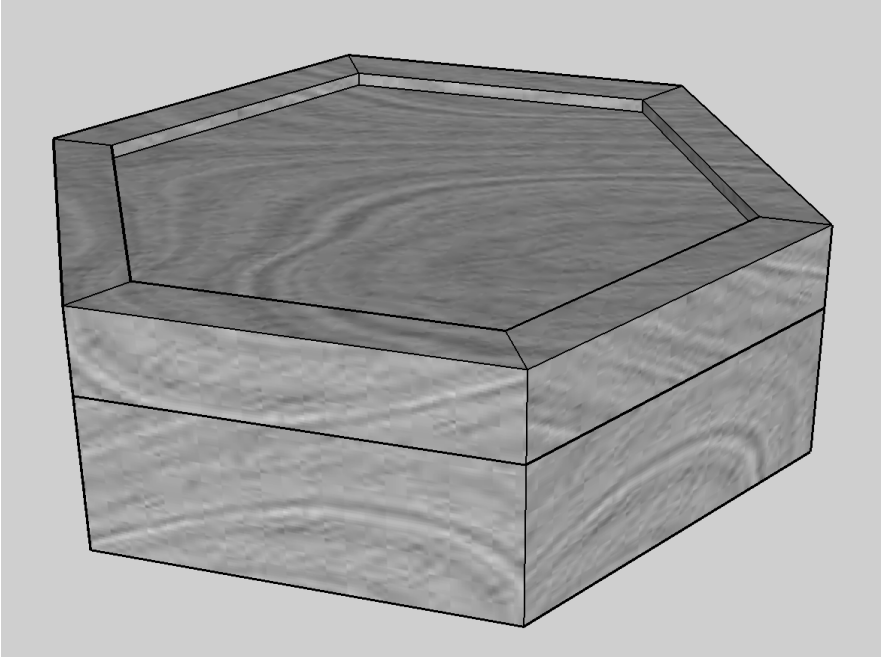
Let’s Make a Hexagonal Gift Box!

A Woodworking Module by Anna Lugthart



IMPORTANT SAFETY INFORMATION

Table saws, if misused, can be very dangerous. One thing that makes the saw more difficult to use than a bandsaw, for example, is the fact that the back of the blade is moving upwards, and many times the workpiece must be pushed past it. Because of this, the saw has a tendency to lift the workpiece, which can result in throwing it and/or pulling your hand into the saw. Below are a few pointers for using the table saw safely.

1. Make sure the fence and blade are in line. Before using the saw, measure the distance from one tooth to the fence, then rotate that tooth to the other side of the fence and measure it there as well. These two measurements should be VERY close. (at least within 1/32” of each other)
    a. The fence can be adjusted with two set screws near the front.
2. Maintain downward pressure on the workpiece throughout the cut, especially where the workpiece touches the back end of the blade. Using a handheld pusher that extends over the full length of the piece, like the one below, is preferable. Additionally, side pressure into the fence, from a push stick or a featherboard helps keep the piece in line.

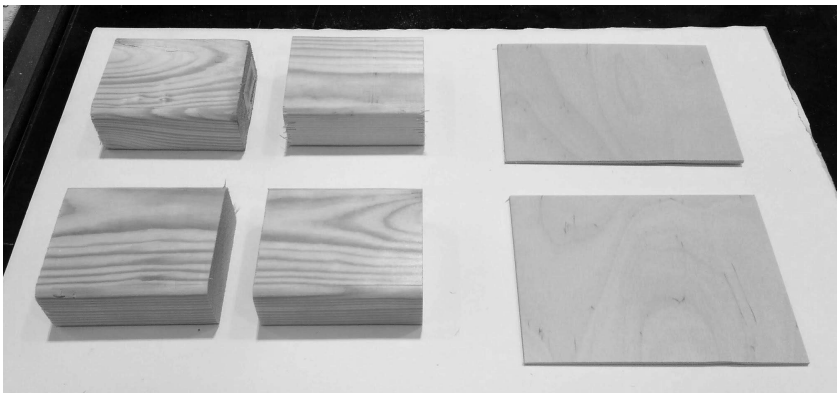
Ripping a board with a pusher

3. If possible, stand clear of the workpiece. This way, if it is thrown by the tablesaw, you won't be along its trajectory.
4. NEVER use the miter gauge (pusher) and fence at the same time. This greatly increases the likelihood of binding a part.
5. Wear safety goggles, closed-toed shoes, tie back hair, don't wear gloves, secure loose clothing, etc.

Part 1: Preparing the Materials

First we'll need some materials cut to starting dimensions. I have these pre-prepared for my demonstration, but you can cut yours on the table saw, chop saw, or even band saw.

1. We'll need at least 4 2x4s, about 4" long, for the sides of the box. We'll also need 2 5⅜"x7" pieces of ⅛" thick plywood for the top and bottom.
    a. Only about 3 of 2x4s will be used up in the box, but we'll use the other piece for test cuts and backup pieces in case we mess up.
    b. If you can't find enough 2x4 lumber, you can cut the pieces out of just about any 4" long piece of wood. Alternatively, you can use nicer materials if they're available. In either case, just make sure you have enough.



Prepped materials for the box

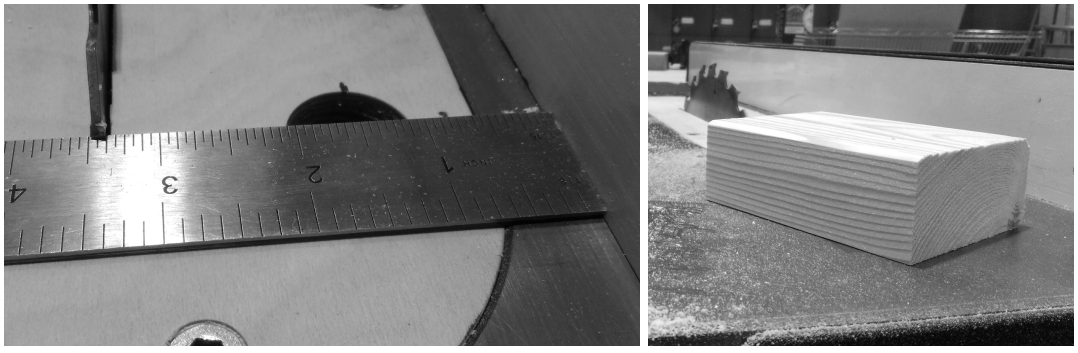
2. Additionally, we'll gather all the tools we'll need for the project. We'll need a combination square, miter gauge, screwdriver, pen/pencil, chisel, angle block (or protractor), 1-2-3 block, as well as some jigs made for this project.

Tools and jigs needed for the project

Part 2: Cutting the Blanks

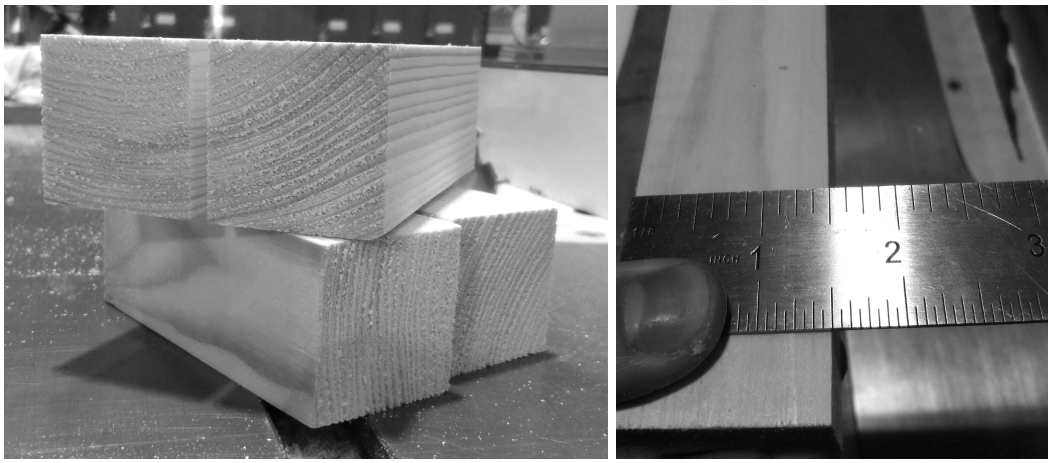
In this part, we'll start with the 2x4s (or whatever wood you're using) and cut them into rectangular blocks of the right dimensions.

1. Before we make any cuts, turn on the fan behind the saw. This will help manage the sawdust, which we'll be making a lot of.
2. Next we need to square up the 2x4s. Set the fence about 3⅜" away from the inside edge of the blade. Run each piece through the saw, exposing fresh wood on one face of each piece.
    a. Set the blade so that the gullets (troughs between the blade teeth) clear the workpiece at their highest point. Adjust blade height as necessary throughout the project.
    b. The goal of this step is to remove the rough outer surface of the 2x4. You can set the fence wherever you'd like to minimize wasted material.



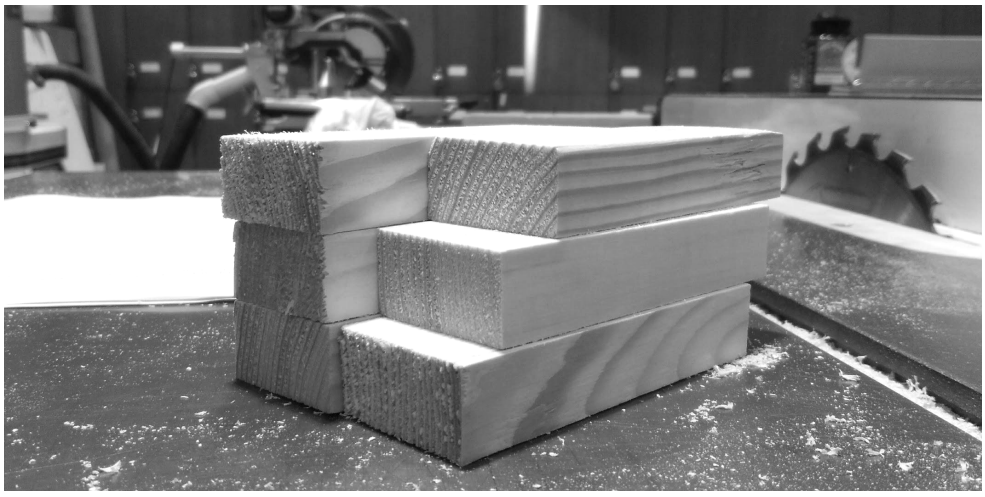
Setting the fence 3⅜" from the fence (left) and a sawn 2x4 (right)

3. Now, set the fence 1½” from the inside edge of the blade. Run one of the pieces through with the freshly cut side against the fence. Repeat with the remaining piece, which should leave you with 2 pieces of wood measuring 1½”x1½”x4”. Repeat this for another 2x4, leaving you with 4 pieces of this size.
    a. These will make up the sides of the base of the box.
    b. The ruler on the table saw can be used to set the fence, but I find a ruler or the depth gauge on a pair of calipers more accurate.
    c. The teeth on a saw blade are typically staggered to reduce friction. Measure the distance between the fence and an inward facing tooth, since this is the inside cutting edge of the blade.



The ripped 2x4s for the box base (left) and checking a block for accuracy (right)

4. Now, set the fence ¾” from the blade. Run the remaining 2x4s through in a similar fashion. You should now have at least 6 pieces measuring ¾”x1½”x4”.
    a. These will make up the sides of the box lid.



The ripped 2x4s for the lid of the box

5. On each piece, there should now be two smooth faces cut by the saw, and two faces with the original exterior of the 2x4. We will now remove one of those faces

in a fashion similar to step 2. Set the fence about 1⅜” away from the blade, and run each piece through, skimming off the original surface of the 2x4.
    a. Like before, you can set the fence wherever you want to minimize waste.
    b. Adjust the blade height to accommodate the two different piece sizes.
    c. There should now be just one original surface remaining on each piece.
6. Now we’ll cut each piece to its final dimension. Set the fence ½” from the inside edge of the blade. Now, with the surface we just cut against the fence (and the original 2x4 surface facing outwards) run a piece through the saw. Then, saw the remaining piece to the same size, leaving the last outside surface of the 2x4 on the drop side of the cut. Repeat for all pieces.
    a. It may be helpful to mark the side you intend to cut off on each piece.
    b. You should now have 8 pieces measuring ½”x1½”x4” and 12 pieces measuring ½”x3/4”x4”. This may seem like overkill, but it’ll be nice to have extra pieces to test on later. (I went through 3 or 4)

The finished blanks

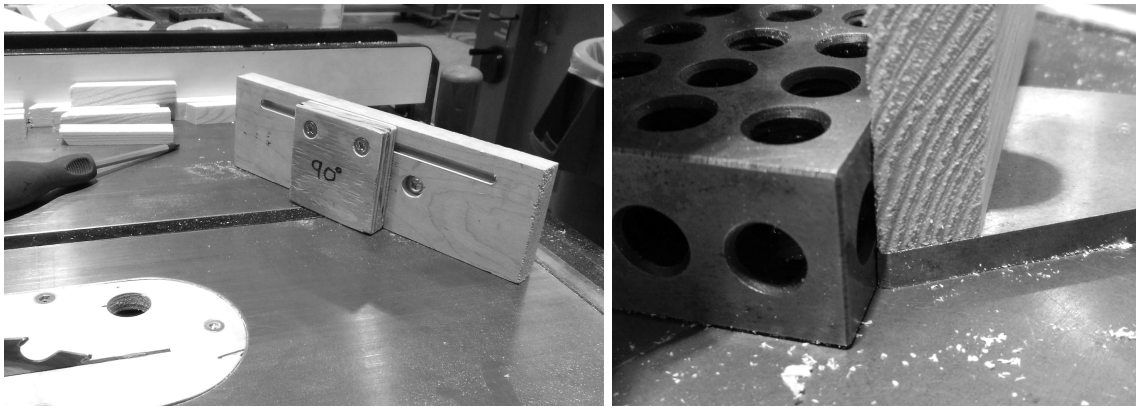
Part 3: Cutting the Pieces to Length

Congratulations! We’re done with the fence (for the moment). You should now have lots of pieces of wood and they should look something like the picture above. Now we’ll take those pieces and cut them to length on an angle so they form two stacking hexagons: a base, and a lid.

1. Before we do any cutting, we need to set the miter gauge to 30º. This is the angle that will form the pieces into a hexagon. This can be done using a protractor or an angle block and 1-2-3 block, as shown below.

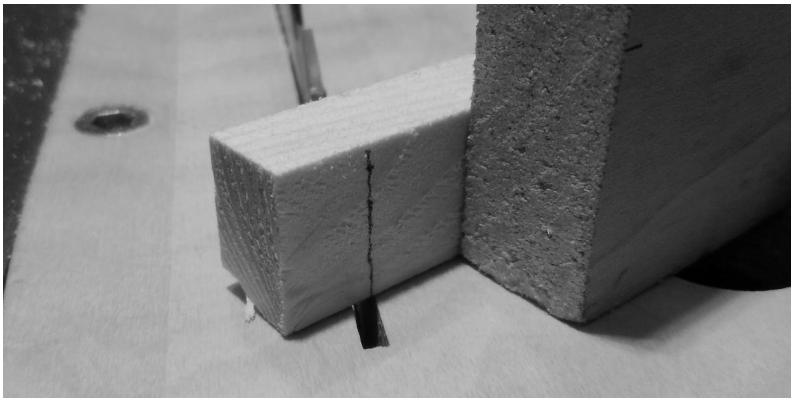
Setting the miter gauge to 30º with an angle block. The fence, which we verified to be parallel to the blade, is referenced.

2. With the miter gauge set, we will now cut one side of each piece to 30º. Attach the 90º length stop jig to the miter gauge, such that the back edge of the 4” workpiece lines up with the saw blade, as shown below, and a clean 30º cut will be made without leaving a flat on the corner.



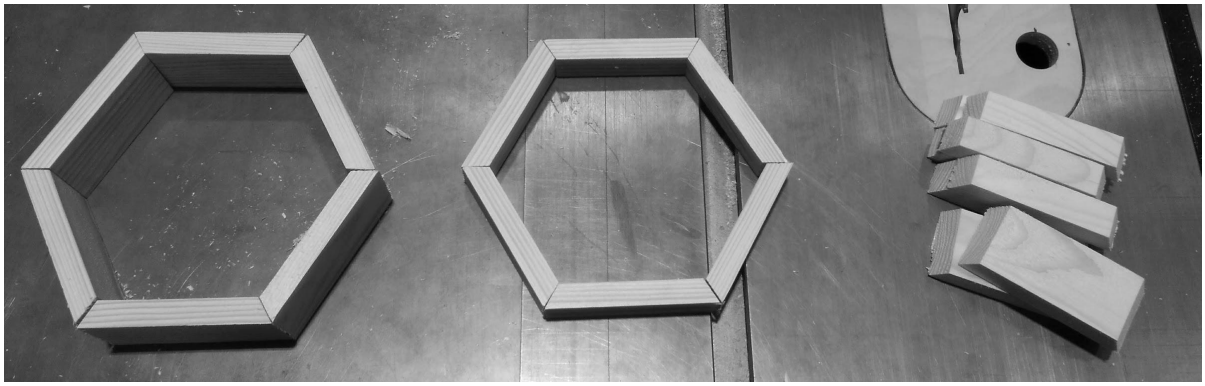
The 90º length stop (left) and the resulting cut (right)

3. Now make one 30º angle cut on each piece of wood, (including test cut pieces) making sure that the piece sits tall, not flat, against the miter gauge.
4. Now, remove the 90º length stop and attach the 60º length stop to the miter gauge. This part is a little tricky, because we want to set it such the piece is cut to the right length without having any easy way to measure the cut.
    a. I suggest marking out the desired length (3½”) on the piece with a pencil and using that to line up the jig on the miter gauge. Once it’s lined up, clamp it to the gauge and cut one of the test pieces.



Testing the cut

5. Measure the test piece. As long as it's within about 1/8", it should assemble, but, if you wish, you can make micro-adjustments and try them out on the test pieces.
    a. As long as the length stop is securely mounted, the side pieces will all be the same length and should assemble into hexagons of equal size no matter what length they're cut to. The main assembly constraint here is the dimension of the plywood panels, which fit into the center of the hexagon. If worst comes to worst, we can alter those later to fit.
6. With the length stop set, make the second 30º angle cut on each piece. Now the pieces should assemble into two hexagons, like in the image below.



Top and bottom hexagons and extra pieces

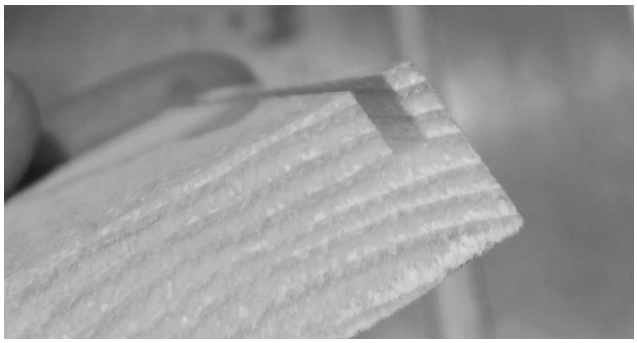
Part 4: Shoulders and Grooves

In order to assemble, the top and bottom panels slide into an ⅛" wide, ¼" deep groove in the side pieces, and the lid and box have corresponding shoulders which seat into each other to hold the box together. Now, with the side pieces otherwise complete, we'll add these last features to finish them off.

1. We'll start by cutting the grooves. All of these are located on the inside faces of the pieces. The bottom edge of the groove should be ⅛" away from one side of

the piece, as shown below. First set the blade height somewhere between 5/32" and 3/16". (You can try this out with a test piece) Then set the fence ⅛" from the inside edge of the blade. Run each piece through, making sure the inside face is against the table.

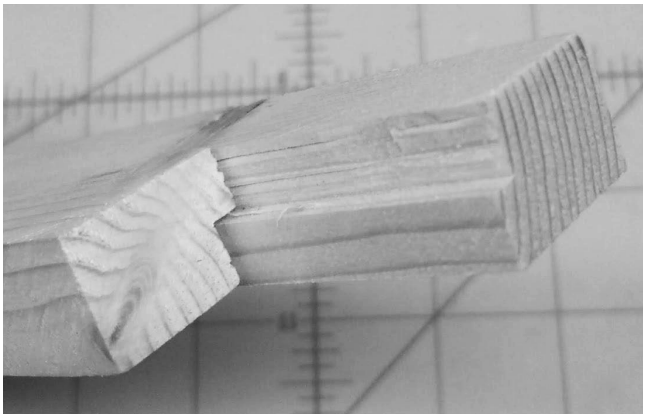
   a. For the bottom of the box, the groove will be on the bottom, and for the box lid, it will be on the top. However, since the pieces are still symmetric, it doesn't matter which side you cut the groove into.
   b. A groove exactly 3/16" deep would fit the hexagonal plate perfectly. But, leaving extra space allows some room for error and glue.



The groove, cut ⅛" from the edge and a little less than 3/16" deep.

2. Try to test fit your plywood into the groove. It should fit snugly, but without deflecting the wood above the groove. If it's too tight, bump the fence slightly away from the blade, run your piece through and test again. You may need to repeat this multiple times and you may mess up a few test pieces, but once it's at the right setting, run each piece through to widen the groove.
   a. Before continuing to the next step, test fit each piece. Chances are, they won't all be the same. If any are still too tight, run them through again, without moving the fence. This should loosen them somewhat.
3. Now we'll cut the shoulders. Set the blade height low, at about ⅛". Set the fence ¼" away from the far side of the blade. Run a test piece through with the normal pusher, then again with the ⅛" spacer. A strip of ⅛" plywood works well.This should form a ¼" wide shoulder. Repeat with another test piece, but face it in the opposite direction. Shave off any tags or excess material with a chisel or a box cutter, and fit the two pieces together. Ideally, when shoulder touches shoulder, they line up perfectly. If not, you can micro-adjust the fence until they fit.
   a. Too narrow a shoulder means the pieces will have play, and too broad means the pieces won't fit. If you don't mind doing some sanding later, you can leave the shoulders a little wide on purpose and sand them down to size later, but I find it's worth the effort to get it as close as possible at this step, as you'll save yourself a lot of time later.

    b. If you want a cleaner cut, you can use a dado stack for this step. Since we won't need it again, and changing blades on the Saw-Stop is somewhat involved, I won't do it for the demonstration.
4. With the fence set to the right height, we can now cut shoulders on all the pieces the same way we did on the test pieces. Just make sure you remove material from the outside edge for the bottom (taller) pieces, and from the inside edge for the top (shorter) pieces. Otherwise they won't fit!

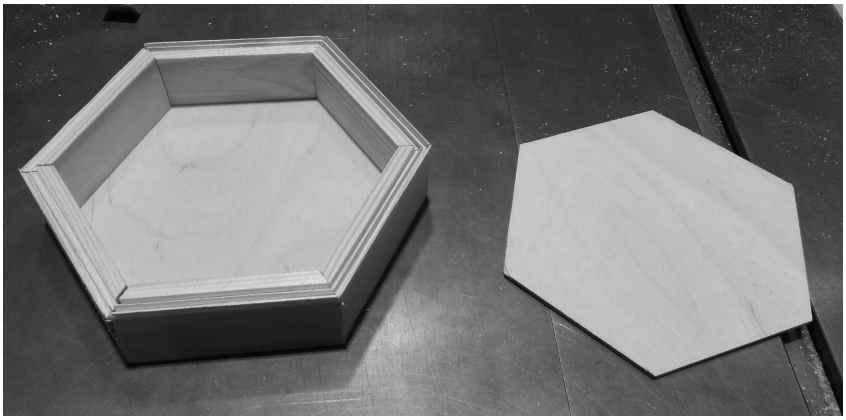



Shaving off the tags with a chisel (left) and grooved pieces shoulder to shoulder (right)

Part 5: Faces

The last pieces to cut out are the faces. They're just two plywood hexagons, and while you could cut them on the bandsaw (or laser cutter), I'll use the table saw.

1. First, trace out the hexagon on each piece of plywood using the template in the back of this packet. Two edges should already come flush against the sides.
2. Now, you should be able to cut the remaining four sides on each hexagon using the miter gauge, again set to 30º.
    a. If you can, try to remove the line without taking away much more, leaving the hexagon just barely under dimension. This will help with assembly.
3. Now, you should have all the pieces. Test fit them dry to see if any adjustments need to be made. If not, you're ready for the glue-up!
    a. Be careful with the wood under the groove when assembling. Since there's only an ⅛" of material holding it in place, it's very easy to snap it off. Once glued, it will be stronger.

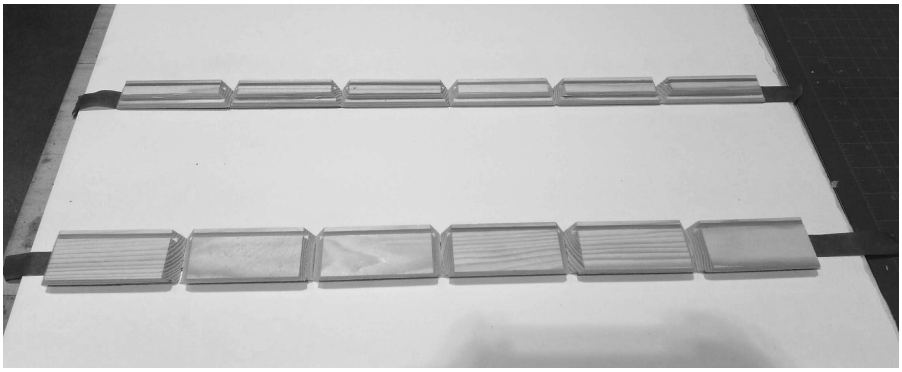


Dry fitting

Part 6: The Glue-Up

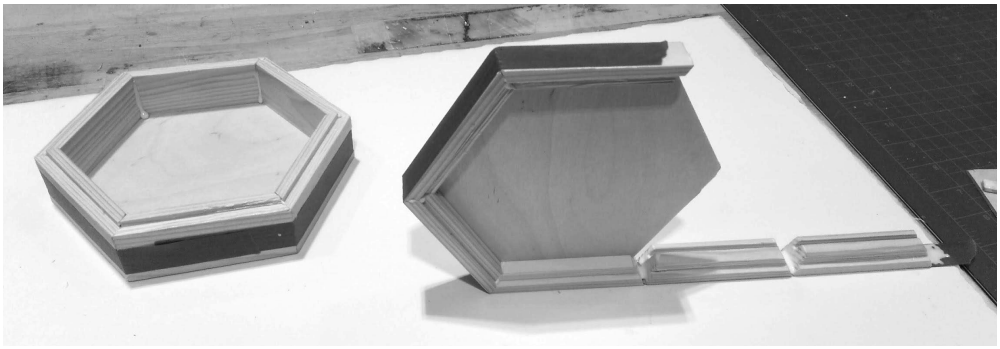
It's all coming together, literally.

1. Since a hexagon is difficult to hold with traditional clamps, we'll need to get a little creative. Take a long strip of masking tape and lay the pieces end to end, ensuring they sit firmly against each other. Let the tape stick out on one side.



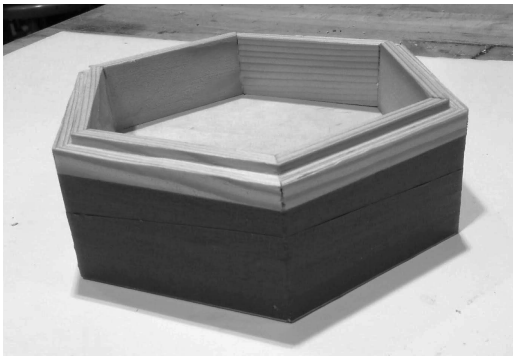
Pieces laid end to end (I messed up and left the tape long on both ends)

2. Now, apply glue to each mating face with a stick or a small paint brush, making sure to spread it evenly over the entire surface.
    a. As tempting as it may be to lay a bead of glue down in the groove, we don't need to. The side pieces will hold the box together, and letting the plates float will allow expansion to occur without damaging the box.
3. Now, assemble the side pieces around the hexagonal plate, and wrap the loose end of tape around to hold everything together. Wipe any excess glue off with a damp cloth or paper towel. (it's easier to get it before it dries)

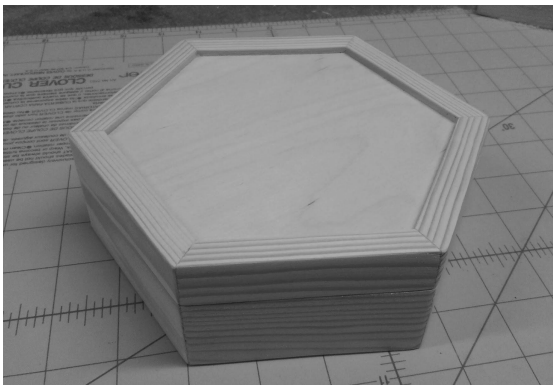


Assembling the box

4. To ensure the top and bottom dry in (roughly) the same shape, stack them together and tape around them. I recommend placing them faceplate to faceplate and leaving the shoulders exposed, since the pieces may stick together.



5. Let the glue dry according to the instructions on the back.
6. After the glue is fully cured, (usually between 12 and 24 hours) use a chisel and rough grit sandpaper (80 or 100 grit work nicely) to remove any excess glue. Also, test fit the lid onto the base of the box, and sand the bottom shoulder as needed to fit them together.



Part 7: Staining (Optional)

You now have a fully functional box, and can stop here if you want to. But, staining and oiling will make your box look way cooler, and (oiling) will make it water resistant as well.

1. First, sand the box with 120 grit, followed by 180-200 grit sandpaper.
    a. If you can't find 120, you can just use the higher grit. It just means you'll have to sand for longer.
2. In the paint booth, apply the stain of your choice to the box. (Stains can be found in the yellow flammables cabinet next to the waterjet). Apply an even coat of stain with a rag or paper towel and let dry according to instructions on the container.
    a. You may want to use latex gloves so as to not stain your hands. These can be found in the cabinets on the wall opposite from the paint booth.

Part 8: Oiling (Also Optional, but Looks Cool)

This is where you can really make your box pop. Oiling accentuates the grain patterns in wood and makes it water resistant. If you just want to bring out the natural look of the wood without changing its color, oiling without staining is a good way to do that. Oiling after staining also looks really cool.

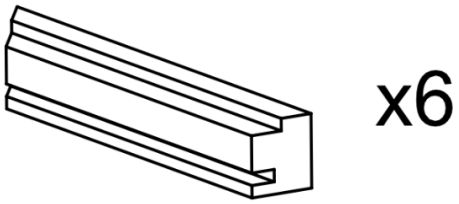
1. We'll oil the box with linseed oil (which can also be found in the yellow flammables cabinet by the waterjet). This method involves sanding oil into the wood. (Credit to Heidi for teaching me this method)
2. First, sand the whole box with 220, followed by 320 grit sandpaper.
    a. There's nothing magic about these specific numbers, so if you can't find them, just use the closest grit you can.
    b. Be mindful of oversanding the shoulders where the lid and base meet, as this can loosen the fit and create unsightly gaps.
3. Apply some linseed oil to a pad of 400 grit sandpaper and sand the box thoroughly, reapplying oil periodically. Wipe off the excess oil with a rag and let sit for at least 4 hours.
4. (Optionally) Apply linseed oil with 600 grit sandpaper in a similar fashion. Wipe off excess and let sit for at least 8 hours.
5. Continue to wipe off any extra oil on the box daily. This could take up to 4 days, but usually it's done after 1 or 2.

Congratulations, you made an awesome box! I hope you had fun and learned something along the way. Please come show it to me and gloat! And if you have any feedback or pointers relating to this module, send that my way, too.

Notes:

1. India Ink can be used as a stain that turns the wood black but still lets you see the grain.
2. Paste wax can be applied after oiling for a more glossy finish.
3. Instead of oiling, you can add a top coat like polyurethane.
4. I've only ever gotten box lids to fit in one orientation. If yours fits in all six, that's really cool (but don't worry if it doesn't)

Parts:



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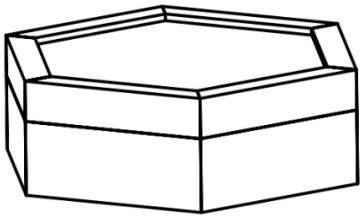

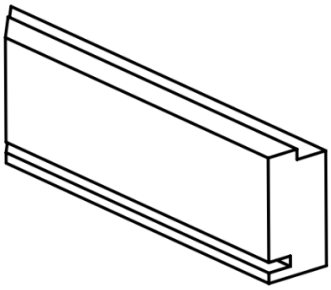

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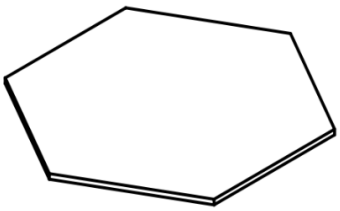

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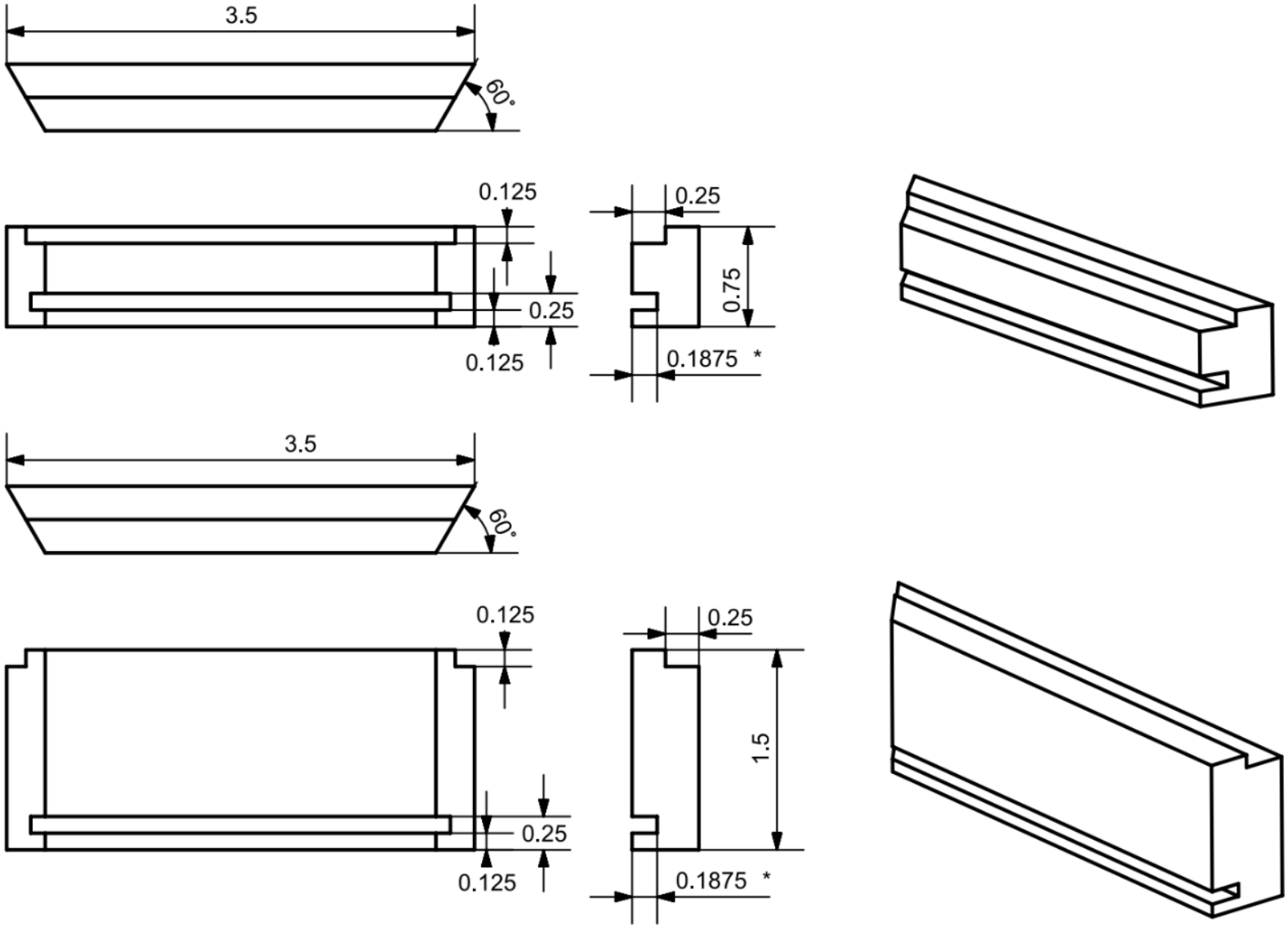
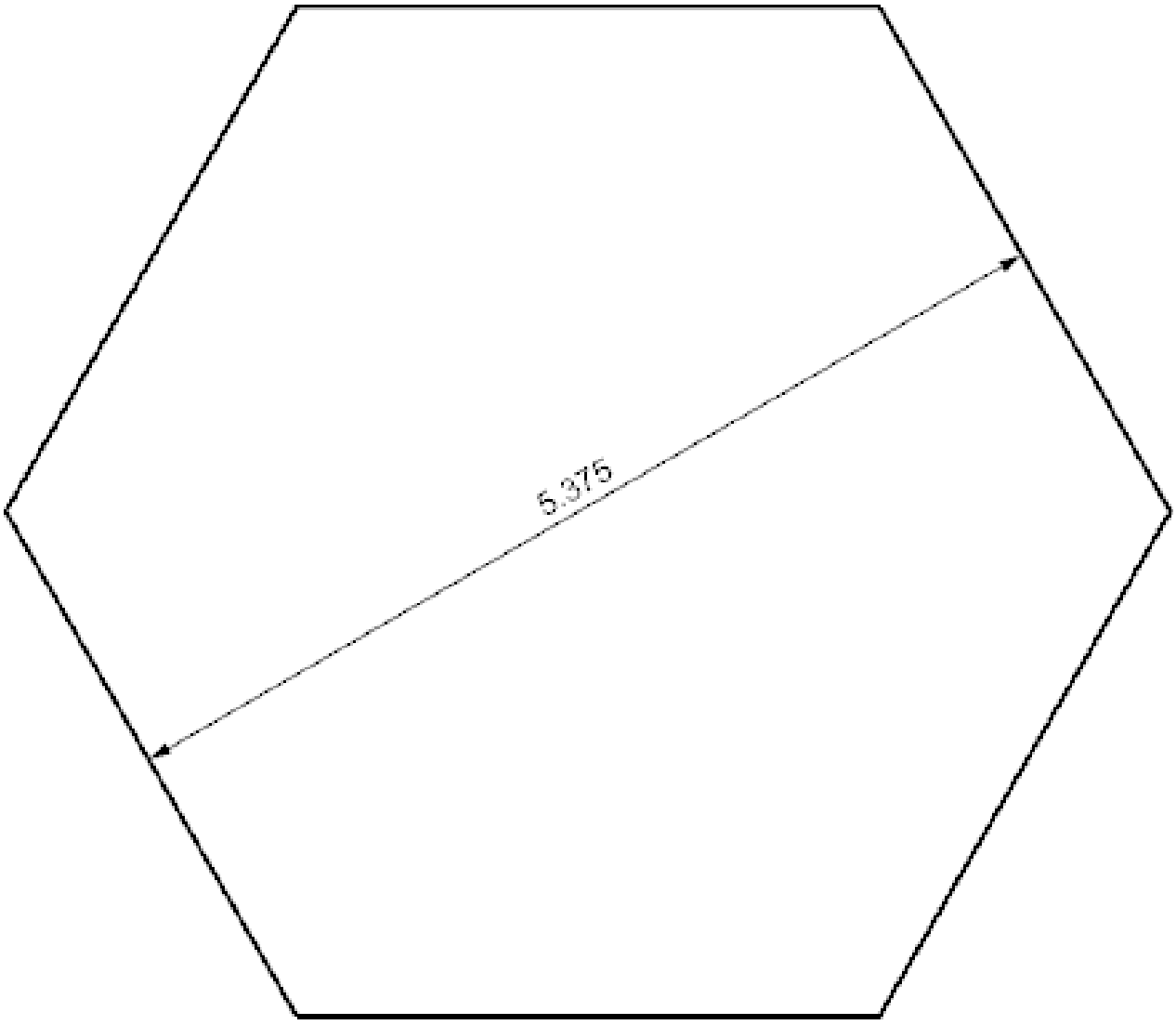


*See Instructions for details



(Actual Size)