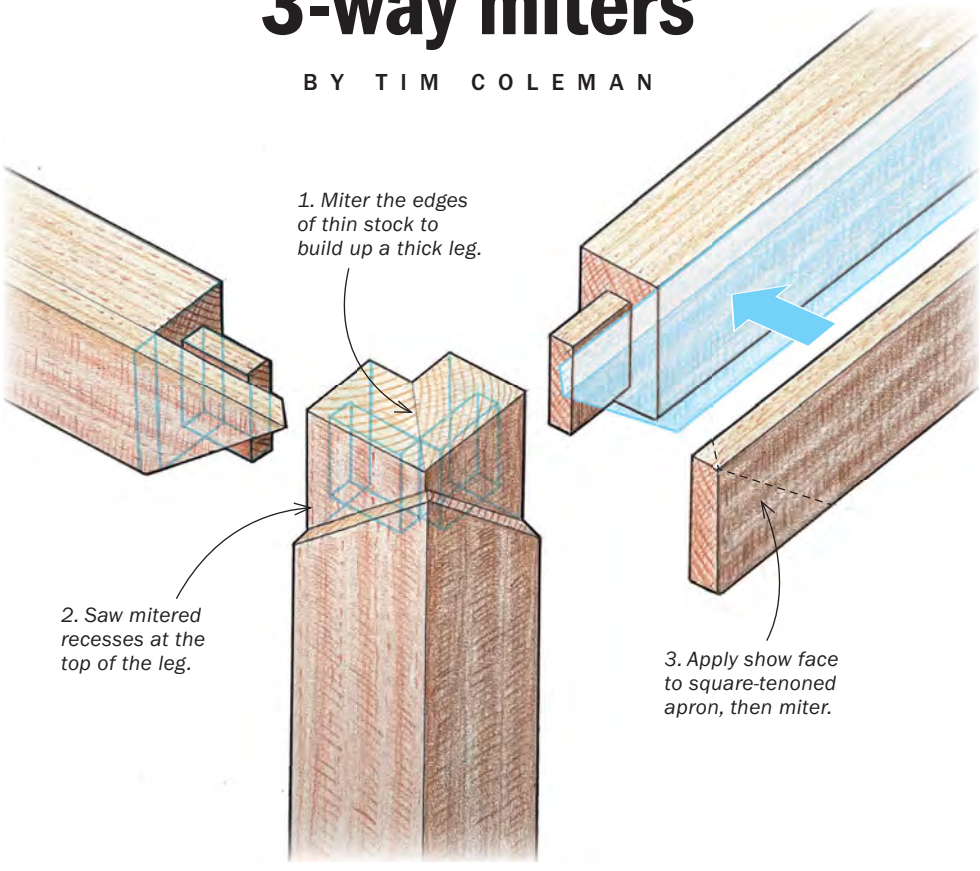
# 3 steps to strong and slick 3-way miters

BY TIM COLEMAN

My furniture designs often rely on joinery in compact areas, so I've had to devise ways to maximize joint strength without compromising the integrity of small parts or cluttering a sleek design.

I faced this challenge on a recent dining table commission. The table was designed to sit in an alcove in front of several large windows overlooking a harbor, and the objective was to create a graceful, uncomplicated silhouette made up of slender parts. Curves on the underside of the aprons would flow seamlessly into the legs and down to the floor, and there would be no lower stretchers to disrupt these lines. I proposed three-way miters for the leg-to-apron joint, a detail seen in historic Chinese furniture. Done well, it is a strong joint, but it relies on a complex arrangement of integral tenons and miters, and requires tricky cuts. Eventually, I came up with a way to simplify the process of making it.

Cutting the mortises and the mitered recesses on the legs wasn't daunting. But I wanted to simplify the aprons. So I decided to make them as two layers: a thick inside layer with a substantial integral tenon, and a thinner outside layer that I would laminate to the inside one after the tenons were cut.






Photos: Barry NM Dima; drawings: John Tetreault

Once the apron was laminated, I would cut the miter on the thin layer, forming a wing that gets glued into the mitered recess in the leg. After cutting that main miter on the wing, I would make the small miter cut at its tip where it mates with the wing of the adjacent apron.

I got the best of both worlds with this arrangement—the predictable strength and easy assembly of a large 90° mortise-and-tenon, and the appearance of a mitered corner. Plus, the mitered wing adds glue surface to reinforce the joint, a welcome boon considering the lack of stretchers. Made this way, the legs are a design element that improves strength and involves a clever technique.

## Check your tools

You want your machines and jigs to be properly set up and tuned with any project, but it's worthwhile to stress the point here. With such a complex joint, "a little out of square" will multiply fast. The front-end work of checking your tools and jigs will spare you plenty of futzing and headaches on the back end.

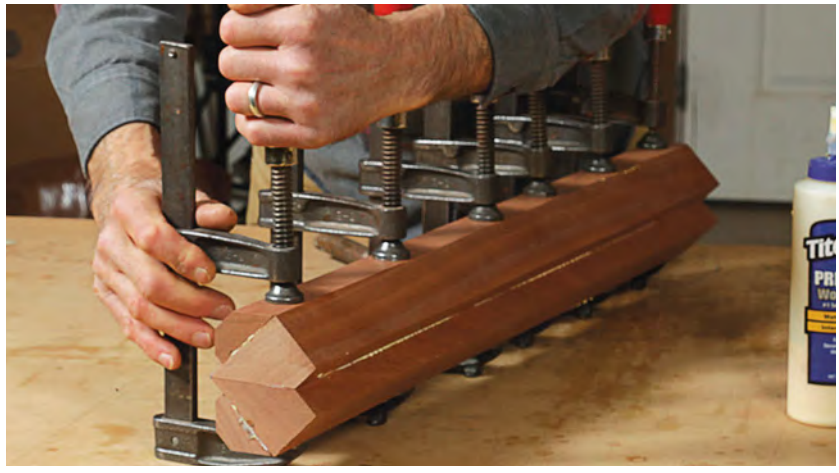
## A bevel builds up the legs

Thick legs are half the equation in the strength and easy assembly of a large, square mortise-and-tenon joint on a table. But I did not have solid stock thick enough to make these legs out of one piece. As a workaround, I constructed the leg blanks from two pieces, mitering them along one long edge and gluing them together. As a result, the legs look and act like thick ones even though they're made up of thinner stock.


***Rip the leg stock at 45°.*** *The ripped edge will be a glue surface, so check it with a miter square and straightedge. Coleman uses offcuts from these rips to make clamping cauls.*

***Tape the miter.*** *Coleman runs a strip of tape along the whole joint. The tape keeps the leg halves aligned, first with the miter dry, as he attaches clamping cauls with a paper joint; and later when he glues and clamps the long miter.*

***Paper joint allows for secure, but temporary, clamping cauls.*** *Using wood glue, adhere the paper to a caul. Then glue this papered face to the leg, avoiding the tape. Align the clamping surface on the trapezoidal cauls with the middle of the leg's miter.*



***Glue the leg halves together.*** *This joint relies on glue alone, so be liberal and use plenty of clamps. After the glue sets, pry off the cauls and clean up the surfaces. Keep the faces straight and square for the joinery. Cut the ends square and to length.*

## 2 MITERS AT THE TOP OF THE LEG

***Cut the shoulders using a miter gauge.*** *Coleman uses his table saw fence as an end stop. He starts with it too close to the blade as he checks his settings.*

This long miter can be tricky to clamp, so I use shaped cauls glued temporarily to the leg halves. The cauls' shape matters. I take the triangular cutoffs from sawing the long miters and trim off their apexes, yielding a shape with two parallel faces and 45° edges. I glue the cauls to the leg halves with a paper joint, placing the clamps on the flattened apexes. When that glue dries, I glue up the two halves of the leg, using the 45° edges of the cauls to clamp across the miter.

Remove the cauls by slipping a chisel into the paper glue joints and popping them off. Using a hand plane, clean and true the outside faces to make them square to each other, then check that the joinery faces are square to these outside faces.

### Cut the joinery in the leg

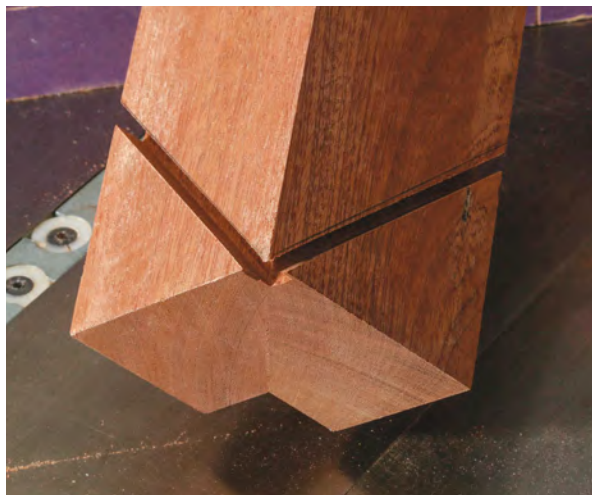
To receive the aprons, each leg needs two mortises and two triangular recesses. I cut the mortises on my hollow-chisel mortiser. The recesses require a shoulder cut and then a cheek cut, both at 45°.

To cut the shoulders, I use a miter gauge with positive stops at 45°, which makes it easy to switch back and forth for the shoulders on each leg.

The setup for the cheeks involves a stout flat-top rip blade and a simple but crucial jig that operates like a tenoning jig, but with two fixed 45° ramps. These ramps hold the leg at the correct angle for the cheek cuts. Pair it with a tall fence on your table saw for safety and accuracy.

I position the leg's outside face against the jig's tall fence for a consistent cut. This does result in the waste being trapped between the workpiece and the fence; it's never been a safety issue for me, but

***Cut the second shoulder after adjusting the miter gauge to its other 45° setting.*** *Having a reliable miter gauge with positive stops at 45° will make these cuts (and subsequent ones) much more manageable. Make this second shoulder cut with the fence at the same setting.*



***The miters should meet at the corner.*** *The meeting point of the angled shoulders should be at the corner of the leg. If it's slightly below, that's OK, because you'll trim the apron's mitered wing to fill the space.*

***One jig for both cheeks.*** *With opposing 45° ramps and toggle clamps, the jig holds the leg for the cheek cuts. The blade will be raised high, so make sure it won't hit any hardware on the jig.*

it's something to be mindful of as you complete the cut. After making all the rips, clean them up and undercut the shoulders slightly with a broad chisel.

**Aprons get tenons, lamination, and wing miters**

When you select material for the aprons, keep in mind that the thin outside layer is what's seen in the finished joint. Pick those carefully, but don't fret over aesthetics with the thicker, inside layer.

First I cut the tenons on the thicker piece. I like to

***Press the jig tight to a tall fence and the saw table to rip the cheeks.*** *The jig's tall fence needs an auxiliary tall fence on the table saw for safety and accuracy. For cuts on both sides of the ramp, Coleman pushes the entire jig through the cut.*

***Undercut the shoulder.*** *This precautionary measure ensures there are no high spots of end grain that will prevent the finished joint from closing.*

leave the tenon about 1/32 in. undersize in height—trimming an extra 1/64 in. off each edge cheek—to create space for the tenon to move up or down in the mortise. Check the fit of all the mortise-and-tenons before moving on.

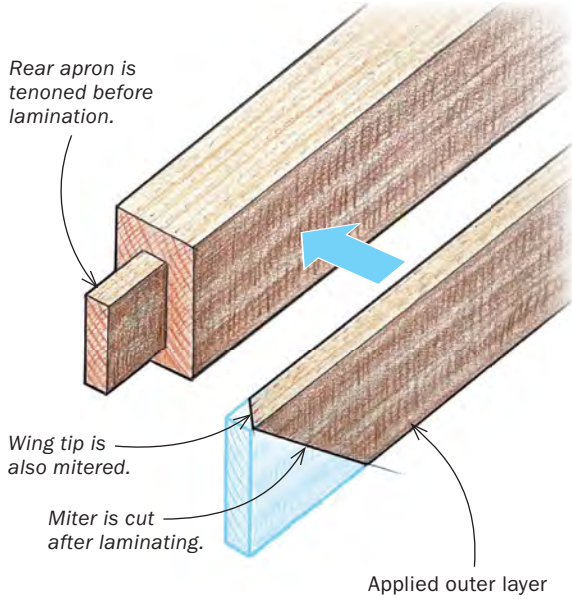
Next, the lamination. It's crucial that the thin layer's thickness matches the depth of the recess in the legs, or is a touch proud to allow for cleanup. As for its width and length, leave them over final size for now. The overhang means you don't have to position the piece precisely when laminating it. Flush the edges after the glue dries.

When laying out the miter on the face of the now-laminated apron, I draw the joint 1/8 in. long so that

***Mortise the leg.*** *These mortises accept the tenons on the apron. Be mindful of your reference faces as you flip the workpiece for mortising.*

## 3 MITER THE APRON LAMINATION

***Glue the apron's thinner outer layer to the tenoned rear board.*** *The applied show face is overlong and slightly wide here, so Coleman doesn't have to fret about locating it perfectly on the tenoned piece. He flushes the edges of the applied face to the rear piece after the glue dries.*

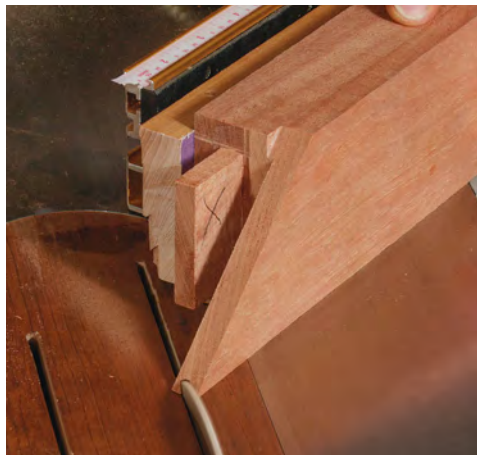



***Mark the miter ⅛ in. long. Then sneak up on the cut.*** *Because of this joint's complex geometry, don't try to lay it out perfectly. Rather, use a pencil mark to get you in the ballpark before working up to the final fit at the table saw.*

***The miter should close when the tenon seats.*** *This is why you gradually sneak up on the cut. If the miter or the tenon shoulders don't close, the joint could be unsightly or weakened. When fitted properly, though, the joint is incredibly strong.*

### IF YOU OVERSHOOT THE MITER, PLANE THE LEG

If the tenons seat but the miter remains open, carefully plane the leg's mortise face. This will make the mortise shallower, so be sure the tenon does not bottom out. Shorten it if necessary.



***Mark the wing tip, then sneak up on the cut.*** *In order for both aprons to seat at the same time so the full joint can come together, you need to cut a second miter at the outside tip of the apron. This miter runs from the outside tip to the inside face. When sawing it, Coleman lines up the outside tip of the apron's miter with the sawblade.*

***Assemble the three-way miters after dry-fitting with clamps.*** *During the final testing of the joint, apply clamping pressure to simulate final assembly.*

I can approach the fit gradually at the table saw. I want the apron miter to meet the corner of the leg recess at the same time the tenon shoulders seat. You can only fit one joint at a time until the tip of the miter is itself trimmed at 45° (see the photos above). After you trim the tip, check all the joints.

### Careful cauls and slow-setting epoxy

To prepare for the glue-up, I prep triangular clamping pads made from cardboard and long wooden cauls. I also ready a thick epoxy with plenty of open time.

The cardboard should match the apron's miters—so cut it to the width of the apron and cut its end to 45°. These triangular pads, which I tape to the apron's miters, guarantee the wooden caul will press against the miter even if it is slightly recessed from the leg. To make the wooden cauls easier to handle, I cut them 10 in. long. Before I assemble the joint, I clamp the cauls to the leg so that they overhang the leg's top end, leaving them perfectly placed for applying pressure to the apron miter.

Spread epoxy on the tenon, in the mortise, and on the apron miter and wing tip. Clamp across the joint from both directions and use a dead-blow mallet to seat the miters if necessary. Finally, check the assembly's diagonals before letting the glue set overnight. □

***Tape triangles of cardboard over the apron's miters.*** *The cardboard, cut to match the shape of the mitered wing of the apron, ensures the clamping cauls focus their pressure only there. The cardboard's necessary in case the wing sits too low in the leg recess, allowing the leg to interfere with the cauls.*

***Glue up all at once.*** *The narrow cauls direct pressure right over the apron's miter, keeping it tight to the leg recess. Coleman uses heavy-body epoxy from Epo-Tek because of its 30-minute open time, letting him seat and check all four corners. Plus, the epoxy's paste consistency keeps it from running.*

*Longtime* FWW *author Tim Coleman is a furniture maker in Shelburne, Mass.*