

The CNC produces the Gold Standard for a Mortise and Tenon

By Andy Amada

Traditionally and currently, the Tenon is cut on a table saw and the Mortise on a router table, although both can be cut on a router table.

Under the traditional methods, there are two ways to match the mortise and tenon. One way is to use a chisel to square the inside corners of the mortise to match the rectangular shape of the tenon. The

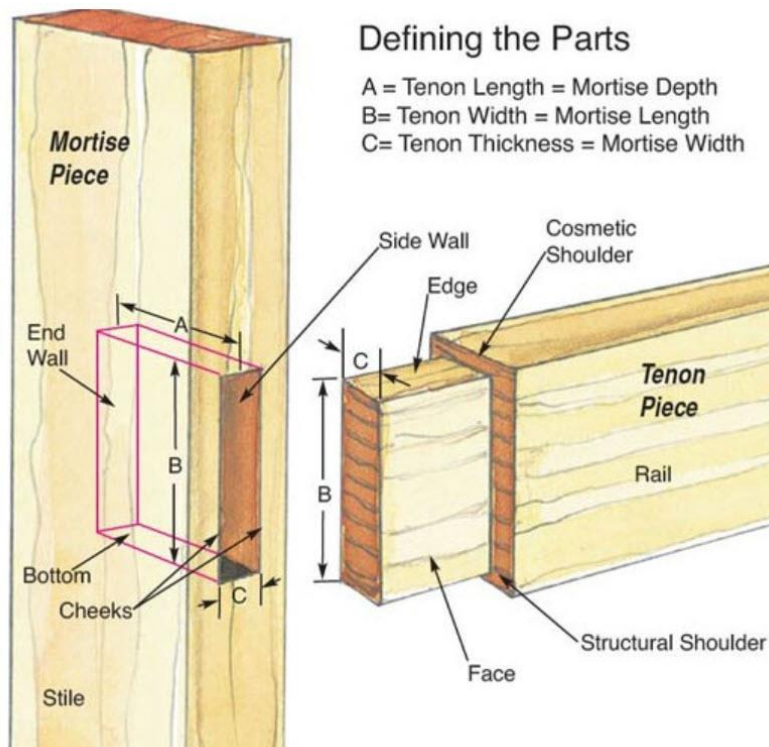


Figure 1

other approach is to leave the mortise with the round inside corners, and round the edges of the Tenon to fit the mortise. Most critical is that the width and thickness of the tenon match the opening shape of the Mortise to create a snug fit. All of the above approaches require careful multiple measurements and multiple cuts. They are time consuming and are subject to less than desirable results. Even the thickness of the pencil line can produce too loose or too tight a fit. A CNC, on the other hand, is simpler, faster and can produce an exact fit.

Adjusting your CNC to create perfectly matched Mortises and Tenons.

The following instructions are how I created a Tenon Jig on my CNC Evolution 4 table. Much of the instructions will make more sense if you first look through the images that accompany the instructions. The Tenon Jig, that sits over a hole cut into the CNC table, will consist of 3 layers of wood cut by the CNC plus an aluminum back plate and C-clamp. It can easily be removed at any time.

Step 1 – You will need to find a location on your spoil board to cut a hole for the Tenon, but do Not cut the hole yet. I routed out a hole about 1.5" x 4". You will want to rout out the hole using the CNC because you will be using the same gcode file to cut additional holes in other wood layers that will sit over the hole in the CNC Spoilboard. You can cut a larger or smaller hole than 1.5" x 4" because the hole is so small, it should not interfere with any other project, especially since you will be able to remove the Tenon Jig from the table spoilboard by removing 4 machine screws. In addition, it is most likely that you will have your own spoilboard that sits above the CNC spoil board.

I located the hole so that it was relatively centered between the spoilboard machine screw receptacles and between the CNC spoilboard supports. That hole will allow you to create a tenon on the end of piece of wood that is the height of the CNC table (or longer if you have a hole going into the floor).

Step 2 – You will need to cut a piece of 3/4" plywood about 7" x 9", which will sit over the spoilboard. For purposes of reference, we will call that piece the "Lower Board".

Step 3 – Drill four 1/4" holes in the Lower Board that will align with the spoilboard machine screw receptacles.

It is important that there be no slop in the alignment of this board as it must hold the tenon jig in the same exact position even after removing from the CNC and placing it back on in the future. The jig has to align with the 2 edges of the wood in the CNC table in order to keep the wood vertical and perpendicular to the router. A perfect alignment of the four 1/4" holes with the spoilboard receptacles can be accomplished through the following method: That doesn't mean it is the only method. An accurate measurement can also accomplish the job.



Figure 2

Take a 1/4" 20 thread bolt and cut it to about 3/4" - grinding one end to a "point" (Figure 2).

Hand turn the bolt into any of the threaded inserts in the spoilboard leaving a small portion pointing up above the spoilboard, and place 7" x 9" Lower Board on top of the bolt about where you want the holes located. Then give the new Lower Board a little hand-pound above where the pointed bolt is located. That will create a small indent in the Lower Board. Then using that indent, drill your first 1/4" hole.

Place a machine screw through that first hole of the Lower Board into the spoilboard, but don't tighten it all the way since you need to raise the board slightly for the next hole alignment. Give a small pound to the board above the second pointed screw to make the indent. Then drill that hole and insert a longer bolt. Continue the process until you have all four holes completed. This is a very short process. (Note: you can probably use a slightly larger bit than 1/4" and still be fine since there will be 4 holes holding the Lower Board in place leaving very little if any room for movement).

Now you have the Lower Board in place. The other parts of the tenon jig will be mounted to this board. This method enables you to remove the entire jig by just removing the four bolts holding the Lower Board.

Figure 3 shows the board you just created and aligned with the spoilboard receptacles.



Figure 3

Step 4 – Cutting the Tenon Hole – Figures 4 and 5 show 2 types of holes. I would start by cutting the 1.5" x 4" hole as shown in Figure 4. Figure 5 allows for a metal backplate, if necessary. I will discuss further as we move forward. The CNC should cut 1.5" deep through the 3/4" Lower Board and 3/4" CNC spoilboard.



Figure 4

Figure 5



Figure 6

Figure 6 shows what the tenon jig will look like after adding an additional 1" of plywood. I used a 4" x 4", attached it with 3 long screws (Figure 8), then used the CNC to cut out that portion over the hole. You will now have 2.5" of wood-backing to hold the Rail in place. The Rail is the wood piece with the end turned into a Tenon (see Figure 1). Using the CNC router is *Critical* since it ensures that the 2 sides of the hole, made up of multiple layers of wood that align the Rail, are in line with one another.

The Rail will be pressed and held against 2 sides of the hole using the C-Clamp (Fig 7 & 8). Thus, the opposite sides will not be touching the Rail and are not critical. While the hole may be 1.5" x 4" the rail may be smaller in both directions.

The bolt coming up goes into a slot in a small block of wood. The purpose of that piece is just to help hold the Rail in place until the C-Clamp can make the final clamp, and it is the C-Clamp that will do all the holding. I also attached some double-sided carpet tape to the small sliding piece of wood to help stop the wood from sliding back down the hole until the C-Clamp can take over. The end of the C-Clamp was cut off, otherwise the end got in the way. I used a Dremel tool. It only took a few minutes using their cutter. Drilling holes in the C-Clamp was also easy.

The reason I made the additional cut for the Aluminum drop-in is discussed on the next page.

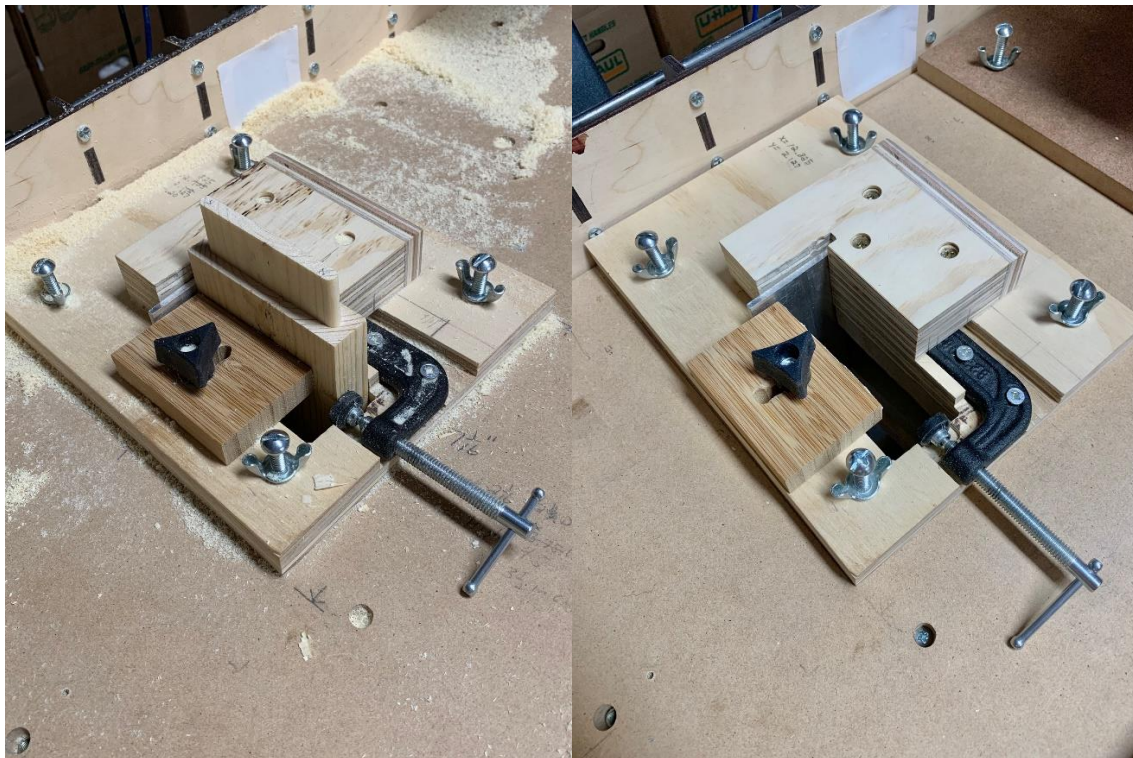


Figure 7

Figure 8

Figure 9 is a top view looking down on the Tenon shown in Figure 7. The Tenon is not parallel to the sides of the rail. It is slightly off, but that amount could cause problems on the other end when applying the tenons to the wood project. For whatever reason, when the Rail was pushed into the back of the hole against the wood, it ended up not being perfectly straight.

It was for that reason I added a slot to hold a 1/8" piece of aluminum (Figure 10). One could place a screw into the wood behind the aluminum to change the angle of the aluminum, but I found it easy to just shim the aluminum with some tape and part of a playing card. It will only be a one-time adjustment. The slot for the aluminum should be open enough to allow movement of the aluminum, thus 1/8 to 3/16" should work. It doesn't matter that the aluminum is loose since the Rail and aluminum will be pushed backwards by the clamp as pressure is applied.



Figure 9



Figure 10

Figure 10 shows the aluminum insert. It is loose and rests on a small ledge below.



Figure 11 shows what you will see once you cut through the CNC spoilboard. It is the top of the table supporting the CNC. You will need to cut through that top as well.

Figures 12 and 13 show how I marked where to cut the table top because using a pencil was not that easy. I cut a piece of scrap wood that was 4" wide by $\frac{3}{4}$ " thick. I placed a piece of blue tape on the end. Then I placed a piece of double-sided carpet tape on top of the blue tape. I then pushed the piece of wood down through the hole until it pressed against the tabletop. The blue tape adhesive is no match for the carpet tape, so when I lifted the wood piece, the blue tape was left on the tabletop, thus providing what portion of the tabletop needed to be cut out.

Figure 11

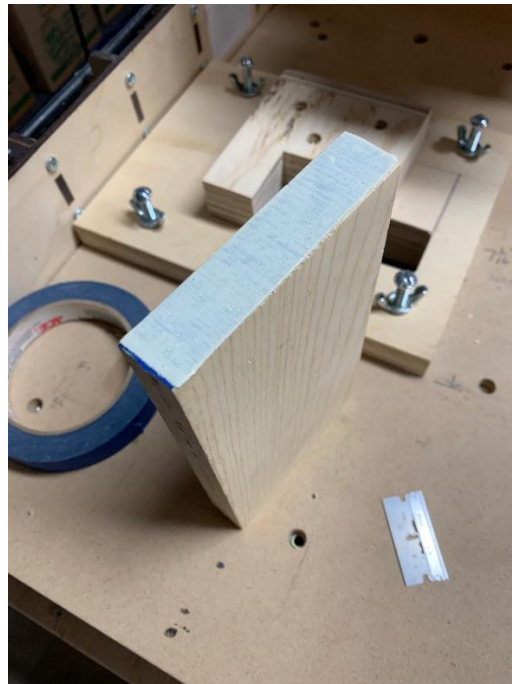
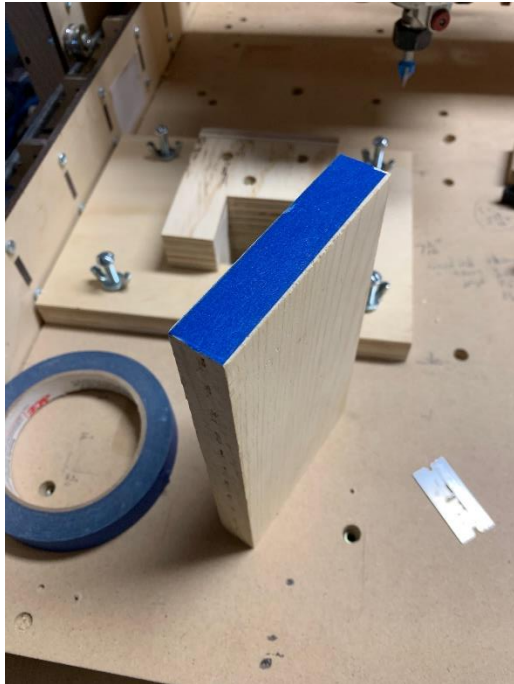


Figure 14 shows the graphic I made in the CAD program. It was a flat file saved as a DXF. For the Tenon I chose "part" and for the Mortise, I chose "hole" - thus using the same image for both parts.

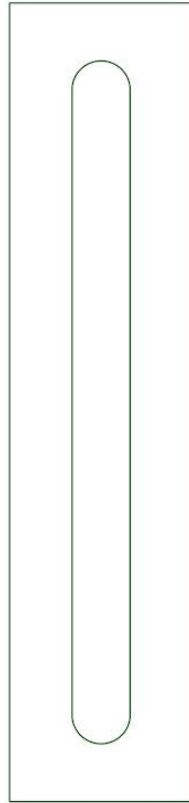


Figure 14

Figures 15 – 18 show a finished Mortise and Tenon. A perfect snug fit. And once the jig is in place, it is very easy to make multiple exact M&Ts significantly more accurate and faster than the traditional methods.

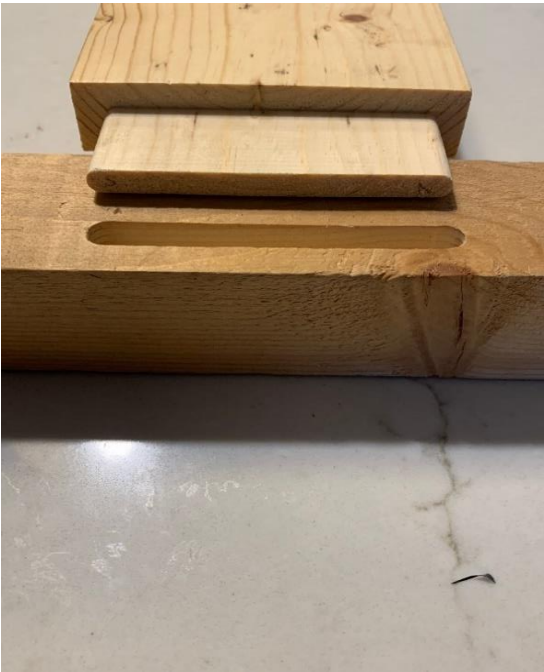


Figure 15



Figure 16



Figure 17



Figure 18