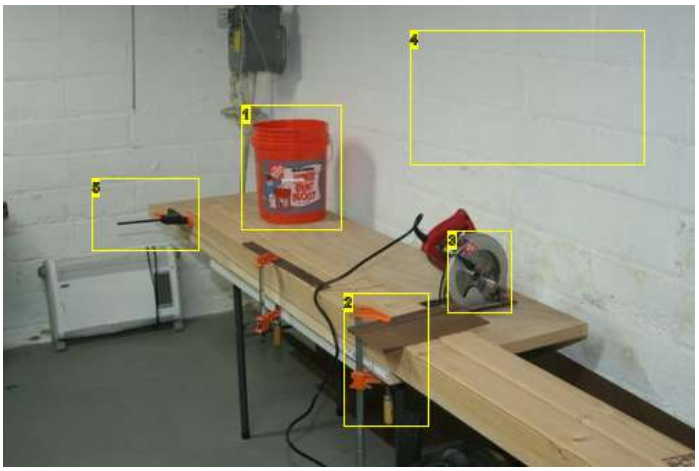


Image Notes
1. Second rough-cut, on the other end, with the new cutting guide

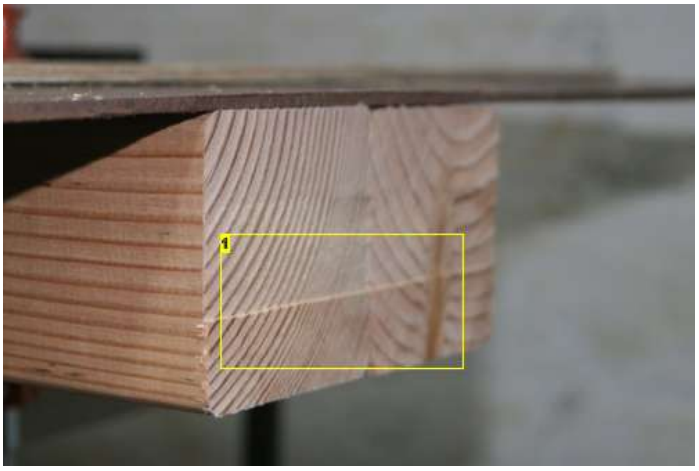


Image Notes
1. About a 16th of an inch - the blade on the saw wasn't quite perpendicular

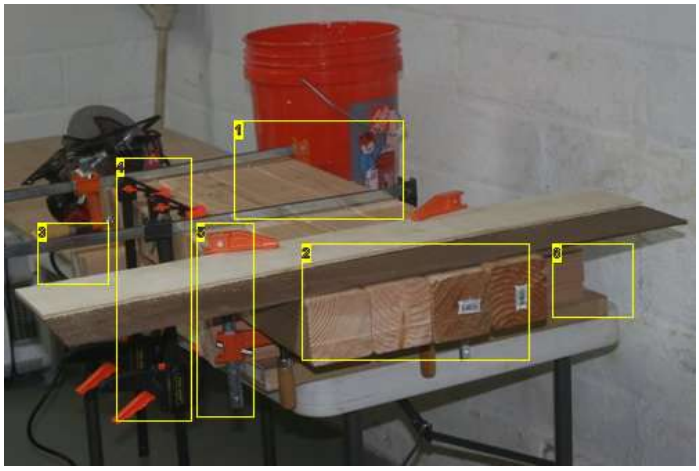


Image Notes
1. Clamp all four legs together - and don't unclamp until you are done cutting both ends
2. Setting up for first try at a final cut
3. Resting on the scraps of 4x4 to provide clearance for the clamps when flipped
4. Clamp the whole mess to the table
5. Clamp the edge guide to the 4x4's
6. Resting on the scraps of 4x4 to provide clearance for the clamps when flipped

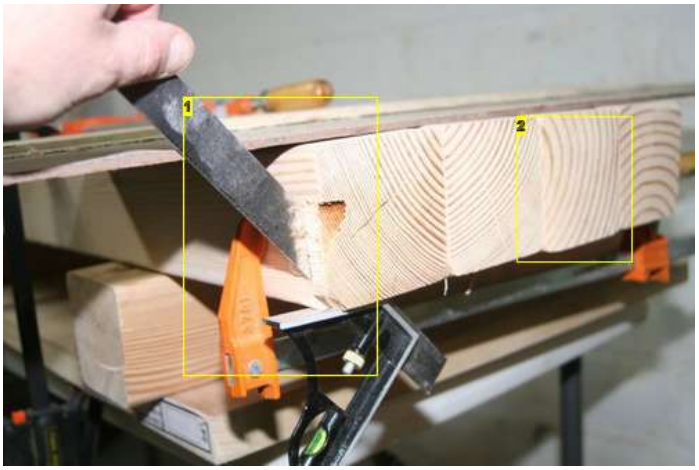


Image Notes
1. After flipping to cut second side, using combination square to line up cutting guide with saw kerf
2. Previous cut wasn't quite right, so shifted the guide back a bit and cut again

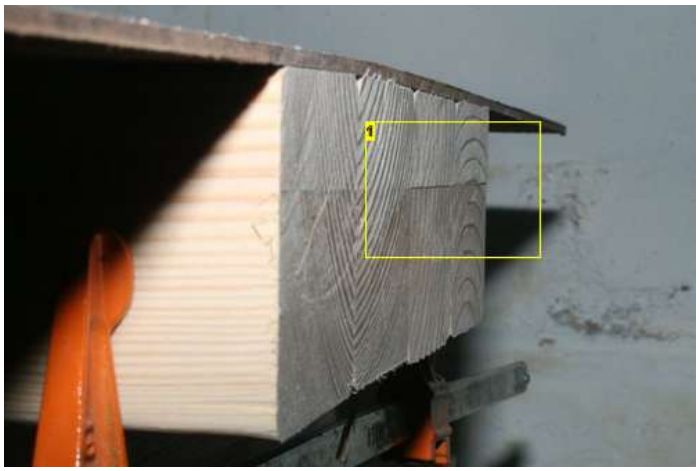


Image Notes
1. Not quite perfect, but close enough

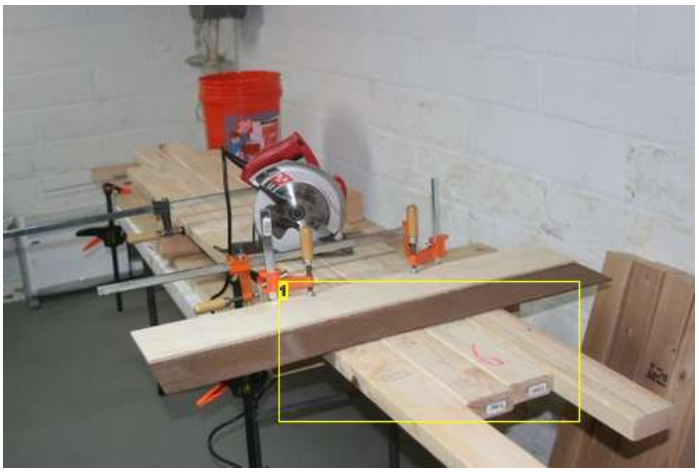


Image Notes
1. First end of the short stretchers

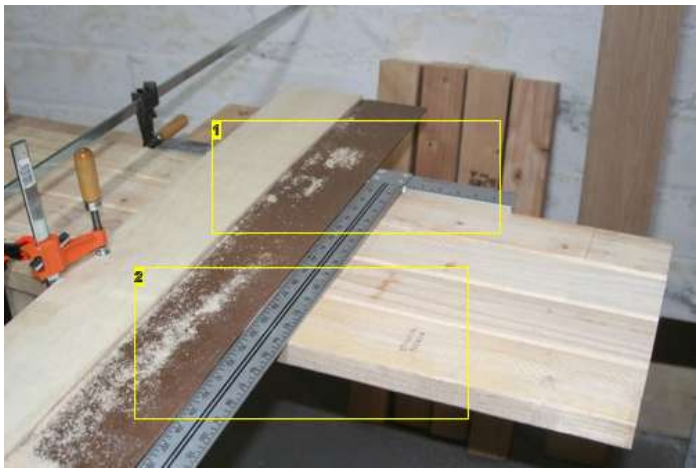


Image Notes
1. A drywall square works wonderfully for keeping things square
2. Cutting other end of short stretchers

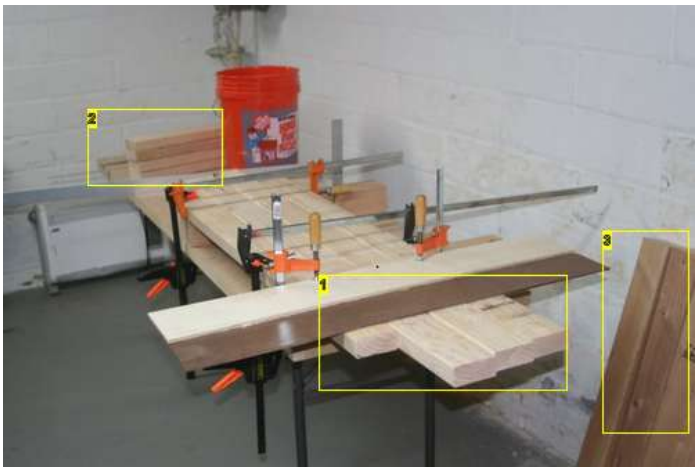


Image Notes
1. Cutting first end of long stretchers
2. The short stretchers
3. The legs

Step 5: The Base, step two - Routing the grooves

The next step is to route the grooves that the threaded rods will pass through. A router table would be best tool for this. I don't have a router table, I used a hand-held router with an edge guide.

There are a number of tricks to using a router. First, the bit spins in a clockwise direction, as you look down at the router from the top. This means that when you cut with the router from left to right, the bit will tend to pull the router away from you, and when you route from right to left, the router will pull towards you. So, if you're hooking the edge guide along the near side of the board, route from left to right, and when you're hooking it along the far side of the board, route from right to left. Second, always test the position of your bit on scrap material. Your odds of getting it exactly right by eye are nil. Third, don't cut more than 1/4" deep on a single pass. We want a 3/8" deep grove, so make your first pass at 3/16", or thereabouts, and make a second pass to reach the full depth.

I ended up making a number of practice cuts. The first revealed that I hadn't tightened the screws on the edge guide enough. The second revealed that the design of the edge guide provided very little support at the end of a board, because of the cut-out for the router bit. In the "Getting Started in Woodworking" video, they had screwed a piece of hardwood to the edge-guide, to provide a continuous -- and longer -- bearing surface. I may do that myself, some day, but I didn't have the materials at hand, so I clamped some 2x4 scrap to the end of each board, to provide a continuous bearing surface past the ends. The two grooves in the long stretchers and the side groove in the short stretchers have identical layout. I made practice cuts in scrap until I had the edge guide set correctly, then I cut them all with that one setting. The bottom groove of the short stretchers uses a different setup, so it was back to the scrap, before cutting them.

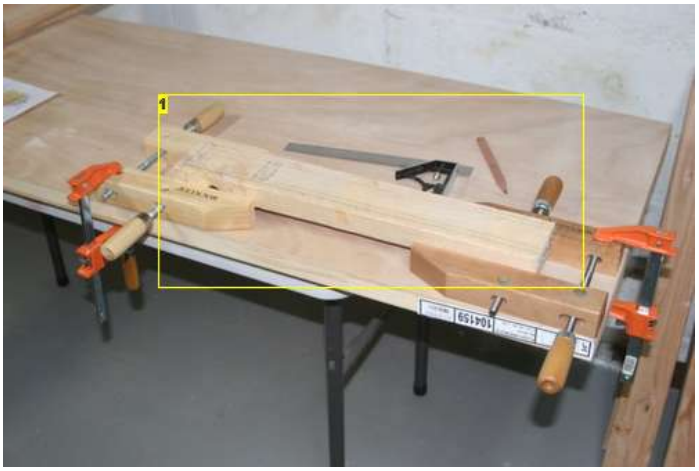


Image Notes
1. "Getting Started in Woodworking"'s neat trick for holding boards for routing

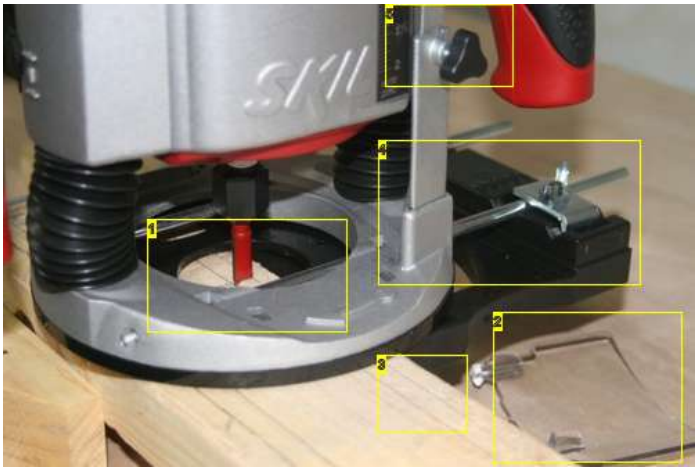


Image Notes
1. Line up bit with marks, prior to trial cut in scrap
2. Dust shield temporarily removed
3. 3/8"-wide grove, 7/16" from the edge, 3/8" deep
4. Edge guide with truly horrid butterfly nuts as tightening devices
5. Depth stop set to 3/8"

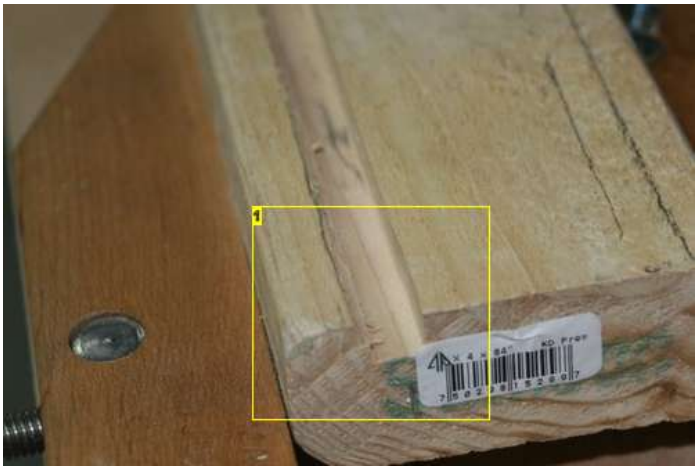


Image Notes
1. Set screws in edge guide weren't tight enough, shifted on second pass

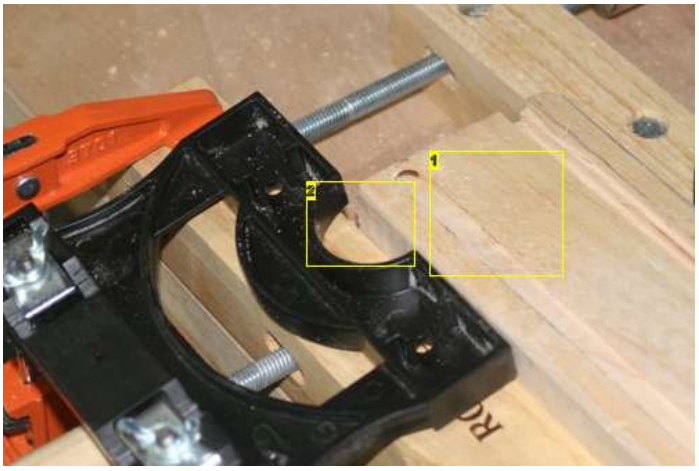


Image Notes
1. Cut goes serpentine in the last inches, because half of edge guide no longer bears
2. This cutout is not only unnecessary for this task, it's unwanted

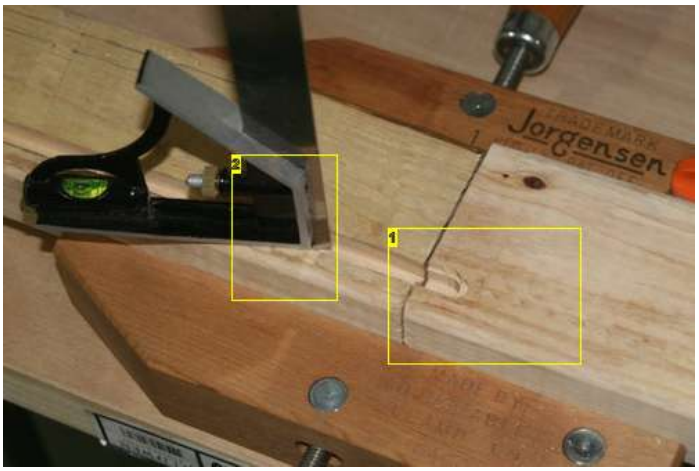


Image Notes
1. Extend bearing edge with scrap -- groove is straight through the end
2. Checking depth

Image Notes
1. Will it hold 3/8" all-thread?

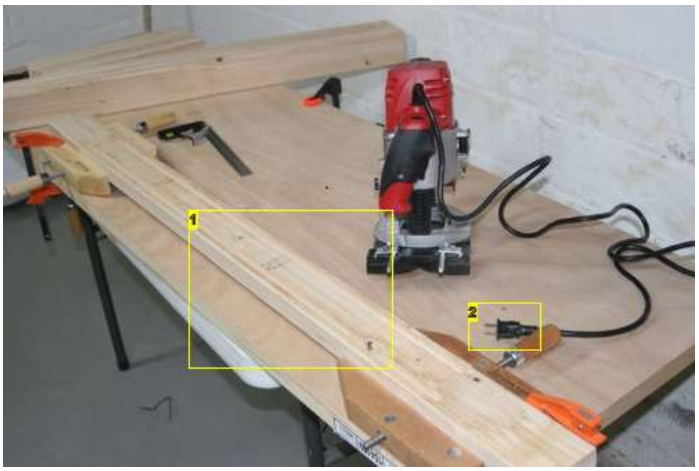


Image Notes
1. Routing grooves in the real pieces
2. Do you stick your fingers into a snow blower, while the engine is running?

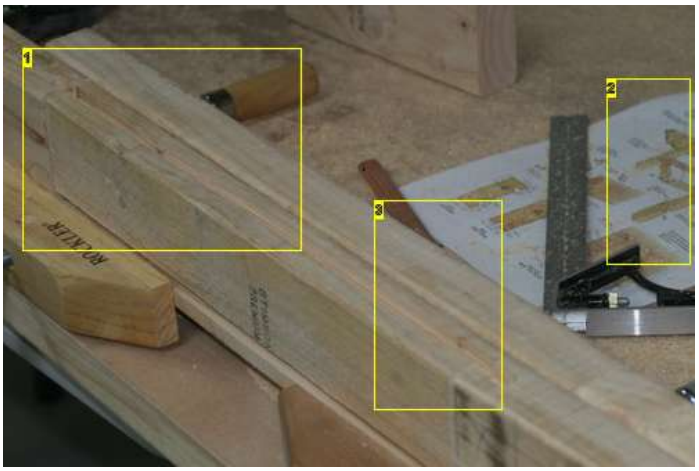


Image Notes
1. On the short stretchers, the second grove is in middle of the bottom side - so we're testing in scrap, again
2. "Getting Started in Woodworking"'s project plans
3. "Getting Started in Woodworking"'s second routing trick - add backup board to provide better support for router

Step 6: The Base, step three - sanding the parts

As I was handling the 2x4's, during the routing, I realized that I really wouldn't be happy with the look of the bench, if it were made from these unfinished boards. They had stamps, pencil marks, and more importantly, incipient splinters left by the saw, none of which I wanted. And I was remembering what other shop furniture made from unfinished pine had looked like, after a few years in the grime of a shop.

So I determined to clean up the boards, to remove the stamps and splinters, and to prep for a finish of some type.

There's only the one picture for this step, but it was by far the most time-consuming.

I used the hand screws again, to hold the pieces. I used a belt sander to remove the surface problems, then used a small random-orbital sander to remove scratches left by the belt sander. In total, it required five passes - 50 and 80 grit on the belt sander, 100, 150, and 220 grit on the orbital.

My advice? Don't do this. If you have jointer and a planer, use them. If you don't, seriously consider using dimensional lumber that has already been planed and sanded. If you are going to try to clean up construction lumber by hand, using a hand plane is a lot faster and more pleasant than using a belt sander. Except, of course, that to do a good job of planing a board you need a solid bench to hold the board, and you don't have a bench, yet.

Me, I'm stubborn, and nearly always insist on doing things the hard way.

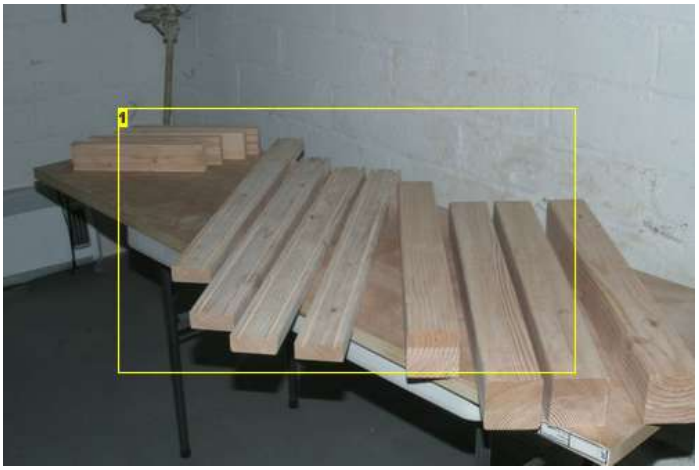


Image Notes
1. Sanded parts

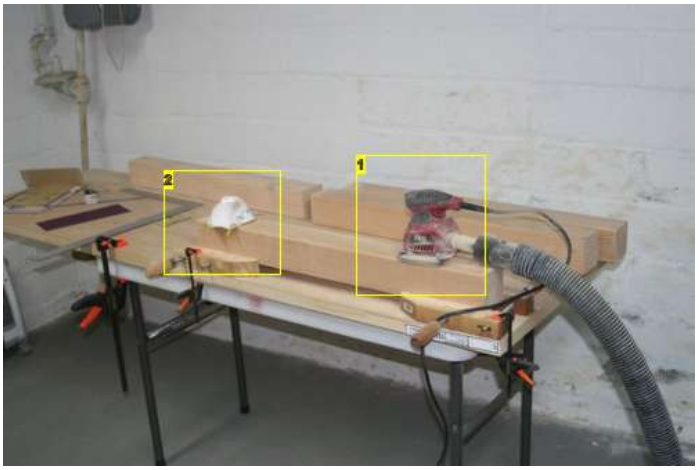


Image Notes
1. Random orbital sander
2. Always use a mask when sanding

Step 7: The Base, step four - Trestle rod holes

Now that we have parts, we'll take some of them -- two legs and to short stretchers -- and make our first trestle.

Matching up the parts

Not every part and not every cut will be perfect. Match up your parts so that the less-than-perfect parts are in less-than-critical locations.

The top is supported by the top ends of the legs and the top sides of the top stretchers. Stand your legs on end on a flat surface (like my door) and see if they wobble. If you have an end that isn't quite stable, use it as a foot, where the leveler will make it's flaws unimportant. Check the top edge of each stretcher for straightness. If one has a bit of a bow, use it for a lower stretcher. It's less critical that the shelf be well supported along its length.

Do a trial layout to see how the parts fit together. Label each part to indicate which part joins with which.

Mark the holes

The holes we want to mark are the holes through which the threaded rod connecting the two legs will run. This threaded rod will run through the 3/8" groove along the bottom of the short stretchers,. The hole for the upper stretcher has to be positioned so that when the rod is running through this groove, the top of the short stretcher is even with the top of the legs. The most precise way I've found for marking the position of this hole is to use a dowel center. Fit the dowel center into the bottom groove, line up the stretcher, and bang on the end with a rubber mallet. The dowel center will leave a mark indicating the center of the hole.

The precise position of the lower stretcher is less critical. I marked out a position 8" from the end of the legs.

Drill the holes

In the "Getting Started with Woodworking" video, the holes through the 4x4's were drilled from the back. That is, they start on the side opposite the precisely-positioned mark, and drill through to hit it. If they can do this, more power to them, but I can't drill through 3-1/2" of wood to emerge at a precise mark without a drill press - and not always then.

I drilled from the mark. That way I could ensure that the hole was where it was supposed to be, on the side where the position was critical. I have two 3/8" bits -- a brad point bit that came with my doweling set, and a perfectly ordinary 3/8" twist bit. Brad-point bits are far more precise than twist bits -- they're more likely to start where you want them to, and they're more likely to stay straight. My problem is that my brad-point bit wasn't long enough to go through 3-1/2" of wood. So I started each hole with the brad-point bit, then finished it off with the twist bit. I clamped a piece of ply on the back, to reduce tear-out.

When the holes were complete, I flipped the legs and drilled the countersinks with a 1" Forstner bit. Trying to drill a countersink when the center was already drilled would be impossible with a spade bit or an auger, but Forstner bits are guided by their edges, not their center, so they can handle this job. On thing about Forstners, though -- they have a tendency to skitter around a bit when starting, before they bite. An easy fix for this is to drill a hole through a piece of ply, and to clamp that to your work, creating a jig that will prevent the bit from drilling in the wrong spot.

The countersinks should be deep enough to hold a nut and washer, plus a little bit.

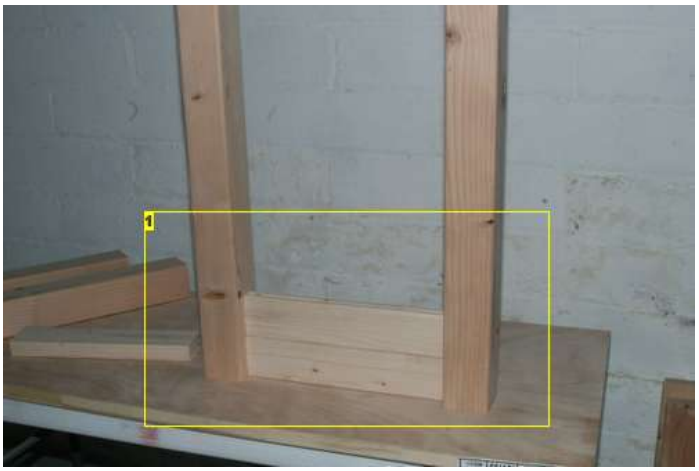


Image Notes
1. Matching up the parts

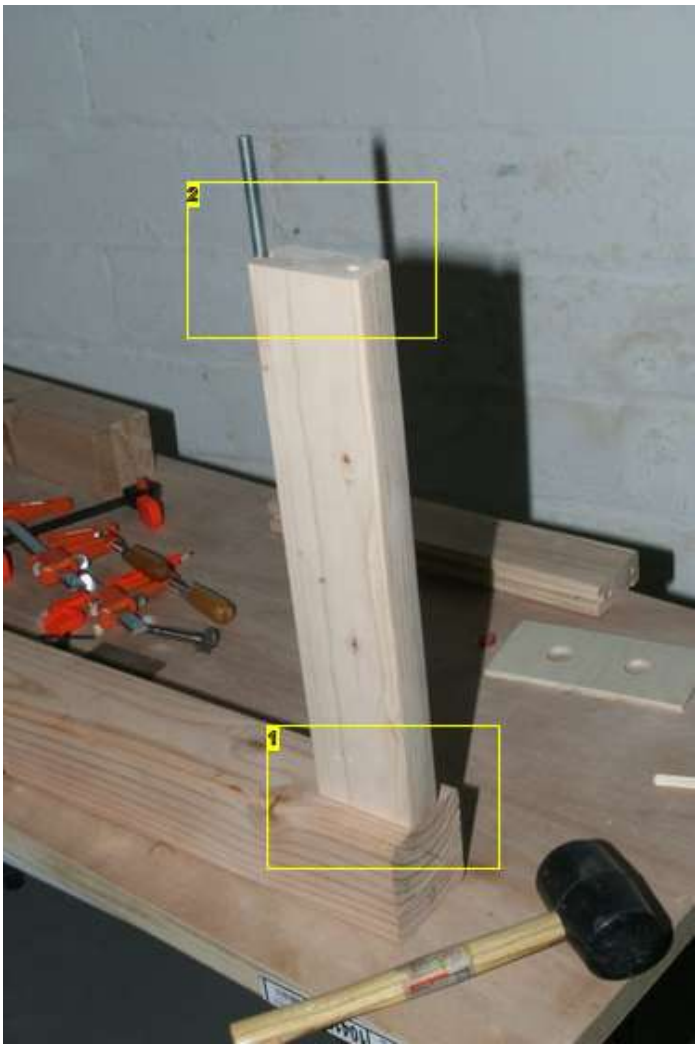


Image Notes
1. Makes mark here.
2. Banging here...

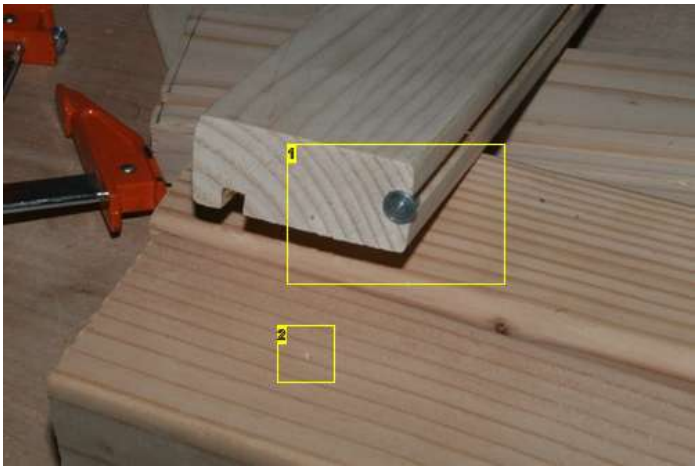


Image Notes
1. Using dowel center to mark position of hole for threaded rod
2. Mark

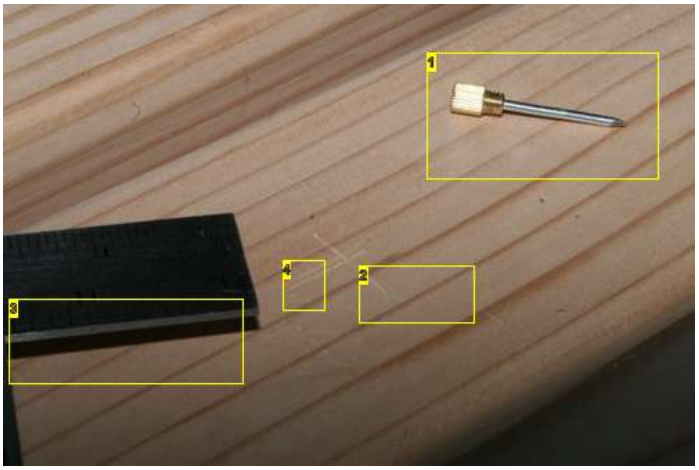


Image Notes
1. Scribe (from combination square) makes more precise mark than a pencil
2. One mark is 8" from the bottom of leg
3. Square is set to 1/2 the width of the leg
4. One mark is supposed to be half the width from one side, the other half the width from the other. The true center is halfway between them.

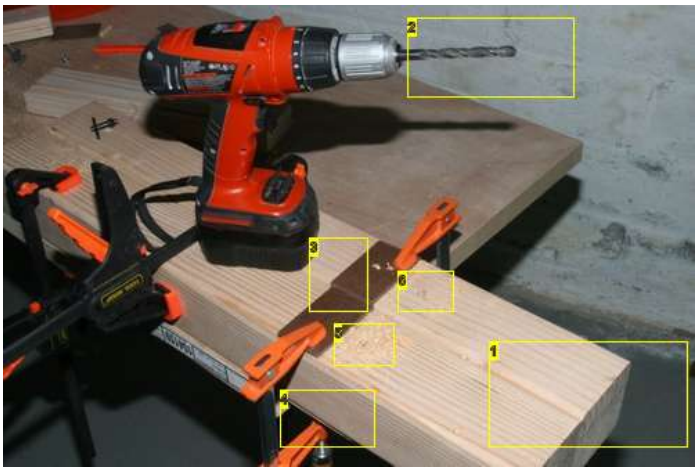


Image Notes
1. Setup to drill 3/8" thru-hole
2. Started holes with 3/8" brad-point bit, but switched to 3/8" twist bit to finish
3. Pads to prevent clamps from leaving marks
4. Strip of 1/4" ply, clamped to back, to reduce tear-out
5. A hole
6. A hole

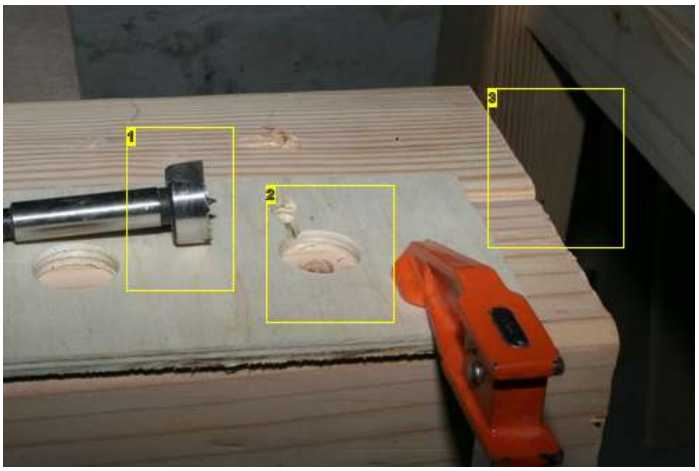


Image Notes
1. 1" Forstner bit
2. Forstner bit jig, centered over back side of hole, to reduce skitter
3. Parts have been flipped, from previous picture

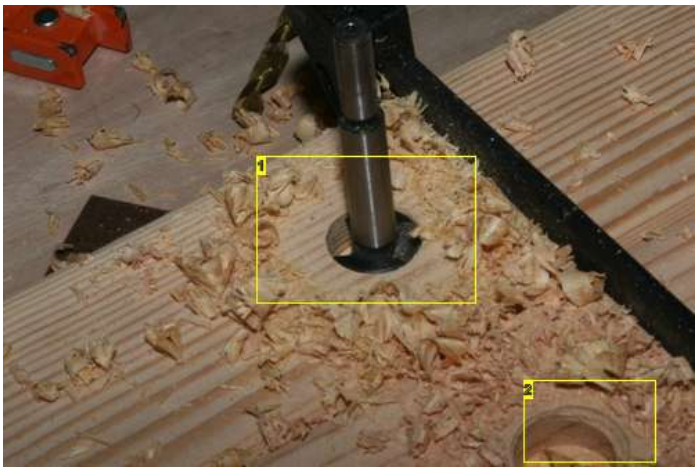


Image Notes
1. Drill until back of bit is slightly sunk
2. Skitter

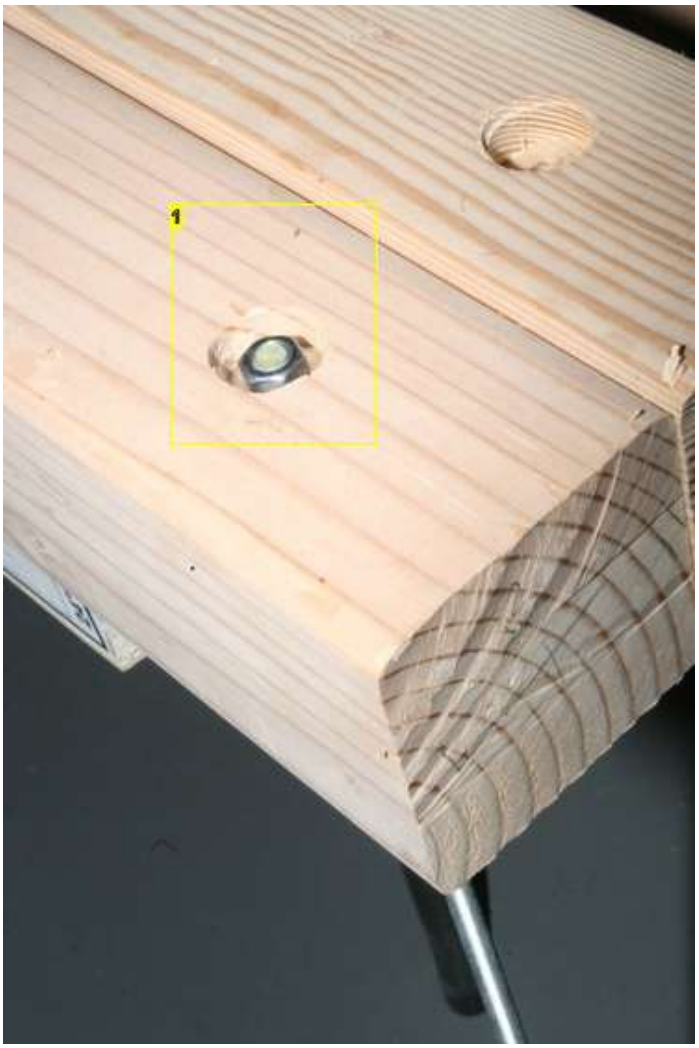


Image Notes
1. Depth looks good

Step 8: The Base, step five - Trestle dowel holes

Drill the stretcher dowel holes

Drill a pair of 3/8" holes in each end of the short stretchers, just over half of the depth of the dowels, using a brad-pointed bit. These stretchers already have a groove running their length, centered on the bottom edge. Precise placement isn't necessary, but keeping track of which part is which is. We need a hole in each end of each stretcher. Take care to keep these holes square, you don't want them running at angles.

Mark the leg dowel holes

Lay a leg flat on your work surface, with the countersink side of the thru-holes down. Stick a piece of threaded rod in each hole. Take a stretcher that is marked to have one end adjoin the top of this leg, stick a dowel center in its dowel hole, line it up against the leg, using the threaded rod for positioning, You want the top of the stretcher to be even with the top of the leg, or just slightly above it. Give the end of the stretcher a whack with your rubber mallet. This will leave a mark indicating where the matching dowel hole in the leg needs to be drilled. Repeat with the lower stretcher than adjoins this leg. Then repeat for the other leg that will form this trestle, and the other ends of the two stretchers.

Drill the leg dowel holes

When you have both legs for this stretcher marked, drill the other dowel holes at the marks. Again, take care to make the holes square.

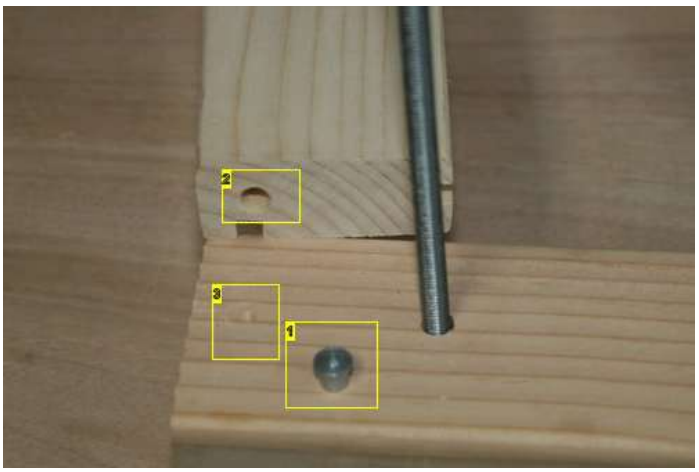


Image Notes
1. Dowel center
2. First dowel hole in stretcher
3. Mark for matching hole in leg

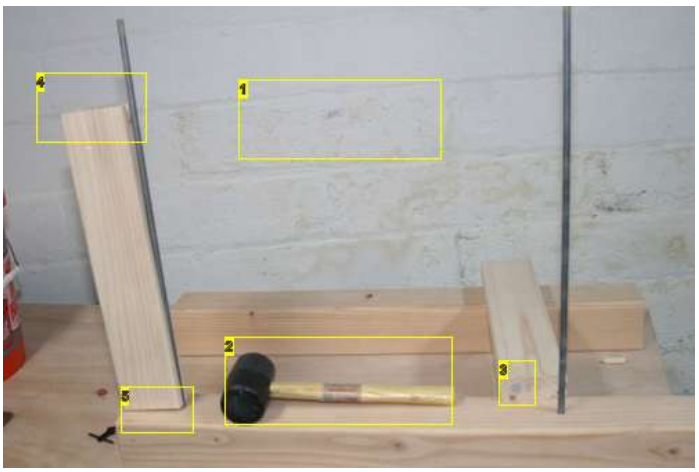


Image Notes
1. Marking position of first dowel holes
2. Rubber mallet for banging
3. Dowel center
4. Bang here
5. To make mark here

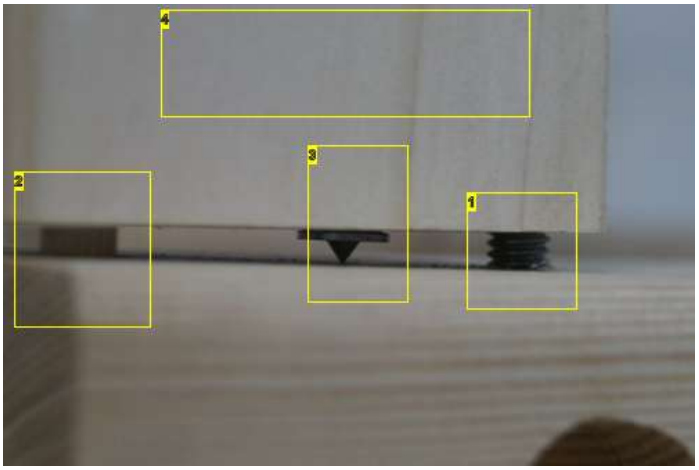


Image Notes
1. Threaded rod
2. First dowel
3. Dowel center marking hole for second dowel
4. Marking position of second dowel holes

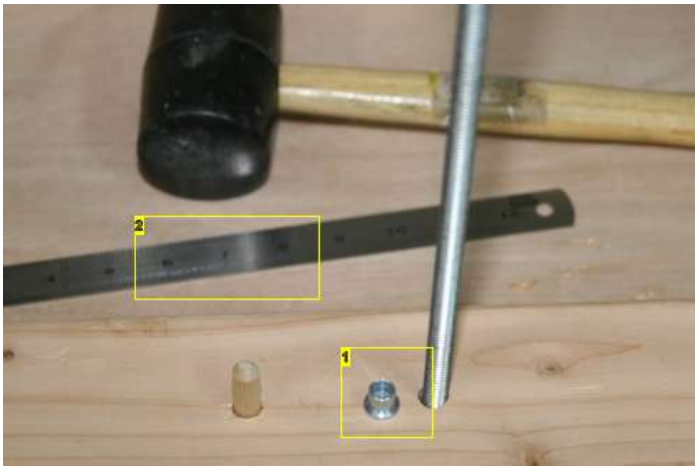


Image Notes
1. Marking second dowel
2. If dowel center won't stay in the stretcher hole by itself, use rule to hold in place.

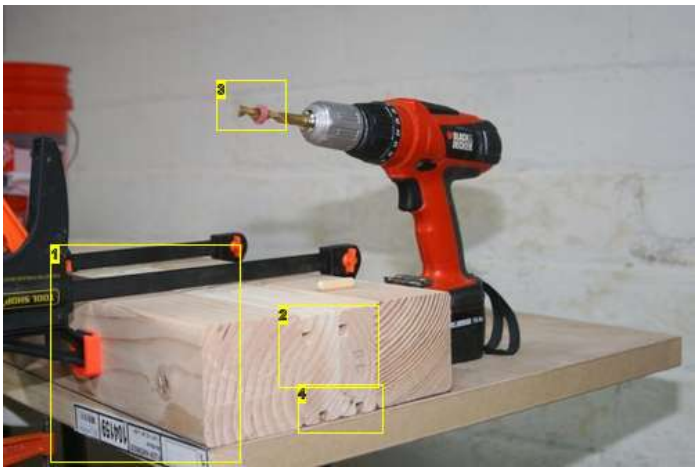


Image Notes
1. Setup to drill dowel holes in short stretchers
2. First dowel holes have been drilled, second have not
3. Brad-point bit with depth guage set to just over half the length of a dowel
4. Grooves for threaded rod

Step 9: The base, step six - board jack holes

A board jack is mechanism to provide support to long boards that are being held in the vise. These can be quite sophisticated, involving parts that can be moved both horizontally and vertically. The simplest mechanism is simply to stick a dowel into a hole drilled into the front of your bench.

The "Getting Started in Woodworking" video showed only one hole, drilled in the right front leg, level with the vise. This is useful only for a narrow range of boards. I decided to drill holes at four different heights in each of the front legs, six inches apart.

So that they would accept the same hold downs as the bench dog holes on the top, I decided they should be 3/4" in diameter, and should be drilled through where possible.

The Jig

Drilling a precisely positioned, deep, wide hole isn't easy, without a drill press. So I bought a WolfCraft drill guide. After experimenting with it, and drilling some test holes, I build a jig around it. I screwed it to a scrap of MDF, and then drilled a carefully-centered 3/4" hole. The MDF can be clamped more easily than the base itself, and the 3/4" hole will keep a 3/4" Forstner bit drilling precisely where it is supposed to.

Marking the holes

I wanted my first hole 1-1/4" from the top, and three others at six inch intervals, all of them on the centerline.

To mark the centerline, set a compass to span something more than half the width of the leg. Draw an arc from corner of the leg. The point where the arcs intersect will be on the centerline. With a centerline point on each end of the leg, place a scribe on the point, slide a straightedge up to touch the scribe. Do the same on the other end. When you have the straightedge positioned so that you can touch both points with the scribe, and in each case it is touching the straightedge - without moving the straightedge - scribe the line. Use scribes, rather than pencils or pens, because they make more precise marks.

Use the compass, again, to mark the center of the top hole, 1-1/4" from the top, on the centerline. Then mark the second hole on the centerline, six inches below the first. Repeat for the other two holes. To precisely set the span of the compass, use a rule with etched markings, and set the points of the compass into the etched grooves.

Place a centerpunch on each of your four points in turn, and press down to make an indentation. This will mark the center of the hole.

Drilling the holes

Because of the depth of the holes, drilling each hole became a four step process:

1. With the jig positioned and clamped, start the hole with a 3/4" Forstner bit, to give a clean entry. Drill perhaps 1/2" deep.
2. Extend the hole with a 3/4" spade bit, to as deep as the jig will allow.
3. Remove the jig and extend the hole further with the 3/4" spade bit, until the point of the bit is just starting to protrude from the other side.
4. Flip the leg, position the jig, and finish the hole off with the Forstner bit. This gives a clean exit.

The top hole on each does not extend through, and only steps 1 and 2 are necessary.

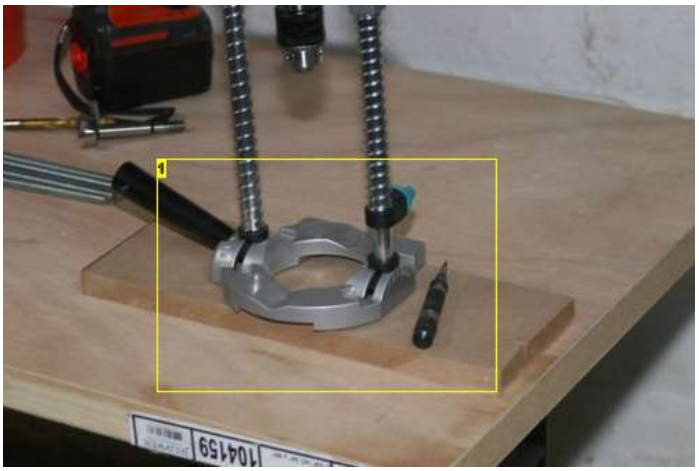


Image Notes
1. Screw drill guide into a scrap of MDF

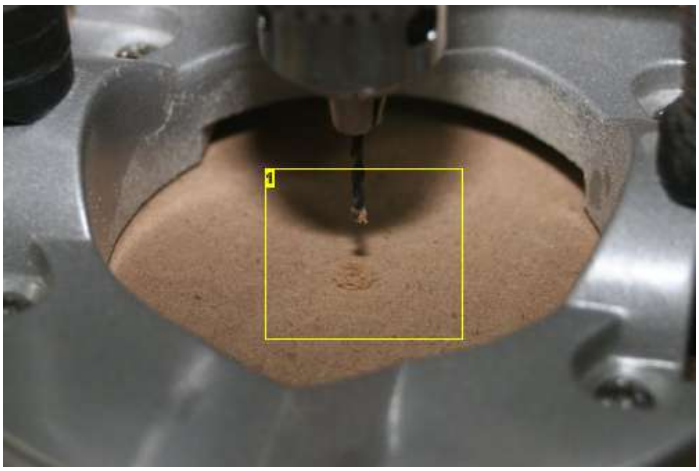


Image Notes
1. Use a small bit to mark the center

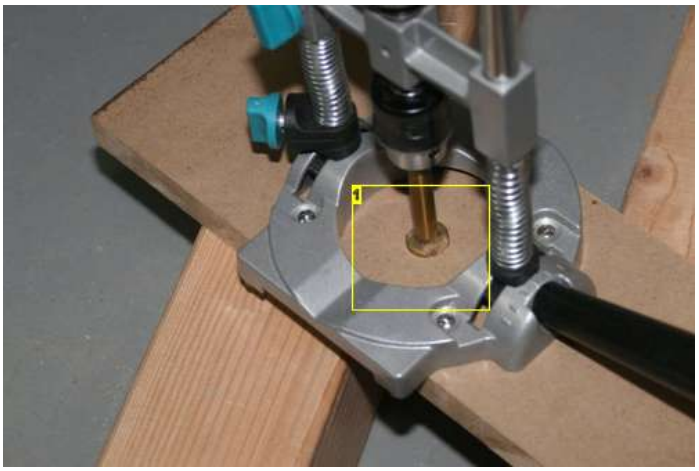


Image Notes
1. Drill out 3/4" guide hole

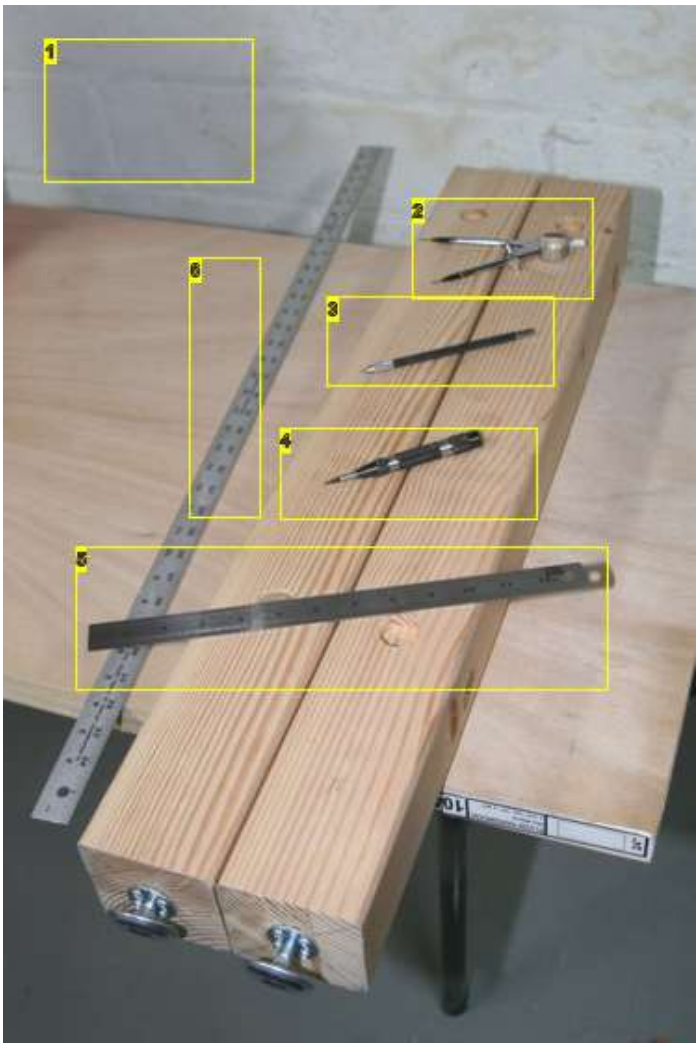


Image Notes
1. Tools for marking the board-jack hole positions
2. Scribe-pointed compass
3. Scribe
4. Centerpunch
5. Etched steel rule
6. Straightedge

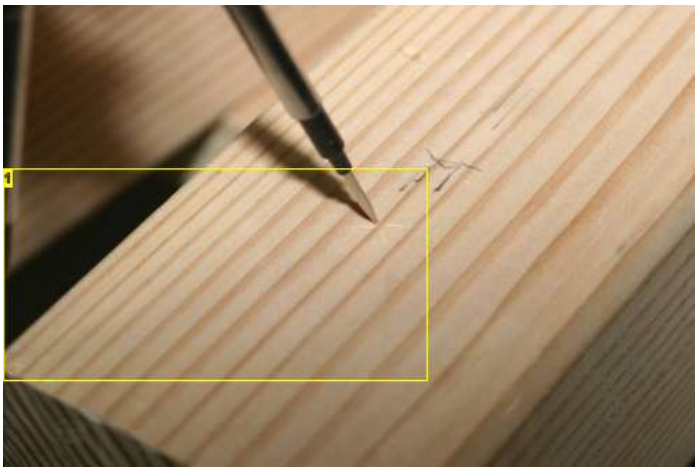


Image Notes
1. Use compass from each corner to find points on centerline

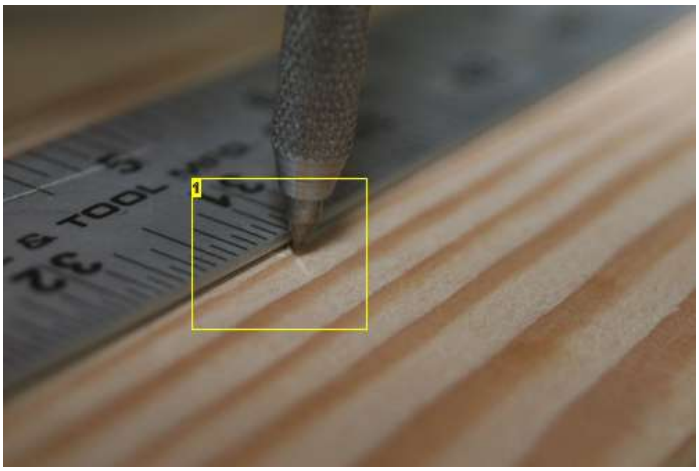


Image Notes
1. Place scribe on point, set rule against scribe. Repeat with point at other end. Scribe centerline.

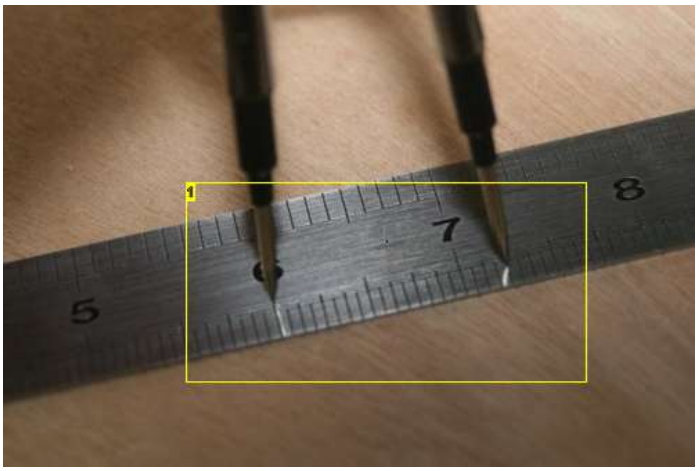


Image Notes
1. Set compass distance by adjusting until the scribe points are in the etched grooves

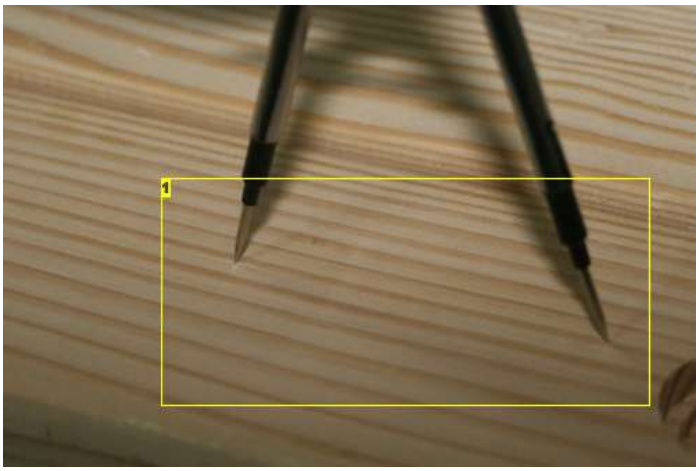


Image Notes
1. Center of first hole is 1-1/4" from the top. The other holes are six inches on center. My compass won't expand to six inches, so I set it to 3" and walked once.

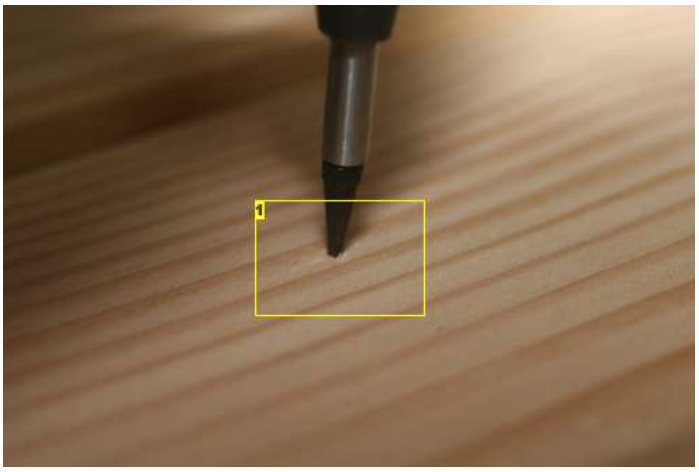


Image Notes
1. Use centerpunch on intersection to create mark.

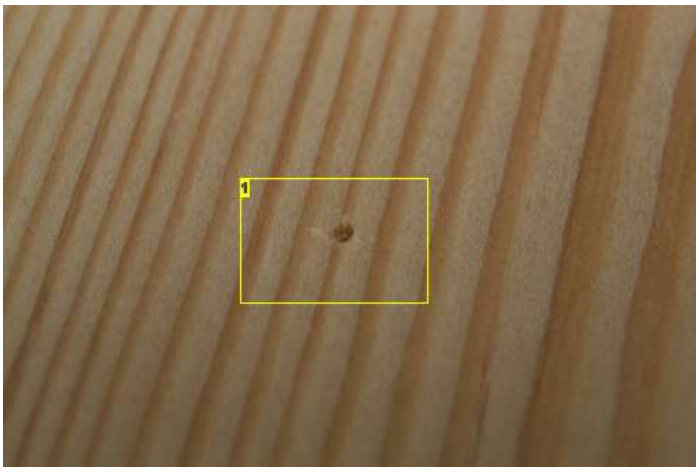


Image Notes
1. Mark made by centerpunch

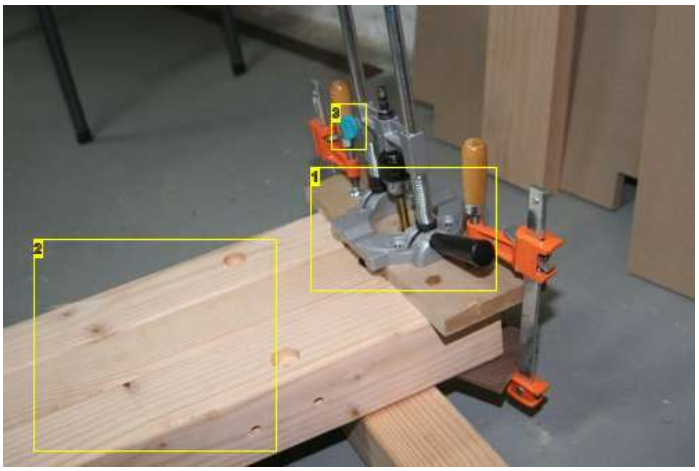


Image Notes
1. With Forstner bit: center guide hole over centerpoint dimple, push chuck down until point of bit enters hole, then engage drill guide vertical lock. Clamp guide in position, chuck up drill, unlock drill guide, and drill half-an-inch or so deep.
2. Front leg being drilled is clamped between two back legs to give more stable support for drill guide.
3. Vertical lock thumbscrew

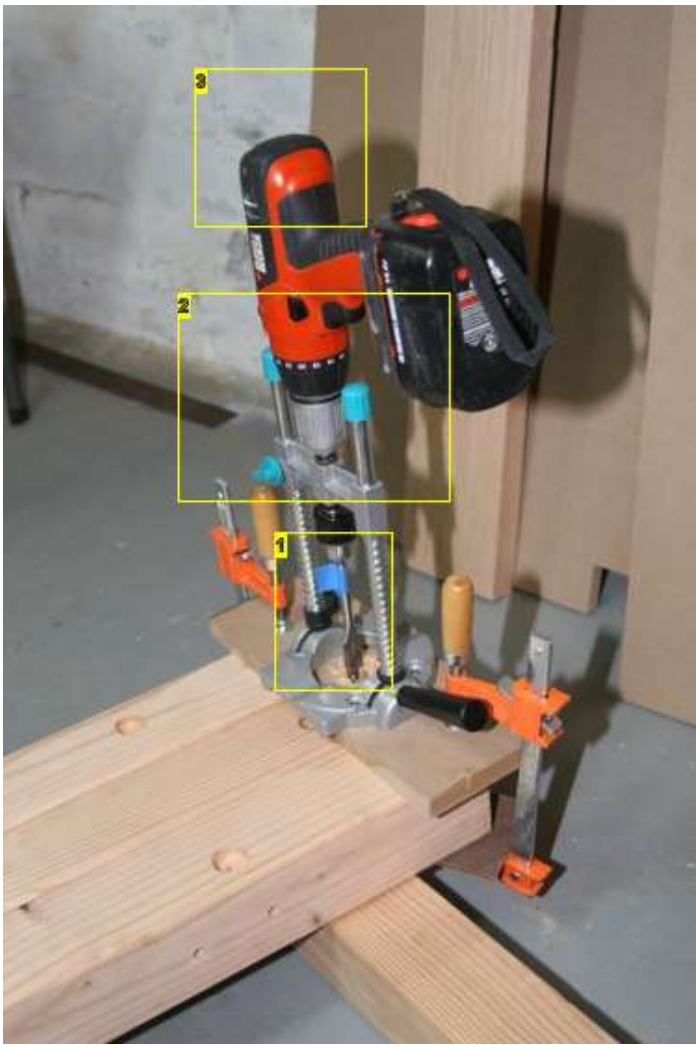


Image Notes
1. Replace Forstner bit with spade bit, drill as deep as the drill guide will allow.
2. Put parts on floor, so you can lean over drill and ensure force applied to drill is perpendicular
3. Push down on end of drill, inline with the bit. Do not put pressure on the handle

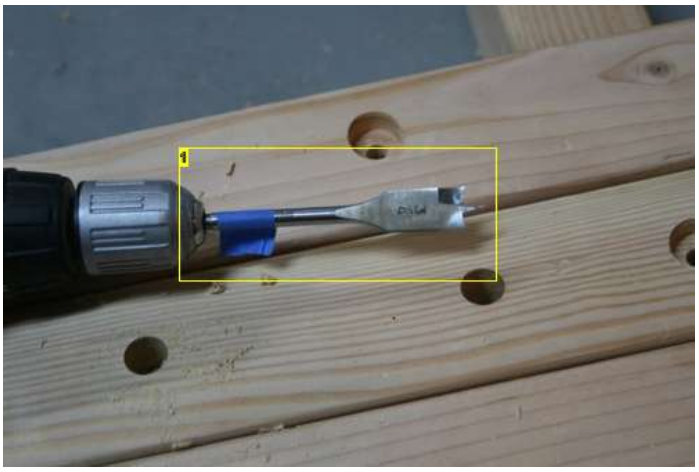


Image Notes
1. Put tape on spade bit to mark depth where the bit will just be breaking out the back

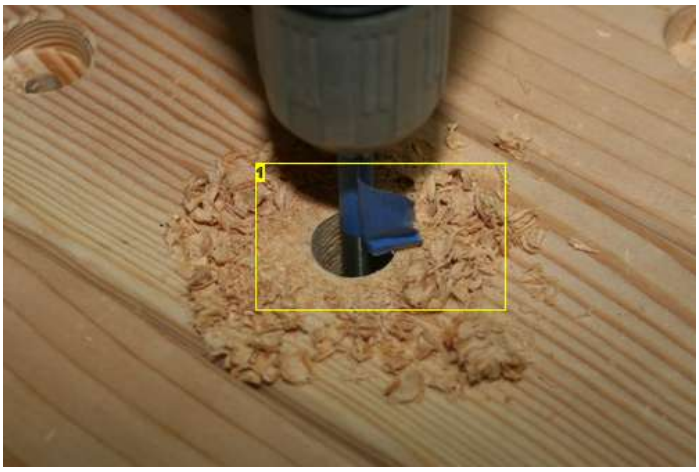


Image Notes
1. When the tape starts sweeping the sawdust, you're done

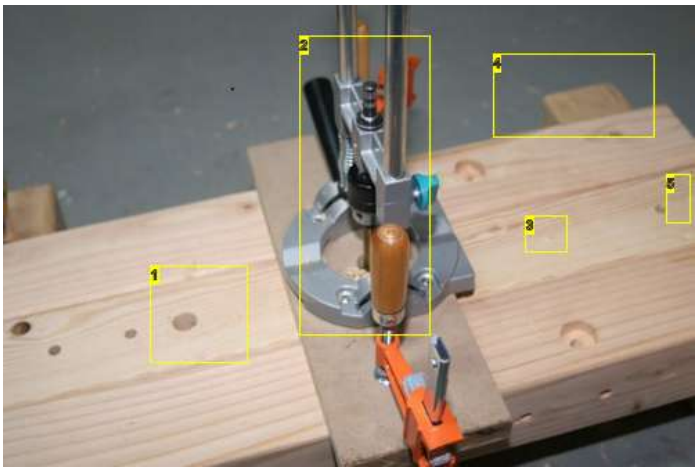


Image Notes
1. Back side of fourth hole cleaned up with Forstner bit
2. Setting up to clean up back side of third hole with Forstner bit
3. Second hole. Point of bit had just started to come through
4. Flipped to clean up back side of holes
5. First hole doesn't go through, so there isn't a hole on this side

Step 10: The base, step seven - Assembling the trestle

Put it all together

Take two 24" long sections of 3/8" threaded rod. If you bought 6' lengths, cut off two 24" long lengths. On one end of each, place a washer and a nut. Screw on the nut only half way, you don't want the end of the rod protruding.

Thread the rods through one of the legs, then set the leg flat on the table. Insert dowels into the dowel holes. Place the matching stretchers into place. Put dowels into the dowel holes at the top end of the stretchers. Place the other leg onto the threaded rod and settle it down onto the dowels. You'll probably have another opportunity to whack away with your rubber mallet.

When you have the other leg seated, the threaded rods will extend father than you want them to. You'll want to mark them so they can be cut to length. Place a washer and a nut on each threaded rod, and then tighten down the nut to pull everything tight. Depending upon the wrench you are using, and how much longer the rod is than it needs to be, you may find it necessary to stack up a number of washers, so that the nut is positioned where the wrench can operate on it.

Once you have pulled everything tight. remove the nuts and washers, wrap a piece of tape around the end of each of the rods, and then mark on the tape where the rod should be cut. You want to cut it slightly below flush. Then take everything apart.

Cutting the rods

There's nothing very tricky about cutting the rods. Clamp them to your temporary table, and cut them off with a hacksaw. Make sure you're using a sharp blade. While you're setting up the clamps,. you can think to yourself how nice it will be once you're able to use the vise for jobs like this.

The hacksaw will often damage the last thread when it cuts. Running a nut off the end will fix this. You'll have to run the nut all the way down from the other end. This doesn't take long, if you chuck up the rod in your drill and let it do the work. Hold the rod vertically, with the drill pointing down, and just hold on to the nut enough to keep it from spinning.

Assembly

When you have the rods cut to length, put everything together the way you did before, and you'll have your first trestle.

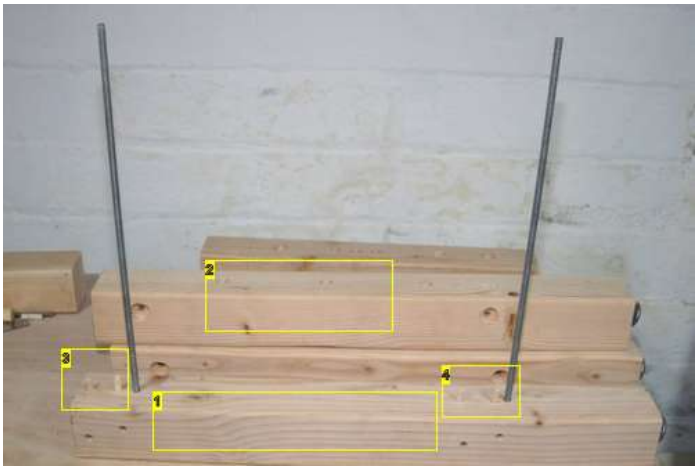
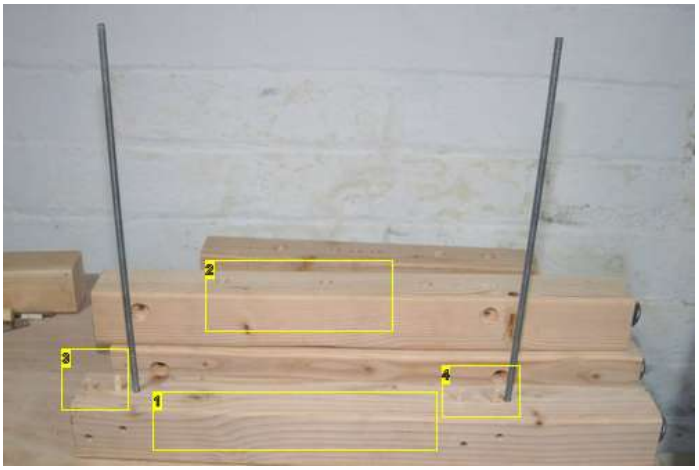


Image Notes
1. Back leg
2. Front leg
3. Dowels

Image Notes
1. Completed trestle



4. Dowels

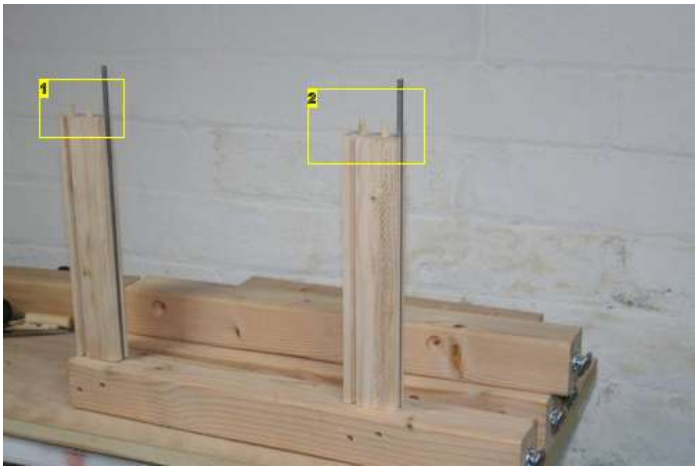


Image Notes
1. Dowels
2. Dowels

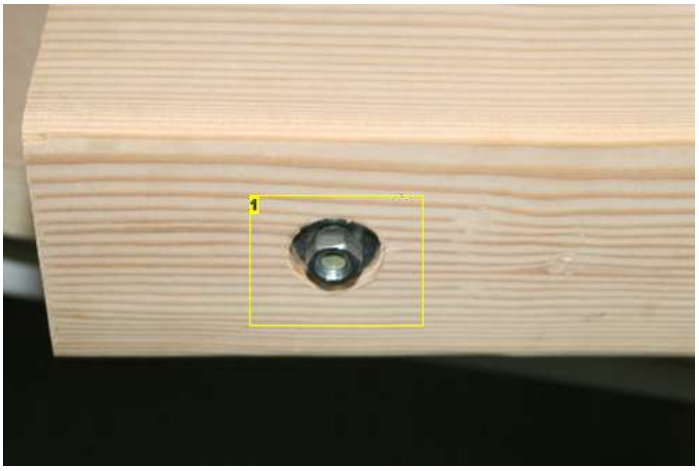


Image Notes
1. Bottom nut partially screwed on to threaded rod

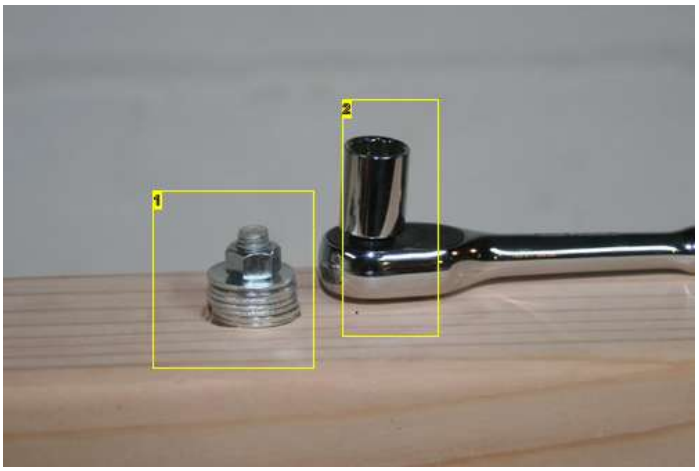


Image Notes
1. Tighten down top nut, to pull everything tight,
2. My 9/16" socket isn't deep enough, so I stacked up washers

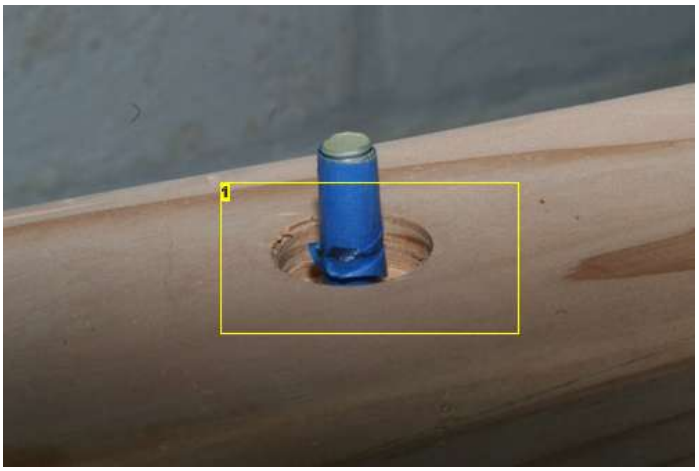


Image Notes
1. Remove nut and washers, tape, and mark for cutting

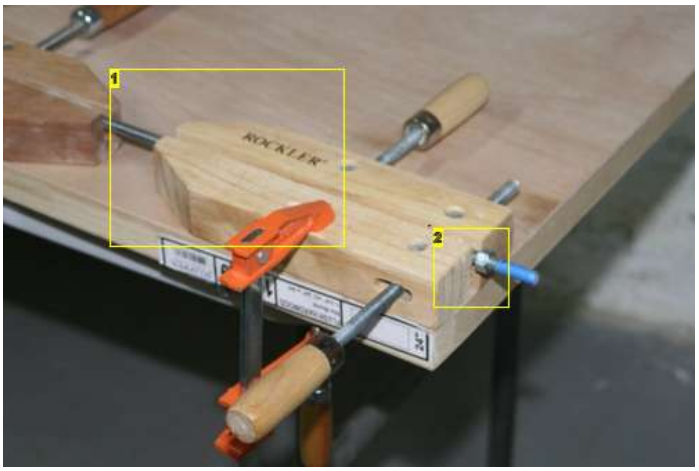


Image Notes
1. Clamp a rod, then go at it with a hacksaw
2. Nut screwed down to end

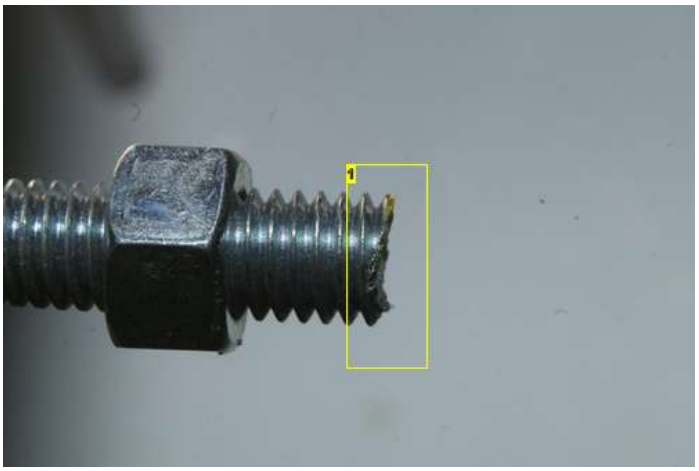


Image Notes
1. Last thread crushed a bit by the saw (and no, I didn't take these photos with my cellphone)

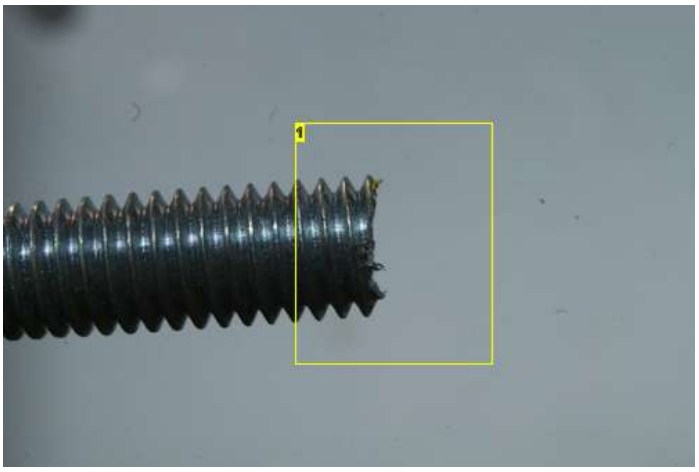


Image Notes
1. Unscrewing the nut cleans up thread

Step 11: The base, step eight - Lather, rinse, repeat

Repeat the same process for the second trestle, and then for long stretchers to assemble the base

Once the stretchers and legs have been connected, flip the assembly upside down, and install the levelers. Then flip it back upright.

Next is the shelf. Start with the 24x48" piece of MDF. Clamp this on top of the base, and pencil in the outside of the stretchers and the inside angle of the legs. Flip it over, pull out your trusty cutting guide, and cut it to width and to length. Cutting out the angles is simple, with a jig saw. It's not much work with a hand saw. If you took enough care with supporting blocks and stops, you could probably do it with a circular saw. Since I did have a jig saw, I used it.

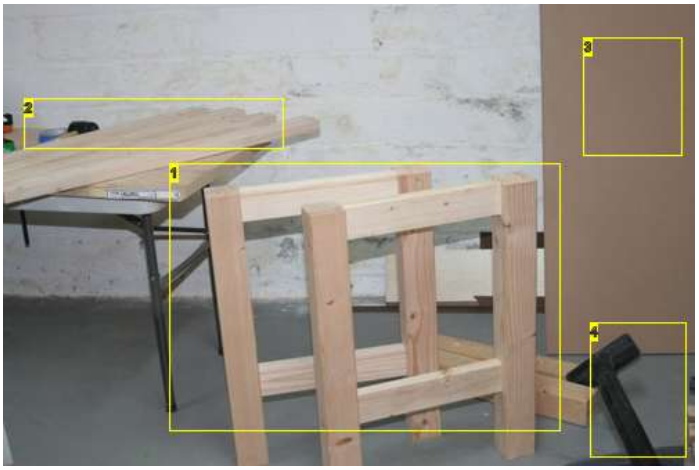


Image Notes
1. Two trestles
2. The long stretchers
3. MDF for the top -- this is stored flat on the door, except while I'm working
4. Always cleaning up sawdust

Image Notes
1. Marking the lengths for the long rods
2. No levelers, yet

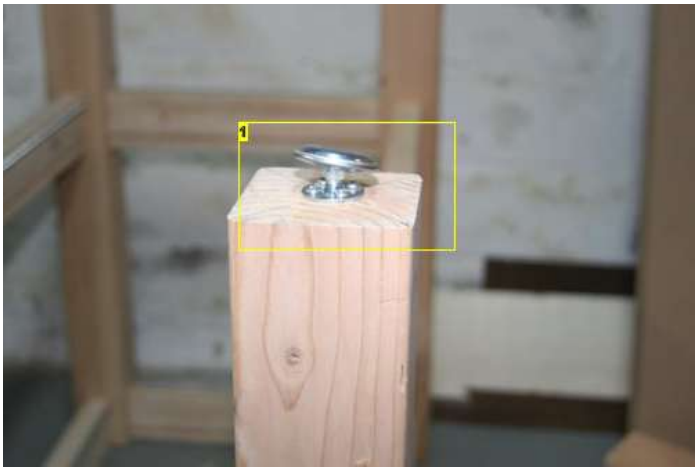


Image Notes
1. Adding a leveler

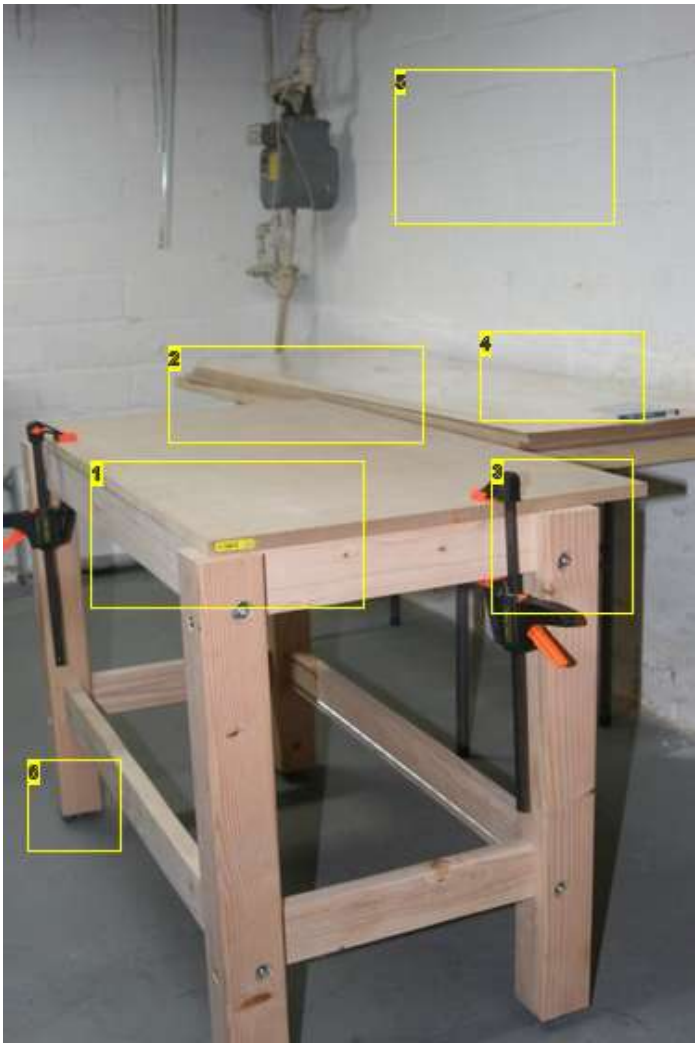


Image Notes
1. If you line up these edges, you'll only need to make two cuts
2. Pencil the line of the outside of the stretchers onto the bottom of the panel
3. Pencil the inner angle of each leg onto the bottom of the panel
4. The rest of the panels lying flat on the door
5. Measuring the shelf
6. See? Now it has levelers

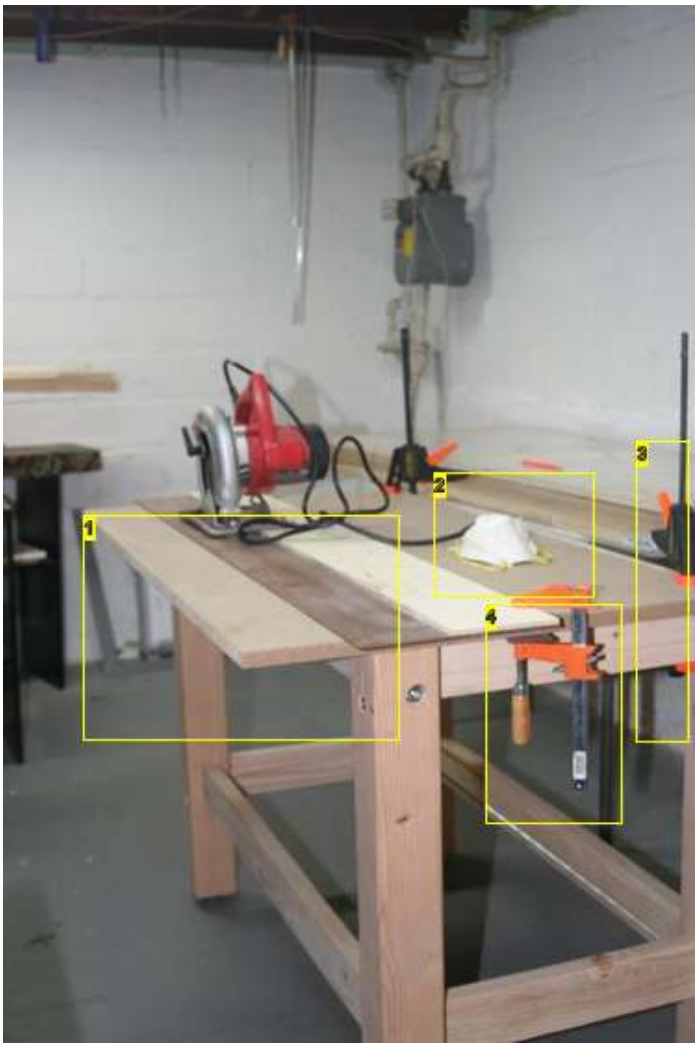


Image Notes
1. With the panel flipped over, we can cut along the lines we drew
2. Always use a mask when cutting MDF. The dust is toxic.
3. Clamp the shelf to the base
4. Clamp the cutting guide to the shelf

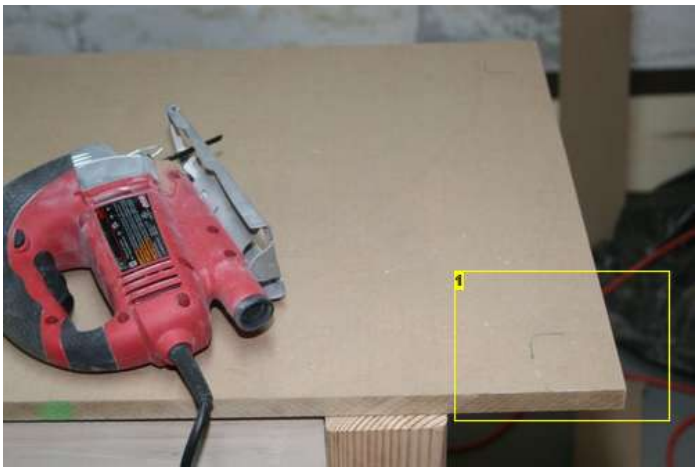


Image Notes
1. After cutting to size, we need to cut out the corners

Step 12: The Base, step nine - Finishing

I'd decided on an oil-and-wax finish. Oil finishes are by no means the toughest. In fact, they're really rather pathetic, so far as protecting the wood goes. But they're easy to apply, and not even the toughest finish will stand up to the abuse that a workbench will suffer, so it's more important that it be easy to repair. Wax is usually used to add a high gloss. On a bench, it's there to keep glue from sticking.

And then decided that the oil alone would be sufficient for the base. The wax serves to give the surface a gloss (which I see no need for), and to make it easier to remove spilled glue and paint (which I also see no need for, on the base). So I oiled the base and oiled and waxed the top.

The "Getting Started in Woodworking" video series has an episode on applying oil-and-wax finishes, that includes steps such as wetting the wood, and then sanding down the raised grain. All of this seemed excessive, for something that I was going to put in my basement and bang on with a hammer.

I made a low table out of a couple of step-stools, my hollow-core door, and one of the MDF panels that would eventually form part of my top. I was concerned that any oil that dripped on the door might interfere with its glue adhesion, when I finally get around to the project for which I'd purchased it. The top side of the top sheet of MDF, though, I planned to oil, anyway. (Ditto for the bottom side of the bottom sheet.

Putting the base up on this temporary table put it an a more convenient height than it would have been on the floor or on a full-height table.

Applying the oil is easy. Put on some vinyl gloves, pour some oil in a bowl, take a piece of clean cotton cloth the size of washcloth or smaller, dip it in the oil, and apply it to the wood. You want the wood to be wet., you're not trying to rub it in until it's dry. Apply oil to the entire surface, and then go over it looking for dry spots, applying more oil as needed. After fifteen minutes of keeping it wet, let it sit for another fifteen minutes. Then apply another coat of oil, and let it sit for another fifteen minutes.

Rub it dry. Wait half-an-hour, and then wipe dry any oil has seeped out. Check it every half hour and do the same, for a couple of hours.

The next day, apply another coat, wait half an hour, then wipe it dry. Do the same on successive days for as many coats as you think are necessary. I applied three.

!!! WARNING !!!

Remember those fire safety tips you used to get in grade school, about the dangers of oily rags? It was linseed oil they were talking about. All oily rags are dangerously flammable. Linseed oil will self-combust. Linseed oil doesn't evaporate, it oxidizes. The oxidization generates heat, and the increased temperature increases the rate of oxidation.

Linseed oil sitting in a bowl, or spread on the surface of wood, is perfectly safe. But a linseed oil soaked rag provides a vastly increase surface area, so the oxidation happens faster, and the rag can provide insulation, trapping the heat. The increased temperature speeds up the oxidation even more, which raises the temperature even more, and the runaway feedback can quickly result in temperatures that will cause the rag to spontaneously burst into flame. This isn't one of those "do not drive car while sunscreen is in place" warnings. This is one of those "keep your finger off the trigger until you have the gun pointed at something you want to shoot" warnings. Rags soaked in linseed oil *will* catch fire, if you don't handle them properly, and they can do so far more quickly than you might think.

When you're working with linseed oil, **never** -- I mean **NEVER** -- leave used rags lying around. Hang them up outside, away from anything combustible, and where there's enough air circulation to keep them cool. Or put them in a bucket of water, and hang them outside later. If you're just setting a rag down for the moment, set it out flat, without folds, on something non-flammable. Hanging outside in the breeze, the oil in the rags won't retain heat while they oxidize. For the oil to completely oxidize can take in a couple of days, if it's warm, or more than a week, if it's cold and rainy. When fully oxidized, the oil will be solid and the rags will be stiff. At that point, they're safe, and can be thrown in the trash. Toss them in the trash before that, and you might as well say goodbye to your garage.

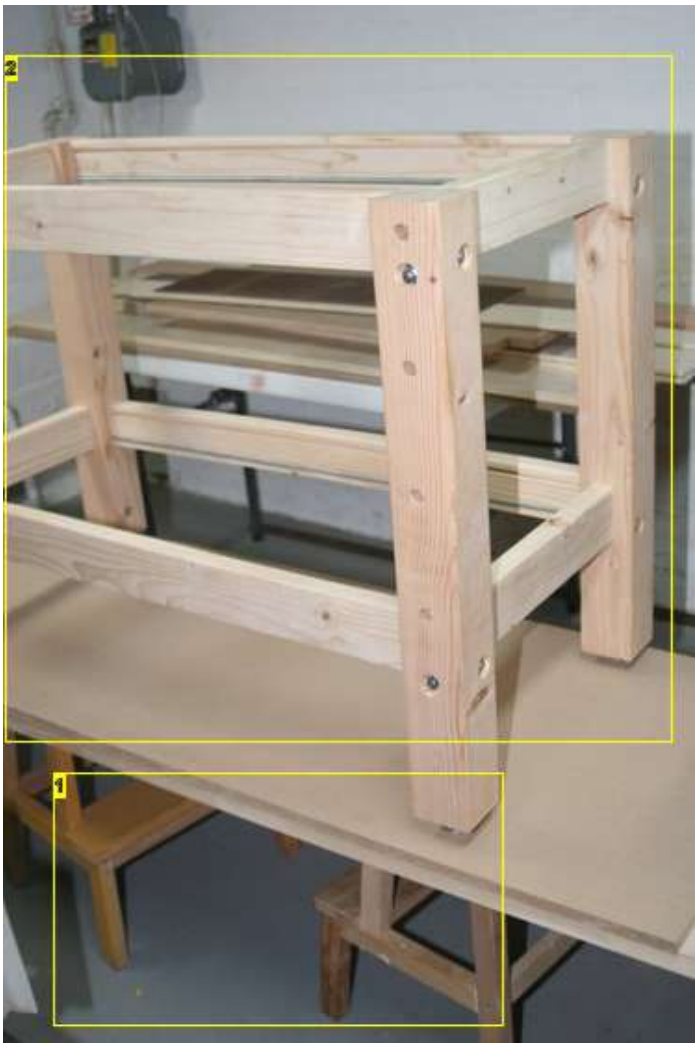


Image Notes
1. Temporary table from a pair of Ikea stepstools and a hollow core door, with one of the MDF layers as a drip shield
2. Assembled base

Image Notes
1. First application
2. Danish oil
3. Vinyl - not latex - gloves
4. A soup bowl I never liked

Image Notes
1. A linseed-oil-soaked cloth, out in the breeze where it's unlikely to build up enough heat to spontaneously combust, and where it won't cause any damage if it does

Step 13: The Top, step one - determining the layout

Before you start cutting or drilling the pieces that will make up the top, determine the layout of the top. This should include the dimensions of the MDF, the dimensions of the edging, the locations of the vises, and of the screws or bolts that will support the vises, and of all of the benchdog holes and of all of the drywall screws you will use to laminate the panels,

If you don't lay it all out in advance, you could easily find that you have a bolt where you need to put a benchdog hole, or something of the sort. I sketched out ideas on graph paper, then drew the plan full-size on the top side of the bottom layer of MDF, using the actual parts as templates.

The width of the top is determined by the width of the base. The length of the top depends upon the vise or vises you uses. The end vise I had purchased was intended to be used with hardwood jaws that extend the width of the bench. I had a piece of 2x6" white oak I intended to cut down for the purpose.

The decision to be made with respect to the end vise is whether the support plate should be mounted to on the inside or on the outside of the stretcher. Mounting the plate on the inside of the stretcher reduces the reach of the vise - it can't open as far, because the support plate is back from the edge by a couple of inches. But mounting the plate on the outside of the stretcher means that we need to add some support structure for the inner jaw of the vise, which the legs would have provided if we'd mounted the plate on the inside.

I mocked up the two scenarios, and determined that with the plate inside the stretcher the vise would have a reach of 8 inches, and with it outside the stretcher it would have a reach of 9 inches. I decided that 8 inches was enough, and that the extra inch wasn't worth the extra effort. With the end vise mounted like this, the right edge of the top would have no overhang.

I wanted the left edge of the jaw of the front vise to be flush with the left edge of the top, the right edge with the left edge of the left front leg. So the amount of overhang on the left depends upon the width of the front vise jaw. The width of the jaw is, at a minimum, the width of the plate that supports it, but it's normal to make the jaw extend a bit beyond the plate. How far? The more it extends, the deeper a bite you can take with the edge of the vise, when, for example, you are clamping the side of a board being held vertically. But the more it extends, the less support it has. I decided to extend by 1-12", which gives me a 2-1/2" bite, and which should still provide solid support, given that the jaw is 1-1/2" thick. This means the top needs a left overhang of 12-1/4".

What you need to determine, by this drawing, is where you need to drill the dog holes, the mounting holes for the vises, and where you will put the drywall screws you'll be using for the lamination. As well as where the edges of the top will be cut.

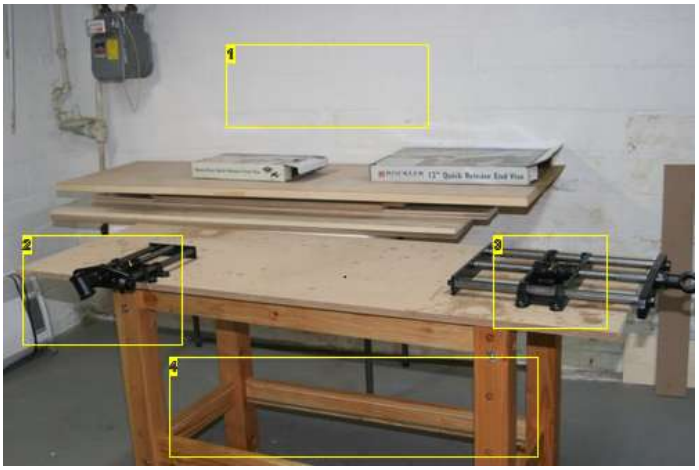


Image Notes
1. Laying out the vises
2. The jaw of the front vise should extend from the leg to the left edge of the top
3. The support plate for the end vise either goes inside of or outside of the short stretcher. Inside gives the vise a shorter reach, outside needs additional support for the stationary jaw
4. It still looks like something hacked together out of construction lumber, but the finish does give it some character. (And makes all the saw marks and clamp dents stand out nicely.)

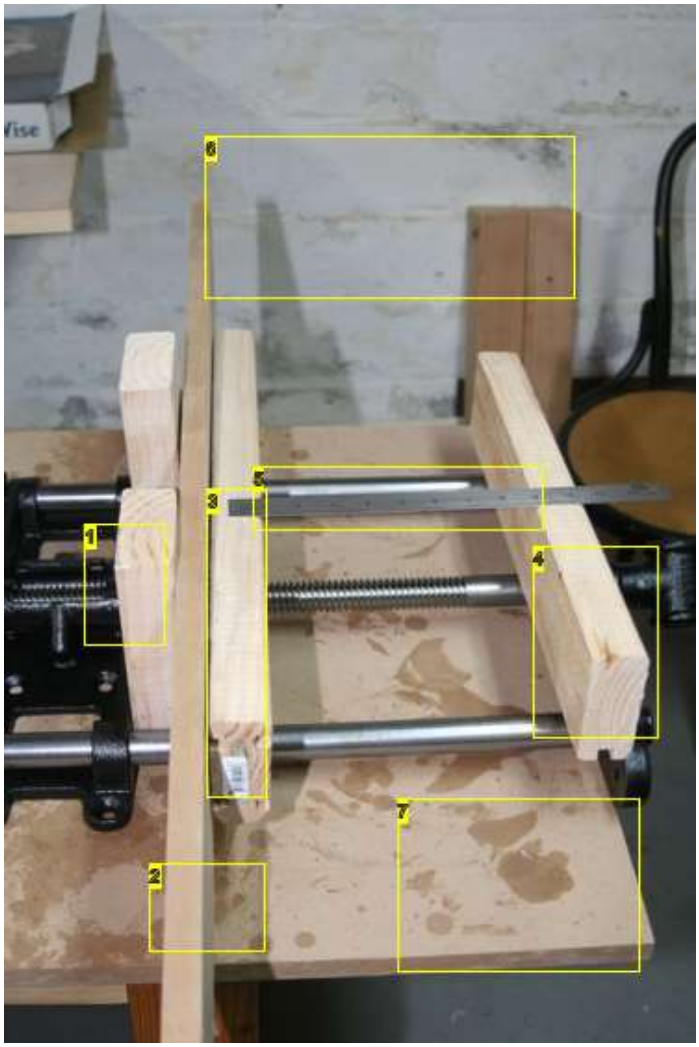


Image Notes
1. The width of the stretcher
2. The offset from the edge of the stretcher to the edge of the legs
3. The width of the inner jaw of the vise
4. The width of the outer jaw of the vise
5. A reach of 8"
6. A mockup of mounting the plate inside the stretcher
7. Plenty of spilled oil from the previous step

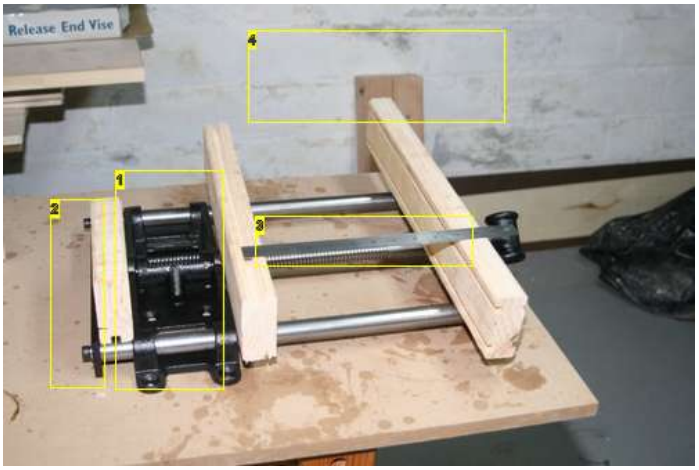


Image Notes
1. The support plate on the outside of the stretcher
2. The end plate on the inside of the stretcher
3. A reach of 9"
4. A mockup of mounting the plate outside the stretcher

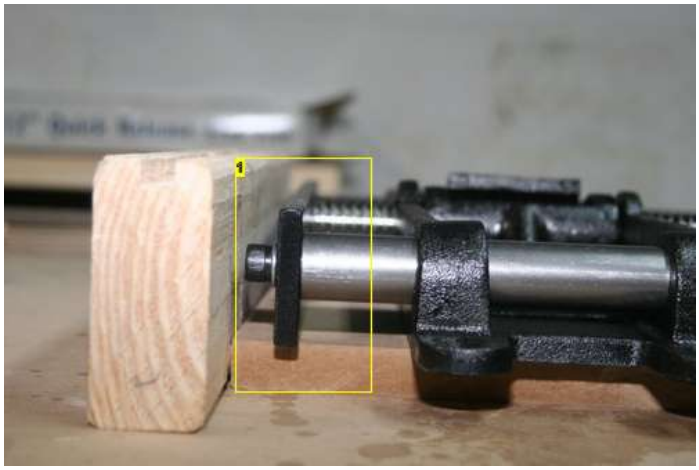


Image Notes
1. With one extra layer of 3/4" MDF, the vise screw still passes by the 3/8" threaded rod at the bottom of the short stretcher

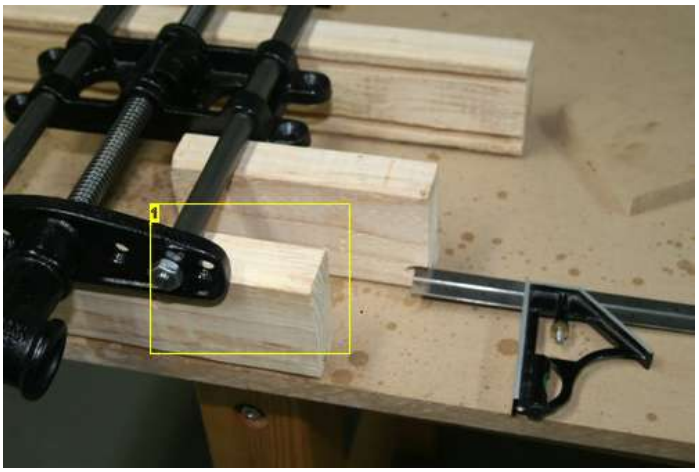


Image Notes
1. How far should the jaw extend beyond its support plate? How deep a reach on a vertical board will the side of the vise allow?

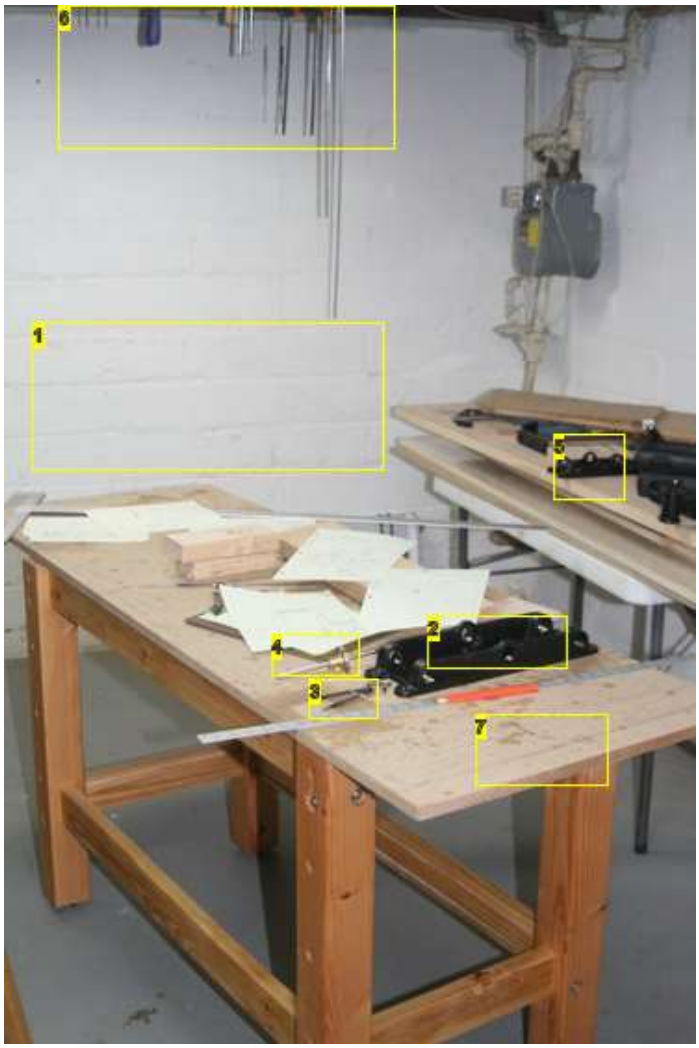


Image Notes
1. Drawing the layout, full-scale, on the top side of the top sheet of MDF.
2. Base plate of end vise
3. Compass
4. Marking guage
5. Base plate of front vise
6. These are my clamps, hanging from the ceiling
7. This is the same surface that I used as a drip shield when oiling the base.

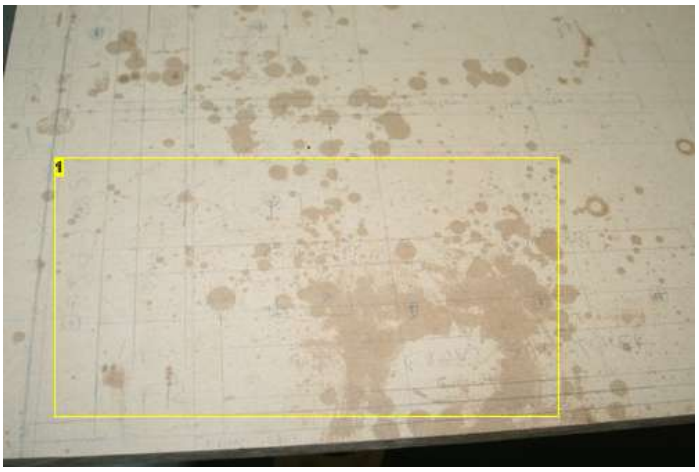


Image Notes
1. It's not very pretty. But then, it doesn't have to be.

Step 14: The top, step two - laminating the MDF

The next step is to laminate the two sheets of MDF that will make up the lower layers of the top.

First, trim the MDF to slightly oversize. You'll want room to clean up the edges after the pieces are joined, but you don't need more than a half-an-inch on each side for that, and there's no point in wasting glue.

If you're lucky enough to have a vacuum press, use that. Otherwise drill holes for the screws in the bottom layer at all the points you had indicated in your layout. You'll also want to either drill a row of screws around the outside edge, in the bit you're going to trim off, or you'll need clamps all around the edge. I just added more screws.

The screw holes should have sufficient diameter that the screws pass through freely. You want the screw to dig into the second layer and to pull it tight against the first. If the threads engage both layers, they will tend to keep them at a fixed distance.

If you're using drywall screws, you'll want to countersink the holes. Drywall screws are flat-head, and need a countersink to seat solidly. If you're using Kreg pocket screws, the way I did, you won't want to counter-sink the holes. Kreg screws are pan-head, and seat just fine against a flat surface. Both drywall screws and Kreg pocket screws are self-threading, so you don't need pilot holes in the second sheet of MDF.

Regardless of which type of screw you use, you'll need to flip the panel and use a countersink drill to on all of the exit holes. Drilling MDF leaves bumps, the countersink bit will remove them, and will create a little bit of space for material drawn up by the screw from the second sheet of MDF. You want to remove anything that might keep the two panels from mating up flat. I set a block plane to a very shallow bite and ran it over what was left of the bumps and over the edges. The edges of MDF can be bulged by by sawing or just by handling, and you want to knock that down.

After you have all the holes clean, set things up for your glue-up. You want everything on-hand before you start - drill, driver bit, glue, roller or whatever you're going to spread the glue with, and four clamps for the corners. You'll need a flat surface to do the glue-up on - I used my hollow core door on top my bench base - and another somewhat-flat surface to put the other panel on. My folding table was still holding my oak countertop, which makes a great flat surface, but I want to make sure I didn't drip glue on it so I covered it with some painters plastic that was left over from the last bedroom we painted.

Put the upper panel of MDF on your glue-up surface, bottom side up. Put the bottom panel of MDF on your other surface, bottom side down. (The panel with the holes drilled in it is the bottom panel, and the side that has the your layout diagram on it is the bottom side.) Chuck up in your drill the appropriate driver bit for the screws your using. Make sure you have a freshly-charged battery, and crank the speed down and the torque way down. You don't want to over-tighten the screws, MDF strips easily.

Once you start spreading glue, you have maybe five minutes to get the two panels mated, aligned, and clamped together. So make sure you have everything on-hand, and you're not gong to be interrupted. Start squeezing out the glue on one MDF panel, and spreading it around in a thin, even coating, making sure you leave no bare areas. Then do the same to the other MDF panel. Then pick up the bottom panel and flip it over onto the upper panel. Slide it around some to make sure the glue is spread evenly, then line up one corner and drive in a screw. Line up the opposite corner and drive in a screw there. Clamp all four corners to your flat surface, then start driving the rest of the screws, in a spiral pattern from the center.

When you're done, let it sit for 24 hours.

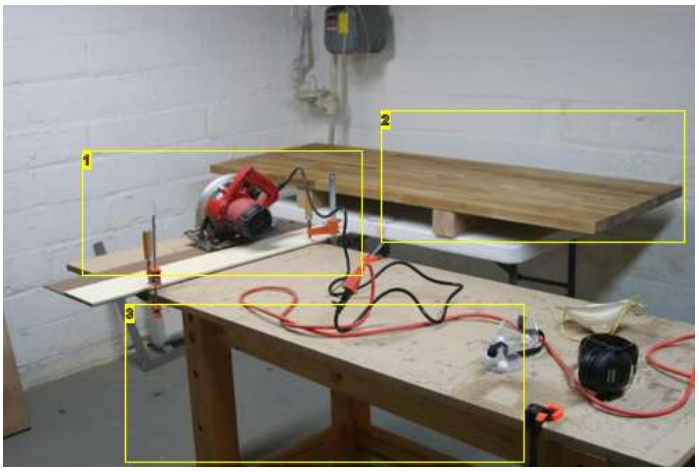


Image Notes
1. Setup to cut off the excess from the lower panel
2. I finally have the oak countertop that will be the top layer of my benchtop. It needs to lay flat, like the other flat stock, but it needs to be up off any surface, so that air can get to it equally from both sides. The moisture content of the oak is very unlikely to match that of your shop, and if only one side of the panel absorbs moisture, the panel will warp. Applying a coat of oil now, as soon as you unwrap the plastic, can slow the moisture absorption, and might reduce the amount of warping.
3. It's amazing how much better a work support the bench is already, just as an unfinished base, than was that wobbly folding table.

Image Notes
1. You can use 1-1/4" drywall screws, but pan-head screws hold better in MDF
2. This oak countertop almost looks too nice to pound on

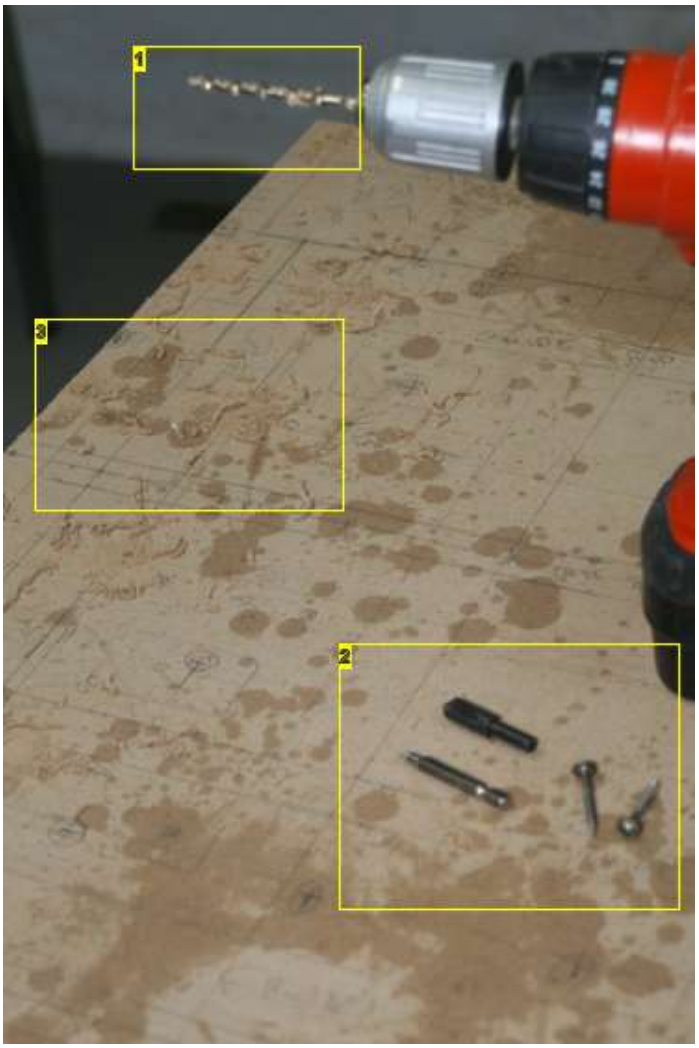


Image Notes
1. Drill holes in the bottom piece that the screws you use will pass through easily
2. Countersink bit, square screw driver, and screws we won't be using for a bit
3. Drill holes close to each edge, and in a regular grid about every six inches. Offset any holes that might interfere with your vise mounts or benchdog holes

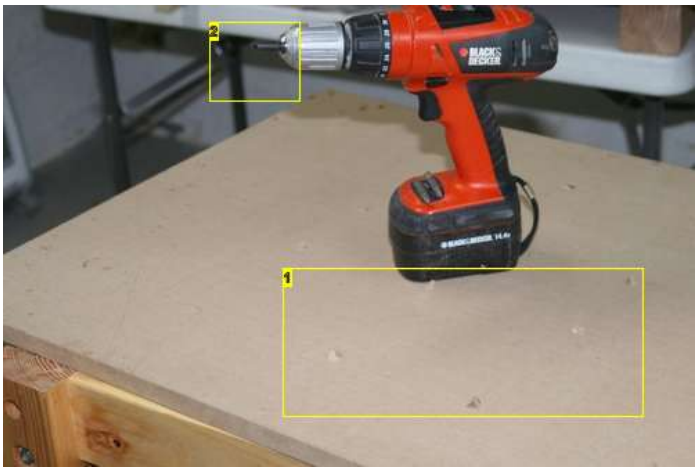


Image Notes
1. Lumps on the back side need to be removed
2. A light touch with a countersink bit will remove most of the bump

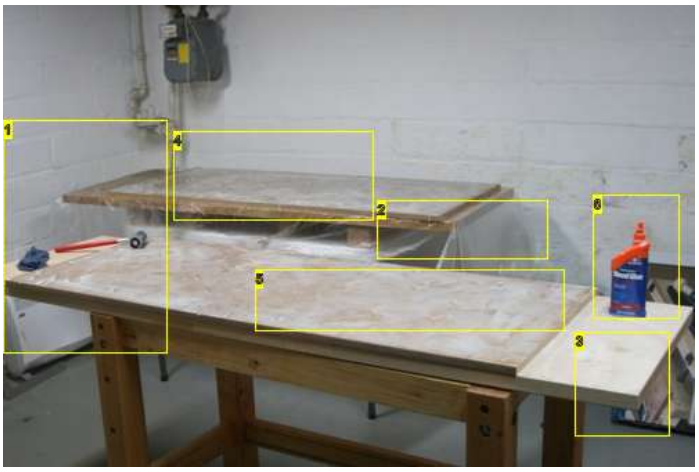


Image Notes
1. Evenly spread thin layer of glue on both surfaces
2. Painter's plastic to keep glue off the countertop
3. The hollow core door is finally being used for what I bought it for
4. This is the bottom layer - in which we drilled the screw holes. We'll be flipping it over and placing it on top of the top layer.
5. This is the top layer of MDF, in which we didn't drill any screw holes. It will be on the bottom of the assembly, as we screw it together.
6. Perfectly ordinary yellow glue works fine

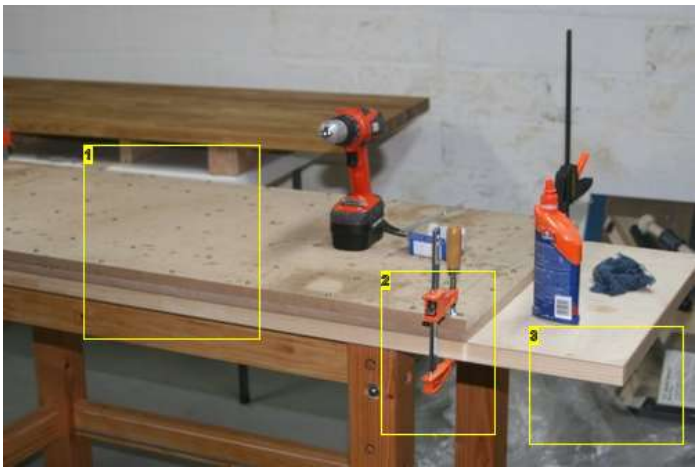


Image Notes
1. The screws will hold the two pieces of MDF together tightly, while the glue cures
2. The clamps on the corners will hold the assembly tight against the hollow core door - and since we know the door is flat, the assembly will be flat
3. MDF isn't anywhere near as rigid as it feels like it is, and it will sag to take the shape of whatever it is lying on while it's gluing up. Once the glue is dry, it will retain that shape, Make sure you do your glue-up on something flat.

Step 15: The top, step three - edging the MDF

The edges of MDF are fragile, easily crushed or torn. MDF is also notorious for absorbing water through these edges, causing the panels to swell. In Sam Allen's original design, he edged the MDF with 1/4" hardboard. This edging is one of the complexities that Asa Christiana left out in his simplified design. I think this was a mistake. MDF really needs some sort of protection, especially on the edges.

Of course, I, on the other hand, with my Ikea oak countertop, probable went overboard in the other direction. Since I needed to trim the countertop to width,I figured I'd take off a couple of 1/2" strips to use for edging the MDF. I clamped the countertop to my bench base, and used the long cutting guide. I'd asked around for advice on cutting this large a piece of oak, and was told to try a Freud Diablo 40-tooth blade in my circular saw. I found one at my local home center, at a reasonable price, and it worked very well.

Remove the screws from your laminated MDF panels, then trim the MDF down to size. Remember, you want the width of the top to match the width of the base, and you're adding edging. With my 5/8" edging, I cut the MDF to 1" narrower than the base, so I could use my router to do a final trim to the precise size.

First, cut one long edge. Second, cut a short edge, making sure it's square to the long edge you just cut. Clamp both pieces of the edging you'll be using along the long edge you've cut, and measure the width of the base plus 1/4-1/2", mark that, and then lay out a line through the mark that is square to the end you've cut, then cut along the line. Finally, cut the remaining short edge square to both long edges. (The length of the top doesn't need to precisely match anything, so we don't need to bother with clamping the trim before measuring.)

Glue up the trim on the end, first. Do a dry fit, first, then as you take it apart lay everything where you can easily reach it as you put it back together again, after adding the glue. To help keep the edge piece aligned, I clamped a pair of hardboard scraps at each end. I used the piece of doubled MDF I'd cut off the end as a cawl, to help spread the pressure of the clamps. Squeeze some glue into a small bowl, and use a disposable brush. As you clamp down, position the trim just a little bit proud of the top surface.

Once you have all the clamps on, take off the scraps of hardboard. You can clean up the glue squeezeout with a damp rag.. When the glue is dry, trim down the strip flush with the panel using a router and a flush-trim bit. Then cut off the ends of the strip with a flush-cut saw, and clean up with a block plane, an edge scraper, or a sanding block. Leaving the ends in place while you route the edge helps support the router.

The strips along the front and back edge is glued up the same way. I suppose you could try to glue both on simultaneously. I didn't try.

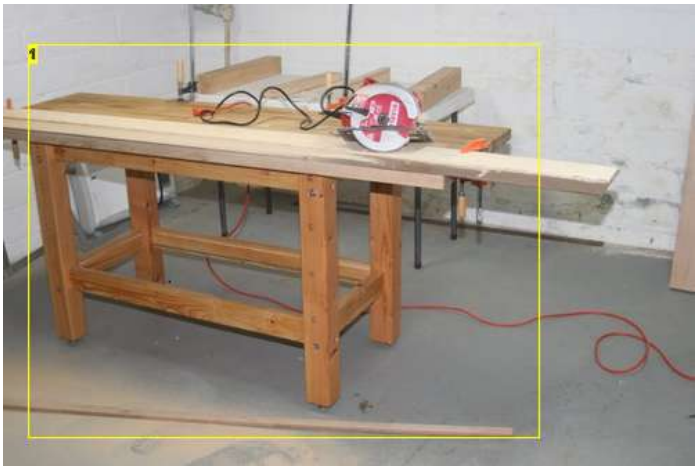


Image Notes
1. Cutting strips from the countertop by the usual process: clamp work piece to base, clamp guide to work piece, layout the cord and extension cord so they won't tangle, and cut ... then vacuum up all the sawdust

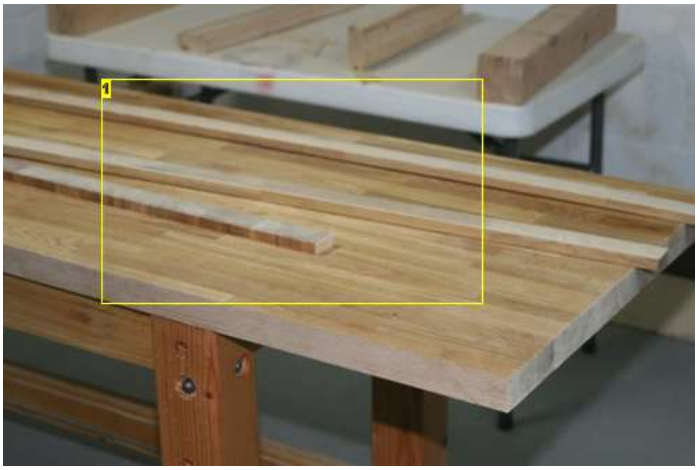


Image Notes
1. Make a narrow pass first, to remove the factory bevel, then cut two 5/8" lengthwise strips, and one widthwise strip, to use for edging the MDF panels. The countertop is 25-5/8" in width, we need 23", so we have some extra.

Image Notes
1. Remove the screws from the laminated MDF

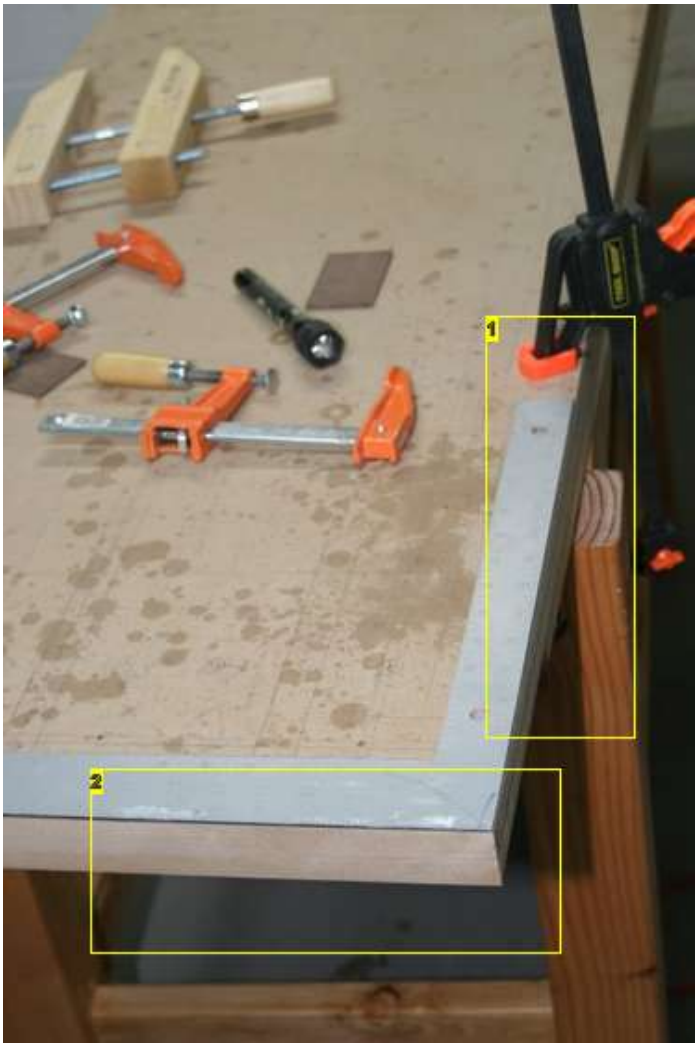


Image Notes
1. Cut one long edge of the doubled MDF, first
2. Cut one short edge second, making sure it's square to the first

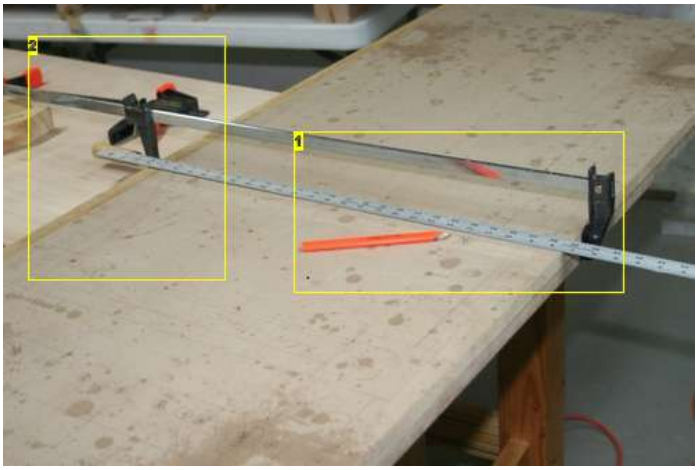


Image Notes
1. Measure width including edging material, cut at the width of the base plus 1/4-1/2" for final trim
2. The two strips of oak edging, clamped to the side of the MDF

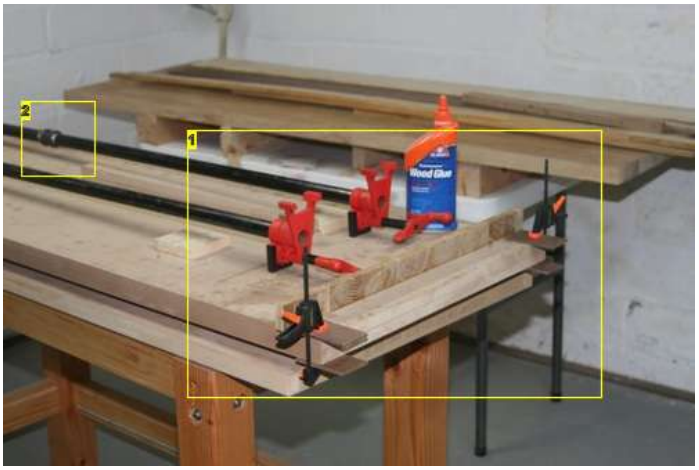


Image Notes
1. Clamping end trim first - do a dry fit, then set everything where you can reach it.
2. Each of these six-foot long pipes is a pair of three-foot long pipes joined by a coupling - I don't often need six-foot long pipe clamps

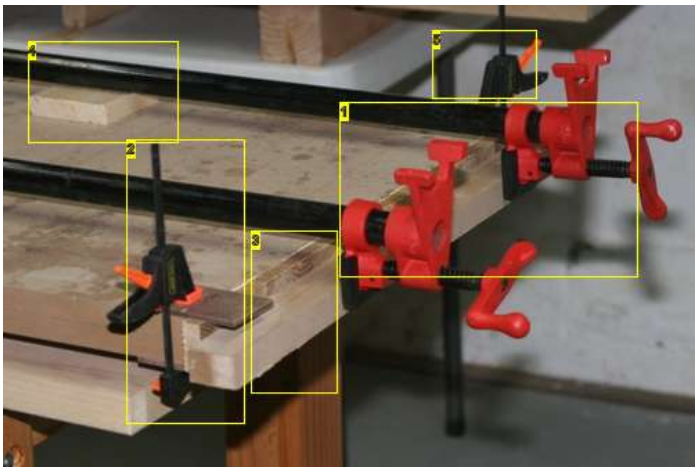


Image Notes
1. Clamping end trim
2. Clamping scrap hardboard to keep trim lined up
3. Using scrap of MDF as cawl, to spread pressure of clamps
4. Using scrap to hold bars off work piece
5. Scraps of hardboard clamped at this end, too

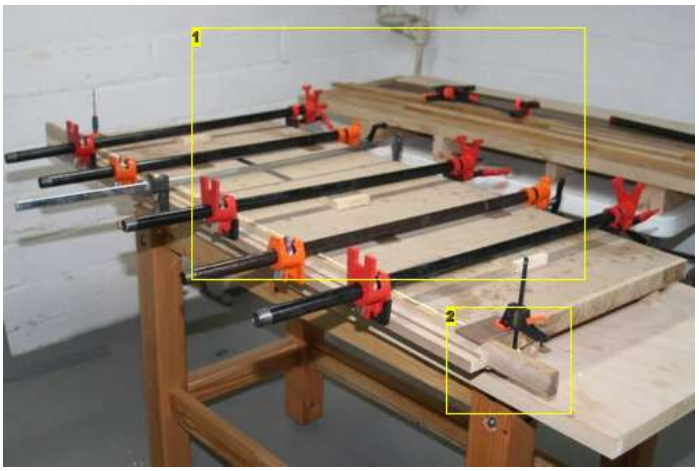


Image Notes
1. Front- and back-edge glue-ups are unexceptional (This is the back-edge - I did't try to do both at once.)
2. Same bit with the scraps of hardboard, removed after the pipe clamps are on

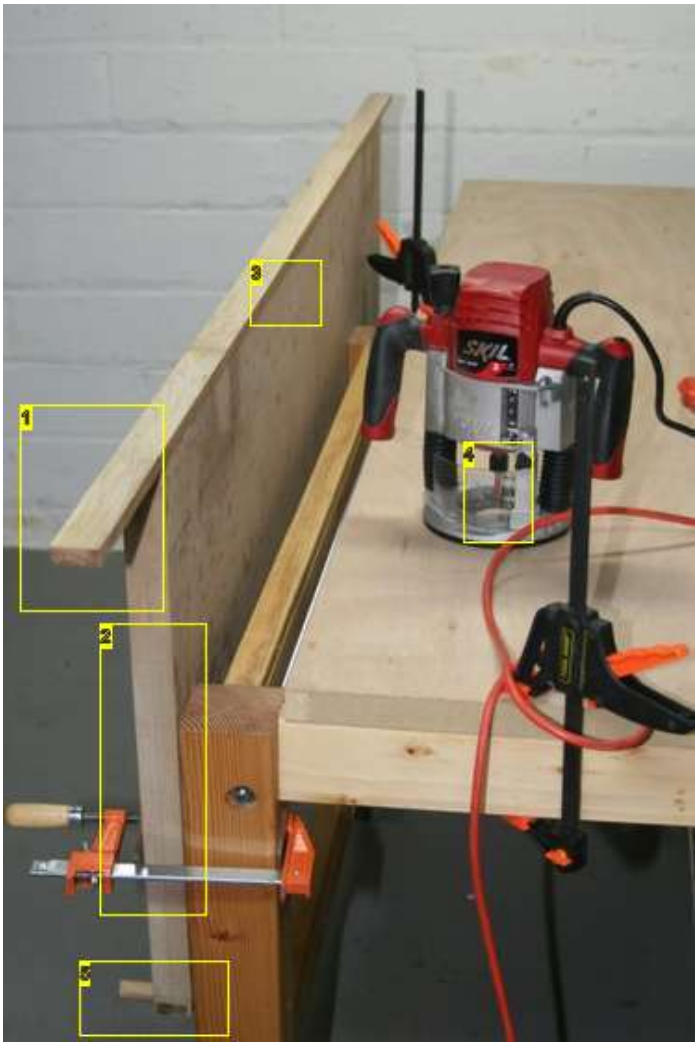


Image Notes
1. These ends help stabilize the router - cut them flush after routing
2. I find it easier to route edges like this when the piece is held vertically
3. Trimming this edge of the strip flush with the top face of the MDF panel
4. 3/8" flush-trim bit
5. One 6" long 3/4" dowel in each front leg - why did you think we drilled all those holes?

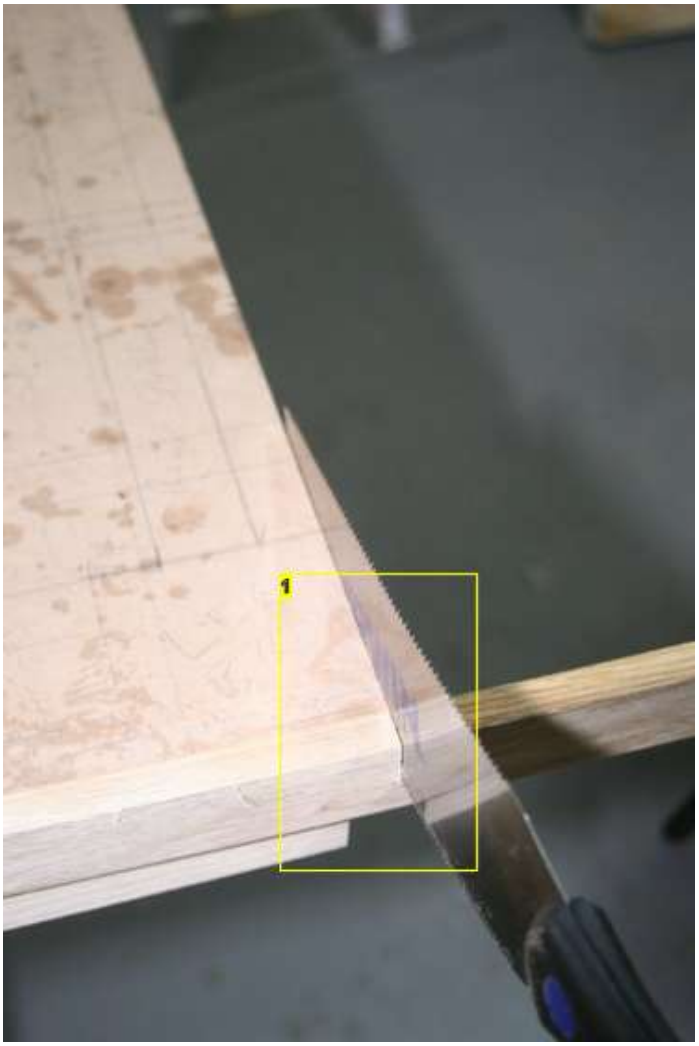


Image Notes
1. Cut as close to flush as possible, then clean up with a block plane

Step 16: The top, step four - trimming the MDF edging

When the top is done, we want the edged MDF and the oak countertop to have exactly the same dimensions, and for their width to exactly match the width of the base.I could see three ways of doing this: 1, join the MDF to the countertop and use my belt sander to sand down their joined edges to match the base; 2, join the MDF to the countertop and use a hand plane to plane down their joined edges to match the base; or 3, use a flush-trim bit against a straight edge to route the MDF to the width of the base, then join the MDF to the countertop and use the flush-trim bit to route the countertop to match the MDF.

Problems? 1, I've never used a belt-sander without sanding more than I had intended to; 2, I don't have a jack or a smoothing plane, and have never used one; 3, I'd need a flush-trim bit with a 1-1/.2" cutting length, and those are available only for 1.2" collets, and the cheap plunge router I bought only had a 1/4" collet.

I asked around, and was told that the router would give the best results, and I was pointed to a great deal on a fixed-base router with a 1/2" collet. So I chose option 3. If you choose the same, you want to trim the edges of the MDF layer prior to joining it to the countertop. In other words, now.

Put the MDF on the floor, bottom up. Flip the base and place it on the MDF. Line up the base on the MDF in the posiiton you feel best, then mark the position of the legs. Sorry, I have no picture of this.

Flip the base upright, put the MDF on top of it, then use a straightedge to draw two straight lines joining the outside edges of the legs and extending the width of the MDF. I used the countertop as the straightedge. We cut it with our cutting guide, which is based on the factory edge of a sheet of 1/4" plywood, so it should be straight enough. Use a carpenter's square to transfer these lines onto the ends of the MDF.

Put the countertop on the base, put the MDF on top of the countertop, and line up the marks you drew on each end of the MDF with the countertop below it. When you have it lined up, clamp things down, and route the edge of the MDF using a 1-1/2" or longer flush-trim bit, with the depth adjusted so the bearing rides on the countertop. I clamped a couple of scraps of doubled MDF at each end to give the router base something extra to ride on at the ends.

Edge-trimming endgrain can result in tearout at the right side, so route the short edge before you route the right long edge. Routing the right edge can then clean any tearout that occurs on the short edge..

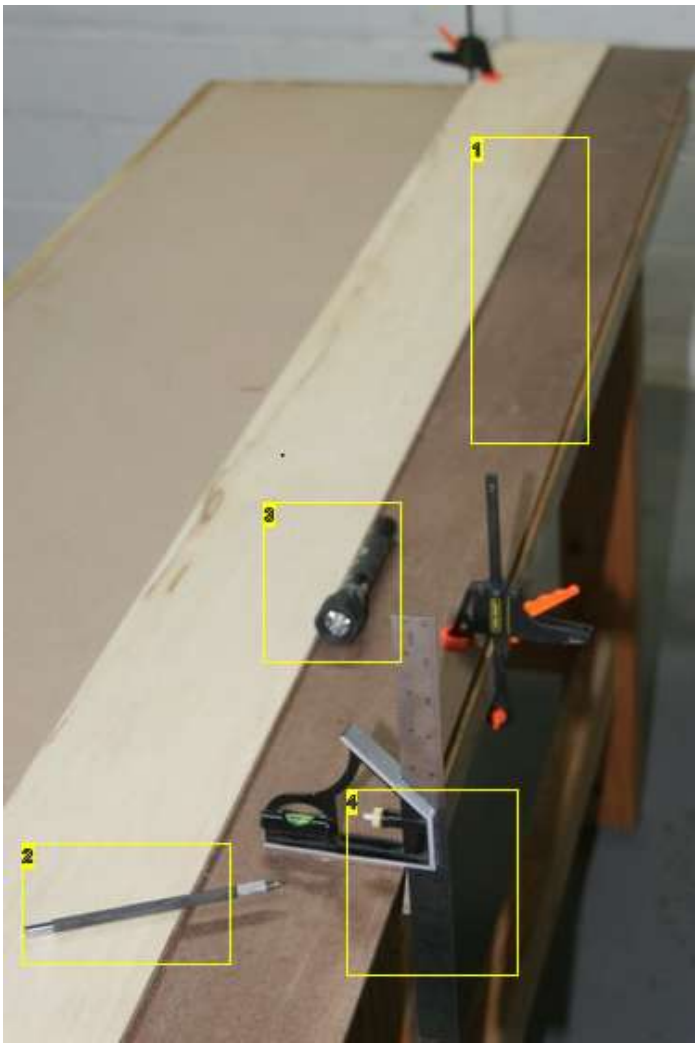


Image Notes
1. Lined up with the marks for the outside of the legs
2. Draw the marks with a scribe or a knife, not with a pencil
3. A bright flashlight can help you see the scribe marks
4. Mark the position of the line on the end of the MDF panel

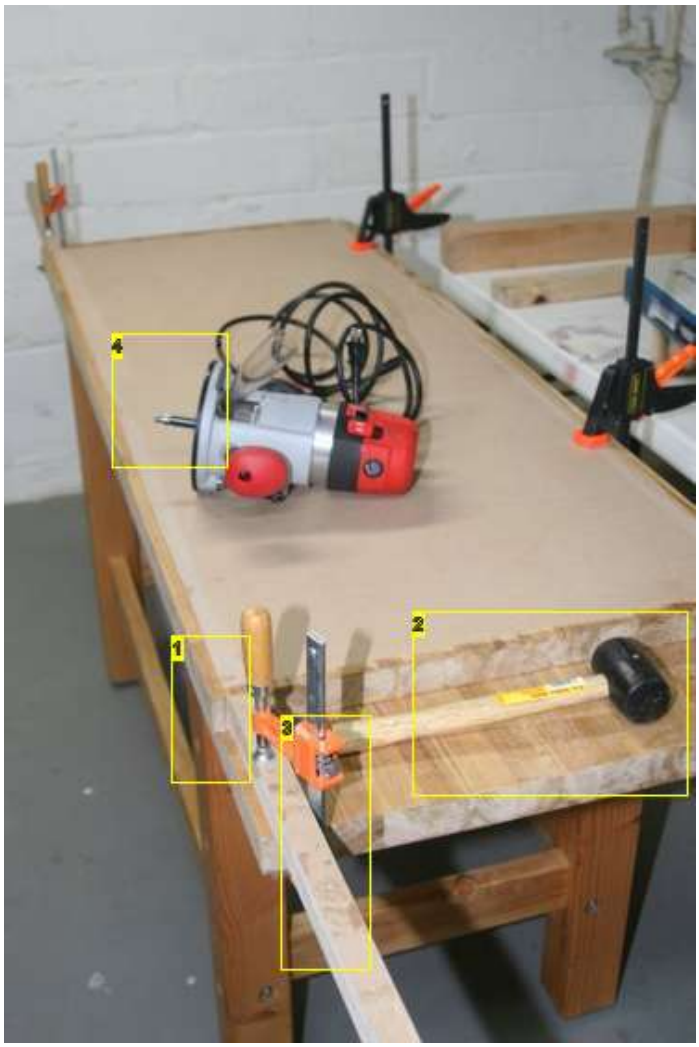


Image Notes
1. MDF extends so that the line we scribed lines up with the edge of the countertop - everything past that we want to remove
2. Light taps with a rubber mallet are the most precise way of positioning the MDF on the countertop
3. Some scrap MDF to help support the router at the ends
4. 1/2" flush trim bit with 1-1/2" cutting surface

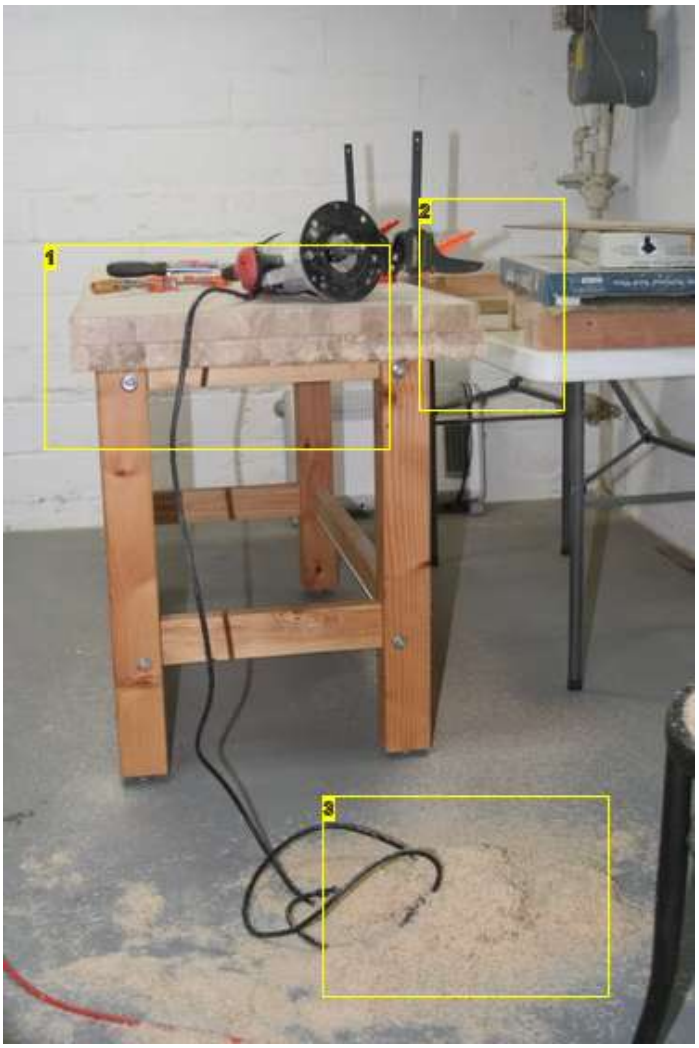


Image Notes
1. The length of the top doesn't need precision. 1/4" longer or shorter on the end doesn't matter.
2. Do the right edge last - it will clean up any tearout on the end edge
3. Edge routing generates large quantities of sawdust.

Step 17: The top, interlude - fixing a mistake

When gluing the oak edges on the MDF, I made a mistake. On the back side, the edging was positioned too low, which would leave a noticeable gap when the MDF and the countertop were joined. I was determined to fix it.

Either of the strips I'd ripped from the oak countertop to remove the factory bevel looked like it would work, if I could figure out how to rip them safely with a circular saw.

I ended up using a couple of strips of MDF and a bar clamp to create a clamp that would hold the strip of oak, and had a profile low enough to fit under the cutting guide.

Once I had the strip cut, I glued it in place, and clamped everything up.

I'd intentionally made it oversize, intending to trim it flush. Trimming is a little more complicated than usual, because I needed to trim it flush on two faces. The end face extended a good 3/8", so I cut off most of the excess with a circular saw and the edge guide, then flipped the edge guide upside down to make a stable platform for the router. Aside from the use of the edge guide, flush trimming the edge face was unremarkable.

For trimming the top face, I again stood the panel vertically, with the router base riding on the top edge, and the bit cutting on the far side of the panel. Because I was cutting on the back edge of the work piece, I needed to move the router from right to left. And here I ran into another problem.

The gap in the edging that I was filling was not of even depth. On the left end it was about 3/16" deep, on the right end the edging was flush with the MDF, and there was no gap. That means that on the right side, I was routing away all of the strip I had glued in. The result was significant tear-out.

I did what I always do when faced with this sort of gumption trap - I turned off the router, set it down, and walked away for a bit. I've found that whatever action I take in the frustration of dealing with something that hadn't worked right is almost always the wrong one, and usually makes things worse.

What I did, when I came back, was to clamp down the strip where it had torn away, and then to start routing from the other end. I still moved the router from right to left, but I did it in six-inch sections, taking light passes, and sort of whittled the strip flush. As the sections I was working were farther to the right, the strip was thinner. Eventually I came to where I was trimming the strip away entirely, at which point I took off the clamps and the remainder fell away.

A better solution would have been to route a rabbet into the side, so that the added strip always had thickness. The way I did it means that the strip I glued in is very narrow, and hence very weak, at a certain point. In this case, that's not a problem, because it's going to be sitting under the countertop layer. I also noticed that because I had only clamped the strip down, and not into the edge, there was a noticeable glue gap where the strip butted up against the MDF. Again, in this application it isn't visible. But if I was doing something like this on the top of a table, I'd make sure to cut a clean rabbet, and to clamp both down and in.

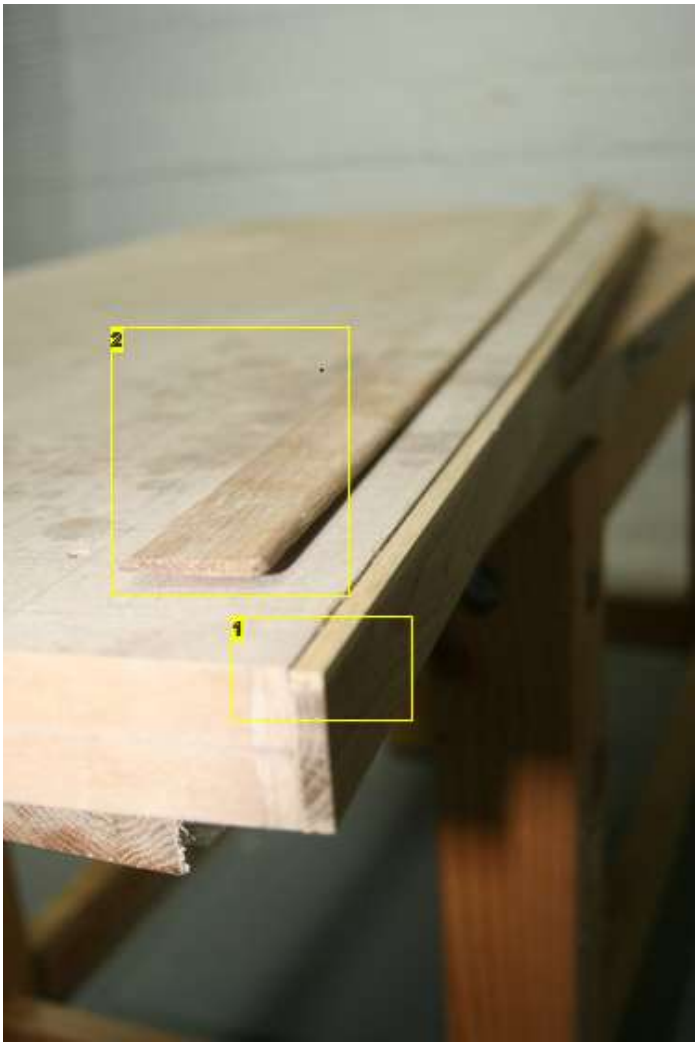


Image Notes
1. Edging is too low
2. This piece of scrap would work for fixing the gap, if we could figure out how to safely rip it.

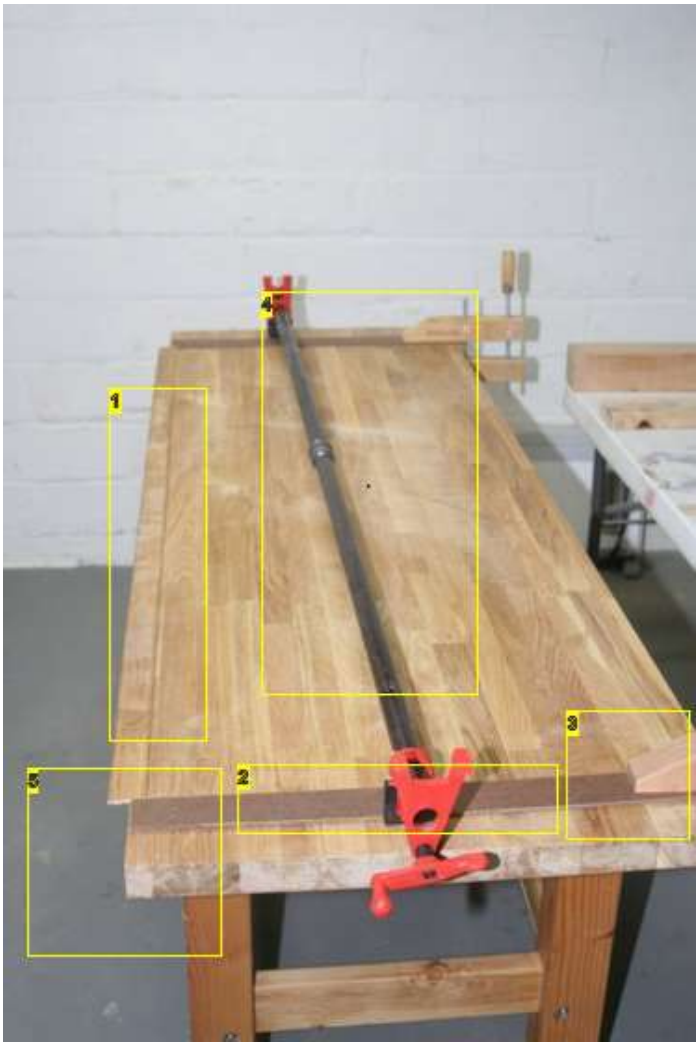


Image Notes
1. This is the strip we wanted to rip
2. Two scrap strips of MDF, used to create an improvised, low-profile clamp. (These are from the strips I cut off when I made the edge guides).
3. Clamp one end of each MDF strip to the bench. (Well, it isn't a bench, yet, it's just the countertop sitting on top of the base, but we're getting closer.)
4. Use a pipe clamp to squeeze the middle of the MDF strips together
5. The ends of the MDF strips will squeeze the ends of the strip we want to rip

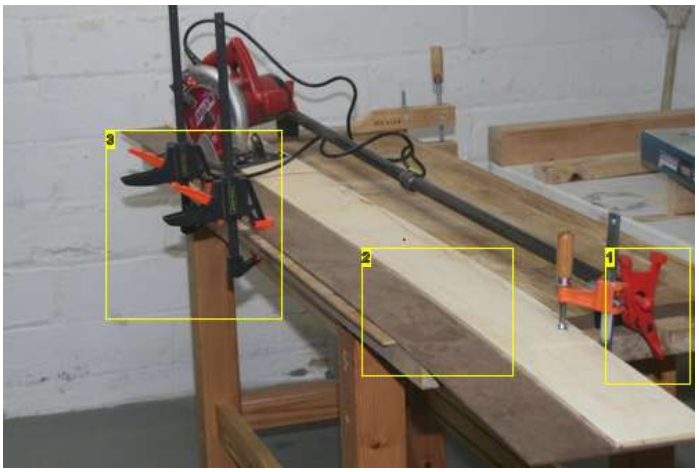
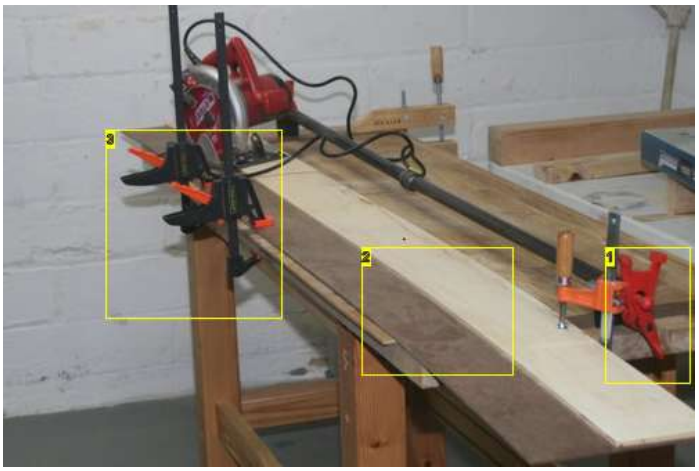


Image Notes
1. The oak strip is clamped by the low-profile clamp we improvised
2. The cutting guide is clamped down on top of the improvised, low-profile clamp. In addition to guiding the saw, it keeps the oak strip from popping up.
3. I used these to hold the guide in place while I lined everything up.



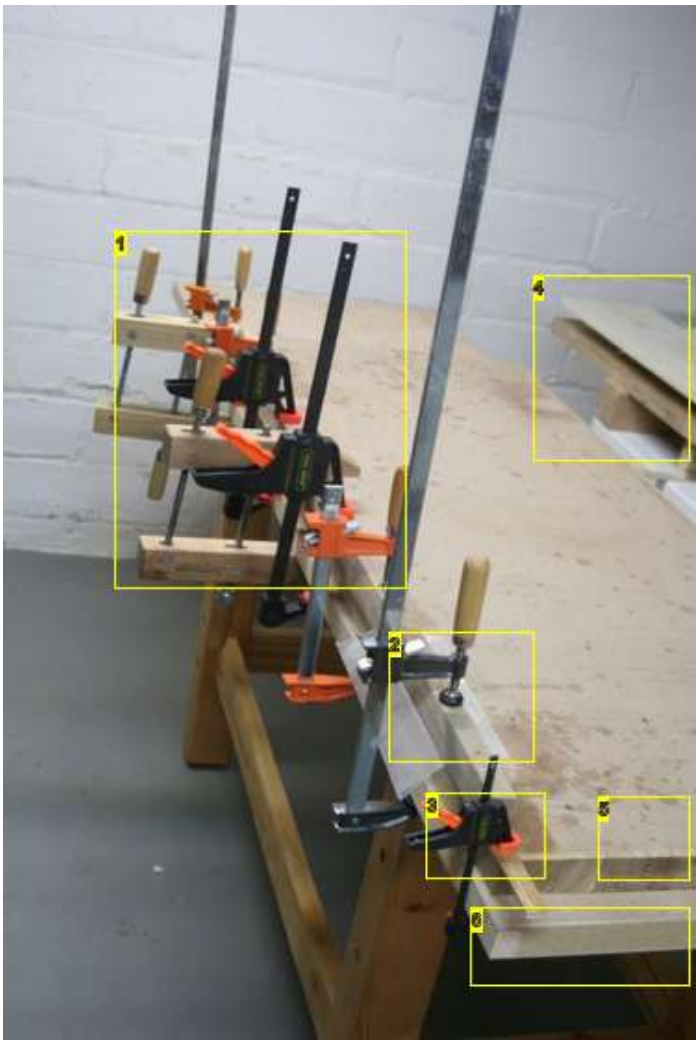


Image Notes
1. Clamping the strip in place (I've always had suspicions about people whose clamps all match.)
2. One of the fingerjoints separated, so I added some glue to it. The wax paper keeps the glue from sticking to the cawl.
3. The MDF I was using as a cawl was just a bit short, so I added an extra clamp here
4. Countertop moved back to its usual storage location
5. Doubled MDF panel
6. We're working on top of the hollow core dore, again

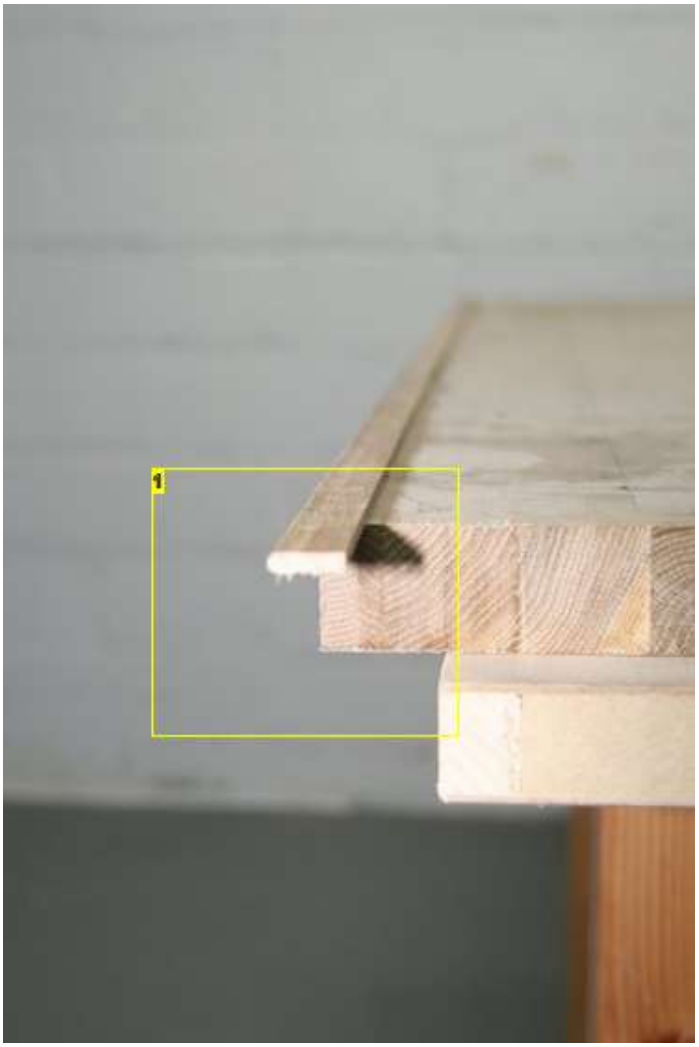


Image Notes
1. We need to trim this flush on two faces. Neither has a flat surface for the router base to travel on.

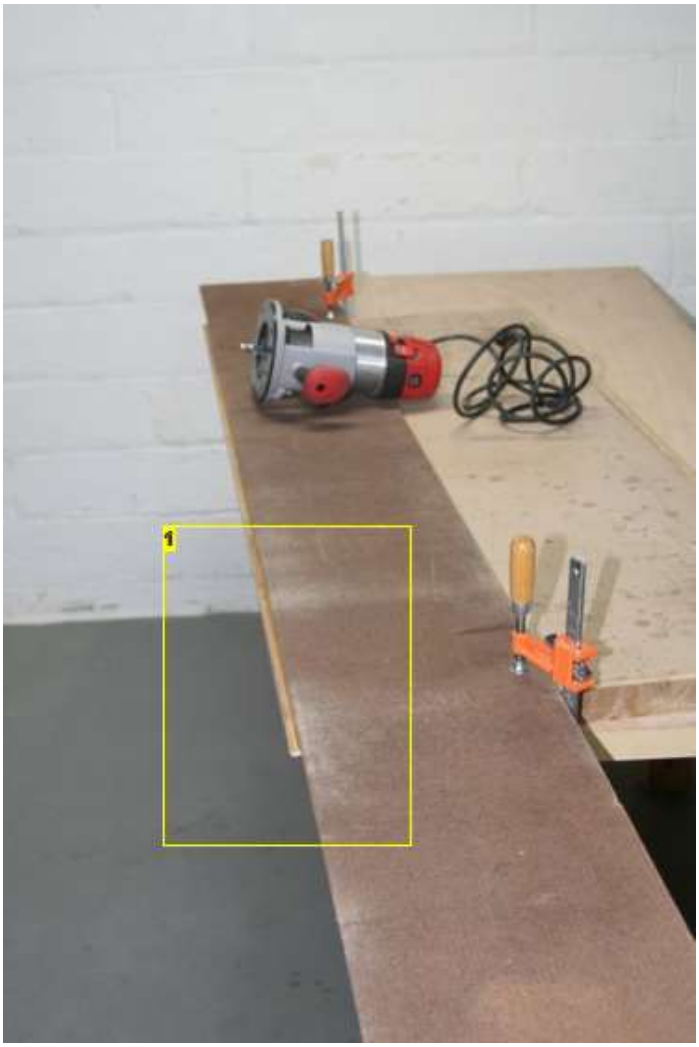


Image Notes
1. The upside-down edge guide provides a flat surface for the router base.

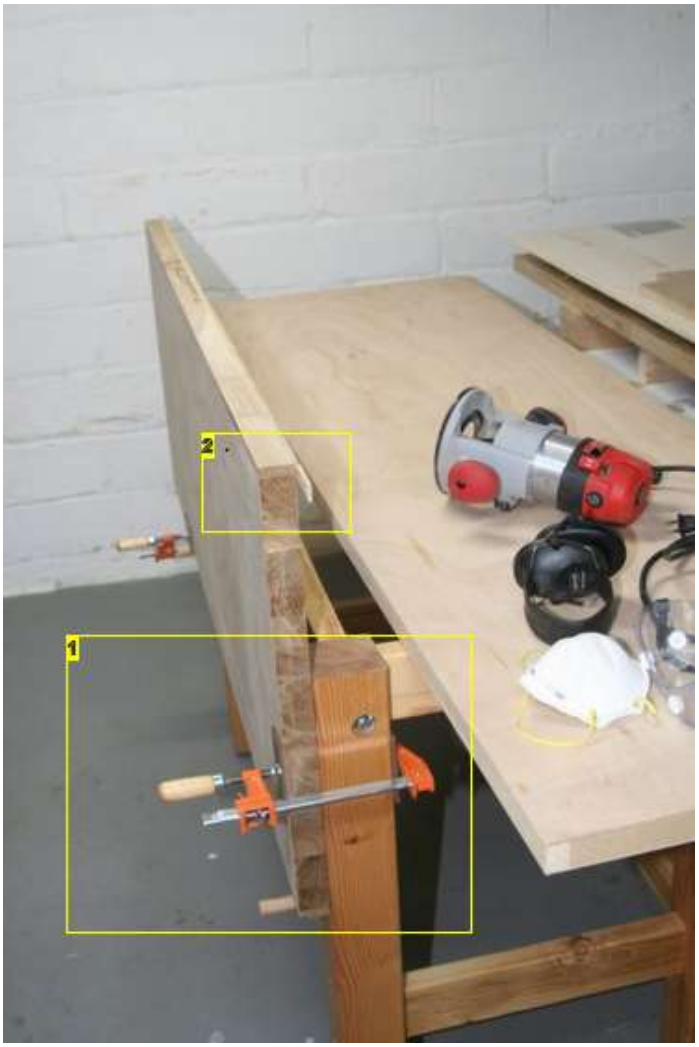


Image Notes
1. Clamped up for routing the top face.
2. We left these extensions on when we routed, before. But this time their edges are not flush with the edge of the top, so they need to be cut off before using the router.

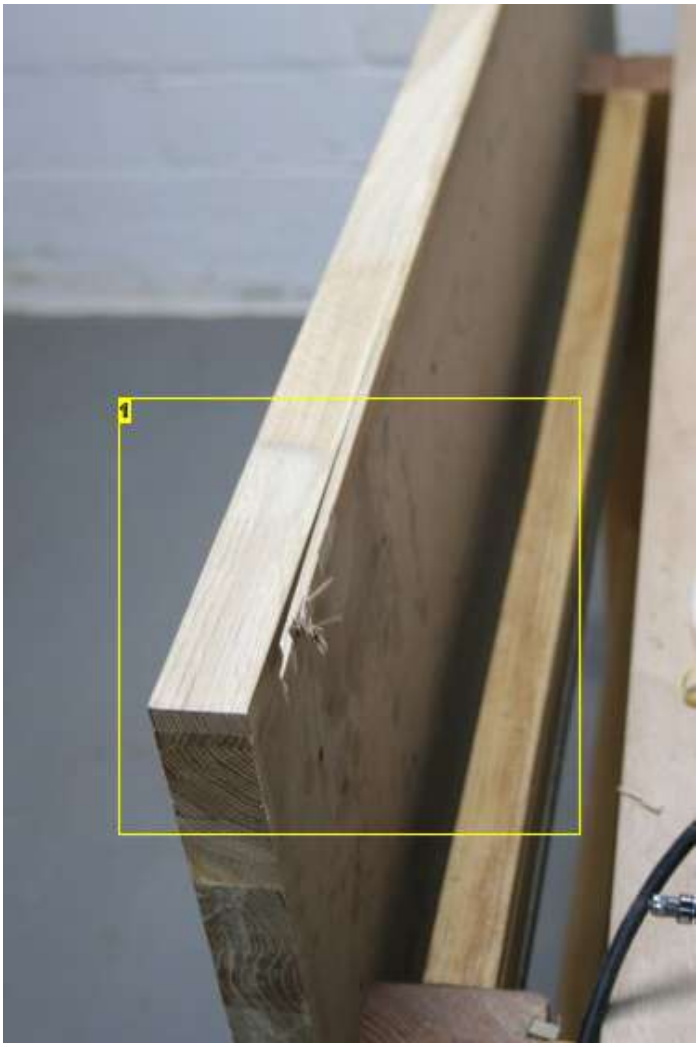


Image Notes
1. At this end, we're routing off all of the added strip - which results in tear-out.

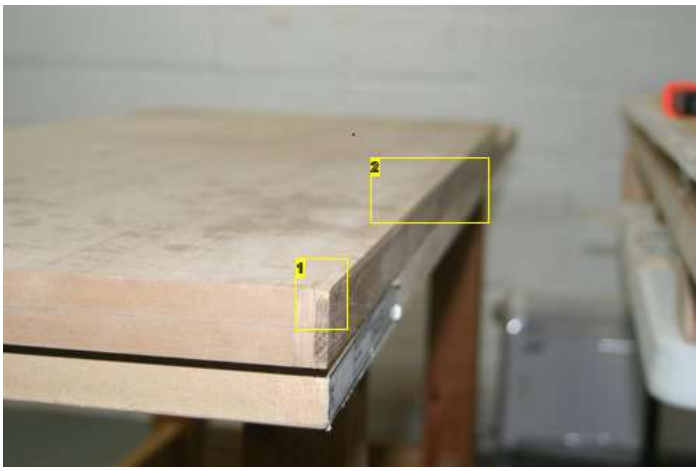
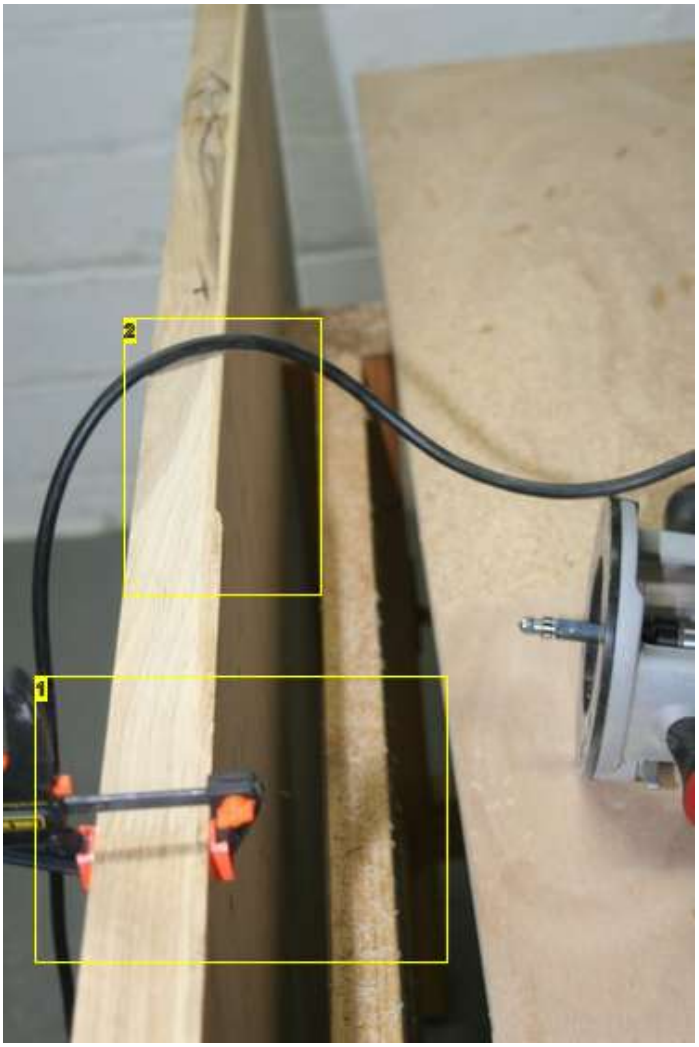


Image Notes
1. Here's the patch
2. Because we were clamping the strip down, but not in, there's a gap in the top glue line, about here. In this case, it won't show, so it doesn't matter.



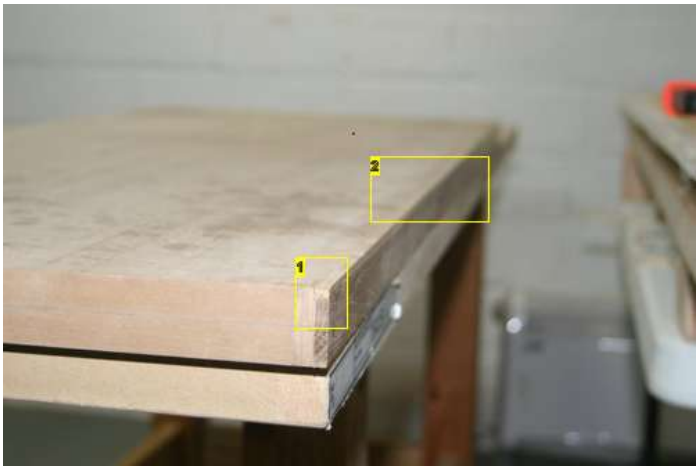


Image Notes
1. Clamps to hold the strip in place.
2. Start at the left end, where the strip is deep, and work towards the right end, where it is shallower. The router still moves on the wood from right to left - it just does so in short segments, starting at the left end.

Step 18: The vises, step one - mounting bases to top

The end vise will have both jaws made out of 1-1/2" thick oak. The front vise has its moving jaw made of 1-1/2" oak, but uses the edge of the bench as its stationary jaw. So while for the end vise, if we mount it lower, we can make both the jaws deeper to compensate, for the front vise we cannot, so we want it mounted as close to the edge of the bench as possible.

So I decided to add an extra layer of 3/4" MDF under the end vise only, and not under the front vise.

It's usual to attach vises with lag screws from the bottom, but there is a limit as to how many times you can tighten up a lag bolt in MDF. I decided to use bolts from the top down, embedding the heads of the bolts inside the top.

First step was to cut a piece of MDF the size of the base of the vise. I scribed the positions of the bolt holes in it, then driilled small pilot holes. I also drilled larger holes at the corners of the rectangular cutouts, and the joined them with a jigsaw.

Then I flipped the top and the base, lied up the base in the proper location relative to the top, I then positioned the front vise and the support MDF for the end vise, and marked the locations of the bolt holes. Then I flipped the base right side up, drilled small pilot holes from the bottom side where I had marked the locations, and then drilled shallow countersink holes from each side, then a through hole that matched the bolts. Finally I tried out the bolts and washers, and deepened the countersinks until the heads of the bolts were just below flush.

With the holes and countersinks in place, I inserted the bolts, used tape to keep them from falling out, flipped the top, applied glue to the support piece of MDF, fit it over the bolts, added washers and nuts, and tightened it down.

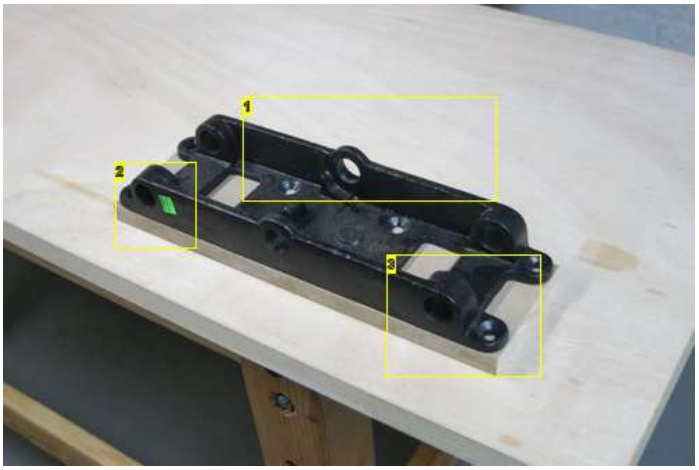


Image Notes
1. The base plate of the end vise sitting on a scrap of 3/4" MDF cut to size.
2. I brought the base to the hardware store so I could make sure I got bolts of the correct size. They stuck this on to indicate that I brought it in with me.
3. Use scribe to outline the bolt holes and the rectangular cutouts

Image Notes
1. Mark center of scribed bolt holes with centerpunch. A flashlight from the side can make the scribe marks stand out.

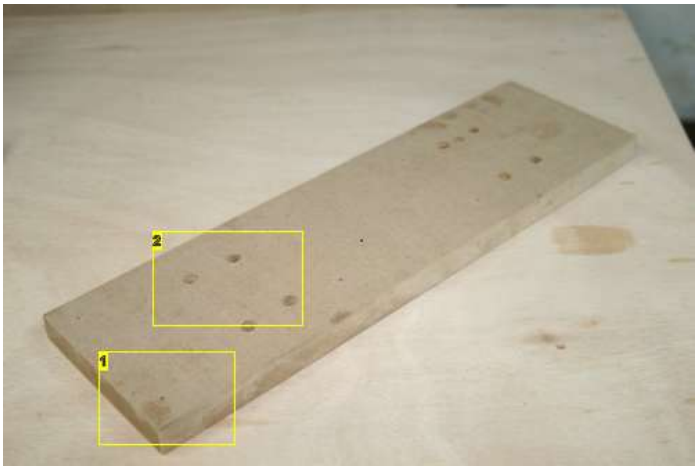


Image Notes
1. Drill small pilot holes through the center of the bolt holes
2. Drill good-sized holes - 1/4" or larger in the corners of the cutout.

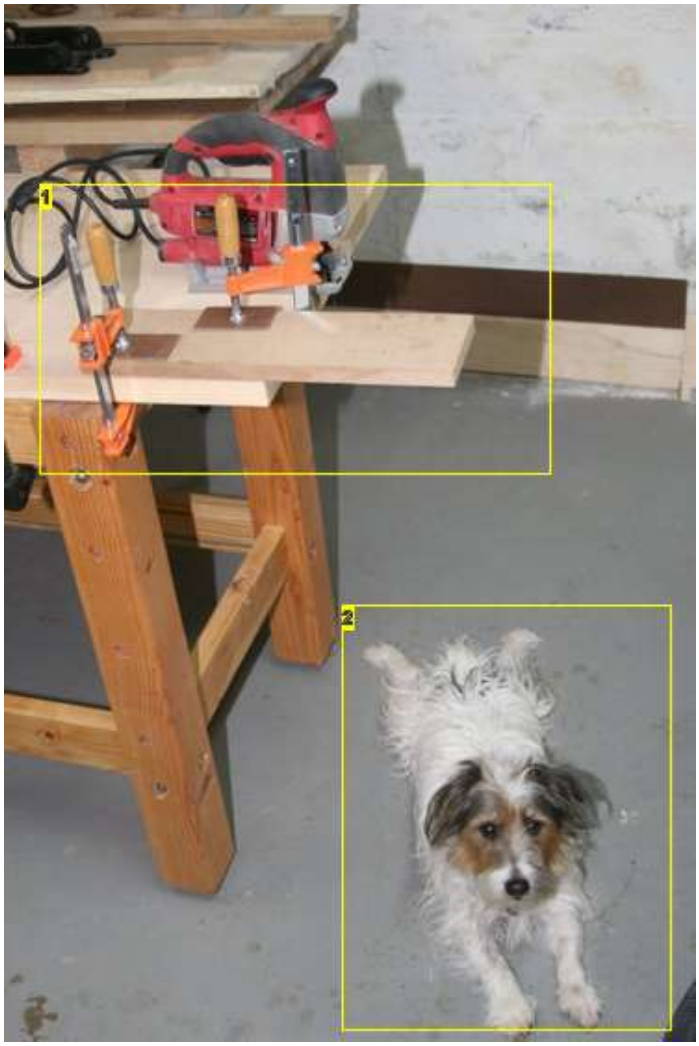


Image Notes
1. Cut out the rectangular cutouts by joining the holes drilled in the corners using a jig saw. (After getting the dog to move out of the way.)
2. Grizzly Bear, wondering why I'm messing about with this when I could be playing with him

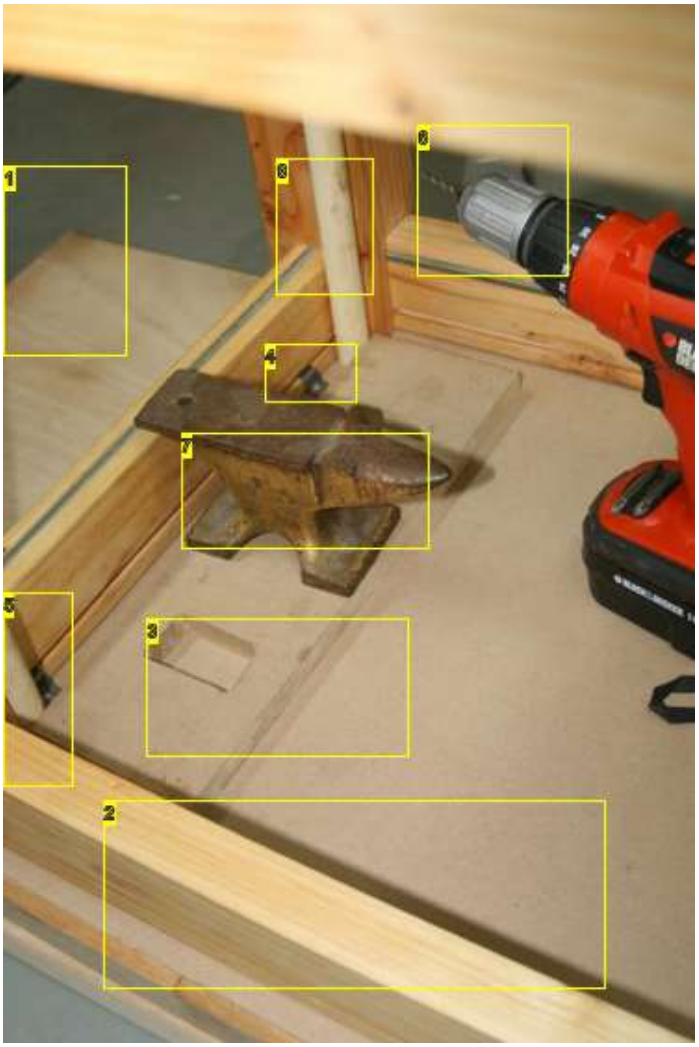


Image Notes
1. This is our old friend, the hollow-core door again
2. Top on floor, top-side down, with base upside down and lined up on top of it
3. Placing the MDF where the base of the vise needs to go
4. We need clearance for the s-clips, which we'll be using hold the top to the base
5. Using a pair of 1" dowels as spacers. 3/4" dowels didn't give enough clearance for the s-clips.
6. Just a touch with the drill through the pilot holes will mark the locations of the bolt holes
7. The anvil is there just for weight, to keep the MDF from sliding around
8. Using a pair of 1" dowels as spacers. 3/4" dowels didn't give enough clearance for the s-clips.

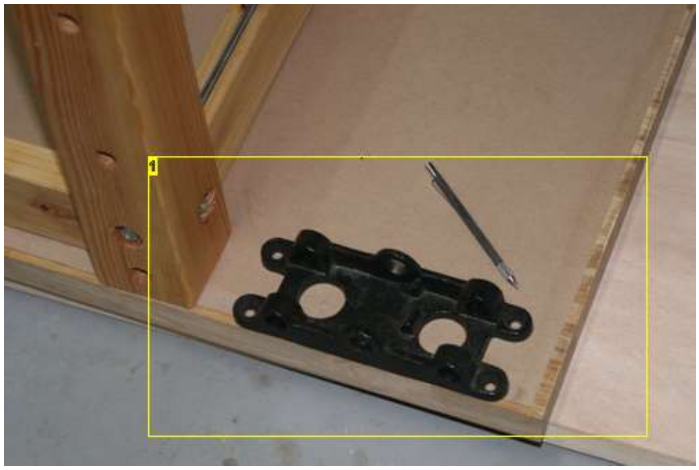


Image Notes
1. Position the front vise and scribe the bolt holes. (Remember, the bench is upside down. For the vise to be on the left side of the front ...)

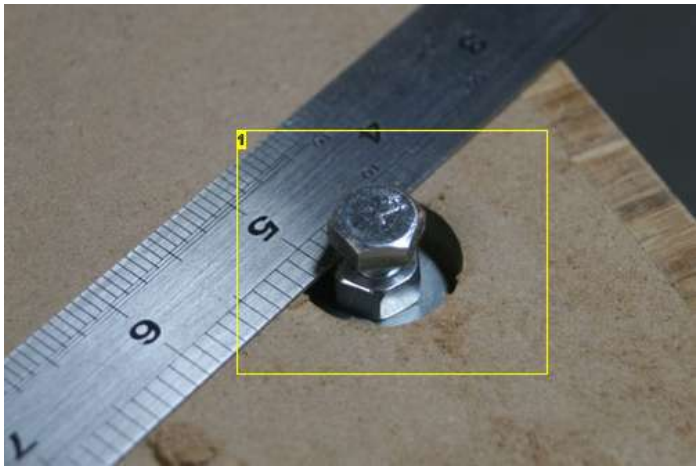


Image Notes
1. Is the countersink deep enough?

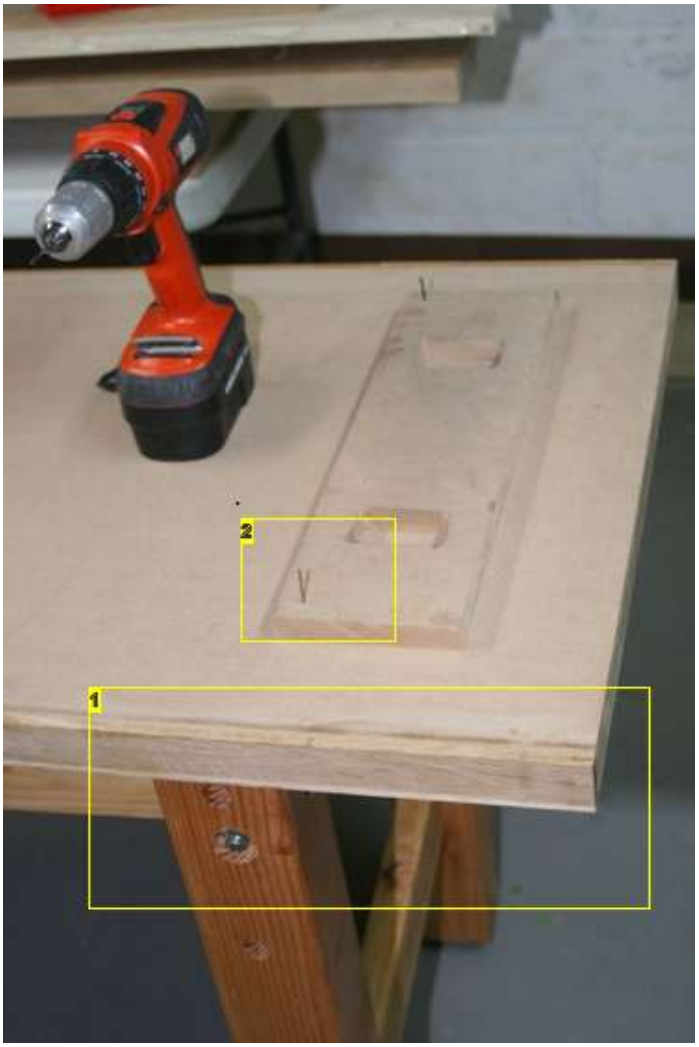


Image Notes
1. The base is right side up, again. The top is still top-side down.
2. Using the vise support as a drill guide, while drilling the pilot holes all the way through the top. Nails or small drill bits through the pilot holes in the support and into the starter holes in the top precisely locates the support.

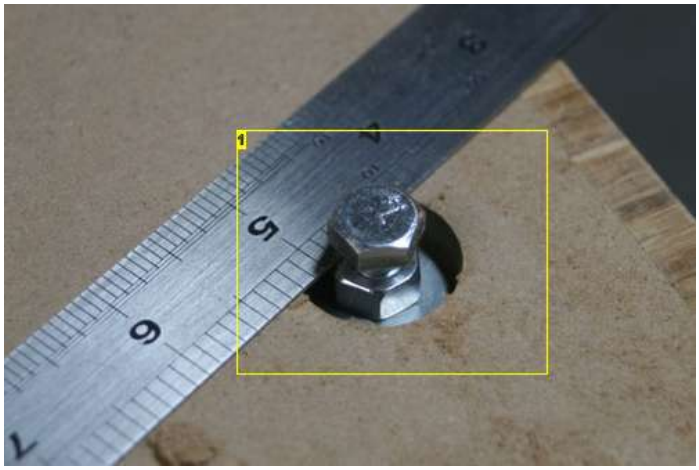


Image Notes
1. I figured glue on one just one surface would would be plenty, this time

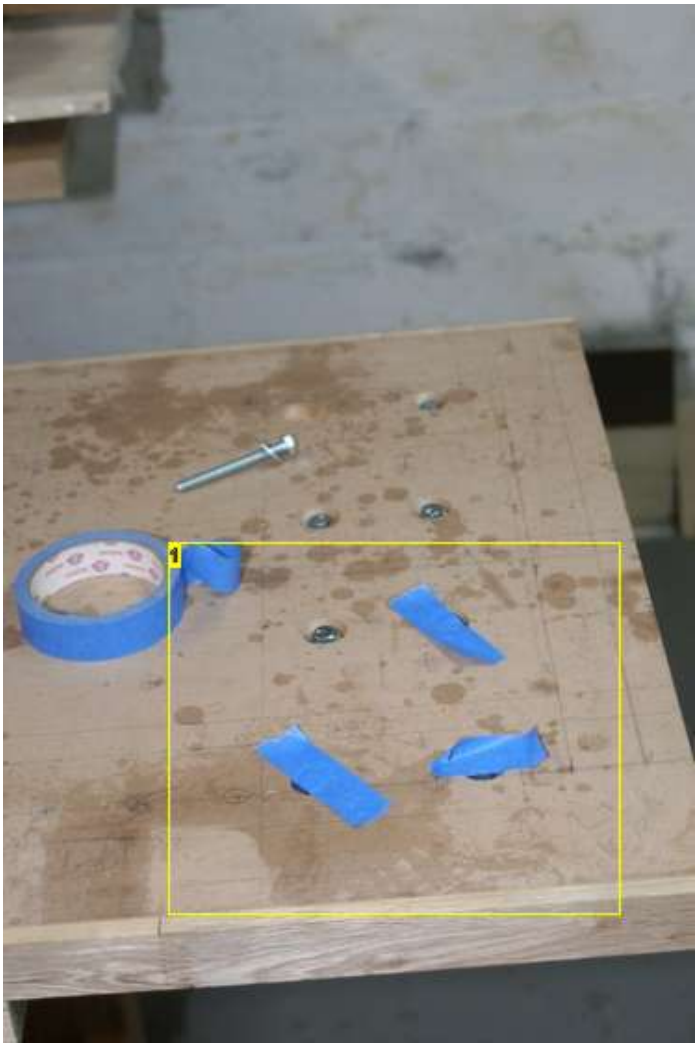


Image Notes
1. Tape holds the bolts in while we flip the top

Image Notes
1. Washers and nuts on the bolts hold the base of the vise in place

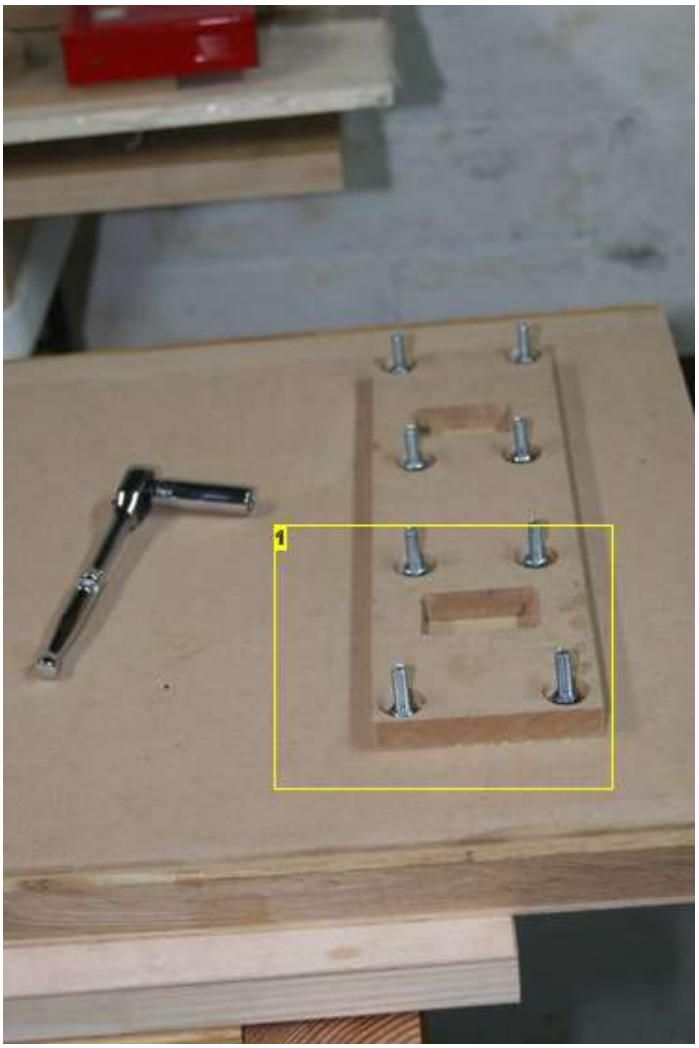


Image Notes
1. Washers and nuts to hold the bolts tight

Step 19: The vises, interlude - fixing another mistake

The reason I'd cut out the rectangles in the vise support was that I'd intended to put a benchdog hole through each, and I wanted the thickness of the top to be the same for all of the benchdog holes. Where I messed up was in not cutting out the ends, between the bolt tabs. I'd intended to put a benchdog hole through there, as well, but I'd forgotten to cut out the segments prior to glue0up.

No matter, It was only twenty minute's work to route out the areas flush with the top,.

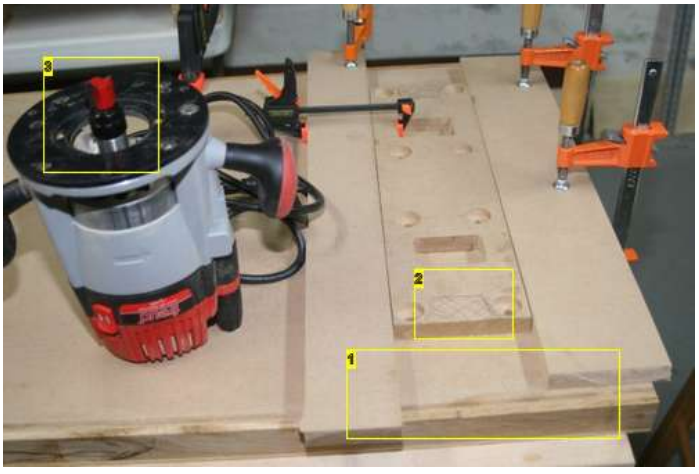


Image Notes
1. Added supports so the router would be stable
2. Marked area to be routed out
3. A 3/4" straight bit takes more material on each pass than narrower bits

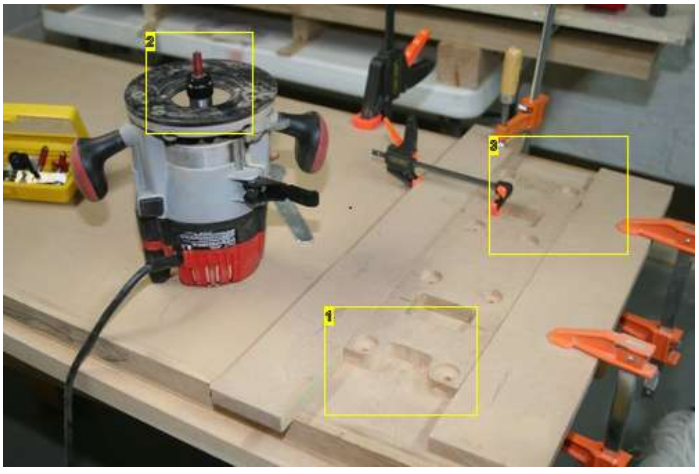


Image Notes
1. Finished
2. 3/8" straight bit gets into the corners
3. Next, do this end

Step 20: The top, step five - benchdog holes, part one

You'll want to get as much done on each of the two layers of the top separately, before we join them, because handling the top after the two layers are joined is going to be a major hassle.

So drill the benchdog holes through the MDF layer. Begin by laying out their positions. You'll want these to be precise, so that the distances between the holes are consistent. The vises you are using will constrain your benchdog spacing. My front vise worked most naturally with two rows of holes four inches apart, my end vise with two pairs of rows, with four inches between the rows and eight inches between the pairs. Because of this, I decided on a 4" by 4" pattern.

I made a template by scribing two adjoining squares on a piece of MDF, using compass and straightedge, then marking each corner with a centerpunch, then drilling the points with a 1/16" bit. I find I'm always breaking small bits, so I picked up a couple of each size some months ago, and on looking I found I had three 1/16" bits, which worked fine for what I intended.

I marked out the one hole location, drilled a shallow 1/16" hole into the top. I then put a 1/16" bit through the hole in my template and into the hole I had just drilled. I lined up the template, and drilled a second hole, then put another bit through that. From then on, I worked entirely from the template. With two bits through the holes pinning the template in place, the other holes in the template would be precisely located (or so the theory goes) on a 4x4" grid.

Having done all this, I'm not sure I'd do it this way again. It might well be faster to layout the positions with compass and straightedge directly onto the top. Either way, you'll want to use a scribe rather than a pencil. Scribe lines are hard to see, and impossible to photograph, but the scribe and compass points click into them, allowing a precision that pencils simply cannot match.

Once you have all the positions marked, drill them through. I pulled out my drill guide and a 3/4" Forstnet bit. With this I drilled in 1/2", to give the hole a clean start. Then I went back and drilled the depth the each hole with a 3/4" spade bit, to a depth where the spike of the spade bit just extended from the other side.

Next, I flipped the top, and from the other side and drilled out the exit with a 3/4" Forstner bit.

Drilling this many holes in MDF burns up bits. You're going to need to either buy several bits or learn to sharpen them. Forstner bits produce holes with cleaner edges than spade bits, but they cost more and they're more difficult to sharpen.

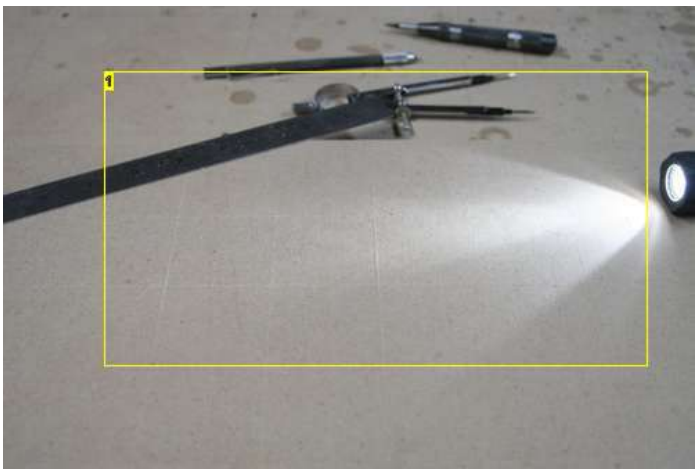


Image Notes
1. Laying out two 4"x4" squares to make the template

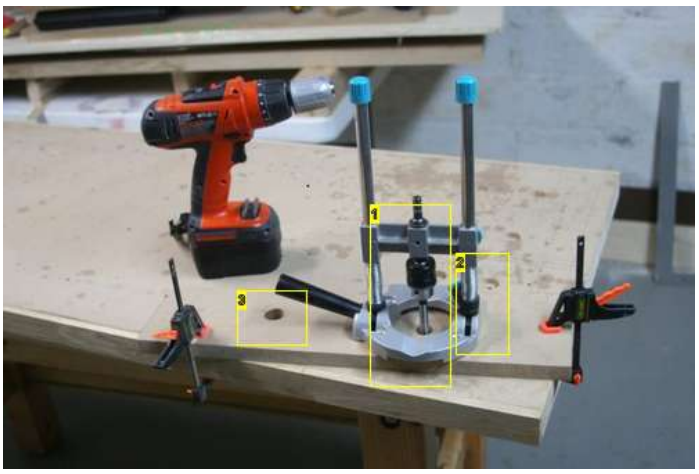


Image Notes
1. Set point of Forstner bit in the starter hole
2. Depth stop set to 1/2"
3. This is a 1" hole from when I was drilling countersinks

Image Notes
1. Grid of 1/2" deep, 3/4" diameter holes
2. Holes I messed up, and am filling in so I can try again (see next step)
3. Put center of spade bit in center hole left by Forstner bit
4. Depth stop set so that spade bit will barely penetrate bottom side

Image Notes
1. Finishing out the holes from the other side
2. 3/4" Forstner bit makes clean edges

Step 21: The top, interlude two - fixing another mistake

With my layout, I needed to drill 52 precisely located holes. I didn't get every one of them right.

If you should drill a hole in the wrong position, if it doesn't overlap the correct position you can just ignore it. If it does, you'll need to fill it.

Cut a length of 3/4" dowel, put some glue in the hole, and around the sides of the dowel, and hammer it into place. Wipe up any glue squeeze out with a damp cloth.

The next day, cut it flush. Use a block plane to ensure it truly is flush. This will be the top of the bottom layer of the bench top, so gouges aren't a problem. (Wiping up glue with a damp cloth can lead to stains and finishes applying unevenly. That won't be a problem here, either.) But bulges and bumps are a problem - they will keep the two layers of the top from matching up evenly.

Then mark the proper position, and drill it again.

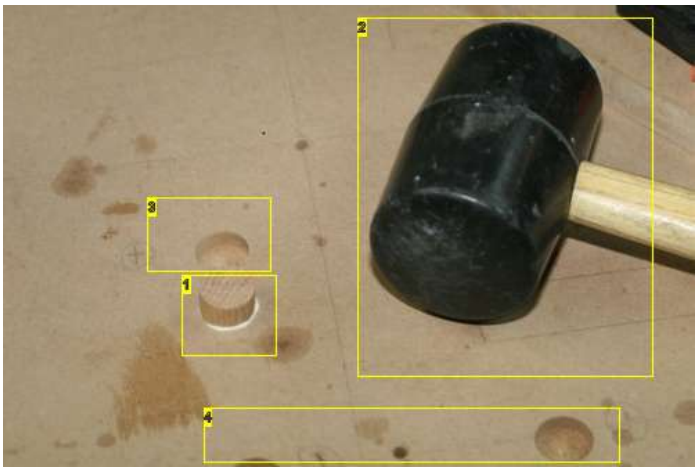


Image Notes
1. Cut off a short length of 3/4" dowel, apply glue, and pound it into the hole
2. Pounding on things is always fun
3. Where the hole was supposed to be
4. These holes are where they belong

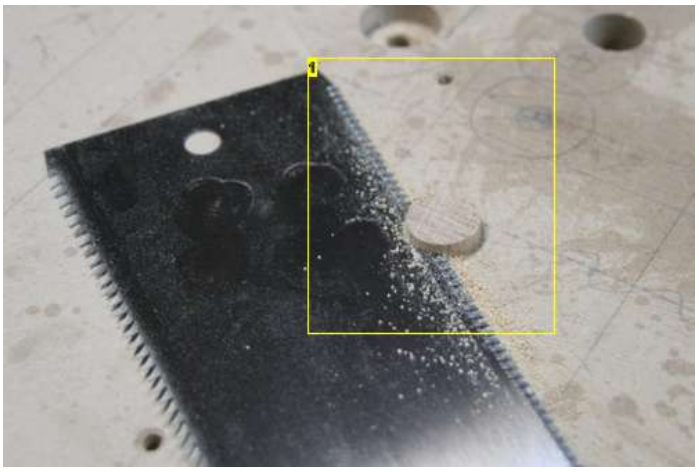


Image Notes
1. When the glue is dry, cut it off flush

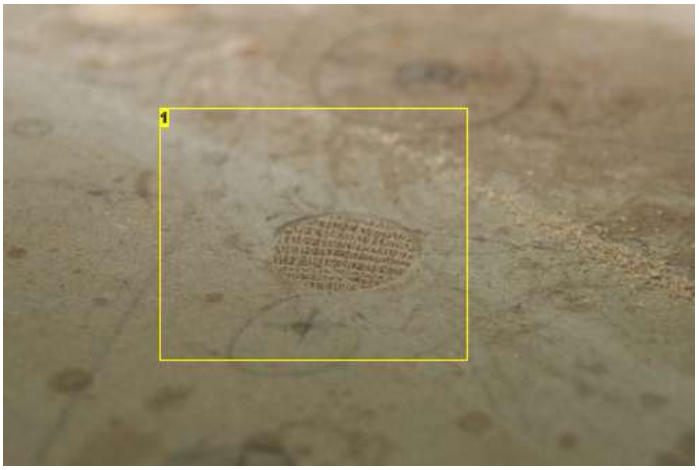


Image Notes
1. Smooth it down with a plane, a card scraper, or sandpaper

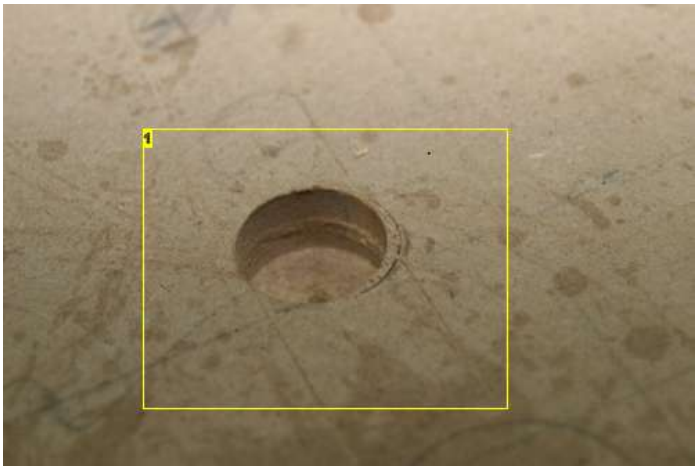


Image Notes
1. If the original hole was misplaced by less than 3/8", you'll be drilling out much of the dowel you just glued in

Step 22: The top, step six - finishing up the MDF layer

There are a few tasks left on the MDF layer, prior to joining it to the countertop layer.

First, we need to drill out the holes for the screws that will hold them together. While the two layers of MDF are glued, the countertop and the MDF will only be screwed. The oak countertop, like any natural wood product, will expand and contract with humidity changes. If it were glued to the MDF, the difference in expansion of the two layers would cause the countertop to buckle and curl.

For that reason, all of the screw holes except one row along the front edge should be drilled oversize. This gives the wood a bit of room to move.

For the most part I drilled through the existing holes left over from laminating the two sheets of MDF. In a few instances I moved a hole over a bit because it was too close to a benchdog hole. And I created a new row of holes around the outside edge, because our original holes along the outside edge were cut off as we trimmed the MDF to size.

Keep an eye on what will be underneath, you don't want the head of the screw to get in the way of the stretchers, legs, or vises.

Again, I used Kreg's pocket hole screws, this time in 2-1/2" length.

The final prep for the MDF layer is to round the bottom edges with your router and a 1/4"-radius round-over bit. Practice on some scrap, first, to make sure you have the depth on the bit set right,

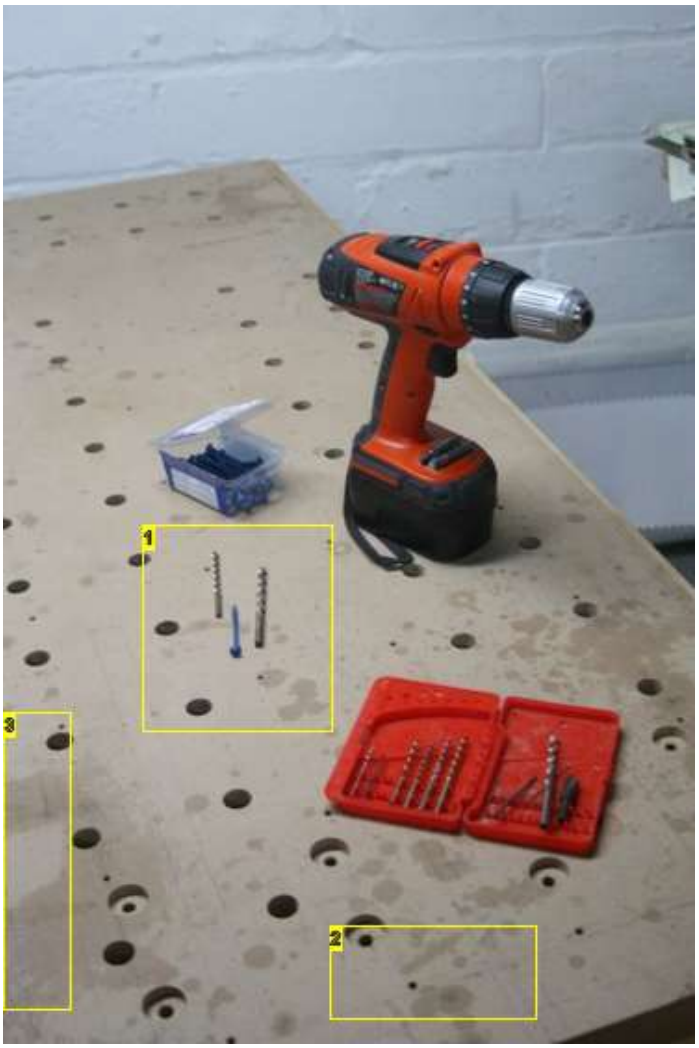


Image Notes
1. A screw, a bit that just fits the screw, and a bit that's somewhat larger (but still won't pass the screw head)..
2. Drill most of the holes with the large bit, and waggle side-to-side some to create a slot oriented to allow movement sideways across the table.
3. On the front edge, use the smaller bit, and don't waggle.

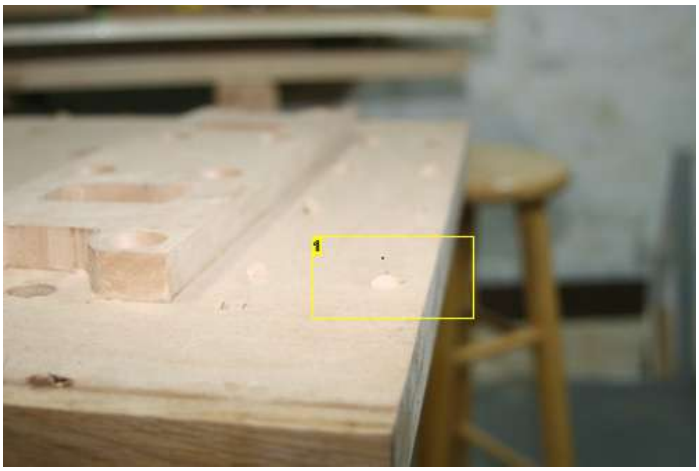


Image Notes
1. On the back side, you'll see some tear-out.

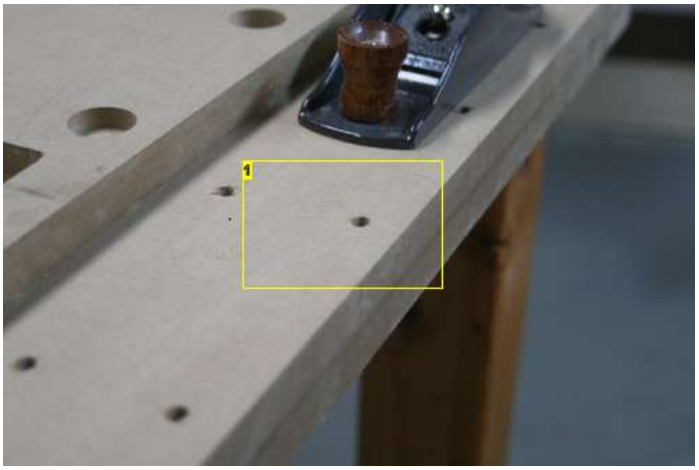


Image Notes
1. I've found a block plane is the easiest tool for cleaning up the tear-out

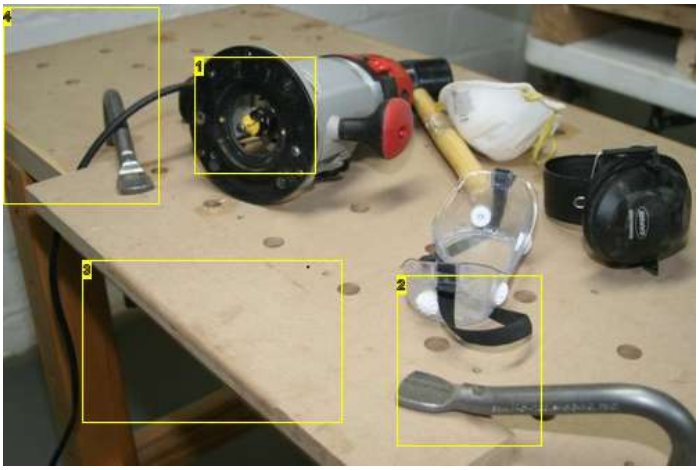


Image Notes
1. 1/4"-radius round-over bit
2. Holdfasts are faster to use than clamps, and we have benchdog holes, now, so we can use them
3. Practice cut in scrap

4. Rounding over the bottom edges of the bottom (MDF) layer

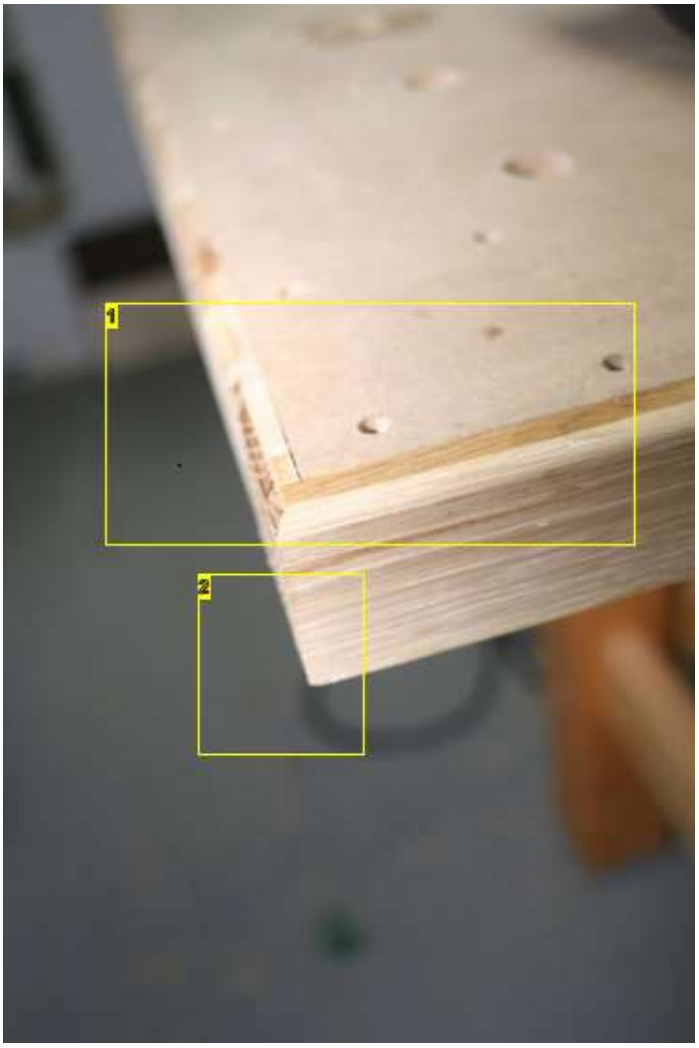


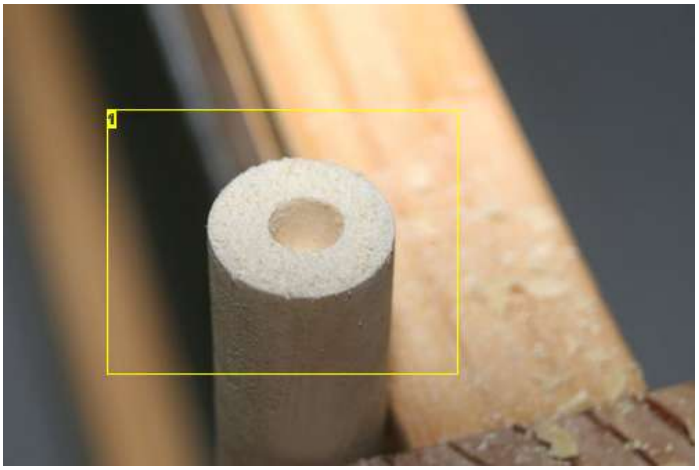
Image Notes
1. A nicely-rounded edge
2. We'll round over the corners after we join the oak countertop

Step 23: The vises, step two - holes through the end stretcher

The end vise needs holes through the end stretcher. The screw and the anti-rack rods are 1" in diameter, so I drilled 1-1/8" holes.

I marked the holes by putting a dowel center in the end of a long piece of 1" dowel. Run it through the holes in the base plate, and bang on its end with a mallet. Rotate it a bit and bang it again, and repeat. Odds are the dowel center won't be precisely in the center of the dowel, so you'll be making a small ring of marks. The center of the hole is, of course, the center of that ring.

You can see my high-tech air-scrubber in one of the pictures. This helps a lot in keeping down the really fine dust that the shop-vac doesn't pick up.



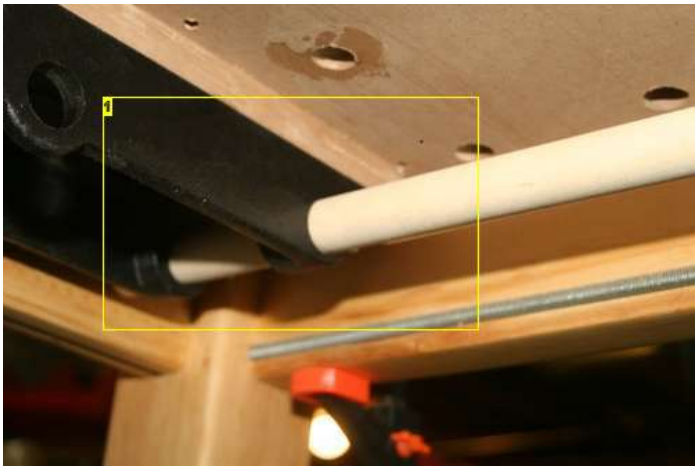


Image Notes
1. Hole for dowel center in the end of a 1" dowel

Image Notes
1. Mount vise to top, line up top on base, and clamp in position, put dowel center in end of dowel, line up dowel through the rod holes, and bang on the end with a mallet

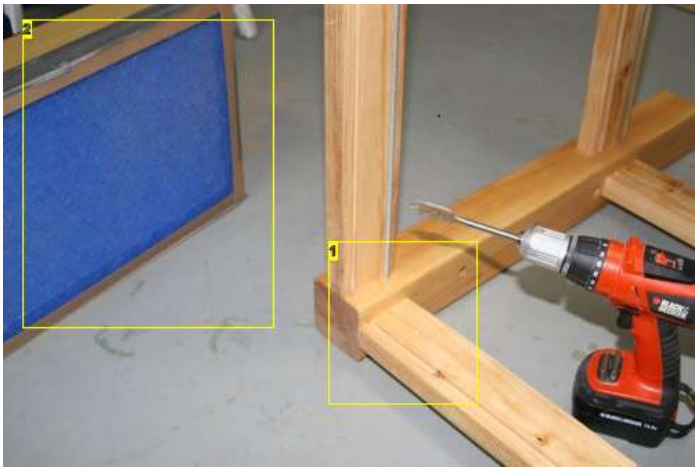


Image Notes
1. Two of the holes are too close to the legs to use the drill-guide, so I drilled them free-hand
2. My hi-tech air scrubber

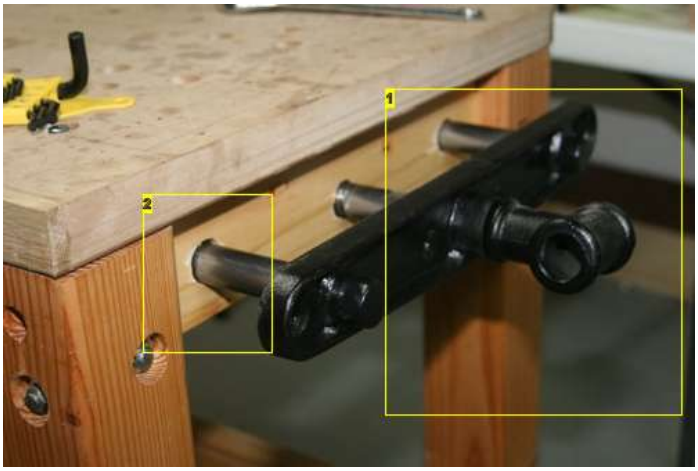


Image Notes
1. Trial-fit the vise to the vise base
2. If you drill only most-of-the-way through, and then finish from the other side, you don't get this sort of tear-out. I don't know why I forgot to to do it, this time.

Image Notes
1. The underside of the vise, during the trial fit.
2. The top is being held to the base by clamps

Step 24: The top, step seven - preparing the countertop

With the MDF layer ready to join to the Ikea countertop, the next step is to prepare the countertop to be ready to join to the MDF.

We need to cut it to length, and to width. We need to mark and drill the pilot holes for the screws. We probably don't really need to oil the surface between the two layers, but I decided to do so, anyway.

I was using 2-1/2" coarse Kreg pocket hole screws. Kreg screws are supposed to be self-tapping, but the coarse-thread screws are intended to be self-tapping in softwood, and the fine-thread screws they intend for use in hardwoods aren't available in 2-1/2" lengths. I decided to drill pilot holes in the oak. Just to make sure, I did a test hole in the scrap piece I'd cut off.

That scrap piece of oak looks like I'll be able to use for something, maybe a cutting board. So I made a platform out of a stool, a scap of 4x4, a couple of srtips of MDF, and some shims, to catch it, as it was cut. My test hole was done at the edge, so as to leave as much of the piece clean as was possible.

The last thing is to semi-permanently attach the bolts for the vises. Given the amount of work necessary to get to the bolt heads, once the top is joined, I had intended to tighten them up so they wouldn't spin, and lock them that way with blue Loctite. (That's the strongest non-permanent grade.) That didn't work. What I found was that the bottoms of the countersinks weren't quite flat, and when I tightened the nuts down that far, the ends of the bolts would be pulled far enough out of alignment that the vise bases would no longer fit. In order for the vises to fit over the bolts, I had to leave the nuts loose enough that the bolts had a bit of wiggle - which meant that they were almost loose enough for the bolts to spin. So I put Loctite on the nuts, to keep them from unscrewing, and filled the countersinks with Liquid Nails, in hopes of keeping the bolts from spinning. I considered using epoxy, or a metal-epoxy mix like JB Weld, but I didn't have enough of either on hand. It seems to be working for now, though the real test won't be until I have to take the vises off.

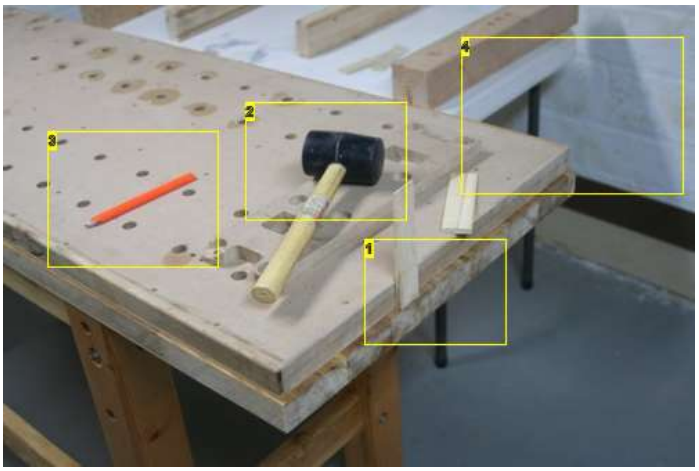


Image Notes
1. We want a 1/8" overhang on each side, which is 1/4" total. These shims are 1/4" thick, so we line the MDF+shim flush with the countertop, and mark the other end.
2. Light taps with the mallet are still the easiest way of precisely positioning the MDF
3. We're going to be routing these edges flush, so a pencil line is precise enough
4. Lining up in prep for marking cut lines on the countertop

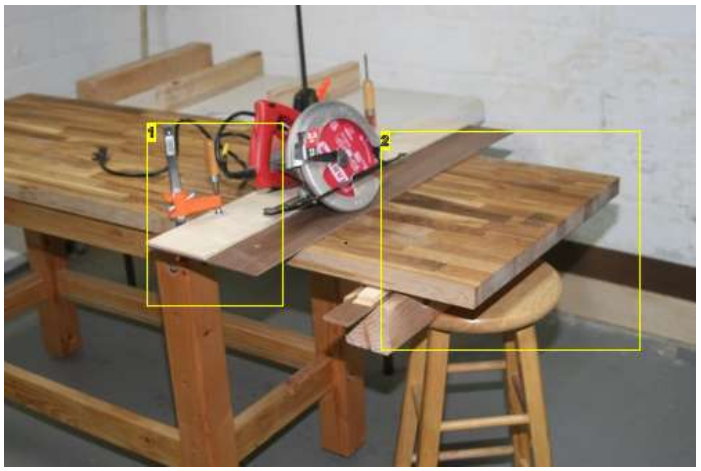


Image Notes
1. Our old friend, the edge guide
2. This tail is pretty heavy, and I was hoping to save it for some future project, so I put some support underneath so it only fell about 1/4".

Image Notes
1. Trim the side
2. Goggles, mask, and hearing protection
3. Leftover chunk of oak. Maybe a cutting board?

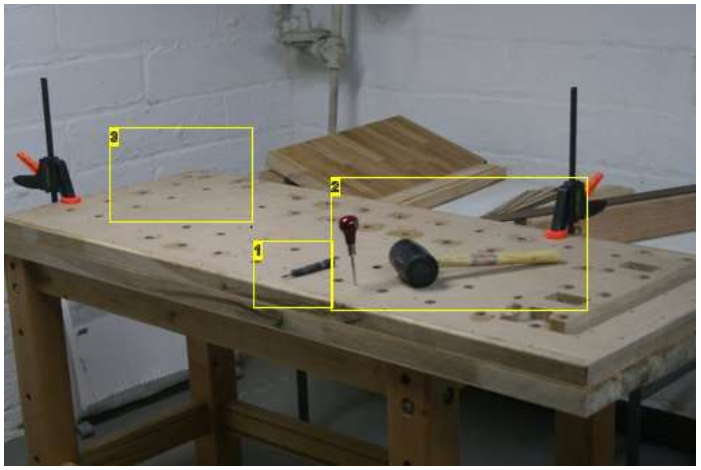


Image Notes
1. My usual centerpunch won't reach 1-1/2"
2. Low-tech - bang on the awl with the mallet
3. Marking the pilot holes

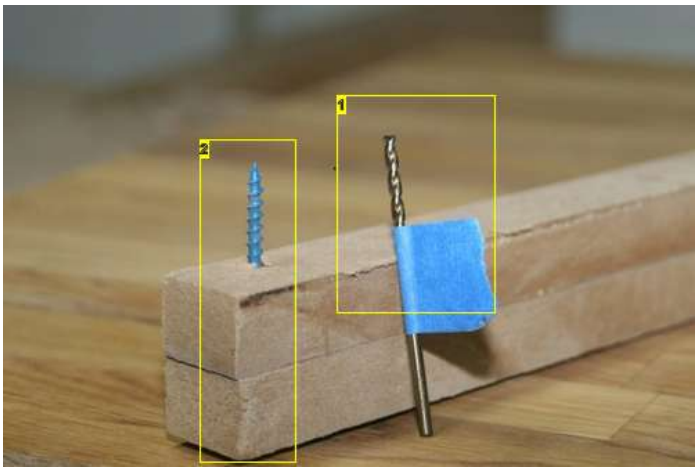


Image Notes
1. This looks like the proper-sized pilot hole - let's give it a try
2. 2-1/2" screw, through 1-1/2" of MDF, leaves an inch

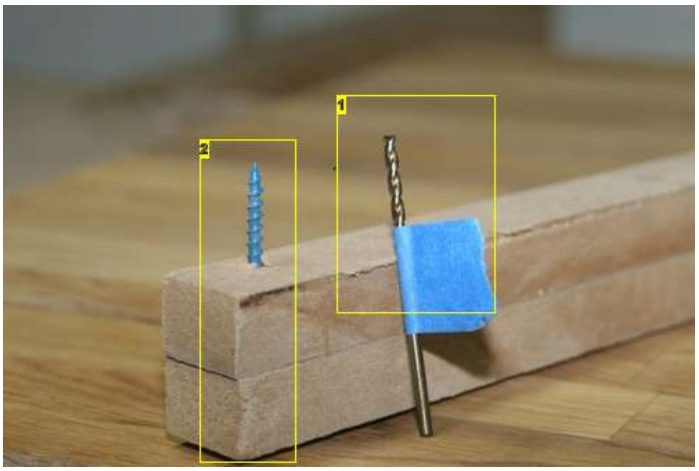


Image Notes
1. Screws in clean, and holds solid

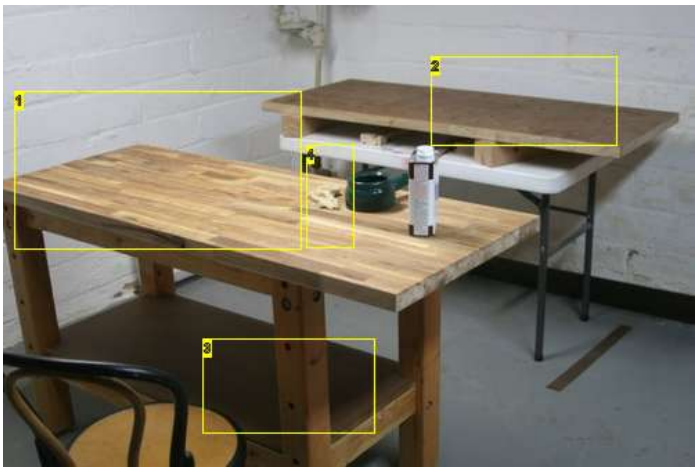


Image Notes
1. Oil the bottom side of the top layer
2. Oil the top side of the bottom layer
3. Oil one side of the shelf, as long as we're at it
4. Remember to hang the rag outside to dry

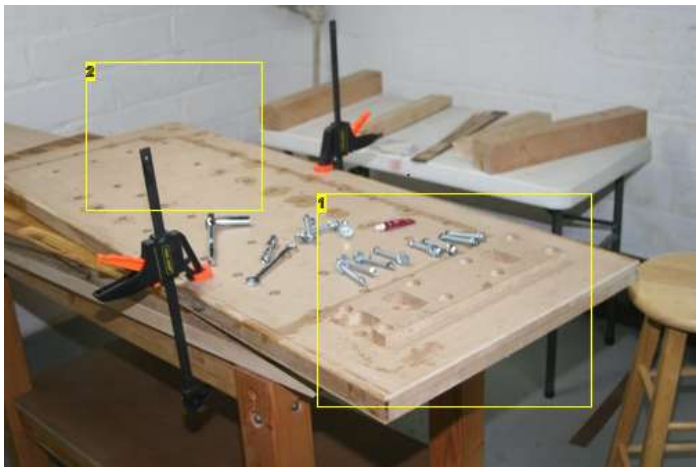


Image Notes
1. Fixing the vise bolts
2. Canted, so that I can access the bottoms of both sets of vise holes

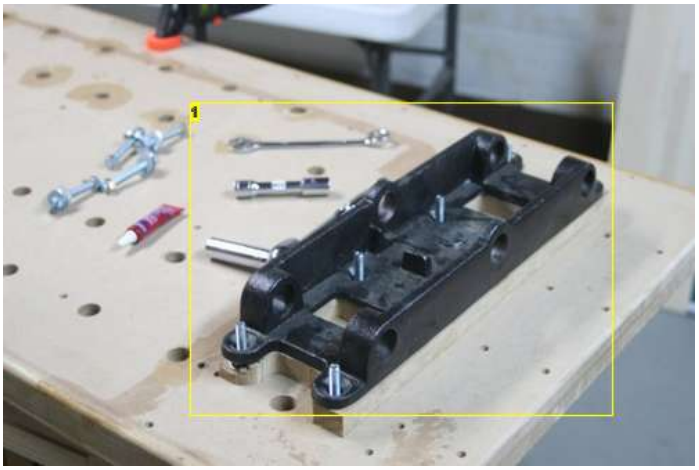


Image Notes
1. Bolts in, nuts on, then test fit

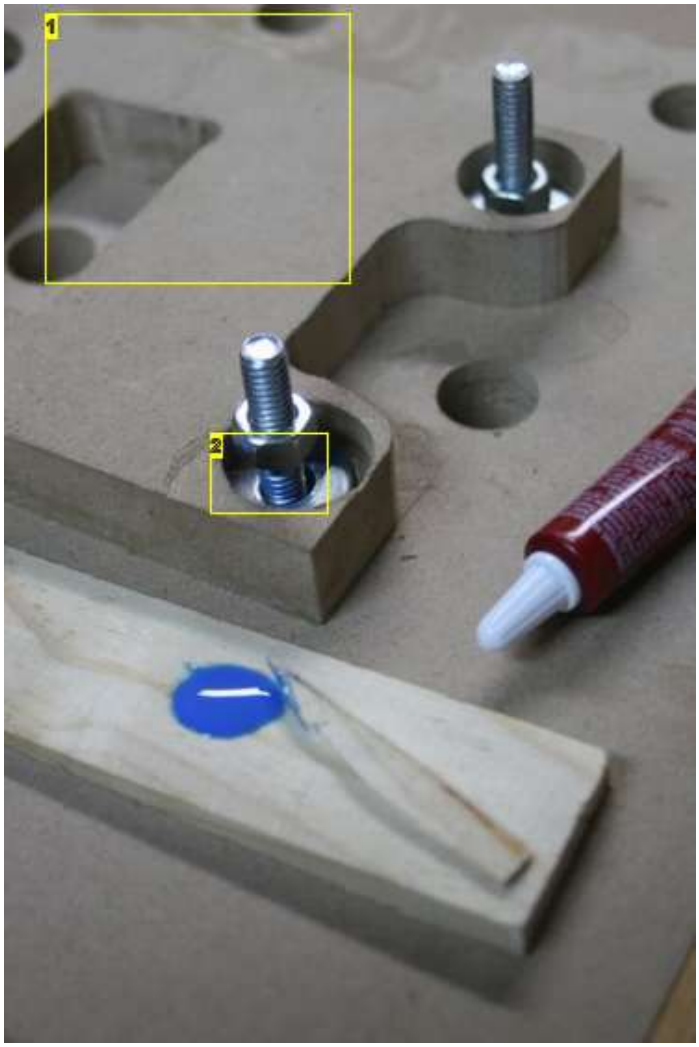


Image Notes
1. Once the two layers of the top are joined, tightening up these bolts will be a royal pain
2. Apply Loctite to bolt threads where the nut will be

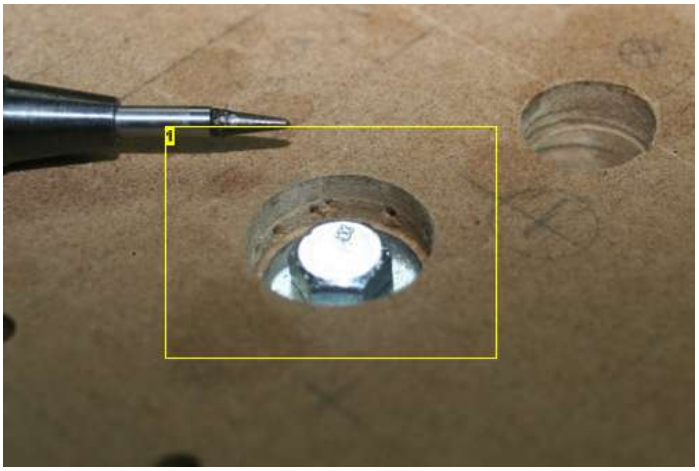


Image Notes
1. Using the centerpunch to rough up the edge of the countersink

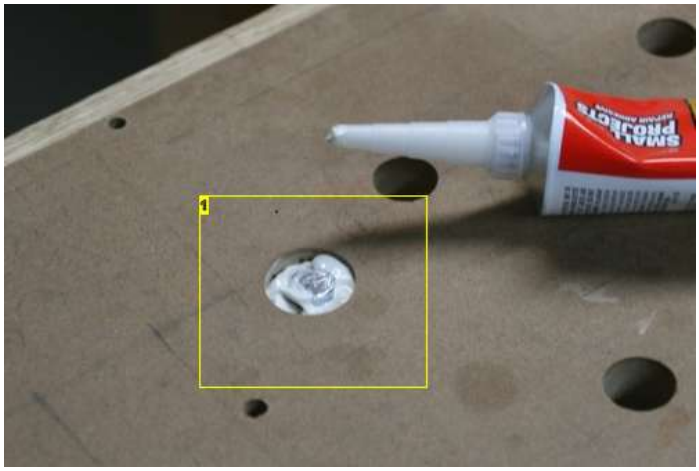


Image Notes
1. I'd thought about using JB Weld, or plain epoxy, but I didn't have either on hand

Step 25: The top, step eight - completing the top

Lay the countertop layer flat, top-side down. Put the MDF layer on top of it, top-side down. Line up the through-holes in the MDF with the pilot holes in the oak. Screw the two layers together.

Be careful. Single 24x60" sheets of 3/4" MDF are pretty easy to lift. A doubled sheet is manageable. The countertop - 24x72" panel of 1-1/2" oak - weighs something over 100 pounds. It takes real care to lift safely. The joined top - 3" thick of oak and MDF - is past the range that can be lifted safely by one person. Don't try. Get a friend to help, or rig a block-and-tackle.

Use a 3/4" spade bit to drill the benchdog holes almost through (I used my drill guide, mainly for the depth stop. It's pretty easy to keep the drill vertical with the existing hole to guide you).

If you remember, when drilling the MDF I finished the holes from the other side using a Forstner bit. It made for a clean hole, but the positioning wasn't as precise as I really wanted. So for this, I decided to clamp a length of scrap MDF to the back side, and to drill straight through. My Forstner bits were too short, so I bought an extender. And then I found that the spade bits I was using gave a cleaner exit hole. Whooda thunk?

Use the 1-1/2" cutting length flush-trim bit to match the sides of the countertop to the MDF. Then use a 1/4"-radius round-over bit to round the top edges and the corners, and a 1/8"-radius roundover bit on the inside of the benchdog holes.

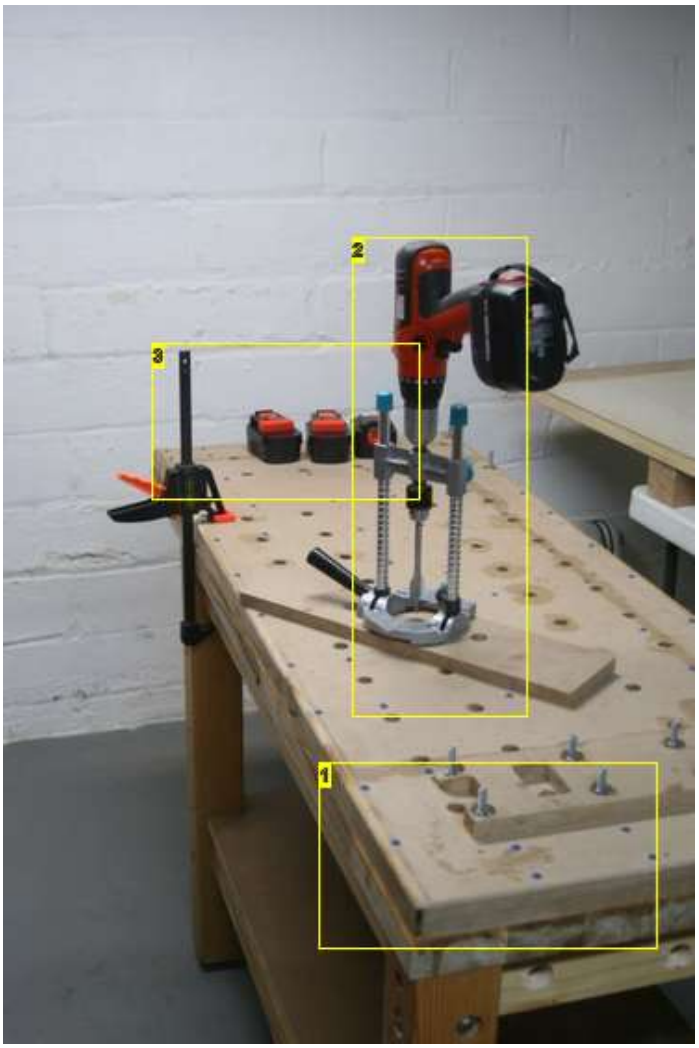


Image Notes
1. Layers are screwed together
2. Drilling the benchdog holes through the oak
3. My old batteries would only drill five or six holes on a charge, so I figured they were no longer holding a good charge, and bought new batteries. The new ones would only do eight. (There are 50 holes in my bench).

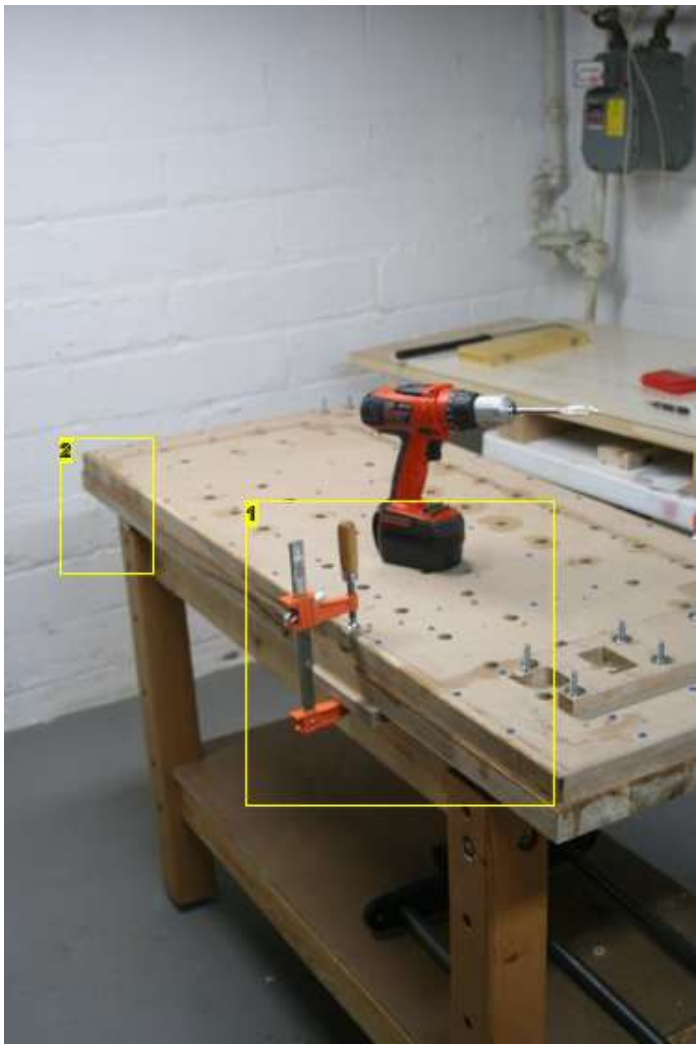


Image Notes
1. MDF scrap clamped behind a row of holes, in prep for drilling the final bit
2. Another scrap of MDF down here so the top sits level

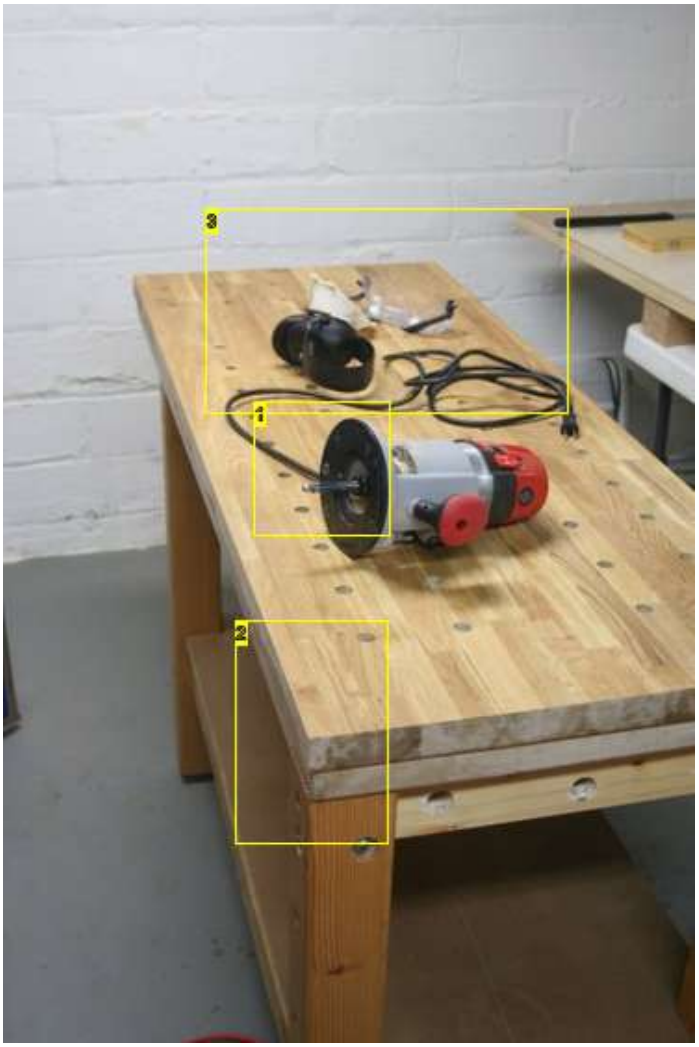


Image Notes
1. 1-1/2" cutting edge flush trim bit
2. Trim the oak to match the underlying MDF layer
3. Do not skip your protection, when routing like this

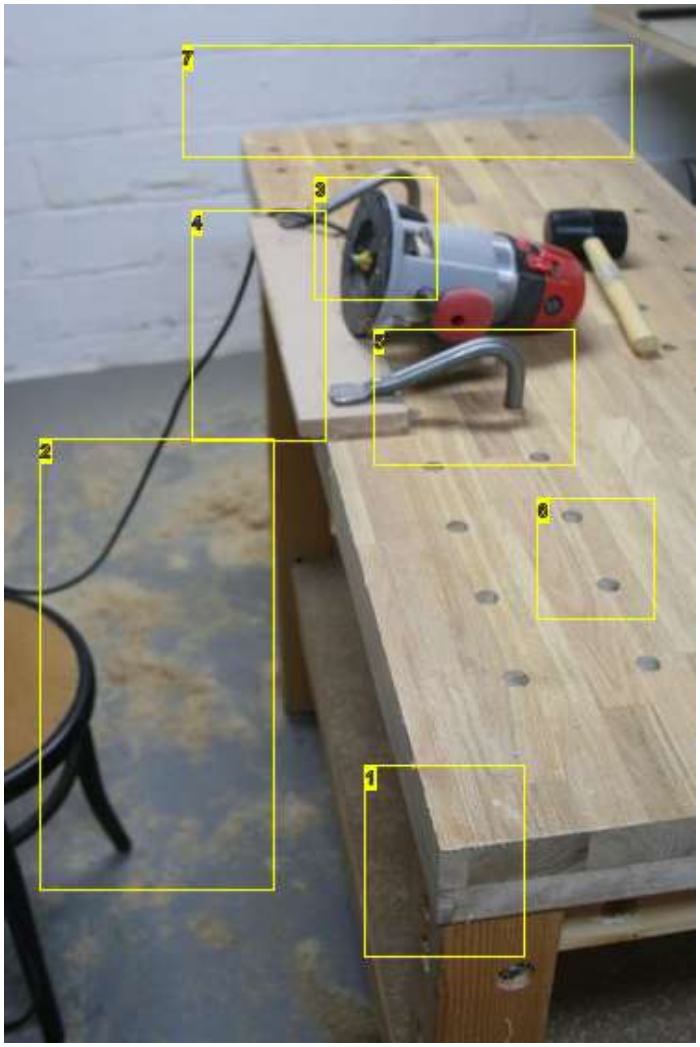


Image Notes
1. Oak is trimmed flush with the MDF, now.
2. Lots of sawdust
3. 1/4"-radius roundover bit
4. Testing to make sure the bit is set to the right height
5. I really like these holdfasts
6. Use a 1/8"-radius roundover bit to ease the edges of the benchdog holes
7. Roundover the sides and the end that doesn't have the end vise

Step 26: The top, interlude three - filling voids

I found, when I cut the oak countertop, that the interior oak wasn't always of the same quality as the exterior. The cuts left exposed a large knot with an extensive void. This needed to be dealt with.

I clamped the top to the side of the base, as I had done before, so that the edge with the knot would be easy to work with. I mixed up some ordinary five-minute epoxy and added just a touch of black epoxy pigment. I applied this freely. After about twenty minutes I checked on it and found that in the deepest spot the void wasn't entirely filled, so I mixed up another batch and added more. After that had cured for a bit I eased the top to the floor and applied a coat of oil to the bottom side. I planned on attaching the base to the top the next day, and I wanted the bottom side oiled to keep it from absorbing moisture.

As I said earlier, be careful moving the top. I rigged a simple pulley system to make moving the top possible for one person. Photos in a later step. But a husky friend or two would work as well, and would be faster.

Image Notes
1. A fairly significant void

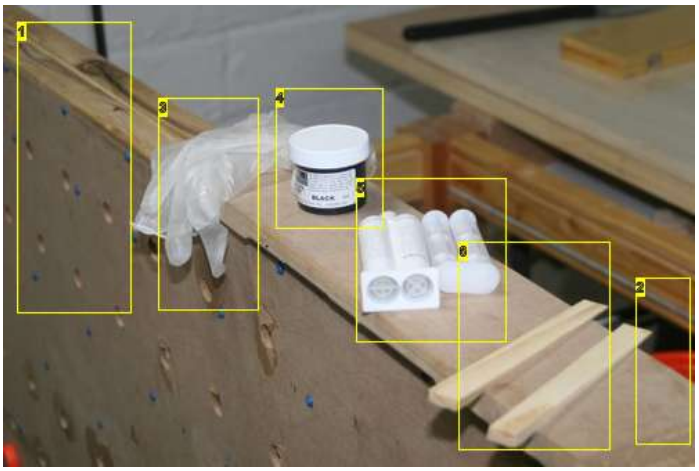


Image Notes
1. Top held on edge, clamped against side of base
2. Five gallons of water as counterbalance
3. Vinyl gloves (latex would work for this - epoxy doesn't dissolve latex the way oil does).
4. Black epoxy pigment
5. Perfectly ordinary five-minute epoxy (tubes and plunger)
6. One scrap of wood to mix, another to apply

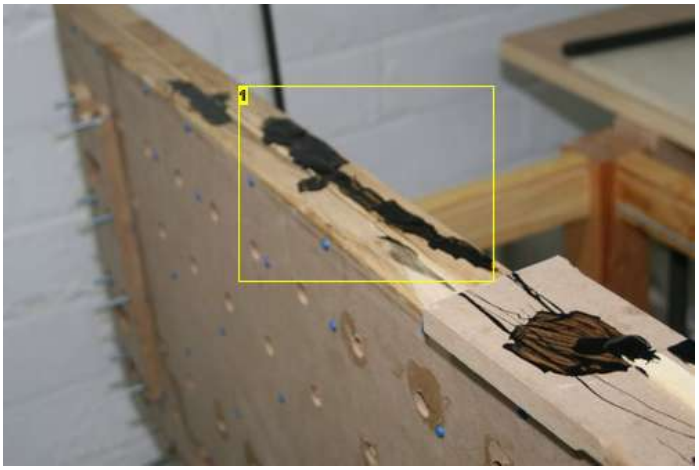


Image Notes
1. fill void and more - will scrape flush later

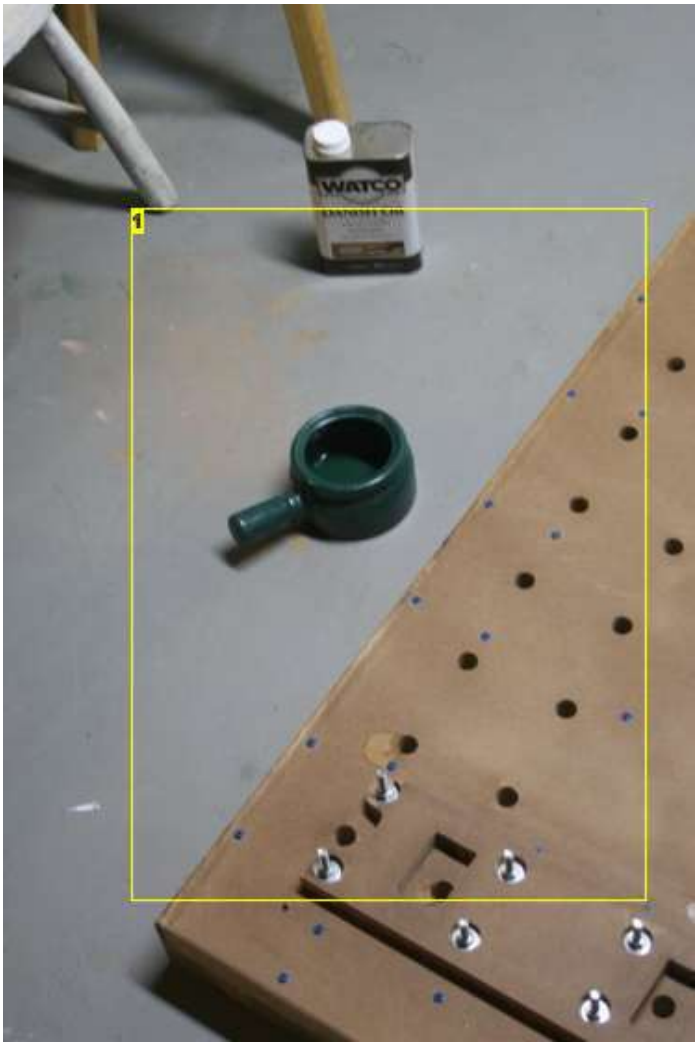


Image Notes
1. While the epoxy is curing, I eased the top to the floor, and applied a coat of oil (Remember - oily rags are hung to dry outside

Step 27: The bench, step one - joing the top and base

With the top laying on the floor, bottom side up, the next step is to flip the base upside down, and attach it to the top. I followed Asa Christiana's design, in using s-clips. When I stopped by my local Woodcraft, though, they only had two packages of ten, so I didn't use as many as I would have, otherwise. For the top I put four on each side and two on each end. For the shelf I put three on each side and two on each end. If it turns out that I need more, I can always add more.

First, line up the base with the top. Then screw it down using the s-clips.

Mount the vise bases, and tighten them down with nuts, washers, and lock-washers.

Flip it on edge, and sand the edges smooth. If you used epoxy to fill voids, as I did, you might want to start with a belt sander. (Or if you're more comfortable with hand tools, you might use a card scraper.) With a random orbital sander, work through 100, 150, and 200 grit. Then flip it over and do the other edge.

After sanding the second edge, clamp the shelf in place, oiled side down. Then flip the bench upside down again, and attach the shelf to the base using s-clips. (You'll need 3/4" self-tapping panhead screws - the screws you used on the top will be too long.)

With the shelf secure, get a couple of friends to come help, and stand the bench on its feet. I said earlier moving the top by yourself is dangerous. Trying to lift the entire bench is foolhardy. Of course, I already said I'm stubborn, so I did it myself by rigging a simple block-and-tackle using lightweight pulleys I got at the hardware store. (Not the lightest-weight pulleys, those are meant for flag poles and have a design load of something like 40 pounds. These had a design load of 420 pounds.)

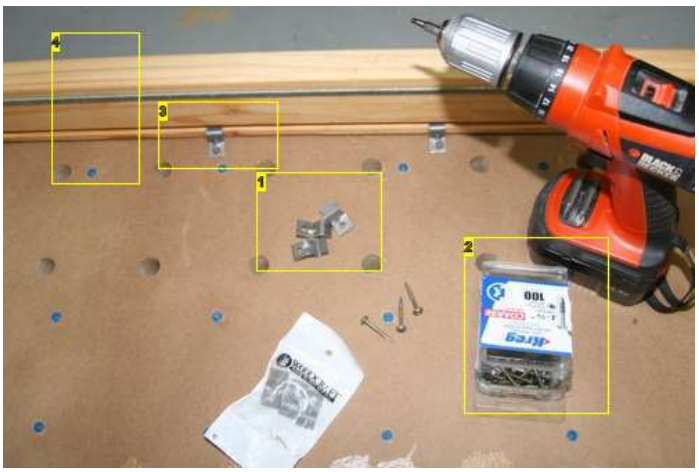


Image Notes
1. S-clips
2. The very same 1-1/2" screws we used in laminating the MDF
3. The clip hooks into the 3/8" groove we routed in the stretchers, way back when we started
4. The top is on the floor,bottom side up, and the base is on the top, upside down

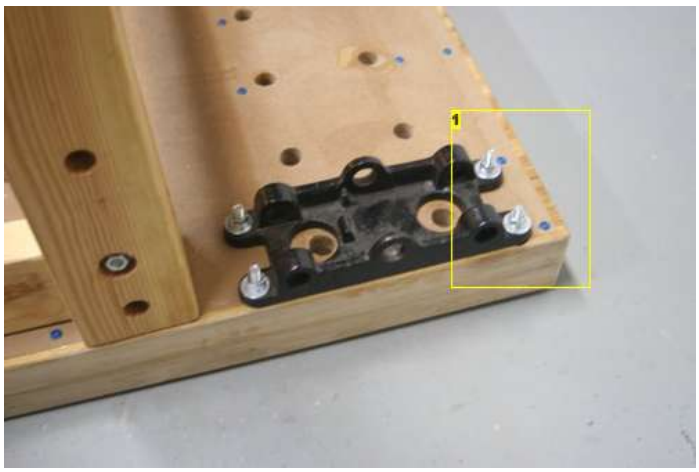


Image Notes
1. Using lockwashers instead of locktite

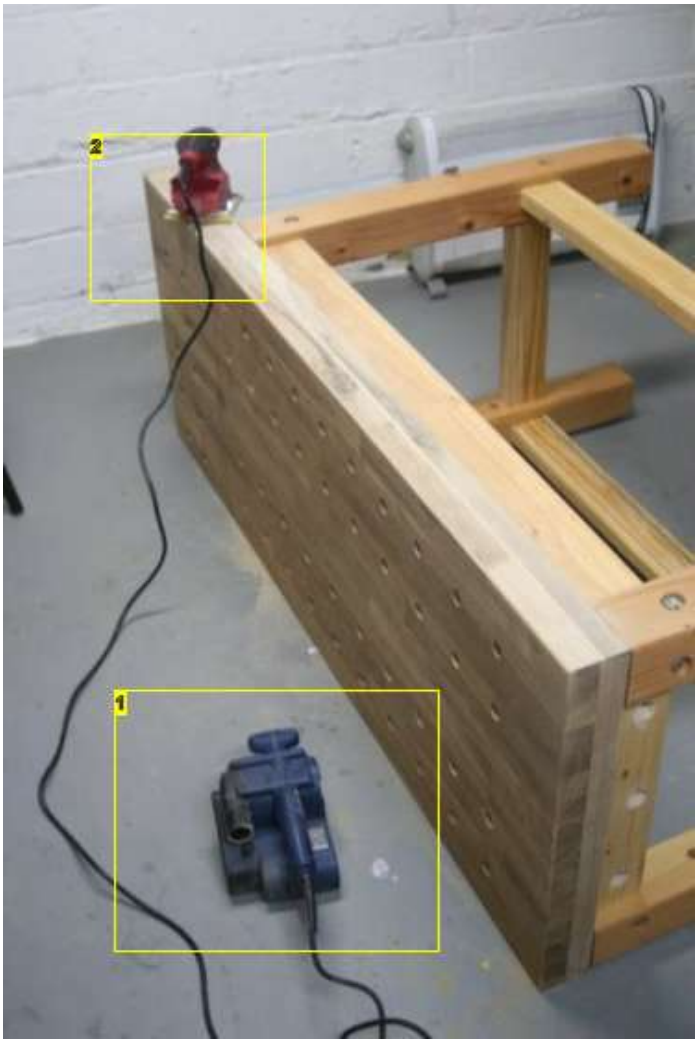


Image Notes
1. Belt sander in 80 grit to remove the excess epoxy
2. Work random orbital sander through 100, 150, and 220 grit

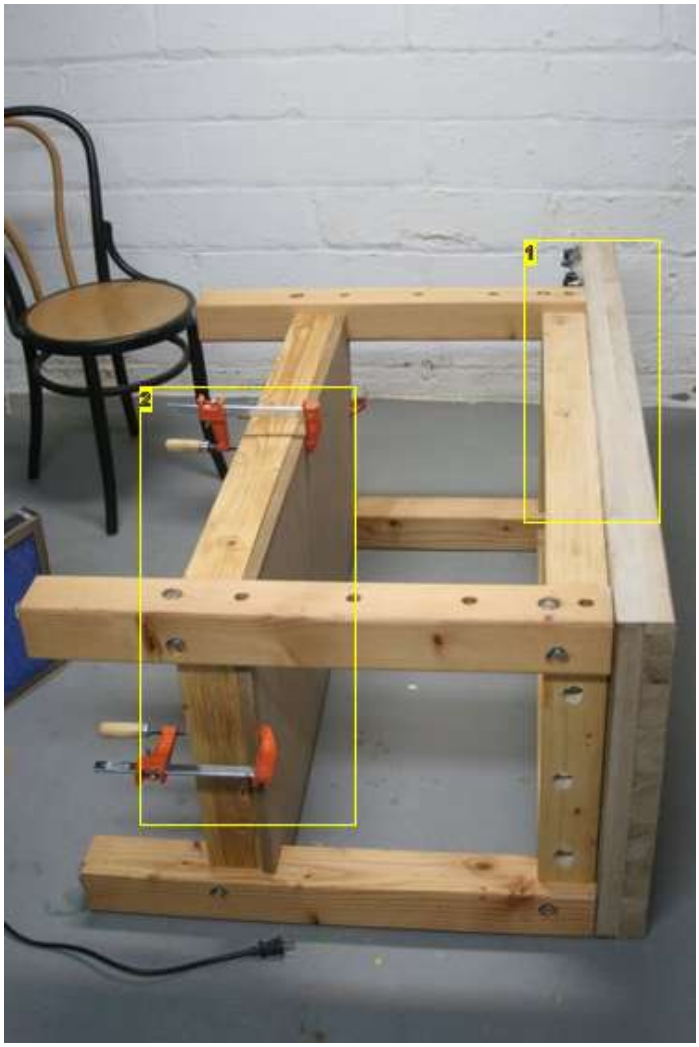


Image Notes
1. Sand the other edge
2. Then clamp shelf to lower stretchers

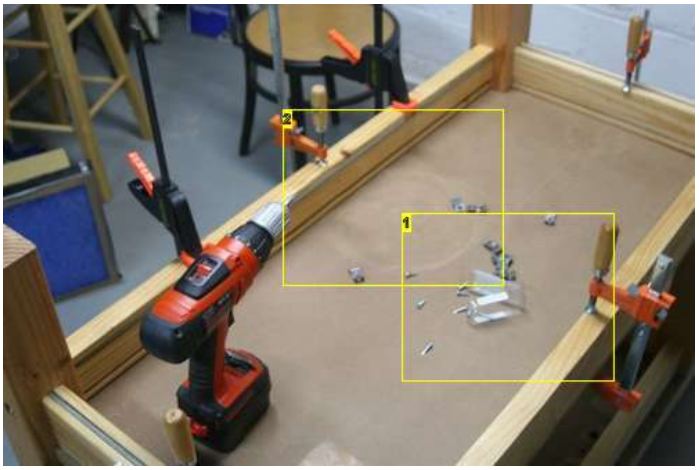
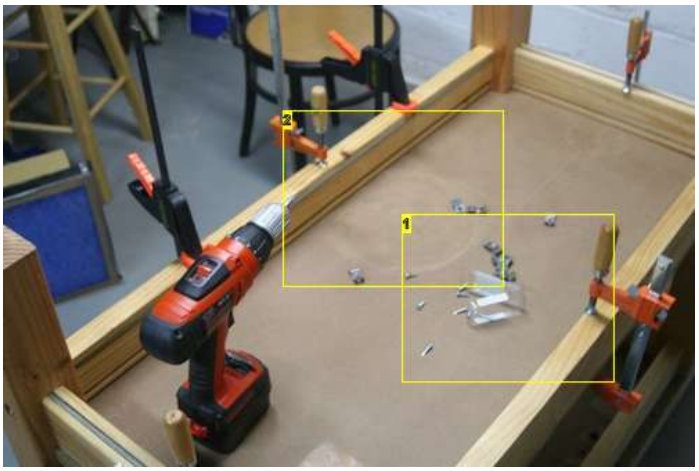


Image Notes
1. Fasten shelf with s-clips and 3/4" self-tapping pan-head screws
2. The circle is from where my five-gallon bucket of water had been sititing



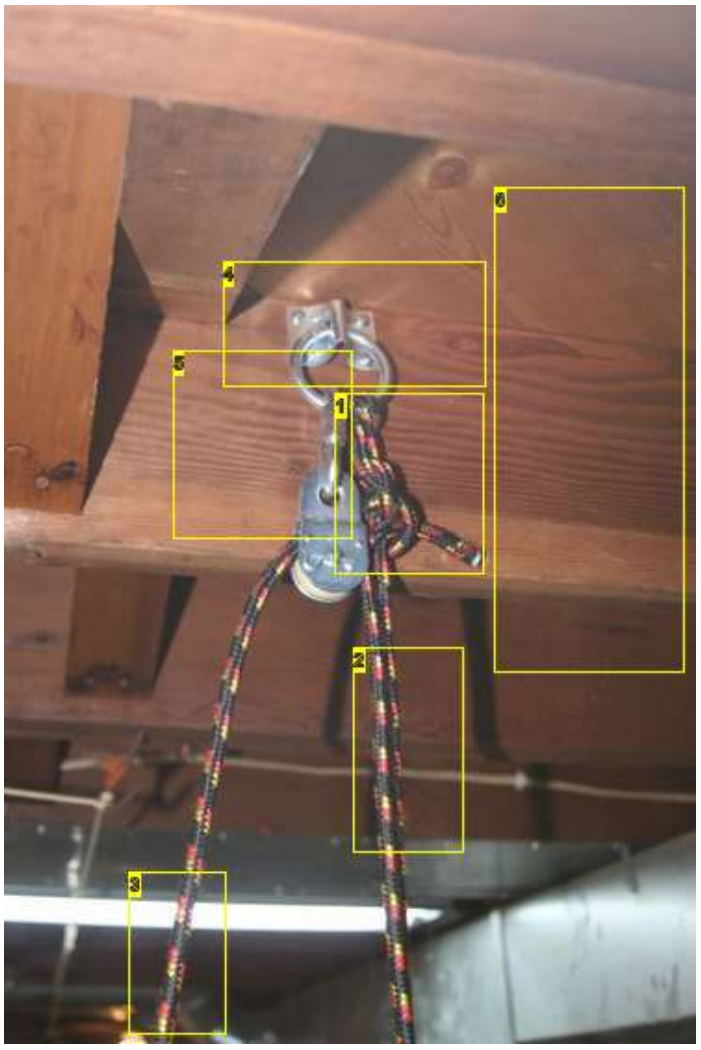


Image Notes
1. End tied to ring with a cow hitch and a series of half-hitches
2. Line runs through pulley attached to bench, then returns
3. This is the end you pull on
4. The bottom third of floor joists are in tension, the top third are in compression. So when you screw or drill into a floor joist, always do it in the top third
5. Pulley connected to ring with quick link
6. Note: This improvised lifting system has a maximum capacity of something around 300 pounds. Don't go lifting any engine blocks with something like this.

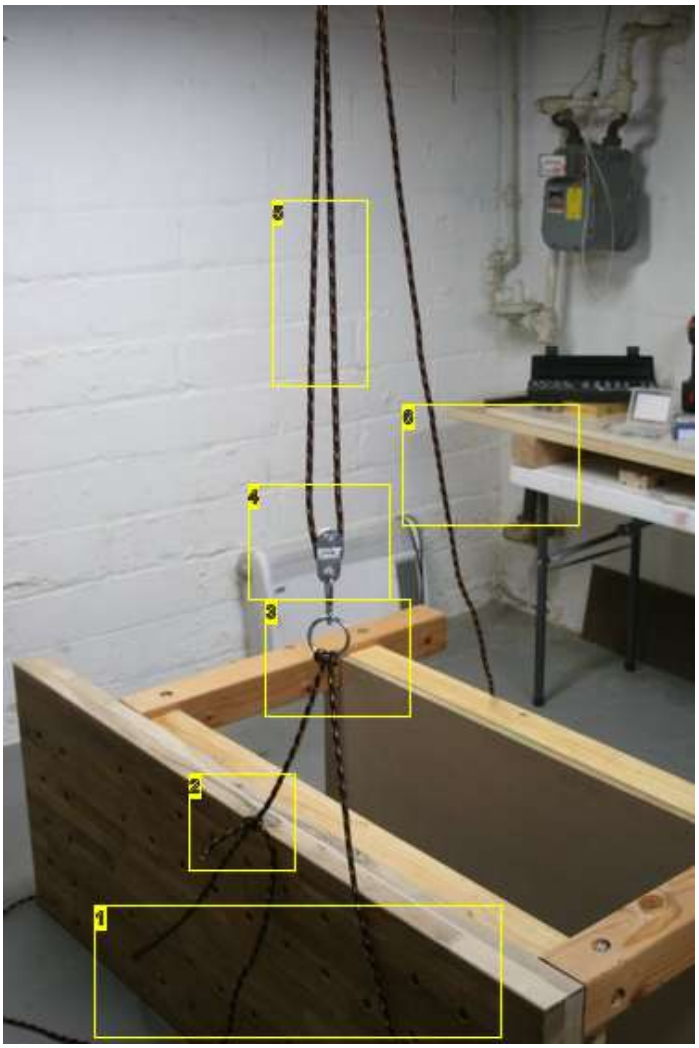


Image Notes
1. Loop passes through two of the bottom row of benchdog holes
2. Loop tied with a bowline
3. Ring connected to loop with a cow hitch
4. Pulley fastened to ring with a carabiner
5. End is tied to the ring screwed to floor joist. Line runs down through the pulley attached to the table, through the pulley attached to the floor joist, then down to the guy who's pulling on the rope
6. Pull on this end

Step 28: The bench, step two - finishing

With the bench now standing up, it's easy to give the top a light going over with the random orbital sander. Again, 100, 150, and 220 grit.

I decided to finish the top with a number of coats of Danish oil, followed by a coat of wax. I applied the first coat of oil in the usual manner, making sure to cover the edges, and down the holes. I applied a coat oil to the top side of the shelf, as well. Wipe it on, let it sit wet for half-an-hour, then rub it off. Wait a day or two, add a second coat, and then again for a third.

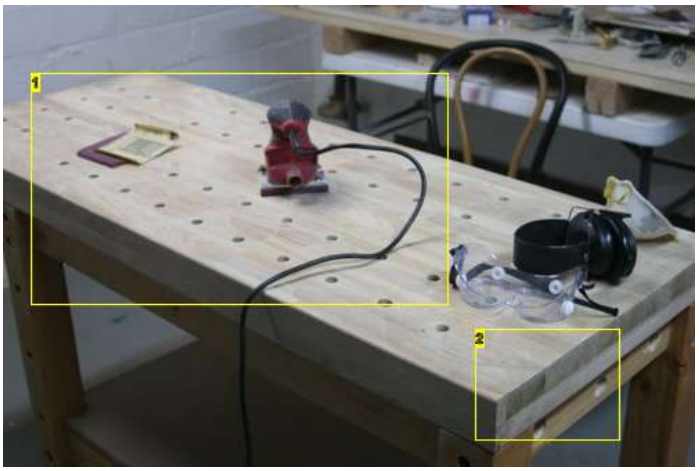


Image Notes
1. 100, 150, then 220 grit. Get the corners with loose strips of sandpaper.
2. You want the edges at this end square, not rounded

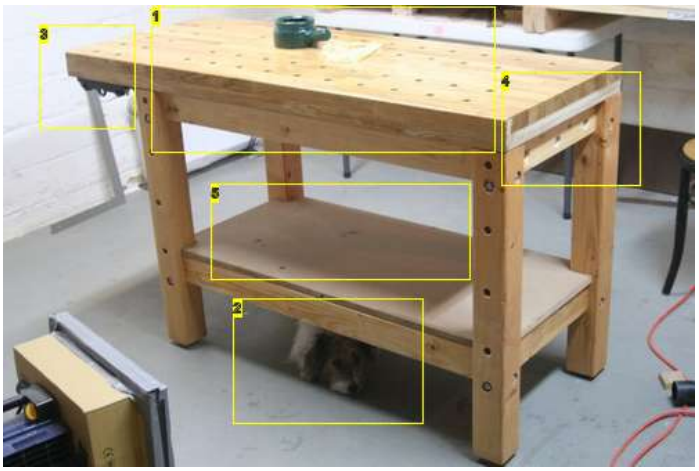


Image Notes
1. Wiping on Danish oil
2. Still waiting for me to come out and play
3. Front vise will go here
4. End vise will go here
5. Assorted junk will go here

Step 29: The vises, step three - gluing up the jaws

With the bench assembled, and the vise bases mounted, it's time install the vise jaws.

On a vise, the surfaces that hold whatever it is they are holding are the jaws. I'd intended to install the front vise so that it uses the edge of the bench top as the stationary jaw, so for it I only needed to build the moving jaw. For the end vise I needed both stationary and moving.

The jaw for the front vise needed to be 10" long - to span the distance from the leg to the end of the top, 1-1/2" thick - to allow for benchdog holes to be drilled in it, and 5" tall. The end vise was mounted 3/4" lower than the front vise, and the screw and guide rods were thicker, so its jaws needed to be at least 6-1/2" tall. Again, they needed to be 1-1/2" thick to allow for benchdog holes, and 23" long to span the width of the bench.

Nominal 2x6 dimensional lumber is actual 1-1/2x5-1/2". My local home store stocked finished clear oak 2x6 in two foot lengths, at a fairly hgh price per board-foot, but a quite reasonable actual price considering my local lumberyard doesn't sell boards in 2' lengths.

The home store didn't carry oak 2x8s. But it did carry oak 1x8s in four foot lengths. Two of these glued together would give me the stock I needed, at a lower cost than buying an eight-foot length of 2x8 at the lumberyard.

The process of cutting them up and gluing them together is straightforward. Once glued, I routed the bottom edge of each straight, then started fitting them.

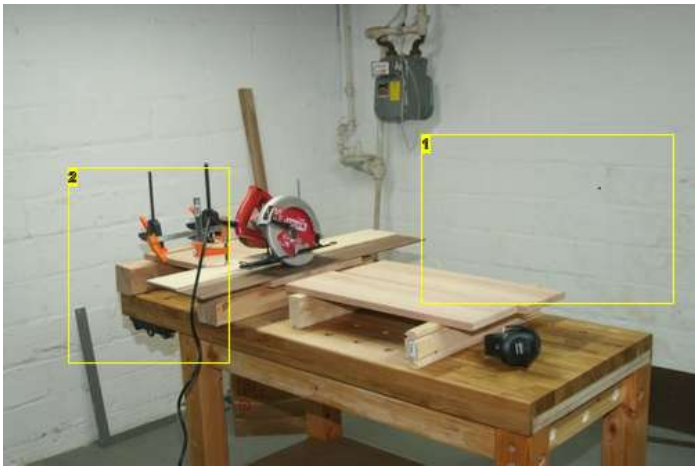


Image Notes
1. The temporary work table is gone - don't need it anymore.
2. One clamp to hold the boards together, two to hold them to the bench, and two to hold the cutting guide to the boards.. (Just because a workbench has work-holding capabilities beyond using clamps around the edges doesn't mean that clamps aren't sometimes the best solution)

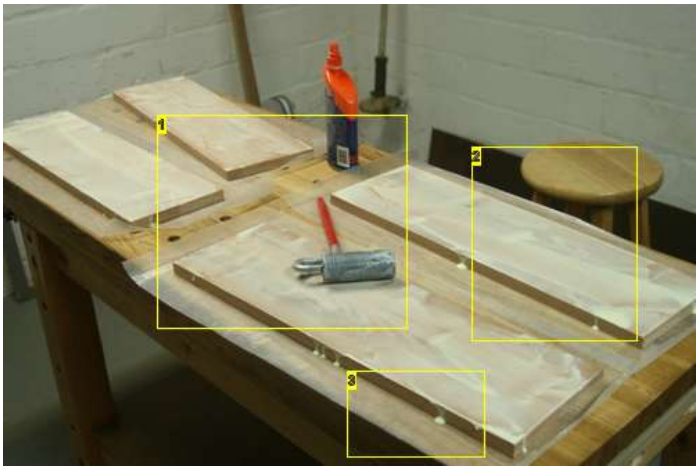


Image Notes
1. Even coats of glue, just like always
2. There's probably too much glue on these, I got carried away
3. Waxpaper works great for catching runoff and squeezeout. (Only a couple of coats of Danish oil on the top so far, glue might not come off as easy as it will after I put on a coat of wax)

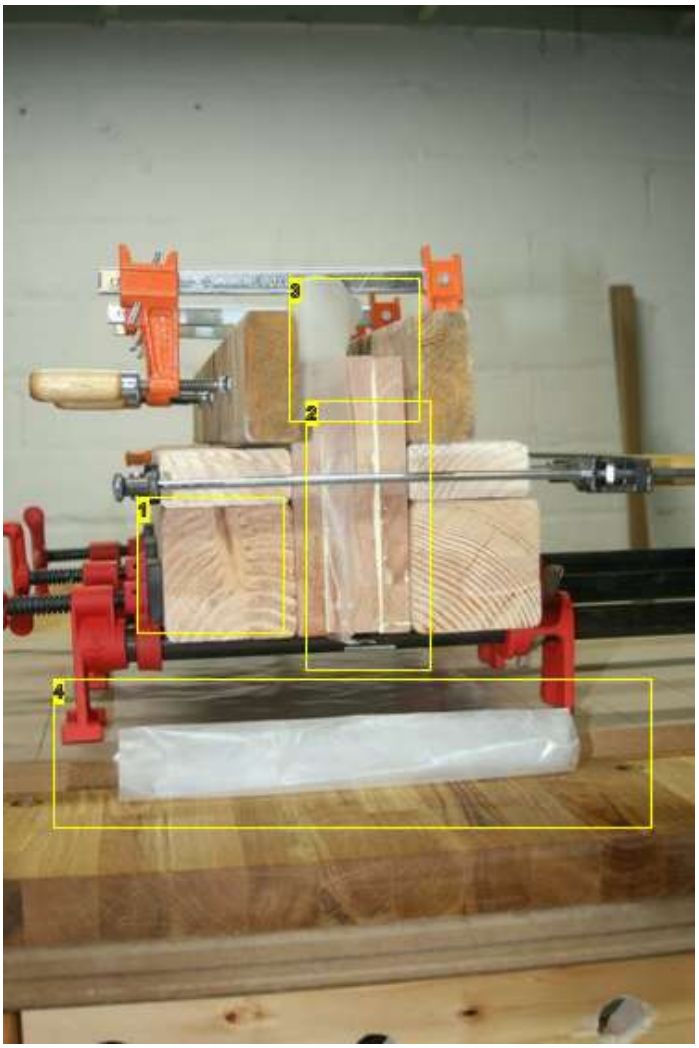


Image Notes
1. I find it fascinating how useful these scrap pieces of 4x4 have proved to be
2. I got a lot of squeezeout on this one - I did use too much glue
3. Board - glue - board - wax paper - board - glue - board
4. Waxpaper underneath

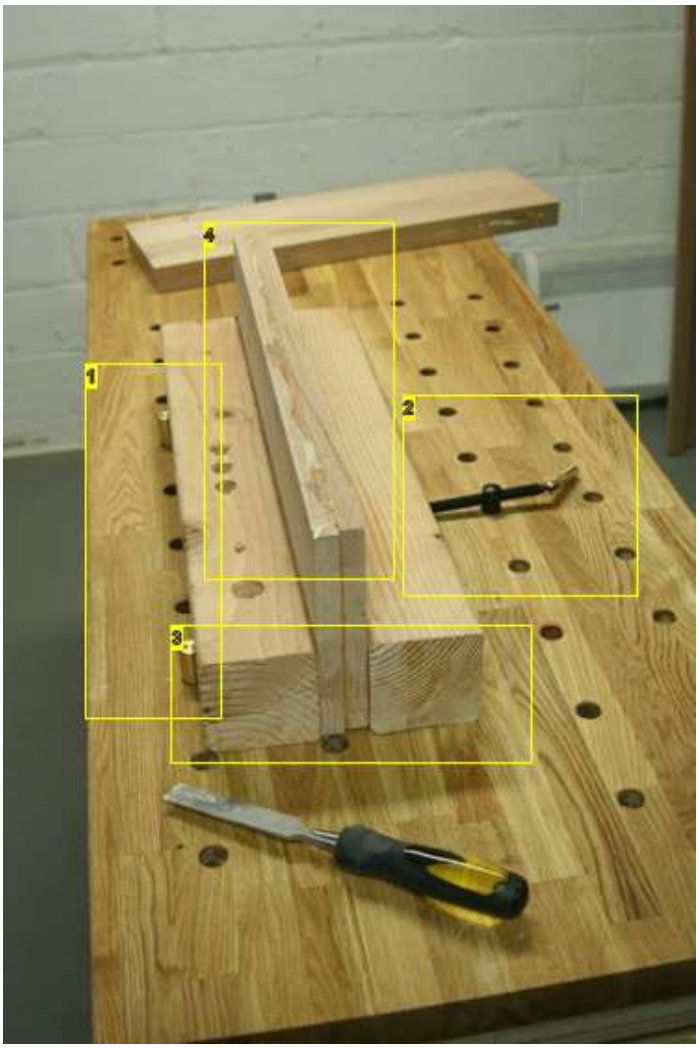


Image Notes
1. ... two benchdogs ...
2. ... one Wonder Dog ...
3. ... those same two scraps of 4x4 ...
4. ... make a pretty decent vise to hold the boards while I remove the dried squeezeout

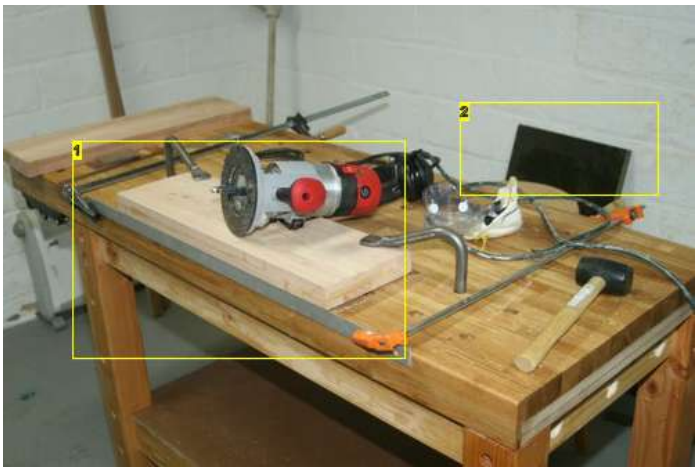


Image Notes
1. Trim the bottom edge of the jaw. That's a metal rule clamped against the bench - the edge of the bench is straight, but not quite smooth (pin knots, etc.). The rule evens things out. The result isn't perfectly flat, but it's close enough for what we're doing.)
2. This is an inch-thick granite tile that we found behind the garage when we moved in - thought it might make a good bed for Scary Sharpening.

Step 30: The vises, step four - cutting and drilling the jaws

Now that we have our material for the vise jaws prepared, cut it to length plus a margin for error.

Clamp the inner jaw of the end vise in position, leaving a little bit to trim off later, and then use the dowel and dowel center trick through the screw and guiide rod holes of the vise base plate to mark the position of the screw and guide rod holes in the jaw. Remove the jaw and drill 1-1/8" holes in the marked positions. I used the drill guide for most of the holes, and drilled freehand for the last bit. When you're starting a spade bit in a deep hole like this, start the drill very slowly, and the bit will move the drill into a perpendicular position. Start it too fast and the bit will bind and you'll damage the sides of the hole.

Do a test assembly of the vise, and see how things fit. The moving part of the vise should move freely. If it binds somewhere, you'll need to identify where and widen the appropriate hole.

If the holes of the first jaw are in the proper position, drill holes in the same locations on the other jaw. I lined the drilled jaw on top of the undrilled jaw, clamped things down, and then drilled about 1/4" into the undrilled jaw, to mark the location. Then I removed the drilled jaw and drilled out the marked locations the same way I did the first.

The jaw for the front vise is prepared the same way,. except there is only one jaw, the dowel is 3/4", and the spade bit is 7/8" or 15/16".

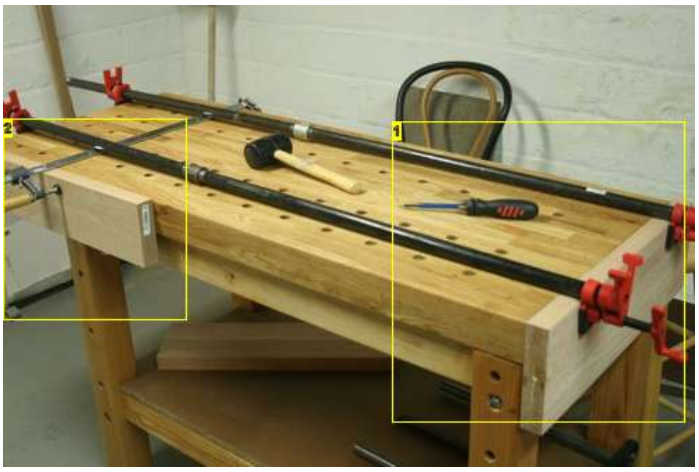


Image Notes
1. Clamping the jaws in position to mark the hole locations (make sure the top edge of the jaw is proud of the top by just a bit)
2. Haven't cut this board to length, yet

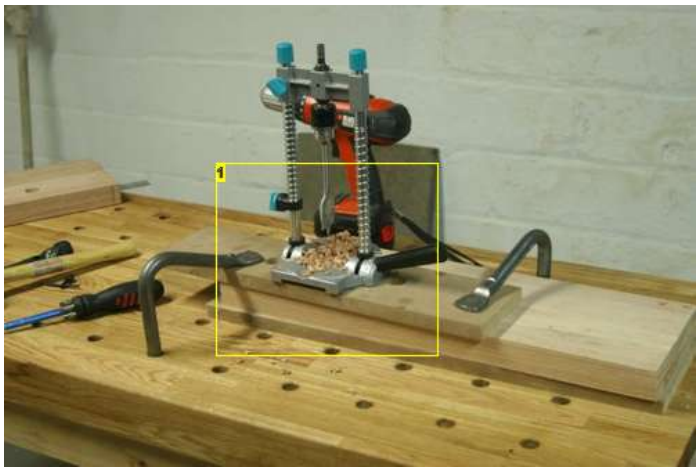


Image Notes
1. Drill most of the hole with the drill guide

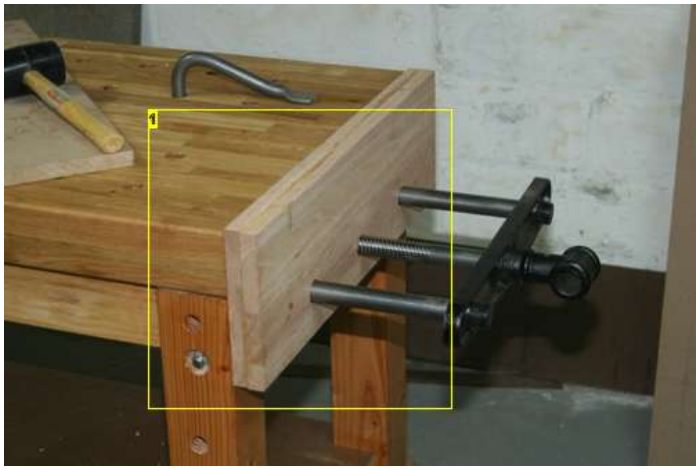
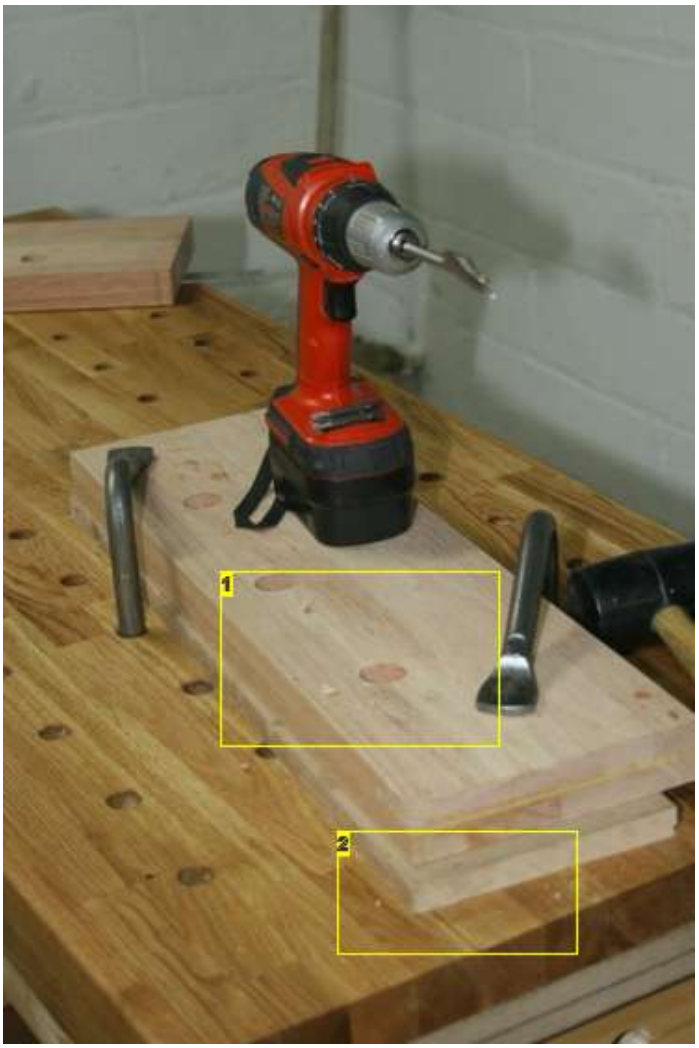


Image Notes
1. Check for fit and freedom of movement



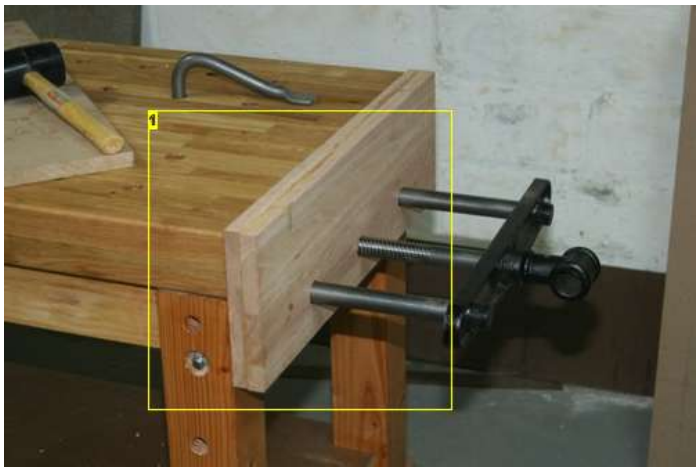


Image Notes
1. Finish the holes free-hand
2. Sacrificial scrap of 3/4" MDF underneath - don't drill into the top

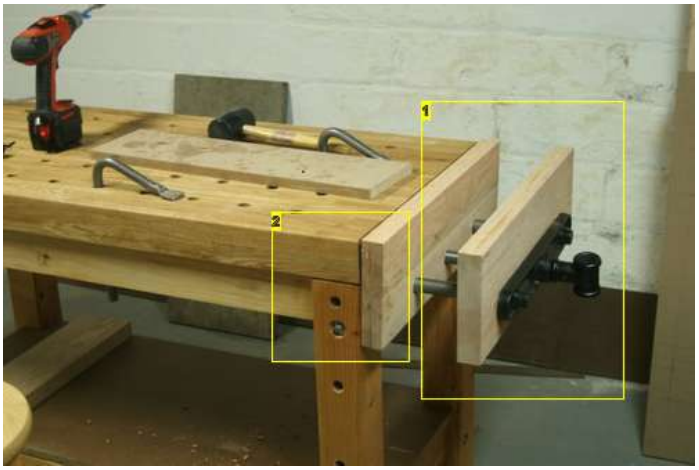


Image Notes
1. If the fit of the first jaw is good, drill holes in the same locations in the other jaw, and test fit again
2. Note that the jaw extends just a bit above the top and beyond the top on each side. We'll trim the jaws flush in the next step.

Step 31: The vises, step five - bolting and routing the jaws

One you have the vise jaws shaped so that the vise moves freely, mark and drill holes in the fixed jaw for the bolts that will hold it to the bench. With these drilled, reassemble the vise and mark the location of the holes with an awl. Disassemble the vise and drill the holes through the stretcher, then reassemble the vise and bolt the inner jaw in place.

With the inner jaw fastened to the bench, I used the router to flush-trim the jaw to the benchtop, across the top and down the sides adjacent to the top (stopping short of the discontinuity between the top and the legs). I'd thought this would be the best way to match up the jaw against the top, but I'd not do it this way again. It was very difficult to hold the router tight against the face of the jaw, and the result was a surface that wasn't as even as I had hoped.

Mark and drill the holes and countersinks that will hold the outer jaws to the vises (for both the front and the end vise).

Remove the jaws and route the edges that you could not route while they were still attached. Then use a roundover bit on all of the corners except the inner edge of the inner jaw of the end vise. Give everything a lite sanding, and apply Danish oil to the inner surfaces of the jaws. (By "inner surfaces", I mean those surfaces that will not be accessible when the vises are assembled - the inner surface of the inner jaw, that bolts to the bench, and the outer surfaces of the outer jaws, that bolt to the vise plates.)

Assemble the vises, for the final time. You'll not be taking them off again, so tighten everything down, and attach the endplate to the ends of the screw and guide rods. Then mark and drill benchdog holes in the outer jaws inline with the benchdog holes in the top. Generally, through-holes are preferred for benchdogs, so that they don't collect sawdust and gunk. With these vises, that isn't possible, there are screws and guide rods in the way. I drilled them just deep enough to hold a Veritas Bench Pony (their reduced-height benchdog), without it sinking to where I can't get a grip to remove it. Rockler sells some very inexpensive plastic benchdogs that can't be adjusted for height, and aren't as strong as metal or wooden dogs, that I intend to keep in the holes full-time, to keep sawdust from collecting in them.

With the holes drilled, finish them with a few coats of Danish oil.

Finish the whole thing up by applying a coat of paste wax to the top.

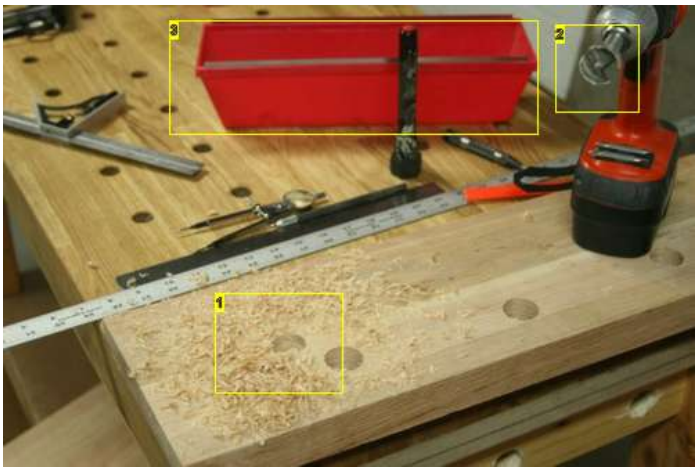


Image Notes
1. Mark the locations for the bolts, drill countersinks, then drill through holes (I'm using 5/16" bolts, with 1" countersinks and 11/32" through holes)
2. 1" Forstner bit for drilling countersinks
3. This is a drywall joint compound tray I'm using to hold my bolts, washers, and nuts

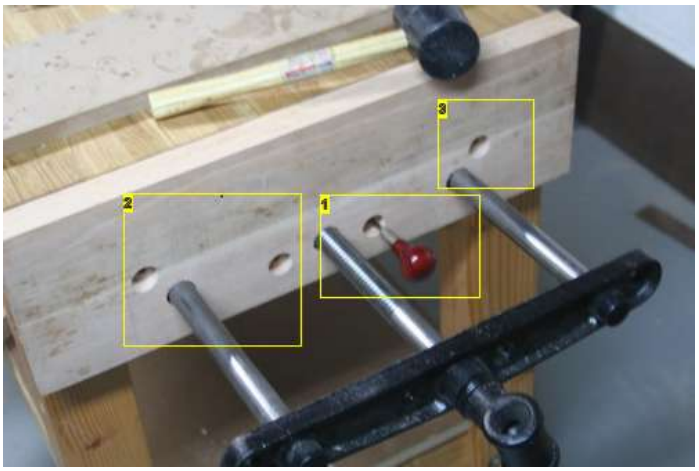


Image Notes
1. Mark position of the bolts on the stretcher - use the awl to scratch a circle
2. Four bolts hold it on - two in the upper corners, and two towards the middle at the bottom of the stretcher (just high enough to clear the 3/8" rod that runs across the bottom of the stretcher)
3. The top corner bolts are positioned 3/4" below the bottom of the top and 3/4" in from the inner edge of the leg - as close to the outer corners as we can manage

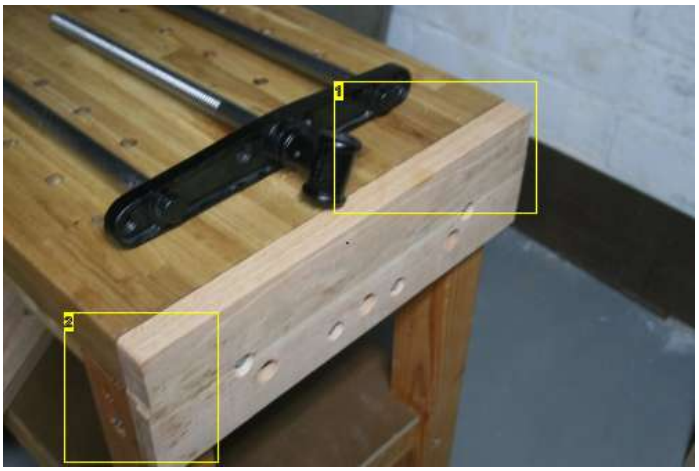


Image Notes
1. Bolt the jaw to the bench, then route the edge to match the top
2. I only routed along the edge of the top, I don't want the edge of the jaw to follow the discontinuity between the top and the leg.

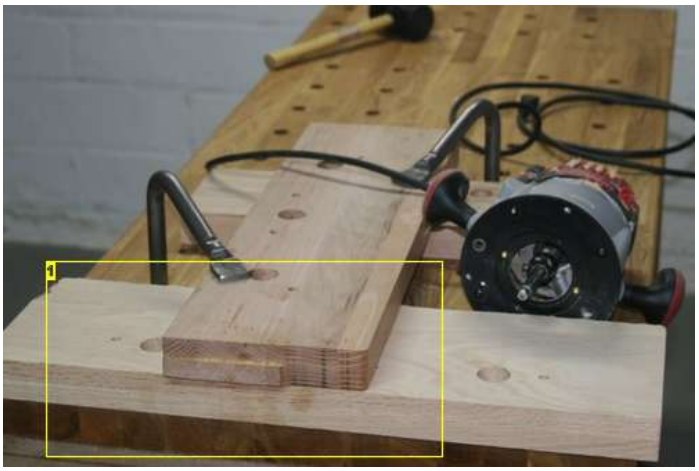


Image Notes
1. Route the edge straight

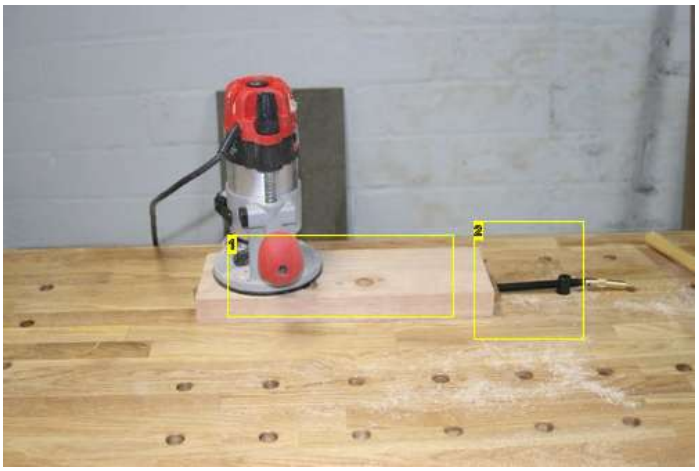


Image Notes
1. Roundover the corners
2. Benchdogs can hold the work without getting in the way of the router

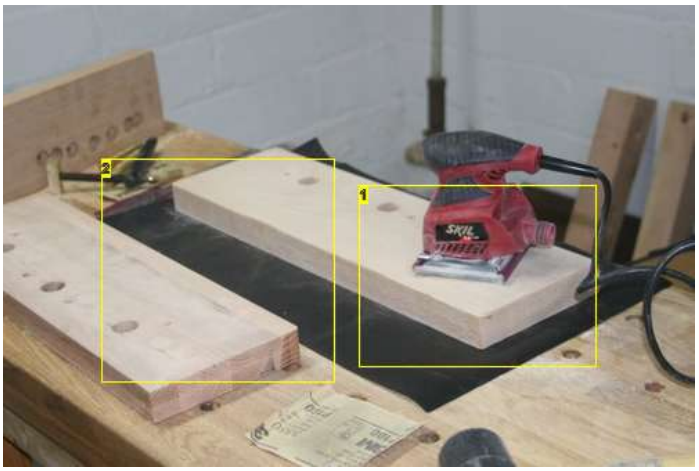


Image Notes
1. A light sanding
2. With a palm sander, all you need to hold the work is a bit of rubber drawer liner

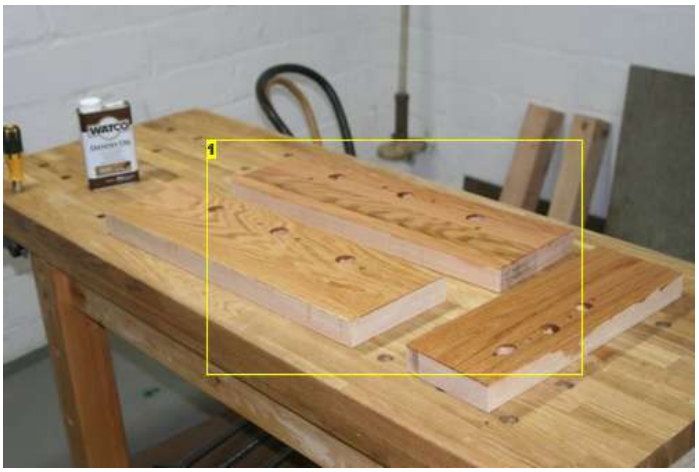


Image Notes
1. Danish oil on the surfaces that can't be reached while the vises are assembled

Image Notes
1. Benchdog holes in the outer vise jaw should be in line with the benchdog holes in the top

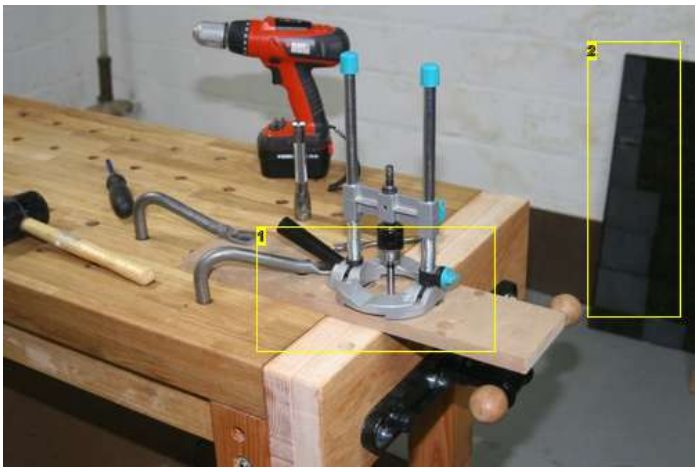


Image Notes
1. Drill out the benchdog holes
2. Stick-on wet-dry sandpaper for Scary Sharpening (which has nothing whatsoever to do with this instructable)

Image Notes
1. Oil the vise jaws, the vise handles, and as long as we're at it, put another coat on the top