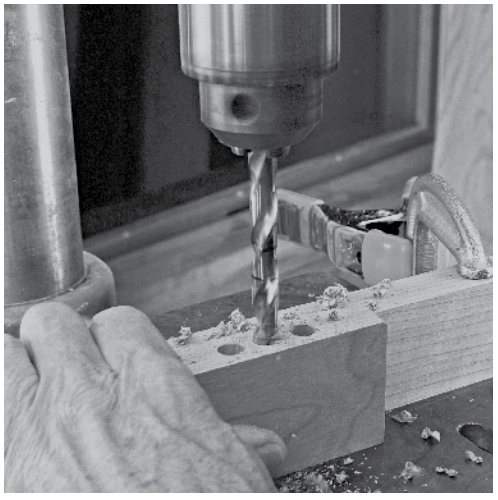
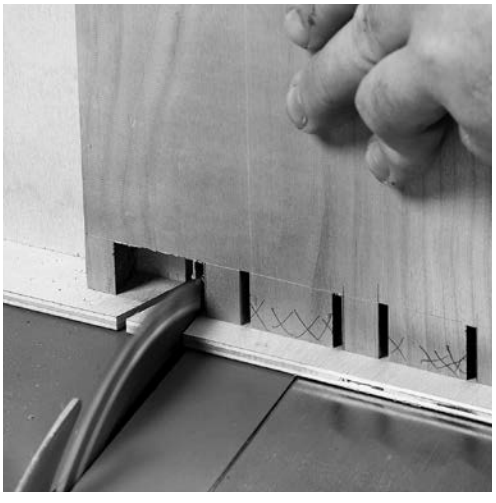
JOINERY

EDITORS OF **FINE WOODWORKING**





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ABOUT YOUR SAFETY: Working wood is inherently dangerous. Using hand or power tools improperly or ignoring safety practices can lead to permanent injury or even death. Don't try to perform operations you learn about here (or elsewhere) unless you're certain they are safe for you. If something about an operation doesn't feel right, don't do it. Look for another way. We want you to enjoy the craft, so please keep safety foremost in your mind whenever you're in the shop.

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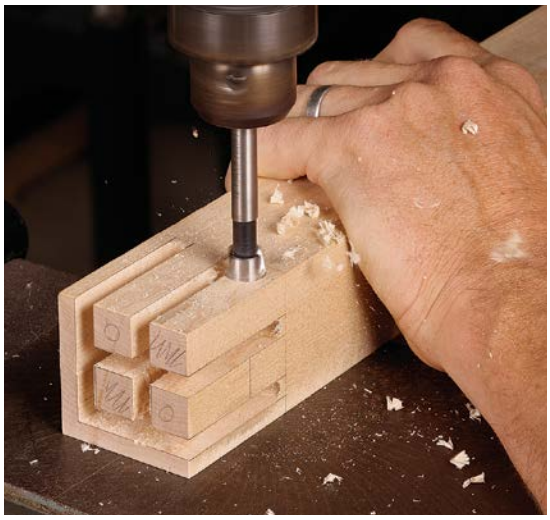


PART FOUR

Dovetails


WATERPROOF
Titebond III
ULTIMATE
Wood Glue

Introduction

Any piece you build in your woodshop is going to face a life-time of stress: drawers and doors get yanked open, tables and chairs get pushed around. Even Mother Nature gets in the game, by throwing in seasonal moisture swings that cause joints to swell and shrink. The defense against all of these attacks is tight-fitting, well-executed joinery.

Learning all you need to know about joinery, where and when each type is appropriate and how to cut it cleanly (by machine or hand), requires lots of training and practice. You'd have to take a number of classes and read lots of articles and books to master each one. But you're in luck.

Joinery is the book to have if you want to learn to cut basic joinery or want to up your game with more advanced techniques. It's a collection of the best joinery articles *Fine Woodworking* magazine has published in recent years, all written by expert woodworkers, each of whom has years of experience in the shop.

Every article is an in-depth look at how to execute any joint you can imagine, from basic pocket holes to complicated mitered dovetails. Along the way you'll get loads of tips on how to prevent glue squeeze-out, how to make joinery stronger, and how to fix common mistakes. You'll learn solid techniques for both hand- and machine-cut joints. And we've even tested a bunch of joints to see which are the strongest.

Read on, and soon you'll be building furniture like a pro, and building it to last. Enjoy your time in the shop.

Tom McKenna
Editor, *Fine Woodworking*

Cut Precise Joints on the Tablesaw

MARC ADAMS

The tablesaw can do more than make rectangles. If you add a dado set and a few shopmade jigs and fixtures, it can become your favorite machine for cutting flawless joinery, too. The tablesaw offers an unmatched combination of accuracy, repeatability, speed, control, and endless jig potential.

To produce joint-quality cuts, both across the grain and with it, you'll need two types of blades. You can stick with your normal combination blade, but make sure you keep the teeth clean of pitch buildup. A clean blade will always cut better. For wider notches in wood, whether rabbets, dadoes, grooves, tenons, or lap joints, I use an 8-in. stack dado set. Quality is very important here. You need a set that cuts clean edges and flat bottoms.

A dado set's inside and outside blades have angled teeth designed to eliminate tearout at the edges of the cut. A variety of chipper blades go between, allowing ¼-in.- to ⅞-in.-wide dadoes. Thin shims go in to fine-tune the width, if necessary. Be aware that dado sets take big cuts and can cause underpowered saws to bog down, and that the shorter arbors on some portable saws won't allow the full stack to be used.

Add a few key jigs and fixtures

You can cut most of the common joints on the tablesaw with just four simple jigs and fixtures: a zero-clearance throat plate, a miter-gauge extension fence, a crosscut sled, and a sacrificial fence for rabbeting. I'll cover the last one here.

Two Kinds of Blades Do It All

DADO
For many joinery cuts, you'll need a good dado set. Get the best stack-type dado set you can afford. It should cut slots with clean edges and flat bottoms.

COMBO
A basic combination blade is fine for miters and grooves. For the cleanest cuts, buy a good one and keep its teeth free of pitch.


SAVE

Ride the fence. Adams makes grooves with a single blade, making multiple cuts for wider grooves. A long push stick gives better downward pressure and control.

The cool thing about learning the fundamental joints, like dadoes and rabbets, is that the same techniques work for many others, such as laps, tongues, and bridle joints. In fact, the design of a tablesaw invites a host of joints and jigs. This chapter is just the beginning. Soon you'll be calling this versatile machine "the variety saw," like I do.

The simple groove

Grooves are the easiest joint to cut. Since they are aligned with the grain, you can use the rip fence to guide the workpiece. I normally use my combo blade, adjusting the fence and taking multiple passes for a wider groove. If the bottom needs to be dead flat, you can also use your dado set.

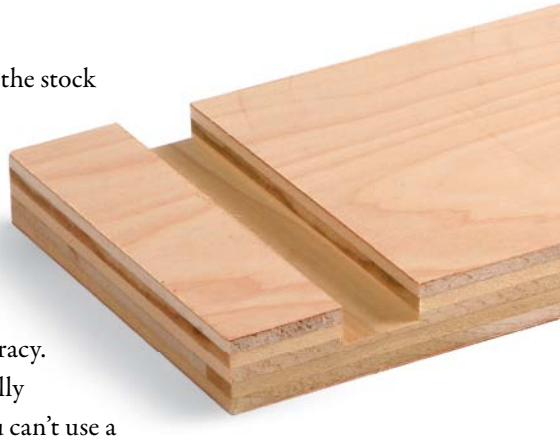
The advantage of the single blade is that it lets you use a riving knife to prevent kickback. If your saw doesn't have one, you can use a shopmade stub splitter.

Use a push pad for short pieces. On these shorter drawer sides, a push pad, lined with rubber and/or sandpaper, gives better control.

In any case, always use a push stick or push pads to maintain good control while keeping your fingers safe (you can't see the blade until it exits the board). Pay special attention to keeping the workpiece flat at the point of contact.

Clean dadoes

A dado is a groove cut across the grain and is usually sized precisely for a second piece to fit into. Since dadoes are crosscuts, tearout can be a problem without a zero-clearance surface below the cut. If the back edge will show, you'll need zero clearance there, too. You can use a variety of fences to make a dado cut safely, but it depends on the size of the workpiece and location of the dado. On wide workpieces with the dado close to the end of the piece, you can run the stock against the rip fence.



But the crosscut sled is my favorite tool for dadoing, because it carries pieces with excellent control and great accuracy. That control is especially important because you can't use a splitter or riving knife in conjunction with a dado set on most saws. A crosscut sled also accepts all types of stops.

Near an edge, ride the fence. You'll need a fresh throat plate to prevent tearout. Insert a blank one, position the rip fence to hold it down without getting in the way of the blade, and then bring the dado set up through it.

Push pad stars again. A push pad works better than a push stick to keep a big panel down on the table and tight to the rip fence.

In the middle, use a sled. To prevent tearout on a sled, tape down a piece of ¼-in.-thick MDF (above). Do the same on the fence (right), and then cut a zero-clearance slot through both.

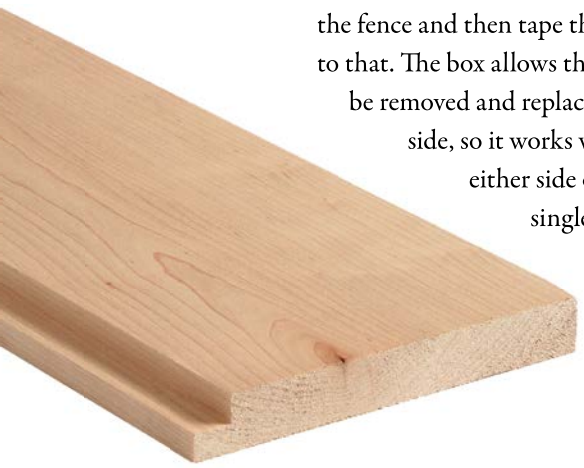
Why the sled is best. A crosscut sled controls workpieces of almost any size, and is a must for the middle dadoes on these long bookcase sides. A hook-style stop offers a long reach and is easy to attach.

Carpet tape grips better. To add holding power to jigs, Adams uses double-sided carpet tape with mesh inside. It is thicker and far stronger than the thin plasticky type.

Accurate rabbets

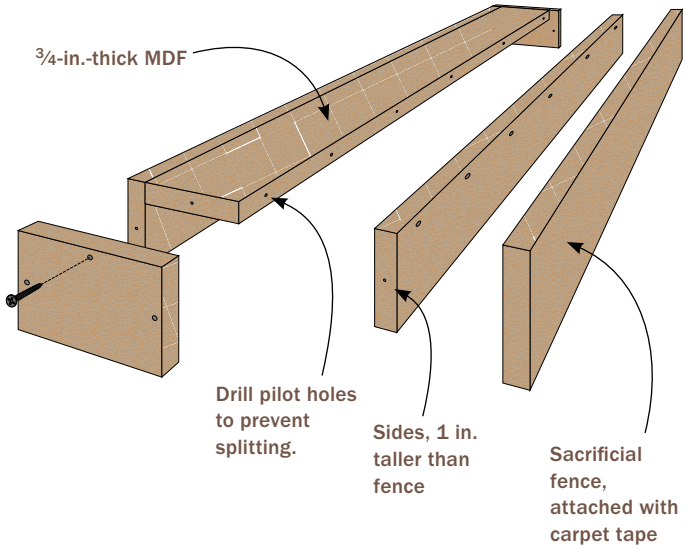
To cut rabbets, you should bury the dado set in a sacrificial rip fence. This makes it easy to adjust the width of the rabbet: You simply nudge the fence a bit instead of fine-tuning the width of the dado stack.

But a sacrificial fence can be hard to clamp to the short sides of a standard rip fence without the clamps getting in the way. My solution is to build a simple medium-density fiberboard (MDF) box that fits snugly over the fence and then tape the sacrificial piece to that. The box allows the sacrificial fence to be removed and replaced easily, on either side, so it works with the fence on either side of the blade. And a single piece of MDF can be positioned four different ways to extend its use.



Build a Box to Bury the Blades

Box must fit snugly on sides of rip fence, but gap is OK at top.



How to get a snug fit. Cut the sides 1 in. taller than the rip fence, and long enough to allow clearance for the lever at the end. Clamp the sides in place to measure for the top plate and attach it as shown. Drill pilot holes to prevent splitting. Keep the clamps on as you screw on the end caps.

Add the fence and bury the blades. Use thick carpet tape to attach a tall MDF fence (above), then move the fence over the top of the dado set and bring the spinning blades up into it (left), only as high as needed.

Fast, accurate rabbets. Whether the rabbets are along the edge (top) or end of a workpiece (bottom), you can run the workpiece against the fence. But you'll need a zero-clearance throat plate to prevent tearout when working across the grain. Push pads do a good job controlling the workpiece, but you'll need to support narrow workpieces with the miter gauge.



Tenons in minutes. Set the rip fence to position the first cut at the shoulder (above left), and make a series of nibbling cuts (above center) to finish the job. To cut the top and bottom of the tenon, change the height of the blades if necessary and just flip the workpiece on edge (above right).

Quick tenons

One way to cut tenons on the tablesaw is to first make shoulder cuts with the pieces lying flat, and then make the cheek cuts using a tenoning fixture. But my favorite method is to cut them with a dado set, which is faster and easier and works on larger workpieces. Long pieces are a problem on a tenoning jig, because they have to stand straight up in the air. With a dado set, the workpiece lies flat on the table, where it is easier to control. You can control the work with a miter gauge and use the rip fence as the stop. You'll need a zero-clearance throat plate to prevent tearout at the shoulders. I stack my dado set to about ¾ in. wide, and I always start with the stock against the rip fence for the first cut and then nibble away the rest. Do not lift the stock when you finish a cut; just keep a tight grip as you pull it back.

Start with the two opposite cheeks, testing the fit in one of your mortises as you dial in the setup. Then change the blade height to trim the tenons to width. You'll notice that the outside blades leave fine lines on the surface, but these will not affect joint strength. Some woodworkers leave the tenon a bit fat and finish the job with a shoulder or rabbeting plane. Using a test mortise, I am able to get a good fit right off the tablesaw.

Get Square First

To get even tenon shoulders, you need a perfectly square miter gauge. You can place a square or drafting triangle against the blade to check, but inconsistencies in the fence or blade can throw it off. Instead, do this simple test. It works for squaring up fences and blades for all sorts of joinery tasks. Rip parallel edges on a long piece of scrap, and mark one side for reference. Make a crosscut (photo inset left) and then flip one of the pieces. Set both against a straight surface like the rip fence (photo inset right). A gap means you need to adjust the miter gauge and try again.


Tight miters on a crosscut sled

The most common type of miter is the flat type used to join frame pieces. They often surround a plywood panel to make a door or a tabletop, and standard moldings are cut this way, too.

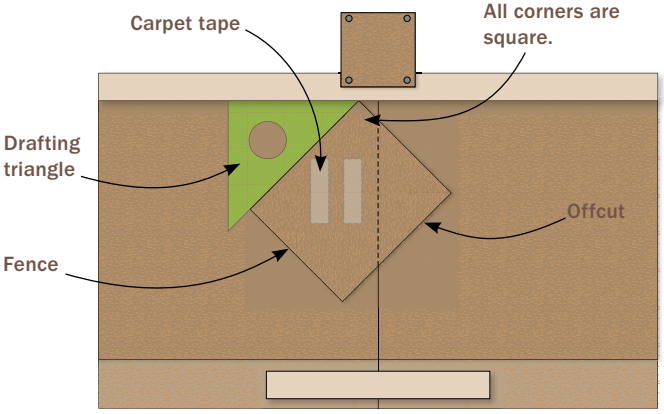
The challenge with flat miters is the wide cut, which makes it hard to end up with a 90° corner and no gaps. If you rely on your miter gauge, you will struggle with accuracy and repeatability. That's why I cut them on my crosscut sled using a simple 45° fence. You use the sled to make the fence, too, and the whole process is easy.

In this case, with flat stock and zero-clearance below the blade, you could keep the fence in one position for all of the miter cuts, simply flipping the pieces to miter the second side. But if the front of the stock is molded or you are getting chipout on the bottom edge, you'll want to flip the fence to the other side of the blade when cutting the second end of each piece, in order to keep the same side up.

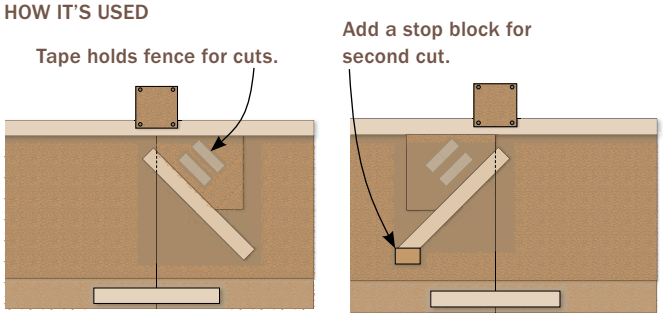
Aside from accuracy, what I love about this setup is how easy it is to attach a stop: You just tape it down.

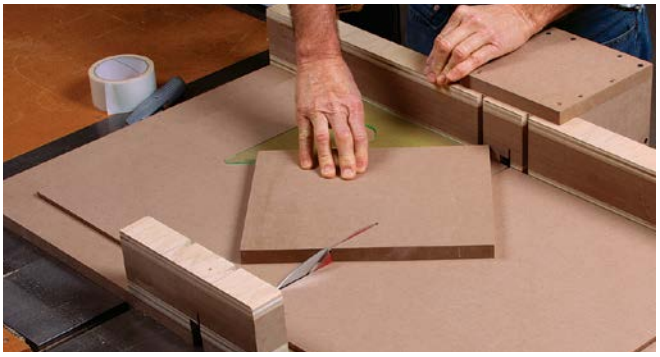
Make an Accurate Fence

Start with a perfectly square piece of MDF and use your crosscut sled to turn it into an accurate 45° fence.



HOW IT'S USED





Easy to make. Use a 45° drafting triangle to position the MDF fence on the sled. Use carpet tape to hold it down, but keep the triangle in place as you cut, to be sure the workpiece doesn't shift.

Miter one end of each workpiece. Put the fence on the left or right, pressing it down very firmly on the carpet tape, and then use it to miter one end of each workpiece. Hold the workpiece firmly to be sure it doesn't drift.

Switch sides. Flip the fence over to set it up on the other side. This time you'll need a stop to set the final length of each piece, but that's as simple as taping a block to the sled. The miters should come out perfect.

Pocket-Hole Joinery Is Fast and Strong

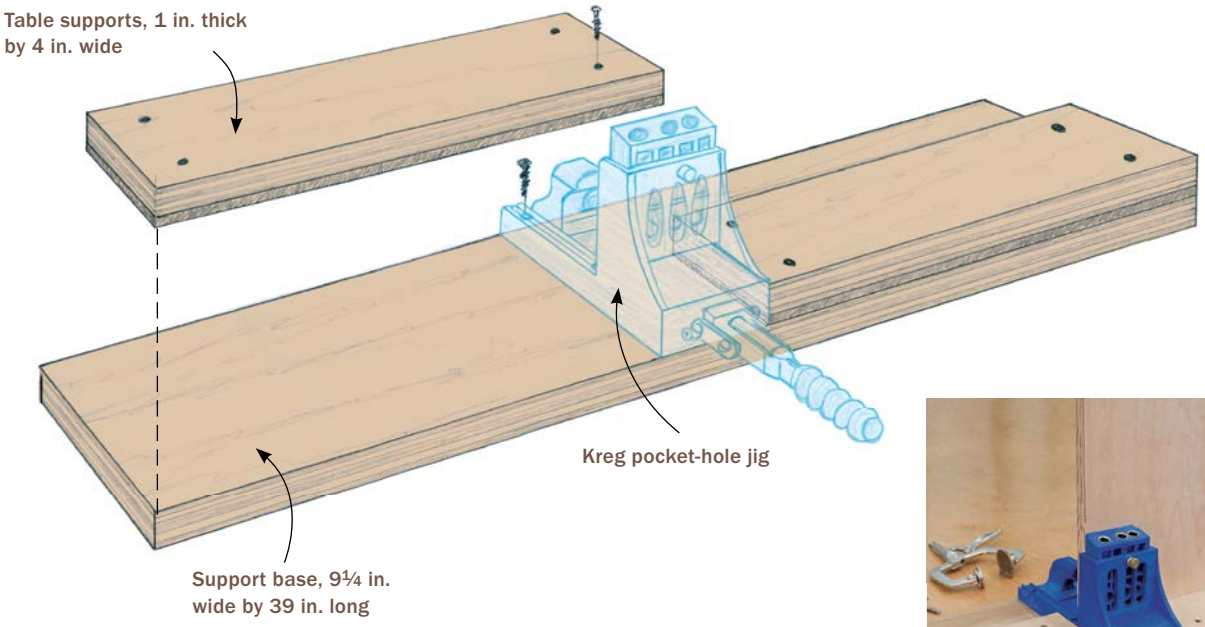
MARK EDMUNDSON

Get a good jig. Edmundson recommends the Kreg® Jig K4 Master System. It includes the jig, the drill and driver bits, and a good face clamp.

Pocket-hole joinery provides real advantages for beginning woodworkers and veterans alike. The first benefit is the relatively low cost of the tools. Second, pocket-hole joinery is easy to learn. If you can place a clamp and pull the trigger on a drill, you can start joining wood with pocket screws. The third advantage is speed. Pieces go together so quickly with this joint that it will redefine what you're able to build within a limited time. Last, if the joint is to be glued, there is no need to wait for the glue to dry to keep going with assembly.

None of this would matter if the joints weren't also strong. Luckily, pocket-hole joinery has that covered, too. The joint

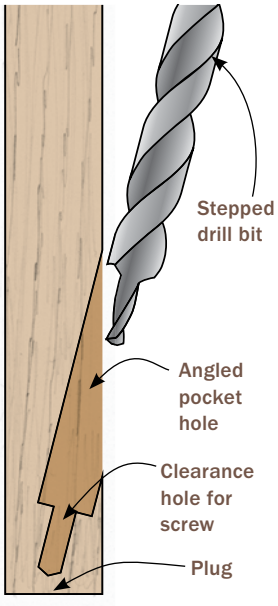
Use a Platform to Support Long Workpieces

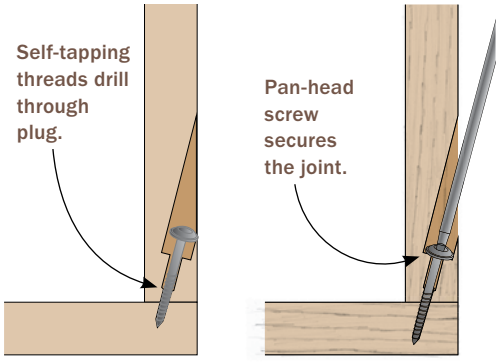


Build a base for the jig. To support long workpieces, build a platform from layers of plywood—a base below and two support tables on top. The support tables are equal to the thickness of the jig itself. The whole assembly can be quickly and easily clamped to a benchtop.

HOW IT WORKS

Drilling is fast and easy. Just make sure the jig and stop collar are set properly for your stock thickness.





Notice how the stepped drill bit leaves a small plug of wood at the bottom of the smaller hole (left). That is critical, as it stops the screw from creeping sideways when it enters the mating piece of wood. The screw's self-tapping tip will drill its own pilot hole in most woods, and the pan-type head seats firmly in the stepped hole (above right).

Flat frames. Clamp them flush. To keep the joints level, use a face clamp to align the frame parts when driving screws.

Casework. When building a cabinet, use a simple right-angle jig to support the big plywood pieces (above) while you attach lightweight bar clamps. Place a clamp at each screw hole to keep the parts from shifting (right).

won't come apart without a good deal of force ... and without taking a fair amount of wood with it. Of course, the pocket hole itself is not pretty. So this joinery method is not appropriate for everything you make. Even if you can hide the holes, you might not want them lurking under an edge where hands might find them. I avoid situations where the screw cannot be hidden from view and the pocket hole has to be plugged. Gluing and trimming the plugs is more difficult and time-consuming than you'd imagine. They don't pare very well and the fit is not exactly tight. In the end, they don't look good.

Fortunately, I can almost always hide the holes: on the back or underside of pieces, on the wall side of a cabinet, behind an end cap, or inside a drawer opening, for example.

The basics

Like a toenail in carpentry, a pocket screw goes into the side of one board at an angle and then down into the board below. But the screw threads make these joints many times stronger than their nailed counterparts.

Before getting started, you have to buy a few pieces of equipment. First, you need a jig, which guides a stepped drill into the workpiece. The drill bit creates a "pocket" that lets the screw seat firmly in the top piece, and includes a stop collar that bumps against the jig to control drilling depth. Pocket screws have a self-tapping auger point that eliminates the need for a pilot hole in the lower workpiece. Occasionally, if the bottom piece is especially knotty or narrow, and thus prone to splitting, you will need to drill a pilot hole.

Last, you need some way to immobilize the pieces when you are screwing them together. A face clamp handles the situations where both pieces are lying flat, as when building a face frame (see the top photo on the facing page). For right-angle joints I make a simple clamping jig (see the bottom photos on the facing page).

If you're buying your first pocket-hole jig, my advice is to go with the Kreg Jig K4 Master System. This jig can be mounted both to the bench, for speed, and directly onto the workpiece, which is essential on big panels. It comes with everything you need to get started.

Don't let the workpiece move

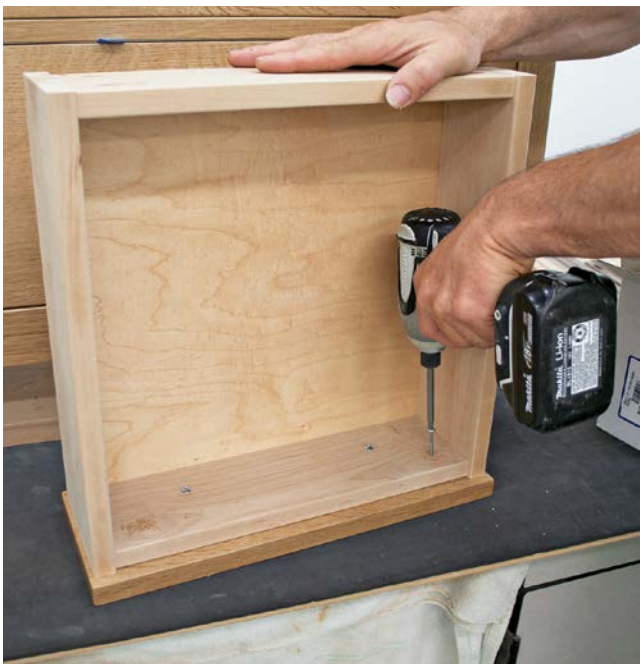
Other than the look of the pocket holes themselves, the complaint most often heard with pocket-hole joinery is that pieces shift as they are joined. This occurs because the screw pulls the wood in the direction that it is driven.

The first key to preventing shift is clamping the workpieces firmly in place as you screw them together, either with the face clamp or bar clamps. The second key is to have the stop collar on the drill bit set up properly. Notice in the drawing on p. 13 that the pocket hole does not go all the way through the top piece, but stops about 1/16 in. from the bottom edge. This last little piece of wood is important. It serves as a plug around the tip of the screw to keep it from wandering as the tip transfers from the vertical piece into the mating piece.

If all else fails, try preshifting the workpieces as you clamp them, offsetting them slightly away from the direction of the shift. The screw action will then pull them into alignment.

Partitions. To keep vertical partitions from shifting as he screws them in, Edmundson uses horizontal drawer partitions as spacers at the top and bottom (top). He makes other spacers to locate the horizontal partitions (above).

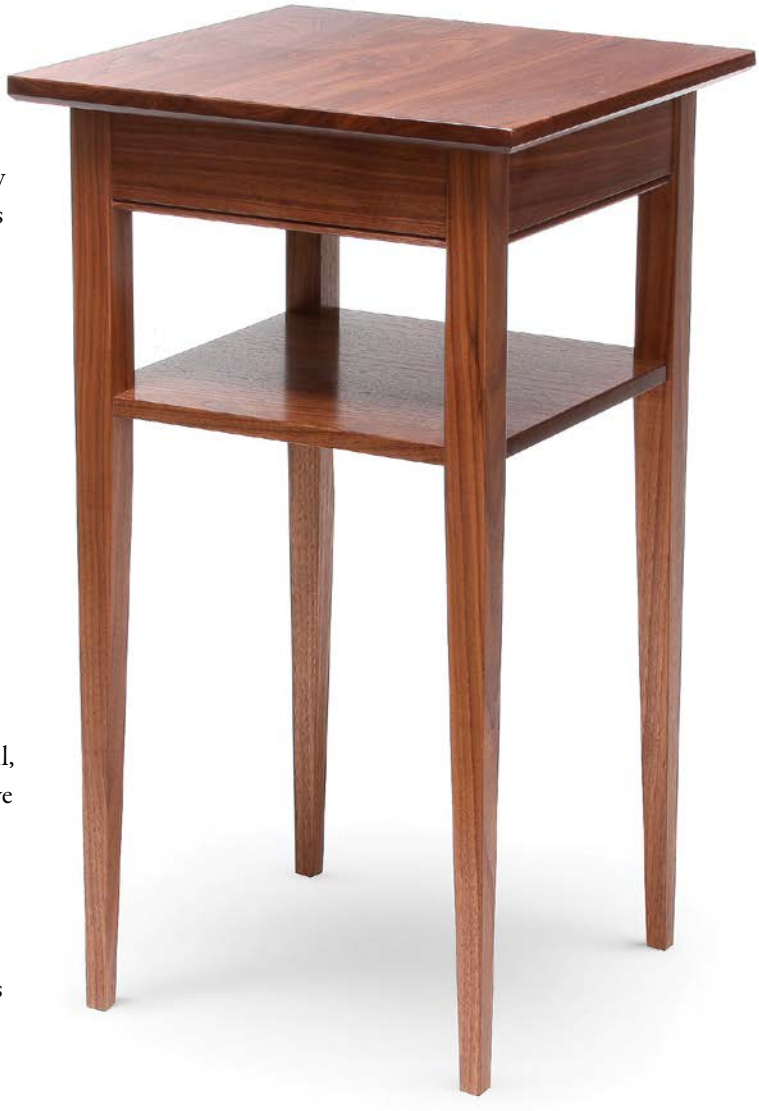
Attaching face frames. In this area, the drawer will hide the pocket holes. Apply the first vertical piece (stile), then the next row of rails, then another vertical, and so on.



Easy drawer boxes with false fronts. Edmundson uses his right-angle clamping jig to hold the drawer parts for assembly (above left). Then he attaches a false front to hide the screw holes at the front of the drawer box (above right).

Make Strong, Simple Joints with Dowels

ASA CHRISTIANA



In all of woodworking, no joint is as undervalued or underused as the one held together by the lowly dowel. Why? The answer lies in a mountain of broken chairs and cabinets. Decades of bad factory-made furniture have given the sturdy little peg a rickety reputation. But savvy pros know better. Dowel joints offer a simple, strong way to make fine furniture, and they often succeed where other joints can't.

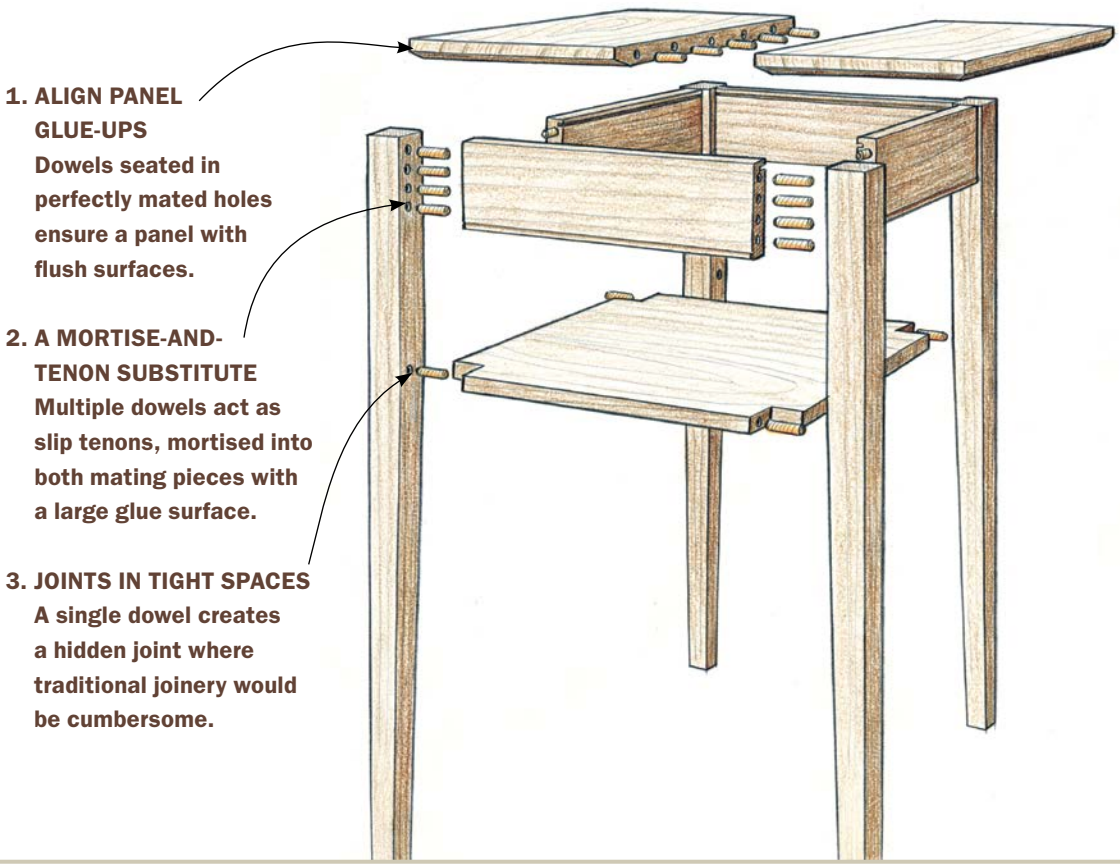
Dowels are easy to use in part because they are cylindrical, meaning you can quickly create accurate holes for them using a handheld drill. As to strength, our most recent joint test showed that properly executed dowel joints are strong enough for all but the most demanding applications. This strength means you only have to make simple butt joints before drilling holes. And the best news, especially for beginning woodworkers, is that all you need is that drill, a couple of good drill bits, and an inexpensive jig. Here are my favorite ways to use dowels.

Align glued-up panels perfectly

Woodworkers often edge-glue several boards into a panel for a wide part like a door or tabletop. Dowels work well to keep the boards aligned so their surfaces stay flush.

To mark out for the joinery, draw tick marks across the joints, about 6 in. or 8 in.

Shaker Table Shows That These Humble Pegs Can Do It All



Secrets of Success

A good dowel joint depends on a snug fit between dowel and hole. Hardware-store dowels won't do, but good, cheap dowels are available from online woodworking suppliers.

To drill accurate holes, use a brad-point bit. Its center spur prevents the bit from wandering and enlarging the hole. To keep mating holes aligned and ensure that the holes are square to the surface, you'll need a doweling jig. The model from Rockler™ at left works with dowels of 3/8-in. diameter, a good all-purpose size.

For places where the jig can't go, a set of dowel centers is a smart accessory. These metal plugs (left photo, center) fit a hole precisely and transfer its location to the mating piece.

A lengthwise slit releases air and excess glue. A simple bandsaw jig handles the task safely.

Ensure a strong joint. The strength in a panel glue-up comes from the large long-grain mating surfaces. Be sure to apply glue on these surfaces as well as in the dowel holes, spreading it evenly inside and out.

apart. Use these marks to align the doweling jig for drilling. This joint's strength comes from the long, edge-grain glue surface, so the dowels don't need to be numerous or large. I usually use ⅜-in.-dia. dowels, unless the panel is less than ⅝ in. thick.

Be sure to drill 1/16 in. or so deeper than needed to hold excess glue when the joint goes together. Also, when gluing any dowel joints, don't put glue on the dowel itself; the hole will scrape it off and create a mess. Instead, put glue in each hole and spread it with a small brush or stick.

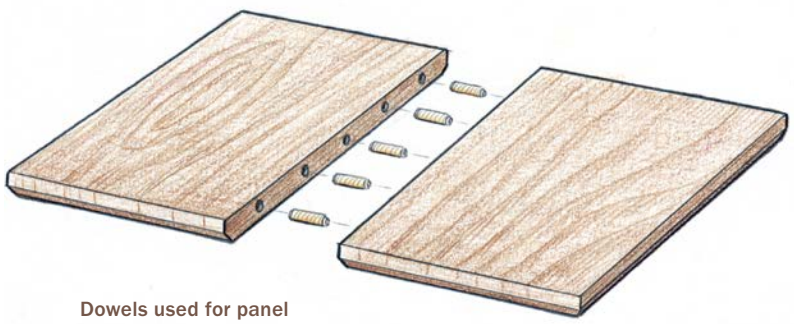
Build sturdy tables, doors, and cabinets

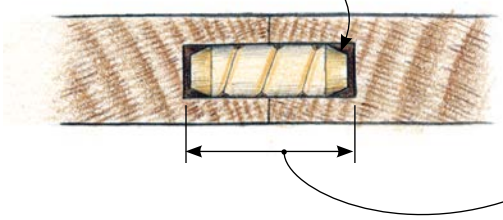
Almost any joint that calls for a mortise and tenon—table bases, door frames, face frames—is a candidate for dowel joinery.

Because this joint relies exclusively on the dowels for strength, you need longer dowels—and more of them. A good rule for

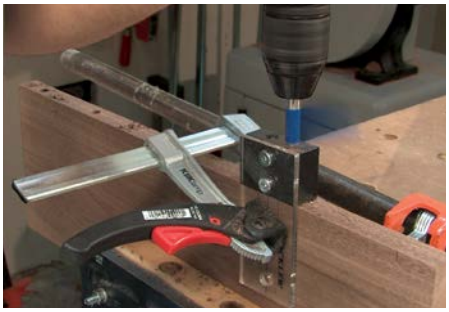
Glue Up Perfect Panels

Set the depth. Insert the drill bit into the doweling jig until the point protrudes to the desired depth. To create a simple depth stop, wrap a piece of painter's tape into a "flag" around the bit where it enters the top of the jig.





Layout is simple. Make a series of pencil marks squarely across each joint to locate the mating holes.



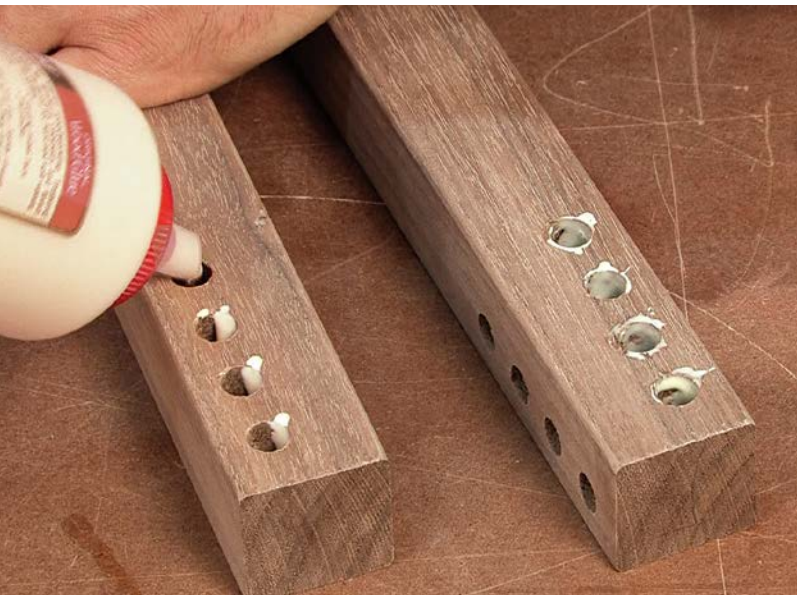
Drill the holes. Registration marks on the doweling jig align with your pencil marks to locate the jig. When the depth-stop flag begins sweeping chips from the work surface, you've reached the correct depth.

dowel size here is one-half the thickness of the workpiece, with ¾ in. or more extending into each hole. A ⅜-in.-dia., 2-in.-long dowel works great in most situations. To ensure that the holes in the mating pieces line up accurately, start with the jig referenced along a common edge. In this case, use the top edge of the rail and the top of the leg, which will be flush when the pieces are assembled. Also, don't apply glue to the mating surfaces. The end grain won't add much strength and you'll get excess squeeze-out, which is best avoided.

Hide a joint where there's no room to hide

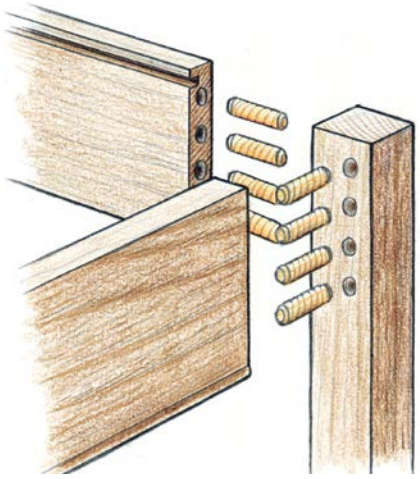
Furniture makers often draft an overall design for a piece first and sort out the joinery afterward. This allows creative freedom but can lead to situations where traditional joinery won't work.

One example is the lower shelf on the table on p. 17. Rest it on stretchers or cleats and it will look clunky. Traditional joinery would be difficult to execute or visually distracting.



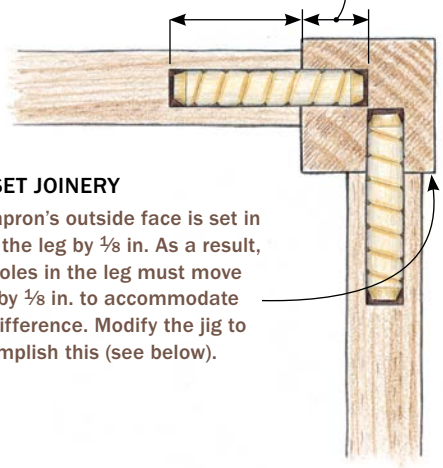
Only the holes. The leg-to-apron joint derives no real strength from glue on the mating surfaces, so apply glue to the dowel holes only.

Build Strong Joints



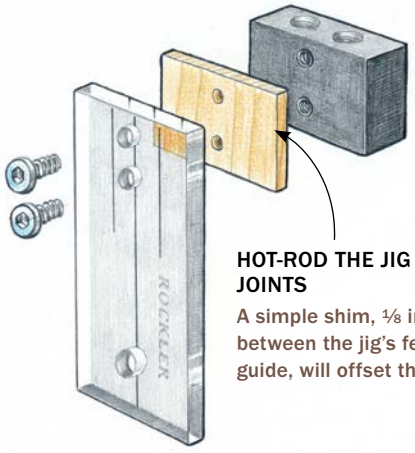
HOLE DEPTHS DIFFER

With a 2-in. dowel, the holes in the leg must be shallower to avoid interfering with one another.



OFFSET JOINERY

The apron's outside face is set in from the leg by ⅛ in. As a result, the holes in the leg must move over by ⅛ in. to accommodate the difference. Modify the jig to accomplish this (see below).

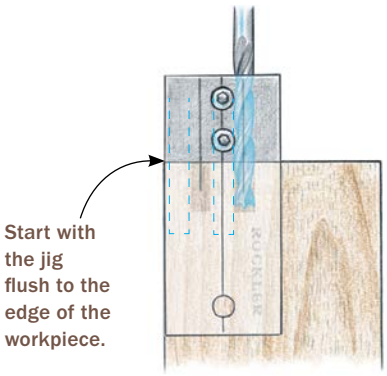


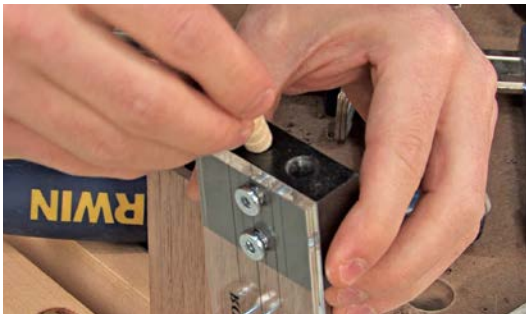
HOT-ROD THE JIG FOR OFFSET JOINTS

A simple shim, ⅛ in. thick, bolted between the jig's fence and drill guide, will offset the holes in the leg.

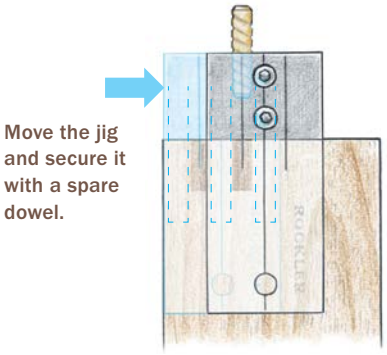
Trick for Accurate Spacing

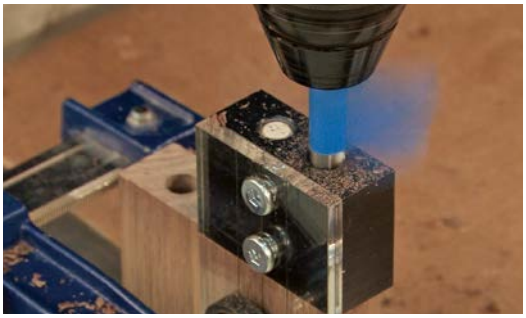
Drilling the first two holes. Secure the apron in a vise and clamp the jig so its edge is flush with the top of the apron.



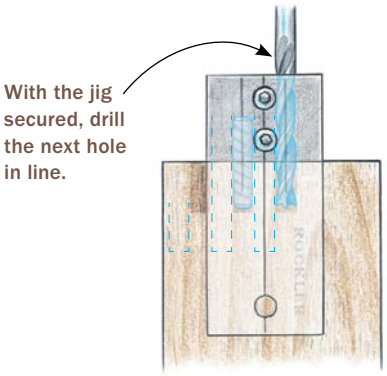


Move the jig over. To continue the line of holes beyond the jig's reach, use a dowel to hold the jig in the last hole you drilled.





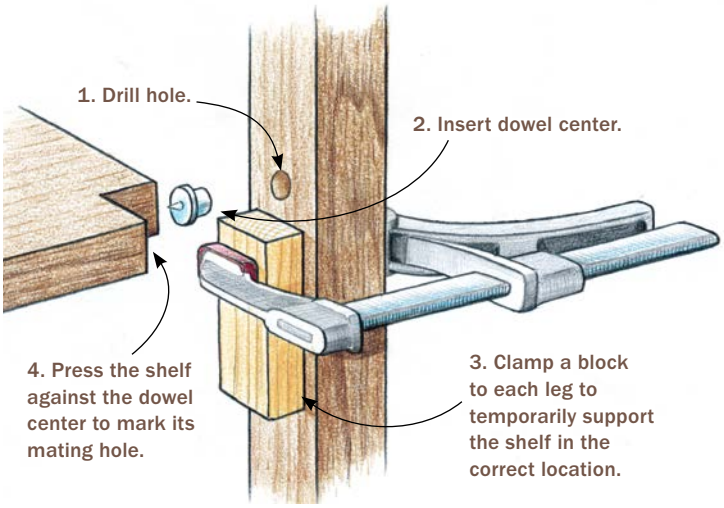
Drill and repeat. With the jig secured, drill the next hole. Repeat as needed for a line of evenly spaced holes.



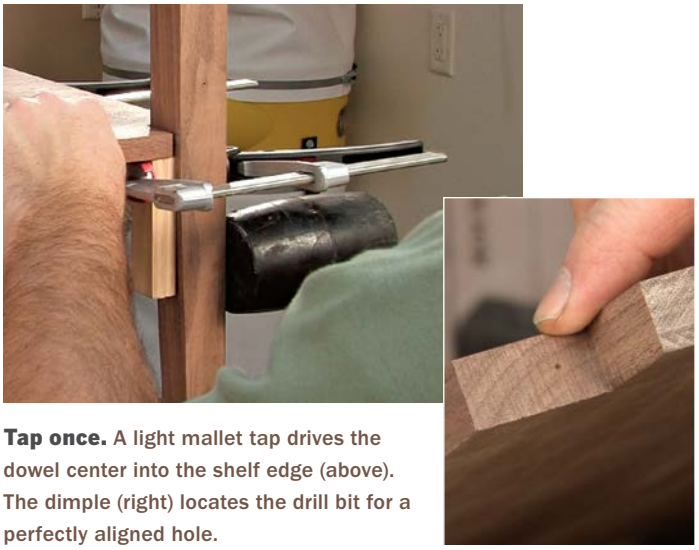
Drill like usual. Drill the leg holes with the jig shimmed out by ⅛ in. (far left). When the joint comes together, the apron will have an attractive reveal (left).

Dowels offer a clean solution. You can use the jig to drill the dowel holes in the table legs, but the jig won't work on the small, notched corners of the shelf. Instead, dry-fit the legs to the aprons, and clamp a support block to each leg so that its top is level with the shelf bottom. Then insert a dowel center into each hole and rest the shelf on the blocks. A light mallet tap on the outside of each leg will press the dowel center's point into the shelf edge, marking for the mating hole. Now drill the dowel hole in the shelf edge. Again, place glue only in the dowel holes.

Dowel Centers Solve Tricky Joints



Locate the shelf. A support block clamped to the leg holds the shelf in place.



Tap once. A light mallet tap drives the dowel center into the shelf edge (above). The dimple (right) locates the drill bit for a perfectly aligned hole.

Drill the shelf edge. Eyeball the drill and the edge of the shelf to make sure the hole is straight and square.

Fine Furniture with Biscuit Joints

MICHAEL C. FORTUNE

If you ask a furniture maker about joinery for fine furniture, you're sure to hear about dovetails, mortises, tenons, dadoes, and even rabbets. But I'd be surprised if biscuits were mentioned, unless only to explain how they have no place in high-end work. That's a shame, because there are some joints where a biscuit is the best solution. They're great for joining the rails and stiles of a face frame, attaching a solid-wood frame around a veneered panel, tabletop, or door, or joining a leg to a veneered panel. Biscuits also let me build more adventurous furniture that would be difficult with traditional joinery.

Perhaps the biggest reason why biscuits have been dismissed by many furniture makers is that biscuit joiners seem incapable of accuracy. The cutter's rotation has a tendency to jerk the machine sideways when you start the cut. Also, biscuit joiners can be difficult to hold and they have small fences, so they jump around and lift off the work. However, I've found a great solution to all of these problems: Turn your biscuit joiner into a stationary tool by attaching it to a shopmade table.

Attached to the table, the biscuit joiner really does have a place in fine furniture. I'll show you where it's smart to use one and how to get the best results.

(Continued)

Break Through to New Designs

When designing, Fortune doesn't worry about construction. He figures it out later. Keeping his mind open, he's found the biscuit joint to be reliable and, more importantly, versatile, allowing him to build furniture that would be impossible with traditional joints like the mortise and tenon.

Make a pyramid. Biscuits join four triangles to make this plywood door and the drawer fronts.

Join a side to legs. Biscuits make a solid connection between wide veneered panels and solid wood.

Wrap a veneered top in solid wood. Biscuits join the wood to the panel and reinforce the miter joints.

Jig Cures the Jitters

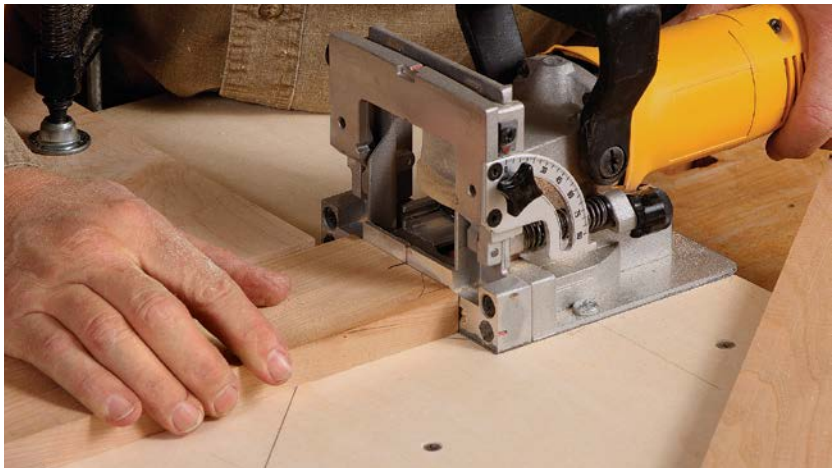
The biggest problem with a biscuit joiner is how much it wants to move around when you use it handheld. To stop it cold, bolt it to this table.

Bolt it down. Attached to a table, a biscuit joiner is easier to control and produces spot-on joinery.

A smarter way to make face frames. Mortise-and-tenon joinery is overkill for a face frame, because after it's attached, the cabinet gives the frame more than enough strength to stay together over the long haul. Replace the mortises and tenons with biscuits, a far easier joint to make. But don't try this with doors and table aprons: They need the strength of a full mortise and tenon.

Stop block does double duty. It aligns the rail and stile with the cutter. And because the cutter's rotation forces them into the stop, it prevents them from shifting during the cut.

Slot the stile. Because of the table and the stop block, you need worry about only two things: holding the stile firmly against the joiner and pushing the cutter into the stile.



Repeat for the rail. The stop block hasn't moved, so just put down the rail and cut the slot. You'll need to flip the parts to do the joint at the opposite end of the rail, so you won't be referencing off the same face. But don't worry: The biscuits will still line up.

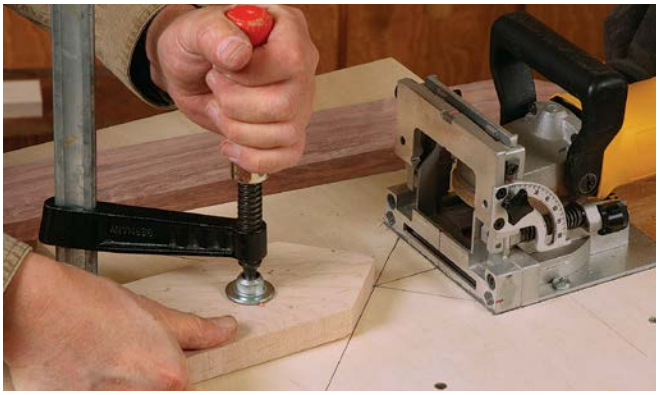
Wrap a veneered tabletop with solid wood. Tabletops made from veneered panels can be quite attractive. They also are more stable than a solid-wood panel and so, less likely to cup. But their edges are unattractive and prone to chipping. The best approach is to glue a broad, solid-wood frame around the panel, reinforcing the joints with biscuits.

When and where to use biscuits

Biscuits can be used to join two solid-wood parts, two veneered panels, and solid wood to a veneered panel. But they can't be used everywhere. Don't use them for heavily stressed joints, like those in a chair, or for joints that hold a lot of weight, like those attaching shelves to a bookcase.

OK, that covers where to use them, but not how. A strong biscuit joint is a balancing act. You need enough biscuits to create adequate glue surface, but not so many that their slots significantly weaken the two parts you're joining. I follow these guidelines to determine how many biscuits a joint can handle and where to put them: First, biscuits should be at least 3⁄16 in. from the top surface and 1⁄8 in. above the bottom one. Second, slots should be at least 1⁄4 in. away from any edge—any closer and the remaining material is too weak. Likewise, the minimum spacing between slots is 1⁄4 in., but I typically space them 2 in. to 3 in. apart.

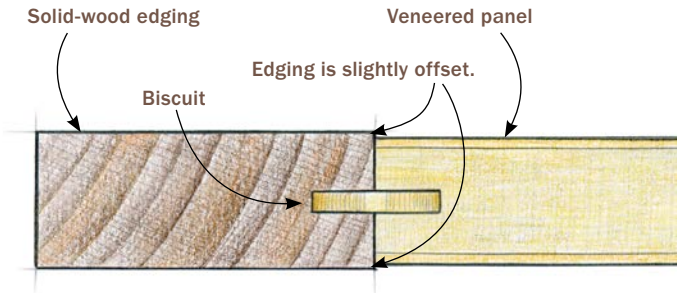
Start with the miter joint. Use a pointed stop block for this joint. Be sure the point forms a perfect 90° angle. To locate the stop block align the joint's centerline with the joiner and trace the part's edge on the table. Repeat for the second part.



Clamp the stop in place. Its point is at the intersection of the two lines, located so that the parts fit snugly between it and the joiner.

Two jobs again. The stop both aligns the parts and provides some resistance against the cutter. Still, hold the part firmly against it.

Offset the Frame, and Plane It Flush



Tape under the panel centers it on the thicker edging. Plane the offset flush after assembly.

Cut slots for the frame's edge. Continuous splines remove too much wood and weaken the joint. Biscuits are a better choice. A fence clamped to the table keeps the workpiece firmly against the joiner, but lets you quickly slide it from one slot to the next.

Raise the panel with a strip of tape. This creates the offset between the frame and panel. Make sure to slot the panel with the face down. Lean into the panel to keep it against the joiner during the cut. A short support stand (bottom right) comes in handy.

Finally, go easy on the glue and apply it only to the slots (spreading it around) and, of course, the mating edges of the parts. Then wait at least 24 hours after glue-up before you sand or plane the parts. Biscuits are compressed during manufacture, and water in the glue causes them to expand and push out on the material surrounding the slot. That creates a slight bump on the surface. If you sand or plane too soon, that bump becomes an indentation after the biscuit dries out and shrinks.

Lock it down

After a lot of frustration and sloppy joints, and just as I was ready to give up on the biscuit joiner for furniture, I decided to try something new. I designed a benchtop table and bolted my joiner to it (see p. 25). Attached to the table, it can't jump because of the cutter's rotation or lift off the workpiece. Now it lives on the table and I almost never need to take it off.

The table is nothing more than a plywood base attached to two sled feet. The feet have

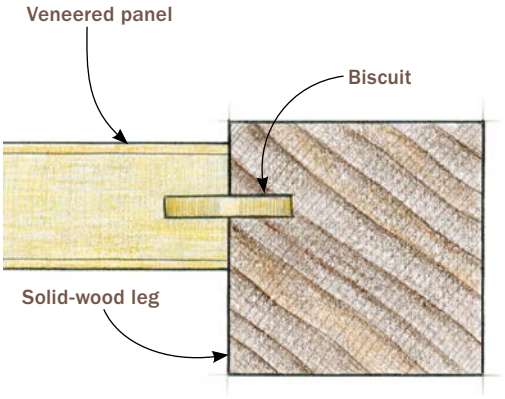
Join a side panel to a leg. Splines, dowels, and tenons are more hassle than they're worth here. A biscuit joint can be cut much more quickly and provides plenty of strength.

flats that allow me to clamp the table to my workbench, putting the biscuit joiner at a comfortable height. The joiner is bolted to one edge of the plywood, leaving a large open workspace where I can temporarily attach stop blocks and toggle clamps as needed.

The stop blocks (and an occasional fence) do two jobs. First, I set them up so that they align workpieces to the cutter. Second, when possible I locate them so that they help the workpiece resist the force of the cutter, and that makes for a cleaner and more accurate slot. As for the toggle clamps, I put them on their own bases, which are then clamped down, making my work much more efficient because it's quicker to clamp down a block

Shim the Joiner

Panels are typically set back from the edge of a leg. To create that offset, put a shim under the joiner. The thickness of the shim determines the amount of offset.



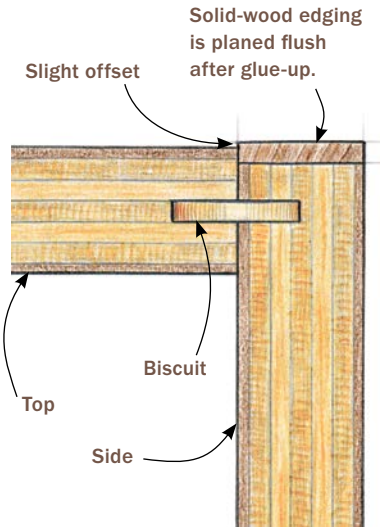
Put a spacer under the joiner. The spacer raises the cutter to offset the slots in the leg. Vary its thickness to vary the offset and remove it for slotting the panel.

Hold the leg with a clamp. Fortune's De-Sta-Co®-style plunge clamp lives on a square of plywood so that he can put it wherever it's needed on a variety of biscuiting setups.

Perfect case joints every time. In theory it's no problem to join two case panels with biscuits, but in practice it can be difficult. Murphy's Law always seems to kick in and the top ends up proud of the side.

Control the Offset

Adding tape to the table ensures that the panels align the way you want.



Tape creates an offset. The top is raised slightly and, after assembly, it ends up just beneath the top end of the side.

and unclamp it when you're done using it than it is to screw down a clamp and unscrew it when you're done. Also, it keeps the table free of screw holes.

I glue 100-grit sandpaper to the faces of all of my stop blocks so they grip better. I also rabbet the bottom edge, because biscuit joiners eject dust from the front of the machine. Without the rabbet, dust builds up on the front of the stop block, pushing the workpiece out of alignment.

Add a clamp for the side. Attach it to a square of plywood that can be clamped to the table (left). That way, it's quicker to switch between using the clamp and not. Be sure the side isn't resting on the tape.

Double Bridle Joint

IAN GODFREY

When I was learning to build furniture at the Inside Passage School in British Columbia, I saw a chair by College of the Redwoods graduate Ben Green that used a double bridle joint. I immediately admired the joint for its strength and understated beauty.

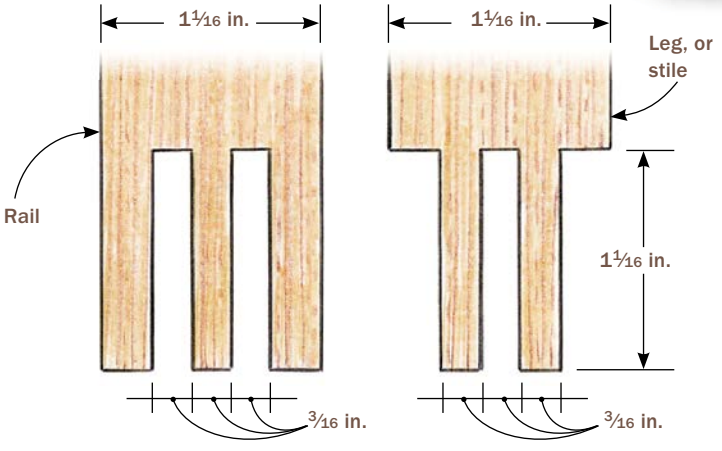
Unlike the standard bridle joint, which is often used in cabinet-door frames, the double bridle joint is better suited to a structural role in furniture. The double mortises and interlocking tenons provide ample glue surface, making the joint incredibly strong even in narrow stock.

With an alternating pattern of end grain and edge grain, the joint is handsome enough. But it also can be dressed up with a mitered inside corner that can be shaped to create a smooth transition from rail to leg. I have been using the joint since I first saw it. It is great for joining a leg and sled foot for a stool, chair, or bench.

Here I'll show you how to cut the basic joint for a tight fit with minimal fussing. Then I'll show you how to cut and shape the mitered corner.

Strength and Beauty

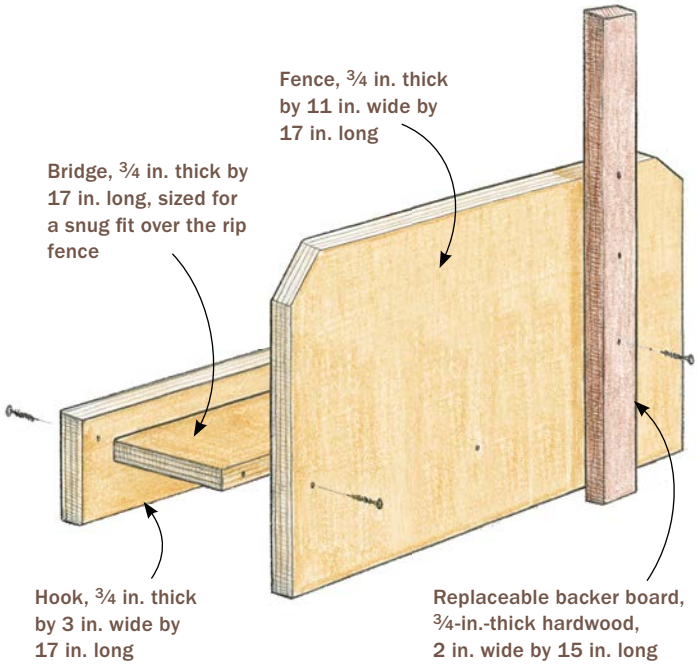
With its interlocking tenons, the double bridle joint ensures plenty of glue surface for a strong, long-lasting connection. The exposed joint draws the eye and is easily shaped to invite the hand, as on Godfrey's Danish-cord bench.



Layout helper. Godfrey uses adhesive paper to mark the layout on setup pieces. The paper makes it easy to see layout lines and prevents the pencil from wandering on coarse-textured stock.

Simple Jig for the Tenons

To cut the twin tenons, Godfrey uses a plywood jig that rides the rip fence. A rip blade with a flat-top grind ensures flat-bottomed cuts. A backer board prevents tearout and holds the work squarely to the table (attach the backer with screws so it can be replaced as needed). He coats the bottom of the bridge with wax to help it travel easily along the saw's fence.



Start with the tenons

I cut the joint at the tablesaw and rely on setup pieces to help dial in the fit. You'll need a pair of them, one for each half of the joint. Use a full-size drawing to transfer the layout for the joinery to these pieces.

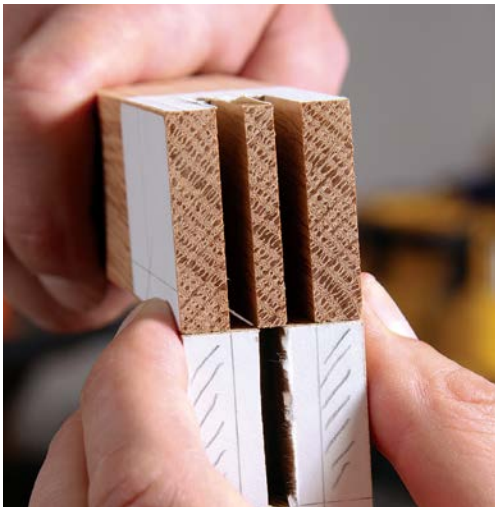
I cut the interlocking portion using a shop-built tenoning jig and a rip blade for a clean, flat-bottomed cut. The blade height will remain the same throughout this process, so get it set precisely using one of the setup pieces.

Start with the center mortise on the stile (or leg) and alternate between that and the mating rail as you go. To position the fence, align the blade with the layout line of one of the tenon cheeks (see the top photos on p. 34).

With the fence set, clamp the stile to the tenoning jig, making sure that it is tight against the saw table, the jig's fence, and the backer board, and make the cut. I typically design the mortise to be a little wider than the kerf of my sawblade. This lets me rotate the piece front to back to make the second cut and create a perfectly centered joint. To cut the twin mortises in the rail, use the setup piece to set the fence. Cut one cheek, then rotate the workpiece to cut the same cheek on the opposite side. Adjust the fence to cut the opposite walls. With this done,

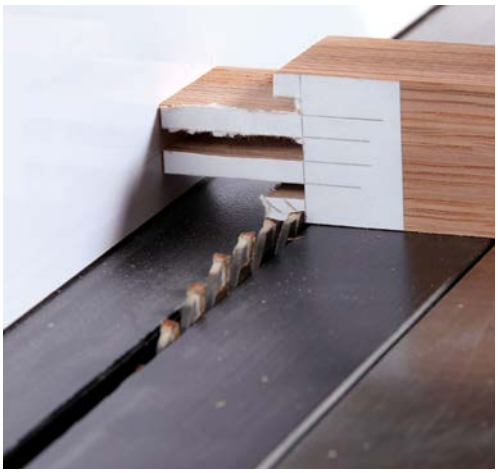
Stile mortise. Align the blade to one face of the tenon cheek. Make a cut, then rotate the stock to cut the other cheek for a perfectly centered mortise. The blade height stays the same until you cut the shoulders.

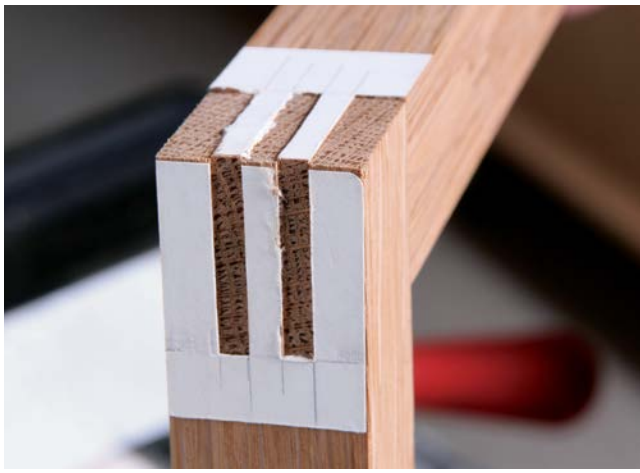
Rail mortises. Align the blade to one side of a mortise. Make a cut, and rotate the stock to make the same cut in the second mortise. Adjust the fence and repeat the process to finish the mortises. Eyeball the fit.



Stile cheeks. Cut the outside cheeks of the tenons one at a time, leaving a tab on each side. Remove most of the tab on the bandsaw so you can check the fit before trimming the shoulders on the tablesaw.

Stile shoulders. Trim the shoulders using a miter gauge and the fence as a stop block so the cut is right on the shoulder line. The joint should come together at this point.



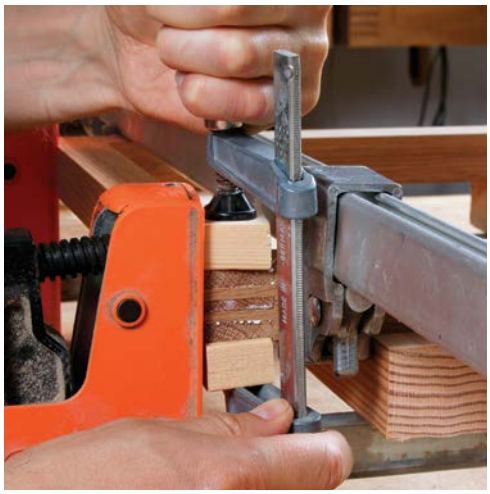


Sanding block for tight spaces. To ease a too-snug fit, Godfrey carefully sands using P120-grit paper glued to a thin plywood sanding block.

switch back to the stile and cut the outer cheeks of the two interlocking tenons. The final step is to remove the tabs of waste left behind when you cut these outer cheeks. First cut away the ends of these tabs at the bandsaw. This way, you can check the fit without altering the tablesaw setup.

When you're sure of the fit, use the tablesaw and miter gauge to cut the tenon shoulders. Reset the blade height so that it just removes the waste and does not cut into the tenons. You'll use the fence as a stop block. Position it to locate the cut in line with the base of the tenons. An added benefit of removing material at the bandsaw

Fine-tune and glue up. The final step is to fine-tune the fit if necessary and assemble the parts.



Elevate the work for glue-up. Godfrey supports the work on blocks and clamps each joint in both directions, ensuring that the joint fully seats. Finally, he clamps vertically across each joint (above) to ensure a good bond.

first is that you make the tablesaw cut safely, without binding the waste material between the blade and fence.

The joint should come together under moderate pressure with a snug friction fit. If it's too snug, lightly sand the tenons with P120-grit sandpaper on a flat sanding block. Once the fit is perfect, glue up the joints.

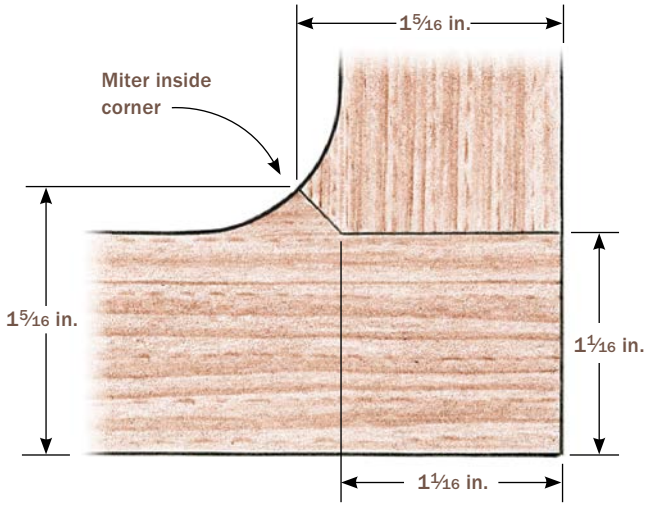
Mitered haunch is easy to do

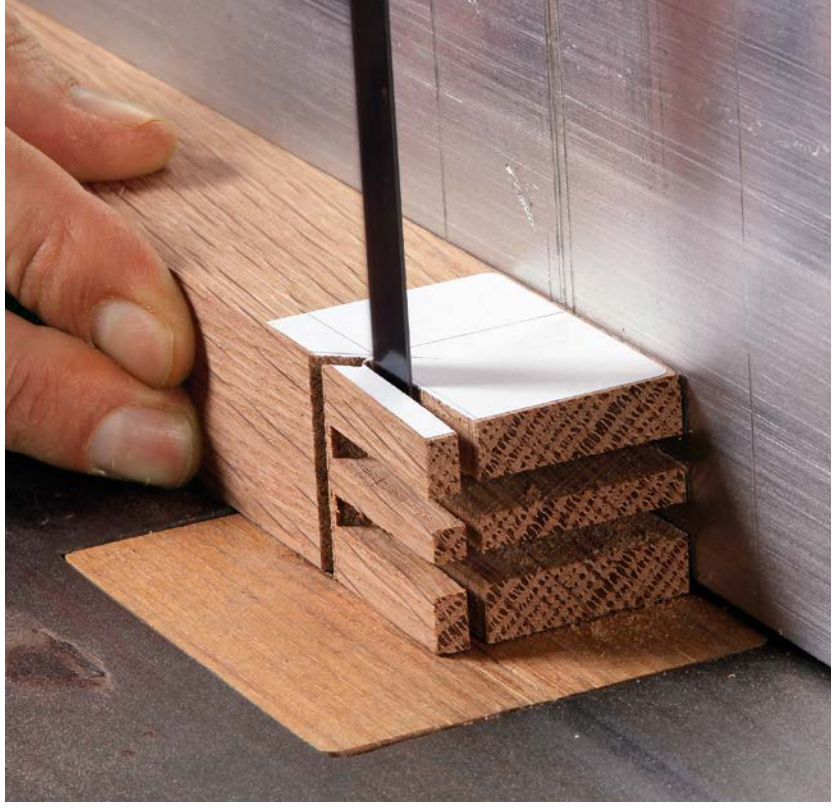
The mitered version of the double bridle is cut the same way as the standard version. You just have to cut the stock a bit oversize so you'll have enough material to create the miters.

After cutting the interlocking portion of the joint, cut the miter on the inside edge of

Add a Miter for a Rounded Inside Corner

Godfrey's Danish-style rocker features the double-bridle joint at both the armrests and the rockers. Each joint is enhanced with a contoured inside miter.



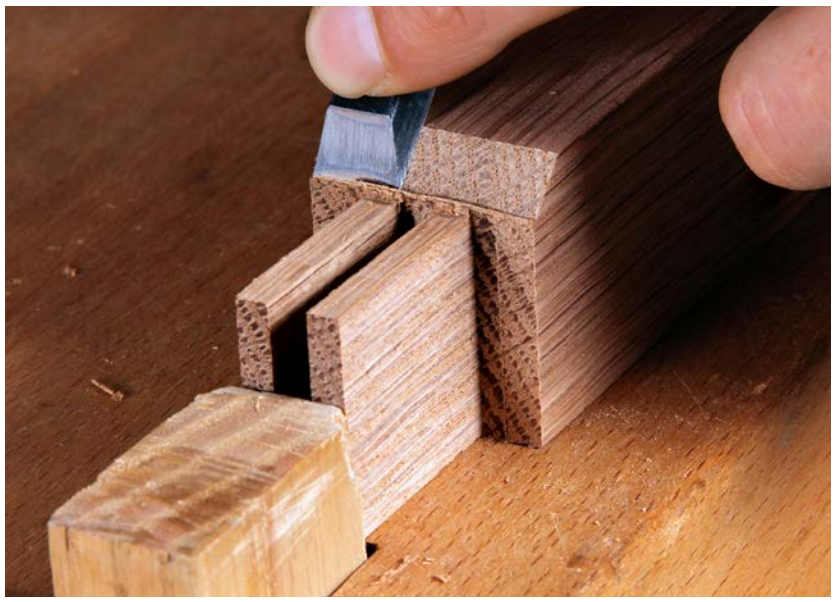


Angled cuts make the miter. Leave the blade a fraction low, to avoid cutting into the bridle joinery, but position the workpiece so that the miter's point will meet precisely with the bridle's shoulder (above). Trim the excess at the bandsaw (right), guiding the cut with the fence.

each workpiece using a crosscut blade, tilted to 45°. Clamp a stop block to your miter gauge to locate the workpieces precisely, dialing in the block's location with test cuts on the setup pieces. The point of the miter must meet the base of the tenons; otherwise, you will wind up with a miter that comes together before the bridle does, or vice versa. Avoid setting the blade too high or you'll cut into the bridle joinery. Better to leave it low by 1/32 in. or so and then clean up carefully with a chisel. The next step is to remove the short length of extra material along the tenons, between the miter cut and the end of the workpiece. I do this at the bandsaw, with the workpiece riding the fence.

To clean up the bandsawn surfaces and adjust the miter's fit, I use a router table and my widest straight-cutting bit raised so that it just touches the raised portion of the bandsawn surface. Use the fence on your router table and again make sure that you do not cut into the miter. You may have to make multiple passes. Check the fit as you go. Afterward, use a wide chisel to pare a

Fine-tune the fit. Godfrey uses a straight bit at the router table to trim the ends of the tenons (left). The table's fence is set to stop the cut at the bridle joint's shoulder. Then pare the miters so that their faces meet the shoulders of the bridle joint (below).



Shape the inside curve. Dry-fit the joint and lay out the curved profile (above). Bandsaw the waste on each part before glue-up (above right) and fair the curve with a rasp and file after the joint is assembled (right).

crisp intersection between the miters and the bridle portion of the joint.

If the miters are tight but there are gaps in the bridle joints, you'll need to remove material from the miters, recutting them at the tablesaw or paring them slightly. If the bridle joints are tight and flush but the miters have gaps, use the router-table setup to take a little more material off the edges of the tenons.

Now it's time to shape the inside corner. With the joint dry-assembled, mark the final thickness of the parts and use a template to trace the radius of the inside corner. Take apart the joint and use the bandsaw to trim the parts to width and to rough out the radiused portion. Clean up the sawn surfaces using a handplane, rasp, or sandpaper. (You could also pattern-rout the parts to save cleanup time.) After gluing up the joint, fair the adjoining surfaces with rasps, files, and sandpaper.

You now have some visually interesting, robust joinery that looks a lot more complicated than it actually is.

Joinery Shoot-Out

DOUGLAS MOORE AND
THOMAS MCKENNA

When it comes to making furniture, woodworkers typically base their joinery preferences on aesthetics, efficiency, and available tools. However, joint strength also is a primary concern; after all, we want our furniture to last generations, without embarrassing joint failures. But how do you know which joint is strongest?

In an attempt to provide some insight, *Fine Woodworking* teamed up with a group of research engineers at a lab in Providence, R.I., to break ... er ... test a bunch of common woodworking joints.

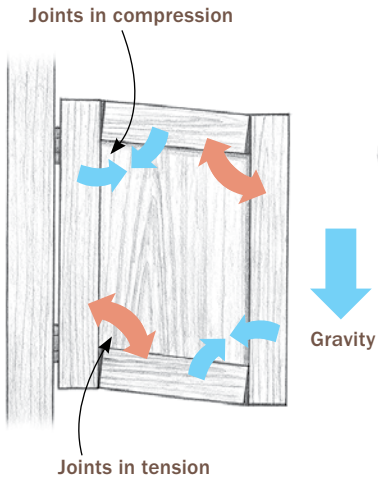
This sounds straightforward on the surface, but many joints have specific applications within woodworking. So, to simplify things and facilitate comparisons, we focused on a single application that appears in a variety of furniture forms and offers many joinery options: the frame joint. Unlike a standing type of joint such as a dovetail or box joint, which is most often used to attach case or box sides, the frame joint is a flat connection typically used to construct face frames, doors, and other frame-and-panel assemblies. Table and chair joints would also fall roughly into this category. We made five sets each of 18 different types of joints using cherry, a species used often by furniture makers. All of the samples were ¾ in. thick by 2½ in. wide

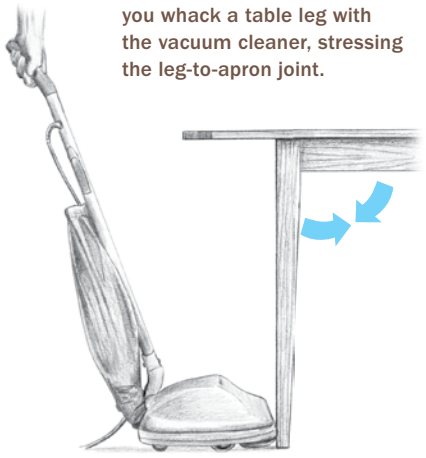
We Applied Racking Force

Our test used diagonal compression to simulate racking force, the most common cause of failure in frame joints. The samples were placed in a servo-hydraulic materials testing machine—essentially a hydraulic ram hooked up to a computer to record force and movement.

WHAT IS RACKING FORCE?

One example is gravity pulling down on the free side of a door, making the frame rack, or deform into a parallelogram, and creating diagonal stresses across the four joints. In other cases, just one or two joints are affected.





by 8 in. long, and all were cut by machine to close tolerances. We did break out hand tools to clean up shoulders and to chamfer the tips of tenons slightly so they would slide more easily into their mortises.

All of the joints were glued with Titebond III® waterproof Type-I polyvinyl acetate (PVA) adhesive, the peak performer in our recent glue test. Per the manufacturer's instructions, we clamped the joints for at least an hour, and let them cure for five days before shipping them to the lab.

The joints were tested to failure in compression using a servo-hydraulic materials testing machine—essentially a powerful hydraulic ram mounted in a rigid load frame. The test was designed to simulate a racking load, the most common cause of failure in frame joints. As the joints were tested, we recorded actuator displacement and resultant force using a computerized digital data acquisition system. Then we analyzed the data to generate numbers for the average peak strength (the force at which the joint failed) for each type of joint. We also inspected the joints to determine how they'd failed.

Some surprises at the top and bottom

Before the test, we surveyed the *Fine Woodworking* staff and our online audience at finewoodworking.com to find out which

Surprising Results

The hallowed mortise-and-tenon joint was not the strongest, even after we fattened the tenon to ⅜ in. thick. Instead, the bridle and half-lap joints, with their broad glue surfaces, withstood the most racking force. The miter was another surprise performer.

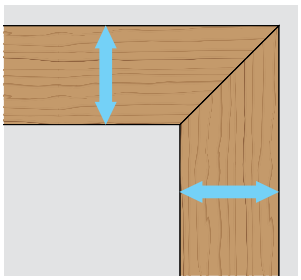
Bear in mind, though, that none of these joints went through the decades of expansion and contraction that a furniture joint must endure. For other caveats, see below. For more on each joint's performance, turn the page.

More to the story

Half-lap	1,603 lb.
Bridle	1,560 lb.
Splined miter	1,498 lb.
⅜-in. mortise & tenon	1,444 lb.
⅜-in. floating M&T	1,396 lb.
Miter	1,374 lb.
⅜-in. wedged M&T	1,210 lb.
⅜-in. pinned M&T	1,162 lb.
5/16-in. M&T	988 lb.
Beadlock	836 lb.
Dowelmax	759 lb.
¼-in. M&T	717 lb.
Pocket screw	698 lb.
Domino	597 lb.
Biscuit	545 lb.
Butt	473 lb.
Cope & stick	313 lb.
Stub tenon	200 lb.

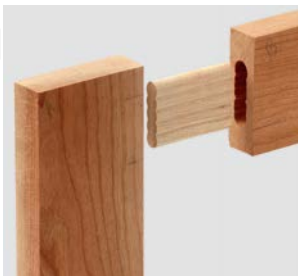
THE LOOK YOU WANT

The half-lap and bridle joints took top honors in our strength test, but these exposed joints don't look right on every project.



SEASONAL WOOD MOVEMENT

We tested joints right after the glue cured. But seasonal cycles of wood movement will stress the gluelines repeatedly, so joints with built-in mechanical strength, such as the mortise and tenon, may have an increasing advantage over time. The miter is especially susceptible to wood movement, actually pulling apart at the tips unless reinforced with a spline.



EASE OF ASSEMBLY

Mortise-and-tenon joints of all types, from traditional to doweled, keep parts aligned properly during glue-ups. Half-laps, on the other hand, must be clamped in a number of directions to squeeze the parts together and to keep them aligned.

HOW THE JOINT IS USED

Not every application demands great strength. For a picture frame or even a cabinet door, the ability to withstand 200 lb. of force at each corner might be plenty (and a door with a glued-in panel will resist racking even more). On the other hand, a chair, with its narrow parts and extreme stresses, demands the strongest joints possible.

Broad Glue Surface Adds Muscle to Bridle and Half-Lap

These two heavy hitters ranked one and two in our test, with an average peak load of 1,581 lb., enough to support a full-grown cow. The two joints are similar in their geometry: Both have large glue surfaces and are clamped across their faces, which strengthens the glue bond. When stresses were applied, the joints failed only because the wood sheared across its fibers. Even though the half-lap and bridle joints have great strength, they are exposed joints, and may not look right on every project.

HALF-LAP

Peak load: 1,603 lb.
Rank: 1 of 18

TYPICAL FAILURE

One lap split along the grain, with fibers shearing out across the grain along the glue faces.

BRIDLE

Peak load: 1,560 lb.
Rank: 2 of 18

TYPICAL FAILURE

¼-in.-thick tenon fractured across the grain; stile split just inside the shoulder.

joint they'd predict to be strongest. Among editors, the pinned mortise and tenon was picked to finish first (it was a close race). Folks who took our online poll predicted the regular mortise and tenon would be king. It turns out, however, that the half-lap joint proved strongest in our test, with the stub tenon bringing up the rear.

Top two have lots of glue—Although we were surprised to find the half-lap and bridle at the top of the heap, in retrospect it was predictable: Both joints have large long-grain glue areas and are clamped across both faces. The only way they can fail is if one or both of the "legs" fracture across the grain.

Thicker tenons are stronger—Most of our survey respondents predicted the trusted mortise and tenon would be strongest, so it's no surprise that two ⅜-in. versions were at the top of the list. What's significant is the margin by which they outperformed their lankier ¼-in. and 5/16-in. cousins. We noticed that reinforcing the joint with a pin or with wedges did not help the pieces resist racking forces; in fact, pins and wedges made the joint slightly weaker.

The lowly miter steps up—The miter has always been considered one of the weak links in the joinery world, so we were shocked to see two versions nestled near the top. The fact that the splined version did well was less surprising given the reinforcement and increased long-grain glue surface provided by the spline. However, our testing configuration may have stacked the deck for both miter joints, loading the tip of the glueline in tension while compressing the fibers of each leg across the grain.

Even so, as well as the basic miter performed, it's hard to recommend it as a top-notch furniture-making joint without

adding a key or spline of some kind. It has no inherent mechanical interlock, so all its strength comes from its glueline. And, as the parts expand and contract, the glueline will be stressed repeatedly and intensely, eventually opening at the outside corner. With a deep key at the outside corner, however, this joint might prove to be very strong over the long haul.

Store-bought systems prove their mettle—We tested several store-bought joinery systems (pocket screws, biscuits, Beadlock®, Dowelmax®, and Festool® Domino) and each put up respectable numbers. We like the fact that they all go together quickly.

Bottom of the heap—The two weakest joints were the cope-and-stick and stub tenon, coming in behind the basic butt joint. These joints are widely used to make production cabinet doors, and they are strong enough for this application, especially when reinforced with a glued-in plywood panel.

Conclusions

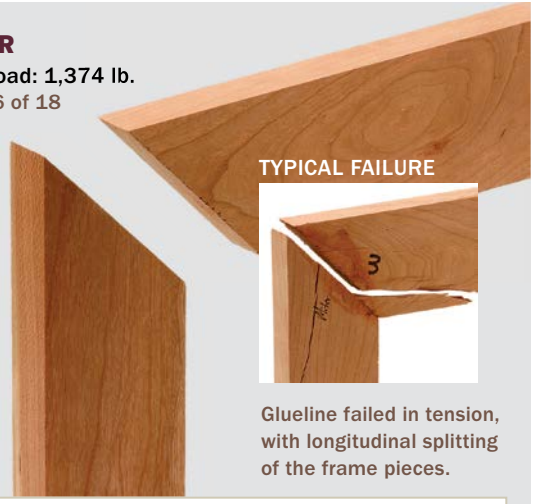
When we looked closely at how joints tended to fail, we found a clear correlation with our test results. The stronger joints forced their component pieces to fail by fracture across the grain or right at the glue joint (miter), while with the intermediate-strength and weakest joints, failure occurred by the splitting of one piece along the grain.

Thick Spline Adds Backbone to the Miter

Though the miter was surprisingly strong, structural limitations make it hard to recommend the unreinforced miter for furniture-making tasks. When assembled, the joint is angled at the typical 45°. However, as wood expands and contracts over time, the 45° geometry will change (see the drawing below), causing joint failure at the outside corner. The spline creates long-grain glue surface, which helps explain the splined miter's No. 3 position overall.

MITER

Peak load: 1,374 lb.
Rank: 6 of 18



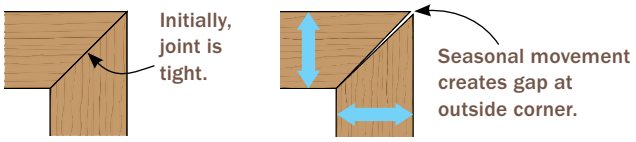
Glueline failed in tension, with longitudinal splitting of the frame pieces.

SPLINED MITER

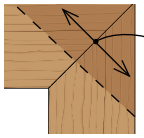
Peak load: 1,498 lb.
Rank: 3 of 18

Glueline failed in tension, with longitudinal splitting along the grain of the pieces and fracturing of the ¼-in.-thick spline.

Angle changes as wood moves



A better way to spline a miter?



We didn't think of this variation in time for testing, but a diagonal key adds a broad long-grain glue surface at the miter's weakest point, which should prevent it from failing in the long-term.

A Thicker Tenon Makes a Stronger Joint

The ⅜-in. mortise and tenon did well in the test, but the performance of thinner versions was surprisingly average. The results prove that making tenons thicker increases strength: The ⅜-in. tenon was almost twice as strong as the traditional ¼-in. tenon. Adding pins or wedges slightly compromised joint strength; however, they do provide insurance against glueline fatigue in decades to come. A floating tenon acted just like a traditional mortise and tenon in our testing.

WEDGED MORTISE AND TENON

Peak load: 1,210 lb.
Rank: 7 of 18

TYPICAL FAILURE

Tenon fractured across the grain; stile split near glueline.

⅜-IN. MORTISE AND TENON

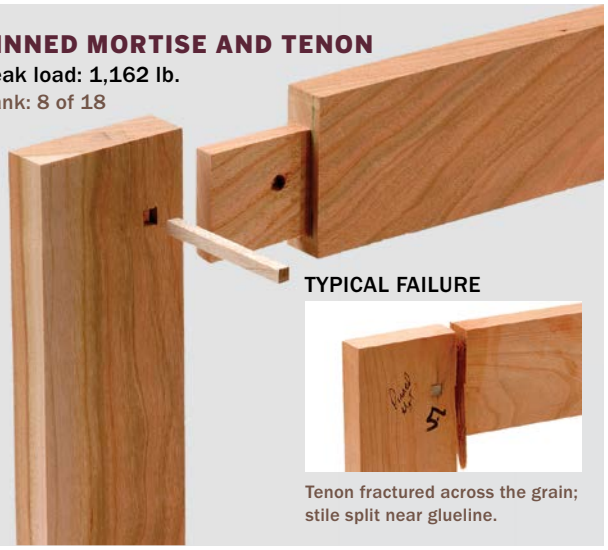
Peak load: 1,444 lb.
Rank: 4 of 18

TYPICAL FAILURE

Tenon fractured across the grain; stile split just (about ⅛ in.) inside the shoulder.

PINNED MORTISE AND TENON

Peak load: 1,162 lb.
Rank: 8 of 18



TYPICAL FAILURE

Tenon fractured across the grain; stile split near glueline.

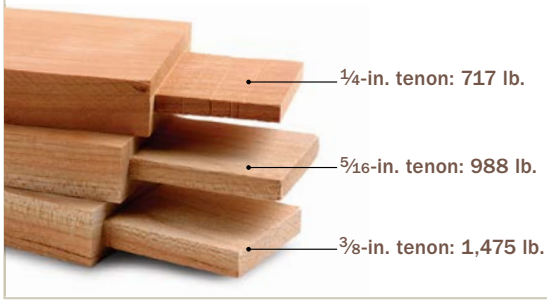
FLOATING TENON

Peak load: 1,396 lb.
Rank: 5 of 18

TYPICAL FAILURE

Tenon fractured across grain; stile split near glueline.

Size matters



Store-Bought Tenons Are a Bit Weaker Than Shopmade

Biscuits, dowels, and premade tenons are all floating tenons of a sort. In general, however, they don't reach as far into the stile as shopmade tenons, allowing the stile to split along the grain without fracturing the tenon. Though we used the manufacturer's dowels and tenons (and followed their directions), we recommend that you choose or make longer ones. Still, these fast and efficient systems made strong joints. When time is money, and you don't need to support a Greco-Roman wrestling team, one of these speedy systems makes a lot of sense.

BEADLOCK

Peak load: 836 lb.
Rank: 10 of 18

TYPICAL FAILURE

Beadlock tenon (⅜ in. dia. by 1⅜ in. wide) remained intact while the stile portion of the joint split along the grain near the tip of the tenon.

DOWELMAX SYSTEM

Peak load: 759 lb.
Rank: 11 of 18

TYPICAL FAILURE

The three ⅜-in. dowels remained intact while the stile split along the grain near the dowel tips.

DOMINO BY FESTOOL

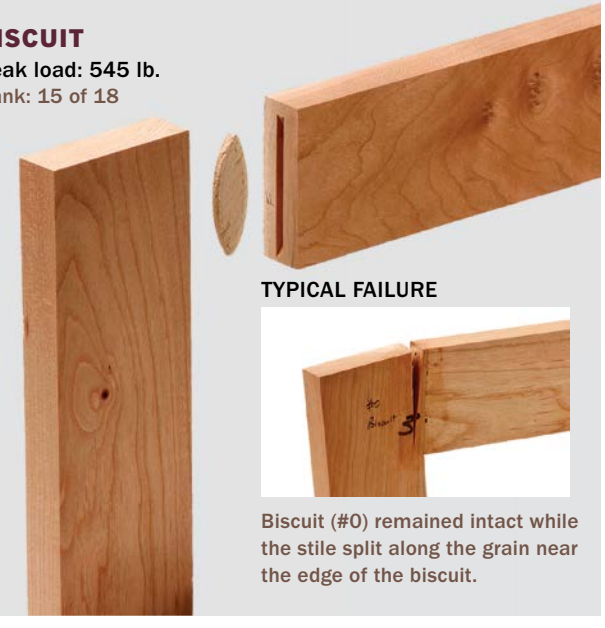
Peak load: 597 lb.
Rank: 14 of 18

TYPICAL FAILURE

Tenon (size 10x50) remained intact while the stile split along the grain near the tenon tip.

BISCUIT

Peak load: 545 lb.
Rank: 15 of 18



TYPICAL FAILURE

Biscuit (#0) remained intact while the stile split along the grain near the edge of the biscuit.

Glue in a Panel to Strengthen Stub Tenons

Most folks expected the butt or miter joint to bring up the rear. But it was the stub tenon and cope-and-stick joints that sank to the bottom of the pile. Even copious amounts of glue did little to help. Both are too weak to be used as-is in large doors. For real strength, stub tenons and cope-and-stick joints need a glued-in plywood panel for reinforcement.

STUB TENON

Peak load: 200 lb.
Rank: 18 of 18

TYPICAL FAILURE

Stile split along the grain near the tip of the stub tenon.

COPE-AND-STICK

Peak load: 313 lb.
Rank: 17 of 18

TYPICAL FAILURE

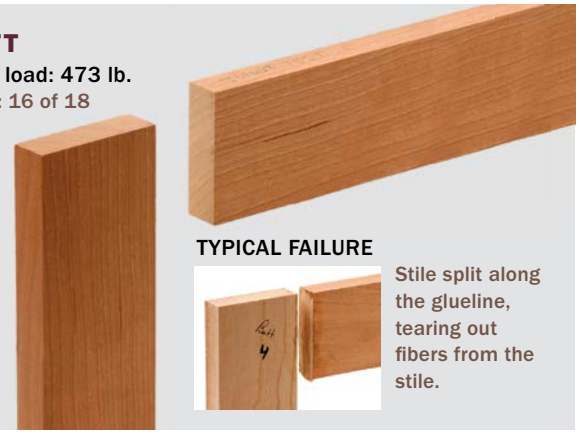
Stile split along the grain near the end of the stub tenon.

Pocket Screws Beef Up the Butt Joint

We included the butt joint in the test to serve as a baseline against the others, but it didn't perform badly. Even so, the butt joint isn't suitable for furniture because the small glue surface depends on end grain, making it very susceptible to seasonal stresses. Pocket screws increased the load capacity enough to make this joint a good option for situations where the interior of the frame is hidden.

BUTT

Peak load: 473 lb.
Rank: 16 of 18



TYPICAL FAILURE

Stile split along the glueline, tearing out fibers from the stile.

POCKET SCREWS

Peak load: 698 lb.
Rank: 13 of 18

TYPICAL FAILURE

Stile split along the grain at the ends of the screws.

But the numbers don't tell the entire story. A lot of considerations go into the choice of a specific joint: How it will look (exposed joinery vs. the clean appearance of a hidden joint); how it will be affected by seasonal wood movement (is there mechanical resistance to keep the joint together over time?); ease of assembly (fast sometimes is best); and how it will be used (picture frame vs. apron-to-leg joint). So take all those issues to heart when making your joinery choice.

The Secret to Making Perfect Joints

STUART LIPP

It is a common misconception that fitting a joint means methodically paring the entire area until all the surfaces match perfectly, but in many cases, wood needs to be removed only from hidden surfaces to allow a joint to close completely. I call this technique undercutting.

Do not mistake undercutting as taking the easy way out; undercutting is part of being a conscientious and concerned woodworker. The secret is knowing when to employ the technique. First, dry-fit a joint. Then decide if undercutting is the best option, or the entire joint needs trimming.

Undercutting can mean a few different things, but it usually involves angled relief cuts on surfaces that are not essential for glue strength. For example, when fitting a mortise and tenon, rather than planing the entire shoulder just chisel out the inner surfaces. By the way, if you undercut a joint and it still needs trimming at the edges, you have less material to remove.

I'll show you ways to apply undercutting to a wide variety of joints and situations. Over the past few years I have noticed myself employing this method more frequently, and in every situation the result is improved quality in far less time.

Trim shoulders on mortises and tenons

Mortise-and-tenon joints employ two forms of undercutting. The most well known is to make the depth of the mortise greater than the length of the tenon, giving excess glue a place to go and allowing the joint to close.

Gap-free table legs. Undercutting is an efficient method for improving the fit of a mortise-and-tenon joint.

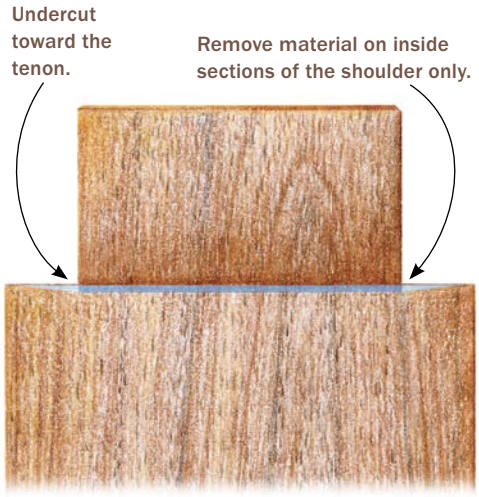
Undercut tenon shoulders. Use a chisel to cut a slight downward bevel (no more than 1/32 in.) on the tenon shoulder.

But what if the tenon shoulder still does not fit well? You can spend a lot of time with a chisel or shoulder plane trying to pare a perfect 90° shoulder, or you can quickly undercut it.

Put the workpiece in a vise, tenon up, and use a chisel to pare the end grain in from the edge of the shoulder to the tenon. Remember to keep the outermost edge crisp. Undercut enough material for the shoulder to fit, but be careful not to take too much; a 1/32-in.

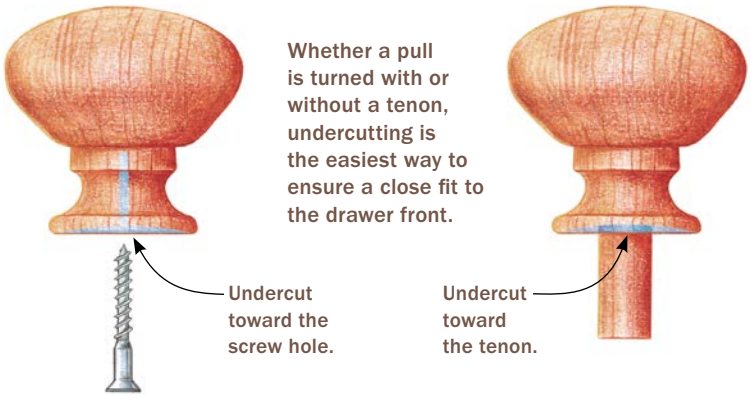
Carry the bevel around the shoulder. Work your way around the perimeter of the tenon, leaving the outermost edge intact.

Trim Tenons



Flush mount. Pulls should sit flush against a drawer front.

Back-Bevel Pulls



bevel should be more than enough. Do this all the way around the shoulder and you will improve the fit of the joint. The technique is not magic—you still may need to pare the visible edges—but undercutting leaves less area to fit.

Back-bevel drawer pulls

Turning your own drawer pulls can elevate the look of a piece of furniture, but not if the pulls don't fit tightly to the drawer front. A very quick and easy way to accomplish this is to turn a slight hollow in the back side of the shoulder, leaving the outer edge untouched. You will be ensured a nice, tight joint.

Undercut dovetails

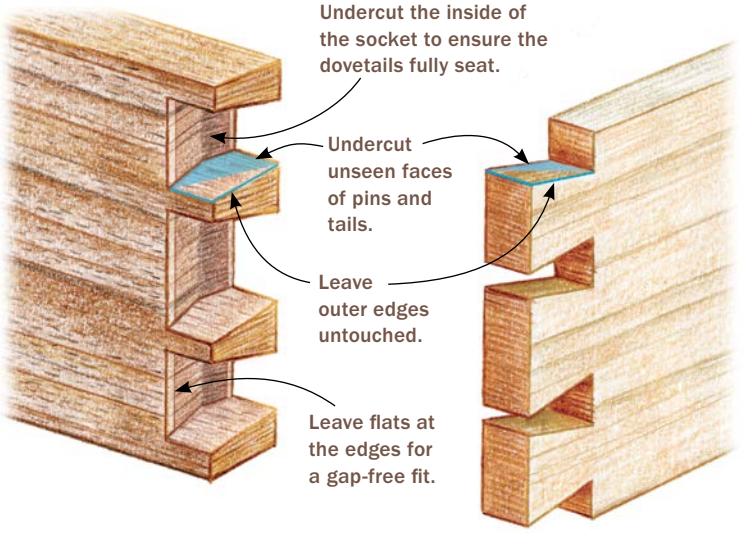
Hand-cut dovetails can be a measure of a craftsman's skill; they also can frustrate and overwhelm. Undercutting dovetails allows for more precise joinery with much less fussing.

Not every face of a dovetail or pin is visible, so the most important edges are the outer ones. First, the bottoms of sockets

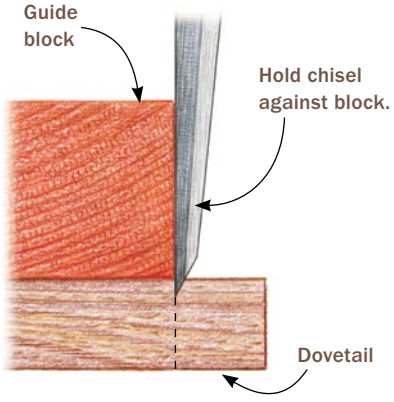
One-touch technique. Use a skew chisel to undercut a pull while it is still on the lathe.

Good fit where it counts. As long as the outer edges of the tails and pins are kept clean and tight, the dovetail is aesthetically correct.

Undercut Dovetails

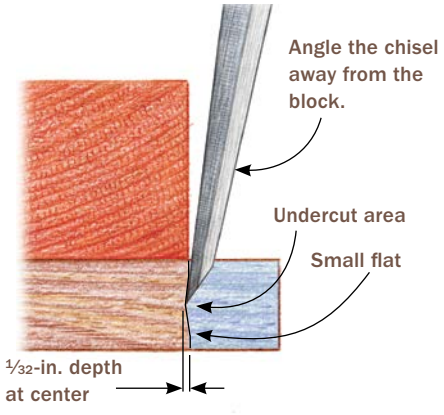


Cut Vertically



Start with a vertical cut. Clamp a guide block to the baseline. Make the first chop with the chisel against the block to establish a flat at the edge.

Undercut The Joint



Angle the chisel slightly to undercut the joint. Angle the chisel away from the block for subsequent chops. At the halfway point, flip the board and repeat on the other side.

can be undercut while simultaneously being chopped (see the drawing on the facing page). When doing your final fitting, you can always take a larger shaving from the bottom side of a dovetail or pin. Doing this creates a slight wedge, and as you hit the joint home you will see it getting tighter and tighter. Don't worry about joint failure or lack of strength. The joint will have great contact, plenty of glue surface, and the inherent mechanical strength of the dovetail.

Angle moldings

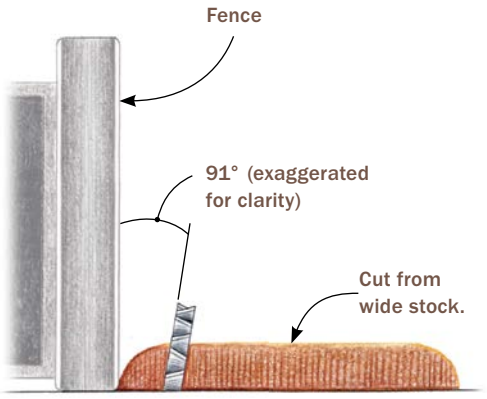
I was making some cabinet doors recently that had flat panels and an added detail of quarter-round molding glued into the step between the panel and the frame. When I milled the molding, I cut the edges intended for the step at 91° instead of the standard 90°. This technique not only guaranteed a nice tight joint at the two visible edges, it also created a recess on the inside that trapped extra glue, thus reducing squeeze-out and minimizing cleanup. I also used a block plane to put a slight chamfer on the molding's inner corner for additional clearance.

Focus on hidden sections. The key to paring dovetails? If you won't see it, undercut it.

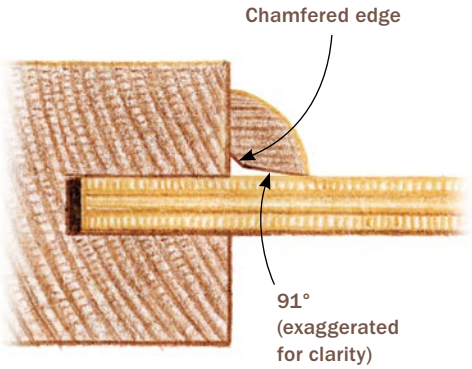
Angle Moldings

Easy-fit molding. Cutting edges at 91° and chamfering the back corner allow for a flawless fit on molding details.

After the profile is cut, rip the molding to thickness with the blade set at 91°.



Chamfering the molding's back edge creates additional clearance for a good fit and for hiding glue.



No clamps needed. A simple rub joint works to adhere glue blocks. Apply the glue and rub the block back and forth until it sticks where you want it.

Create a chamfer. Using a block plane is the easiest way to chamfer a glue block.

Chamfer glue blocks

Glue blocks are great for adding strength to joints. They can be used to support drawer or chest bottoms, to strengthen bracket feet and mitered joints, and to attach tabletops. However, if there is dried glue squeeze-out in a corner, you won't be able to press the glue block against both sides of the joint. Put a slight chamfer on the inner corner of the glue block, providing clearance for glue or debris.

Spring long edge joints

The most common place for an edge joint to fail is at the ends. The rate of shrinkage is greater there than in the middle; this means more stress is put on the glue joint at the ends. A way to solve this is to undercut the center section, leaving a little extra wood at the ends to accommodate the shrinkage, so the tension that would usually be put on the glue joint is now absorbed by that extra material. Known as springing a joint, this technique also helps ensure that the ends of the boards stay tight during glue-up. You can spring any size joint, but unless it is over 18 in. long, the benefits are negligible.

To spring a joint, start with machine-jointed edges; that way you know you are dealing with straight, square surfaces. Next, put the boards horizontally in a vise, and break up the distance into five equally spaced sections. With a handplane, take three light passes: the first over the center section, the second over the middle three sections, and the last over the entire length of the boards. It is crucial that you get a complete shaving on the last pass because any snipe or chatter

Spring Edge Joints

"Springing" a joint helps ensure that the ends of the boards stay tight.

Bombproof joint. A nearly imperceptible gap, 1/32 in. at most, toward the center of an edge joint ensures a tight fit for decades.

will compromise the fit of the joint. When you put the boards together with the ends touching, there should be a small gap in the middle, often almost invisible, never more than 1/32 in.

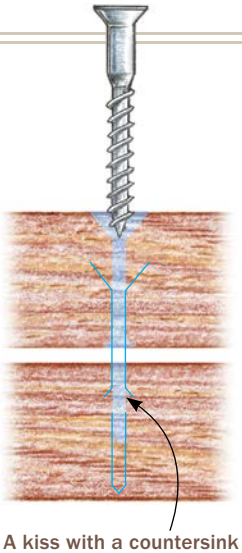
Chamfer backs of holes

When drilling clearance holes for screws, I find that even with a sharp bit I often get some type of tearout or fuzz on the exit hole. When screwing the piece down, there is a good chance that the little fibers of wood will prevent the joint from closing completely. The remedy is pretty simple: Just kiss each exit hole with a countersink. That removes the fibers and creates the slightest hollow, ensuring a tight fit.

Lay out a visual guide. Separate the boards into five equal sections. Plane the middle section, the middle three, and then the entire edge.

Plane both mating edges at once. This will help compensate for any misalignment in the planing angle.

Chamfer Screw Holes



A kiss with a countersink removes tearout and ensures a tight fit.

Fast Fixes for Joinery Mistakes

COMPILED BY FWW STAFF

We asked *Fine Woodworking*'s most frequent contributors for their favorite methods for concealing mistakes made while cutting joinery. Although these mistakes may or may not affect the look of a piece, they most certainly have an impact on its strength, and can force you to scrap a valuable workpiece. Luckily, the pros have a bunch of tricks up their sleeves.

Solutions for Gappy Dovetails

ANGLED SHIM FOR THROUGH-DOVETAILS

A common mistake when hand-cutting through-dovetails is to cut on the wrong side of the scribe line, which leaves a small but noticeable gap between the pin and tail when the piece is glued up. A surefire solution is to fill the gap with a thin shim that's the same wood species as the project. Widen the gap first, glue in the shim, then trim it flush.

—Michael Pekovich is Fine Woodworking*'s art director, and a prolific furniture maker.*

Obvious mistake. Even a small dovetail gap can be a big eyesore on a cabinet case.

Widen the gap. A slight gap can be hard to fill. To make it easier, widen it slightly with a dovetail saw, angling the saw and cutting to the baselines of both the pins and tails.

Insert the shim. Chop the bottom of the strip at an angle so it will fit the widened gap, then glue it in place. Be sure to orient the end grain of the strip in line with that of the tail board.

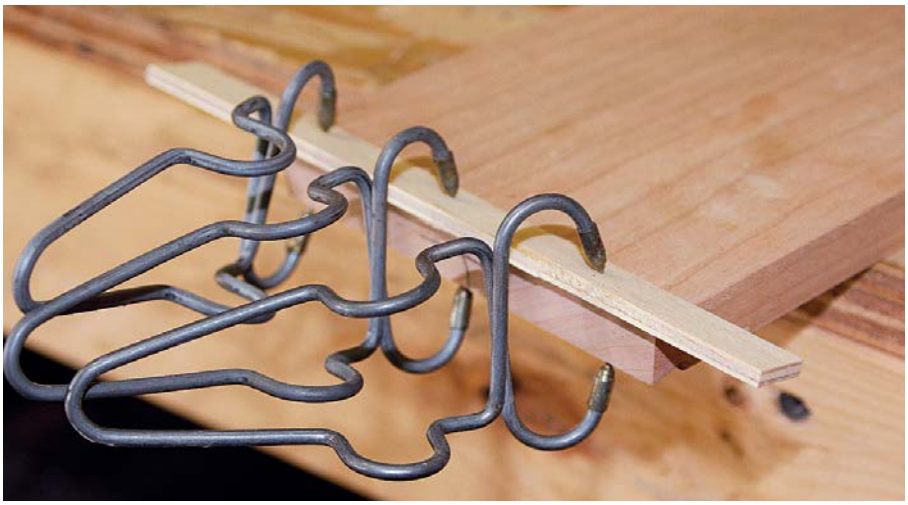
Trim it flush. After the glue dries, use a wide chisel to slice the shim flush.

Loose key. If your router-table fence is misaligned, you'll end up with an unsightly gap on a sliding dovetail.

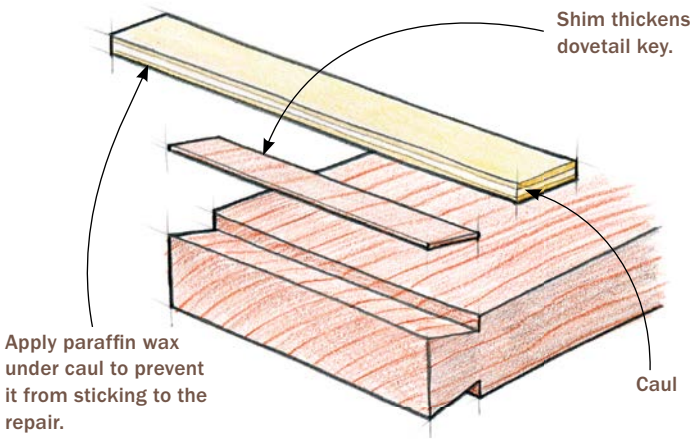
WIDE SHIM FOR A LOOSE SLIDING DOVETAIL

This fix came to me while I was working on a wall shelf made with sliding dovetails. As always, I'd set up the router-table cuts using test pieces and verified the fit. But after I finished routing the dovetail keys, I discovered that I was off by a little more than 1/16 in. Yikes! Turns out that I'd not tightened down my fence sufficiently, and it shifted slightly as I made the cuts. Fortunately, I came up with a fix that was pretty quick and easy. I filled the gap with a piece of thick veneer, glued along the face of the key. Be sure to run the grain in the same direction. Then I re-routed the joint to get a tight fit.

—Greg Brown is a furniture maker in New Hampshire.



Spring into action. Glue a piece of veneer or a thicker shim to the face of the dovetail key. Brown uses spring clamps and a thin caul to ensure a good glue bond across the width.



Tight joint. After re-routing the shimmed key, it fits perfectly.

Glaring gap. This small gap will drive a veteran woodworker nuts every time the drawer is opened.

TAPERED SHIM FOR HALF-BLINDS

Here's a simple way to fix a gap in a half-blind dovetail. Use end-grain shims that closely match the color and grain pattern of the pin. This fix is slightly different from the through-dovetail fix on p. 55, which uses a triangular, flat shim. Because there's no way to widen the gap cleanly, and it's trapped by the edge of the drawer front, I taper the shim to create a wedge that is easier to put in. I tap it into the gap with a hammer, then trim it flush.

—Garrett Hack is a Fine Woodworking *contributing editor.*

Make a wedge. Cut a shim slightly wider and thicker than the gap. Then taper the sides and ends using a chisel and block plane.

Drive it home. Put glue on the tip of the shim and tap it in place (above). Saw off the excess and trim the patch flush (right).

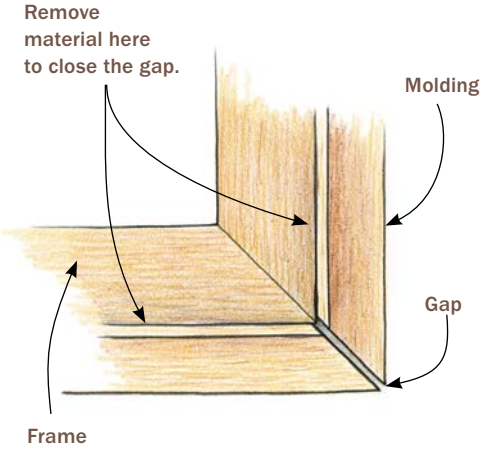
When Miters Don't Meet

Open corner. It's easy to trim too much off a miter, creating a gap.

RELIEVE THE BACK, NOT THE CORNERS

When trimming the miters on moldings, it's easy to take off too much from one end, leaving a small gap. Instead of cutting a new piece of molding, you can fix the pieces you have. Simply take a very light jointer pass off the back face of the molding (a handplane will work too). This has the effect of lengthening the distance between the miters, giving you one more chance to close the gap.

—Will Neptune is a furniture maker in Massachusetts.



Joint the back. Run the back of the molding over the jointer, taking a shallow cut. Be sure to use push blocks. If the molding is too small for a safe jointer pass, use a handplane.

Tight miter. Taking material off the back brings the miter together.

Rx for Tenon Troubles

Shim splint. Add a strip of veneer to thicken a loose tenon. Cut the veneer so that it overhangs the tenon just a hair on each side.

FATTEN UP A THIN TENON

It's easy to trim too much from a tenon, creating a loose fit in its mortise. There is an easy fix, which I learned from Phil Lowe. You just glue veneer to the tenon cheek and try again. First partially assemble the joint and look for a gap to see which face of the tenon is undercut (shimming the wrong face can mess up the alignment of the parts). Now resaw a strip of veneer just a bit thicker than the gap. Glue it on, using a small caul to get even pressure and a tight glueline, and then trim the tenon again to creep up on a perfect fit.

—Tom McKenna is editor of Fine Woodworking, *and Phil Lowe runs the Furniture Institute of Massachusetts.*

A little off the top. Trim the edges of the veneer flush, and then plane the fattened tenon until it fits.

Hanging tight. A perfect fit is one where the joint stays together when you hold it in midair.

Bad corner. When fitting a long through-tenon, it's easy to chip out a corner or just overtrim it, ruining the look.

CAP A BAD THROUGH-TENON

A through-tenon is an attractive detail, but it's easy to end up with a gap or chipped corner while you're fitting the extralong tenon. A simple fix is to cut back the bad tenon and then cap it. The cap can either be flush or protruding, depending on the style. Start by cutting a slip tenon for a snug fit in the mortise. Then trim the damaged tenon back so that it's about ¼ in. shy of the outside end, and insert it fully into the mortise. Cut the cap long enough to bottom out against the internal tenon, especially if it is designed to protrude evenly. Now you can glue in the real tenon and add the cap on the outside. If it is a chamfered cap, be sure to do that beforehand.

—Michael Pekovich

Make a cap. Mill a slip tenon for a snug fit in the outside of the mortise. Then cut off a piece long enough to meet the end of the real tenon.

Top it off. Glue in the cap over the tenon for a seamless repair.

Bad shoulder. Get an offset tenon wrong and the problem is obvious. But even this can be fixed without starting from scratch.

REPLACE A TENON COMPLETELY

It's all too common to orient an offset tenon backwards on a rail, creating a big step on the finished frame. But it's not a fatal error. You can simply slice off the miscut tenon, cut a big stopped groove in the rail, and slide in a slip tenon. This fix works for bad tenons of all kinds. Here's how to do it.

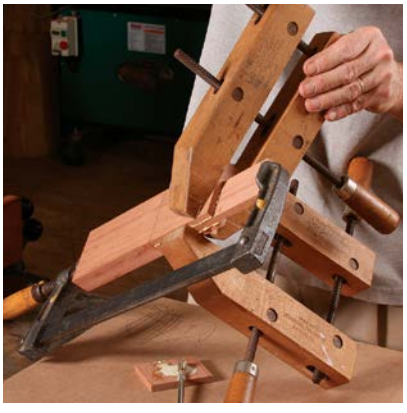
Install a dado set on the tablesaw equal to the tenon thickness. Set the height for the width of the tenon and use the rip fence to locate the dado set in the rail thickness. Be sure you have the location right this time! Feed the rail in far enough to cut a reasonable-size pocket—stop the cut just after you reach the apex of the blade. Turn off the saw and wait for the blade to stop. Use the same species of wood to make a slip tenon that fits snug in the curved pocket. Cut the tenon to length and glue it into the rail. When the glue dries, clean up the bottom edge and fit the new tenon to its mortise.

—Will Neptune

Remove the tenon altogether. Cut off the tenon at the shoulder.

Curved piece fits right in. Mill a slip tenon for a snug fit in the groove, with one end curved to match the arc of the blade. You can use the blade to trace the arc.

Clear a path for a new one. Use a dado set to plow a groove where the tenon should have been. Stop the cut when the blade is at the apex of the curve, turn off the saw, and hold the piece until the blade stops.



Slippery glue-up. When gluing in the tenon, you need to clamp it in three directions: One clamp pushes the tenon in, one keeps it from pivoting out, and one goes across the face to ensure a good bond with the cheeks.

The Miter Joint for Casework

DAVID HYATT

Many woodworkers are familiar with the miter joint as used in picture frames or on a solid edging that wraps around a tabletop. However, this joint is also a useful and attractive means of joining the body of a cabinet. Whether constructed from plywood or solid stock, this clean, simple joint shows no core or end grain, and can be particularly appropriate in enhancing clean lines on furniture.

Unlike many woodworking joints, the carcase miter with its long, straight cuts lends itself to easy production with a variety of power tools. Although the joint can be reinforced with splines or biscuits, accurately cut mitered surfaces are strong enough for most locations using glue alone.

Clean lines and no end grain. Miter joints allow the grain to flow uninterrupted around this small cabinet.

Cut miters with a tablesaw or router

The fastest and easiest way to cut miters is on a tablesaw, but you'll need a sharp blade to get a smooth, accurate cut with no burning or tearout. With veneered materials in particular, check the entire surface of the tablesaw and outfeed table for bumps that will scratch the thin surface.

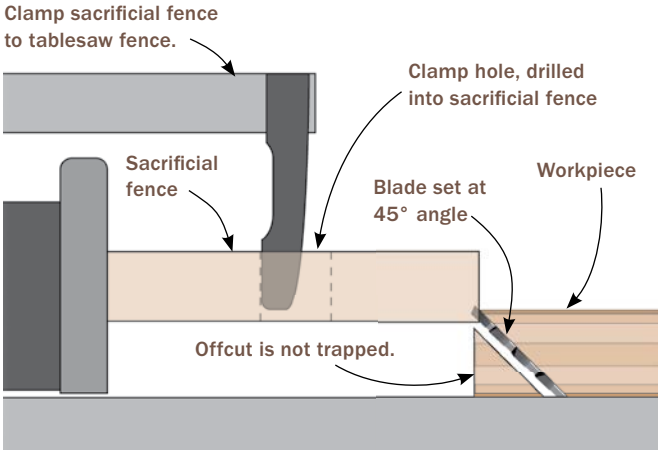
Use a slow, steady feed rate to reduce burning and tearout. Be vigilant about the last few inches of the cut; it is easy to twist the workpiece slightly and make a curved edge that will not fit properly with its counterpart. Also, make sure that the workpiece is pressed down firmly on the tablesaw. If the workpiece is at all warped, it will be difficult to cut a good joint.

Easier on a left-tilt saw—If you own a left-tilt saw, cut the workpiece roughly to size, tilt the sawblade to 45°, and cut the first miter with the inside of the workpiece face down. Then simply spin the workpiece 180° so that the mitered cut is against the fence. Make a series of cuts until the blade cuts the

Miters on the tablesaw. Miters are simple on a left-tilt saw. Here, the thin point of the first miter runs against the rip fence.

Right-Tilt Sawing with a Sacrificial Fence

A simple auxiliary fence and a precision setup make it safer and easier to cut case miters on a right-tilt tablesaw.



Using a right-tilt saw. When cutting the miter on the second side, to prevent the thin point of the first miter from burrowing under the rip fence, attach a sacrificial fence and cut the miter as shown. Hyatt uses a rubberized glove for better control.

top of the workpiece to the correct width, and complete the cut.

Possible on a right-tilter—On a right-tilt saw, the procedure is slightly different. You could just relocate the rip fence to the left of the blade, but there isn't as much capacity on that side for wide workpieces. To cut miters safely with the rip fence in normal position, first cut the piece to its finished width, then tilt the blade and cut the first miter with the inside of the workpiece face up. If you then turn the workpiece 180° and run the sharp, mitered edge along the rip fence, that edge will try to burrow under the edge of the fence. At best you will get an inaccurate cut; at worst, kickback.

The best solution is to run the edge you are mitering against the rip fence. This will let you cut with the inside of the workpiece face down. To make this cut safely, clamp a sacrificial fence of medium-

density fiberboard (MDF) to the rip fence, positioning the MDF so that its bottom surface is about ⅛ in. below the top of the workpiece. Then draw a pencil line along the edge of the MDF fence at the level where the top of the workpiece will make contact. Adjust the position of the rip fence and the height of the blade to a setting where the cut just meets that pencil line. This should ensure that the miter extends the full thickness of the workpiece, but doesn't reduce its width. You will want to make test cuts on a spare piece. With this setup, the offcut will fall away freely under the sacrificial fence.

Cut clean miters with two types of router bit—Although it takes longer to create miter joints using a router, the resulting cut is cleaner than one made on a tablesaw.

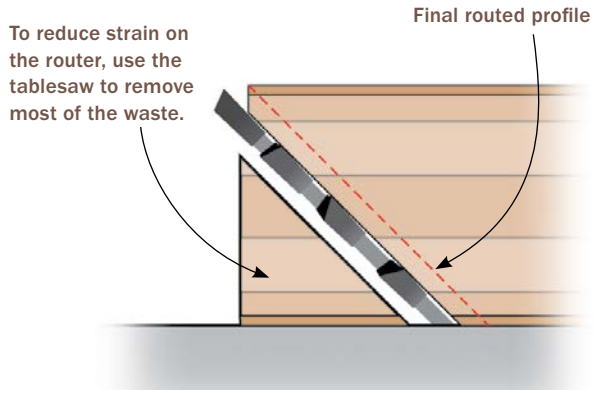
To cut miters with a router, first cut the workpiece to its final size. Next, to reduce strain on the router, not to mention the quantities of dust it will create if you are working with MDF, tilt the sawblade to 45° and remove the bulk of the waste, leaving a 1/16-in. shoulder at the corner of the miter.

A chamfer bit makes perfect miter joints. It takes longer to create miter joints using a router, but the cut is cleaner than one made on a tablesaw.

It is safest to use a chamfer bit in a router table. Because the miter will extend the full thickness of the workpiece, the bearing will have no surface to run against. Instead, the workpiece will be guided by the router-table fence alone. Set the bit height to leave a sharp corner on the workpiece.

A third way to create miters is with a specialized locking miter bit that produces a strong joint with a large glue surface and interlocking parts. Because the height of the bit and the location of the fence must be set exactly, a locking miter bit

Miters on the Router Table



Remove the waste on the tablesaw, then finish with a router bit. Use a router table, where the workpiece can be guided by the fence, not the bearing.

A locking miter bit. This router bit offers a specialized variation of the joint: the lock miter. It produces a strong joint with a larger glue surface and self-aligning parts.

can be used only in a router table. The pieces should be cut to their final size, and then run past the bit either vertically or horizontally to create the matching sections for each corner.

Assemble the carcase by rolling it up

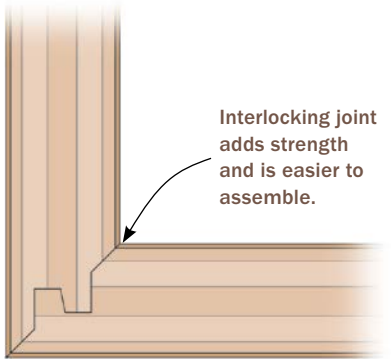
The best way to assemble a mitered box or carcase is by gluing it all at once. Masking tape makes this possible. Place the four components in line in the sequence front/side/back/side, with the top edges toward you and the outside face up. Use a straightedge to align the top edges and slide the panels together so that the sharp edges of the miters are touching.

Tape together the three touching joints by stretching short pieces of masking tape across them to create tension, and draw the seam together tightly. To make the assembly stiff enough to flip over to expose the faces of the miters, clamp a strip of wood on each side of the top edge of the panel.

With the inside of the carcase now face up, insert any bottom or back piece and do a dry run by rolling up the sections. If all is well, lay the sections open again, and run strips of masking tape along the inside edge of each miter joint. The tape will be carefully peeled away after the glue has begun to solidify, removing almost all squeeze-out.

Use a small roller or brush to apply glue to both sides of each miter joint. Then slowly roll up the assembly and apply masking tape to the final, untaped joint. Set the assembly on a flat surface and check that everything is square. Stubborn joints can be drawn together with band clamps. If you use the locking miter bit, the joints can be clamped with no need for masking tape.

Miters with Locking Miter Bit



One setup, two different cuts. When using a locking bit to create miters, one piece of each corner is run through the bit horizontally (top photo), while the adjoining piece is run vertically (bottom photo).

Use the tape trick for easy assembly. With the inside of the carcase face down, stretch masking tape across the joints to draw them together. A straightedge at the top aligns the sections.

Flip the boards over. To turn over the sections together, clamp a strip of wood on each side of the top edge.

Glue the miters. Tape the areas adjacent to the inside of the miters to make squeeze-out easy to remove. Apply glue with a roller.

Assemble the carcase. With the base or back installed, roll up the sections and tape closed the remaining corner. Stand the piece on a flat surface and check for squareness.

Reinforce the corners. While the glue is soft, run the shaft of a screwdriver up and down the edge to round over the corners slightly. This closes small gaps and makes veneered corners less prone to catching and tearing.

Peel off the tape. After the glue has set, remove the tape. Pull it across the grain to lessen the chances of pulling away wood fibers.

Two ways to reinforce vulnerable corners

Plywood veneer lends itself to miter joints because they conceal the core, but the outside corner of veneered surfaces can chip or sand through easily.

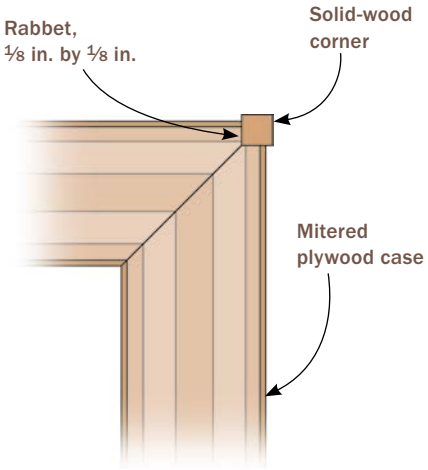
One way to overcome this problem is to burnish the joint. You can use a burnishing tool, but any smooth metal rod, such as a screwdriver shaft, will do. Use the tool to rub the sharp corners of the miter joints after the glue has grabbed, but before it dries completely. The sharp edge will be pushed back on itself and will form a small roundover, and the glue will help solidify the burnished corner when it hardens.

As soon as the joints have dried to the point that they can be handled safely, carefully peel off the masking tape. It's a good idea to peel away the tape in one direction so that it won't pull up the grain of the wood. Burnish the joints several more times as the assembly dries. This process usually will eliminate any gaps in the miter joints that were the result of slight inaccuracies in machining or where the joint was not completely pulled together during clamping. Continue to be very careful when sanding the corner after it has dried or you will sand through the veneer.

Another way to strengthen a mitered corner is to insert a strip of solid wood. It will be almost invisible if the wood and the veneer are the same species and the strip is ⅛ in. square or less. To create a contrasting design element, use a different species. Once the miter joint has dried, use the tablesaw or router to cut a small rabbet in the corner. Glue on a solid strip that is slightly larger than the rabbet and clamp it with masking tape. When dry, plane and sand it flush with the sides and round over the corner with no danger of sanding through the veneer.

Solid-Wood Corner for Added Durability

To strengthen a mitered corner, a strip of solid wood can be inlaid into it. For an almost invisible joint, use the same species as the sides.



Rabbet the corner. Cut a ⅛-in.-sq. rabbet in each corner using the tablesaw or router.

A solid-wood corner. Plane and sand the strip of wood flush with the veneered sides. The corner can then be slightly rounded without risk of cutting through the veneer.

Precision Jig for Precise Joints

TOBY WINTERINGHAM

"What's that?" asked Peter Korn, looking at the thing clamped in the tail vise of my bench. The object was a screw miter shoot that I use on almost every project. Korn, director of the Center for Furniture Craftsmanship in Maine, had come to my shop to invite me to teach at the school. When I accepted, he asked if I would bring my miter shoot. "No," I replied, "but I'll make one for you while I'm there."

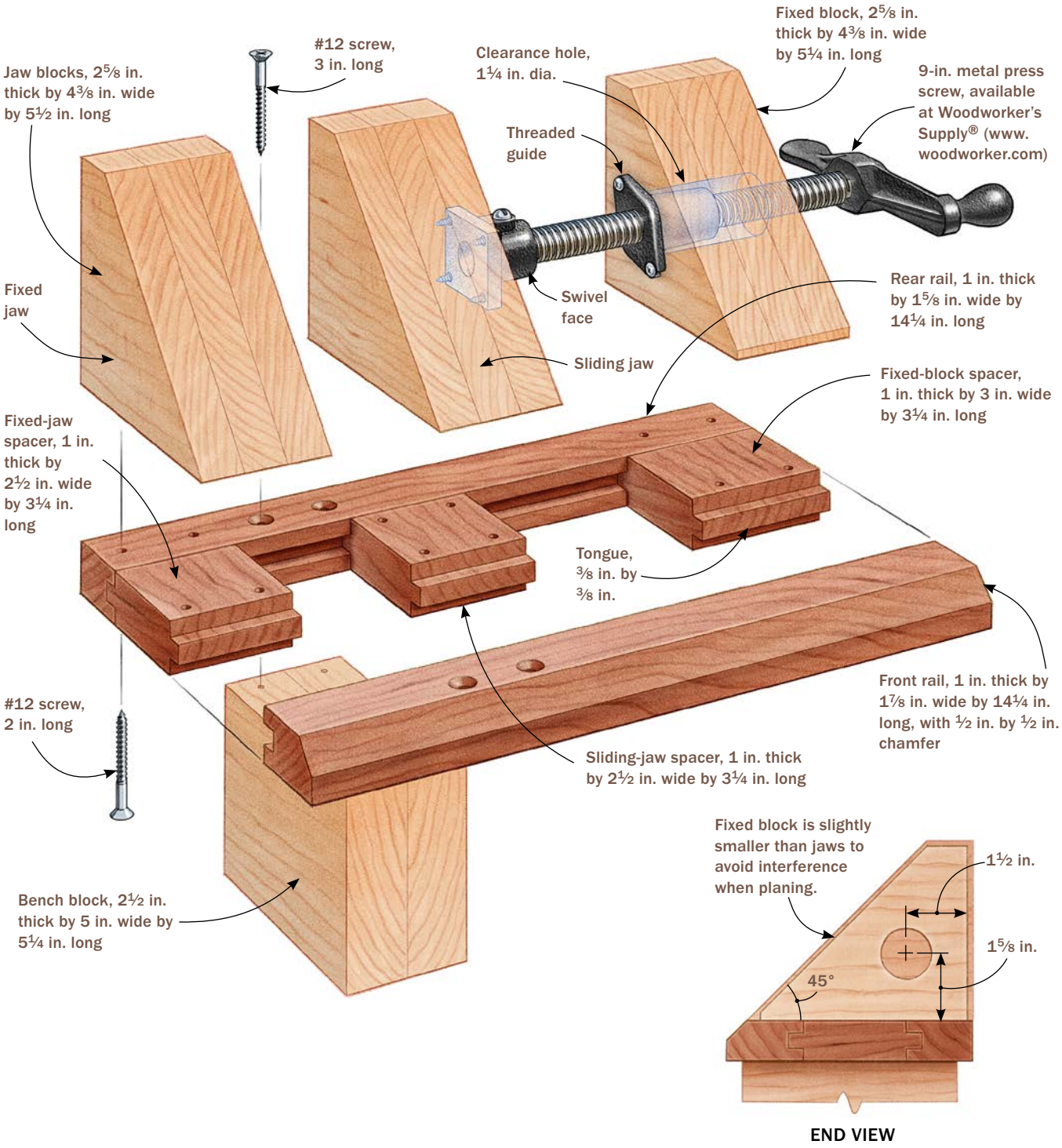
In my workshop, students make a miter shoot as their first task. It teaches them the importance of accuracy, care, and respect for tools, and they leave with a jig that will benefit them throughout their careers.

The miter shoot consists of two working surfaces aligned at 45° and 90°. The former is used to true up miter joints; the latter, to square up tenon shoulders and cheeks.

I can't claim credit for inventing this tool. As a student at the Royal College of Art in London, I discovered a decrepit one gathering dust under a bench. Even in poor condition, the jig was so much better than a bench vise for trimming miters that I decided to build one for myself.

Precision Jig for Precise Joints

The measurements listed are finished dimensions. You should cut the rails slightly wider and the jaw blocks slightly longer because you will handplane them when you true up the jig.



Good for More than Miters

Although the jig is known as a miter shoot because it can be used to trim joints at precisely 45°, the opposite side is set at 90° and can be used to fine-tune mortise-and-tenon joints.

Master the miter. Use the shoot to true up parts for miter joints. The base prevents tearout on the outside edges.

Tame your tenons. A shoulder plane can be used on its side (above center) to trim a tenon's cheeks. Used vertically (above right), it can trim and square the tenon shoulders.

The base has a sliding block

The shoot consists of a metal press screw attached to a fixed block; a pair of wooden jaws, one of which slides along a tongue-and-groove base; and a block attached to the underside of the base that mounts in a bench vise. I quickly realized that the secret to this tool is accuracy: The sliding jaw must run smoothly on the base with no sloppiness. Time invested in construction will pay dividends during use.

The base consists of two rails separated by three spacer blocks. The middle block slides up and down the rails. The easiest way to cut the tongue-and-groove joinery is with a rabbeting bit in a router table, but you also could use a dado blade on the tablesaw. In either case, the three spacers must start out identical in length to keep the rails parallel. Then take a thin shaving off the shoulders and the cheeks of the center spacer, just enough that it will slide while keeping the fit snug. A little wax on the final assembly also helps. When you are certain that you have

Make the frame and attach the fixed jaw. To start, dry-fit the base. Before you glue the two end stretchers to the rails, check that the center stretcher will slide freely but with minimum play.

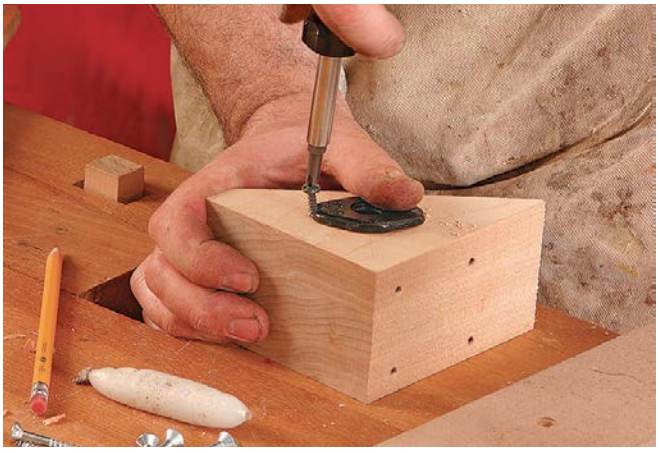
Create the jaw blocks. After flattening and squaring the laminated stock for the jaws and the fixed block, make the 90° and 45° crosscuts. You might have to screw on a piece of scrap to handle the short blocks safely.

the right fit, glue the end spacers to the rails with the sliding spacer between them. After glue-up, plane the base perfectly flat.

Fit the jaws and install the metal screw

Although you can make the fixed block and the two jaws from any tight-grained 12/4 or 10/4 hardwood, it is cheaper to laminate three pieces of 4/4 wood. This also results in less wood movement. After the glue has dried, mill and handplane the sections perfectly true and square—the sides must meet at exactly 90°. Then make the 45° and 90° cuts on the miter saw or the tablesaw, leaving the jaws slightly oversize. Later you will handplane them flush with the base.

Attach the fixed block and fixed jaw. With the block held in a vise, insert a short screw into the block through predrilled holes in the base (above left). Check that the block is square to the base (above right), and then insert longer screws into the three remaining holes before replacing the first screw.



Add the hardware. Detach the fixed block from the base, insert and screw on the threaded guide, then reattach the block.

On the drill press, drill and countersink holes on the underside of the base for attaching the jaws and the fixed block. On the top of the rails, drill holes for the bench block (see drawing, p. 70). While at the drill press, drill a hole in the fixed block to accept the threaded guide of the press screw. I locate the hole just below center—nearer to the rails to lessen the chances of the jaws skewing on narrow pieces. Don't install the guide just yet.

Both blocks and jaws are attached to the base with long woodworking screws. Because I don't use glue, I can dismantle the miter shoot if it needs adjustment. The easiest way to attach the fixed block to the base is to clamp the block in a vise, then clamp the base to the block. Extend one hole into the block, drive in a short screw, and use a good square to make sure that the block is perpendicular to the long sides and the face of the base. Complete the other three holes one at a time, installing long screws and constantly checking the block for squareness. Finally, replace the first screw with one of the correct length.

Repeat these steps with the fixed jaw. If the fixed jaw is aligned correctly, you can clamp the sliding one to it while fitting its screws. It is still worth checking as you go, because screws tend to pull one way or another. I set the sliding jaw just over the edge of the sliding block so that the jaws make contact but the spacers don't.

Lightly hammer the threaded guide into the fixed block and secure it with screws. Insert the threaded rod, screw on the removable swivel face, and place it against the sliding jaw. Find the location that allows the rod to run true. If there is any angle, the thread will bind as the jaw slides.

Attach a large block to the back of the miter shoot, screwed through the top and bottom rails. This allows the miter shoot to be clamped in either a tail or front vise

Attach the sliding jaw. After you have screwed the fixed jaw to the base, clamp the sliding jaw to the fixed jaw and screw it to its sliding spacer.

Add the swivel face. Screw the threaded rod through the guide to see where to attach the swivel face to the sliding jaw.

Screw on the bench block. A block of wood, screwed to the two rails of the base, holds the miter shoot in a bench vise.

with either the 90° surface or the 45° surface face up. Finally, use a handplane to true up the jaws in line with the base, keeping the surfaces flat and square. Again, the secret is accuracy; so take your time.

How to use your miter shoot

Take care when you first use the tool. In time, you'll get a feel for the crucial last stroke of the plane that brings the workpiece level with the miter shoot, and will avoid the next pass that planes the surface of the shoot. Used correctly, the surfaces of the jaws do not get worn quickly. I only true up mine once a year.

To true up tenons, fit the workpiece between the jaws with the shoulders fractionally proud of the surface. A few strokes with a shoulder plane will clean up the shoulders and bring them to an even height. Then, with the plane on its side, check that the tenon's faces are square.

Miter joints will lose their terror now that you can plane each component flat and true without the risk of tearout.

True up the miter shoot. After the tool has been assembled, the two working faces of each jaw must be planed flush with the base while keeping them flat and square.

Check the angle. Use a good combination square to check that the face of the miter shoot's jaws are at 45°.

Pinned Miter Combines Strength and Beauty

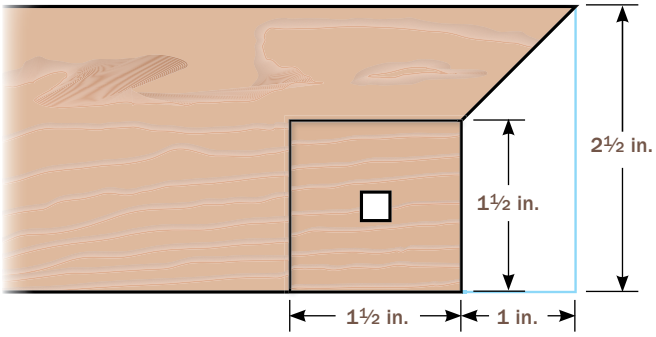
RUSSELL JENSEN

On one of my many quests over the Internet for woodworking knowledge, I happened upon a fellow woodworker from Japan who had gone into great detail about traditional Japanese furniture joints. Of the 50 or so joints illustrated, one really caught my eye: The *kane tsugi* (literally, right-angle corner) joint is basically a miter and a pinned bridle joint fused together. After making many examples of the joint, I am still impressed at its incredible strength. Even without glue, the joint is almost impossible to move once you insert the pin.

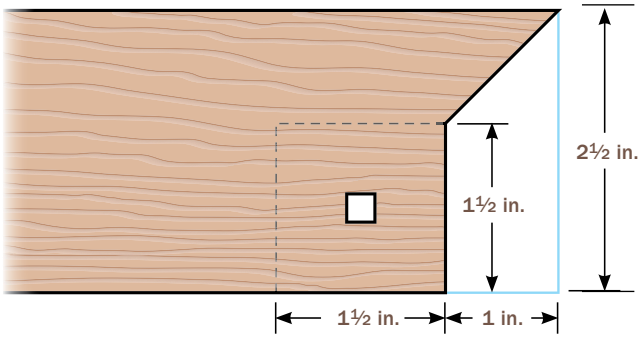
Traditional Japanese joinery normally consists of a lot of painstaking handwork,

Five Layout Steps

Lay out both pieces that form the joint at the same time. Use the same settings on a marking gauge to ensure a tight-fitting joint.

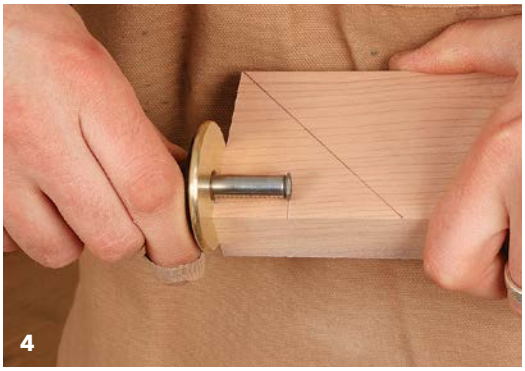


TENONED PIECE

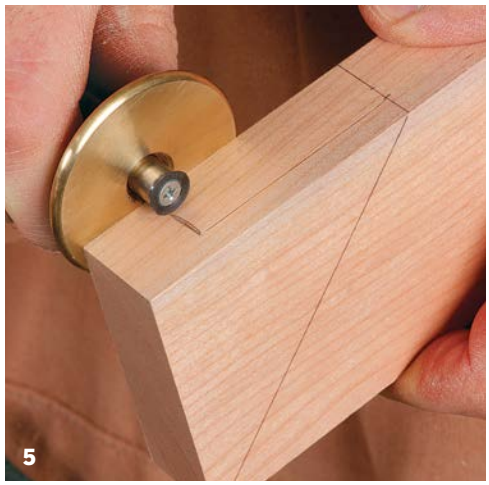


MORTISED PIECE

Lay out the miters. Draw a 45° line from the outside corner of both pieces (1). Where the 45° line meets the inside edge on the piece to be tenoned, mark the tenon's shoulder with a 1½-in.-long line parallel to the end (2).



Set a marking gauge to 1 in. Scribe a line from the tenon's shoulder line to the end of the board (3). On the board to be mortised, use the same setting to scribe a line parallel to the end of the board (4).

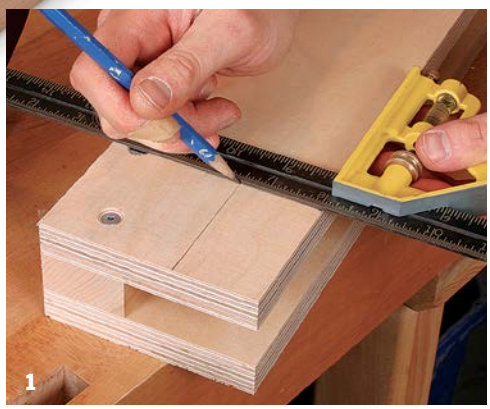


Lay out the mortise and tenon. Working off both faces, center and mark the mortise (above), then use the same setting to mark the cheeks of the tenon.

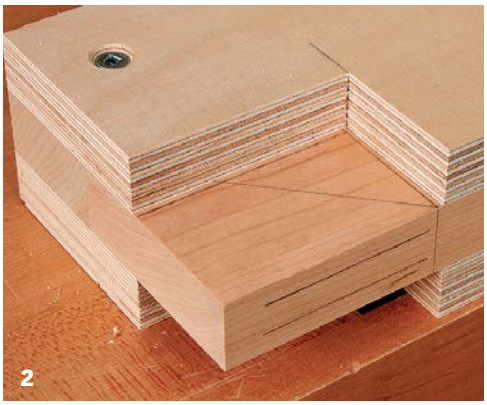
but this joint can be created using a simple jig, some power tools, and a small amount of handwork—a nice combination.

A simple jig for cutting the tenon

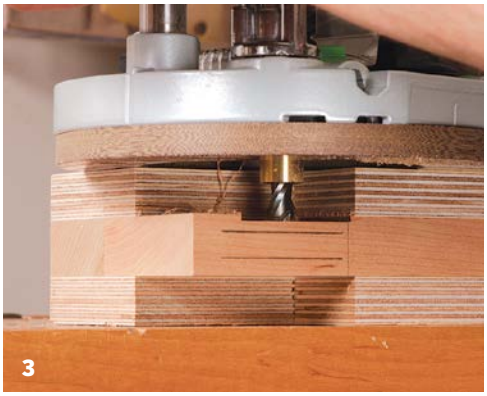
While milling the wood for the joint, mill an extra piece to the same thickness. This piece should be about 2 in. wide and at least 14 in. long, with parallel sides. Then, cut two pieces of ¾-in.-thick Baltic-birch plywood about 6 in. wide and as long as the piece of scrap.



Use a jig to rout the tenon. Create a tenoning jig by sandwiching a piece of wood the same thickness as the workpieces between two pieces of plywood. Then mark the corner to be cut away.

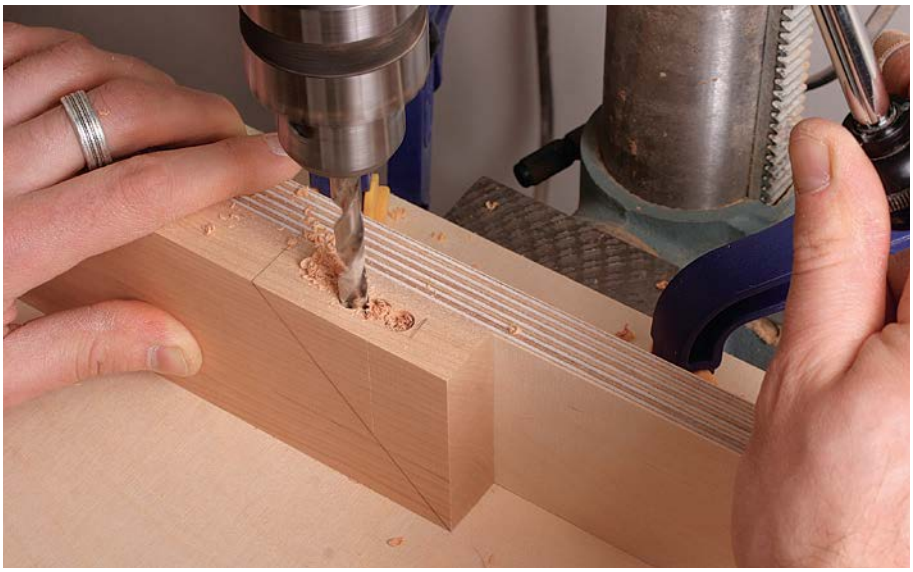


Bushing or bearing? For a bushing guide, the opening in the jig must be slightly larger than the tenon (above). For a bearing-guided bit, the opening should match the tenon.

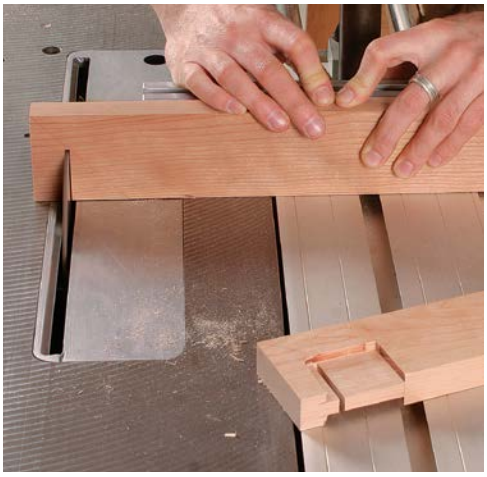


Cut the tenon. Cut down to the layout line in stages. When the first cheek is cut, flip the jig and workpiece over and cut the other.

Square up the corners. Use a chisel to square the rounded corners left by the router bit. Work carefully, as this will be a visible part of the joint.



Cut the mortise. With the joint laid out, cut the mortise using whatever method works best for you.



Measure once, cut twice. With the blade at the same height for both cuts, define the edge of the mortise and tenon on both pieces. Jensen uses a stop on his miter gauge to ensure uniformity.

Miter the tenoned piece first. Sneak up on the right blade extension (height). It's OK if you nick the tenon a bit as this will be invisible later.

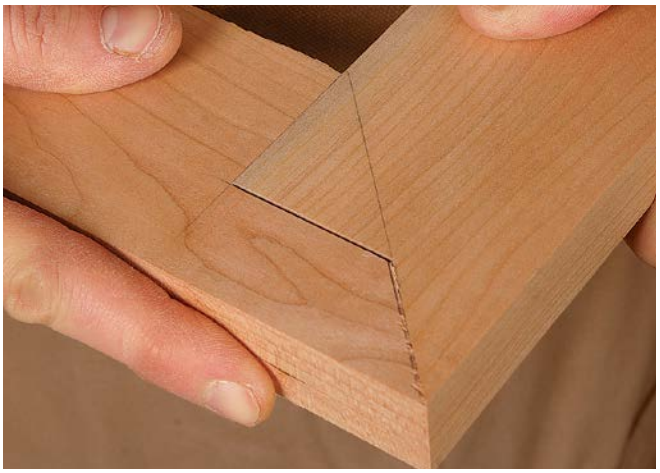
Safety first. Before cutting the miter, remove most of the waste on the bandsaw to prevent the piece from catching on the tablesaw blade.

The plywood should come from the same sheet for consistent thickness.

Now screw the two pieces of plywood to the scrap, leaving the scrap protruding about 1/16 in. on one side. After laying out the joint (see photos on p. 76), insert a piece of your project wood into the jig and mark the width on the jig. Remove the workpiece, and rip the jig to this width with the protruding edge of the scrap running against the fence. Flip the jig and trim the scrap overhang. Finally, cut one end of the jig square.

You now need to cut away one corner of the jig to guide the router when cutting the tenon. You can either equip the router with a bushing guide or use a top-bearing straight bit. I use a bushing with an outside diameter of 5/8 in. to guide my 1/2-in.-dia. spiral up-cut bit, so I have to make the opening 1/16 in. larger than the tenon. On the jig, I mark two lines using a square; the first 1 9/16 in. from the open side of the jig, and the second 2 9/16 in. back from the squared-off end. The extra inch is removed when the miter is cut. With the bearing-guided bit (Freud® #16-520), the dimensions would be 1 1/2 in. by 2 1/2 in. Cut the opening on the tablesaw using a tenoning jig and a crosscut sled.

Matching miter. With the blade now set at the correct height, cut the matching part of the miter on the mortised piece.



Getting close. If your joint isn't perfect the first time, you may need to trim one of the miters to get a tight joint.

Cut the tenon, then the miter

Insert the piece to be tenoned into the jig, making sure the end is flush, and clamp the assembly to the workbench. I only remove 1/16 in. or so with each pass.

Leave a 1/2-in.-wide strip at the end of the board to avoid going too close to the end of the jig and tipping the router. Remember, this section will be removed later when cutting the miter.

After you have reached full depth, unclamp the jig and flip it over, making sure the workpiece stays aligned with the end of the jig, and cut the other side of the tenon. To check the fit, I open up the end of the mortised section on the bandsaw, staying a good distance from where the final end of the mortise will be. When done, remove the workpiece from the jig and use a chisel to square up the rounded corner on each side.

Now measure back 1 1/2 in. from the shoulder and mark the tenon to length. At the tablesaw, raise the blade to just under 1 1/2 in. and cut to this line. With the blade at the same height, make the same cut on the mortised piece 1 in. from the end.

Before cutting the miter, use a combination square to check that the 45° miter line still meets the shoulder of the tenon at the inside edge. If you cut the tenon a little deep, redraw the miter line. You'll simply make the workpiece a little shorter.

After removing the majority of the waste at the bandsaw, tilt the tablesaw blade to 45°. I cut the tenon miter first, sneaking up to the line. If the blade ends up slightly high, I'll be cutting into the tenon, which is hidden in the completed joint, unlike the shoulders of the mortised section. With the blade set to the correct height, I can now cut the miter on the mortised board.

A wooden pin locks the joint

Cut a groove for the fixed or floating panel that goes in the frame. Now sand all the parts, insert the panel, and glue the joints together. Although most wooden pins don't go all the way through the joint, this one does. At the drill press, drill a 1/4-in.-dia. through-hole for the pin; then square up the sides with a 1/4-in. chisel.

Cut a 1/4-in.-square strip of wood at the tablesaw, then take the strip to the miter saw

A square hole. After the joint has been glued and allowed to dry, drill a ¼-in.-dia. through-hole on the drill press and then square up the hole from both sides using a chisel.

Soften the blow. Use a piece of softwood to prevent damage to the pyramid-shaped peg when inserting it into the joint.

A pyramid peg. To cut the four-sided pyramid on the top of the ¼-in.-square rod, use a stop block on the miter saw and tilt the blade 15°.

and tilt the blade 15°. Using a stop block, make four cuts, revolving the strip 90° after each cut, to leave a four-sided pyramid on the end of the pin. Cut the pin about ¼ in. longer than the thickness of the joint, and bevel the non-pyramid end with sandpaper so it doesn't get hung up when you drive it into the hole. Place a little glue in the hole, and gently drive the pin into place. I use a piece of softwood to protect the top of the pyramid. Stop when the base of the pyramid is flush with the top of the workpiece. When dry, cut off the excess from the back with a flush-cutting saw.

Display the joint. The *kane tsugi* can be used either vertically as on the doors of this bookcase, or horizontally as on a tabletop (see photo, p. 75). The panel inside the frame can be fixed or floating.

Superstrong Three-Way Miter

ANDREW HUNTER

At first glance, this double-tenoned lapping miter joint might seem as complicated as its name. I am sure some of the Chinese craftsmen using the joint more than 500 years ago puzzled over it, too. But once you have taken the time to create an accurate layout, this intricate joint can be made quickly and precisely.

In China it is known as the rice dumpling joint, after the three-way mitered fold of a dumpling, and has been in use since the Ming dynasty (1368–1644). Since its early history, Chinese furniture has been constructed predominantly with miter joints. In addition to its strength, mitered joinery lets shaped profiles meet seamlessly. Curves can flow into curves without the need for a more difficult cope.

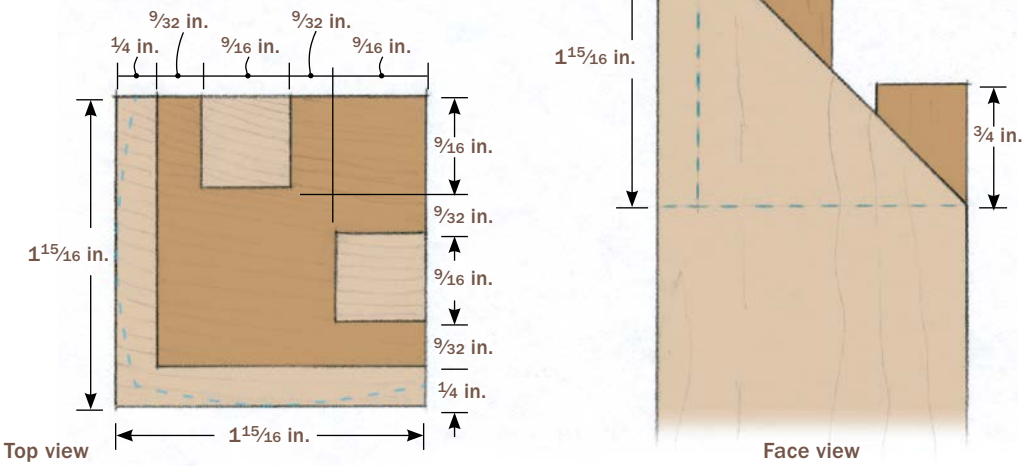
This oak cabinet has 16 separate corners all with this mitered joint. For this article, I'm demonstrating one joint made from start to

Strength and beauty. Hunter cut the three-way miter 16 times to create all of the corners in his oak dressing cabinet (right). The joint lends great rigidity to the piece, which consists of two stacked cases.

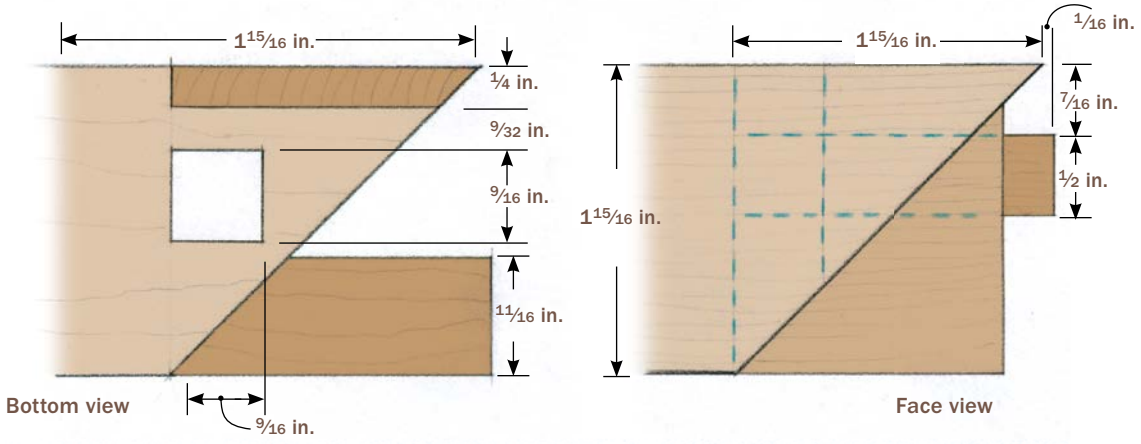
Precise Layout Is Key

Begin by labeling the outside faces of each piece and using them exclusively as reference surfaces for locating the layout lines. Hunter lays out the stile first, then uses an adjustable square to transfer most of the layout lines to the two rails.

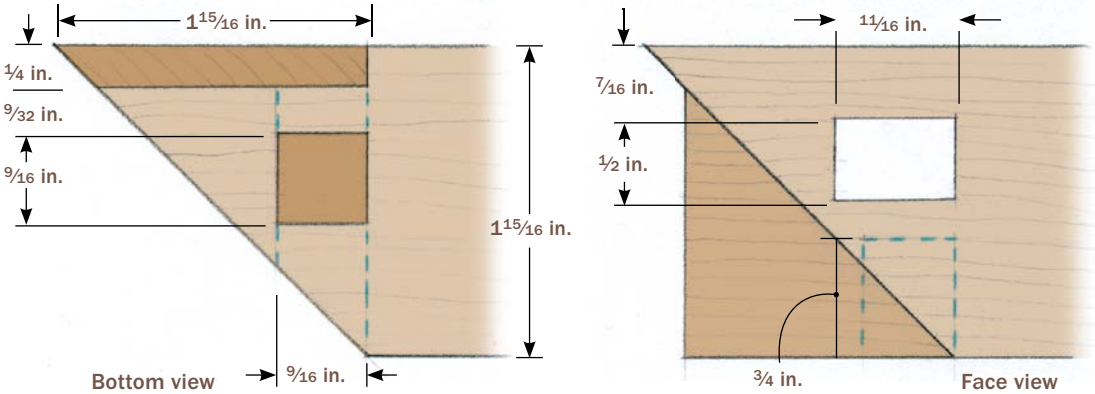
STILE



FRONT RAIL

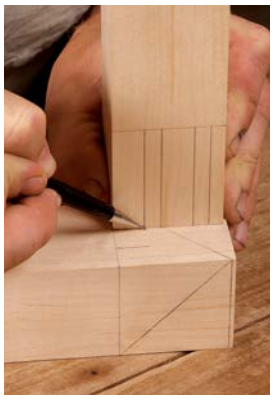


SIDE RAIL

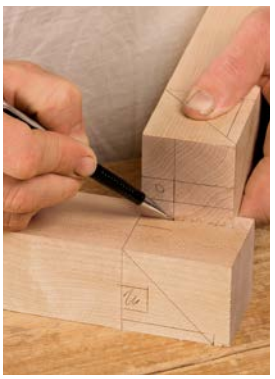


Mark the bottom shoulders and 45° miters first. Start the miters about 1/16 in. from the end of the workpiece to let the tenons protrude.

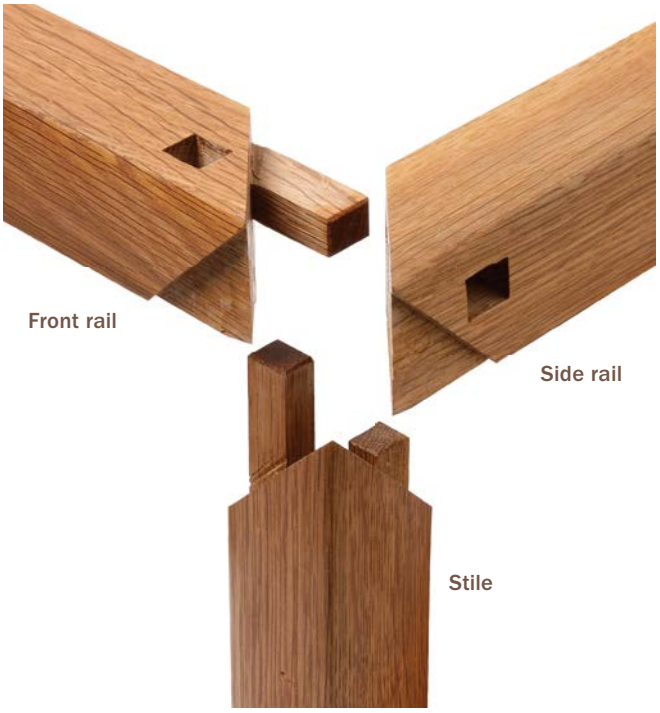
Two tenons top the stile. On the end, lay out four pairs of perpendicular lines at equal distances from each reference face. Two of the resulting squares will become tenons. Mark the waste tenons as shown and carry the lines down to the baseline on each inside face.



Front rail is next. This piece has a vertical through-mortise that accepts the long tenon from the stile. A beefier horizontal tenon goes through the second rail. Transfer most of the layout from the stile using a square, but mark directly from the stile to locate the mortise wall opposite the baseline.



Side rail gets mortises only. A stopped mortise underneath accepts the short tenon from the stile, while a rectangular through-mortise accommodates the long tenon from the front rail.



finish. However, it's worth mentioning that because the three parts of each joint are so different, in an actual project I lay out all the like pieces, move on to the next set of like pieces, and then lay out the last set. I do the same with the construction. I cut all the stiles first, then I cut all the mortise-only rails (side rail, above), and then the rails with one tenon and one mortise (front rail, above).

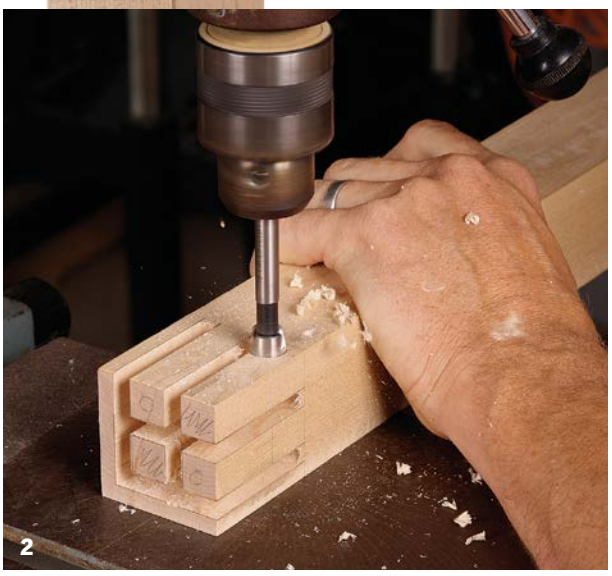
Whether the tenons are through- or concealed is a matter of personal preference. I use through-tenons. Also, because there is so much mechanical strength to this joint, I am able to leave it unglued, which allows for any repairs in years to come. But feel free to lock your joints with glue.

The key to a successful three-way miter joint is an accurate layout. It is important to begin with straight, square stock and to really take the time to draw out every line accurately. Once you are confident your layout is perfect, you can breathe easy. Carefully excavating to these lines should leave you with little or no fitting.

Make the Stile

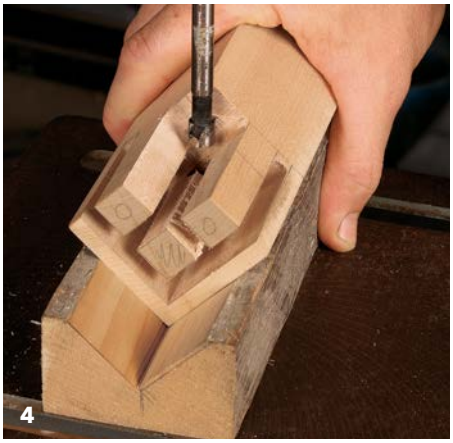
Some slick hand-tool and machine tips will get rid of the unwanted material and leave you with two perfect miters and two tenons.

Magic at the router table. Using a ¼-in. spiral bit, work slowly (about one-third-depth intervals) to clean out between the layout lines. Mark the bit's location on the fence so you can eyeball when to stop the cut before the bottom shoulder line. After an initial rough pass, go back and clean up right to the pencil line. This step will leave you with four perfect tenons, though you only need two of them.

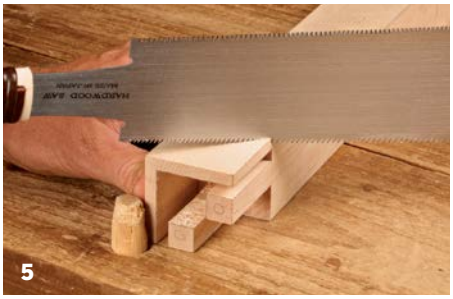


Remove the front tenon. Use a Forstner® bit in the drill press to remove the section of the tenon that you wouldn't be able to reach with a handsaw.

Follow up with a handsaw. Carefully cut off what remains of the front tenon.



Get rid of the back tenon. With the front tenon gone, you have access to the back one. Drill between the two side tenons to remove it. Clean up the bottom of the joint with a chisel.



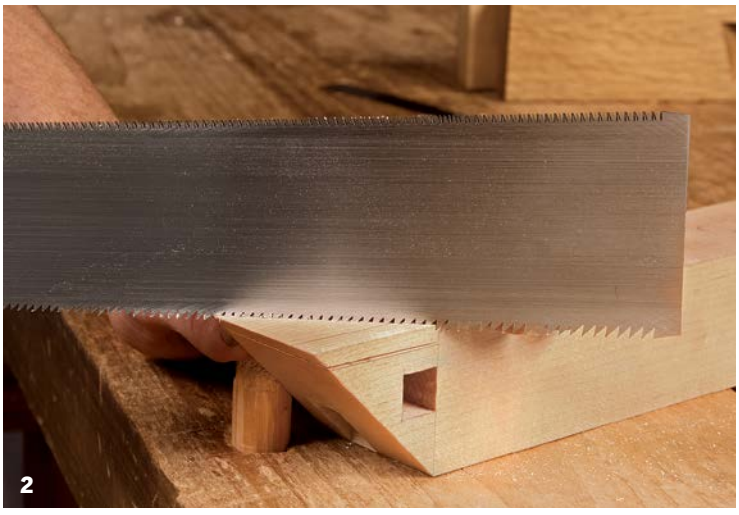
Outside miters are easy now. Cut the two mitered shoulders with a handsaw, then shave right to the line with a shoulder plane.

Cut one tenon short. Finish by cutting one of the tenons short to accommodate the tenon that will come in from the rail.

Tackle the Rail without Tenons

Of the two rails, the side one has no tenons, and Hunter likes to tackle that next. This piece is the most straightforward of the three.

Two mortises and a miter. Use a drill press to remove the bulk of the mortises, and then chop to the lines with a chisel. Then use a chopsaw to cut the miter. Hunter cuts just outside the layout lines and then shaves right to the line with a handplane or chisel.

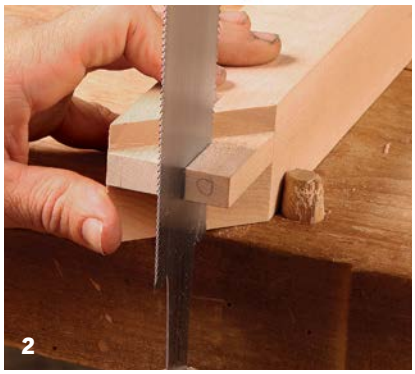


Cut the mitered shelf. Use a handsaw to cut the ¼-in.-deep shelf that will accommodate the mitered laps of the stile. Clean it up with a shoulder plane.

Final Rail Combines All the Elements

This piece combines elements of the other two. It has one long tenon, one through-mortise, a mitered face, and a mitered shelf. As with the other two parts of the joint, Hunter makes the front rail easy to cut, and you've already done all of these moves on the first two pieces.

Mortise first, then the tenon. Drill the mortise and square it with a chisel, then saw away the sides to reveal the tenon's cheeks. Use a shoulder plane to clean those faces to the line.



Finish up the tenon. Again with a handsaw followed by a chisel, cut away the remaining waste to leave the tenon.

Add the shelf. Like the other rail, this one gets a mitered shelf that holds the mitered laps of the stile.

Shaping Is the Final Touch

With the joinery complete, you can shape the outside faces of the joint. This is where the genius of this joint becomes so apparent. Superior strength aside, you can seamlessly transition any profiling you do from one face of this joint into the next.

Creating a profile. Cut the desired profile on a piece of scrap, then transfer the shape to the stile. Mitering the ends of the scrap makes the transfer easy.

Rough the shape at the tablesaw. Rip the facets first, then fine-tune the shape with a handplane. Reassemble the joint and trace the profile from the stile onto the rails.

Cut a Mortise in Minutes

CHRISTIAN BECKSVOORT

Many woodworkers cut mortises by drilling away much of the waste with a drill press, then cleaning up what remains using a bench chisel. The technique is popular because it doesn't require a special machine or jig. It's a challenge, though, mainly because the chiseling process is slow and easily goes awry.

I've been building furniture full time for more than 30 years, and I still use drilling and chiseling to make many of my mortises. But I've managed to refine the process to just a few surefire steps.

The tools are simple. After removing most of the waste using the drill press, I use a mortising chisel to square an end and lever away—in one shot—most of the waste. A bench chisel quickly cleans up what's left.

This method delivers clean, accurate mortises, and quickly.

Mortises in no time. Drill out the waste, then use a unique chiseling technique to handle the rest.

Scribe the sides. After marking the location with a pencil, use a marking gauge to scribe each side of the mortise, stopping at the pencil lines.

Scribe the ends. To complete the layout, use a knife to scribe a cut line at each end of the mortise.

Keep the mortise at least ¾ in. away from the end of the workpiece. Otherwise the end-grain at the end of the mortise could blow out when you drive in the chisel.

Including the drill-press work, I can finish a ⅜-in.-thick by 1½-in.-wide by 1½-in.-deep mortise in about 4 to 5 minutes. By the way, if you don't have a drill press, use a doweling jig and handheld drill to remove the waste accurately.

Mortise chisel is the star

A bench chisel is ideal for a lot of applications, but it's not the best choice to clean up the waste after drilling a mortise.

When driving a bench chisel with a mallet to square the end of the mortise, the chisel tends to twist. That's because the blade is relatively thin and the edges are beveled, so there is little side support. Typically, you'll need to start and stop the cut several times to keep it on track. And chances are it won't be as clean a cut as you'd like.

It's also challenging to keep a bench chisel square when cleaning up the sides. So the mortise may not end up straight and smooth. Plus, compared to my method, it's slow.

The solution is a mortise chisel. They come in two basic types: One has a blade with a rectangular cross-section (parallel sides), and the other has a blade with a trapezoidal cross section (tapered sides). You want the rectangular one. A rectangular mortising chisel won't twist easily as you bang it with a mallet to square the end of the mortise. And because the corners of the chisel meet at sharp right angles, you get a shearing cut when you lever it forward. That means much of the sidewall waste can be removed in one quick motion.

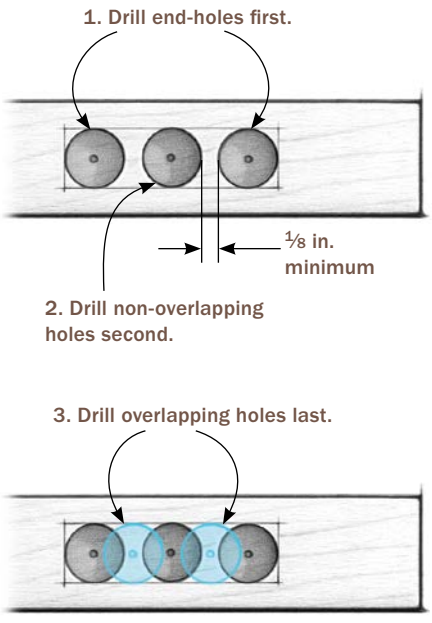
In addition, while bench chisels are normally sharpened to 25°, most mortising chisels are sharpened to 30°. That means the sharpened edge is less likely to fracture when levered.

Drill press does the grunt work. Use a bit that matches the mortise width. Clamp a fence to the table to ensure that the bit drills into the center of the piece.

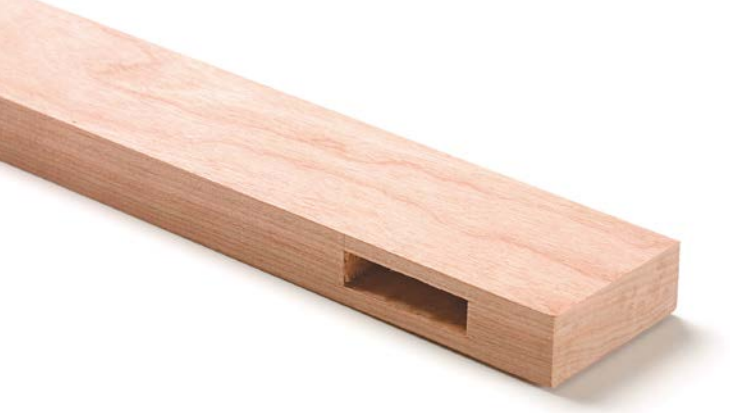
Dial it in. After drilling a single hole in the test piece, use a dial caliper to make sure the hole is centered.

Drill the end holes and 'tweeners. With the stock against the fence, drill a hole at each end of the mortise. In between, drill as many non-overlapping holes as possible (above), leaving ⅛ in. between holes. Then drill overlapping holes, anchoring the center spur in the material between each hole to help keep the bit from drifting.

Drilling Sequence

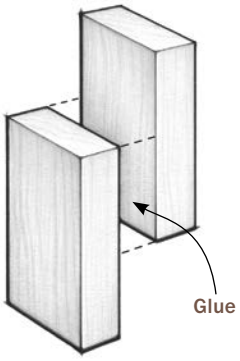


No drill press? Use a doweling jig. It's nearly as fast and just as accurate as a drill press.



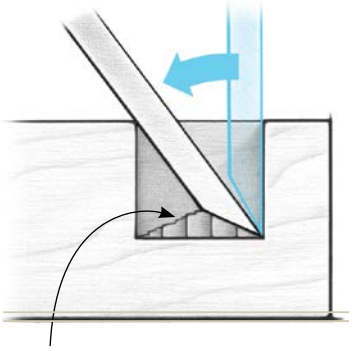
Mark the depth. With an ink marker and a square, mark the mortise depth on the blade of the chisel.

Drive the chisel. Place the tip of the chisel into the cut line on one end of the mortise (bevel facing away from the end), then use a mallet to drive it to the full mortise depth.



If keeping the chisel plumb is a problem, clamp a block of wood to the workpiece. Hold the blade against the block and you can drive the chisel knowing it's aligned perfectly.

The Levering Trick



Small triangle of waste remains after levering from both ends.

Lever the chisel. Lever the chisel toward the opposite end of the mortise. As you do, the square corners of the mortise chisel shave a good part of the waste stock. Repeat from the other end. The levering trick removes all but a small triangle of waste.

Last, mortising chisels are thicker and longer than bench chisels. That adds stiffness and leverage, making them better suited to the forceful levering action.

It takes just four steps to cut any mortise. But first, make sure your chisels are sharp.

Keep in mind that this technique requires that the mortise and the mortising chisel are the same width. That means if you want a ⅜-in.-wide mortise, you need a ⅜-in.-wide mortising chisel. I find that three different chisel widths—¼ in., ⅜ in., and ½ in.—cover almost any mortise I need.

Layout is critical

Begin by carefully laying out and marking the length and width of the mortise. Use a sharp pencil to mark the ends. Then use a marking gauge to cut the two scribe lines for the sides. Now, with a square and a marking knife, cut scribe lines at the mortise ends. The cut lines are important: When you slip the sharpened edge of the chisel into them, they align it perfectly for the start of the cut.

Drill out the waste

Now you're ready to start removing waste wood to create the mortise. You could remove all the waste with the mortise chisel, but it's a lot faster to remove most of it by drilling a series of holes. Plus, drilling makes it easier to maintain a consistent depth along the length of the mortise.

I put the drill press to work here. Either a brad-point or Forstner bit works fine. Both of these bits let you drill overlapping holes to remove the maximum waste from the mortise. Just be sure that the bit diameter is the same as the mortise width, and position the fence carefully so that all the holes are bored dead-center into the mortise.

Start by drilling the first hole at one end of the mortise, and then do the same at the other end. After that, drill as many non-overlapping holes as possible. Then cut overlapping holes as needed to remove most of the remaining waste.

Plunge and lever

With most of the waste drilled out, mark the depth of the mortise on the chisel blade. Place the tip of the cutting edge into the scribe line on one end with the bevel facing away from the end. Make sure the chisel is plumb. Also, with thin stock, it's a good idea to clamp the sides of the stock at the mortise so it won't split.

Clean out the last of the waste. A bench chisel removes the remaining triangle. Elapsed chiseling time for both the mortise and bench chisels: one to two minutes.

Now, use the mallet to pound the chisel to the full depth. Keep the chisel plumb as you go (see the drawing on p. 90).

Once you reach the full depth, lever the chisel forward, toward the opposite end of the mortise. This is where the rectangular chisel pays big dividends. Because the chisel sides are parallel, their leading edges slice away—in one quick motion—a good portion of the waste at one end. Repeat the cut-and-lever technique on the opposite end. If the wood is hard, use both hands and lean into the chisel a bit.

Just a bit of cleanup left

You now have only a small triangular section of waste in the middle of the mortise. Since this is mainly a paring operation, use a normal, bevel-edged bench chisel. Simply start at the top of the waste triangle and carefully pare down to the bottom. Use the mortise chisel to clean up what remains.

Sources of supply

PARALLEL-SIDED MORTISE CHISELS

Lie-Nielsen® Toolworks
www.lie-nielsen.com

Sorby
www.woodcraft.com

Precise Tenons by Machine

TIM COLEMAN

When I cut mortise and tenons, I look at the job as a production process. Seldom is there just one tenon in a piece of furniture, so it is imperative that I have a way to ensure consistent, repeatable results.

Toward that end, I developed a system for cutting tenons on the tablesaw that allows me to move through the process quickly and efficiently. All the setup and fitting is done with test pieces. Once I get the setup dialed in, I can crank out the tenons in bunches, and all of them will fit right off the saw, with very little fine-tuning by hand.

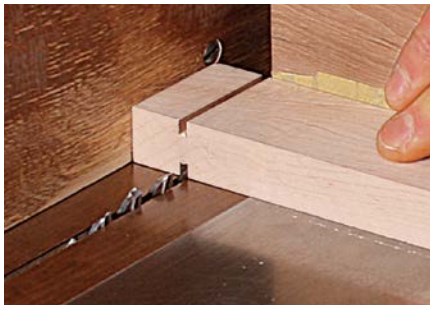
Make extra stock for test pieces

The process begins with a full-size layout on paper. I draw several views showing the joinery in plan and elevation. With the drawing in hand, I mill all stock to dimension, including plenty of extra for test pieces to set up all the cuts. Accurate tenons begin with accurate milling. Consistent thickness is especially critical, and I wait to do any hand-surfacing until all the joinery is done. I cut all the mortised parts to length, but I treat the tenoned parts differently.

If the tenon length varies, I cut the parts so that all the tenons can be machined to the same length at first, with the shorter ones cut to final length later. This takes a little planning to make sure the shoulders end up in the right place, but it saves me from having

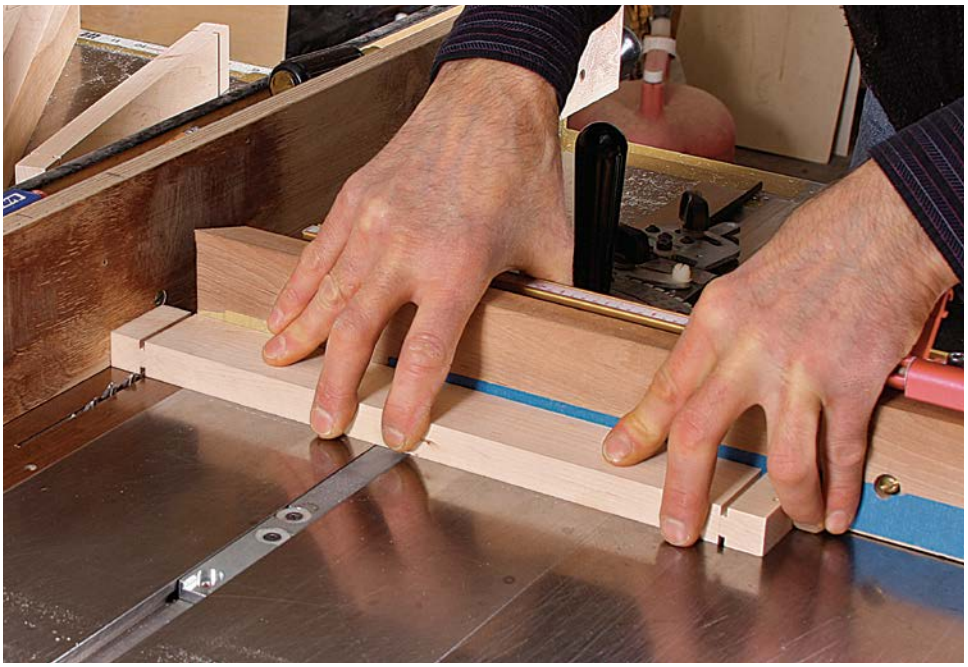
3 Simple Steps

1. DEFINE THE SHOULDERS

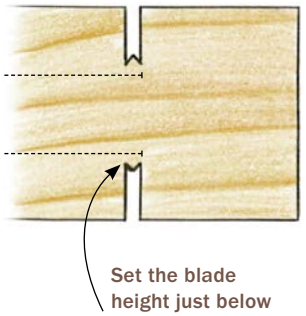


2. CUT THE CHEEKS

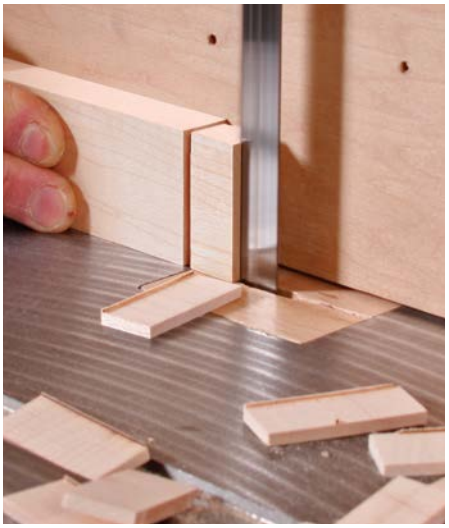
3. TRIM TO WIDTH



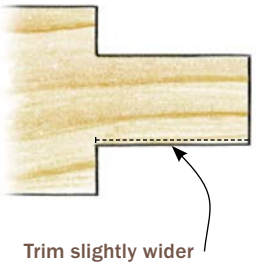
Shoulders first. With the workpiece facedown, raise the blade to within about 1/32 in. of the tenon cheek. Use the tablesaw fence as a stop, holding the workpiece against the miter-gauge fence and squarely against the tablesaw fence.



Top and bottom, too. To cut the top and bottom shoulders, keep the fence in the same position. Adjust the blade so it's about 1/32 in. from the base of the tenon.



Close shave. Zip off most of the waste using the bandsaw. Be sure to use a fence, and aim to leave the tenon about 1/16 in. over final thickness.



to adjust the blade height for different tenon lengths. Make sure the ends are square across in thickness and width. If needed, adjust the blade tilt and crosscut device to correct them.

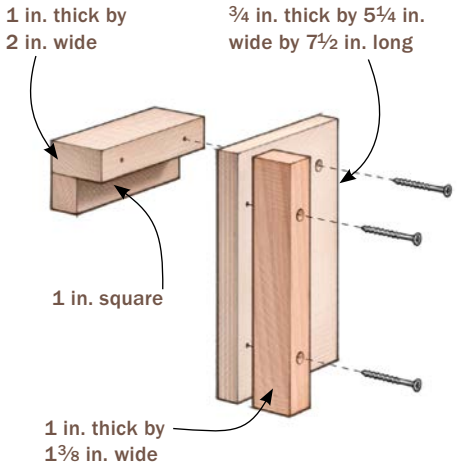
Cut the mortises first

I cut mortises first, typically with a hollow-chisel mortiser. While I'm cutting the mortises in the real stock, I also cut two extra mortises in test stock. I cut two because repeated test fittings in the same sample mortise will begin to enlarge it and give an inaccurate fit. Once all the mortises are done, you can start on the tenons. By the way, I cut the joinery before I do any shaping of the parts.

Tenons next, starting with the shoulders

Because I cut the tenons all to the same length, I have to do the layout only on a couple of test pieces. That said, I do scribe

Simple Jig Trims the Cheeks

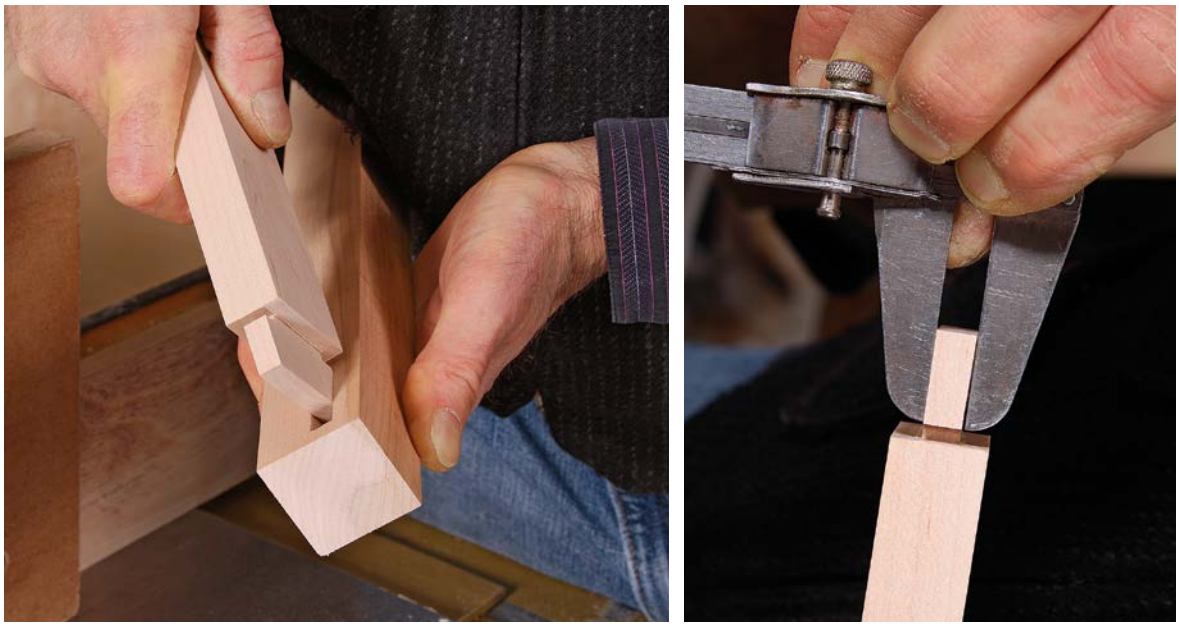


The key to perfect cuts. Coleman uses a shopmade tenoning jig (left) to cut the cheeks. The jig rides a tall auxiliary fence that he screws to his tablesaw fence. He sets up the cuts using a test piece. His goal is to trim each tenon with just two cuts, one on each cheek.

the shoulders on all the parts, which reduces tearout from the tablesaw cuts.

Cut the shoulders first. I use a combination blade and a miter gauge. Because this is a non-through cut, I can use the tablesaw's fence as a stop so that the shoulders are all cut in the same spot. I use a test piece to set the fence and the blade height. I cut the shoulders at the base of the cheeks first, setting the blade height so that it's just shy of the cheek, about 1/32 in. This little bit of material gets chiseled away later. I typically center the tenon on the rail or apron for efficiency. This way I can make both shoulder cuts simply by flipping the workpiece. The exception is when the rail or apron is curved in front. In those cases, the tenon must be offset, so you'll need to dial in two setups at the tablesaw.

Next I cut the top and bottom shoulders, again keeping the blade about 1/32 in. from the tenon. The top shoulder may be deeper than the bottom and require a change in the depth of cut. For efficiency and consistency, make all the cuts with one setup before moving on to the next: That means cut the top shoulders



No tapers allowed. Even if you've squared the blade to the saw table, the tall tenon cuts could be off and could taper from one end to the other. The probable cause is the auxiliary fence being a pinch off 90°. Check the test tenon with calipers, and look for any change in thickness.

in all the parts, then the bottom shoulders, or vice versa.

Cut the cheeks in two steps

After the shoulders are done, it's on to the cheeks. I rough-cut the cheeks on the bandsaw, leaving the tenons about 1/16 in. too thick, and then I finish them at the tablesaw using a shopmade tenoning jig with a tall auxiliary fence. The bandsaw step is tempting to avoid, but I have found that I achieve more accurate and consistent tenons at the tablesaw when the blade is just skimming the cheek face. There is less heat buildup and less blade deflection.

For the tablesaw cuts, I use a flat-top rip blade (Amana® heavy-duty ripping blade, 20 tpi), which allows me to get very close to the shoulder with minimal cleanup at the base of the tenon.

For a tenon centered in the thickness of the workpiece, there is only one fence setup, with the piece being flipped around to cut both cheeks. I position the fence so the blade will cut on the outside of the cheek. To set up the cuts, I use a test piece, with the blade raised just above the table (3/32 in.). Make cuts for both cheeks and test the fit in the sample mortise. When you're satisfied with the fit, raise the blade to within 1/64 in. of the tenon shoulder, and cut along the full length of the test tenon.

There's one more check before you cut the real tenons. You want to make sure that the tenon's thickness is even from top to bottom so there's a solid glue bond with the mortise walls. Even though the blade may be perfectly square to the table, the resulting cut is what is most important. Use a caliper to check, and adjust blade tilt to compensate.

Now you can cut all the tenon cheeks on the actual pieces. Periodically check the fit during the process to make sure that nothing has changed. Once the tenon cheeks are cut, I trim the tenons to the correct width. I usually do this on the bandsaw. Then I cut them to length on the tablesaw.

Back to the bandsaw. Cut the tenons to final width on the bandsaw. Set up the bandsaw fence using the test piece, then bang out all of the tenons at the same time.

Only light cleanup required

With my method, there's very little work at the bench. I use the corner of a chisel to clear away the waste at the base of the tenon. While I'm there I give a slight undercut around the base, a small extra step that ensures that the tenon shoulders are tight against the mortise face. I also soften the leading edges of the tenon with a file. This allows easier entry into the mortise.

Finally, I label all tenoned pieces as I fit them to their corresponding mortises. With my tenoning method I don't have to do much test-fitting, a bonus since too much of it can burnish the surfaces of the tenons and mortises. Burnished surfaces are not good glue surfaces. Done. Have some lunch.

A little off the bottom and top. Use a chisel to trim the small amount of waste at the base of the tenon left by the combination blade (top). Coleman likes to go a bit deeper, undercutting that area to ensure a snug fit. He also relieves the corners on the end of each tenon with a file (bottom).

The end is here. Test-fit each tenon in its mortise, and mark the parts so you don't lose track. You're now ready for assembly.

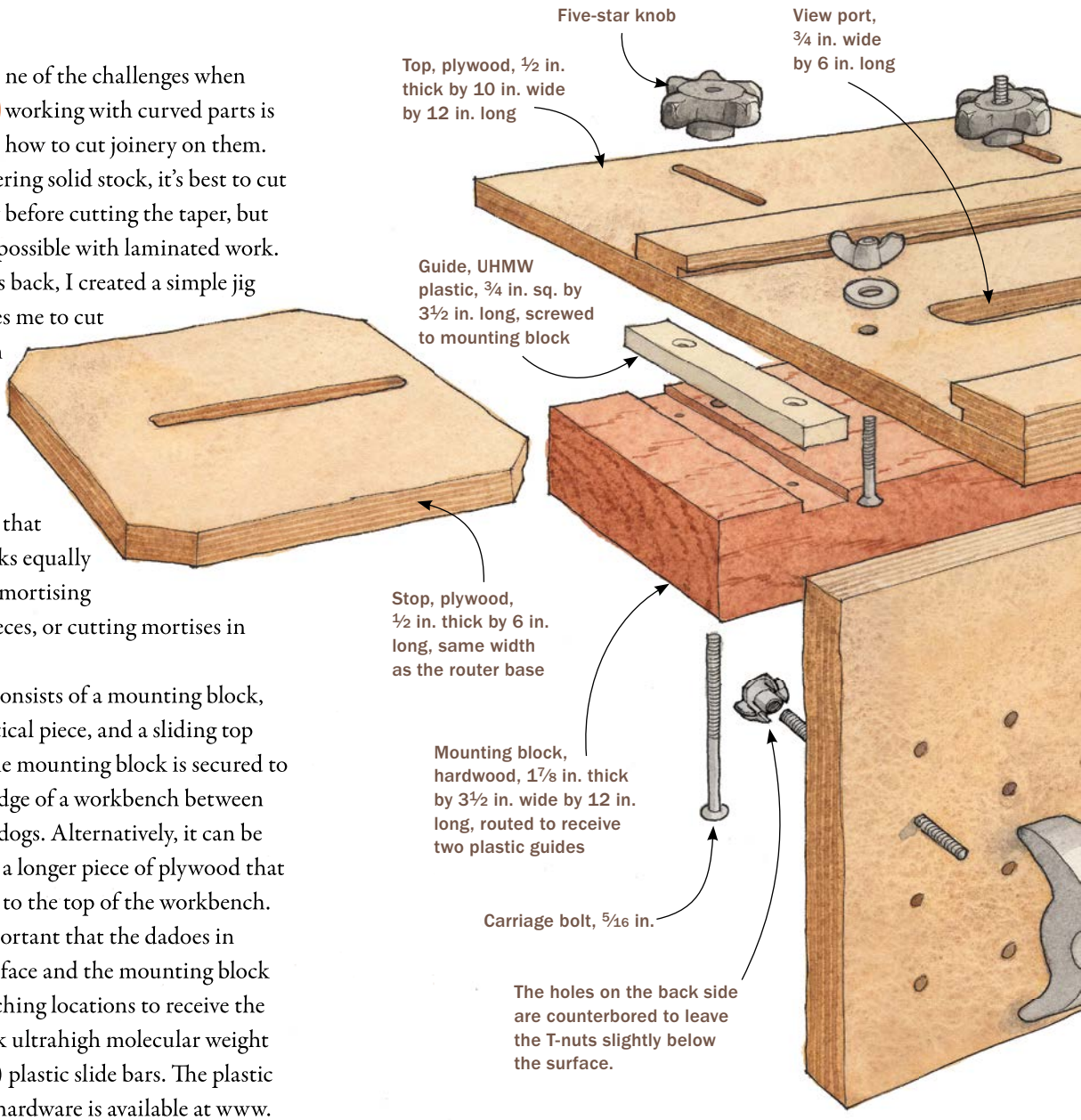
Try This Versatile Mortising Jig

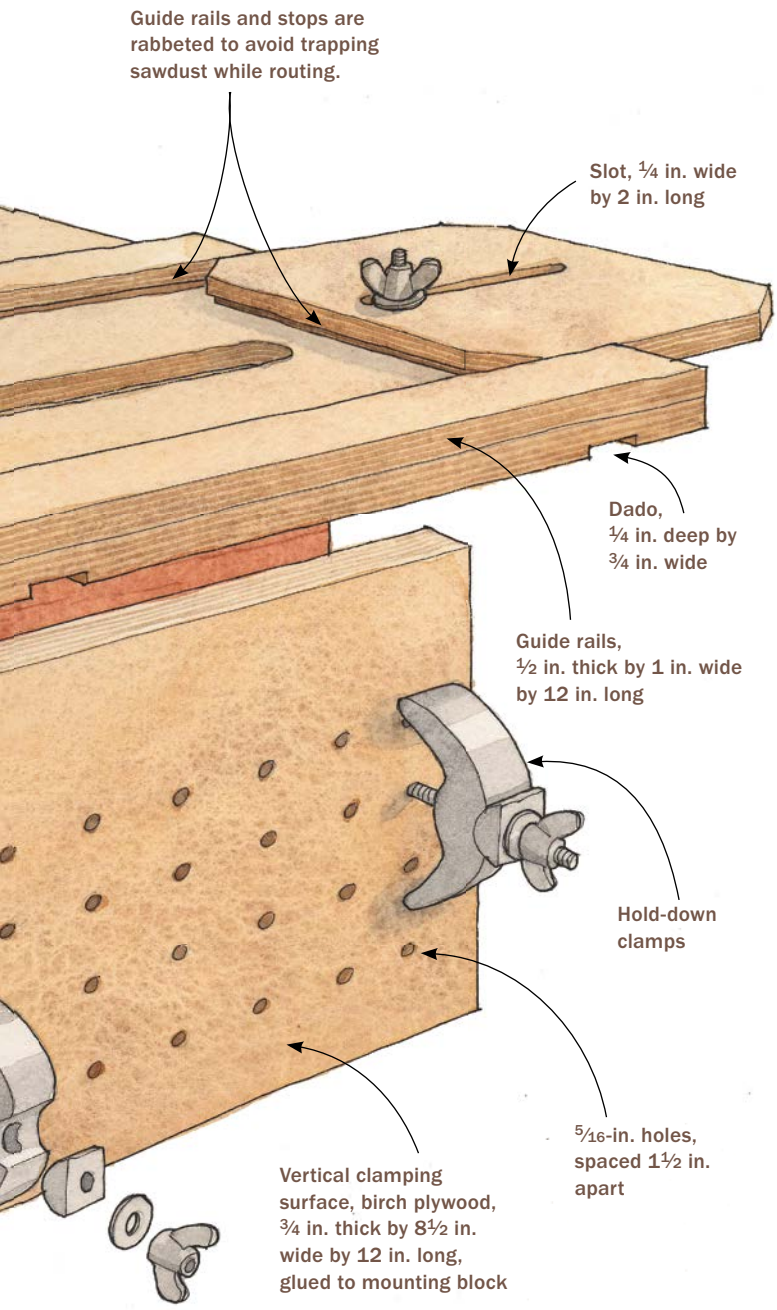
MICHAEL C. FORTUNE

One of the challenges when working with curved parts is how to cut joinery on them. When tapering solid stock, it's best to cut the joinery before cutting the taper, but this is not possible with laminated work. A few years back, I created a simple jig that enables me to cut mortises in a variety of curved pieces. I've since discovered that the jig works equally well when mortising straight pieces, or cutting mortises in end grain.

The jig consists of a mounting block, a fixed vertical piece, and a sliding top surface. The mounting block is secured to the front edge of a workbench between two benchdogs. Alternatively, it can be screwed to a longer piece of plywood that is clamped to the top of the workbench.

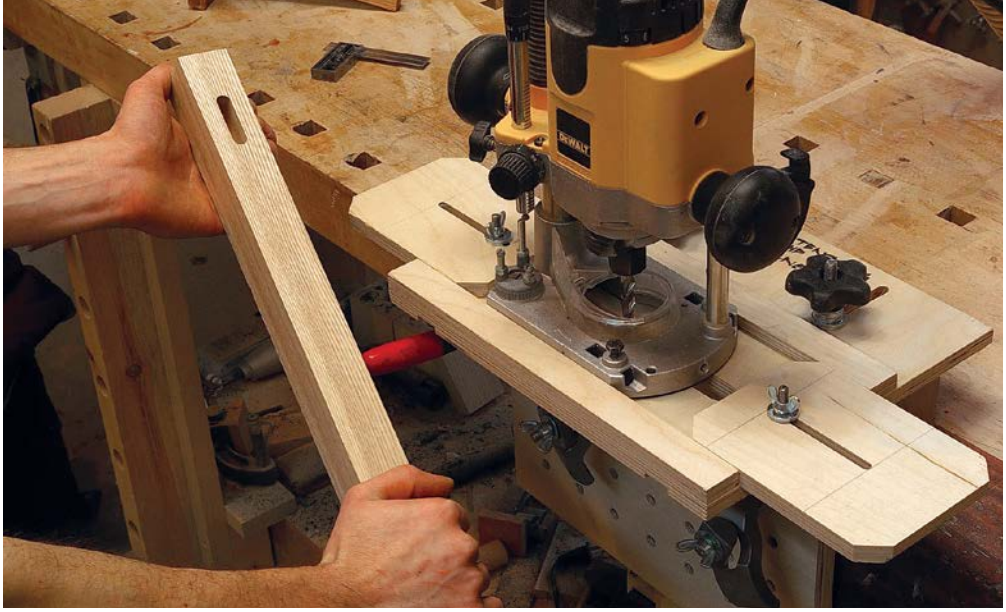
It is important that the dadoes in the top surface and the mounting block are in matching locations to receive the ¾-in.-thick ultrahigh molecular weight (UHMW) plastic slide bars. The plastic and other hardware is available at www.rockler.com.





Clamp the piece to the jig. Center the mortise in the viewing port and tighten the hold-down clamps. If more than one piece is being cut, a stop block aids repeatability.

Adjust front to back and side to side. Slide the top so the view port is centered on the mortise (right). With the router bit just touching one end of the mortise (below), move the slide until it touches the router base and tighten the wing nut.



On straight pieces. With the workpiece secure and the jig aligned, use a straight-cutting bit to excavate the mortise, increasing the depth ⅛ in. with each pass. You can either square up the mortise with a chisel or use a rounded loose tenon.

Lay out the mortise on the workpiece and then clamp it to the front vertical surface of the jig, touching the underside of the top. Now slide the top forward until the mortise is centered in the large viewing slot. Eyeballing it is sufficient, as once set up, the jig will cut matching parts identically. Now place the router on the jig and lower the bit until it just touches one end of the mortise. Slide the adjustable stop up to the base (round or square) of the router and tighten the wing nut. Repeat these steps at the other end.

Although you can use any straight bit, I use two-flute (three- or four-flute bits won't plunge) high-speed end mills available at www.wttool.com. You will need to buy a collet adapter for the ⅜-in.-dia. shaft. The bits work perfectly at 12,000–20,000 rpm. I plunge in a maximum ⅛ in. and do a medium-fast pass from side to side, not hesitating at the ends. The bit's spiral up-cut design clears the chips from the mortise and a vacuum attached to the router removes them.

Into end grain. The jig is flexible enough to allow end-grain mortises to be cut, such as for slip tenons.

Curved pieces, too. The jig allows clean, accurate mortises to be cut on all sorts of curved pieces.

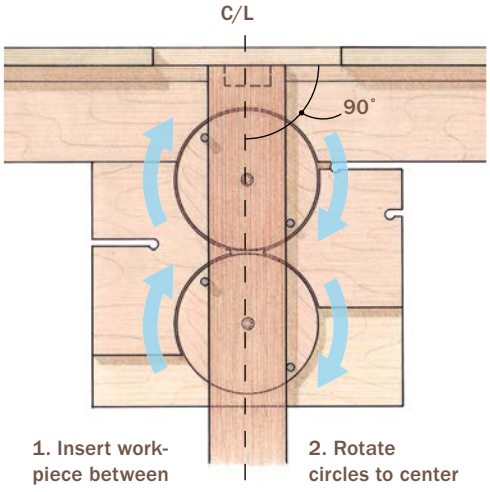
Self-Centering Mortising Jig

DAVID LEHMAN

Recently, as I considered a set of bedroom furniture I was designing, I counted more than 50 mortise-and-tenon joints. I needed a way to make them as simply, precisely, and consistently as possible. To me, that meant using loose tenons; it's much easier than working with standard tenons. There are no shoulders to cut (and then fine-tune) for a perfect fit. There's no need to add tenon length to rail length; just cut to exact shoulder-to-shoulder dimensions. And it's easier to cut tenons separately than at the ends of rails.

All it takes is two perfectly matching mortises in mating pieces. And I decided a shopmade jig would do that job best.

How the Jig Works

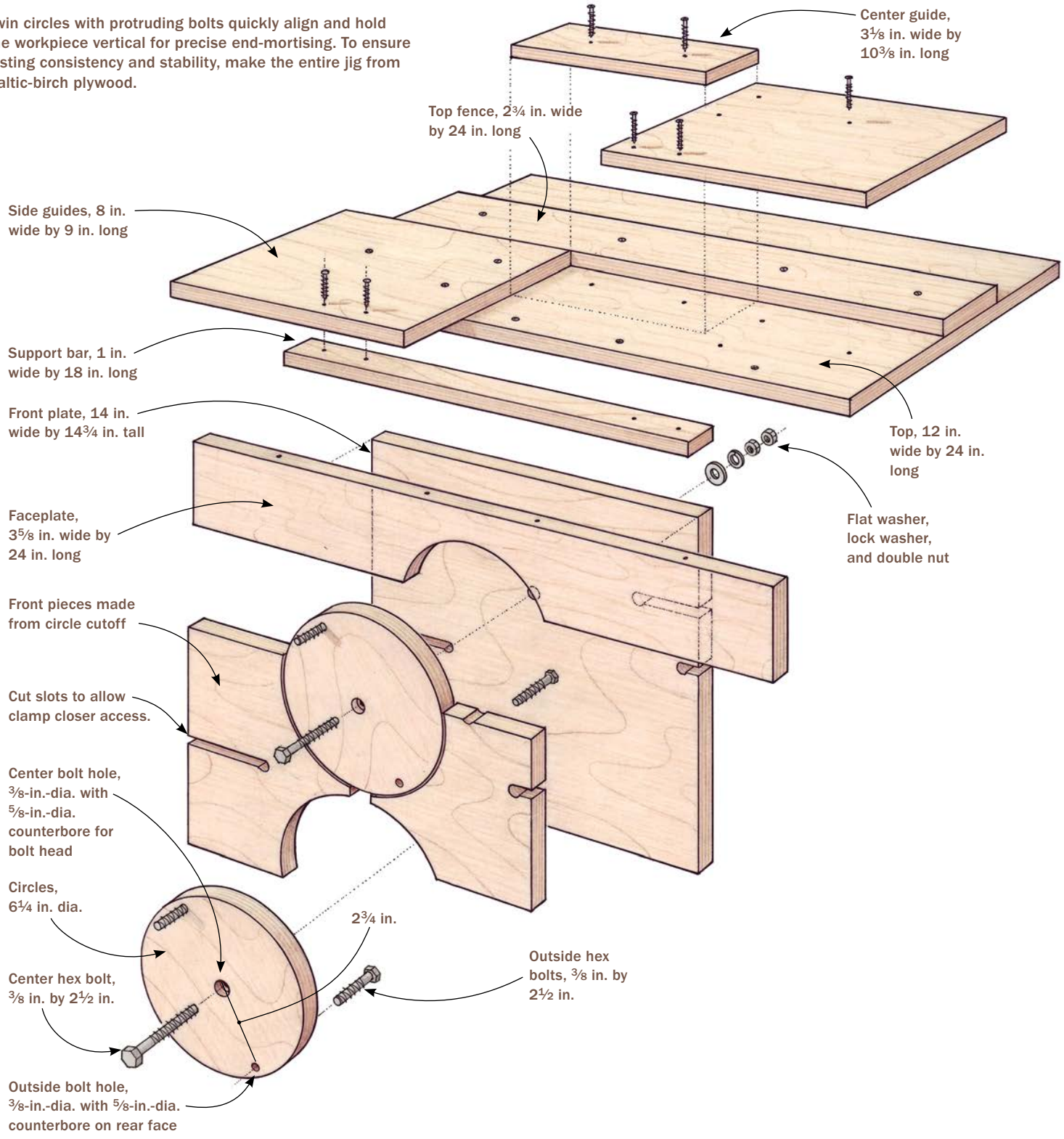


1. Insert workpiece between protruding bolts.

2. Rotate circles to center workpiece in jig.

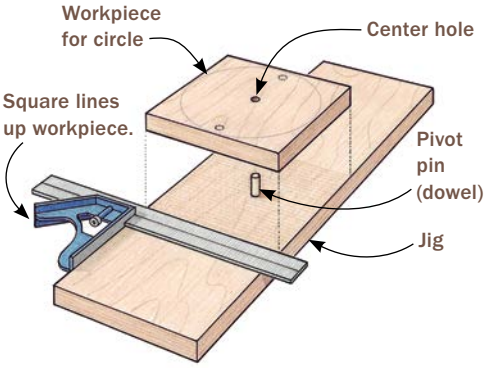
Simple Parts, Aligned Precisely

Twin circles with protruding bolts quickly align and hold the workpiece vertical for precise end-mortising. To ensure lasting consistency and stability, make the entire jig from Baltic-birch plywood.



Bolt Holes Are Critical

Use a drill press and a simple jig to make matching center and outside bolt holes in both circles. Outside holes must be equidistant from the center hole.



Make a jig for the bolt holes. Clamp a fence to the tabletop and drill two holes in the jig 2¾ in. apart and parallel to one edge. Then, clamp the jig in place, keeping one hole aligned with the drill bit. Insert a pivot pin (dowel) into the other.

My jig uses two vertically aligned, rotating circles with protruding metal bolts to center the rails automatically for end mortising. The jig, made of Baltic-birch plywood, also aligns the stiles horizontally for matching mortises using a simple stop-block setup. And it's semidedicated—made to cut the widest mortise I'd need while allowing me to make narrower, and even offset, cuts.

Start with the circles

The jig is centered on the circles, so begin by making them. They must be large enough to accept the widest piece to be end-mortised between the bolts that protrude from them. My circles are a bit over 6 in. dia. and can accommodate a board up to 5 in. wide between the bolts.

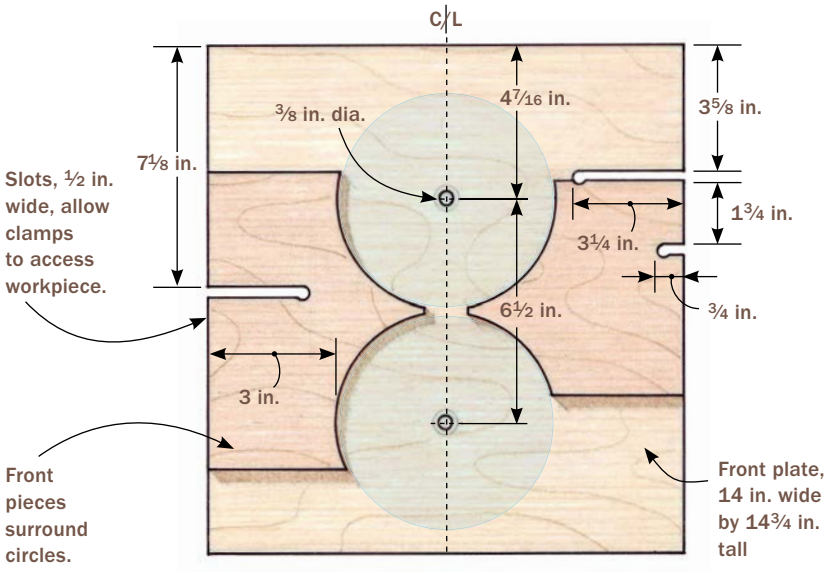
To make each circle, start by cutting a perfectly square blank slightly larger than the circle it will become.

Mark the center point of the square. Install a ⅝-in.-dia. Forstner bit in your drill-press chuck and make a counter-bore as deep as the bolt head it will receive. Then switch to

Drill the holes. Place the blank's center hole over the pivot pin, using a square to align the edge. Drill the first hole, then rotate the blank 180°.

Assemble the Front

The jig front is critical. The center holes of the circles must be aligned precisely on a centerline perpendicular to the top edge of the front plate. Use a drill press to make sure the holes are true. Slots are machined from the sides to hold the clamps.



Locate the circles on the front plate. Drill two 3/8-in. holes on the centerline for the circles' center holes. Use a fence to ensure that the holes are aligned.

a 3/8-in. brad-point bit (or a spiral bit if your brad-points cut with their outside edges first) and drill a through-hole. Put the blank aside.

Cut a simple drilling jig from 3/4-in. wood or medium-density fiberboard (MDF) long enough to span the drill-press table from left to right. On the jig face, draw two parallel lines perpendicular to the front, separated by the distance between the circle blank's center and an outside bolt hole.

Clamp a fence to the table and place the drilling jig against it, lining up the left-hand line with the drill bit. Drill a 3/8-in. through-hole on the line. Slide the drilling jig to the left and drill a second through-hole on the right-hand line. With the drill bit still in the hole, clamp the drilling jig to the table. Then, raise the bit out of the hole.

Insert a 3/8-in. pivot pin into the left-hand hole, and place the circle blank facedown on the drilling jig with the pivot pin protruding up through the center hole.

Using an accurate combination square, adjust the blank so that its sides are perpendicular to the front edge of the platform and drill a 3/8-in. hole for one outside bolt. Then rotate the blank 180° and line it up again with the square. Drill the other bolt hole. The two holes will be equidistant from the center.

Without moving the table or the jig, switch back to the 5/8-in. Forstner bit. Turn the blank

Attach the circles. With outside bolts in place, secure the circles to the front plate with ⅜-in. bolts through the center holes. Hand-tighten double nuts over the washers and lock the nuts.

Attach the top faceplate. Align its top edge with that of the front plate. Clamp it in place, and attach with screws from the rear.

Test for vertical alignment. Square the end of a test piece and place it between the outside bolts, rotating the circles for a snug fit. The top edge of the test piece should align perfectly with the top edge of the jig. If it doesn't, you can mark and trim the top edge.

over and make the outside bolt counter-bores on the back of the blank, squaring up for both. The bit's outside edges will come down centered over the ⅜-in. holes.

Finally, using the center hole as a pivot point, cut a circle out of the blank with a bandsaw or router. Repeat the entire process for the second circle.

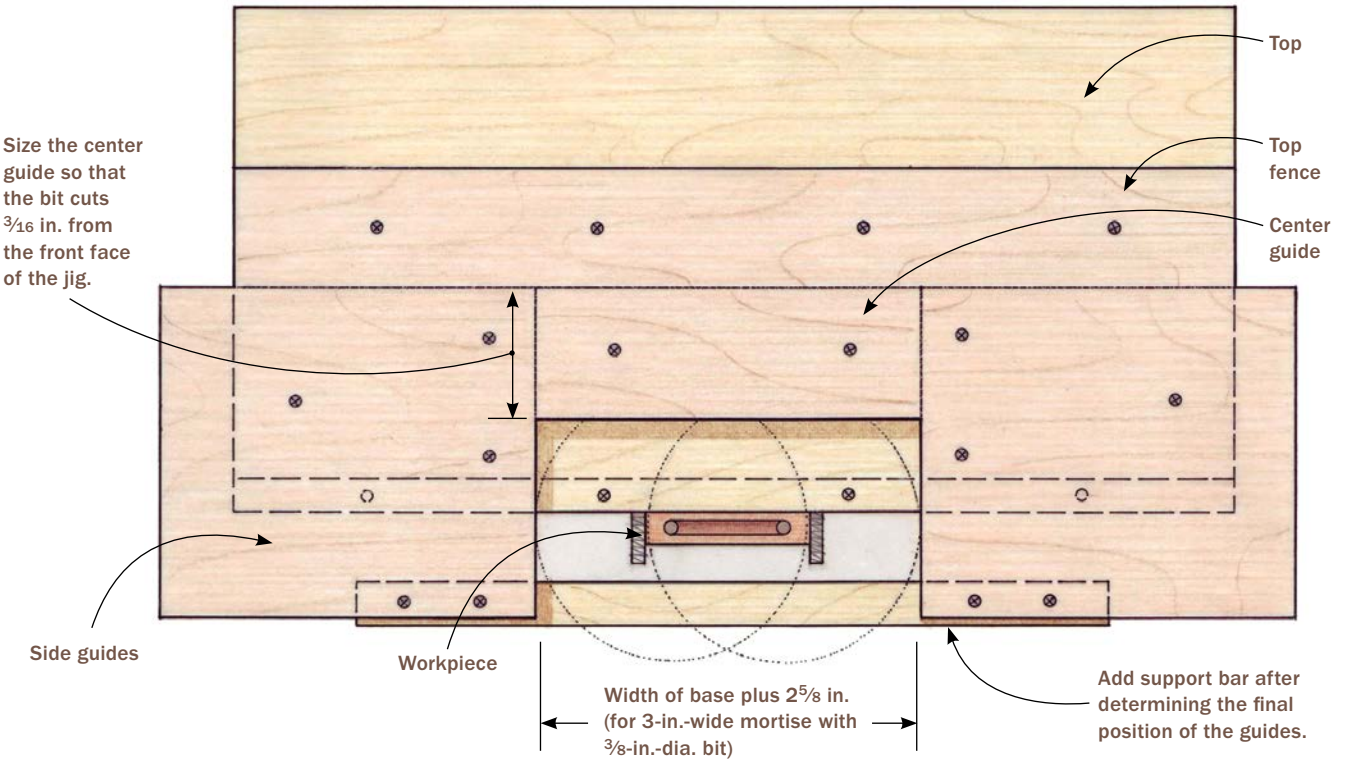
Attach the circles to the front plate

Next, make the front plate and draw a vertical line, perpendicular to the top edge, down its center. On that line, mark and drill ⅜-in. holes to receive the center bolts of the circles, allowing the circles to be about 1½ in. from the top and centered vertically with their edges ⅛ in. to ¼ in. apart. Make the clamp-access slots on both sides of the front plate (see the drawing on p. 104). Insert the ⅜-in. outer bolts through the circles so that they protrude out the front, their heads nestled fully into the back-side counterbores. Then attach the circles to the front plate with ⅜-in. bolts through their center holes. Use flat washers, lock washers, and hand-tightened double nuts to make the circles turn with some resistance. This will enable them to stay tight against the sides of the workpiece and hold it in place for clamping.

To add stability to the jig, I attached front pieces on both sides of the circles. I made them from the circle cutouts so they could be attached to loosely "hug" the diameters.

Add the Top

Your router determines the layout of the top pieces. The size of the router base and width of the largest mortise to be made determine the center guide's length. Side guides abut the center-guide ends to create the router track.



Attach the top. After cutting the top to size, align its front edge with the front of the faceplate and screw it in place (above). Then attach the top fence parallel to the front edge of the top, leaving room for the center guide.

Clamp the side guides in place and make a test cut. With a test rail in place, make a cut to determine if the mortise is centered on the workpiece.

Adjust the side guides until the mortise is centered. Slide the parts along the top fence to make small adjustments. When the mortise is centered on the rail, screw the parts in place.

Mortise the end piece first. Start by aligning the workpiece securely inside the bolts and clamping it in place. Then with the router firmly against the center guide, start the first cut by plunging approximately ¼ in. as you move the router left to right. Repeat the process in increments until the desired mortise depth is reached.

Test for vertical alignment

Next, make the top faceplate with the half-circle cutout, and screw it in place on the front plate, with both top edges aligned. Square up the end of a 4-in.-wide to 5-in.-wide test rail and place it on the circles with the bolts tight against the sides. Adjust the test rail vertically so its top edge is even with the top of the faceplate and front plate. If they don't align evenly along the entire top edge of the rail, mark and trim the top edge of the faceplate/front plate until they do. Make sure this edge is square in the front-to-back plane as well.

Test the centering

Make the top and use 1½-in. drywall screws to attach it flush with the front. Make the top fence and clamp it to the top, parallel to the front edge. Next, make the center guide against which the plunge router will track. It should be precisely as long as needed to rout the longest mortise you intend to make. And it should be precisely as wide as needed to align the router bit over the center of the thinnest rail to be mortised. My jig is set to cut a centered ⅜-in. mortise in a ¾-in. board.

Place the center guide against the front of the top fence. Center it left-to-right over the circles' vertical axis, parallel to the top's front edge.

Next, make the side guides and clamp them to the top, abutting the center guide on both sides.

Reinsert and clamp the test rail in the closed circles flush with the top. Cut shallow test mortises and keep adjusting the center

Attach a stop block and mortise the mating piece. For the matching side mortise, leave the first workpiece in place and clamp a stop block firmly against one of its sides (right). Then align the mating piece by butting it against the stop block (below). Clamp it in place. Now rout the mating mortise.

and side guides until both shoulders are exactly equal. Then screw the guides in place.

Finally, install a support bar under the front edges of the guides, spanning the gap between them. This will provide a front base to keep your router from tipping.

Use the right router and bit

This jig is designed for a plunge router. I use a 3-hp DeWalt® with a flat edge on its base that I run along the back fence. If you use a router with a fully circular base, keep the same point against the fence throughout the cut (circular bases aren't always circular or concentric with the bit).

You can use either a straight bit or an up-spiral bit, which will pull the chips out of the mortise. I hook up my router's dust collector for extra chip-clearing.

Do the bulk of the cutting from left to right, so the cutting force keeps the router pressed against the fence. Most router bits won't cut at their very center, so plunge down in ¼-in. increments on each left-to-right stroke, returning to the left without plunging.

Mortises can be centered or off-center

Centered mortises are made by clamping the rail in the circle guides and plunge routing to the desired depth. Make sure to mount matching workpieces consistently, front and back.

For a face frame, rout the mortise in the rail end first. With the rail still in the jig, clamp an end stop in place on either side of the rail. Remove the rail from the jig, and clamp the stile against the stop and flush to the bottom of the wings. Then mortise the stile.

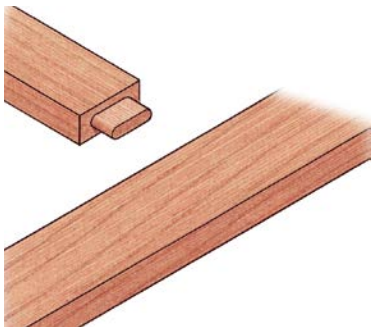
To make off-center rail-end mortises, or to change their length, place appropriately sized shims inside either or both side guides. The same shims are inserted alongside the stop blocks when mortising the matching stiles. A shim inside the center guide sets up for thicker or offset workpieces. I use masking tape to hold the shims in place.

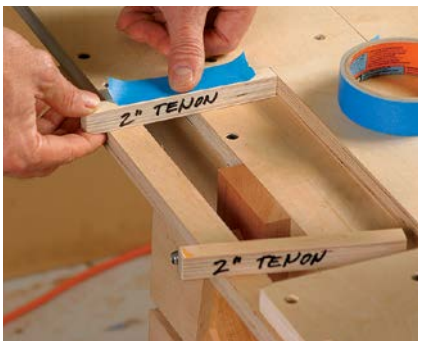
Once the mortises are made, you've come to the final step—making the loose tenons. Cut long pieces of wood slightly thicker than your mortises will accept. Round over their edges, and plane them down to fit snugly into the mortises. Finally, cut them to length.

Vary Mortise Size and Location with Spacers

SIDE SPACERS FOR NARROW MORTISES

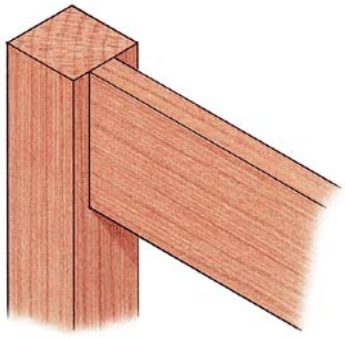
Lehman taped ½-in. spacers inside the side guides to switch mortise lengths from 3 in. to 2 in., the two sizes he needed. Size the spacers to match your own needs.





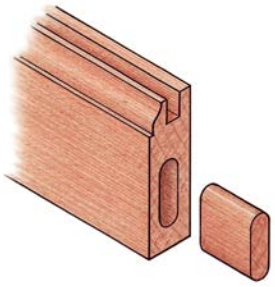
BACK SPACER FOR THICK OR OFFSET PIECES

A thin spacer taped to the front of the center guide gives you several options. You can center a mortise in a thicker workpiece, or make an off-center mortise (for a table apron-to-leg joint, for example).



WORKPIECE SPACER FOR OFF-CENTER MORTISES

Placing a spacer on one side of a workpiece sets up for an off-center mortise.



Drawbore Your Tenons

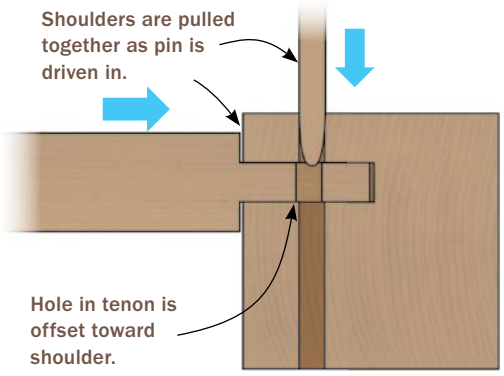
STEVE LATTA

More often than not, I add drawbored pins to my mortise-and-tenon joints. They send a message of strength and endurance, and speak of a time when things were built to last longer. More importantly, they make assembly much easier.

Drawboring means offsetting the hole in the tenon so that the pin pulls the parts together tightly—and permanently. If your tenon shoulders are square, your assembly will be, too. This changes the way you work. Clamps, which can damage workpieces and pull them out of square, are eliminated. This is especially great on doors, where a

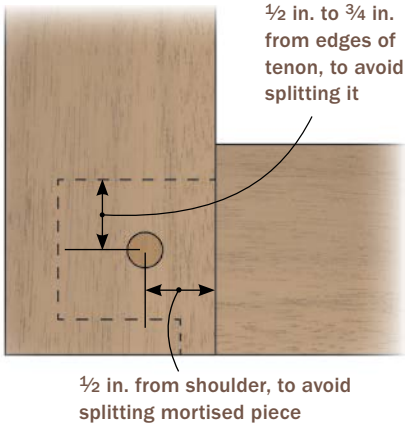
Offset Holes Are the Key

As the pin passes through the offset holes in the mortise and tenon, it pulls the joint tight, eliminating the need for clamps.



Drill the Mortised Piece

Getting the offset dead-on is critical. Too much, and the pin will jam and could split the mortised piece; too little, and you won't pull the shoulders tight. The steps below will help you nail the offset in any situation.

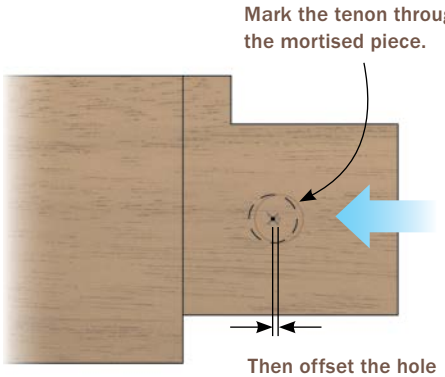


Go all the way through. After laying out the pin locations, use a drill press and a brad-point bit for clean, accurate holes. Put a sacrificial piece below to keep the exit hole clean, too.

Mark the tenons. Insert the tenons all the way, with no gap at the shoulder. Then use the same drill bit to mark the center of the pin holes.

Mark the offset. Use an awl to offset the center of the hole in the tenon.

Offset the Hole in the Tenon



Drill the tenons. Use the same drill and be sure to center it on the right mark.

little twist can add up to a big problem. I also like the flow of my work when I draw-bore. Without clamps in the way on each subassembly, I can just pin the joints and keep moving, without having to wait for glue to dry.

Drawboring is also a godsend when clamping is difficult. Long tables, like the one I'm making for a local church, sometimes exceed the reach of my clamps, but drawbored pins work all the same.

They also work well for the angled joints in chairs, which are tough to grip firmly with clamps. In other cases, where a pin goes into an elongated slot to allow wood movement, such as on breadboard ends, I use drawboring to ensure those pieces stay tight.

This type of construction often lends itself to prefinishing components, which can be damaged by clamps. After assembly, a bit of oil on the pin ends and perhaps another layer of finish are all that is required.

Strong, but subtle

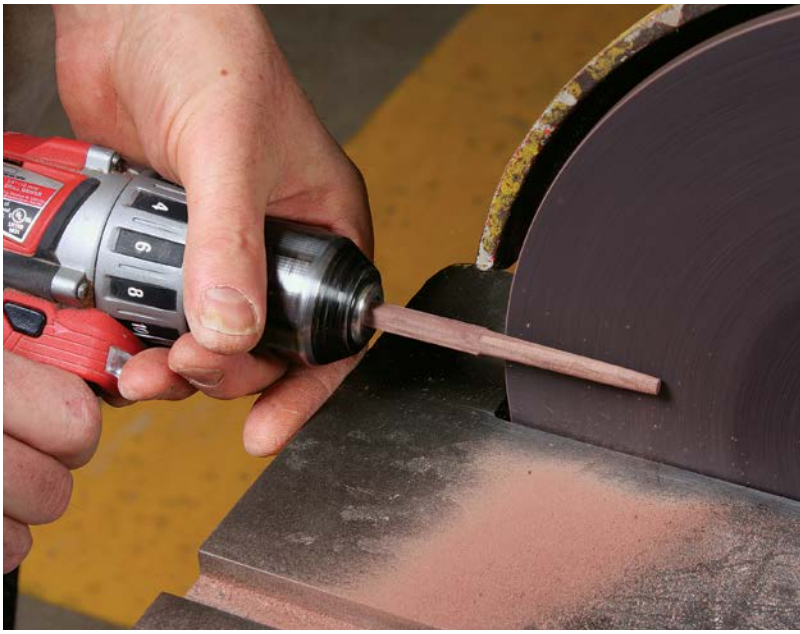
There are a variety of ways to style the heads of pins, whether drawboring them or not. I think of myself as a tradesman more than a designer, and I like to keep it simple. I tend to match the pin material to the surrounding wood, so the darker end grain of the pin stands out only slightly, and I trim the pins flush with the surface. For very soft woods, like pine, I make the pins from a harder wood like maple, providing extra strength while maintaining a nice color and grain match.

I make pins from rift-sawn or quartersawn stock if possible, with straight grain on both faces, cutting them ¼ in. square and 4 in. or 5 in. long. You don't need to use thicker pins on bigger pieces, at least not for strength reasons, because the glue reinforces the joint and you'll never shear a ¼-in. pin. However, I occasionally vary the size for aesthetic reasons, using slightly fatter pins on big timbers or slightly thinner ones on small doors.

I generally use square heads on my pins, and turn them 45° to create a traditional diamond look. A bonus is that if they go in a little twisted, it is less obvious in the diamond orientation than if I were trying to get them perfectly square. Some woodworkers cut a square slot in the top of the hole to accommodate a square head, but I haven't found this necessary. If you use the same or harder wood for the pins, a square head will make its own pocket, especially if you taper the transition from the round section to the square head when making the pins. Occasionally, the head gets rounded slightly, but imperfection is part of the handcrafted look.

If the pieces being joined are narrow, say less than 2 in. wide, square pins can look like overkill, so I use round ones there. But there is no right or wrong here. It's up to the

Make and install the pins. Latta always uses straight-grained stock for pins to avoid splitting. Except on narrow workpieces, he prefers the look of square heads. Whether they will end up round or square, however, he makes the pins the same way.



From square to round. Rip the pin stock square, the same size as the pin holes. Cut the pieces 3 in. or 4 in. longer than necessary, and chuck the pin in a drill to round the lower section, holding it against a belt or disk sander (above) as the drill spins. Take the pin to a full round near the bottom, but taper the transition to the square section. Sharpen the tip so it will grab the drawbore offset.

No glue needed. Latta uses paraffin wax on his drawbored pins (above), not glue, making them easier to drive. Don't worry; they'll stay put for life. Working over a dog hole on his bench, he drives in the pin (right) until he is happy with the way the head looks. Use a wrench to steer square pins as you drive them. Latta prefers to twist his square pins 45° for a diamond look.

individual builder to give this age-old joinery detail his or her unique spin.

Pinning a door is lesson one

Drawboring is a wonderful way to assemble doors, and this is a good first lesson in the basic technique. The same steps apply in any situation. On most doors, only a single pin will fit into each tenon, but on very large doors, two pins are better. See p. 117 for how to position two pins in a tenon.

Once you've cut the mortises and tenons, pin layout always starts on the mortised piece, in this case the door stile. Bore the holes on the drill press, using a ¼-in.-dia. brad-point bit. You are drilling through the stiles only here, with the door apart. You'll drill through the tenons later. Use a backer board to avoid blowout on the back side of the stile. If you drill slowly, you'll get only minimal chipout inside the mortise.

Assemble the door, using a clamp as necessary to draw the joinery tight. Then insert the same brad point into the hole to mark its center on the tenon. Now disassemble the parts and, using the tip of the bit or an awl, make a more pronounced mark just a hair more than 1/32 in. toward the shoulder of the tenon. Be sure you go toward the shoulder and not away. It is an easy mistake with the direst of consequences.

Now, using a drill press and the same brad-point bit, bore through this new mark. Afterward, reassemble the joint and eyeball the offset to make sure it is right.

Trim 'em flush. Use a flush-cut saw (left) to trim the pins close but not completely flush. Then pare them level with a chisel (above).

Prep the pins—To round and taper the pin body, I simply chuck it into my cordless drill and spin it against a belt or disk sander, leaving the last couple of inches square. This method is fast and accurate. With doors, where the inside face will be visible, I leave the round section a little fuller, not quite rounding the square entirely, to be sure the hole is filled on the inside of the door. But I always sharpen the tip of the pin on the sander so that it will clear and then catch the offset hole.

Watch Your Backside

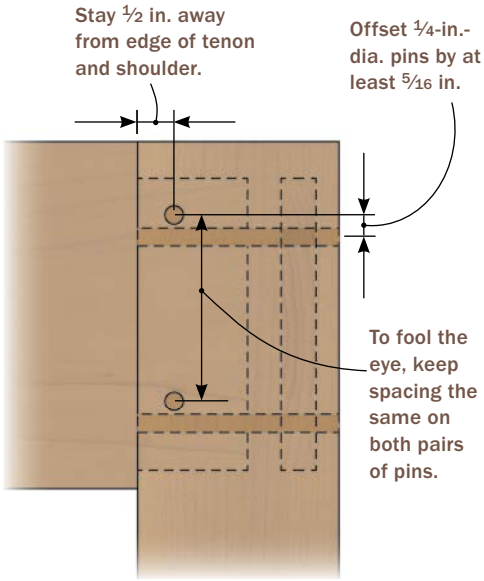
The back of the pin will be visible on a door, so it needs to look as good as the front.

Saw it off. Cut off most of the excess, leaving a little extra for paring.

Check for gaps, and fill if needed. If you see a problem (above) after sawing off the back of the pin, grind a round tip onto a piece of steel and use it to dimple the end, expanding it (right). Then trim the pin flush with a chisel as usual.

Stagger the Layout

Follow the general layout rules shown on pp. 111–112, but stagger the pins on adjacent faces of each leg so that they don't run into each other inside.



Tame difficult glue-ups. Drawboring works great on a large table, where you might not have clamps long enough for the job. The technique also lets you assemble the entire base at once without waiting for a subassembly to dry.

Easy assembly. Pin the long sides first (top), laying them flat on the bench to make them easy to handle. Finish up the assembly with the table base standing upright (above).

Angled joinery. Drawbored pins are perfect for chairs, pulling together the angled and curved joints as easily as square ones.

Tight joints and no waiting. Latta starts by assembling the chair back (above). Without waiting for glue to dry, he can assemble the front of the chair, and join it to the back (right). It's only now that he must pause, to take the final measurements for the arm joinery.

Drive them home and trim them flush—There's no need to glue the pins. Instead, prior to assembly, put a thin layer of glue on the tenons and a heavier layer along the walls of the mortise. Excess glue on the tenons will end up as squeeze-out.

I wax and insert the pins from the front of the door, holding the square section with an adjustable wrench. This helps me control the orientation of the head as I pound in the pin, using a steel hammer. I hammer the pin until the head has firmly established itself in the face of the stile.

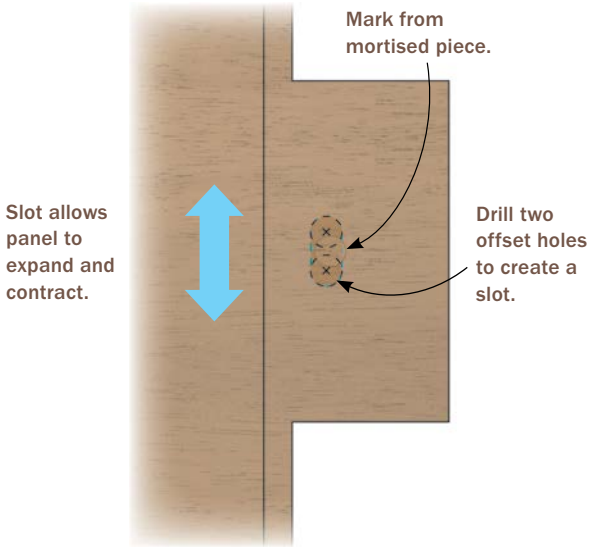
Trim the pins after the glue on the mortise and tenon is dry. I cut them close with a flush-cut saw, and then pare them perfectly flat with a chisel.

A host of other uses

A long table is one place where drawboring works great. The process here is very similar

Pull Breadboards Tight

Breadboards must allow the panel to expand and contract with the seasons while staying tight to it for decades to come. The solution is elongated holes in the tenons, combined with drawbored pins.



Two holes in the tenon. To lay out the slots, Latta uses dividers to mark centers for two offset holes with ¼ in. of wood between them.

Turn them into a slot. A bit of chisel work knocks out the material in the middle, creating a smooth slot.

Assemble and pin. To keep the front of the breadboard flush with the front edge of this chest lid, Latta applies glue to the front tenon only, and drills a normal hole there. The panel's movement is directed toward the back, via slots in the other tenons.

to the one on a door, with a few differences. Because the aprons are wider than the door parts, two pins are required, and since the legs are so much thicker, the pins need to be a couple of inches longer. Also, because I don't care about the back side, I sand the round section a bit smaller, too.

Most importantly, though, you need to stagger the pins in a table leg, or they will intersect inside. You'll want to keep their spacing consistent so they look good, while keeping them far enough from the edge of the tenon to avoid splitting.

Because of their angles and curves, chairs are often difficult to assemble. Again, drawboring offers an easy solution. Pinning the tenons ensures tight joints and makes this multistage glue-up much faster.

Breadboard ends are a great way to keep an unsupported panel flat. Whether it's the top of a trestle table, the lid on a blanket chest, or the drop-front on a traditional desk, tenoning a long rail to the ends does wonders to stop warping as moisture content changes with the seasons.

But these cross-grain rails create a problem. Their length won't change, but the width of the panel certainly will. That means you can't glue all the tenons, and instead must use pins or screws to attach them, elongating the holes in the tenons to allow them to move sideways.

That inevitable movement leads to another problem: The ends of these rails won't stay aligned with the edges of the panel. On a tabletop, you want to lock down the tenon in the middle to divide the misalignment between each end. But on a blanket chest that will always be against a wall, you want to lock in the front tenon to keep the front end flush and send all of the movement toward the back edge, where the misalignment won't be as noticeable. Chalk up another victory for drawboring.

Straightforward Joinery for Curved Work

JEFF MILLER

My first saw was a bandsaw, so from the very beginning of my woodworking career, I found myself working with curves. If you've only been a straight shooter until now, you'll find that curves not only open up a world of design possibilities, but they also offer plenty of chances to expand your repertoire of woodworking skills: from laying out eye-pleasing shapes to cutting and smoothing those shapes, or even bending them (with steam or by lamination).

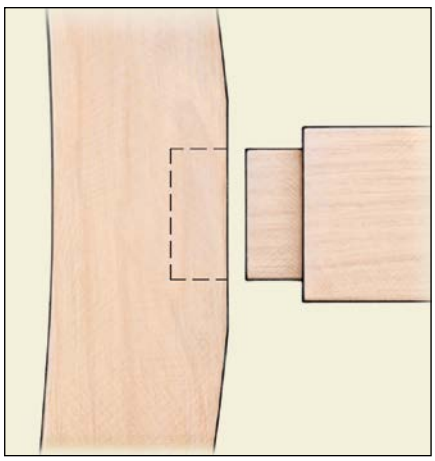
What stops most people, however, is the prospect of cutting and fitting joinery on these curved parts. I'll show you three techniques that I've used over the years with great success. There's nothing exotic or difficult about them, and once you see them in action, you'll soon be adding graceful curves to your own work.

Creating a flat spot on the curve

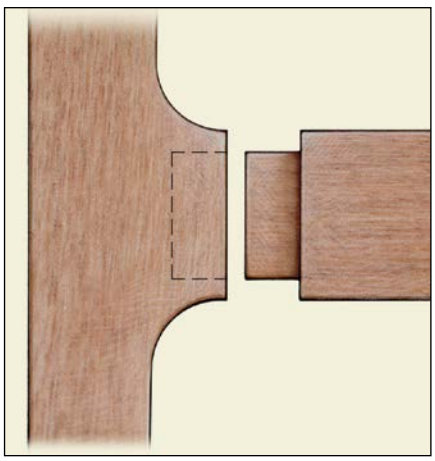
The simplest way to join two pieces when one of them is curved is by leaving or creating a flat area on the curved work where the mortise is to be cut.

If you are cutting the curved piece out of square stock, it's easiest to locate and cut the mortise while the workpiece is still square.

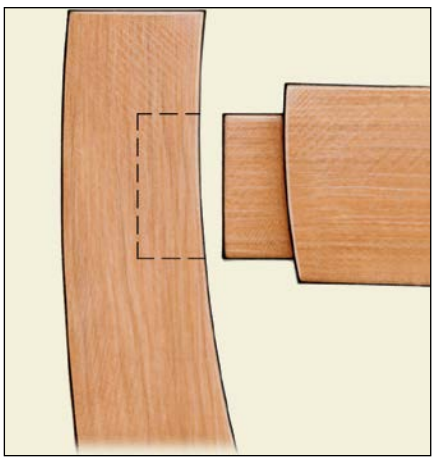
Three Joinery Options



1. Create a subtle flat as an easier landing spot



2. Make the flat stand out for a curved transition



3. For inside curves, scribe the tenon shoulders

Then you can leave the area around the joint flat when cutting the curve. The tenon on the mating rail can then be cut and fitted just as for any other mortise-and-tenon joint. When creating the flat, be sure to extend it ⅛ in. or so beyond the rail both above and below the joint to accommodate any expansion across the width of the rail. When the piece is glued up, you can sand lightly to ease the transition from flat to curve, leaving about 1/16 in. flat.

Things get more challenging if you're cutting several identical parts from square stock. If you want to minimize waste, you'll need to "nest" the layout of the parts and cut them all out before doing anything else. This means you'll then have to create the flat—and cut the mortise—in an already curved part. To do this, I make a simple jig that holds the work while I create the flat spot and then cut the mortise.

Clamp the curved piece into the jig so that the area to be flattened projects above the jig's fence. Now you can create the flat spot, using a handplane to remove the projecting material and bring the part flush with the top of the fence. To use the jig with a router, screw on a top plate to support the router. Use a spiral up-cut bit or a straight bit, set to cut flush with the top of the jig's fence. The first cut should be a clockwise pass around the area to be flattened; this is a climb cut to avoid tearout.

To mortise with the same setup, equip a plunge router with a fence that will ride along the back of the jig. Adjust the fence to locate the mortise on the thickness of the workpiece. Rout between the layout lines in shallow passes (perhaps 1/32 in. of added depth per pass) until you reach the desired depth.

Create a flat that stands proud

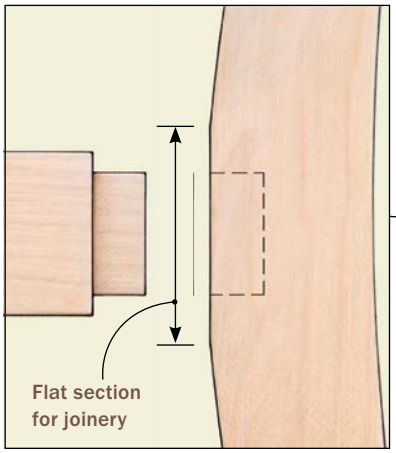
Some designs call for seamless curves that flow from one part to the next, regardless of whether the parts themselves are curved.

In these cases, don't shape the curve, or much of it anyway, on the end of the tenoned piece. The outer tips of the curved ends will consist of very fragile short-grained stock.

(Continued on p. 125)

Option 1: For Shallow, Outside Curves, Create a Flat

This works best with shallow curves so the flat spot won't stand out. It's good for joining straight rails to curved posts on a chair or bed, or straight aprons to curved legs on a table.



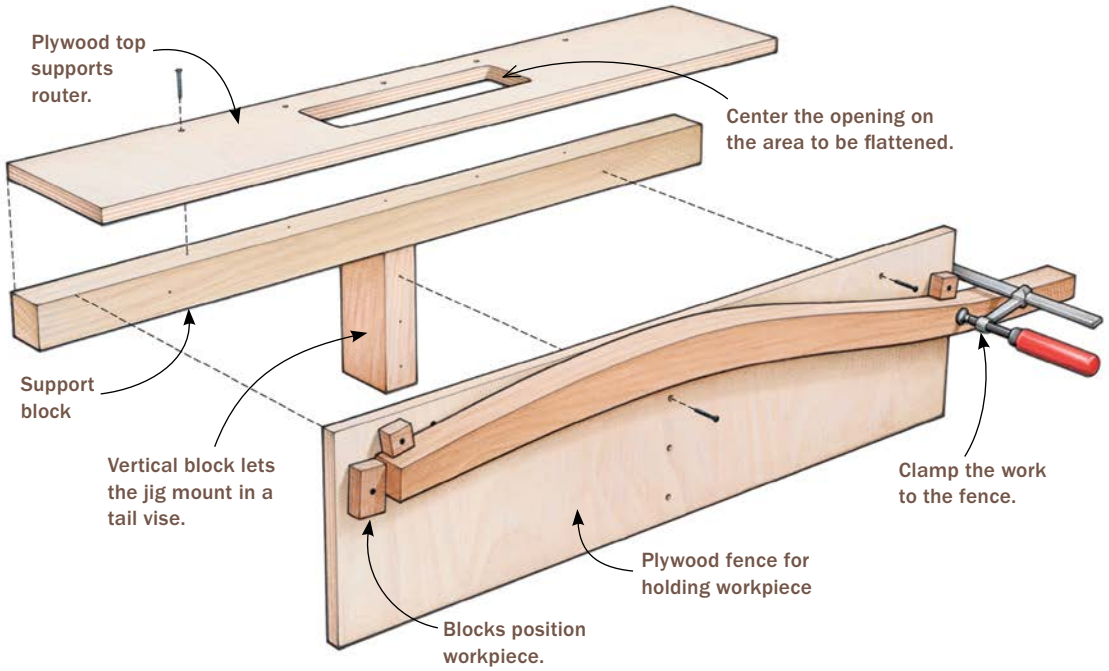
Leave a section of the stock's square edge intact when cutting the workpiece to shape. Mark the flat's boundaries on the pattern and let that section hang over the stock's edge when tracing the layout.

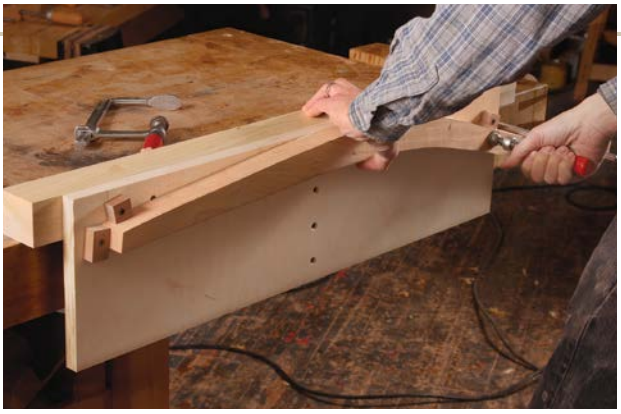
Saw the piece to shape. But before bringing the work to the bandsaw, go ahead and cut the mortise—a task that's much easier while the stock is still square.

Or rout a flat on nested parts. "Nesting" curved parts saves material. However, it also makes it impossible to leave a precise flat when sawing each part. So Miller uses a simple jig to shape the flat afterward.

Simple Jig Can Flatten and Mortise

The assembly is based on a piece of thick, wide stock screwed to a vertical plywood fence so the mating edges are flush.

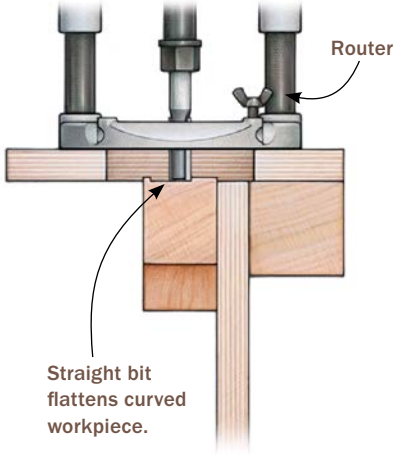




Hold the jig in a bench vise. The workpiece clamps to the jig's fence. Three hardwood stops locate the workpiece so that the section to be milled protrudes above the fence.

Add a top plate to support the router. Use ¾-in. plywood and make the plate opening larger than the desired flat by 1½ in. in each direction.

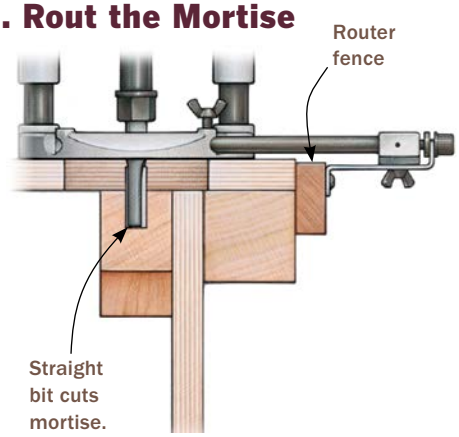
1. Rout the Flat



Rout the workpiece flush. Set the bit depth even with the top of the jig's fence.

The same jig lets you mortise, too! Attach the router's fence to guide it and locate the mortise.

2. Rout the Mortise



Option 2: For Flowing Curves, Add a Pad

For curves that flow into each other, there is a right way and a wrong way. This table by Chicago furniture maker Chris Bach shows how it should be done.

Cut the joint while the stock is square. Then saw the shape as shown, making sure that the flat surface is ⅛ in. or so wider than the rail.

Finish by hand. After the joint is glued, remove the excess material and create a smooth transition using a round or half-round wood rasp (above), followed by a card scraper (left).

Instead, leave a raised area on the mortised part, and form the transitional curves there. Just rough them in, and then refine the transitions after gluing the joint together. A well-known example of this technique can be seen on the leg-to-rocker joints of a Sam Maloof rocking chair.

Here's a final point to consider when using this type of joinery: It makes a lot of sense to use quartersawn wood for the rail. This is because after the joint has been smoothed to seamlessly flow together, seasonal expansion and contraction of the rail across its width could create minor misalignment between the parts. Quartersawn stock, which moves less across its width than flatsawn material, will minimize this problem.

Match the shoulders to the curve

When you're joining a tenoned part like a chair's crest rail or a table apron to a concave section of curve, it won't work to create a flat spot on the curve. The simplest approach is to scribe the tenon shoulders on one piece to exactly match the curve of the adjoining piece. By the way, this is another instance where a quartersawn rail is a good idea. Excessive wood movement can cause gaps to appear in a scribed joint, because expansion or contraction will actually change the curvature of the shoulder.

The task of cutting the mortise and tenon is roughly the same as before. You can use the jig again to cut the mortise, although you may need to use a curved offcut as a brace between the jig and the workpiece to help hold the work squarely when clamping.

The real trick in this technique lies in shaping the tenon shoulders to tightly hug the curve of the mating part and create a gap-free joint. This process will be simpler if, when cutting the tenon, you angle the tenon shoulder so that it generally follows the direction of the curve to which you'll be scribing. You can do this with a tablesaw tenoning jig, clamping the workpiece in the jig against a precut wedge. Cut the tenon to normal length to fit in the mortise.

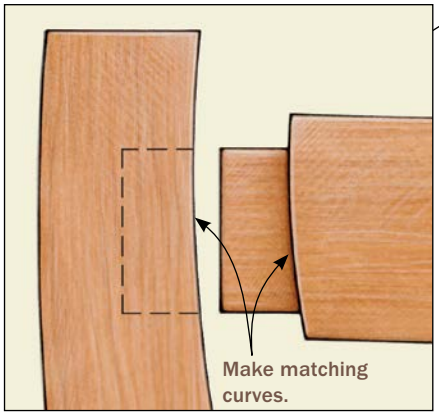
Start the scribing process by inserting the tenon fully into the mortise. Next, use a marking knife to ride along the curved workpiece and scribe a line into the shoulder of the mating part. It's ideal if the scribed line is made with a single-bevel knife so that the straight side of the cut is toward the shoulder—this will leave a very crisp edge to pare toward. Facing the knife that way often will create the offset you need to transfer the full curve to the shoulder, while ultimately shortening the tenoned part as little as possible. But you can use a shim of some kind (an automotive feeler gauge or a small scrap of wood) to increase the scribing offset for deeper curves.

The paring requires a very sharp chisel with a flat back. Nibble a little bit away at a time, until you are just one or two paring cuts away from the scribe line. Now put the chisel's edge right in the scribed line and pare down. The easiest way to keep the cut perfectly on your line is to make each cut after the first one with only the leading quarter of the chisel, registering the rest of the chisel against the existing shoulder. A gentle twist of the chisel, applying a little extra force against the existing shoulder, should keep you from inadvertently crossing the line. It also helps to undercut the shoulder a little. Just be careful not to do that at the corners, where undercutting from one side will leave unsightly gaps on the adjacent face.

As you trim back the shoulders, you might also need to trim the tenon length back so the final depth is about 1/32 in. less than the depth of the mortise. This leaves room for excess glue.

Option 3: Inside Curve? Scribe a Shoulder

This technique creates tight joints between two pieces when one of them is a concave curve.



A curved shoulder starts on an angle. When cutting the tenon, angle the shoulders to follow the arc of the curved mating piece. Aim for a close fit to minimize the paring.

Mark the shoulder. An automotive feeler gauge hugs the curve when transferring the layout to the shoulder. Use a wood scrap for a wider gap.

Pare to the scribe line. Nibble away most of the waste, then seat the chisel in the scribe line and pare straight down. Use overlapping cuts, advancing only a quarter of the blade with each new stroke.

Bring the joint home. You may need to shorten the tenon slightly to allow the shoulder to seat completely. With the shoulder pared carefully, the joint should come together with no gaps.

Housed Double Tenons: A Powerful New Joint

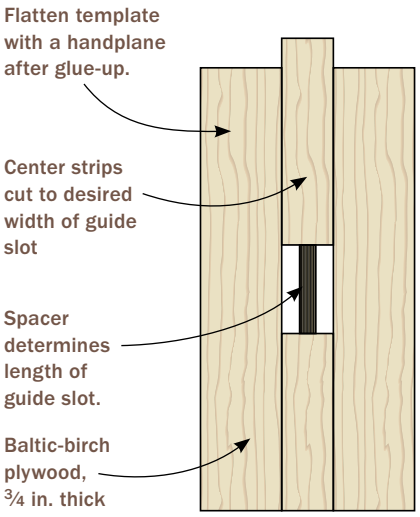
BRIAN BOGGS

When I began building outdoor chairs 10 years ago, I searched for a strong, weather-tight joint. The traditional mortise and tenon works well for interior pieces, but outdoors, moisture can wick into the end grain of the tenon shoulders, undermining the joint. I designed this U-joint, with its only shoulder hidden between twin tenons and set below the surface of the mortise, to solve the moisture issue. But I soon realized that the joint delivered a bundle of other benefits. With four wide tenon cheeks instead of the standard two, it had far greater glue surface,

Better Joint for Chairs

Boggs developed the U-joint (a double tenon without shoulders) as a weather-tight connection for use on outdoor furniture like his settee (left). But because of its strength and the way it simplifies joining curved and shaped parts, he favors it for many indoor chairs as well (right).

Router Template for Mortises



An accurate, durable guide slot. Boggs makes the template by ripping a piece of plywood and reassembling it. He coats the edges of the guide slot with cyanoacrylate glue and sands them.

and so greater strength. The joint also made for a stronger rail, since there were no exterior shoulders to reduce the width and thickness of the rail at either end. And it was very well adapted to joining rails to shaped legs, since there were no external shoulders that had to be coped to fit. And while the shoulders of traditional tenons can pull away when they shrink in dry weather, reducing the joint's rack-resistance, the U-joint's shoulder remains locked between two tenons. The joint succeeded so well that I also use it on indoor chairs and tables.

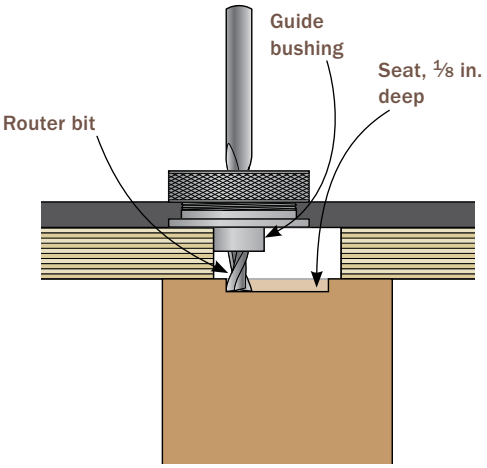
Routing twin mortises

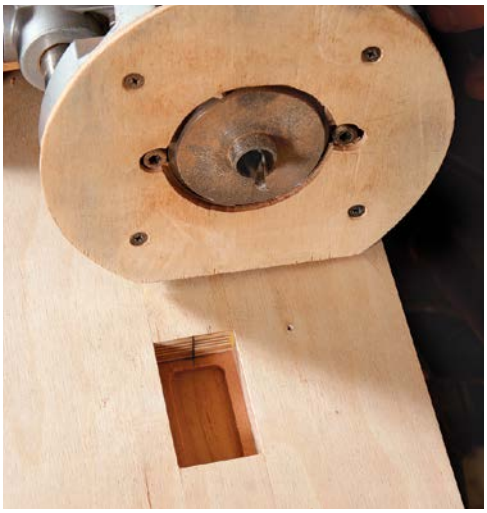
Using a plunge router with a guide bushing and a simple plywood template, cutting the double mortise is not difficult. The U-joint mortise has three sections—the twin deep mortises and the seat between them that receives the tenon's shoulder—but the cuts for all three are guided by the single slot in the template.

Screwed to the workpiece. The mortising template can be affixed to the workpiece with screws driven into a waste area. Boggs uses centerlines on the template and the workpiece to locate the mortise.

Clamped with a fence. When there are multiple mortises to cut, or when it's not practical to screw the template to the workpiece, you can attach a fence to the template and clamp it to the workpiece.

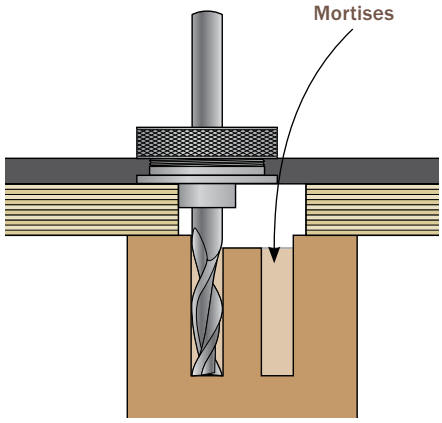
Rout the Mortises: Step 1

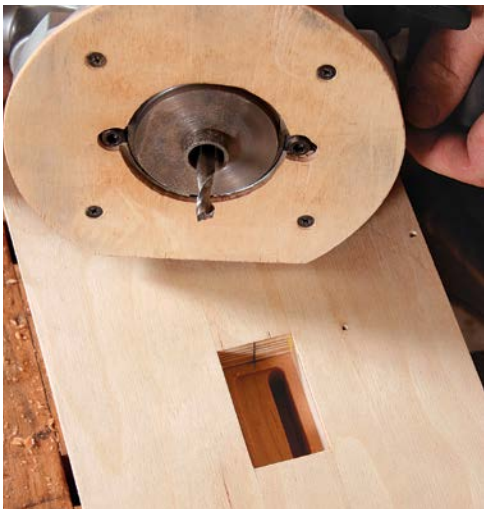




Make a seat. With the bit set to cut ⅛ in. into the workpiece, rout the whole area of the mortise. This first cut creates the seat for the tenon shoulder.

Rout the Mortises: Step 2





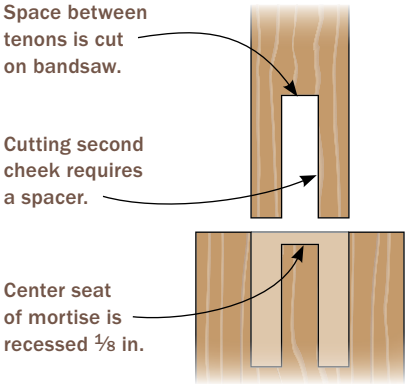
Then go deep. Set the bit deeper for the twin mortises. Run the guide bushing along one side of the slot, then the other, making the cuts in several passes.

Switch on the router—With the leg blank still square, I start the mortise by milling the entire area within the guide slot to about ⅛ in. deep. This creates the seat for the shoulder between the tenons. I want the seat deep enough that it won't be exposed when I shape the leg.

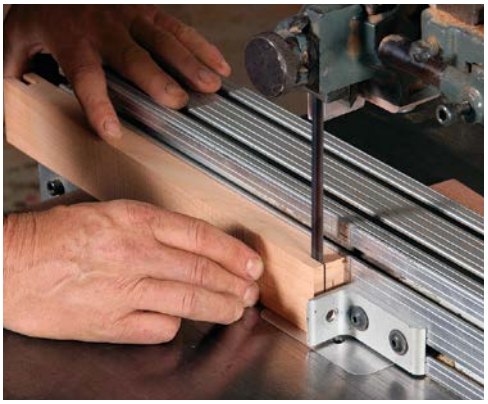
Then I reset the plunge depth and cut the twin mortises. One side of the slot guides the router bushing for the first mortise, then I slide the router to the other side and change the feed direction for the second. Cut to full depth in a series of passes, and use compressed air to clear the mortises periodically.

Twin Tenons

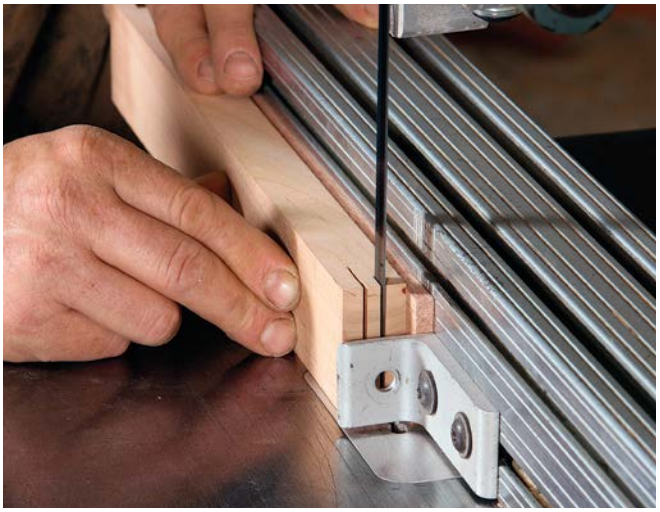
A precisely milled spacer is the key to cutting the two tenons perfectly. The thickness of the spacer must equal the gap between the tenons minus one bandsaw kerf.



Measure a kerf. To find the width of the bandsaw kerf, use a micrometer to measure a scrap before and after it's been sawn down the middle.



First cheek. Cut the cheek of the far tenon with the workpiece riding against the bandsaw fence. A stop controls the depth of cut.



Second cheek. With the bandsaw fence in the same position, insert the spacer and cut the cheek of the near tenon.

Stop and slide. After removing most of the waste with angled cuts, Boggs slides the workpiece back and forth against the stop to create a smooth shoulder between the tenons.

Tenons on the bandsaw

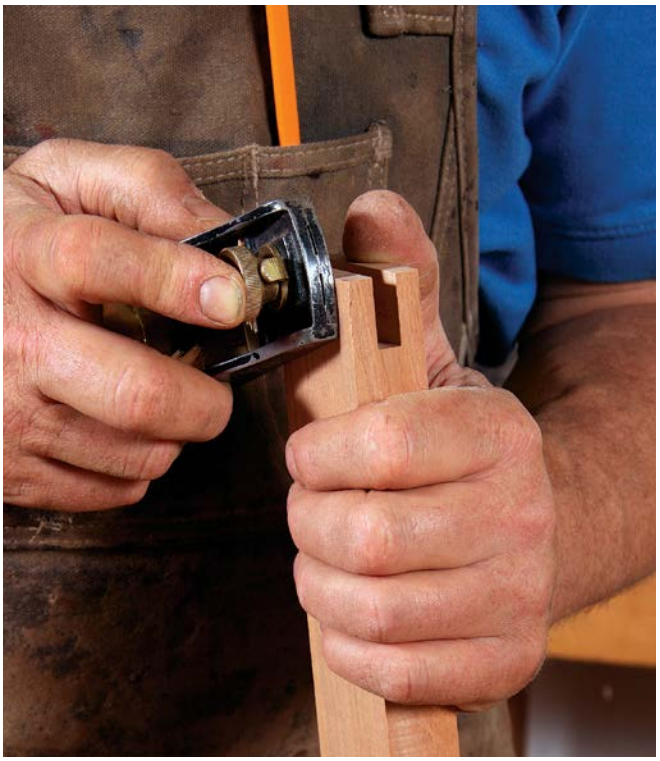
I cut the tenons at the bandsaw, making two stopped cuts for the cheeks, a series of angled cuts to remove the waste, and a scraping, side-to-side cut to establish the shoulder. Because I will shave the outsides of the tenon to a very slight angle to aid assembly, the rail should be a hair thicker (maybe 0.010 in.) than the overall width of the U-joint mortise.

I reference both cheek cuts off one face of the workpiece and use a stop block to limit the depth of the cut. First, I set the fence to cut the cheek of the far tenon. For the cheek of the near tenon, I leave the fence at the same setting and insert a spacer between the fence and the workpiece. The spacer must be very precise. Its thickness should equal the space between the tenons minus one bandsaw kerf. To determine the width of your bandsaw kerf, first mill a scrap about ½ in. thick and measure its exact thickness with a micrometer. Then resaw the scrap, stack the halves back together, and check their combined thickness with the micrometer. The difference in the measurements is the width of your kerf.

Keep good pressure against the fence and feed slowly and steadily for an accurate, smooth glue surface on both cheeks. I use a ½-in., 4-tpi, skip-tooth blade, which gives the smoothest cut of all the noncarbide blades I've used.

Fitting the joint

I taper the tenons just a couple of thousandths of an inch so they enter the mortise easily and pinch the opening tightly closed when assembled. A few block plane strokes on each side tapers the tenons to an easy fit. Alternately, you could do the tapering with sandpaper. Adhere a sheet



Fitting the U-joint. A few fine shavings with a block plane create a subtle taper on the ever-so-slightly oversize rail. The taper makes insertion easier and ensures a seamless glueline.

Round the tenons. Sandpaper used with a shoe-shine stroke makes quick work of knocking the corners off the tenons so they fit the rounded corners of the routed mortises.

Expando-sander. If he needs to widen the gap a trifle, Boggs makes a special sander with a strip of foam sandwiched between two strips of wood. He makes it a tight fit between the tenons so the foam will exert outward pressure as he sands.

of 120-grit paper to a piece of MDF and take a few strokes against it. To generate the slight taper, tape a card scraper to the workpiece 10 in. or so from the end to be sanded.

For tenons ⅜ in. and thinner, the corners can be chamfered with a chisel. Press the joint together and let the mortises squeeze the tenon corners round. Larger tenons will need more rounding. You can use a combination of routing and chiseling, or use heavy sandpaper with a shoe-shine stroke to create rounded corners.

Fit, then shape. After dry-fitting the joint, Boggs will disassemble it and shape the parts before final glue-up.

Juice Up Your Joinery

HANK GILPIN

I was seduced into the woodworking field when I walked into a college class in 1973 and watched Tage Frid tie a piece of steamed ash in a knot. But it was my enchantment with joinery that sealed the deal. I quickly discovered that if I worked with solid wood and traditional joinery I could make simple, strong, practical pieces fairly quickly and get a thrill out of doing it. I became Mr. Mortise-and-Tenon. The more I used the joint, the more variations I discovered. Forty years later, I'm still experimenting with the mortise and tenon, finding new ways to add a little more strength and visual zing to a piece of furniture and a little more delight to the process of making it.

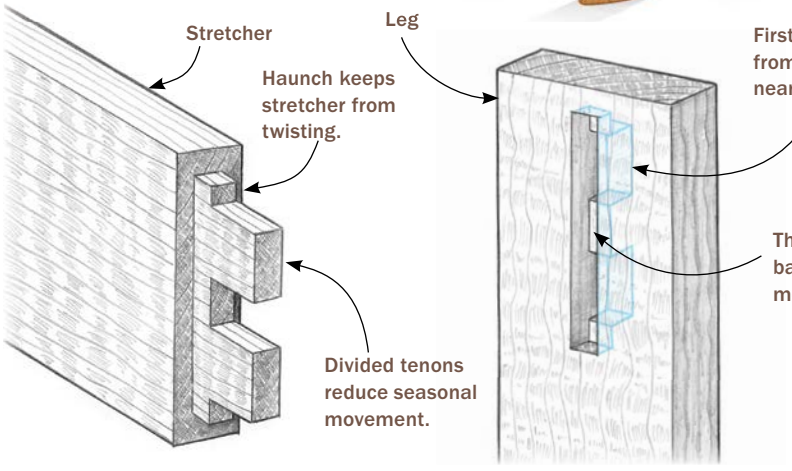

DOUBLE TENONS


SHAPED TENONS


TUSK TENONS

Split vertically. Dividing a large tenon into two or more smaller ones is beneficial when the stretcher is wide.

Creating Multiple Through-Tenons

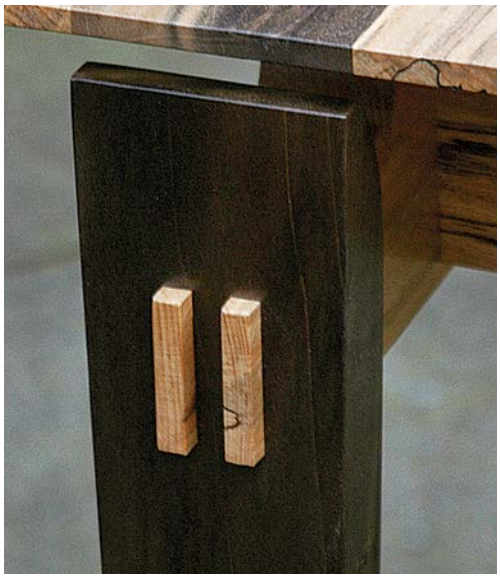


Multiple tenons multiply the impact

Through-tenons bring something special even to an otherwise simple piece, adding visual appeal and a good deal of strength. Soon after I made my first ones, I began doubling the tenons where it made sense structurally. I looked everywhere for ideas, and I found the vertically stacked and haunched tenons in an old English book on door-making. Separated tenons reduce problems with wood movement and take less meat out of the mortised member. As a bonus, they're beautiful. And if you cut the tenons in contrasting wood—poof!—they're as dramatic as inlay.

Outside in. Start chopping the through-mortises from the show face of the board, and stop the cut ⅛ in. before going through.

Flip and finish. Registering the same edge against the fence, flip the workpiece end for end and chop the housing from the inside face.

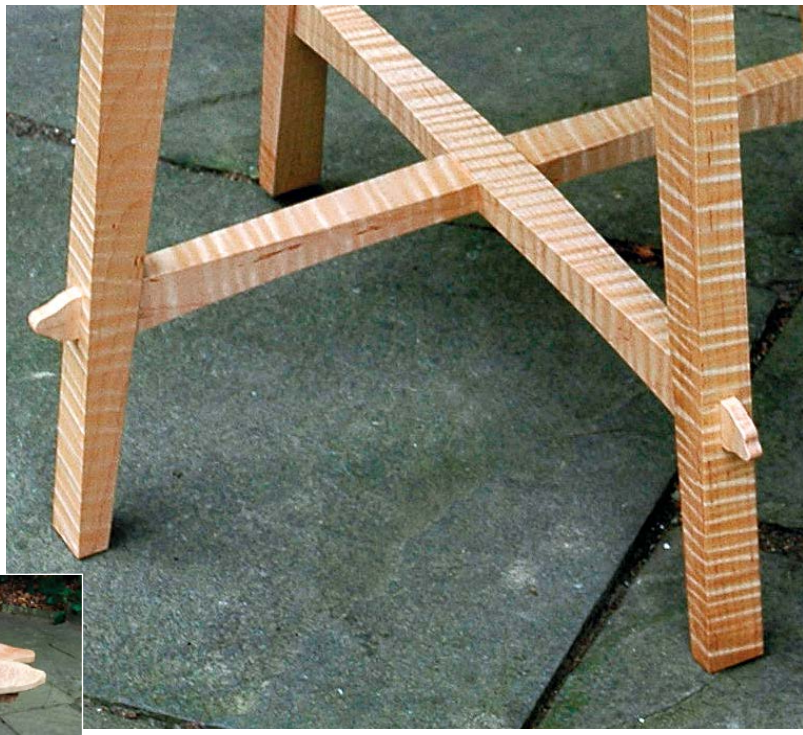


Split sideways. Two tenons side by side create more glue surface than a single large tenon. The visual pop is doubled, too—unless it's quadrupled with contrasting woods, as it is here in this table made of spalted maple and tulip poplar.

Through-tenons with extra sizzle

Shaped Tenons Make a Showpiece

Once you start using through-tenons, and then proud through-tenons, you open up a whole new realm—why not make really proud tenons? Then you can shape them any way you want. I typically give them a shape that picks up another detail in the piece. There are no rules. On the little curly maple table below, I designed different shapes for each tenon. That makes it more fun to look at and more fun to make.



Very proud tenons. Leave the through-tenon long and you can give it nearly any shape. On Gilpin's curly maple table, the extended stretcher tenons are profiled in response to the table's cloud-shaped top.

Tenon template. If the shaping on the tenons will be alike, a quick template can be used to transfer the design from the drawing to the workpiece.

Hand tools refine the shape. After bandsawing to the line, use files, rasps, scrapers, and sandpaper to achieve the final shape.

Carved to a curve. On his walnut and cypress table (left), Gilpin curved both the leg and the through-tenon to complement the circular tabletop. On his oak table (above), the through-tenon echoes the rounded bumps on the leg.

Taking the bridle path. On tables with tops raised off their legs, Gilpin often uses bridle joints, leaving the tenons proud and pinning them for insurance (above left). A similar open-topped joint can be made in a dovetail version (above right).

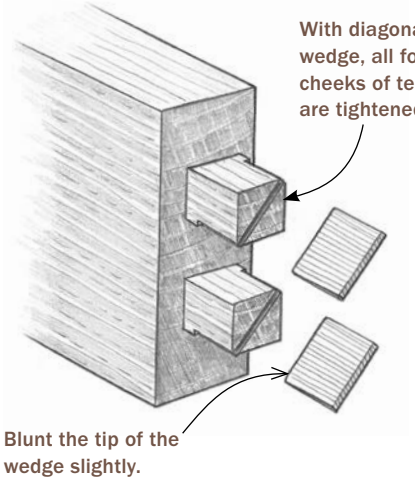
The Open Approach

Having the top of a table rest on the leg is an ancient habit that I like to break. I often lift the top a smidge, which draws attention to the structure below. When I do, I'll often use an open-topped mortise. It gives me a good amount of glue surface and strength even while exposing the tenon on two edges.

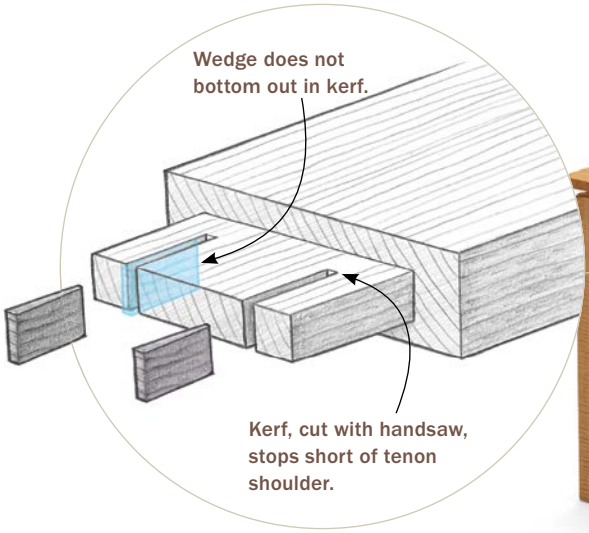
Wedges Add Spice and Strength

Wedge a tenon and you instantly have a stronger joint—and a cooler looking one. If the wedge is on the diagonal in a square tenon, it will tighten all four cheeks of the joint. I sometimes use contrasting wood for the wedge. In the curly ash chair on p. 138, I used walnut wedges to echo the small walnut spacers in the doubled crest rail and side stretchers.

Adding Diagonal Wedges



Adding Vertical Wedges



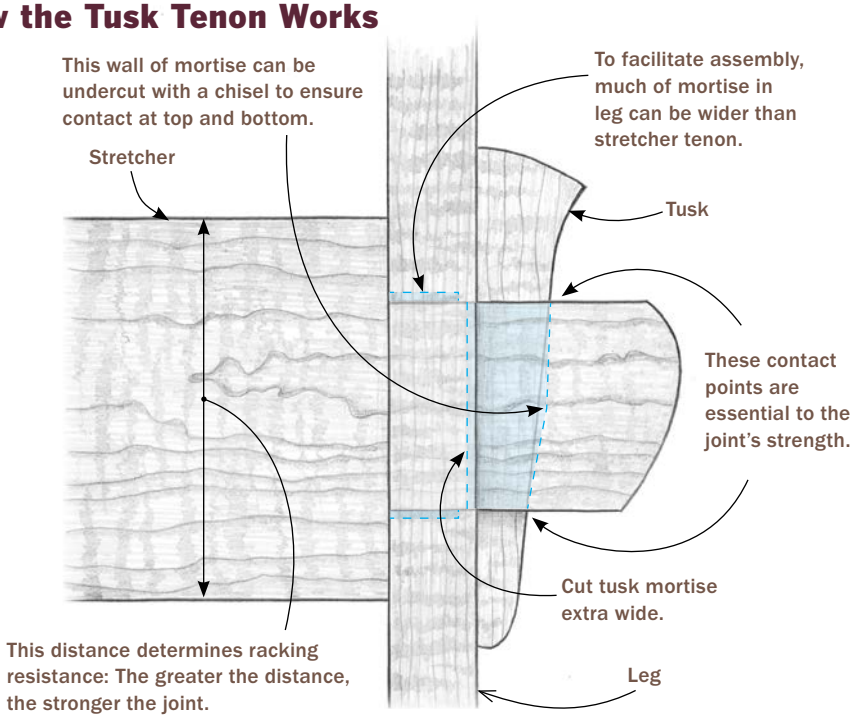
Versatile and very strong. Tusk tenons can be used on tables of all sizes and styles. They provide a powerful connection without glue that can be disassembled for shipping and tightened with a tap.

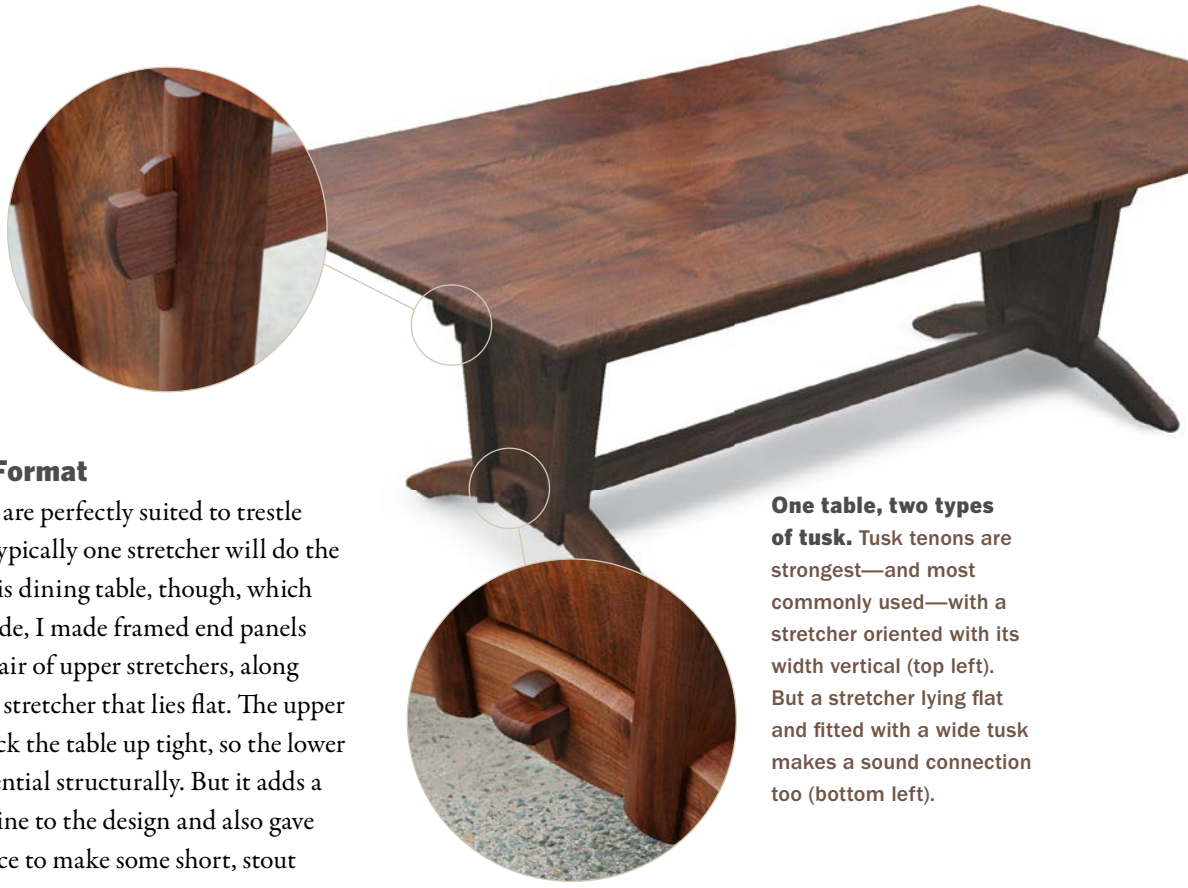
Tusk tenons: stylish and strong

Tusk tenons—they're a miracle, aren't they? Structurally, they create a perfectly rigid connection with a little wedge and not a drop of glue. You can knock them apart with the tap of a hammer and tighten them up the same way. And if you decide to spice things up a bit, you can make the tenons and wedges in limitless variations.

One important thing to note about making them is that the stretcher tenon should slide very easily into the leg mortise, so the whole assembly is rather loose until the wedge goes home—tap—and it's suddenly rock solid.

How the Tusk Tenon Works





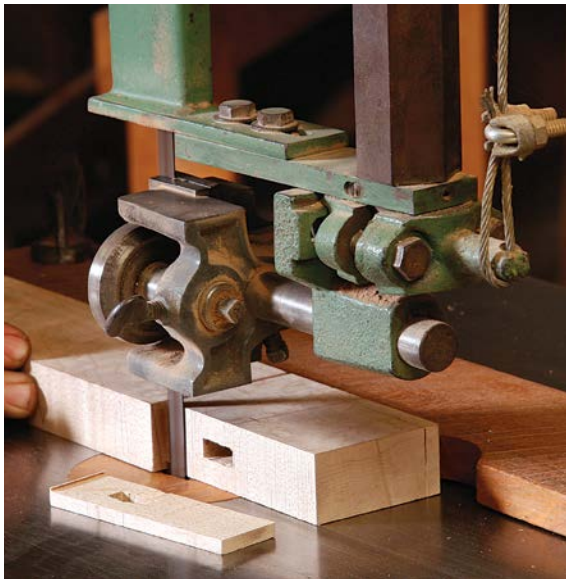
Vary the Format

Tusk tenons are perfectly suited to trestle tables, and typically one stretcher will do the trick. On this dining table, though, which was quite wide, I made framed end panels and used a pair of upper stretchers, along with a lower stretcher that lies flat. The upper stretchers lock the table up tight, so the lower one isn't essential structurally. But it adds a nice lateral line to the design and also gave me the chance to make some short, stout tusks to fit it.

One table, two types of tusk. Tusk tenons are strongest—and most commonly used—with a stretcher oriented with its width vertical (top left). But a stretcher lying flat and fitted with a wide tusk makes a sound connection too (bottom left).

Mortising Narrow Stretchers

Chop from the top. On stretchers narrow enough, you can chop the tusk mortise from one direction. Stop the cut before going through.



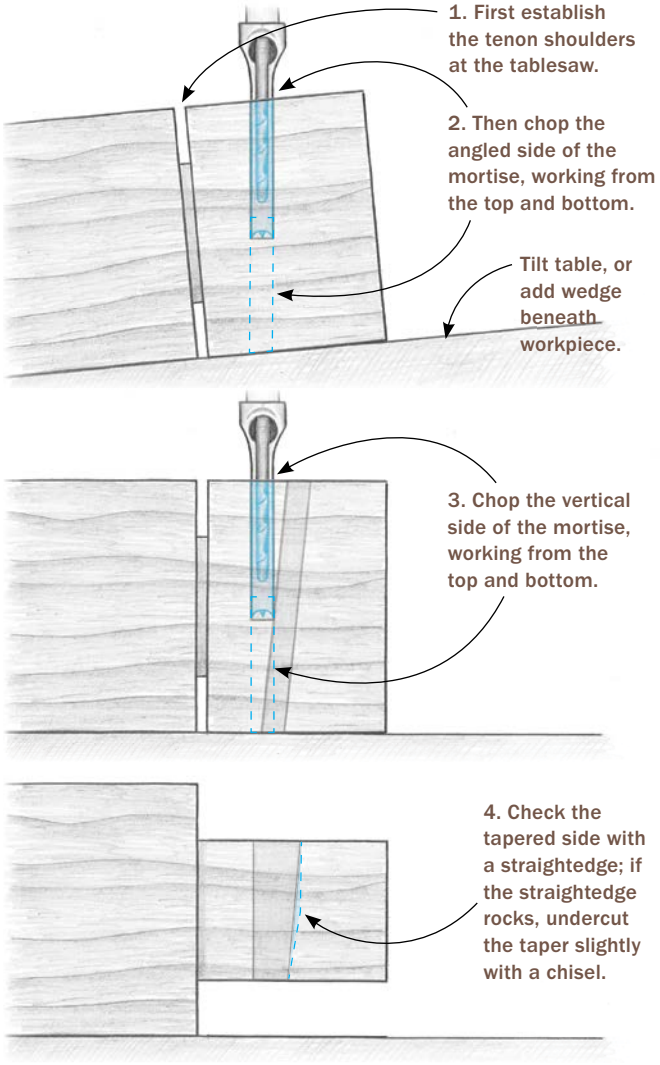
Saw off the bottom. With the mortise chopped nearly through, saw the bottom cheek to reveal a clean mortise opening.

Making tusk tenons

Cut the Mortise

Table stretchers tend to be too wide to be through-mortised from one side, so most tusk mortises are chopped from the top and bottom to the middle. My hollow-chisel mortiser has a tilting table, but on a fixed table you could insert a wedge beneath the workpiece. These mortises also could be chopped by hand or cut on a drill press and squared up with a chisel.

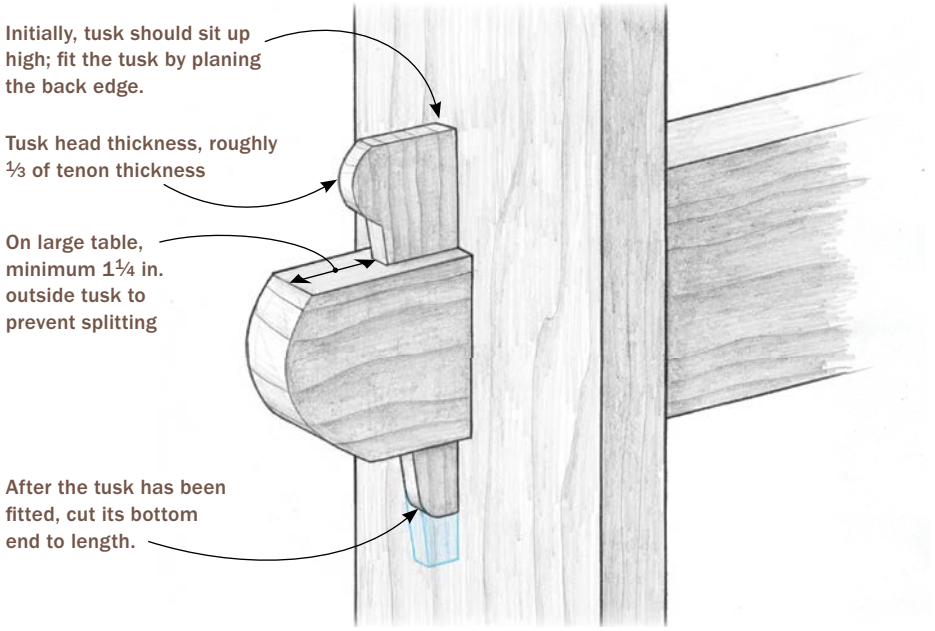
Cutting the Tusk Tenon Mortise



Fit the Tusk

After cutting and smoothing the tapered edge of the tusk, assemble the joint. At this point the tusk should sit above its final height by an inch or more. Fit the tusk to its final position by handplaning its back edge; proceed carefully, as it will drop down quickly. After fitting, label each tusk and tenon with permanent marker on a nonshow face.

Fitting the Tusk



Stop the taper. To make a tusk with a head, you need a stopped taper. First make a relief cut below the head, then use an angled jig to bandsaw the taper.

Back adjustment. Off the saw, the tusk should be over width by ⅛ in. or more. Final fitting is done by trimming the back edge of the tusk with a handplane.

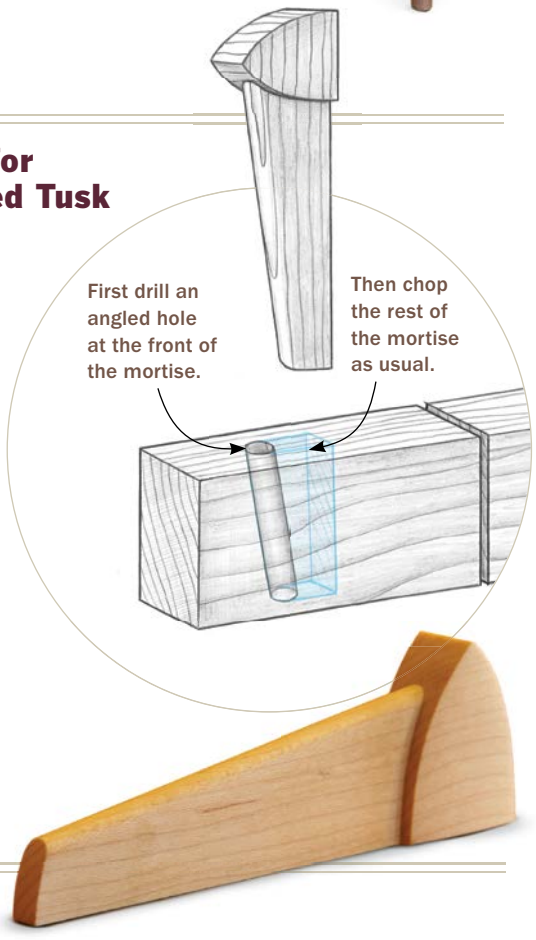
Shape the Head

You'd think a wedge would be a simple thing to make—and it can be. But once you start exploring the possibilities with tusks, you can wind up making some quite sophisticated shapes. The shaping may not make the joint stronger, but it can make the table sing. It's a little like car design—they all have four wheels, but it's the doo-dads and spangles that separate one from the rest.

Heads of note. Twin tusks share a shapely head design on Gilpin's oval table, demonstrating the breadth of design possibilities offered by tusk tenons.

Rounding the tusk for a softer look. Gilpin sometimes gives the tapered side of his tusks a radiused edge and fits them in mortises with a front wall rounded to match.

Mortise for a Rounded Tusk

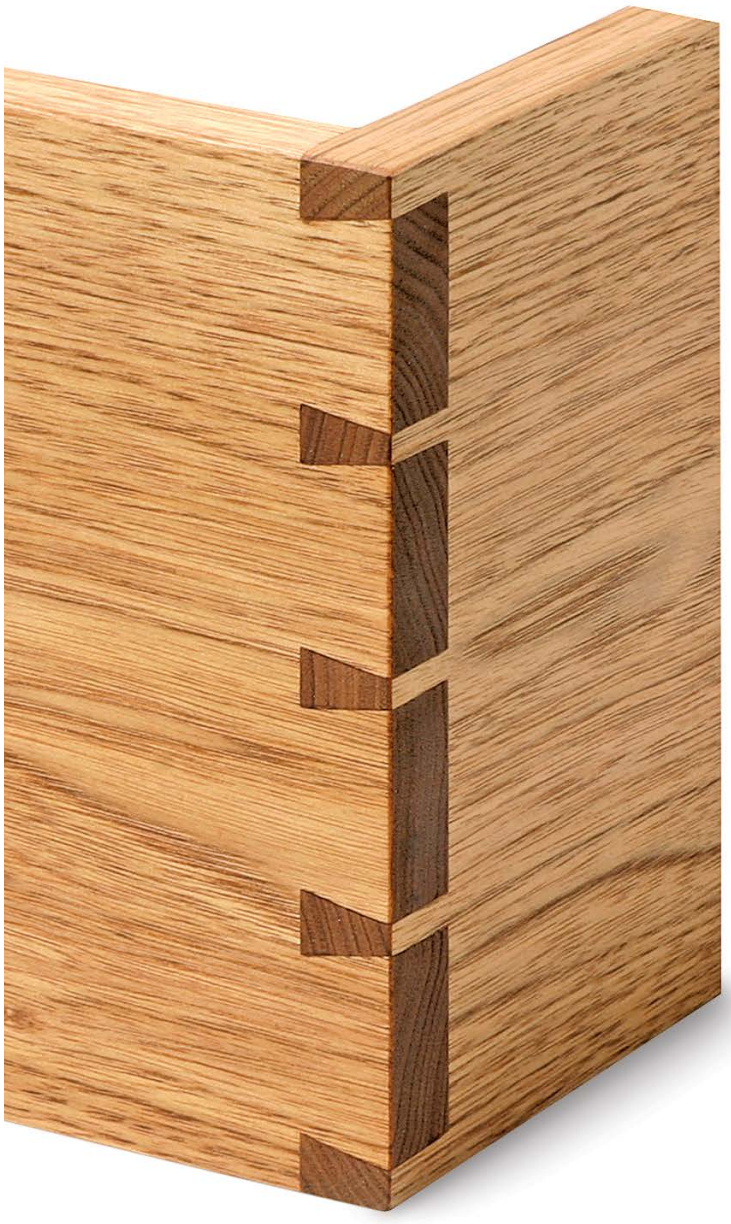


Laying Out Dovetails

CHRIS GOCHNOUR

Striking a perfect blend of form and function, dovetail joints add great interest and detail while enhancing the structural integrity of a case, box, or drawer.

Cutting dovetails can become second nature after plenty of practice with saw and chisel. Dovetail layout, on the other hand, is where I see students get frustrated. Here are the key steps in laying out a basic through-dovetail joint, with tips on creating an attractive joint that is sturdy enough to last generations.



How to balance aesthetics and strength

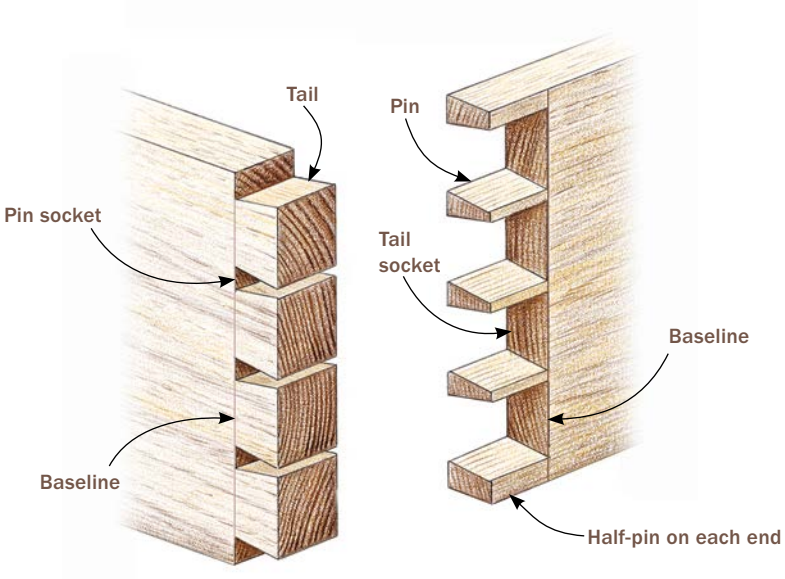
Several factors go into the design of a dovetail joint. These include the size and spacing of the tails and pins, and the slope of the tails (see the drawings on p. 144).

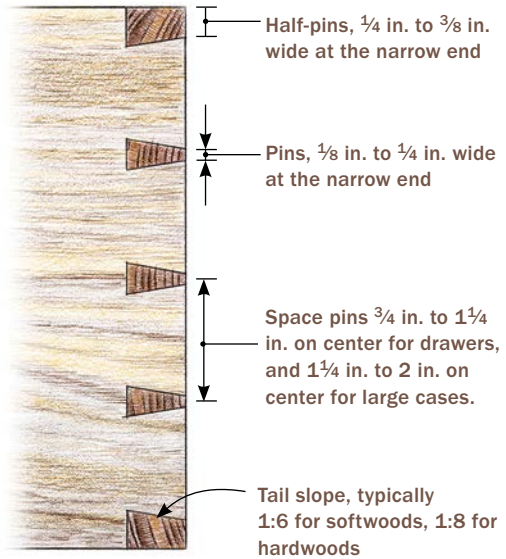
Most dovetail joints begin and end with a half-pin on the outside, with the rest of the space subdivided into multiple pins and tails. This creates plenty of long-grain glue surfaces as well as mechanical strength to tie the elements together.

A common practice is to span the joint with pins and tails of equal proportions. Although it's structurally very sound and typical of machine-cut dovetails, this joint has little design appeal. A better method is to span the joint with tails that are larger than the pins (see the right drawing on p. 144).

Anatomy of a Strong Joint

Dovetails provide not only mechanical strength as the pins and tails interlock, but also plenty of long-grain-to-long-grain glue surfaces for a long-lasting joint.





PIN AND TAIL DIMENSIONS

Sizing pins for router-cut dovetails. If you plan to cut dovetails with a router, the minimum pin width will be dictated by the diameter at the base of the bit.

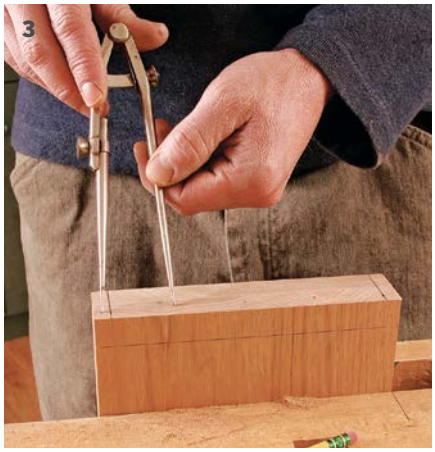
This is a common practice with hand-cut dovetails and also can be done on the bandsaw or tablesaw, as well as with the better machine-dovetail systems.

I recommend sizing the half-pins on the outer edges from ¼ in. to ⅜ in. at their narrow end. Interior pins range from ⅛ in. to ¼ in. wide and can be spaced anywhere from ¾ in. to 2 in. on center, depending on the application.

Last, it's important to choose an appropriate slope, or angle, for the tails. That slope is what draws the pin board up tight during assembly. More slope pulls the joint together efficiently; too little slope may require clamps or other aids to pull the joint together, much like a box or finger joint requires clamping pressure in two directions. Partly a matter of preference, the traditional ratio is 1:6 for softwoods and 1:8 for hardwoods; the reason being that the

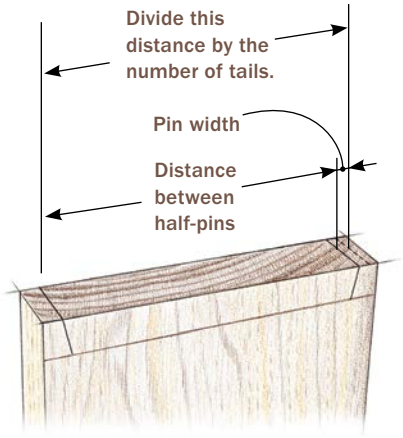
Set the tail spacing. Gochnour lays out and cuts the tails first. His method uses the narrowest dimension of the pins, and simple math, to divide the tail board evenly. To start, mark the pin width. Stack both tail boards in the vise. Lay out the half-pins, and then mark the pin width on one end.

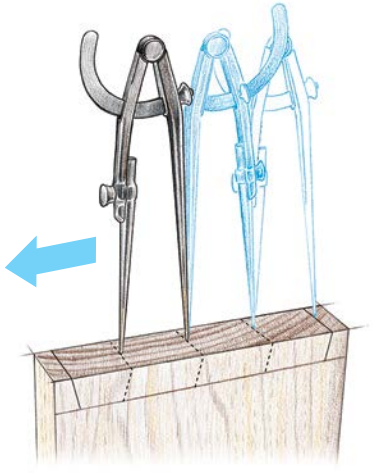
Measure from the half-pin mark on one end to the pin-width mark on the other. Divide that distance by the number of tails; adjust the dividers to this dimension.

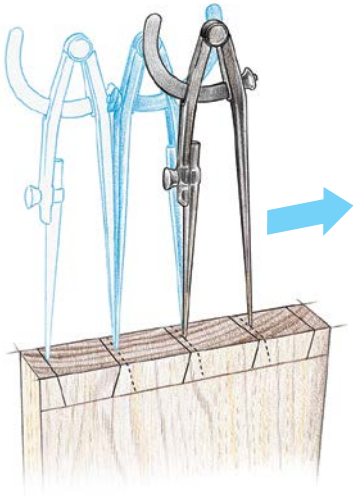


Mark the left edges of the tails. Place one point of the dividers on the right half-pin line and walk the dividers across the end grain.

Mark the right edges of the tails. Repeat the process beginning from the left half-pin line.







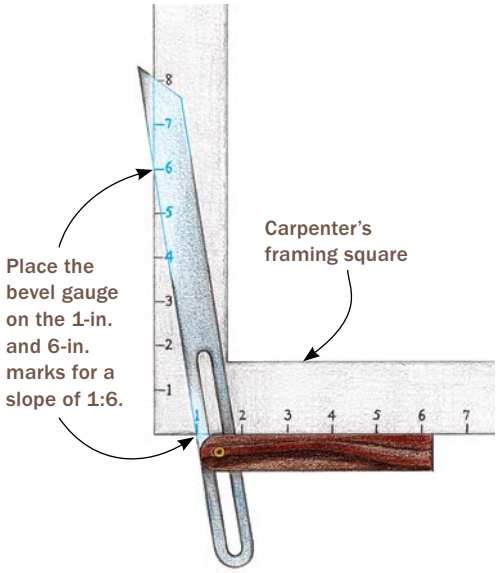
Mark the widths of the tails on the end. Set the pencil point into the depressions from the points of the dividers, slide a square up to the pencil point, and draw lines across.

Set a bevel gauge to the desired slope. Lay a bevel gauge across a carpenter's framing square to set the slope.

fibers of softwoods can compress more easily and therefore require a bit more angle to ensure that the pins are drawn tight to the tail board.

Keep the layout process simple

When laying out dovetails, use as few steps as possible. Begin by marking out the orientation of the pin and tail boards: inside and outside faces, top and bottom, front and back. Remember that tail boards generally make up the sides of drawers and cases, and the fronts and backs of chests; pin boards are usually the fronts and backs of drawers, tops and bottoms of cases, and ends of chests.



Scribe baselines—With the orientation of the tail board and the pin board established, scribe the baselines on both using a marking gauge. Set the gauge to the exact thickness of the pin board and scribe the tail board on both faces and edges. Setting the gauge to the pin board's exact thickness means there are no proud pins to

Mark the tails on the face. Use the bevel gauge to draw in the tails on the face of the board.

Saddle markers speed the process. A dovetail saddle marker allows you to draw the lines on the end and face of a board in one step and with one tool. These jigs come with preset slopes, or you can make one based on your preference.

interfere with clamping and leaves little to trim flush after glue-up. After scribing the tail board, scribe the inside and outside faces of the pin board in the same way.

Determine tail spacing—Though some woodworkers will argue that it's best to lay out and cut the pins first, I prefer to work the tails first for a few reasons. First, I can lay out and cut more than one tail board at a time. Second, I find it easier to align, hold, and transfer the tails to the pin board because the pin board can be held securely in a vise and the tail board can lay horizontally, easily registering on the pin-board ends. Last, any adjustments or fine-tuning during assembly will be done to the pins, and it is much easier to trim and fit the open, right-angled pins than the tight, angular confines of the tails.

Clamp both tail boards in a shoulder vise so that they are 2 in. to 3 in. above the benchtop and square to it. Measure and mark the half-pins across the ends of the boards and perpendicular to the faces. Now divide the tails based on the number that you want and the pin sizes between them (see the drawings on p. 144).

For example, say you want four tails with 3/16-in.-wide pins and two 3/8-in. half-pins. Lay out the half-pins 3/8 in. from both edges, then make a mark on the end of the tail board 3/16 in. past the half-pin mark on the right side (this distance is based on the width of the full pins). Then measure from that mark to the half-pin mark on the left side. Say that distance equals 6½ in. Because you want four tails, divide the 6½ in. by 4, which equals 1⅝ in. Now adjust a set of dividers with the points 1⅝ in. apart.

Lay one point of the divider on the right half-pin and walk it across the board end until you pass the half-pin on the left. If your math has been done correctly, the divider should be 3/16 in. past this mark. Now put one of the divider points on the left half-pin mark and walk back across the board end to the right.

Mark out the tails—The divider technique will leave a series of impressions spaced appropriately, in this case 3/16 in. apart. Place a sharp pencil in each impression, slide a square up to the pencil, and square a line across the ends of the boards.

Next, set a bevel gauge to the appropriate slope (see the drawing and photo on p. 146) and mark the face of the tail board. A dovetail saddle marker can be handy here because it allows you to draw the two lines across the top and down the face quickly and without misalignment. Dovetail saddle markers generally come with one of two slope ratios, 1:6 or 1:8, and are available from a number of sources, such as www.leevalley.com.

Now you're ready to cut the tails and remove the waste. The end-grain cuts must be absolutely perpendicular to each face of

Use the tail board to mark out the pins. Line up the baseline of the tail board with the inside edge of the pin board. Now use a marking knife to transfer the tail locations clearly to the pin board.

the board. Otherwise, during the next step the information transferred from inside the boards will not match the outside, causing problems.

Transfer layout to the pin board— With the tails laid out, cut, and pared, secure the pin board in the shoulder vise, with its outside facing you and its end 2½ in. to 3 in. above the benchtop.

Place the tail board with the outside face up on the end of the pin board. Use a spacer to keep the tail board level (see the photo above). Line up the baseline of the tail board with the inside edge of the pin board. If the tail's baseline overlaps the pin board's inner edge, the tails will be too tight. If the baseline is proud of the pin board's inner face, the pins will be too small, resulting in a loose joint.

Holding the tail board securely—use clamps if needed—knife in the tails clearly on the pin board. Extend the marks perpendicularly down the pin board's face to the baseline. Now you are ready to cut the pins and complete the joint.

Have Fun with Dovetail Layout

Mastering the basics of dovetailing opens the doors to many design options, allowing you to increase the strength of the joint as needed or add visual pop. Each of these designs works with the layout process described in this article.

ADD PINS AND TAILS

This joint has enough pins to ensure that the joint is sound, but not so many that the joint is laborious to execute. The 1:6 slope of the tails ensures that the pin board is drawn up tight during assembly.

INCREASE THE SLOPE OF THE TAILS

This joint has a unique visual appeal and a great ability to draw the pins up tight. It also leaves a lot of short grain on the tails, creating a potential weak spot.

ADD PINS AT THE ENDS

The outer edges of a joint are the most susceptible to failure. Fortifying the edge with an extra pin is a great way to strengthen this potentially weak corner. It looks good, too.

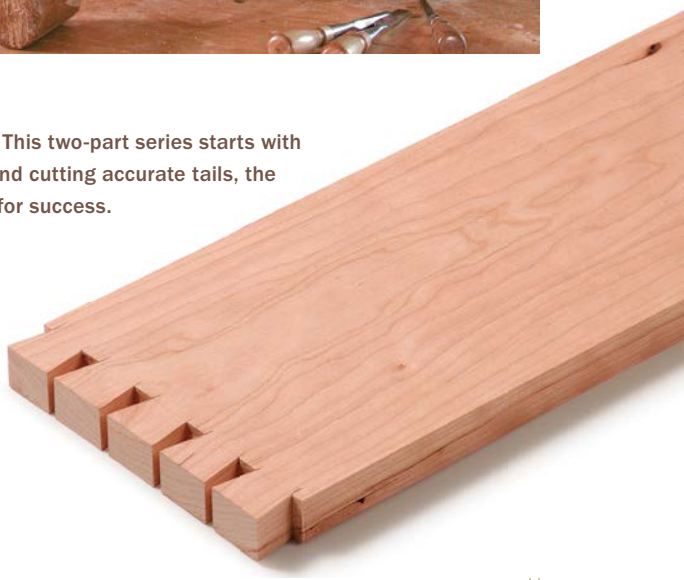
ALTERNATE TAIL WIDTHS

The sky is the limit in what can be done to capitalize on both the form and the functional aspects that the dovetail joint affords the craftsman.

Don't Fear the Hand-Cut Dovetail

CHRISTIAN BECKSVOORT

I've been working wood for more than four decades now, and I've always considered hand-cut dovetails the bedrock of my furniture. Nothing else so clearly indicates strength, quality, and craftsmanship. Starting out, I tried making dovetails in a variety of ways—cutting the pins first, or the tails first; chopping out the waste between kerfs with a chisel, or sawing it away with a coping saw; using a Western saw or a Japanese one. Gradually, I developed a system that gave me strong, well-fitting, aesthetically pleasing joints at a very good clip. Over the years, I've continued to refine my method in subtle ways. Mine isn't the only approach to dovetails, but I think you'll find it straightforward, efficient, and relatively easy to master. I'm going to cover every last tip and trick in a way I haven't done before, so this will cover two chapters, continuing in Cut and Fit Perfect Pins (see p. 157).



Tails first. This two-part series starts with laying out and cutting accurate tails, the foundation for success.

Pins vs. tails

The first book I consulted on dovetails recommended cutting the pins first. So did my father, a European-trained cabinetmaker. So I did. But I soon tried cutting the tails first, and I found it both faster and more accurate. Cutting tails first, you can clamp the two tail boards together and cut them at once. You not only save time sawing, but you also increase accuracy, since the longer layout lines are easier to follow. I also think

it's easier to trace the tails onto the pin board than the other way around, since the tail board can be laid flat while you trace it. Do pins first, and you have to hold the pin board vertically to mark the tail board. The transfer also is more precise when you do tails first, since it is done with a knife into end grain, the most accurate means of marking wood.

Mapping out tails and pins

The number and size of pins and tails has a huge bearing on the strength of a dovetail joint. The strongest possible joint would be 50% tails and 50% pins, but that is aesthetically boring and resembles a machine-cut joint. Narrow pins are just more appealing. But don't take it too far. If you spread six ⅛-in.-wide pins across a 10-in.-wide board, you'll be removing almost 92% of the wood on the pin board and just 8% of the wood on the tail board. That sort of ratio may work on a delicate jewelry box or a small desk drawer, but on a cabinet or a large drawer, those joints will be far too weak. As a compromise, I remove 70% to 80% of the wood on the pin board and 20% or 30% of the wood on the tail board. Don't get too hung up on the angle of the dovetails. There are passionate proponents for dovetail angles ranging anywhere from about 7° to 12°, but the practical difference is minimal. Outside that range, however, things get iffy. Angles above 15° result in weak corners on the tail board. And with angles below 5° or 6°, the dovetail begins to resemble a finger joint, losing its distinctive appearance and mechanical strength. I borrowed the angle of my dovetail marker, about 10°, from the first Shaker piece I restored, and I've been using it ever since.

Layout

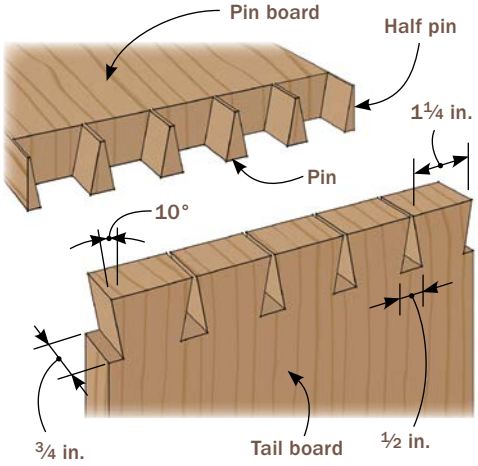
Scribing the baselines with a marking gauge is the first step in the layout process. Any gauge with a sharp, knife-edge cutter will work. When I set the gauge, I let the cutter hang just over the edge of the board. This results in pins and tails that are slightly proud. Scribe both sides of both ends of all pieces.

Next, mark the centerpoints of the pin sockets. For efficiency, I make my pin sockets the width of a chisel (¼, ⅜, ½, ⅝, or ¾ in.). That way, they require only one setting of the

Layout. Becksvoort cuts both tail boards at once, so he only needs to lay out the dovetail angles on one of them.

Anatomy of a Becksvoort Through-Dovetail

Becksvoort uses a standard chisel to lay out the pin sockets. His rule of thumb is to choose a chisel one size down from the thickness of the stock: for example, a ½-in.-wide chisel for ¾-in.-thick stock. He multiplies the chisel width by 2 to 2½ to get a rough idea for spacing between centerlines of the sockets.



Set the gauge to scribe the baseline. Adjust the marking gauge so its cutter just overhangs the pin board (above). The overhang will produce dovetails that are slightly proud. Scribe the base-line across both faces of the tail boards (right).

Space the tails. To space out five tails evenly, Becksvoort angles a ruler from 0 to 10 in. and makes a mark every 2 in. That gives him the centerpoints of the four full-pin sockets.

Transference. Use a square to transfer the center marks of the pin sockets to the end of the board.

chisel per socket. Use the chisel itself to lay out the sockets. Holding the chisel flat on the tail board with its blade crossing the scribed baseline and centered on the pin's centerline, draw marks on both sides of the blade. You can mark the width of the half sockets by eye. Then use a dovetail gauge and a pencil with a very fine point to draw the angled sides of all the sockets.

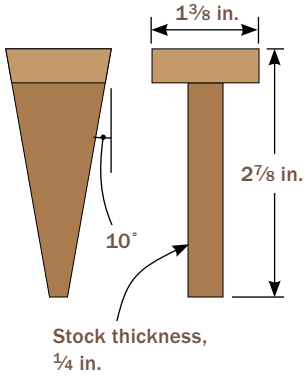
Last, bring the two tail boards together, inside face to inside face, exactly flush on the sides and ends, and clamp them into a vise. Then use a square and a pencil to extend the layout lines across the end grain.

Sawing tails

Sawing to the line is usually the hardest part for most beginners. I recommend practicing

Chisel trick. Establish the width of the pin sockets by tracing the chisel you'll use to chop them. Using a fine pencil, mark across the scribe line on each side of the chisel (above left). Gauging by eye, make a mark for each of the half-pin sockets so they are roughly half the width of the full-pin sockets (above right).

Mark with a Dovetail Gauge



The essential angle. Using a dovetail gauge, mark from the baseline to the end of the board, angling from the side mark toward the centerline. Becksvoort made his gauge to match a Shaker chest he admired.

Saw the tails. Cut right to the layout lines. The tails are the template for the pins, so slight variations won't matter as long as the sawing is square.

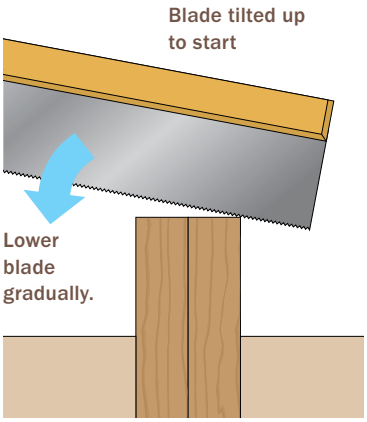
Pair up the tail boards. Clamp the two tail boards together in the vise with their sides and ends perfectly flush. Then carry the pin socket lines across the end grain of both boards. Cutting both boards at once improves accuracy, since the lines are longer and therefore easier to follow with the saw.

on scrapwood until you learn the nuances of your saw and get a feel for its action. Stand comfortably, feet slightly apart, facing the boards. Optimally, your forearm should be horizontal.

Start the cut with the sawblade resting at the back of the square line and the handle slightly elevated. A light touch is required to start the cut. Just keep the saw moving, with no downward pressure. Then, as you saw, drop the handle of the saw so that you are cutting a full kerf along the pencil line. Once the kerf is established, slight downward pressure can be applied. Hold the saw at the same angle as the dovetail line and saw down to the scribe line. I like to saw all the right-tilting angles, and then go back and saw the left-tilting ones, so I can get into a rhythm and let muscle memory take over.

Before putting the saw away, cut out the waste in the half sockets. It is definitely worth the time to reposition the boards so they are horizontal in the vise, since a vertical cut is much easier to make.

Starting the Saw



Start the saw with a light touch. Begin cutting at the far side of the line, with the saw's handle elevated. As you saw, gradually drop the handle until the blade is engaged right across the board.

Perfect posture. It's best to saw with your feet slightly apart and your forearm horizontal. With longer boards, if necessary, you can stand on a stable platform that raises you to a comfortable position.

Chopping between the tails

With both tail boards sawn, stack them on the bench, like stairs, and clamp. When making multiple drawers, I will stack up to six pieces at a time. This saves wear and tear on the arms. Constantly reclamping takes time and energy. If you clamp six pieces at once, for instance, you only have to clamp four times. Clamp those same six boards individually, and you'll be clamping them 24 times!

Some folks like to stand, but working that way is hard on the back. I prefer to sit while chopping. The work should be at lower chest height, so your forearms are almost horizontal. A shop stool of the right height is essential.

I chop away the waste in two distinct steps: First I create a shallow, square shoulder on all the sockets; then I go back and

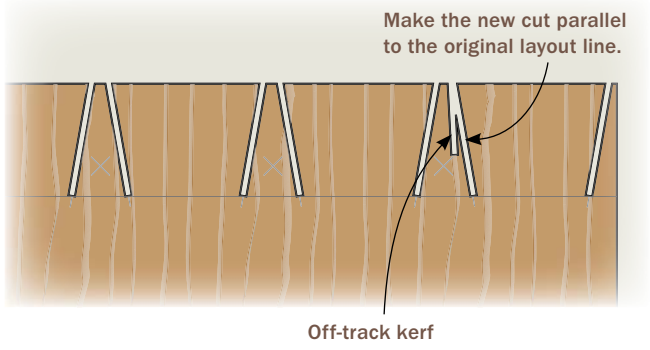
Cut one set, then the other. To maintain a good sawing rhythm—and maximum accuracy—first cut all the kerfs slanted in one direction, then go back and cut the ones slanted the other way.

Reclamp and re-mark. To mark and cut the shoulders of the half-pin sockets, turn the tail boards 90° in the vise, being sure to keep all sides flush.

Make it easy on yourself. Repositioning the boards is worth the trouble, since a vertical cut is much easier to make accurately.

Off Track? Start Anew

Oops. If your cut wanders far off track, start a new kerf parallel to the original pencil line. One of the tails will be slightly narrower than the others, but the angles will be consistent.



remove the bulk of the waste with angled, undercutting strokes.

Begin by placing the layout chisel directly in the scribe line between the two sawcuts. Hold it at 90°, and give it one light tap with a mallet. Although the chisel is flat on the back, it is still a wedge, and too heavy a hit will widen the scribe line in both directions. Go up the stairs, making light hits on all the pin sockets. Then, with a narrower chisel, held horizontally with the bevel up, hit into the end grain to remove a chip of waste about 1/16 in. thick. This will leave you a nice, square shoulder directly on the scribe line.

Then comes stage two. Returning to the layout chisel, place its tip against the shoulder you've created. Tilt the handle toward you by a degree or two, and give it two hard hits with the mallet. This will undercut the joint slightly and ensure that the pins, when cut, will be tight against both inside and outside shoulders of the pin sockets. I use a chisel with very narrow flats on the sides to keep from deforming the tails.

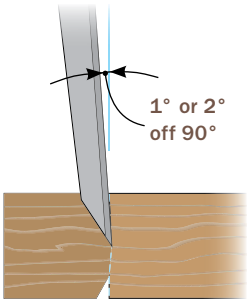
Chop out the waste. Becksvoort takes a quick route to a flawless shoulder. Instead of trying to make a perfect shoulder the whole thickness of the workpiece, he makes a shallow shoulder right on the scribe line and then undercuts it.

Chop all the sockets this way, and then, with the smaller chisel, go along and remove a chip of waste about ⅛ in. thick from each one. Continue until you reach the center of the board. Then unclamp, flip, and re-stack the boards. Perform the same two-stage operation on the other side. As you approach the center of the joint, use light taps instead of heavy ones until the waste pops down and forward. If you're not careful, you can ruin

Go lightly at first. Start straight up. Using the same chisel you used to lay out the pin sockets, seat the tip of the blade in the scribe line, hold the chisel perfectly vertical, and give it one light mallet hit. This creates a 90° shoulder right at the scribe line.

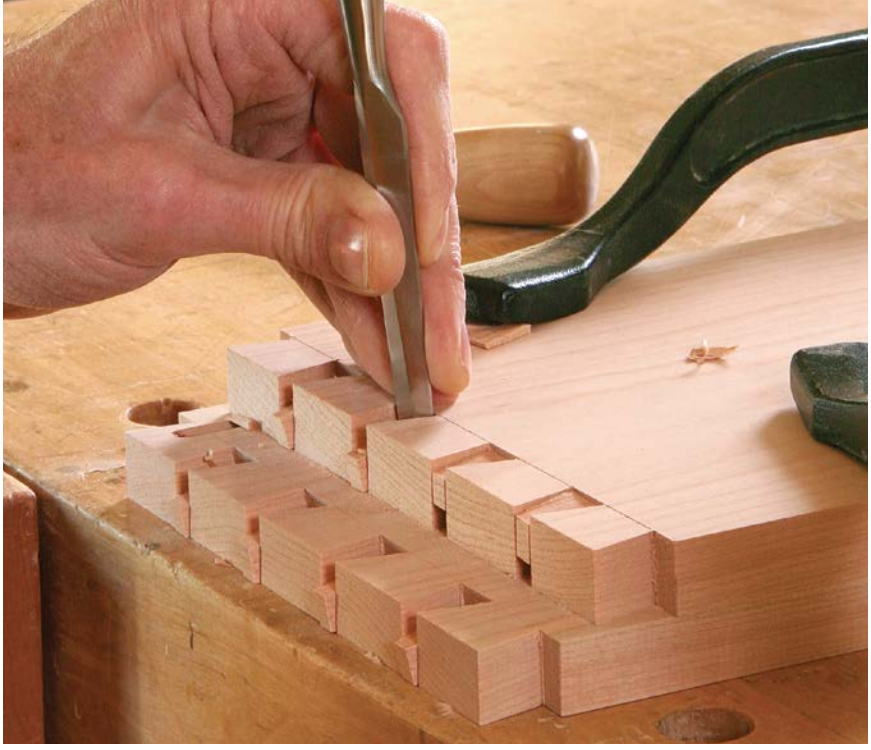
Pop out a slim chip. After lightly chopping all the pin sockets, use a narrower chisel to remove the top layer of waste wood with a tap into the end grain. The shoulder should now be about 1/16 in. high.

Now Go Heavy



Angle in for safety. Make the next series of chops using heavy mallet blows and holding the chisel so it angles toward you a degree or two. This undercuts the shoulder without changing it.

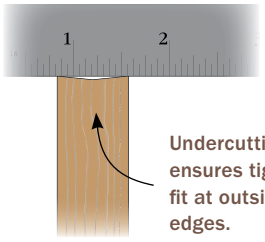
Halfway home. Remove the thick waste chips (above) and then resume chopping with the chisel angled. Continue chopping to the halfway point in the board's thickness.



Flip and repeat. Turn over and reclamp the boards to chop in from the other side. Start with light, vertical chops as before, followed by heavy chops at an angle. Be careful not to strike the last waste too hard, as the chisel could damage the shoulder below.

Knife work. Use a sharp knife with a narrow blade to clean up the tight corners of the pin sockets.

Finish Up



Straightedge tells the tale. With the center of the shoulder undercut, a straightedge laid across the joint should contact only at the outside edges.

the shoulder on the other side and hit the workpiece below.

Since the sawcuts are at about 80° and the edge of the chisel is at 90°, there is usually a small bit of waste wood left in the corners of the pin sockets that needs to be removed. Use a sharp, narrow knife to clean these corners. Finally, place a chisel or a square across the inside of the sockets and sight across it to be sure that the joint is properly undercut—low in the middle and with the shoulders as the high points.

At this stage, if you've sawn square across and straight down to the scribe lines, and chopped correctly, you're still on track for a perfect dovetail. The tail boards you've produced are the templates for the next step in the following chapter.

Cut and Fit Perfect Pins

CHRISTIAN BECKSVOORT

In the previous chapter I described every step of the process I use to lay out, saw, and chop the tails in a through-dovetail joint. I always cut the tails first and use them as the template for the pins. In this part, I'll show you my method for transferring the tails to the pins, as well as how I cut the pins and assemble the joint. Even if you use a different method to cut the tails—as long as you cut them first—you can apply all these techniques to your process.

Transfer the tails with precision

When you're making hand-cut dovetails, transferring the first half of the joint to the second half is where the rubber hits the road. Accurate scribing is essential. Luckily, two of the big benefits to cutting tails first and pins second come into play as you make the transfer. One is that you can lay the tail board flat as you trace the tails. The other is that you can make the marks with a knife

Easy alignment. Use a scrap block to support the tail board during scribing. First clamp the pin board in the vise so its top edge is flush with the block (left). Then move the block to support the far end of the tail board. If your boards are grooved for a bottom or back, insert a small square of wood into the groove to control side-to-side alignment (above).

Knife work. Align the tail board so the gap between its shoulder and the face of the pin board is just barely closed (above). This will leave the ends of the tails proud by about the thickness of a fingernail. Trace the tails onto the end grain of the pin board (right), starting with a light stroke and following with one or two heavier ones.

Finish the layout. Use a square and a pencil with a fine point to draw the lines between the scribed angles and the scribed baseline.

into end grain for maximum accuracy. Before you begin tracing the tails, number the mating joints—1,1; 2,2; 3,3; 4,4—so it's clear which sets of pins belong with which sets of tails.

I use a simple trick to keep the tail board flat and steady while I scribe. Place a square block on the benchtop in front of the vise. Then clamp the pin board in the vise so its top end is flush with the top face of the block. Now when you set one end of the tail board on the pin board for scribing, you can use the scrap to support the other end.

Align the tail board so that its sides are flush with the sides of the pin board. Then line up the shoulders of the tails with the inside face of the pin board. The tails, which will be proud in the finished joint, will protrude slightly past the outside face of the pin board.

Holding the tail board down firmly with one hand, mark along both cheeks of all the tails. Use a sharp knife with a long bevel, and hold the bevel flat against the wood. For maximum accuracy, make a light cut first, followed by a heavier cut. Then use a square and a fine-point pencil to carry these knifed lines down the faces of the pin board to the baseline.

Remove the waste between pins

When you cut the pins, your sawkerfs should, ideally, be right on the layout lines. You could saw close to the lines and pare to them later, but this is a slow and inefficient process. Better to put the extra time into practicing cutting to a line beforehand.

Once all the pins are sawn, you can move on to chopping out the waste. Clamp the pin boards flat on the bench, stacked like steps, and begin by establishing the shoulder. Use a wide chisel held vertically and with its point right in the scribed baseline. Make one light

Saw and chop the waste. Your kerf should be right on the knife and pencil lines. Mark the waste with Xs to avoid mistakes.

Strike lightly. With the chisel held upright and its point in the scribed baseline, establish the shoulder with a light mallet blow.

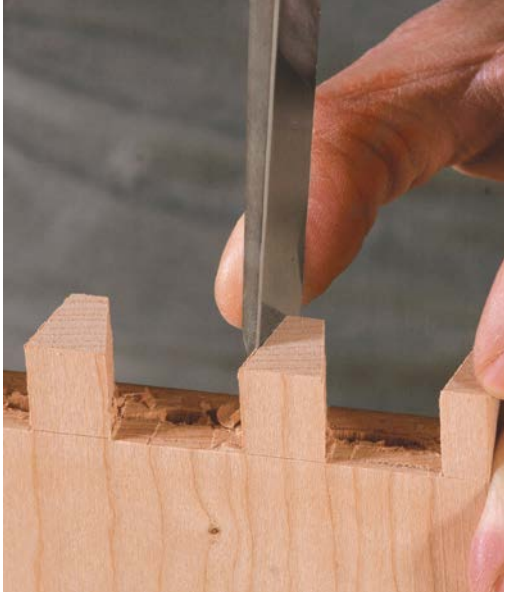
First chip is the slimmest. Remove a thin chip of waste with a tap on a horizontal chisel, and you'll have a 1/16-in.-deep square shoulder. To chop out the rest of the waste, hold the chisel just off vertical—tilted toward you—and use harder mallet blows. This undercuts the joint, leaving the shoulder intact.

mallet blow at each setting of the chisel—you'll likely have to set the chisel twice to span the baseline from pin to pin—and chop between all the pins. This light chop establishes the shoulder without driving the chisel beneath the baseline.

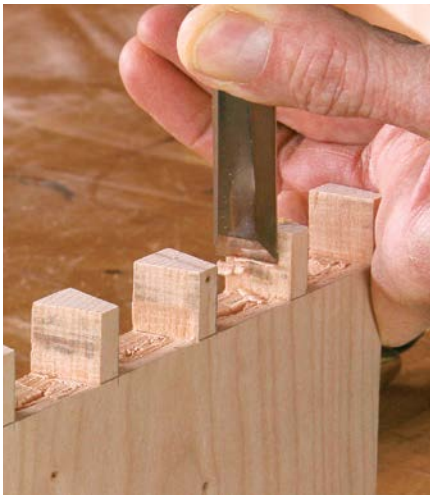
Use the same wide chisel held horizontally to tap into the end grain and take out a chip of waste about 1/16 in. thick. Now you have a shallow, square shoulder. The rest of the joint will be undercut slightly, speeding up the process and leaving the shallow shoulder pristine. You can afford to undercut, since this is all end grain and is not a good glue surface anyway.

With the chisel tilted toward you slightly, make each chop with several firm mallet blows. Chop between all the pins and follow up by removing a thick chip of waste. Continue chopping this way between all the pins until you reach the middle of the boards. Then flip them, reclamp, and repeat the two-step chiseling process from the other

Same sequence on side two. After chopping to the middle of the pin boards, flip them and use the same techniques to establish a square shoulder and chop away the waste on the other side. Lighten up at the end to avoid damaging the shoulder below.



Slice on the scribe lines. If any of your scribed lines are visible on the end grain, put the tip of a chisel in the line and pare away the waste (above). If the grain is running into the pin, pare from the side instead of the top (right).



Gauge the fit with graphite. Blacken the first ⅛ in. or so of the tails' cheeks with a pencil (above left). Engage the joint evenly with moderate fist pressure (above right). Where the graphite has transferred to the pins, pare it away gingerly, coming from the top if the grain permits (right), or from the side if the grain is tricky.

Knock it home. After paring the pencil marks away, test the fit again, disengaging the boards and reapplying graphite as often as necessary until the joint slides snugly home.

Clever glue trick. To simplify the glue-up, assemble the box so the joints are just barely engaged. Then apply glue to the cheeks of all the pins and tails before pounding the joints home.

face. When you are working on the last bit of waste, use a series of light hits to avoid damaging the shoulder and stock below.

With the chopping finished, clamp each pin board in the vise in turn and examine the end grain. If any of the scribe lines are visible, you have paring to do. Select a chisel that's wider than the pin, put its point in the scribe line, and pare straight down. Be careful of the grain here; if it runs in toward the pin and pulls the chisel with it, try paring from the side instead of from the top. After paring, use a knife to clean

Use clamps if you need them. After pounding the joints home, use clamps if necessary to close any gaps and to adjust the box for squareness.

Easy squeeze. Becksvoort doesn't need specially made clamping blocks to contend with the proud tails. He just makes white pine blocks, which are soft enough to conform to the proud parts of the joint.

A Fine Fix for Gaps

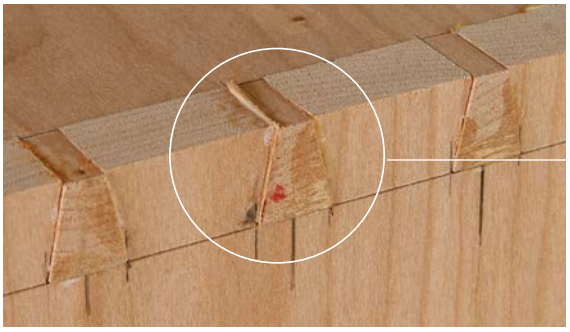
As the glue dries, examine the joints. If there are any hairline gaps between the pins and tails, you can fill them with commercial wood filler or with a homemade recipe: ⅔ glue to ⅓ water, to the consistency of heavy cream, then blend in sanding dust (not sawdust) to the consistency of peanut butter. With white or yellow glue, avoid contacting metal while you mix and apply the filler, since the glue will react with the metal and turn black.

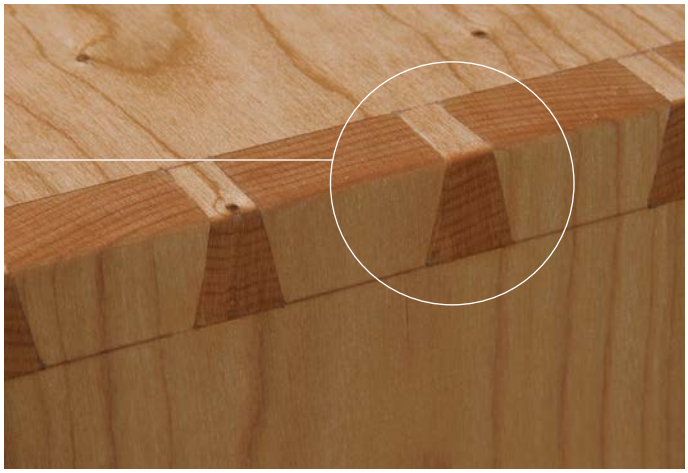
Larger gaps—the width of a sawkerf or less—can be fixed after the clamps are off. Widen the gap with a handsaw. Then cut a thin shim from a scrap that matches your project and glue it into the kerf. Depending on which direction you insert it from, the shim's grain will match either the pin or the tail.

Kerf the corner. To repair a gap between a pin and a tail, start by sawing into the gap with the blade on a 45° angle. Cut the kerf from baseline to baseline.

Create a kerf-size shim. Using the tablesaw and a scrap of stock that matches your project, cut a shim that fits your handsaw's kerf.

Trim the shim. Cut one end of the shim on a 45° angle with the chop of a chisel. After gluing it in place, trim the shim flush (right) with a few strokes of a knife.





Seamless repair. Glued in with its side grain and end grain matching the neighboring pin (above), this shim is virtually invisible once it's sanded flush (right).

out all the inside corners. Lastly, check with a square to see that the joints are properly undercut—the shallow shoulders you established on each face of the board should be the high points.

Pare the pins to fit the joint

In a perfect world, you would now be able to drive the joints all the way home with moderate fist blows. But in reality, fitting comes next. Always do this paring and fitting on the pins; the tail board is the pattern, and the pins must conform to it.

With a pin board in the vise, align the matching tail board and press down lightly. If the two pieces barely engage, that's good. Remove the tail board and, with a pencil, darken the leading edges of the tails. Re-engage the pieces and pound a bit harder. Where the graphite has transferred onto the pins, pare ever so slightly, keeping the chisel vertical. Don't undercut, since this is your glue surface. If the joint is already engaging, don't pare all the way from the top of the pin, since it already fits there. Be patient; it may take three, four, or even five tries before you get a good fit.

If there are gaps between any of the pins and tails, you'll need remedial action after the glue-up (see p. 163).

Tricks for a confident glue-up

For small glue-ups, you can coat the pins and tails with glue while the parts are separate and assemble as normal. But for medium and large glue-ups, partially engage all four corners—by ⅛ in. or so—before applying any glue. Then use a narrow stick to apply glue to the exposed faces of the tails and pins on all four corners. Pound the joints together with a caul and mallet. If the joints don't come completely home with the mallet, use clamps. I use scraps of pine as clamping pads. Even though the joints are proud, there's no need for custom clamping blocks. The pine conforms easily to the shape of the joint while delivering the clamping pressure. If there's much glue squeeze-out, slip a piece of waxed paper under the pine to keep the blocks from adhering to the workpiece.

A Trip to the Dovetail Doctor

STEVE SCOTT

Earlier this year, a frustrated woodworker sent us a note that was both challenging and matter-of-fact. His subject was dovetails. "I've read most of the stuff *Fine Woodworking* has published and seen several videos (offering dovetail instruction)," he wrote. "I still can't do 'em."

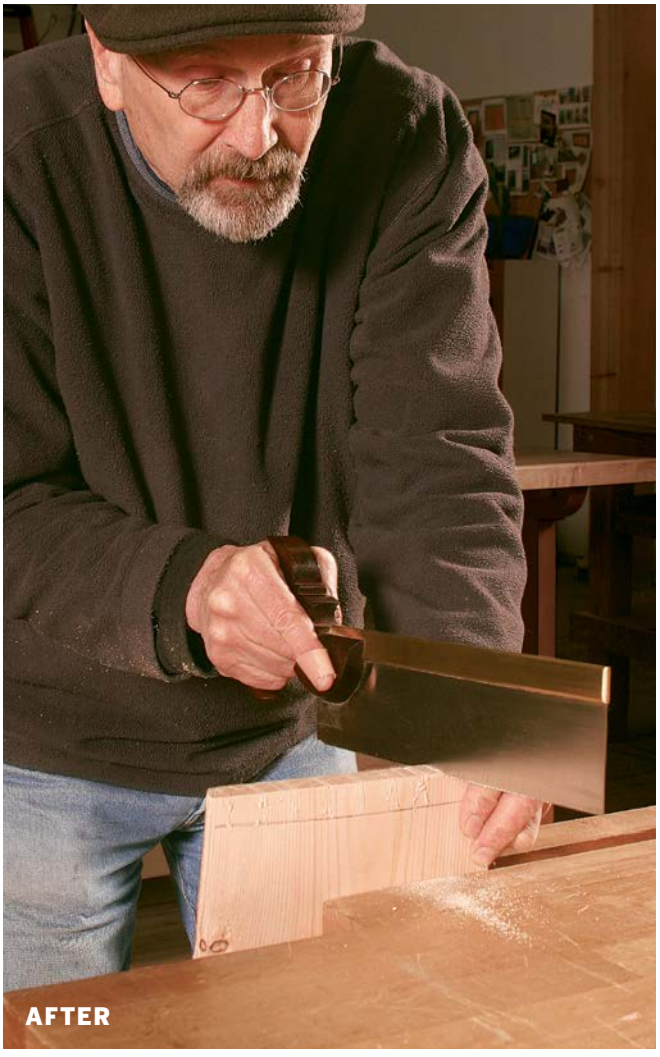
The reader, Tom Rawson of Oakland, Calif., said he had also taken a local woodworking class and practiced dovetails diligently for months afterward. The results? "I tried. I focused. I failed."

The problem as Rawson sees it is that even the most thorough instruction tends to gloss over the basic mechanics. He proposed we address those details, and as a way of getting at them he suggested something we had never tried. What if we arranged for a struggling woodworker like him to have a one-on-one tutorial with an expert? The student could explain his difficulties to the expert, who would teach him the nuances he'd been missing. We'd be there to capture the action in photos and in video.

We arranged for Rawson to spend a couple of days working on through-dovetails with contributing editor Gary Rogowski at Rogowski's school, the Northwest Woodworking Studio in Portland, Ore. When he arrived in Portland in April, Rawson brought with him a host of frustrations and preconceptions, but a willingness to drop them all in pursuit

Keep layout at arm's length. Scribing a clean, deep baseline is more of a challenge if you're clutching the workpiece to your chest. Rogowski suggested that Rawson hold the work on the bench for greater stability and a much cleaner line.

Key to straight sawcuts. Rawson's white-knuckle pistol grip on the backsaw caused the saw to bind and drift. Rogowski encouraged him to use a one-handed grip and "let the saw do the work."



of better dovetails. Meanwhile, Rogowski worried that he wouldn't be able to identify any problems or that his student would lack the hand-eye coordination to follow through—that after two days he would have to politely suggest that Rawson outsource all his dovetails or sell his woodworking tools and take up crossword puzzles.

Exam reveals a host of ailments, cures

He needn't have worried. Almost from the moment Rawson began working, Rogowski

began spotting problems, small and large. At every important stage—layout, sawing, chopping away waste, paring and fitting the joint—Rogowski was able to give Rawson critical pointers. Here are the tips that helped the most.

Good dovetails start with good layout—The first step in dovetailing is to scribe a baseline matching the thickness of the stock on the end of both workpieces. Rogowski quickly spotted a problem. Rawson was holding the workpiece against his chest while drawing the marking gauge across the work. Rogowski suggested holding the workpiece flat on the bench instead, allowing him to use his hands more effectively. This resulted in a crisper, deeper line.

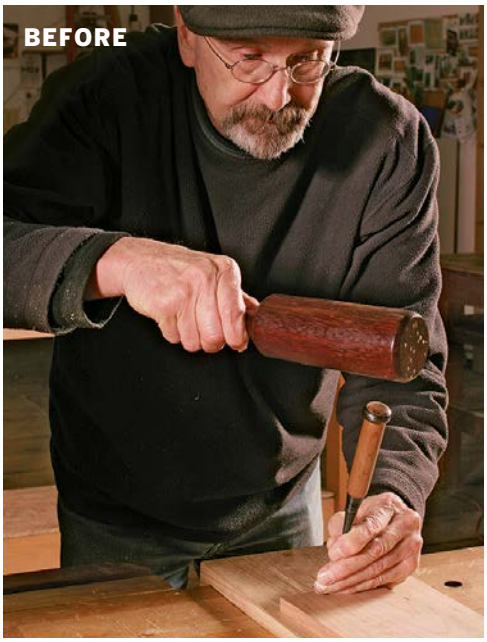
It's a saw, not a pistol—Rawson's troubles with the backsaw stemmed mainly from his grip: a locked-down, two-fisted clench that looked to Rogowski "like he was shooting a .45." This was causing the saw to wander and to bind in the kerf.

"You've got to give up that other hand and let the saw do the work," Rogowski told him, demonstrating a light but firm one-handed grip with the index finger extended.

As that first morning progressed, Rawson got more comfortable with the new grip and his sawing became more fluid and less labored. He described the switch as "kind of a breakthrough."

Rogowski also suggested simple practice drills in pine for sawing on a line. And he showed Rawson how to start a cut cleanly by setting the saw's teeth on the opposite corner of the stock and gently pulling toward him.

Square or not depends on your point of view—To chop out the waste between tails, Rawson positioned himself



Better angle on chopping. When chopping waste, Rawson's stance at the end of the workpiece meant he couldn't tell if the chisel was square to the work. Rogowski had him reorient so that he had a side view of the chisel.

V-groove for square shoulders. Before sawing the shoulders at each end of the tail board, Rogowski cuts a V-groove that meets the baseline. This makes it easier to locate the sawkerf and pare a perfect shoulder. He saws shy of the baseline, leaving a small ledge of material to be pared away precisely.

at the end of the bench, facing the end of the workpiece.

"OK, now wait a second. Stop right there," Rogowski said. "How do you know you're chopping square?"

Rawson paused, mallet frozen midswing, "I guess I don't."

Rogowski moved Rawson to the side of the bench so he could see the chisel in profile and gauge whether it was straight up and down before striking it. He also showed Rawson a trick for finding the baseline with the chisel edge by lightly dragging the edge, bevel down, until it snaps into the line. The results were encouraging. "It certainly feels like things are possible here that haven't felt possible before," Rawson said.

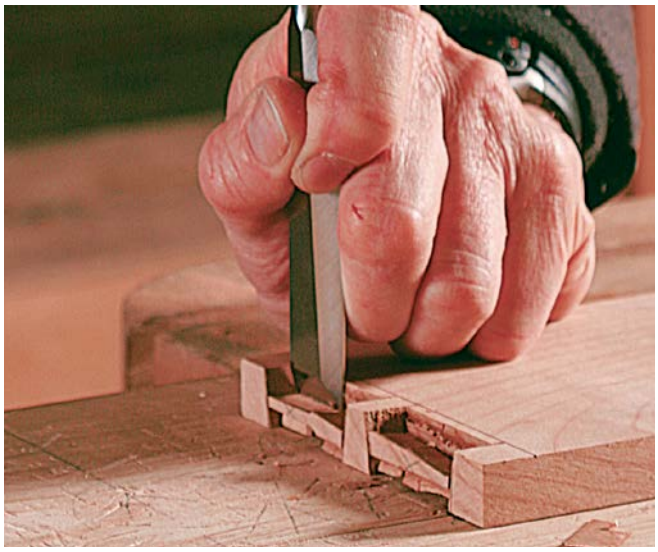
A problem at the end of the tails— When sawing the shoulders on the ends of the tail board, where the half-pins go, it's easy to cut or pare past the scribed baseline. Rogowski demonstrated a simple way to avoid that risk. Before sawing, he uses a chisel to cut a V-groove that meets the baseline. This makes it easy to locate the sawkerf and maintain a straight cut. The sawcut stays a bit shy of the line, leaving a small ledge of material to be pared away.

A clean transfer is critical—The mating pins are laid out by scribing the outline of the finished tails onto the pin board. Rogowski showed Rawson a couple of ways to help ensure accuracy. First, he used a small square to check that the tails were square front to back, making corrections with a sharp chisel before transferring the layout. He also took care to align the two workpieces precisely during the transfer, using a wide, flat scrap as a straightedge.

Fit the joint in stages—Paring for a final fit "makes my blood run cold," Rawson

Align the parts for a clean transfer. Rogowski suggested resting the tail board on a handplane with the pin board clamped in a vise. He uses a knife to mark the pin locations, then pencils in the lines to make them more visible.

said. "If things were askew from the saw, what makes me think they're gonna get better with a chisel? Seems like the errors compound." As an antidote, Rogowski told Rawson to pare and fit each mating surface in turn, working from one side of the board to the other. He demonstrated how to identify where the pins need paring by blackening the edges of the tails with a pencil so they mark the tight spots when test-fitting the joint.



Sneak up on the fit. When a chisel is placed in the baseline too early, all the waste wood in front of it pushes the chisel backward, past the line. Rogowski emphasized chopping out the bulk of the waste first (top) and then paring right to the line (above).

The patient takes home a prescription

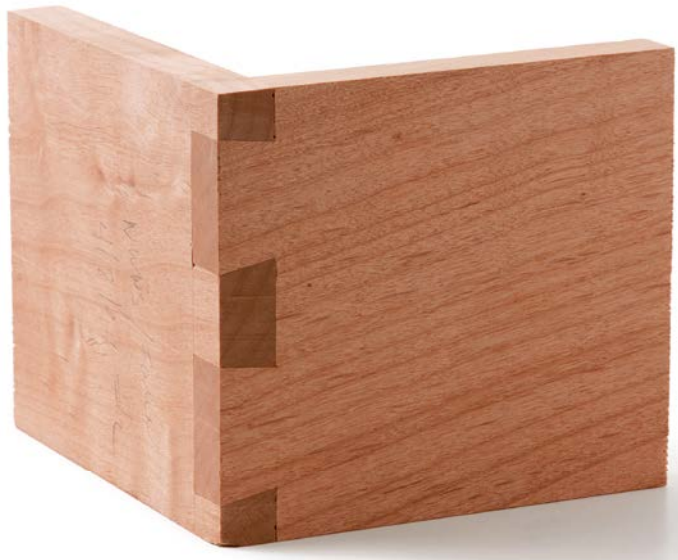
Beyond the specific tips, Rogowski encouraged Rawson to continue practicing regularly, and to set aside the 1-in.-thick birch he'd been practicing on in favor of friendlier material like poplar.

Fitting a snug set of tails at the end of the second day, Rawson was tired but excited and newly confident.

"This is where I never thought I would be," he said.

The good doctor, meanwhile, was relieved that he'd been able to help. "It was good," Rogowski said. "It felt good."

Rapid recovery. With Rawson's second set of tails, the doctor's remedies appeared to be working. The patient has since finished several dovetailed drawers.

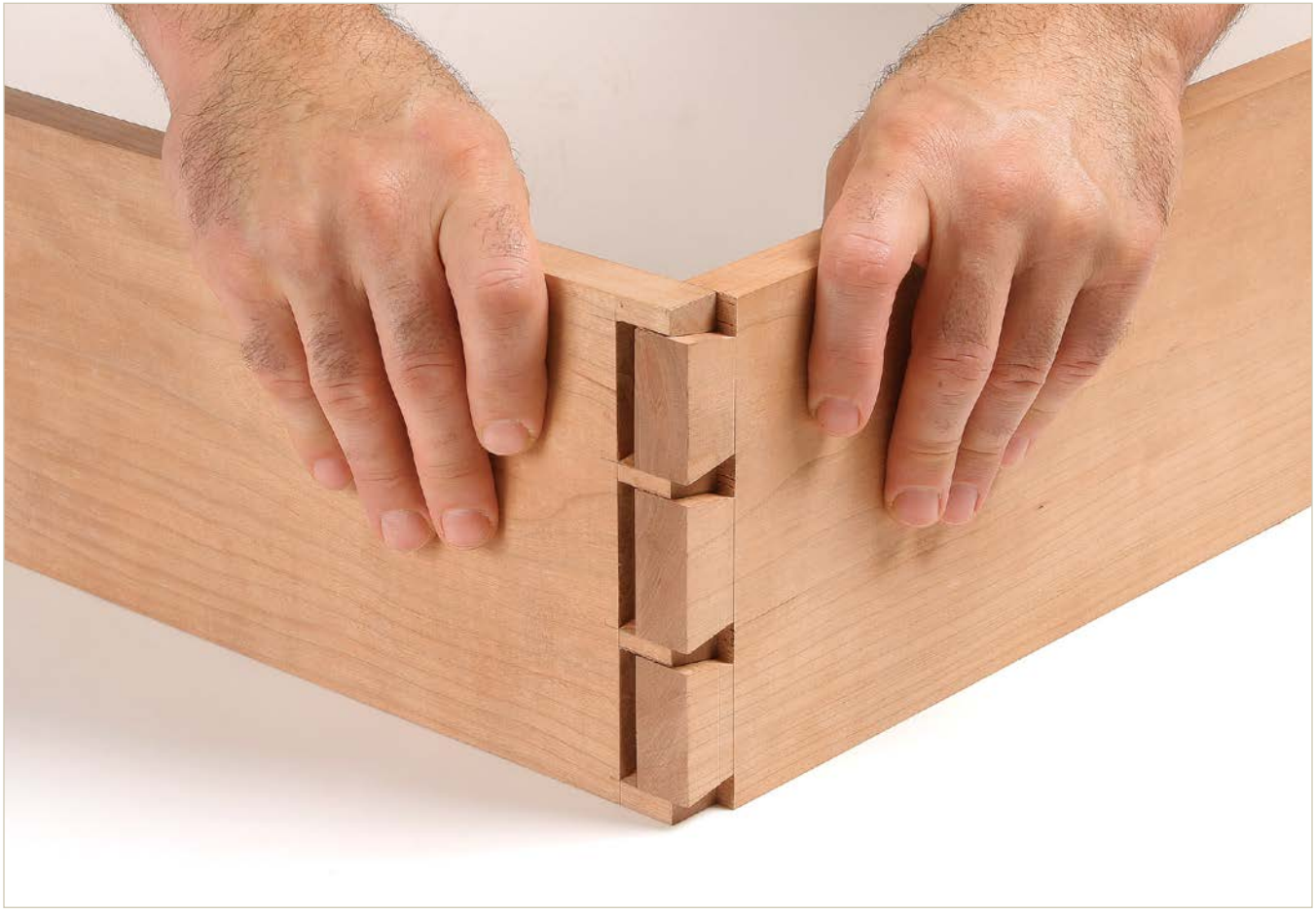


Dovetails on the Tablesaw

GREGORY PAOLINI

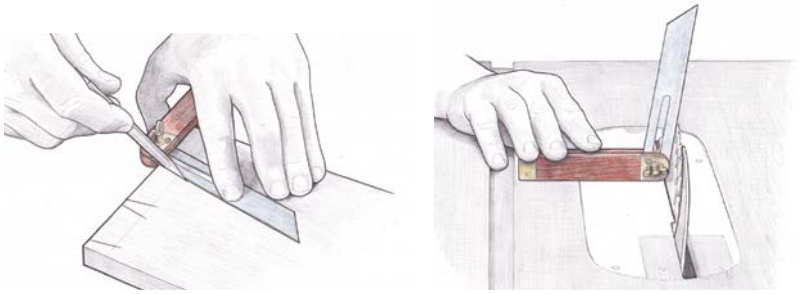
It takes an awful lot of practice to cut dovetails by hand and to do it well. Your sawcuts should be straight, at a consistent angle, and square to the board's face. And you can't cut into the baseline. Later, when you're paring and attempting to make up for bad sawcuts, you can make things much worse.

There are ways to cut dovetails that bypass those challenges. With a router and jig, you'll get straight and square tails and pins that have consistent angles. Unfortunately, they won't look as nice as hand-cut dovetails. It's difficult to reproduce the wide tails and narrow pins that make the hand-cut version so appealing.

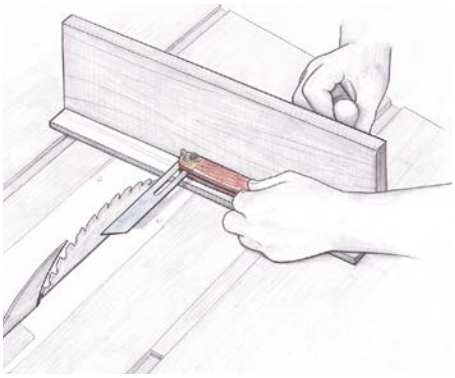


Bevel Gauge Guides the Way

To take advantage of the tablesaw's accuracy, you need to set it up precisely. Using a bevel gauge is the secret.



Mark the tails, setting the gauge at your favorite dovetail angle (above left). Paolini likes 10°. Then use the same bevel-gauge setting to angle the blade (above right) to cut the tails.



With the blade at 90°, angle the miter gauge for the pins. Don't change the setting on the bevel gauge, and the pins are sure to match the tails.

Angle the blade to cut the tails. The tablesaw locks in the cutting angle and a stop block allows you to make eight cuts from a single layout line. So all you need to do is lay out the tails at one end of one board.

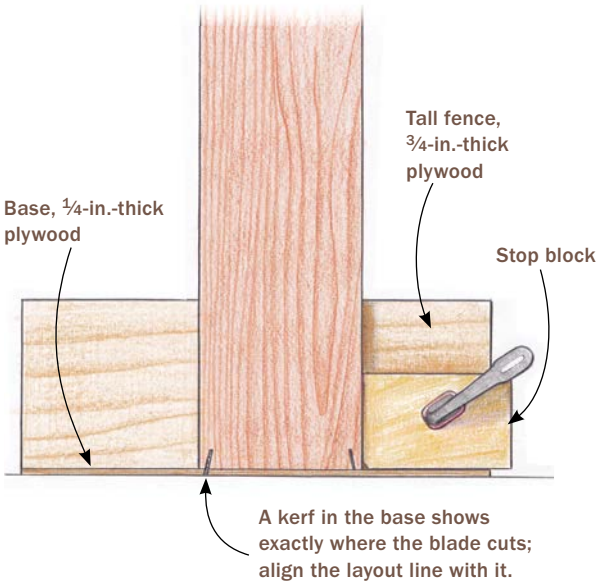
Scribe the baselines, then lay out the tails. Scribe all the boards (far left), wrapping the marks around the edges on the tail boards. You can space the dovetails any way you want (left), but they should be symmetrical around the centerline.

Angle the blade. Make sure the bevel gauge's setting hasn't changed and that it's flat against the blade's plate, coming up in a gullet between teeth.

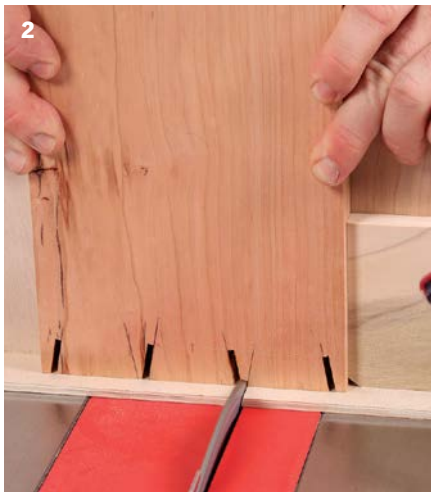
However, there is one power tool in your shop that excels at cutting straight and square, and can easily maintain the same angled cut for both tails and pins: the tablesaw. What's more, because tablesaw blades are no more than ⅛ in. thick, you can reproduce hand-cut dovetail spacing, too.

Of course, because both the tails and the pins are cut at the tablesaw, you're limited to through-dovetails. That's great for case joints and the back joints on a drawer, but what about the half-blind dovetails we all use to join the drawer front to the sides? No prob-

Get Accurate with an Auxiliary Fence and Stop Block



Four cuts from a single setup. Flip the board to make two mirror-image cuts, then rotate it end for end to make the same two cuts on the opposite end. When you've done the same with the second tail board, you've made eight cuts without moving the stop block.



The mirror effect. As you work across the board, moving the board (and stop block) to a new layout line and making all four cuts each time, you naturally begin to cut the second side of every tail.

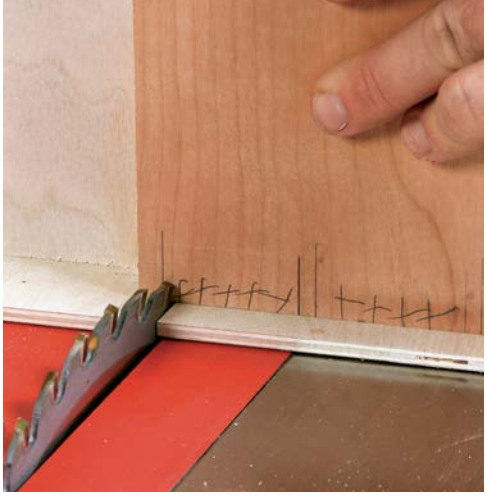
Nibble the ends. A few eyeballed cuts knock off most of the waste at the ends.

Clean out the waste. After defining all of the tails at the tablesaw, cleanup goes quickly. Work to your scribe lines.

On the first side of the pins transfer the tails to the end grain. Do this on all your boards. Paolini uses a 0.5-mm mechanical pencil because of its very fine line.

Wrap the line onto the face grain. You can't see the end grain when the board is standing on the auxiliary fence, so you'll need these lines to align the board for cutting.

Angle the miter gauge for the pins. Move the blade back to 90°. One side of every pin is cut with the miter gauge angled in one direction. Use the bevel gauge, still set to the angle used for the tails. Paolini attaches a new auxiliary fence so that the kerf for this cut doesn't overlap the one used for the tails. You will angle the miter gauge in the other direction to cut the second side.



Don't cut into the pencil line. If you do, the pin will be too narrow and you'll have gaps in the joint. Take advantage of the zero-clearance kerf, aligning the board so that the pencil line is right next to the kerf, but not in it.

lem. I have a trick that turns a through-dovetail into a half-blind, with added benefits you can't get the traditional way. But let's start with the basics.

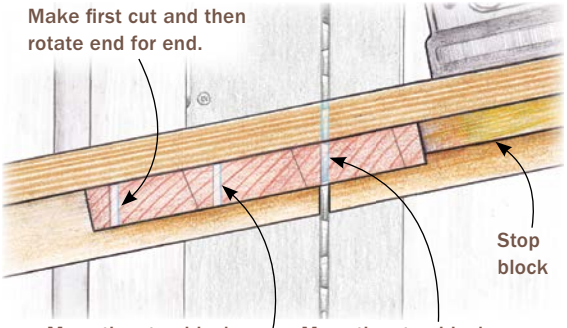
Use a rip blade and auxiliary fence

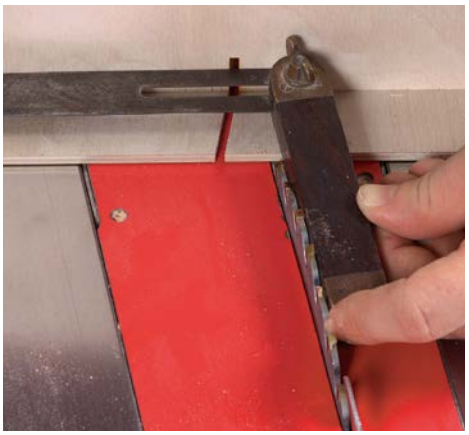
To cut dovetails this way, you need only your stock miter gauge and a blade. I use a rip blade because these are ripcuts and because it has a flat-top grind, which leaves a flat shoulder when I cut the pins, with no paring needed. However, any standard blade will leave a bit of material between tails, so you'll still have some paring to do. If you're going to cut dovetails this way all the time, get a blade with the teeth ground to match the dovetails' slope. Any saw-sharpening service can do it. Use it for the tails and you won't have any paring to do in the corners, either.

You also need two L-shaped fences for the miter gauge—one for the tails and one for the pins. They should be at least twice as long as the drawer sides are wide, so the sides always have support as you move them to cut the pins and tails. After the fence is attached to the gauge and a kerf is cut into it, it's easy to align layout lines with the kerf so the blade cuts exactly where you want it to.

Make All the Cuts You Can

You can't flip the board this time to make a mirror-image cut on the same end, but you can invert it. Keep the same face out.

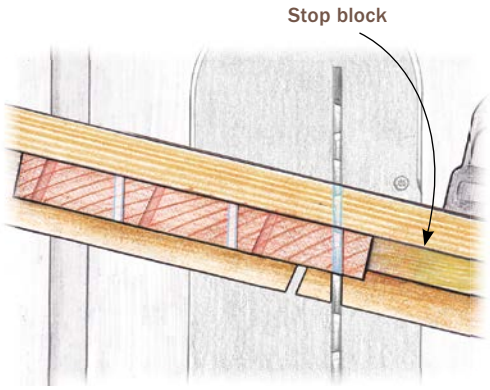




Reset the miter gauge. There's no way around it to cut the second side of the pins. Be sure the bevel gauge is still locked into its original setting.

Opposite Angle for Side Two

This is just like cutting the first side of the pins, except the board goes through the blade at a different angle.

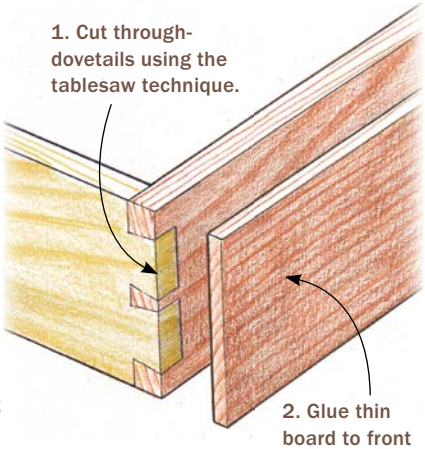


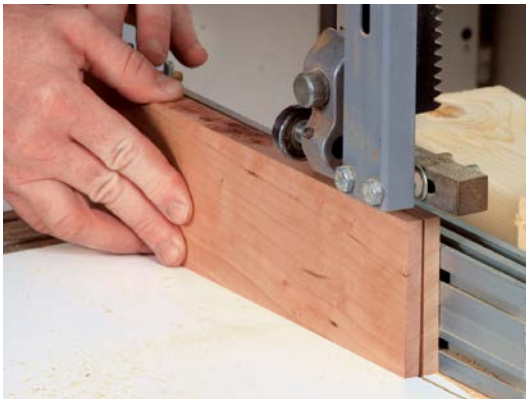
Nibble the waste by eye. Most of the waste can be cut out with the fence at the second setting, but you'll need to move it back to the first setting to get all of the waste.

Payoff is perfect joints. After cleaning up the baseline of the pin board with a file, the joint should come together square, without gaps, and without much persuasion.

Use the Same Technique to Make Half-Blind Dovetails

You can use through-dovetails in lots of places, but typically not drawer fronts. There, you want half-blind dovetails. But you can still use this dovetailing method by gluing a thin board (⅛ in. to ¼ in. thick) to the front of the drawer box after it's glued together. That allows you to use through-dovetails for all of the joints, but still get the half-blind look. As a bonus, you get more mileage from your best lumber, which you can resaw to get book- and slip-matched fronts.





Cut the fronts. Resawing from a thicker board lets you spread a beautiful board over several drawers.

Brads lock it in place. Cut them off short and they'll stick into the front and prevent it from creeping under clamping pressure.

Don't skimp on clamps. Paolini uses a caul made from melamine-covered particleboard to protect the front and help spread the pressure over the entire surface (for a tight glueline around all four sides).

Just rout it flush. Routing is faster than a handplane and makes it easier to keep the edge square to the face. Do the ends before the long edges, and use a pin in your router table to help you enter the cut safely.

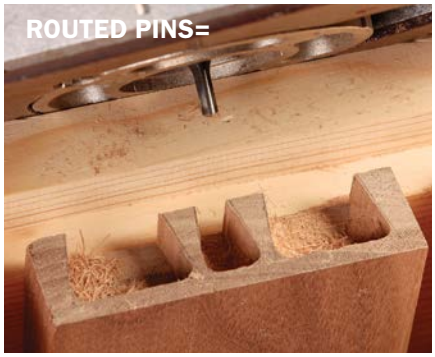
Half-Blind Dovetails in Half the Time

STEPHEN HAMMER

No joint says "handmade" more than half-blind dovetails with delicate pins, so I use them on drawers as one way to distinguish my furniture from the furniture churned out by factories. However, because traditional techniques for making dovetails rely heavily on hand tools, they can eat up a lot of shop time. Time is something a professional furniture maker can't waste, so I developed a method for cutting the joint with a bandsaw and a router. It gives me the best of both worlds. I get the refined look of a hand-cut joint, but I achieve it with the speed and consistency only power tools can offer.

BANDSAWN TAILS + ROUTED PINS = PERFECT FIT

Zip, zip. A simple jig delivers accurate and uniform tails every time. You also get narrow pins and variable spacing.



No wasted time. The router is much faster than a chisel and mallet, and it guarantees uniform depth.

Clean up and enjoy. After a few minutes of paring, the joint goes together without any trials or tribulations.

Dovetail layout is simple. Because you'll be using a bandsaw jig to cut the tails, you need to lay out the tails just once. Use a marking gauge to mark the length of the tails with a knife-type cutter. Scribe all four sides. Do this on all the drawer sides. By the way, Hammer turned his pin gauge into a knife gauge by filing a bevel on the pins.

Rabbet the sides for easy alignment. Use a dado blade to cut a shallow rabbet on the inside face of the drawer sides, right up to the scribe line. This will make it easy to align the parts when marking the drawer front later.

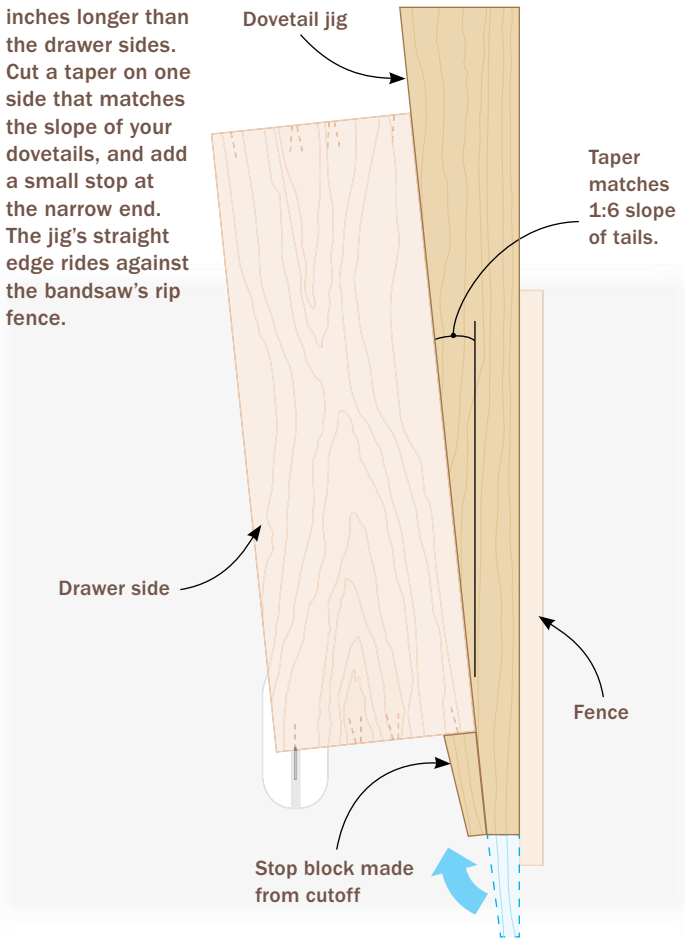
I start by cutting the tails at the bandsaw, using an incredibly simple jig—it's really just a tapered board with a stop—to hold the drawer side. It slides against the fence and lets me cut every tail quickly and with a consistent slope. Then I cut the pins with a handheld router and a straight bit, working freehand right up to the scribe lines. Only the corners of the pin sockets are left to clean up with a chisel, and fitting the joint takes

Now lay out the tails. Do it on one drawer side only. You'll use that piece to line up the cuts for all of the others.

Bandsaw the tails in minutes. You could cut the tails freehand at the bandsaw, but you'd have to lay out every workpiece and then risk straying from the line. Hammer uses a tapered jig that rides against the rip fence to ensure perfect cuts on stacks of drawer sides. Taper the jig to match the tails. It should be several inches longer than the drawer sides.

Jig Is Just a Wedge and a Stop

Joint and plane a board that's several inches longer than the drawer sides. Cut a taper on one side that matches the slope of your dovetails, and add a small stop at the narrow end. The jig's straight edge rides against the bandsaw's rip fence.



only a bit of paring. Even if you're not as worried about time as I am, you'll enjoy perfect joints with very little fuss.

Cut tails with a bandsaw, not a backsaw

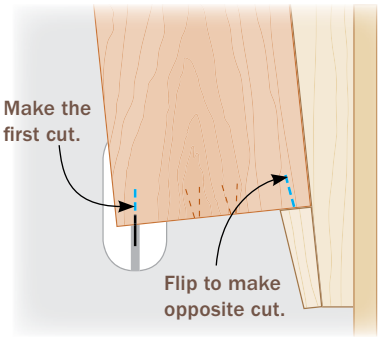
First, use a marking gauge to scribe shoulders on all four sides. I use a "cutting gauge" with a sharp knife because a cut shoulder line is one of the telltale signs of hand-cut dovetails. It also is more precise than a pencil line and serves as a guide for your chisel when you're paring down to the line.

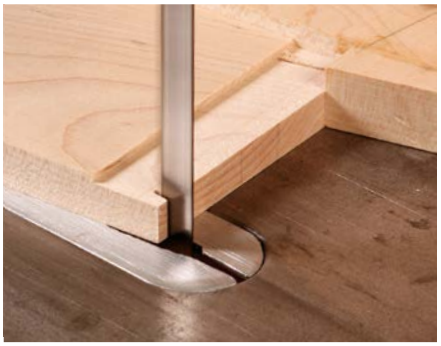
Then cut a shallow rabbet, about 1/16 in. deep, across the inside faces of the sides, under the tails. I use a dado set in my tablesaw, setting the fence so that it cuts right up to, but not past, the shoulder line. There are three reasons for the rabbet. First, a clean shoulder on the inside contributes to the overall attractiveness of the joint. Second, the rabbet's shoulder helps to align the side to the front when you transfer the tails. Finally, the shoulder also can be used as a chisel guide when you're paring away the last bit of waste between the tails.

Joint the taper for a clean edge. It's fast and accurate. You also could use a handplane.

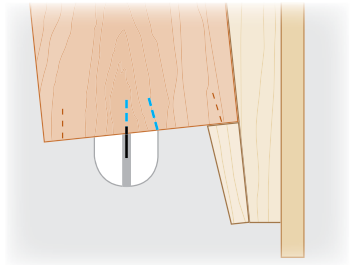
Glue on a stop. Put it at the narrow end, which leads into the blade, so that the jig can handle drawer sides of any length.

Put the jig to work. You need to reposition the bandsaw fence only three times to make all six cuts—on both ends of the drawer side, if desired.

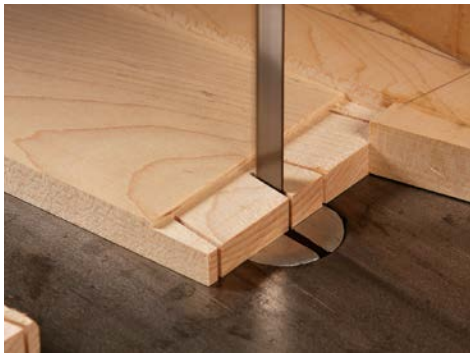


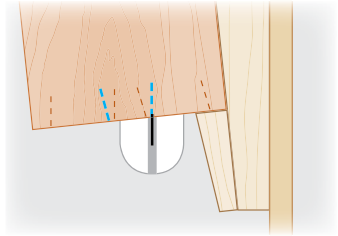


First position. Set the fence and cut down to the shoulder. Flip the board for a second cut. And make the same cuts on your other drawer sides before moving the rip fence for the next cut.



Move the fence. Cut one side of the center tail and then flip the board for the second cut.





Final cuts. Move the rip fence one more time for the last tail cuts.

Next, lay out the spacing for the tails—you only need to do this on one of the sides. The tail cuts are made using a jig that's guided by a fence. Use the marked board to set the fence, and all the other unmarked boards can be cut using the same settings.

The jig that holds and guides the drawer sides is nothing more than a piece of wood that is straight on one side and tapered on the other side to match the slope of the tails. Make sure it is sturdy enough to be used over and over again. I use a 1:6 slope for my tails,

Clean out the waste with a coping saw. There really is no faster way to get the job done (left). Leave just about 1/16 in. for paring. Pare from both sides, starting on the outside face. On the inside face, you can use the rabbet's shoulder to guide the chisel (above).

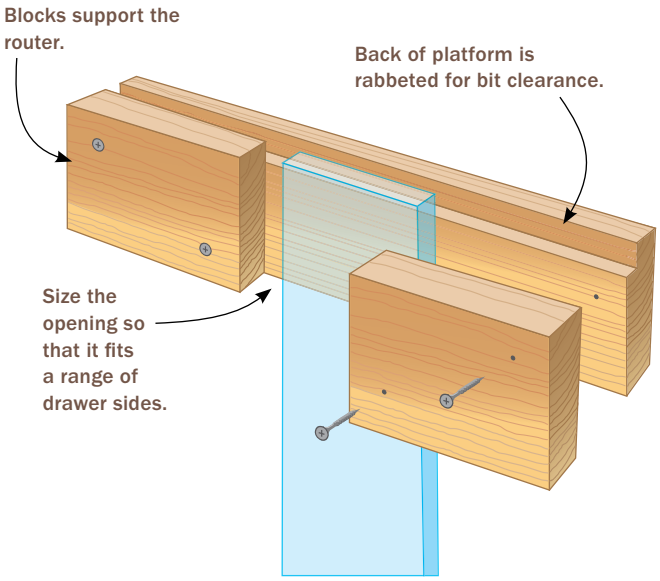
which gives them a traditional look. Lay out the taper on a board at least 2 in. or 3 in. longer than the drawer sides and then cut it at the bandsaw. Clean it up on the jointer or with a handplane, then glue on a stop at the narrow end of the board.

Before using the jig, adjust the bandsaw's fence to compensate for the blade's drift. Place the jig against the fence and put the marked drawer side in place, making sure that it is against the stop. Set the fence so that the bandsaw blade lines up with the first tail cut from the edge of the drawer side. You'll make two cuts with the fence in this position, one on each side of the drawer side. Make the first cut, pushing the jig and side together. Then flip over the drawer side and make the first cut in from its other edge.

Transfer the tails. Hammer clamps the drawer front in a vise and pushes the rabbeted underside against it. The side doesn't move and the transfer is dead accurate (above). Mark the length, too. Taking it directly from the drawer side (right) is more accurate and easier than using a marking gauge.

Make a Platform for Routing

There is no way you could balance a router on the end grain of a board and rout accurately. Make this three-sided jig and clamp it to the drawer front to create a large surface for the router to ride on. The back rabbet prevents you from routing into the jig as you move from socket to socket.



Router jig is easy to set up. Use your benchtop to bring the top of the jig level with the drawer front. Then clamp it in place.

Now make the same two cuts on the drawer's other side.

If you are doing multiple drawers, make the tail cuts on every drawer side before adjusting the fence for the next cut. Put the marked drawer side in the jig so that you can see your layout lines, adjust the fence, and make the first cut on the next tail in. Flip the board and make the next cut. Continue to adjust the fence and make cuts. At first, you're cutting one side of the tails, but when you pass the middle you begin to cut the other side of the tails.

After all of the tails are cut, remove the waste between them with a coping saw, leaving about 1/16 in. of waste above the shoulder line. Use a chisel to pare it away. Pare first from the outside, starting in the

Set the plunge depth. After zeroing out the bit, place a tail between the stop and the turret on the base for an accurate setting.

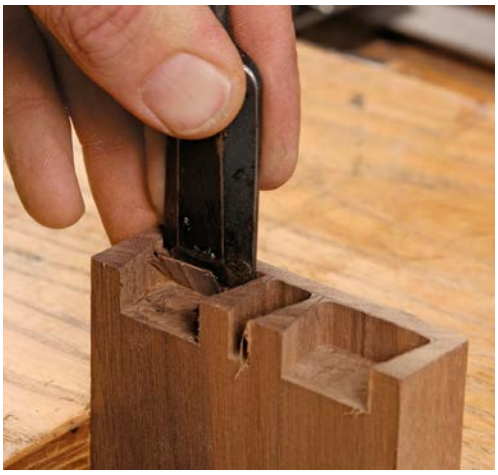
scribed shoulder line and chopping straight down. Don't worry, there isn't enough waste to force the chisel into the shoulder. Stop before you go all the way through, and finish the job by paring from the other side, using the shoulder of the rabbet as a guide.

With the waste removed, transfer the tails to the drawer front. I use a marking knife because it's more accurate than a pencil, but I darken the lines with a pencil to make them easier to see. Next, use a marking gauge to mark the depth of the pins on the inside face of the front. Set the gauge directly from the thickness of your tails.

For pins, a router is mightier than the chisel

After you're done laying out the pins, you are ready to rout away the waste between them, using a ¼-in.-dia. straight bit. Make sure the bit is sharp; it will be easier to control. To improve the router's stability as I rout the pins, I clamp a simple jig to the drawer front and then clamp the jig into my shoulder vise. Set the bit depth so that it reaches the shoulder line you marked with the gauge earlier. Rout the first socket, cutting as close

Rout freehand. The jig offers enough surface area to keep the router stable. Shine some light into the work area to improve visibility (top). After a bit of practice, Hammer discovered that he could rout right up to the layout lines without any trouble (above). It helps that long grain is easy to rout.



Tips for clean paring. Pare down the back first (above left). It's easier to get a straight cut with the workpiece and chisel vertical than with the workpiece horizontal on the bench. On the pin walls, work across the grain (above right). Use a chisel wide enough to pare the entire wall in one pass.

Check the fit. The joint should come together without any trouble. But if it doesn't, pull it apart, pare carefully, and try again.

to the layout lines as possible. Rout the remaining sockets in the same manner.

After the waste has been removed, clean up the sockets with a chisel. Again, because there is so little waste left, you can place the chisel right on the shoulder and pare straight down. Test the joint's fit, paring the pins as needed (but that shouldn't be much) until it comes together.

Better Way to Attach Tabletops

ANDREW HUNTER

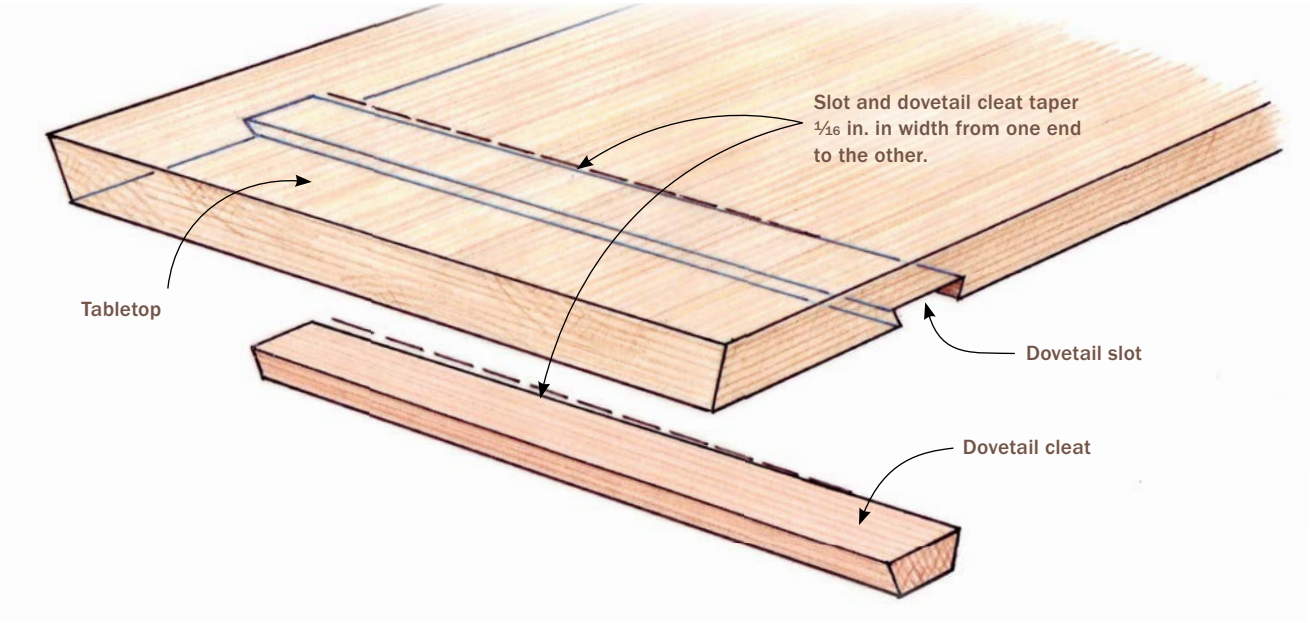
The sliding dovetail joint is not a modern invention. Examples are found in furniture dating back over 500 years, and I suspect the joint's origins go back into ancient history. But I use this joint to secure tabletops to their bases. The dovetailed cleats keep a solid-board top flat, and they also allow for expansion and contraction. And by leaving them exposed, I make them part of the design.

A taper along the length of the cleat and slot makes for a tight-fitting joint. The farther you slide the cleat into its slot, the tighter the joint. This taper eliminates the precision needed to fit a straight cleat and the need for glue. With no glue, you can remove the base

Flat cleat. Simply a board with beveled edges, this cleat is easier to make than the shouldered version, but can't be very tall. It works well with a base that has four legs.

Taper the Dovetail for Easy Assembly

With the table base attached to the cleats, assembly would be devilish if the cleats and slot were not tapered a bit. It's not hard to do. Most of the work is done with machines, and handwork brings the taper to a perfect fit.

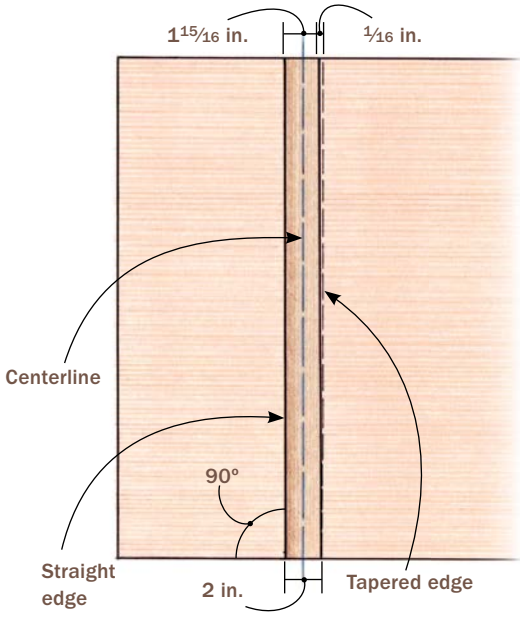


Shouldered cleat. A shouldered cleat can be much taller and narrower, so it can be profiled and used as the top member of a trestle-style base.

Start with the slot. For either type of cleat, rout the slot on the tabletop first.

Lay Out the Taper

Hunter begins by marking a centerline for each slot, and then lays out the sides, marking the 1/16-in. taper down the length of one side.



from the top if needed, and if the fit of the cleat loosens due to wood movement, you can tap it back home or remove and shim it if necessary. I've never had to do either because I start off with very dry wood and use quartersawn lumber for the cleat.

I prefer this joint to slotted screws or steel brackets. When you put so much time and care into the base and top, it makes sense to put that same care into joining the two, without relying on mechanical devices.

I use two types of tapered sliding dovetails to secure tabletops: shouldered and unshouldered, depending on the design. Most of the work for an unshouldered cleat is done on the tablesaw, and I make the shouldered cleats on the router table. The key to a tight-fitting joint is matching the taper of the cleat with the taper of the slot, then fine-tuning the fit with a handplane. For shouldered cleats, you typically would need a specialized dovetail plane to adjust the tapered shoulder directly, but I figured out

Clear the waste. Before routing the slot, take a few passes with a circular saw, set to depth, to make it easier for the router to go through the wood.

Straightedge keeps router in line. A solid-wood straightedge clamped to the tabletop guides a handheld router.

that a piece of wood taped to the edge of the cleat lets you use a router and then a bench plane instead.

Begin by gluing up the solid-wood tabletop, making sure it is straight and true. A sliding dovetail cleat can straighten a slight cup in a top, but correcting twist is difficult.

Cut the tapered slot

It's easiest to rout the tapered dovetail slot in the underside of the tabletop, and then create the cleat and tweak it to fit. For both shouldered and unshouldered joints, the slots are made with a handheld router and clamped straightedges. First, draw a centerline for each slot, making sure they are parallel to one another and square to the table edges. Then lay out the sides, marking the taper down the length of one edge.

Using a dovetail bit and a clamped straightedge, rout a test piece to determine the exact distance from the straightedge to the inside and outside edges of the slot. Transfer these measurements to the underside of the top, clamp the straightedge along those lines, and then rout.

Three passes to a clean slot. Hunter cuts one edge of the slot, resets the straightedge to waste away the center, and resets it again to cut the other edge.

How to make the cleats

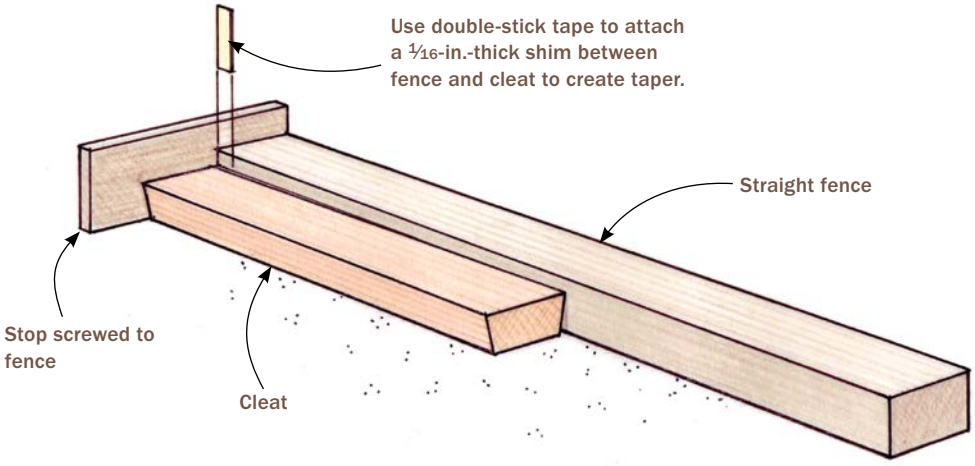
To make an unshouldered cleat, begin with stock 6 in. longer than the width of the tabletop. This extra length helps when fitting the cleat to the slot. Lay out the joint on the blank, centering it in its length. With the tablesaw blade tilted to match the angle of the dovetail slot, cut the straight edge of the cleat. Then, using a simple tapering jig (below), cut the tapered edge of the cleat to match the tapered edge of the slot. Handplane the taper to get an exact fit in the slot. After waxing, drive it home and mark and cut its finished length.

Unshouldered cleat is quick and easy. To make an unshouldered cleat, use the tablesaw to cut one untapered edge, and a jig on the tablesaw to cut the tapered edge. Then fine-tune the fit. Because the angled edge is wide and flat, it is easy to use a bench plane to tweak the taper to the perfect fit.

To make the shouldered dovetail cleat, begin as with an unshouldered cleat, with a blank longer than the table is wide. Now lay out the dovetail, centering it on the cleat and tapering one edge 1/16 in. over the same length as the slot. Cut the dovetail shoulders on the router table. For the straight shoulder, simply run that edge of the cleat along the fence, cutting to the layout line. To cut the tapered shoulder, handplane the desired taper onto a long stick, and attach it to the edge of the cleat. Run this edge along the router-table fence. Creep up on the cleat's fit, testing it in

Tablesaw cuts both edges of cleat. Cut the straight side of the cleat on the tablesaw with the blade tilted (above). Then use a simple L-shaped jig with a 1/16-in. shim between the jig and cleat to cut the tapered side of the cleat (right), and tweak the fit with a handplane.

Make a Tapering Jig for the Tablesaw



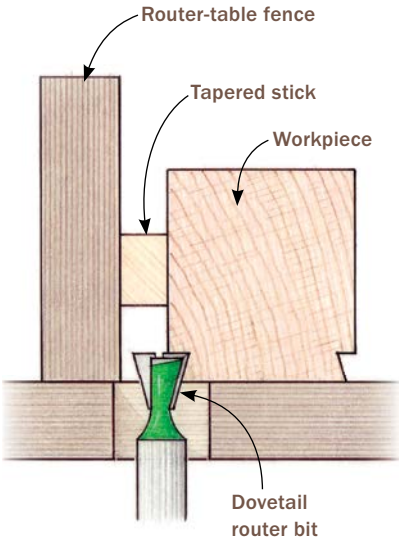
the slot as you go. The joint can be fine-tuned by handplaning the stick and rerouting until the tapers match exactly and the cleat can be driven to the far end of the tabletop. The extra length of the cleat comes in handy here. Now wax both the slot and the cleat and drive it home. Remove the tapered stick and cut the cleat to length.

Taper an auxiliary stick. Draw the 1/16-in. taper along the side faces of a 3/4-in.-square stick and simply handplane to the lines.

Rout the shouldered cleat. The shouldered cleat uses the same concept as the unshouldered cleat, but the dovetail is best made at the router table, with a simple stick attached to create just the right taper. Start by routing the straight side of the dovetail.

Attach the tapered stick to the cleat. Use double-sided tape to ensure it stays attached to the cleat during routing.

Rout the Dovetail



Run the tapered stick against the router-table fence. This automatically builds the taper into the dovetail shoulder on the cleat.

Test-fit the cleat in the slot. You can check the accuracy of the taper by inserting the cleat and lifting the front and back. If either pulls away from the top, it is loose in that spot. Plane a shaving off the stick in the tighter area and rerout.

Perfect Dovetails on a Curve

BRIAN ROY

Most woodworkers have cut dovetails to join two straight boards. Some have even used the joint to bring together a curved drawer front and a straight side. But confronted with two parts that are curved across their width—perhaps for the sides of a jewelry box—many would hesitate.

Because both parts are curved across their width, the ends are also curved. So, there are no straight edges for your square and bevel gauge to register against, which makes layout very difficult. There's also no obvious way to clamp the bowed parts securely when you saw and chop the dovetails. And how do you keep the shoulders properly curved while cleaning out waste?

The answer is a pair of hardwood blocks that sandwich the workpiece. Each block has a straight edge that lets you lay out the dovetails. Nested around the workpiece, they can be clamped in a vise, so you can saw the pins and tails. Also, they can be used as a chisel guide when you're cleaning out the waste. I'll show you how to make and use the blocks, including some tips on laying out and cutting dovetails on curved parts.

Make the blocks

The blocks are used in pairs. One goes on the inside curve of the workpiece and has a convex face and edge to match its curved face and end. The other goes on the outside and has one convex side and one concave side.

To make the blocks, you need two templates (p. 195), made from ½-in.-thick MDF. For an asymmetrical curve like the one shown, I rough-cut the curve at the bandsaw. Then I clean up and fair the curve with sandpaper attached to a flexible caul made from a

Curved Blocks Are the Key

A pair of these blocks gives you a straight edge for layout and clamping, and a curved one that helps you chop perfect shoulders.

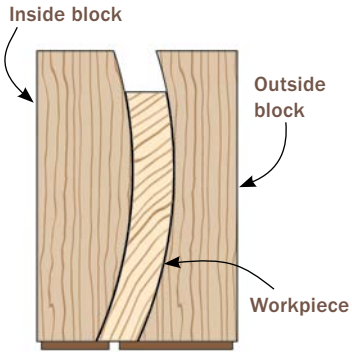
LAYOUT

CLAMPING

CHOPPING

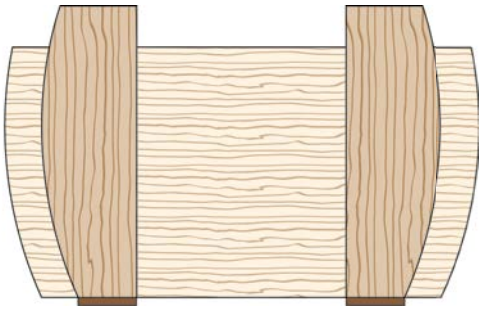
Start By Making the Blocks

Because the sides of this box have an irregular curve, you can't just flip one pair of blocks over and use it at the other end. So, you'll need a second pair that is a mirror image of the first pair. For sides with a regular curve, one pair is all you need.



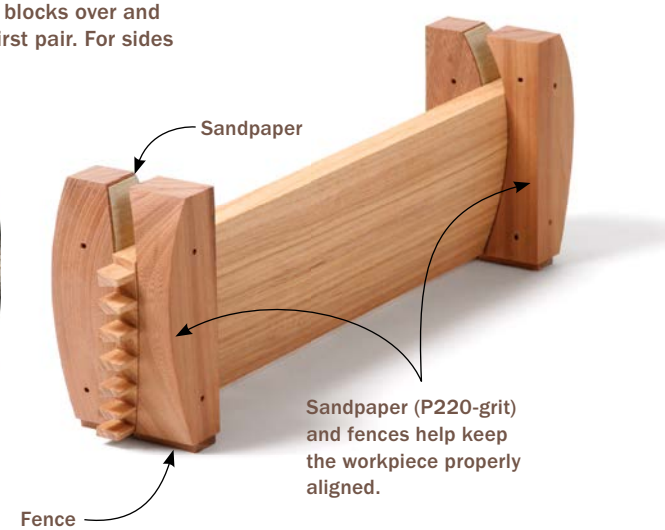
END VIEW

The mating faces of the blocks match the profile of the workpiece.



SIDE VIEW

The outside faces of the blocks match the ends of the workpiece.



Use a pair of templates to make the blocks. Templates ensure that all of the convex curves—and the concave ones—are identical. Cut the curves at the bandsaw and then sand them fair, backing up the sandpaper with posterboard so that it skims over the low spots while knocking down the high ones. The curves need to nest together tightly.

One fence for both templates. The fence sits in a number of grooves on both sides of the templates, to keep the blocks in the same orientation.

Use the template to lay out the curve. With the blank pressed against the fence, trace the curve onto it.

Bandsaw the curve. Leave about 1/32 in. of waste to remove at the router table. Before you do that, tape the offcut back on and then trace the second curve and cut it.

Rout flush. If your bit isn't long enough to trim the entire block, use a block plane to remove the remaining waste. Then flip the block onto the opposite template to rout the concave face.

Shape the workpiece. Shape the end grain first, when the blank is still straight and square. Then you can register the curved side of the block against the curved end grain, making it easier to lay out the side's shape. While the workpiece is still square, as shown, use the template's fence for alignment. It registers against the bottom edge, so the same section of curve is used for all eight ends. Lay out the curve and then cut it.

Block for the curved faces. A fence on the block aligns it with the bottom edge (above left). The shim under the block is the same thickness as the workpiece's final thickness. Remove the shim to trace the inside face (above right).

Rough out the inside curve first. Make a series of ripcuts. Keep the blade square to the table and adjust its height so that each cut is just shy of the layout line.

Clean it up with a plane. You'll need one with a radiused bottom tighter than the tightest part of the curve. Roy made his, but you can buy new and used "round" molding planes from a variety of sources.

Mark the curved baseline. The fence on the block is too small to keep the block square and steady, so make a long plywood square to do the job.

Resting place for the bevel gauge. The second pair of blocks holds up the other end of the workpiece.

Extend the pin lines. With the square against the block's straight side, extend the pin lines so they are parallel to the length of the sides.

few pieces of stacked posterboard. For symmetrical curves, I cut the templates with a router and a circle-cutting jig.

After the templates are made, make the blocks. Trace the template's curve onto the hardwood blank and rough it out at the bandsaw. Then trace and cut out the curve on the adjoining face (you may need to tape on the offcut to do so). To clean up the bandsaw cuts, screw the blank to the template and rout it flush.

Lay out and cut the dovetails

After the blocks are made, you're ready to lay out the dovetails. Of course, first you need to make the sides. On a small box like this one, I start with thick sides and use the template and blocks to lay out the shaped ends and faces.

The dovetailing is no different from what you'd do to join two straight boards: Lay

Cradle for clamping. Nestled between the two blocks, the workpiece won't flex under the vise's pressure, and you'll get a more secure grip.

Curved chisel guide. Aligned with the baseline, the block keeps your chisel perfectly plumb and prevents it from cutting beneath the baseline.

out the baseline and pins (or do tails first), cut the pins and chop out the waste, then transfer the pins to the tail board.

Of course, you do have to compensate for the curved parts. The blocks take care of that. One rests on the outside face and allows you to draw a baseline. Then sandwich the side between the pair and lay out the pins.

To cut the pins, cradle the side between the blocks and clamp it in a vise. The pins can be sawn like those on any other board. Chopping out the waste is a snap, too. Just align the block with the baseline and use it as a chisel guide. Finally, clamp the block to the baseline on the tail board, stand the pin board against it, and transfer the pins' location. Use the blocks to clamp the tail board for sawing and chopping out the waste.

Transfer the pins. Align one block with the baseline and hold the pin board against it. The lower block cradles the bottom of the workpiece.

Easier Joinery for Curved Drawer Fronts

ALAN TURNER

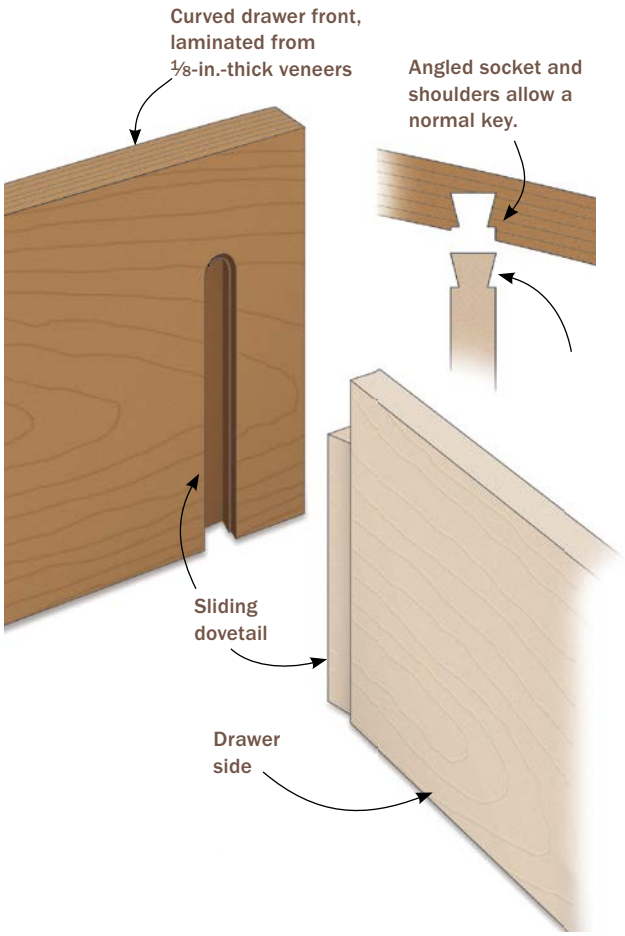
My colleague at the Philadelphia Furniture Workshop, Mario Rodriguez, recently designed this three-drawer bowfront dresser and handed it off to me, the resident jigmeister, to figure out an efficient way to build it. The key questions I faced were how to produce the curved drawer fronts and how to join them to the drawer sides.

I considered steam-bending the drawer fronts, but I thought I wouldn't get consistent enough curves. I could have bandsawn the fronts out of solid wood, but that would have wasted material and created an unappealing grain pattern. I decided on bent lamination, which conserves wood, has minimal springback, and affords complete control of the grain. I decided to join the drawer sides to the fronts with sliding dovetails, the strongest method of attaching overlay drawer fronts.

To produce predictable curves and accurate joinery, I built a series of jigs to speed up and simplify the building process. I made a two-part bending form, a cradle for crosscutting the curved drawer fronts, a jig for routing the stopped dovetail sockets, and a curved fence for the router table that enabled me to cut the slot for the drawer bottom on the concave inner face of the drawer fronts.

Puff out your chest. Gently bowed overlay drawer fronts give the chest a clean, elegant appearance. The overlay also allows the sliding dovetails this article relies on.

New Angle on a Sliding Dovetail



Master patterns are the starting point

I built all these jigs using convex and concave ribs. The MDF ribs are easy to produce on the router table using male and female pattern-routing jigs.

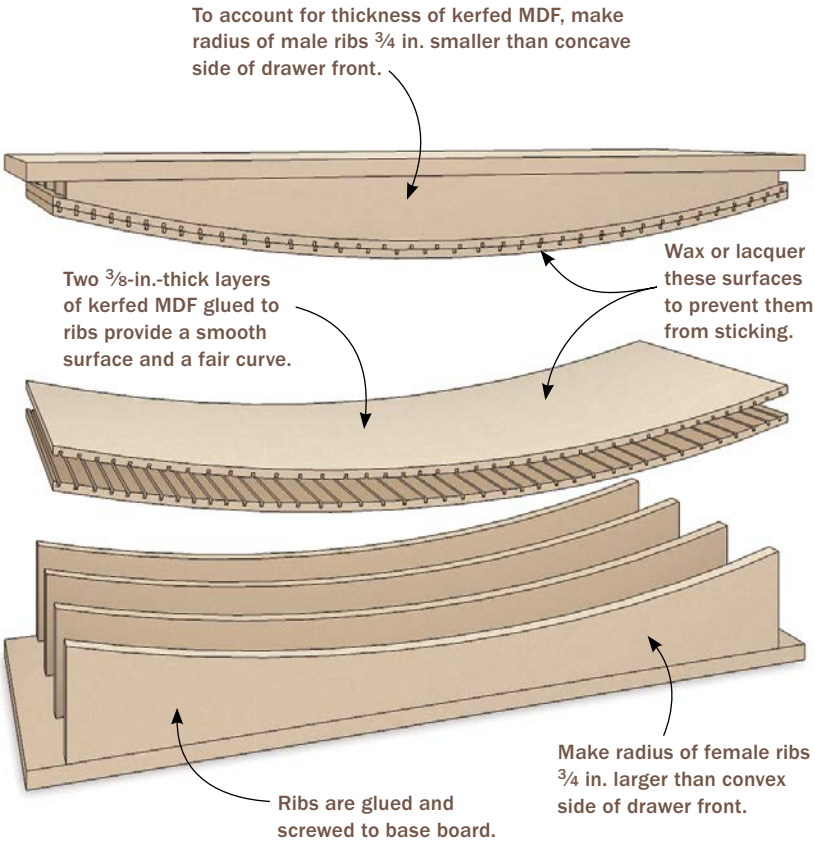
These master routing patterns are the key to the whole chest. I generated the curves with an adjustable trammel arm and a router. I drilled right into our wooden floor to set the trammel pin, and then I screwed a fence into the floor perpendicular to the trammel arm. To ensure that it was exactly 90° to the arm, I measured carefully to make the two ends of the fence equidistant from the trammel pin. After routing a ½-in.-deep groove with a ⅜-in.-dia. bit, I bandsawed through the waste and then cleaned up with a router and a flush-trimming bit.

I used one pair of patterns to generate all the ribs for the various jigs and I had no problems as a result. If I were making the chest again, however, I think I would take the mathematically precise route and make a separate set of patterns to produce the ribs for the bending jig, so that I could account for the thickness of the layers of kerfed MDF in that jig.

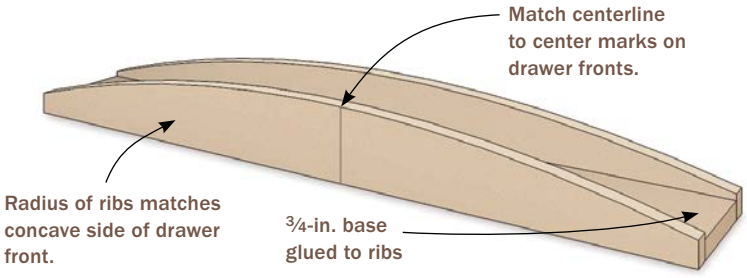
Trammel cuts the master curve. Turner uses a router on an adjustable trammel to produce male and female curved templates. He routs a curved groove ½ in. deep, then bandsaws through the waste and trims it flush with a router.

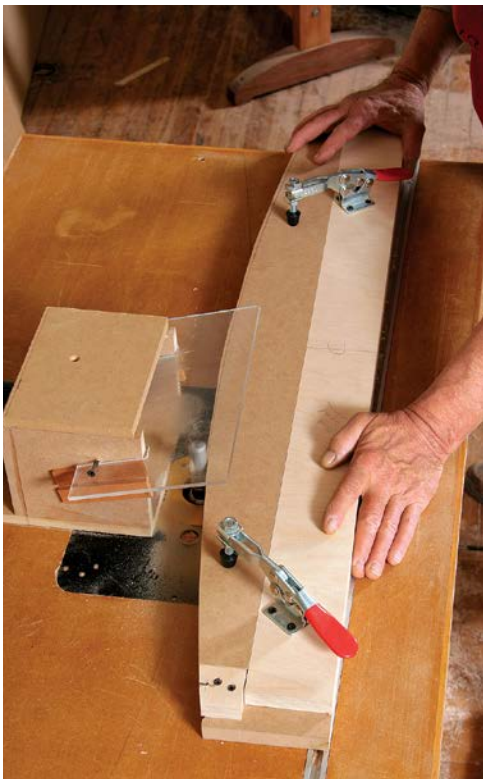
Two Bending Forms

Mating male and female forms create the bent-laminated drawer fronts. Make them several inches longer than the drawer fronts. If you have a vacuum press, you need only the male form. All parts are MDF.



CROSSCUT CRADLE





Make ribs at the router table. After bandsawing the ribs to rough shape, use the trammel-cut master templates to pattern-rout male and female ribs for the various cauls, jigs, and fences.

Create the curve. After rolling Unibond 800 urea resin glue onto the stack of ⅛-in.-thick laminates, Turner binds the ends in stretch-wrap to keep them registered. Then he clamps the stack between forms and lets the glue cure overnight.

Cut it to length. Mark the centerline on the drawer front and align it with the center mark on the cradle.

Bent-lam basics

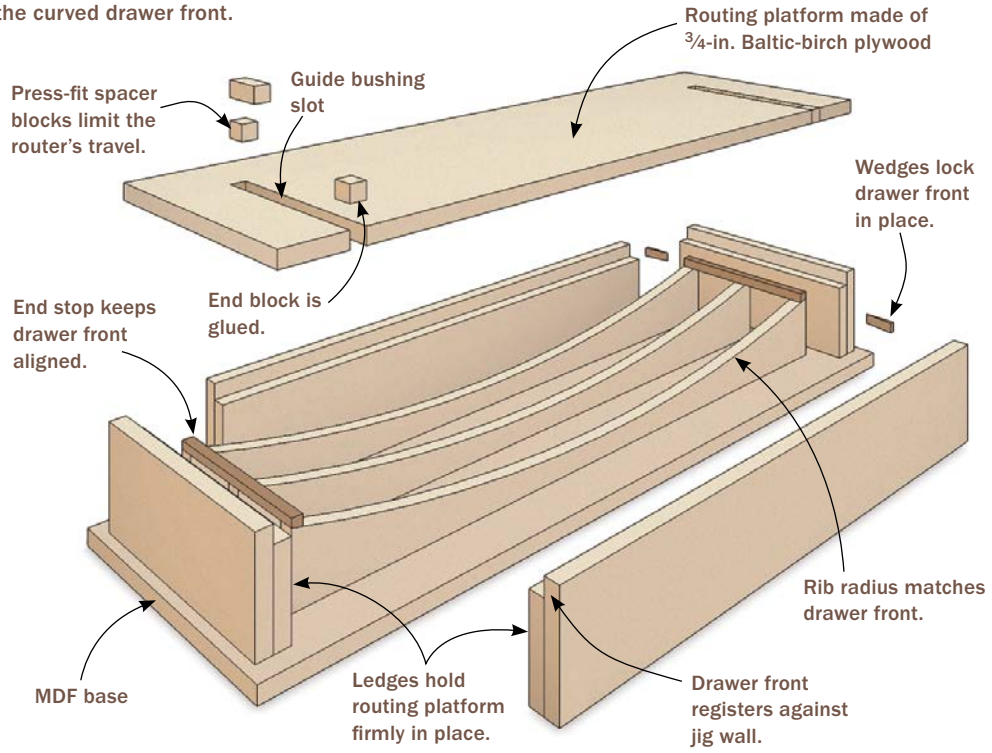
To make the bent-laminated drawer fronts, resaw a plank into slices slightly more than ⅛ in. thick and then use a planer or thickness sander to bring them down to ⅛ in. Each drawer front is a sandwich of six slices. When you glue up the bent lamination, you can add a sheet of commercial veneer as the show surface. Slip-match the show veneers so that the grain pattern is consistent from drawer to drawer. After gluing them up and letting them cure overnight, joint one edge, rip the pieces to width, and then crosscut them to length.

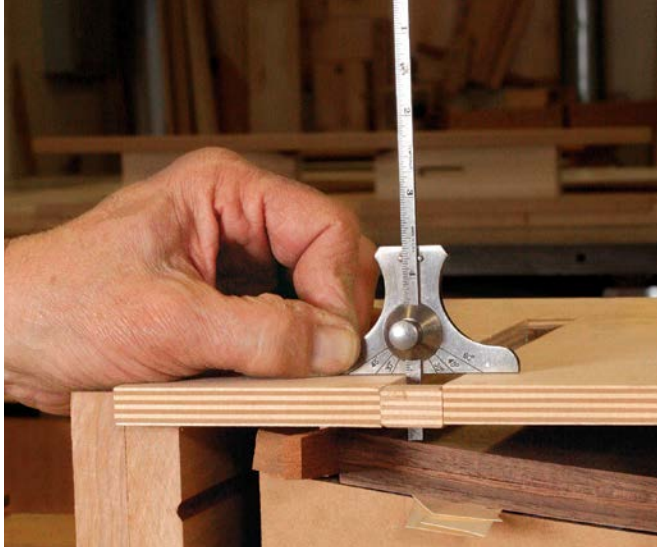
Perfect joint for curved drawer

Perhaps the trickiest part of this project was cutting the sliding-dovetail sockets

Jig Levels the Curve

This router jig helps you cut straight sockets in the curved drawer front.





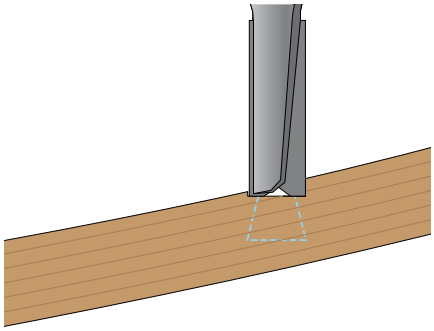
Precise height is key. Due to springback, no two bent-laminated drawer fronts are exactly the same. Use paper or card-stock shims to level the drawer fronts.

in the drawer fronts. The router jig I built, however, let me cut the dovetail sockets and shoulders as if the drawer front were flat. And that allowed me to cut the dovetail keys on the drawer sides just as I would if they were joining flat stock. The router jig takes most of the guesswork out of the process, but because there is some minor springback even with bent-lamination, the drawer fronts may not be perfectly consistent curves. Once the drawer front is in the routing jig, it's important to ensure that the four corners

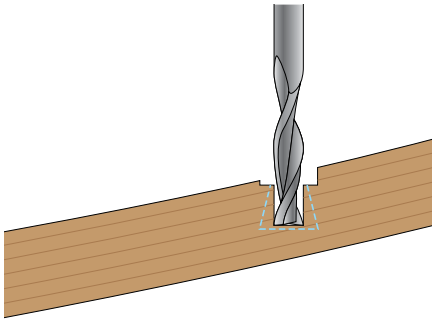
Spacers control the length. Graduated drawers require different-length sockets. Use press-fit spacers to control the router's travel.

Multiple passes. To cut the joints from start to finish without disturbing the drawer front, Turner sets up three routers with different bits. If you don't have extra routers, change bits between cuts and use test cuts in a sample board to reliably reset the depth of cut.

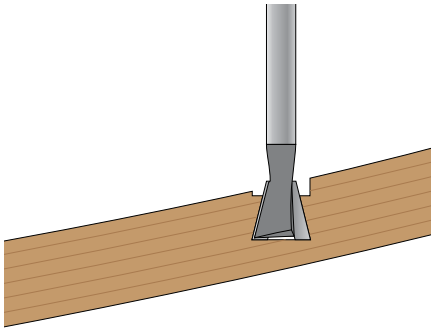
Rout in Three Steps



1. 12 mm straight bit establishes the shoulder.



2. ¼-in. up-cutting spiral bit roughs out dovetail in a single pass.



3. 10°, ½-in.-dia. Whiteside Machine® dovetail bit finishes the joint.

Scribe the angled shoulder. After cutting normal dovetail keys on the drawer sides using a router table, insert the key into the socket and transfer the drawer-front angle onto the drawer side. Turner uses a flat-sided marking knife for an accurate transfer.

of the drawer front are equidistant from the routing surface. I used a Starrett® depth gauge to check this and paper or card stock shims to adjust for any disparities.

Getting the glue-up right

The final step is gluing up the drawers so that when the glue dries, they fit the openings. To assemble the sliding dovetails when glue is applied to both the male and female parts of the joint, the joint must be a bit looser than might at first seem appropriate. Too tight, and it's difficult to get the parts together. But with the dry joint a bit loose,

Notch the top end. Use a backsaw and then a chisel (above left) to cut away ¾ in. or so at the top end of the dovetail, creating an angled surface that mates with the slightly curved inside face of the drawer front (above right).

Curved fence for a curved groove. To rout the stopped groove in the drawer front that will accept the drawer bottom, use a slot-cutter in the router table. To support the piece, make a fence from male ribs cut to the same radius as the concave side of the drawer front.

how do you assure that the glued up drawer will still fit the carcase?

The solution is to use the carcase as a gluing form. Use packing tape inside the carcase so the drawer is not permanently glued in place, and use shims and wedges to get a precise fit, so that the ends of the drawer meet up exactly with the outside of the case. There could not be a better gluing form, and no extra work is required.

A coat of shellac and a bit of wax, and these drawers will perform flawlessly.

Miter Your Dovetails

JOSH METCALF

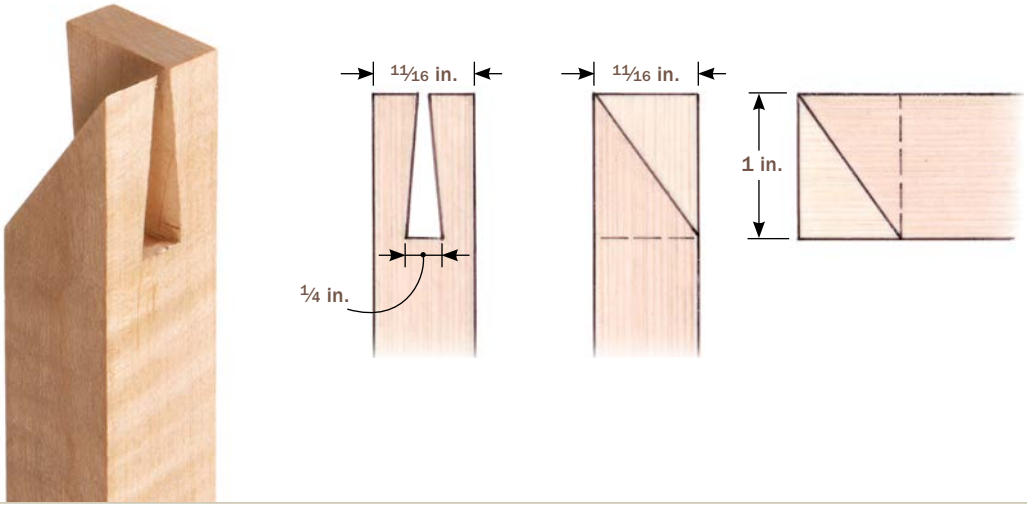
Among my favorite things about making this small dresser mirror is the joinery—two different combinations of dovetails and miters that are strong, look great, and allow me to cut molded profiles on the edges and faces of the piece.

On the case, the lap of the half-blind dovetails enables me to cut a continuous ovolo edge detail around the top. The miter

It works on frames . . . The interlocking nature of a dovetail adds strength to the miter. The square shoulders of the half-lap make it easy to square the frame and prevent the miters from slipping during glue-up.

. . . and cases. Like the frame version, the mitered front on the half-blind dovetailed case sides lets Metcalf cut a continuous decorative profile on the case front and along the edges.

The Frame Version



Layout Is Critical

Start with the miter. Use a marking gauge to scribe the width of each piece onto both edges of its mate. Then use a bevel gauge to lay out the angles on the front faces.

Mark out the socket. Use the bevel gauge to mark the angled socket cheeks on the edge of the piece. For the pin, the straight lines are on the edge and the angles go on the end grain.

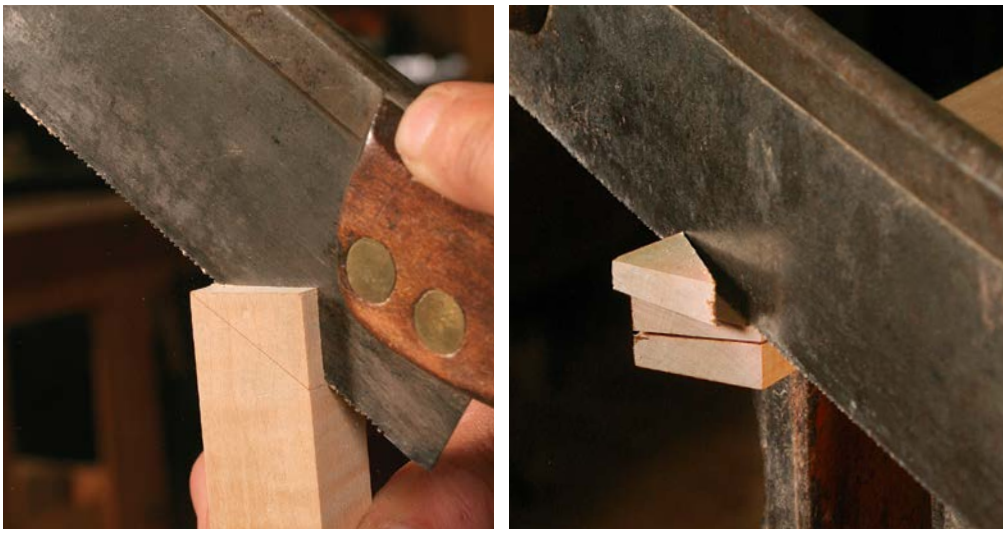
Bevel gauge alternative. For easier layout on narrow stock, Metcalf made an adjustable jig by fitting Plexiglas® into a kerf in a hardwood block and adding screws. A cleat on the end helps locate the jig.

at the front of the joint also lets me cut a molded profile on the front of the case.

I wanted the same molding details on the edge and face of the mirror frame, and I wanted its joinery to visually echo the dovetails on the case. The joint I use—a dovetailed through-tenon with a miter in front and a half-lap in back—is challenging but fun to execute, and the results speak for themselves.

The frame version

This joint can be used in a variety of applications, such as mitered cabinet doors or picture frames. It works especially well for small frames that are too thin for a standard mortise and tenon. The joint has great mechanical strength and it clamps easily across the face to ensure the best bond. However, it's not an easy joint to cut. Visualizing it can be confusing, and the sawing and fitting must be accurate. Also, the dovetail layout is a little out of the ordinary. The dimensions of the joinery make it very awkward to transfer the layout from one workpiece to another,



Cut the dovetailed tenon. The front cheek is cut at an angle (above left) with the saw stopping just before the outside corner of the miter. The rear cheek is cut to the baseline. Clamp the stock horizontally to cut away the waste (above right). Cut on the waste side of the line and pare with a chisel.

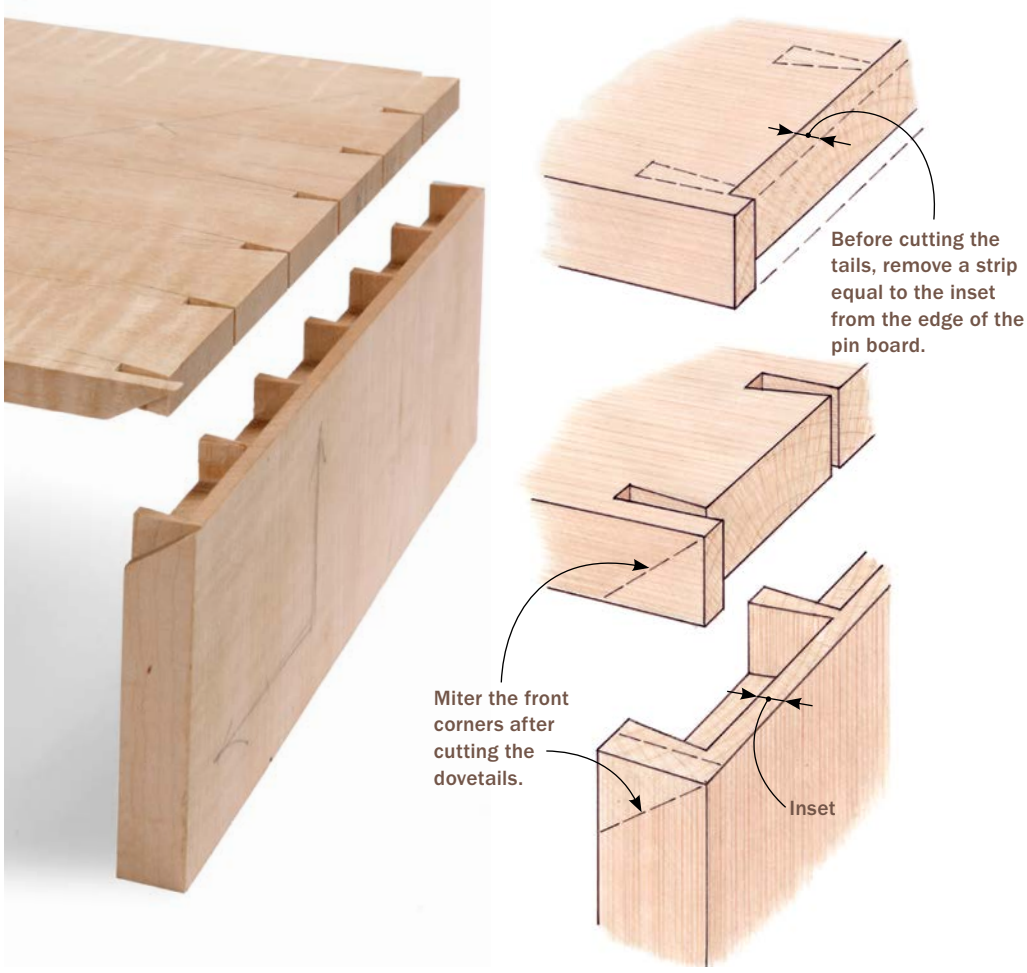
A single, long socket. A pair of angled cuts establishes the socket walls. Carefully saw to the waste sides of your marks (above left), and then use a bandsaw or coping saw to hog out the majority of the socket (above right). The remaining waste can then be cleared with a coping saw and chisel.

so I lay out the tail and socket separately using the same gauge settings for each. Still, with careful layout and saw work, the result is strong and pretty.

Add a miter to half-blind dovetails

The dovetails for the case are, for the most part, ordinary half-blinds. However, the mitered front complicates the layout and joinery slightly. To begin with, you'll need to dimension the top piece so that it is the full

Mitered Half-Blind Dovetails



Cut the tails. To start, trim the tail board. With a router and fence, remove the extra material (above left). Use a chisel to square up the tab (above right), which will form one half of the mitered front. Its rear face also captures the half-pin behind the miter.

length of the case, to allow for the miter at the front. And before laying out for the tails, you'll need to remove a narrow band of stock so that the tails will come up short of the end of the case.

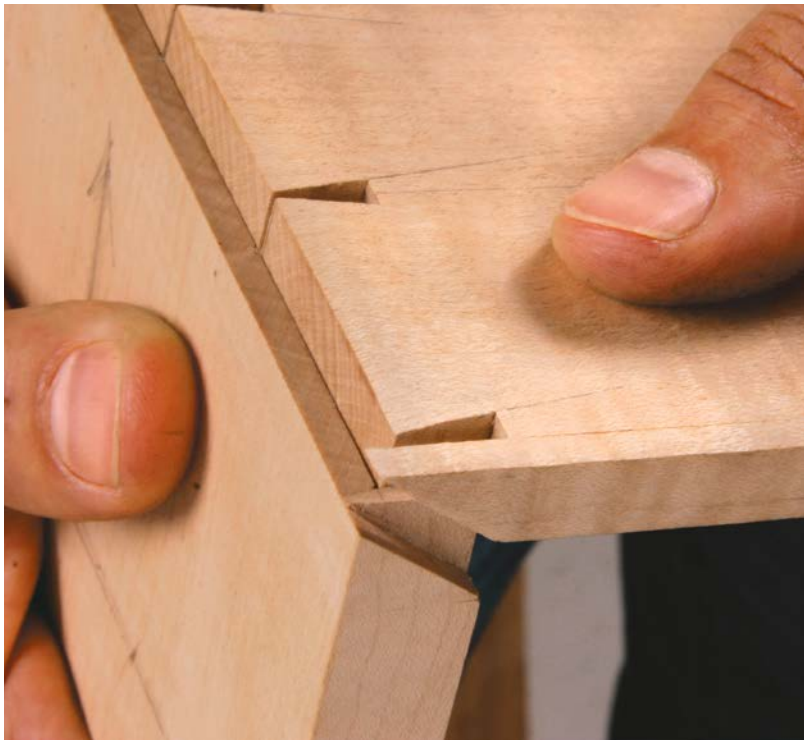
On this case, the top and sides were also of different thicknesses. This meant the miter wasn't 45°, requiring different bevel-gauge settings to create the mating angles.

Mark and cut the tails. Scribe a line for the tail length using a gauge setting picked up from the pin board. You can scribe the underside of the top all the way across, but scribe the show face only between your angled pencil lines. To pare the waste from the narrow sockets (left), Metcalf uses a chisel that he ground to 1/16 in. wide.

Transfer the layout and cut the pins. Scribe the socket shoulders with a knife (left), then flip the piece in the vise and mark the vertical portion of the pins with a pencil. After sawing to the lines and hogging away the waste with a router, Metcalf does a careful final cleanup with a chisel (above).

Mark out the miter for the top. Adjust the sliding bevel to the angle between the top's outside corner and the scribe line for the tails on the underside. Trim the miter. After sawing tight to the line with a fine saw, the paring required should be minimal.

Check the fit. If all is well, you should now be able to tap the top and sides together, and you should have a tight-fitting miter at the front.



Half-Blind Mitered Dovetails

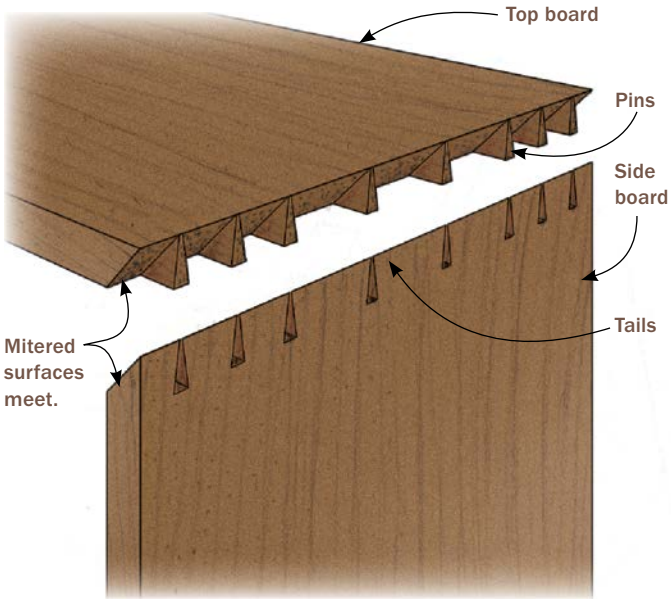
MICHAEL FORTUNE

When you use half-blind mitered dovetails to join a case piece or a table, you combine the visual effect of a miter joint—continuous grain wrapping around a corner—with the strength and classic appearance of dovetails. I used the joint on a sideboard, where I wanted a sleek, uninterrupted surface on top, but welcomed the visual punch of through-pins at the ends.

Typically, creating a perfectly true mitered shoulder surface between the pins is the most difficult aspect of making half-blind mitered dovetails. But I built a router jig that

A Look Inside

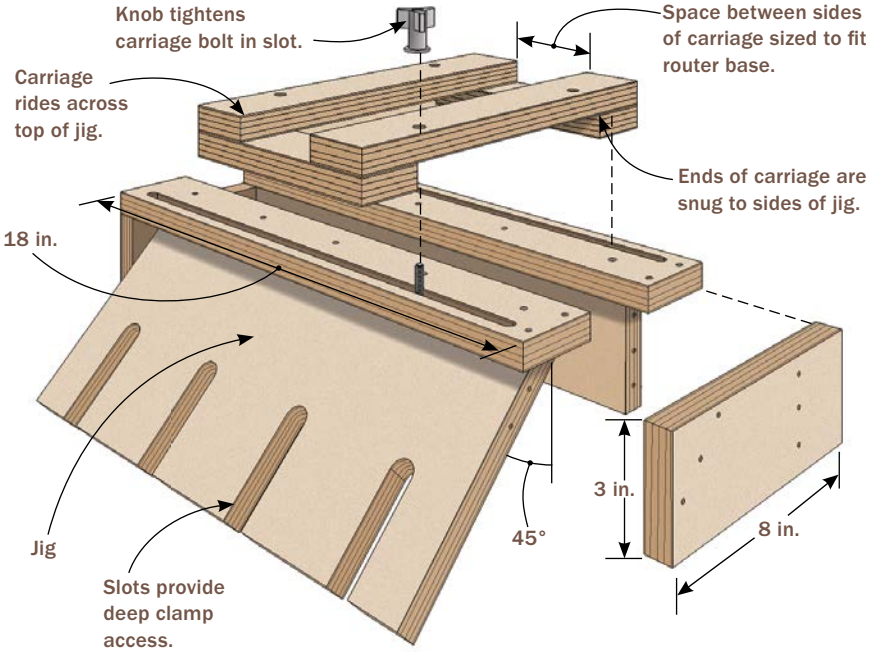
The tails of a half-blind mitered dovetail are cut as normal tails and mitered afterward. The trick to the joint is mitering between the pins.

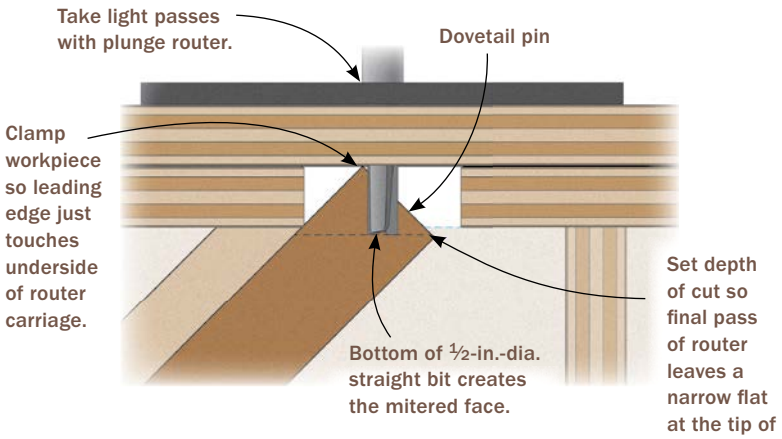


Mark the pins with a knife. Deep layout lines are essential to guide the routing. Don't lay out the miter so it comes to a complete point—leave a 1/32-in.-wide flat at the tip to allow for planing and sanding after assembly.

Hog out the waste. Lock down the carriage for each pass, staying clear of the knife lines. Cut to full depth with a series of light passes. Then creep up on the lines.

Shopmade Jig Guides the Routing

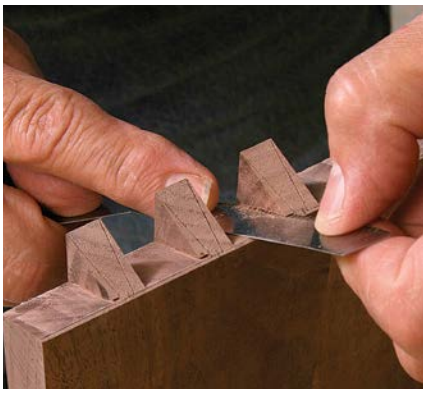




Straight bit leaves the cheeks square. The router establishes the mitered face of the joint but leaves the pin cheeks vertical—as if they were finger joints. The rest is done by hand.

makes the process very straightforward. It holds the workpiece at a 45° angle, and you simply rout with a straight bit between your layout lines. To avoid the look of template-cut dovetails, I cluster the pins at either side of the joint and use wider spacing in the middle.

With the routing completed, the cheeks of the pins are parallel. I angle them by hand. First, using a flush-cutting trim saw with its blade held flat on the mitered surface, I cut the shoulder kerfs. Then I chisel away the waste to finish the cheeks. Mark and cut the tails just as for normal through-dovetails.

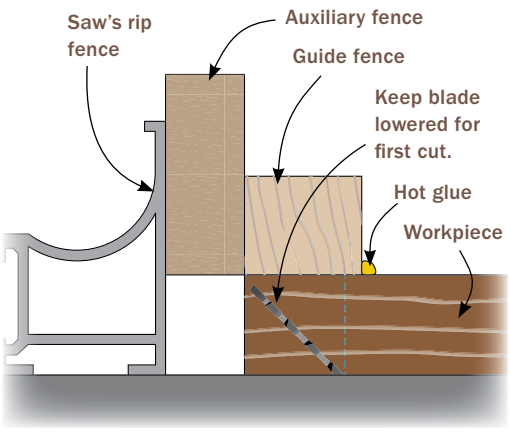


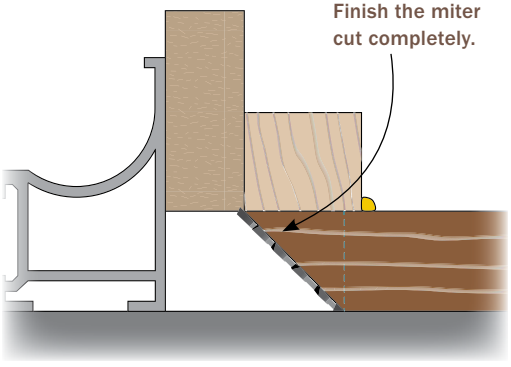
New dovetail tool: tin snips. To cut the angled shoulders of the pins, Fortune modifies a $17 flush-cutting trim saw so it can fit between closely set pairs of pins.

Tail boards start out square. After marking the tails from the pins (top), cut them as you would for ordinary through-dovetails. Fortune saws the cheeks and then pares the shoulders (above) with the aid of a guide block clamped to the workpiece. Sandpaper keeps the block from shifting.

Pare the angled cheeks. Follow the layout line down to the sawkerf to create the angled cheeks of the pins.

Two Cuts Make the Miter





First cut goes nearly through. A straight piece of scrap hot-glued to the workpiece rides against a raised auxiliary fence to guide the cut. To avoid trapping offcuts beneath the blade, make an initial pass with the blade slightly lowered.

Snap off the waste. After the first cut, remove the waste pieces, then raise the blade for the final pass.

Second pass completes the miter. With the majority of the waste removed, raise the blade and make the final trim cut.

I cut the cheeks with a bandsaw and finish the shoulders with a chisel. Only after the tails are cut does the tail board get mitered. I cut the miter on the tablesaw. To make the cut safe and accurate, I never run the mitered point against the fence. Instead, I guide the cut with a straightedge hot-glued to the workpiece and an auxiliary fence raised off the tablesaw bed.

Before assembly, I lightly chamfer the edges of the tails on the mitered face so the joint will go together more easily. And I apply glue only to the mitered faces and the pin sockets—the spaces between the tails—not to the pins themselves, which could swell and create a difficult glue-up.

How to clamp a half-blind miter. Triangular clamping blocks adhered with quick-setting cyanoacrylate glue provide the purchase for clamps on the tail board. On the pin board, where the joint is blind, a long triangular block glued to a scrap of plywood (with sandpaper adhered below) and clamped in place does the trick.

Clear the decks. After assembly, knock off most of each clamping block with a few quick strokes of a chisel. Finish the job with a handplane, being very careful of the mitered edge. Use sandpaper to produce the finished surface.

Contributors

Marc Adam's woodworking school in Franklin, Ind., is one of the largest in the world. Go to www.MarcAdams.com for a course listing.

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The articles in this book appeared in the following issues of *Fine Woodworking*:

pp. 4–11: Cut Precise Joints on the Tablesaw by Marc Adams, issue 235. Photos by Asa Christiana. Drawings by Kelly J. Dunton.

pp. 12–16: Fundamentals: Pocket-hole joinery is fast and strong by Mark Edmundson, issue 245. Photos by Mark Edmundson. Drawings by Kelly J. Dunton.

pp. 17–22: Fundamentals: Make strong, simple joints with dowels by Asa Christiana, issue 222. Photos by Steve Scott. Drawings by John Tetreault.

pp. 23–30: Fine Furniture with Biscuit Joints by Michael Fortune, issue 227. Photos by Matt Kenney, except for the photos p. 23 by Michael Fortune. Drawings by John Tetreault.

pp. 31–38: Double Bridle Joint by Ian Vincent Godfrey, issue 247. Photos by Steve Scott. Drawings by John Tetreault.

pp. 39–46: Joinery Shootout by Douglas Moore and Tom McKenna, issue 203. Photos by *Fine Woodworking* staff. Drawings by John Tetreault.

pp. 47–53: The Secret to Making Perfect Joints by Stuart Lipp, issue 193. Photos by Anissa Kapsales. Drawings by John Tetreault.

pp. 54–61: Fast Fixes for Joinery Mistakes compiled by *Fine Woodworking* staff, issue 233. Photos by *Fine Woodworking* staff. Drawings by John Tetreault.

pp. 62–68: The Miter Joint for Casework by David Hyatt, issue 190. Photos by Mark Schofield. Drawings by Kelly J. Dunton.

pp. 69–74: Precision Jig for Precise Joints by Toby Winteringham, issue 190. Photos by Mark Schofield. Drawings by John Hartman.

pp. 75–80: Master Class: Pinned miter combines strength and beauty by Russell Jensen, issue 200. Photos by Mark Schofield. Drawings by Kelly J. Dunton.

pp. 81–86: Master Class: Super-strong 3-way miter by Andrew Hunter, issue 227. Photos by Anissa Kapsales, except for the detail photos of joints by Kelly J. Dunton and the top photo p. 81 by John Waldie. Drawings by Kelly J. Dunton.

pp. 87–91: Cut a Mortise in Minutes by Christian Becksvoort, issue 200. Photos by Tom Begnal. Drawings by Christopher Mills.

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pp. 199–204: Master Class: Easier joinery for curved drawer fronts by Alan Turner, issue 233. Photos by Jonathan Binzen, except for the photos p. 199 by Mario Rodriguez. Drawings by Kelly J. Dunton.

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pp. 211–215: Master Class: Strong and handsome: half-blind mitered dovetails by Michael Fortune, issue 236. Photos by Jonathan Binzen. Drawings by Kelly J. Dunton.

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TOPICS COVERED

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- Fix common joinery mistakes
- Cut a mortise in minutes
- Create a versatile jig for miters
- Join curved parts with ease
- Build strong pocket-hole joints

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