

## TECH TIPS

### Square-Ended Tenons on the PantoRouter

As most PantoRouter® owners have discovered, perfect fitting integral mortise and tenon joints can be cut faster on the PantoRouter® than any other method in the shop.

Between the Essential Template set and the Segmented Mortise and Tenon Template set, over 180 sizes can be cut with ease. The only caveat is all of those sizes have rounded ends on the mortise and tenon. Structurally, this is insignificant but occasionally when building certain styles of furniture with through tenons a square-ended tenon looks and feels more appropriate. Using the Segmented Mortise and Tenon Template set and selecting the square template ends, an additional 77 sizes of Square-ended mortise and tenons can be cut. These require a bit of hand work with a mallet and chisel but the PantoRouter® gives you a big head start and some of the tricks shown in this Tech-tip will make the process even easier.



**Segmented Mortise and Tenon Templates for the PantoRouter™**

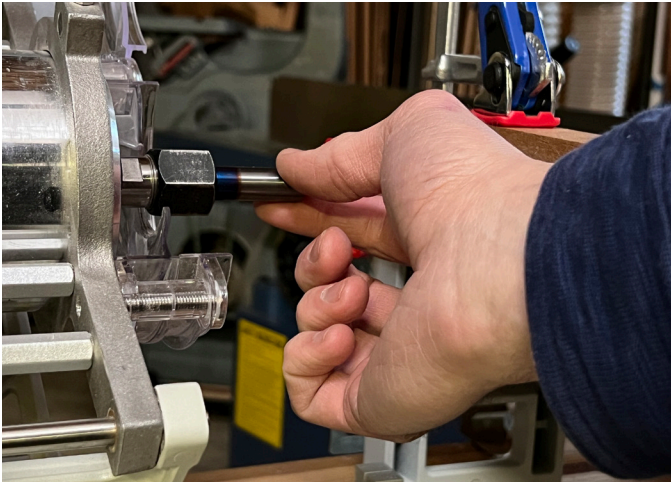
Mortise Bit Size Guide Bearing	1/8" M&T		1/4" M&T		5/16" M&T		3/8" M&T		1/2" M&T		3/4" M&T		1" M&T		Segment Combinations		
	6mm	10mm	12mm	15mm	18mm	22mm	25mm	30mm	35mm	40mm	45mm	50mm	55mm	60mm	65mm	70mm	
Mortise and Tenon Width (Rounded to 3/16")	3/4	7/8	15/16	1	1 1/8	1 3/8	1 5/8	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8	1 7/8	
	1 1/4	1 3/8	1 7/16	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	
	1 1/2	1 5/8	1 11/16	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	1 3/4	
	1 3/4	1 7/8	1 15/16	2	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8	2 1/8
	2	2 1/8	2 3/16	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4	2 1/4
	2 1/4	2 3/8	2 7/16	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2	2 1/2
	2 1/2	2 5/8	2 11/16	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4	2 3/4
	2 3/4	2 7/8	2 15/16	3	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8	3 1/8
	3	3 1/8	3 3/16	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4	3 1/4
	3 1/4	3 3/8	3 7/16	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2
	3 1/2	3 5/8	3 11/16	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4	3 3/4
	3 3/4	3 7/8	3 15/16	4	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8	4 1/8
4	4 1/8	4 3/16	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	
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4 1/2	4 5/8	4 11/16	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	
4 3/4	4 7/8	4 15/16	5	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	
5	5 1/8	5 3/16	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	
5 1/4	5 3/8	5 7/16	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	
5 1/2	5 5/8	5 11/16	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	
5 3/4	5 7/8	5 15/16	6	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	
6	6 1/8	6 3/16	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	
Mortise and Tenon Width (Rounded to 3/8")	3 3/4	3 3/8	3 7/16	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	
	4	4 1/8	4 3/16	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	4 1/4	
	4 1/4	4 3/8	4 7/16	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	4 1/2	
	4 1/2	4 5/8	4 11/16	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	4 3/4	
	4 3/4	4 7/8	4 15/16	5	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	5 1/8	
	5	5 1/8	5 3/16	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	5 1/4	
	5 1/4	5 3/8	5 7/16	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	5 1/2	
	5 1/2	5 5/8	5 11/16	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	5 3/4	
	5 3/4	5 7/8	5 15/16	6	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	6 1/8	
	6	6 1/8	6 3/16	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	6 1/4	
	6 1/4	6 3/8	6 7/16	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	6 1/2	
	6 1/2	6 5/8	6 11/16	6 3/4	6 3/4	6 3/4	6 3/4	6 3/4	6 3/4	6 3/4	6 3/4	6 3/4	6 3/4	6 3/4	6 3/4	6 3/4	

\*Note: On the 5/8" and 5/4" round-end M&T and the 5/8" square end M&T, there is not a centering hole. Align the ends to be equidistant from center using a square for these sizes.  
 ● indicates the round-end pieces with the circle mark. Using these together makes a 2" wide M&T x 1/2" thick (other sizes according to the chart above).  
 ▲ indicates the round-end pieces with the triangle mark. Using these together makes a 1 1/2" M&T x 1/2" thick (other sizes according to the chart above).  
 ■ indicates the square-end pieces. Using these together makes a 1" M&T x 1/2" thick. The tenon will have square ends.  
 The square-end templates do not have steps in the mortise slot since these will always be through M&T and the ends of the mortise will need to be squared with a chisel.



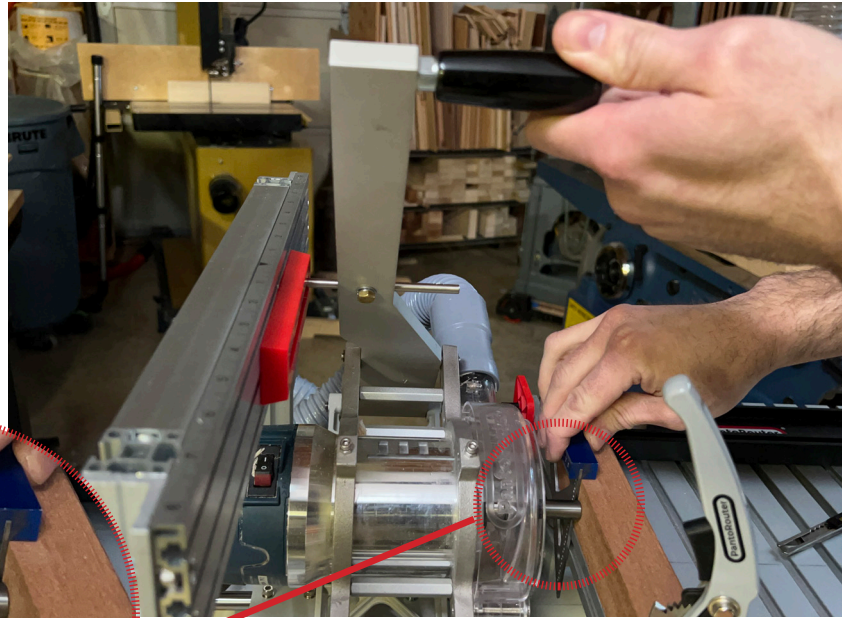
Consult the segmented mortise and tenon chart provided with the template set or on page 37 of the how-to guide to determine which template sections will be used for the desired tenon size. The lower section is for square-ended mortise and tenons. In this example, we will be cutting a 1/2"x 2-5/8" tenon so we will use the 1-1/2" template section with the two square ends. Center the middle template section using a 6mm guide bearing shaft and the centering holes in the template section and template holder. Note that the square ends do not have the same steps at the ends of the interior mortise slot to adjust mortise width, this is because the only situation you would cut a square-ended tenon would be a through tenon which would mean the innermost step would be used creating a perfect fit side to side.



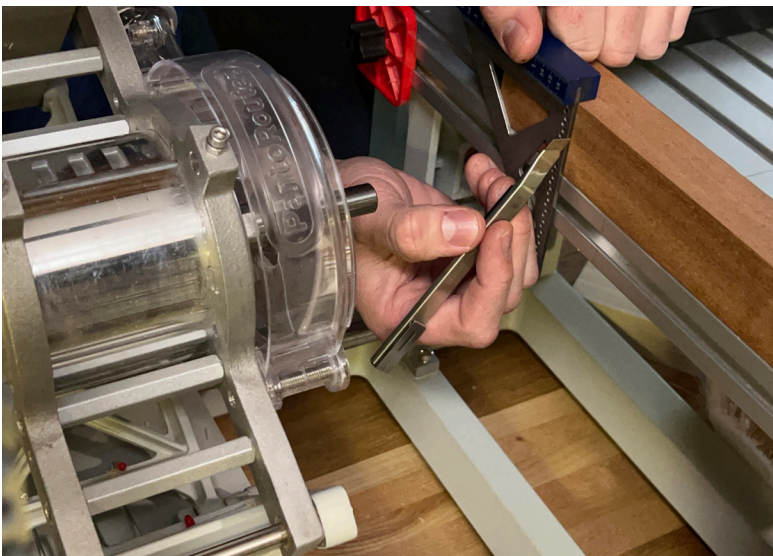


Begin by unplugging the router. Select the correct diameter bit for the mortise, in this case 1/2" and gently place the cutting end of the bit into the collet so the blunt shank is protruding out. Lightly hand-tighten the collet until just snug so the cutters are not damaged.

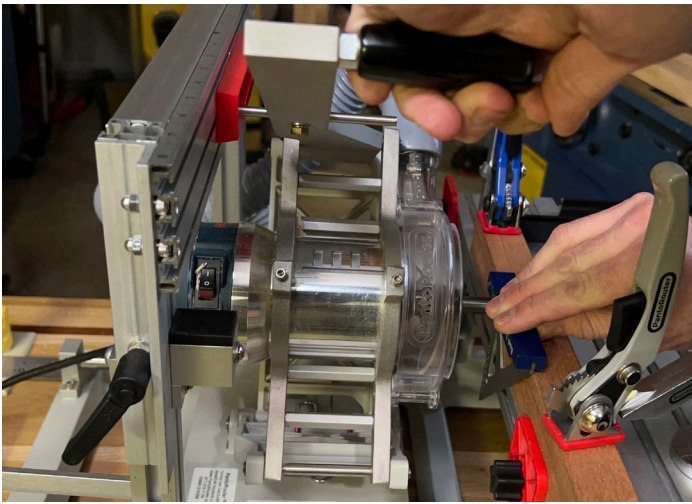
Clamp the workpiece to the table in the location you would like the mortise cut. With the 10mm guide bearing in the mortise slot and the blunt router bit shank contacting the face of the workpiece, move the router all the way to one end of the slot. Using a small square positioned across the front face of the workpiece, slide it over until it contacts the outside edge of the router bit shank. This locates the end of the mortise. Hold the square in that position, then slide the Pantograph carriage back and out of the way.



Use a marking knife along the edge of the square to mark the mortise end location. This will come in handy later.

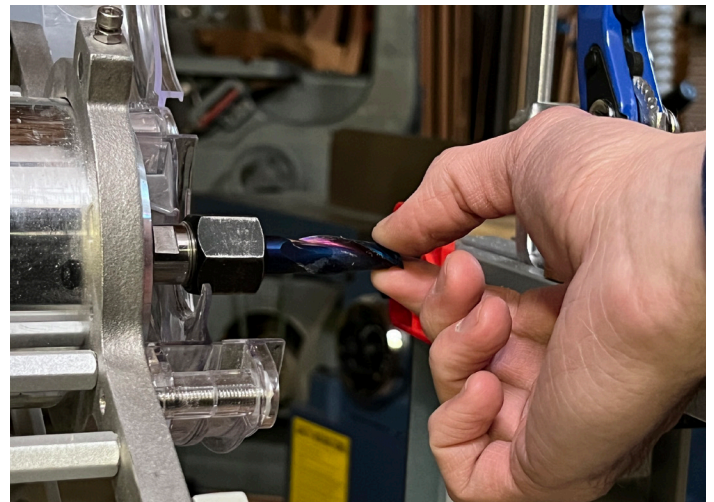






Repeat this process at the other end of the mortise slot. Now both ends of the mortise are marked out. This method works with the 1/4", 3/8", or 1/2" spiral up-cut bits provided with the machine because the cutters and shank are the same diameter but would not work using the 3/4" or 1" bits because the cutting head would not fit in the collet.

Now loosen the collet and flip the bit so the shank is in the collet and tighten with the router wrenches.

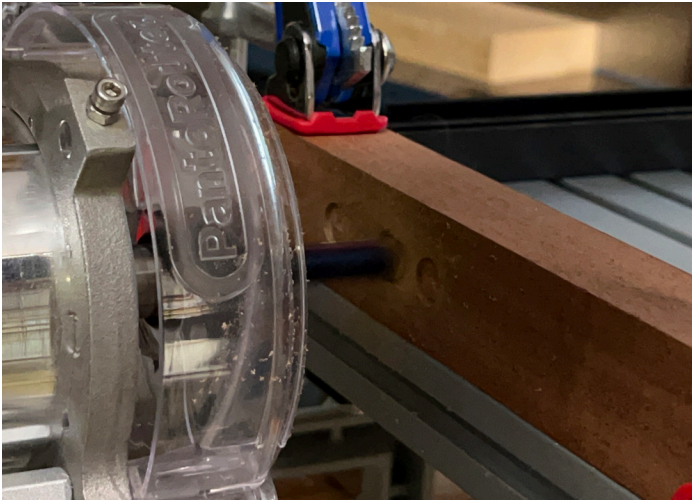


The workpiece in this example is 1-1/4" thick. Since we are cutting a through mortise, we will set the depth of cut to 1-5/16". Now we are ready to cut!

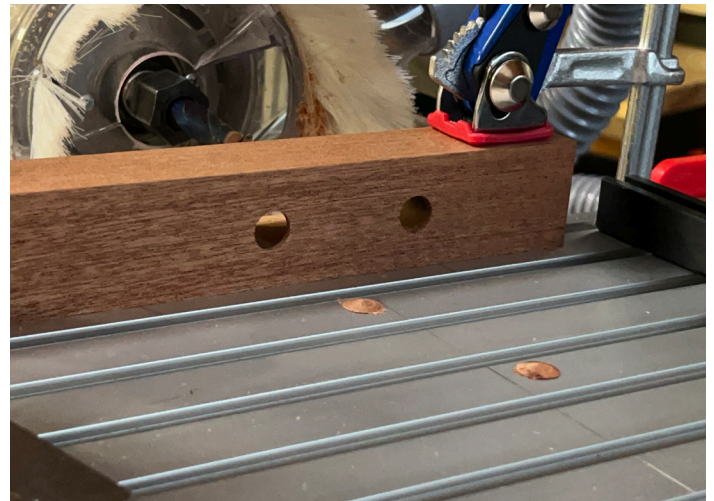
When cutting a mortise on the PantoRouter®, it is always a good practice to make a light plunge cut on either end of the mortise approximately 1/16" deep before moving the router back and forth to cut the mortise. This ensures the ends of the mortise have clean cuts free of tear-out.







After the two plunge cuts are made, progressively plunge in while moving the router back and forth along the length of the mortise slot.

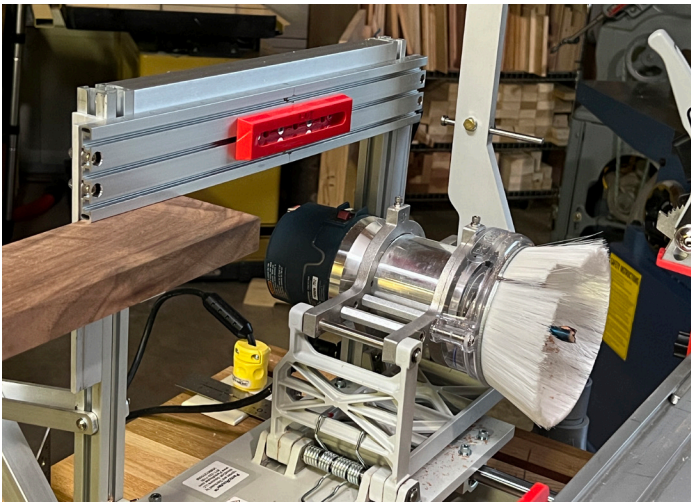


As you are cutting the mortise, keep an eye on the depth gauge. When about 1/16" of material remains, make the same two plunge cuts before making the cut all the way across.

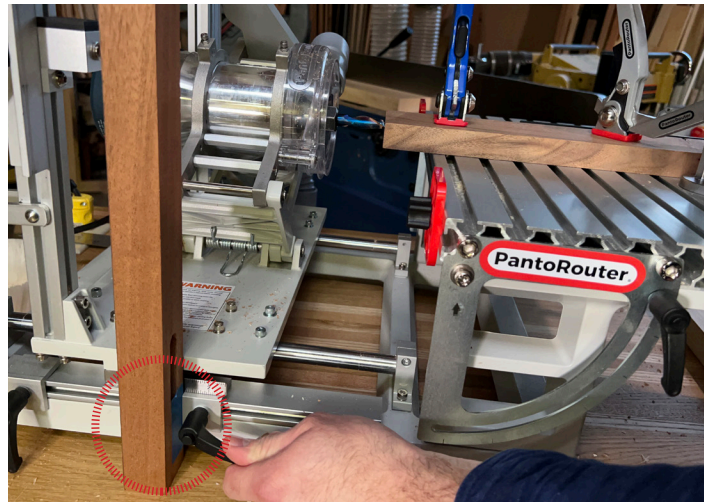
Now we have a through mortise free of tear-out on both sides.



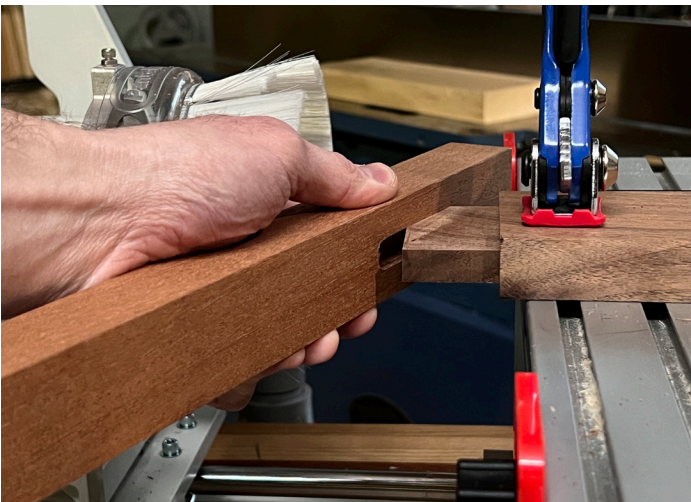




Now move on to the tenon. Remember to re-set the thickness if the mortise and tenon workpieces are different sizes.



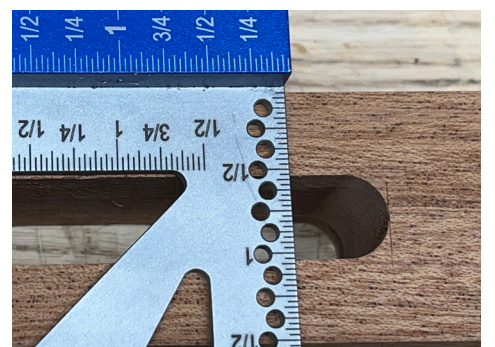
Place a piece of blue painters tape on the face of the mortise workpiece and with the tenon workpiece clamped to the table slide the router forward until the bit contacts the end. Use the mortise workpiece with tape to set the depth of cut.



Cut the tenon using the same method as the round-ended templates by following the exterior of the template with the correct guide bearing. Use the taper on the template to sneak up on a perfect fit and test as you go using the previously cut mortise workpiece.



With the show face up, locate a marking knife in the scribe line that was made prior to cutting the mortise on the PantoRouter<sup>®</sup>. Slide a square over to the knife and make a more defined line at the end of the mortise that the tip of a chisel can fit in. Repeat on the other end.



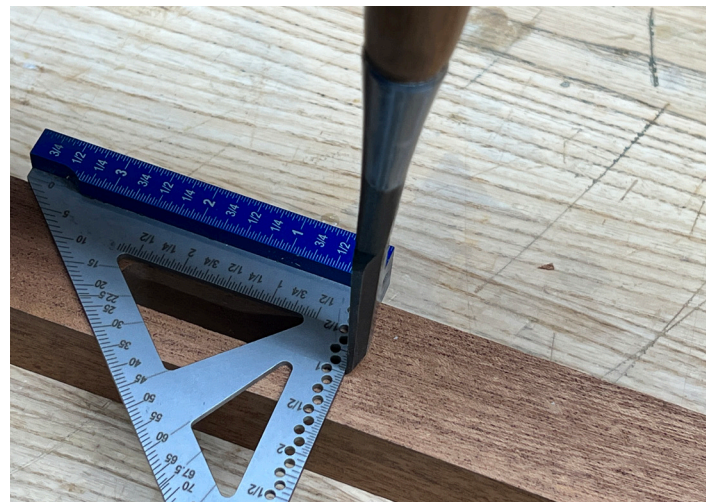




Use a wide chisel referenced off of the mortise wall to define the rectangular outline of the mortise.



Using a mallet and a narrow chisel, follow the outline of the scribed marks. Since this is the show face, carefully remove about 1/8" deep of material without cutting past the line to establish a perfect outline of the through tenon.



Flip the workpiece over so the back side of the mortise is up. Use a square to locate a narrow chisel where the mortise ends. This location is less critical because it will never be visible.





Remove the remaining material from the back side, making sure to not cut into the established 1/8" deep square-ended mortise that has been cut on the show face.



Once all of the material is removed, check the fit. You should have a nice snug fitting square-ended mortise and tenon!