Making Mortise and Tenon Raised Panel Doors on the Table Saw

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1. Begin with proper wood selection to find straight grain boards for door stiles and rails. This prevents warping. I prefer to make doors and frames that are 7/8" thick.
2. If you are making the entire carcase, be sure to select enough straight grain wood and take the time to match the grain on the stiles and rails of the frame to the stiles and rails of the door as closely as possible. For the stiles, begin with three wider boards of sufficient length and similar straight grain. Select two and determine left and right side. Rip the boards along matching grain at appropriate rough width. Bring them back together and mark these outside door stiles where they match the frame stiles with a triangle mark to denote upright orientation and left or right for each door. For center stiles, rip a single plank to achieve perfect grain match, place the two back together and mark with a triangle and "C". Take the same approach to the rails for both the doors and the frame.
3. Mill the stock to final 7/8" thickness and rip to final width dimensions. Include extra pieces of rails and stiles for testing.
4. Construct the frame to the specifications of the case piece using mortise and tenon joinery. (Follow the process as described below. I made the demo frame out of 2 ½" wide stiles and rails. *NOTE: The finish cut length on the rails is the distance between tenon shoulders <u>plus</u> 3" (1 ½ "tenon on each end))*
5. Once the frame is complete and dead square, measure the case opening. Create a center line that bisects the top and bottom rails.
6. Decide on whether you want inlay, overlay or rabbeted doors. (I prefer inlay doors whenever possible.)
7. Determine the length and width of the stiles and rails. Begin with the stiles. (Stiles run the full length of the height of the opening. The outside stiles may be wider than the inside stiles. When closed, the doors can appear bulky if the inside stiles are too wide. I typically make the inside stiles at least ¼" narrower.)
8. Leave the stiles a few inches longer than the height of door opening for now. These "ears" will make it easier to assemble and disassemble during fitting. (The two outside stiles are 2 ½"; the two inside stiles are 2 ¼")
9. Make a story stick(s) of appropriate length to fit the exact height and width of the opening. Insert one story stick across the width of the opening, and transcribe the center line and the width and placement of the stiles. (As you progress, you will refer to the story stick to add/confirm details such as the reach of the tenons and certain decorative profiles; and to provide visual checks that don't require math.)
10. As with a picture frame or matte, for visual balance the top horizontal is often narrower than the bottom. For the same reason I make the top rail ¼" narrower than the bottom.
11. Create another story stick for the height and capture the width and placement of the rails. (Later you will capture the placement and extent of the mortises.)
12. Cut rails to rough length remembering to include 2X the tenon length. (Two top door rails are 2¼" wide. Two bottom rails are 2½")

13. With the stile and rail stock arranged inside the frame stock and grain matched, determine the layout and location for mortise and tenon joints. Butt one of the extra-long outside stiles against its matching frame stile and clamp the stile at each end flush to the frame stile. Use a marking knife to mark the exact length of the stile where it will terminate inside the rails of the assembled frame. Continue this line around to the front face of the stile.
14. Place a mating top rail on the line at the top of the stile and mark the rail width on the stile with a pencil, continuing this line across the inside edge of each stile. Repeat this step with a mating bottom rail.
15. On both ends of this stile locate where the mortises begin and end on the inside edge between the knife and pencil marks. For simplicity place the mortise in the center of the stile edge. (For the sample 7/8" thick door I chose to use a ¼" mortise. Depth will depend on the length of the tenon plus the width of the decorative edge that will be removed (usually 5/16"; more on this later). I prefer at least a 1 1/2" tenon length inserted into a stile 2" or more. Balance maximum available glue surface with other practical joint construction factors.)
16. Mark the outside edge of the mortise 3/8" to ½" from the end of the stile to prevent a short grain breakout. Leave a 1/8" shoulder mark at the other end. Incise the location and extent of the mortise using a mortise gauge. (For a door with more than one panel, be sure to mark where the center rail(s) tenons will meet a mortise.)
17. Stack the stiles in the same upright orientation and clamp all four together with the inside edges face down and flush on a flat surface (Remember that the inside and outside rails are different widths.) Once the inside (mortise) edges of the four stiles are aligned and flush, extend the marks from the marked stile to the other three. You should now have identical marks on the inside edges of all four stiles indicating where each mortise begins and ends. Unclamp and incise the location and extent of the mortises using a mortise gauge on the remaining three stiles. Be sure to extend the outermost knife marks designating the final length to all four sides of the stiles.
18. Excavate the mortises using the most convenient means available, whether by machine or hand. Ensure the bottom is clean and reaches the correct depth and the walls are plumb, square and smooth.
19. Place the door stiles back in their marked position against the frame stiles and clamp to the rails.
20. Lay an extra (scrap) rail across two of the stiles along the width marks previously made at the top of the stile. With a square end of the rail against the inside edge of a stile, mark with a pencil where the other end of the rail terminates at the inside edges of the opposite stile. Continue this line around all four sides. (*This represents distance between edges of the stiles <u>without</u> the decorative thumbnail profile. Add another pencil line beyond this line at a point that includes 2X the desired tenon length <u>plus</u> 2X the thumbnail width (5/16") to account for the thumbnail waste removed from the stile, plus 1/8" extra for fudge factor, to equal the finish cut length of the rail. In this case the length is the distance between stile edges plus 3 3/4"*)
21. Cut the test rail to length and square ends. Scribe shoulder lines at the prescribed distance (1 ½") from each end. Place back on stile marks to ensure that the both shoulder lines fall about 1/16" past the inside edges of the stiles, and that the tenon lengths both extend the proper distance past the edge.

22. Set up a cutoff saw; or use a sled on a table saw to saw the four rails to the same length as the scrap piece. (Remember that you have rails of differing width: two rails at 2 ½" and two at 2 ¼" widths.)
23. On the end of the scrap piece, scribe the tenon dead center using the same mortise gauge still set for the mortises. (Mark from both faces to test that the lines are still centered.)
24. Place the piece on the table saw and raise the blade to just below the lower line of the gauge mark.
25. Set up the table saw miter gauge in the left slot, and test to ensure it is dead square to the blade
26. Set the fence ¼" to ½" from the blade.
27. With the scrap piece firmly against the head of the miter square, push the end against the fence.
28. Turn on the saw and make a test cut, keeping the scrap piece against the fence throughout the cut. Make additional passes with the piece slightly away from the fence to clear the remaining waste. Observe where the blade cuts in relation to the tenon line. Adjust the blade as necessary so that the saw cut leaves the line. Make additional cuts as necessary after adjusting the height of the blade. Flip the piece edge for edge and cut the opposite face in the same manner. The result should be a short tenon, a corner of which should fit snugly in one of the mortise openings. If necessary, move the fence back to continue cutting from both sides until the proper fit is achieved.
29. Now lock the fence at a distance from the blade corresponding to the final tenon length (1 ½") . With the scrap piece against the head of the miter, run the end of scrap piece up against the fence and make a cut. Flip the piece edge for edge and cut again from the opposite face. This establishes the shoulder line. Run the piece back and forth along the head of the miter gauge into the fence advancing into the blade very slowly (1/8" at a time) with sufficient passes to remove all the waste between the shoulder line and the end on both sides. This creates the flat tenon cheek. (A dado blade can speed the process of removing waste.)
30. Repeat the process for both ends of all four rails. Once completed, you will have identical-thickness tenons defined by sharp, square shoulders.
31. Lay one of the rails with its tenon surface flat on the edge of its mating stile halfway across the mortise, making sure to align the width of the tenon with the marks denoting the width of rails.
32. Mark the top and bottom of the tenon on the ends of the rail to match the length of the mortise. Extend these marks as lines down to the shoulder. Rip and remove the edges of the tenon to match the length and position of the mortise on the edge of the stile. Clean up the shoulder.
33. Test fit the tenon into the mortise. If necessary removing thin, even shavings from both cheeks of the tenon with a shoulder plane, test fitting as you go until the tenon fits snugly into the mortise with hand pressure only. The shoulder should close tightly against the stile edge with no gaps on either face.
34. Repeat the process for all four corners of the first door.
35. Now that the joinery is complete, use a router or router table to establish the thumbnail profile on the inside edge of the outside face of all the stiles and rails. (I used a 3/8" radius round over bit set at a depth to produce a 3/32" deep shoulder.)

36. Once the profile is created run a ¼" wide by 5/16" deep groove down the inside edge of the stiles and rails that will house the panel. The groove should align perfectly with the mortises and stop at the outside end of each mortise. (I used a grooving bit set up in a router table. You can also use a straight bit. A stop cut with a dado blade would also work although it requires more clean-up/squaring of the termination points.)
37. Dry assemble the door frame and square up. With a sharp pencil and a combination square create a line that extends the shoulder of the thumbnail profile running along the inside edge of the rail straight across the stile. Continue this line across all four faces of the stile. This line marks the point at which the table saw blade will cut a 45^0 corner for the thumbnail on the stile to mate cleanly when the tenon of the rail is inserted into the mortise in the stile. Repeat this so that you have this line at the top and bottom of all four stiles
38. To make this cut, begin by setting the table saw blade to a true 45^0 angle. Attached a dead flat and straight sacrificial fence to the miter gauge and test that is 90^0 to the blade. Raise the angled blade to a height equal to the width of the round over profile measured from the shoulder. Make a pass through the blade with the fence. With a sharp pencil extend a line from the peak of the cut in the fence upward and across the top edge of the fence. This is an alignment mark. Make a test cut on a piece of scrap with the thumbnail profile. The cut should stop at the base of the round-over shape.
39. On the extra (scrap) rail, align the shoulder with the alignment mark on the fence. Make a pass across the blade to achieve the first 45^0 cut (angled toward the long edge). Be sure that the cut terminates exactly at the intersection of the shoulder line and the base of the thumbnail profile.
40. Mount the first rail face out against the fence, align the shoulder with the mark on the fence and make the cut. Flip the rail so that the face is now against the fence cut the opposite end. Cut all four rails this way.
41. Mount a stile **outside face out** against the miter fence and bring the line (that was created to extend the shoulder of the thumbnail profile around the stile) into alignment with the alignment mark on the fence. Make the cut. Flip the stile end for end with the face now against the fence and again align the marks. Make the second cut. Cut all four stiles this way.
42. The waste section of the thumbnail profile must be removed in order to assemble the joint. It may be removed using a stopped cut on the table saw and a chisel, a grind cut similar to the manner in which tenons were created, a bandsaw or a wide chisel.
43. Reorient and assemble the door frame. Test fit the mortise and tenon joints. Make adjustments with a sharp chisel to any element of the joint that is preventing tight closure with no gaps.
44. Once the door frames can be assembled satisfactorily, it's time to fashion the floating panel. (I prefer to use single wide boards that have been milled flat to ¾". For double doors on a high style piece I would seek a "flat" section of board with attractive figure and thick enough so that I could resaw it into two pieces for a book-matched set.)
45. One way to measure the final dimensions of the panel is to cut two thin strips from scrap and insert them inside the grooves when the frame is assembled to find the exact length and width. The final length should be about 1/8" shorter than the actual distances to allow for expansion.
46. With these sticks as gauges, set the fence and first rip one edge to final width. Use a sled or cutoff saw to cut to final length.

47. To establish the field for the panel, decide how wide the visible border needs to be, remembering that up to ¼" or more of the perimeter of the panel will be buried in the groove. Locate the fence this exact distance from the blade, now set at 90^0. Lower the blade to the height that will create an attractive shoulder, e.g. 3/32" to 1/8". Run the panel face down against the fence along all four edges to create the cross-hatch cut.
48. Scribe a line around all four edges that is offset 3/32" from the back face. (The border slopes toward this line. Given the angle, this edge must be less than ¼" to fit in the groove).
49. The border waste may be removed at the table saw or by hand using hand planes, chisel and scraper. Doing this on the table saw requires a jig that attaches to the fence and enables the panel to be pushed across the blade at an angle while fully supported from behind. **Do not attempt this without a support jig.**
50. Tilt the blade to an angle necessary to connect the edge lying flat on the table surface (marked by line that is 3/32" from the back face) to a point just below the saw cut that defines the field. (I used 15^0 for the sample.) Raise the blade to a height just below the shoulder of the field.
51. Make the long grain rip cuts first. With the panel on one side, clamp or hold the panel against the jig. Push the panel through the cut, making sure that the panel remains at tight to the jig at 90^0 and in continuous contact with the table surface. Then make the short gain cuts across the width of the panel.
52. Clean up the border with hand planes and scraper. Assure that the outside edge is a consistent thickness -- ~1/16" less than the width of the groove. The bevels should meet cleanly at each corner, as defined by the crisp, straight "miter" line that should connect each corner of the panel with the corner of the raised field.
53. Fit the panel within the door frame and ensure that all the joints close. You may have to shave more from portions of the border to close any gaps.
54. Place the dry-assembled door on the face frame. Flush the outside stile to the face frame stile and check for square. Note the position of the inside stile relative to the centerline on both top and bottom. If the overlap is consistent, this is the amount to be planed off the outside stile. Otherwise you may have to plane a bit on each stile to bring it into alignment with the face frame and centerline.
55. Once the stiles fit, square up and trim the ears off the stiles.
56. Place the top edge of the door against the top face frame rail. Flush the outside stile to the face frame stile. If there are no gaps, make marks along the bottom rail at each end where it hits the face frame rail. Connect these marks and plane to the line to enable a snug fit inside the frame.
57. Proceed to make the second door to fit the remaining opening.
58. To hang the doors, lay the face frame on a flat surface. Plane the outside edges of the doors to create a gap of ~1/32" using spacers to fit snugly between the doors and the face frame. Plane a sight bevel into back edges of the center stiles so that they don't catch or ban when opening or closing.
59. Locate the hinges and mark out, mortise and mount. (This is its own tutorial.) Door knobs a plus…

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Woodworkers Guild of Georgia Mini-Symposium
Suwanee Lumber
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