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editor's letter

MAKING THE MOST OF THE MACHINERY

Power tools are both a blessing and a curse. When they're well-tuned and used with good fences and jigs, power tools let you cut and carve wood with incredible speed and precision. Even beginners can make shapes or create joints that require skill and practice to cut by hand.

But if you don't have the right setup or the tools haven't been properly tuned, they will seem to fight everything you want them to do. I know from experience how frustrating that can be.

It doesn't have to be that way. As Michael Fortune explains (p. 30), he set up the bandsaw in his shop a generation ago—and it hasn't needed any tweaking since, even though it's seen daily use. If you follow his advice, you too can have a bandsaw that will easily cut curves, rip thick boards, or produce veneer-thin sheets. Other articles in this collection from *Fine Woodworking* will help you get the most from the tablesaw, drill press, jointer, mortiser, scrollsaw, and router. These are easy-to-follow tips, designed to let you spend more time working with wood, less time playing mechanic.

We'll also help you refine your woodworking techniques. You'll learn how to make simple router jigs for cutting perfect mortise-and-tenon joints, shaping curves, even turning simple shapes without a lathe. You'll also learn how to use the tablesaw for cutting dadoes, grooves, rabbets, and raised panels.

Safety is an overriding concern. We've provided numerous tips that explain how to hold workpieces securely, how to keep your fingers safely away from moving blades, and how to prevent a piece of wood from kicking back at you with potentially lethal force.

Even though we used "basics" in the title, this magazine isn't just for beginners. Experienced woodworkers will find plenty of useful information here, too.

—David Heim
Power Tool Basics editor

Fine WoodWorking

Power Tool Basics

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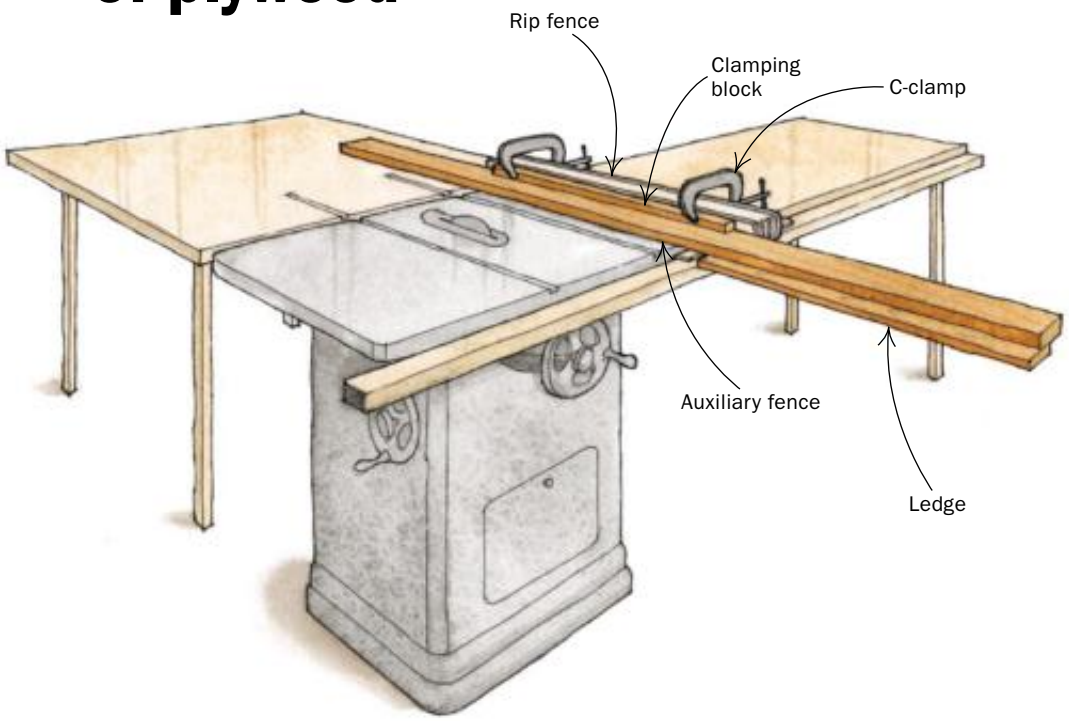
quick tips

EDITED AND DRAWN BY JIM RICHEY

Tablesaw fence extension supports a full sheet of plywood



On most tablesaws, cutting a 4x8 sheet of plywood is, at best, a dicey proposition. The sheet is heavy, the rip fence is too short, and, at the beginning of the cut, most of the sheet hangs unsupported in front of the saw.

As a solution, I added a rip-fence extension to my tablesaw. It helps support the right side of the plywood when it's overhanging the front of the saw table.

The extension has just three parts: an auxiliary fence, a ledge, and a clamping block. The auxiliary fence serves as a substitute for the rip fence, extending forward to provide a longer, more positive reference for the right edge of the plywood. The ledge provides vertical support for the overhanging plywood. And the clamping block provides a means to clamp the extension securely to the rip fence.

When cutting the auxiliary fence, make sure its two edges are straight and parallel. The clamping block and ledge attach to the auxiliary fence with glue and a few screws. To use it, clamp the auxiliary fence tightly to the rip fence. Establish the cut width by measuring the distance from the blade to the edge of the auxiliary fence, and lock the rip fence in place. Place the front of the plywood on the saw table, and keep the right-hand edge of the plywood against the auxiliary fence during the cut.

—PHILIP A. HOUCK, Boston, Mass.

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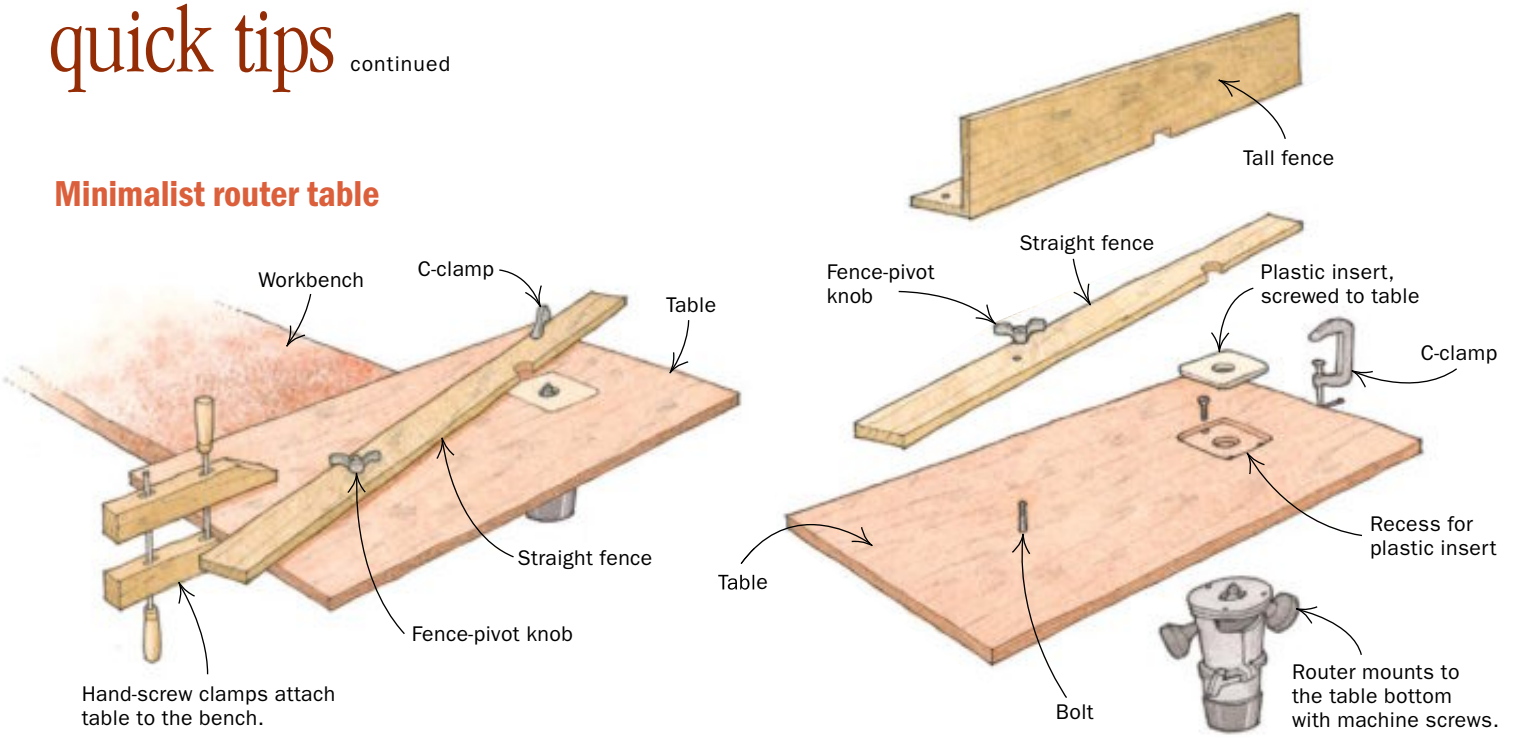
Minimalist router table



This uncomplicated router table is at the other end of the scale from those ultimate router tables replete with bells and whistles. It is just a router mounted upside down on a piece of plywood. The simplicity of the design makes it far more flexible than most router tables. You can build it in about 20 minutes and add a simple fence in another 10. Additional fences are made easily for special purposes.

To make the table, start with a piece of ¾-in.-thick plywood about 2 ft. by 3 ft. Cut a hole in the center of the table. Make and install a plastic insert to fit around the bit. Make additional inserts as needed to provide a close fit around other bits in your collection. Also, to prevent the insert from lifting when the router runs, screw the insert to the table. Attach the router to the table by running machine screws through the recess for the insert.

The fence is simply a 1x4 that pivots on one end and is clamped on the other. A small movement at the clamp end provides very close and precise movement at the bit, allowing for adjustment in the thousandths of an inch. When the standard flat fence does not fit the application, I just make a new fence. I use a tall fence for making lock miters and making raised panels.

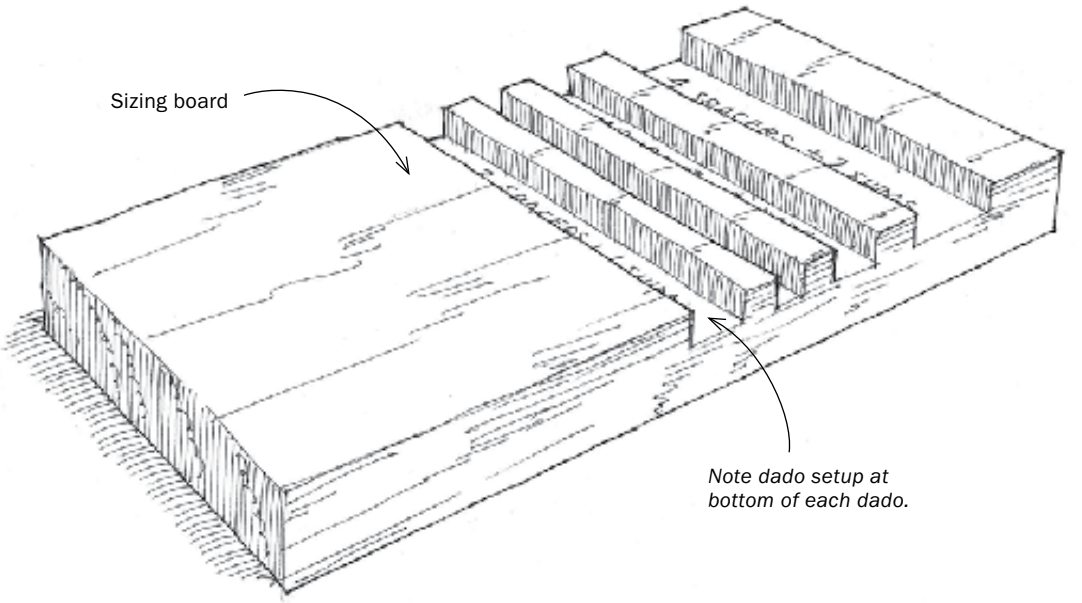
To use the table, simply clamp it to your workbench with wooden hand screws. When you're done, just unclamp the whole fixture and store it out of the way to save space.

—DOUG STOWE, Eureka Springs, Ark.

Dado-sizing board

A "sizing board" makes it easy to remember my stacked-dado setup for a given cut. Every time I cut a dado that has a width I've not used before, I take a minute to cut the same dado in my sizing board. Then, at the bottom of the dado, I note the arrangement of cutters and spacers. The next time I need to cut the same width, all of the pertinent information is there for the taking.

—WILL BRAUN, Lacombe, Alta., Canada



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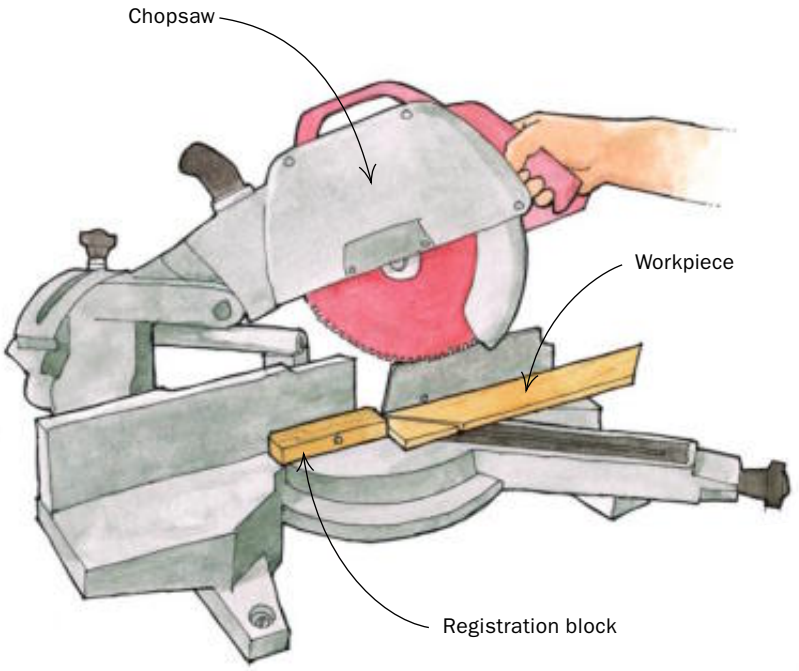
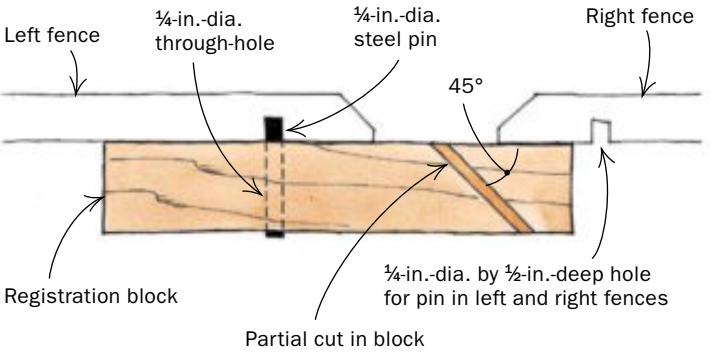
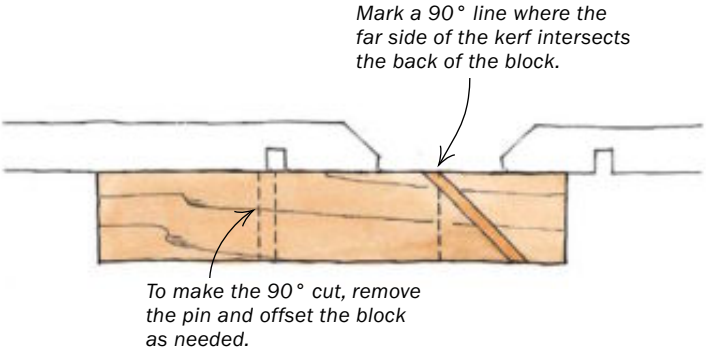
Chop mitered pieces to precise lengths



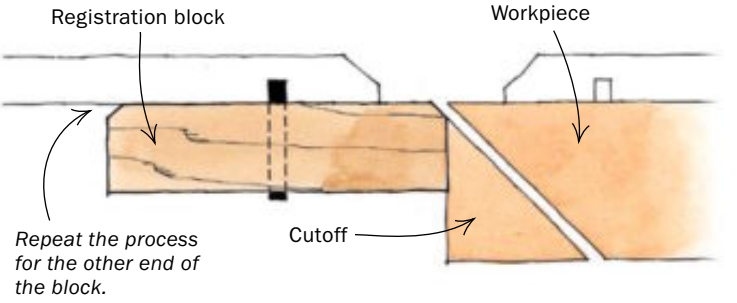
1. To make the registration block, drill a ¼-in.-dia. hole into a piece of hardwood. Then drill into the chopsaw fence through this hole. Affix the block to the fence by inserting a metal pin into the hole, and make a partial cut at 45° in the block.



2. Mark a line on the block that intersects the sawkerf at the back edge, remove the pin, and trim the block to that line.



3. For precise miters, first cut the workpiece to length, then butt the workpiece against the registration block and cut the miter.



With this easily made registration block, you can avoid the tricky process of cutting mitered stock to the right length. To use it, first chop the workpieces to the desired length with the blade setting at 0°. Then set the blade to 45°, install the registration block, and trim a miter from one end. The registration block ensures that the mitered workpiece will measure exactly the same length as the square-cut workpiece. To miter the other end accurately, install the block on the other side of the blade.

You don't need precise measurements to make the registration block. Use a drill press to cut a ¼-in.-dia. hole through a scrap of hardwood. With a portable drill, transfer that hole through the block into the left and right fences. The exact distance from the sawblade to the hole is not important; just be sure to start with a wood block that is long enough on each side to overlap the saw's cut line.

The next step is to press a ¼-in.-dia. steel pin into the wood block, leaving about ½ in. of the pin projecting from the surface. After engaging the pin in the hole in the left fence, swing the chopsaw to 45° on the right side and cut partway into the block. Remove the block from the saw and mark a square pencil line across the block, beginning where the kerf intersects the back edge of the block, as shown in the drawing. Return the block to the left fence and complete the 45° cutoff. Finally, set the saw at 0°, remove the pin, and cut off the waste up to but not including the pencil line on both ends. Then swing the saw to the 45° left setting and do the same thing with the block on the right fence.

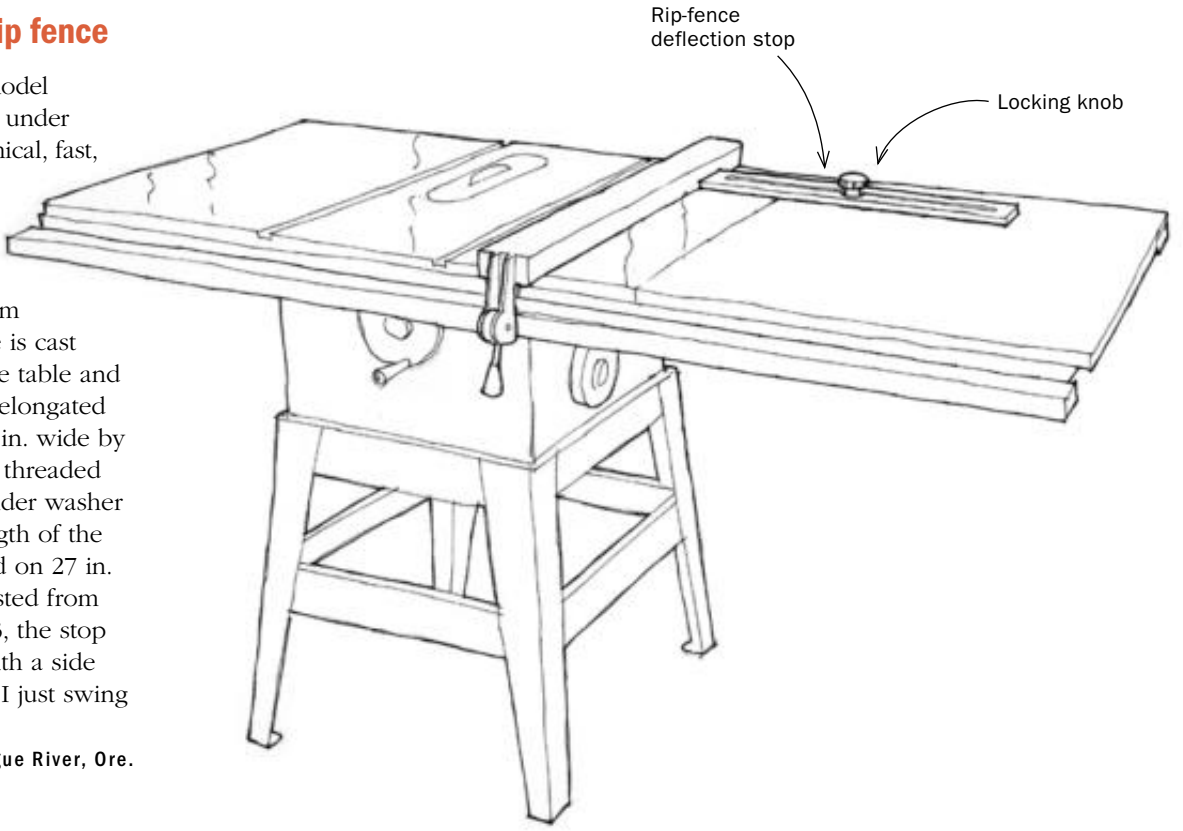
Reinsert the pin, and the registration block is ready for use. Cut stock to the right length first before installing the block on the left and right fences to cut the miters at both ends of the workpiece.

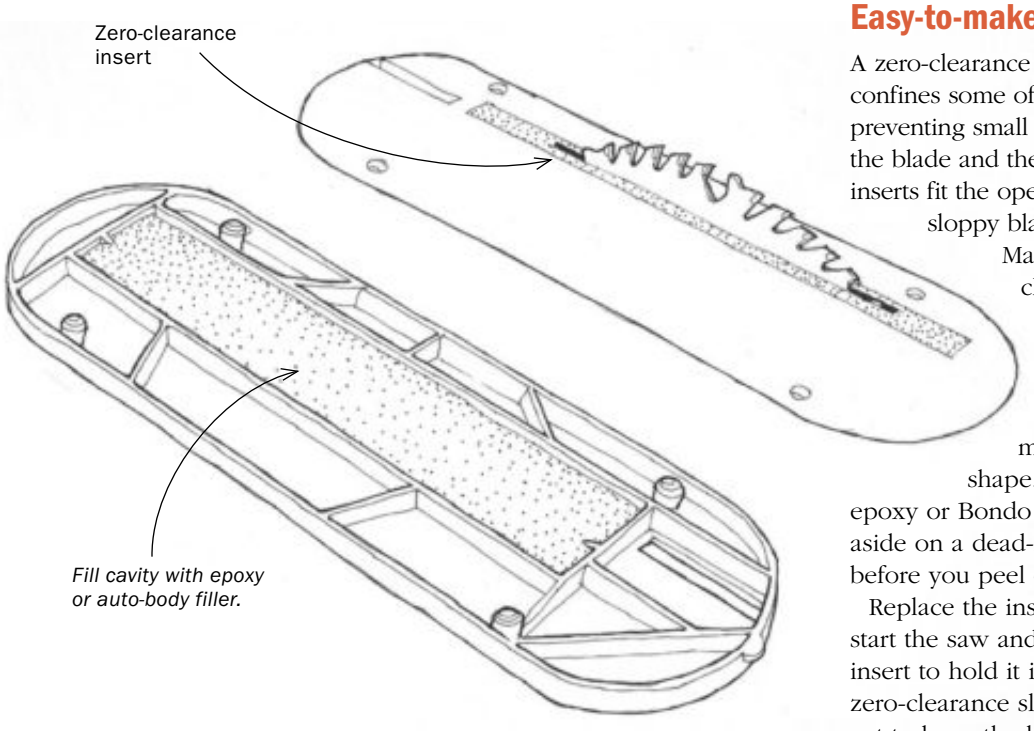
—THOMAS KOSZALKA, Hicksville, N.Y.

Simple stop backs up rip fence

Frustrated by my contractor-model tablesaw's rip fence deflecting under pressure, I devised an economical, fast, and foolproof solution. First, I drilled a ⅜-in. hole through the medium-density fiberboard (MDF) side table and inserted a T-nut from underneath. If your side table is cast iron, you can just drill into the table and tap the hole. I then made an elongated slit in a piece of hardwood 2 in. wide by 27 in. long. A piece of ⅝-in. threaded rod, a fixture knob, and a fender washer complete the device. The length of the stop is arbitrary, but I decided on 27 in. so that the fence can be adjusted from zero to 24 in. For less than $3, the stop will work on any tablesaw with a side table. When it is not needed, I just swing it away or remove it.

—BOB GLASCOCK, Rogue River, Ore.





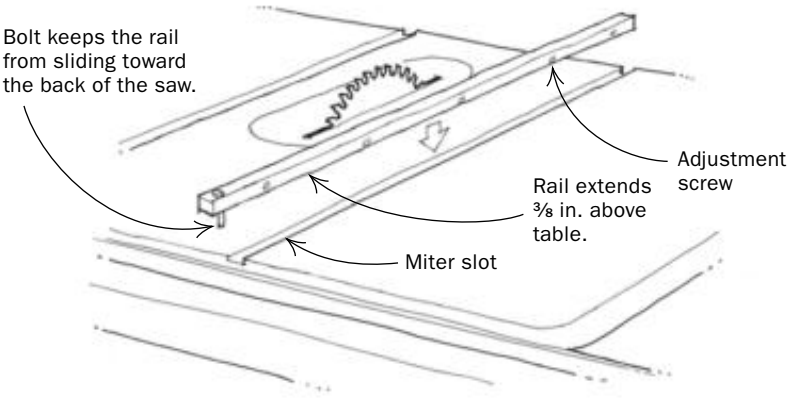
Easy-to-make zero-clearance insert

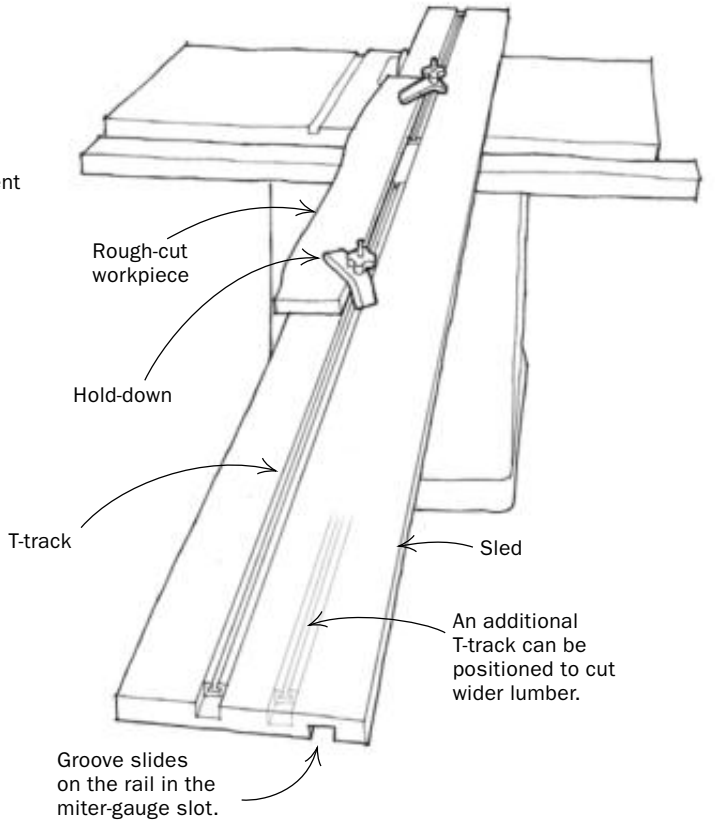
A zero-clearance insert on a tablesaw helps prevent tearout, confines some of the sawdust, and makes work safer by preventing small cutoffs from becoming jammed between the blade and the insert. The problem is that most factory inserts fit the opening in the table pretty well, but have a sloppy blade opening.

Many woodworkers make or buy zero-clearance insert blanks, but I have devised an easier method. I fix a piece of common packing tape over the top of the blade opening in the stock cast insert. Put the tape on smoothly and make sure the insert is clean and in good shape. Turn the insert over and pour some epoxy or Bondo in the webbing of the cast insert. Set it aside on a dead-flat surface, and wait for the epoxy to set before you peel off the tape.

Replace the insert in the saw with the blade lowered, start the saw and, with a block of wood clamped over the insert to hold it in place, raise the blade to cut your new zero-clearance slot. The major advantage here is that you get to keep the leveling screws and the little nib that stops the back of the insert from flipping up.

—KEITH PRICE, Campbell River, B.C., Canada





Creating a straight edge on a piece of rough lumber

This jig is great for creating a straight edge on a rough piece of lumber. The main part of the jig is a 1x8 pine sled a few inches longer than 8 ft. The sled slides on an oak rail that locks into the miter slot on a tablesaw. Countersunk screws in the side of the rail can be adjusted in or out to ensure a snug fit in the miter-gauge track. A groove cut along the full length of the underside of the sled allows it to slide on the rail. On top of the sled I installed two 4-ft. sections of T-track (available at most retail or mail-order woodworking outfits) and a pair of hold-downs with T-bolts.

—PAUL COMI JR., San Gabriel, Calif.

Tune-up kit for machines

THREE BASIC TOOLS GET YOU STARTED

BY GARY ROGOWSKI

If your woodworking machinery arrives needing only to be unpacked and plugged in, I suggest you buy lottery tickets that day. It's a lucky one.

Woodworking machines always need tuning or tweaking before they really purr. Which tools do you need to set them up properly and to check them periodically so they keep running smoothly? Fortunately, the list is short. Some might be in your shop already: a good straightedge, a combination square, and a plunge-style dial indicator. With these basic tools plus a set of feeler gauges, you can go a long way toward making your machines run true and your woodworking accurate.

A straightedge is the foundation

In the woodshop, flat surfaces are priceless. On them, you can mill lumber true, joint an edge square, and check pieces for twist after assembly. But how flat is flat? And how do you check?

You can't use a piece of wood to check for flatness unless you are sure it's flat. Instead, buy a good straightedge with a guaranteed tolerance of 0.002 in. over 24 in. This is more than adequate for setting up tablesaw tables and checking the flatness of jointer tables and other cast-iron or steel surfaces. A 24-in. straightedge will meet most needs, but for longer jointer tables or other especially large surfaces, you'll be better served if you can invest in a 36-in. straightedge.

Use the straightedge on the tablesaw to see that your extension tables and

STRAIGHT

Check for flatness with a straightedge

Jointer tables should be dead flat. *Measure any gaps with a feeler gauge. A variation of more than 0.002 in. on a new machine is reason to ask the seller for a replacement. Tables on older machines can be reground if necessary.*

Level the table and wings. *A tablesaw's bolt-on extension wing may need adjustment or shimming to bring its surface level with the rest of the table. Lay a straightedge across the junction of the table and wing and look for telltale gaps underneath.*

Photos: Steve Scott

SQUARE

Keep machines in line with a combo square

Check the fence. *Use the combination square to ensure that a jointer's fence is set at 90° to the tables. Make similar checks on the tablesaw and bandsaw.*

the main table form a continuously flat surface. Edges that appear flush where they meet are not enough.

Stand the straightedge on its narrow edge and look for gaps between the edge and the surface you're checking. Check across the table's width and length, then check the diagonals. Measure any gaps underneath the straightedge with the feeler gauges.

Acceptable tolerance for a tablesaw measuring 28 in. by 36 in. is 0.008 in. to 0.009 in. You might need to insert shims between the wing and the table to ensure a completely flat top.

Also check your tablesaw fence. The piece of composite material bolted onto the fence is not always perfect, but you can shim it to make it flat.

The jointer has three major cast-iron surfaces: the infeed and outfeed tables and the fence. A jointer table should be dead flat within 0.001 in. to 0.002 in. over any of its lengths. You can return a new machine to the seller if the surfaces are seriously out of flat or misaligned. On an older machine, a machine shop might regrind the surfaces for you.

On a belt-driven machine, the pulleys attached to the motor and the arbor should line up with one another in a flat plane to minimize bearing and belt wear. Use a straightedge to check by laying the narrow edge across both pulleys.

Combination square is a versatile setup tool

Just as important as checking flat surfaces is making sure that two machine surfaces meet up squarely.

You don't need a specialized machinist's square. If you use a combination square for joinery layout, it will work if it is truly square. Here's a simple test:

Hold the square up to a flat edge and mark a line. Then flip the square over and see if your mark again lines up perfectly with the blade of the square. Any variation means it's out of square.

Use the square to check the jointer fence. It can be adjusted and then locked into place. A tablesaw fence will need adjusting or shimming if it's not square to the table. A word of warning: Simply checking with the square isn't always enough. Squaring a blade to a table

Adjust the miter slot. *The combination square also can help check whether a tablesaw's miter slot is parallel to the blade. Mark a tooth at the front of the blade and measure the distance from the blade to the slot. Next, rotate the marked tooth to the back of the blade opening and measure again. If the readings are different, you need to adjust your saw's tabletop or trunnions to bring the slot parallel with the blade.*

on a bandsaw, chopsaw, or tablesaw will mean making practice cuts and checking those.

A combination square also is handy for aligning a tablesaw's miter-gauge slot parallel with its blade. This is crucial for safe operation and square crosscuts. With the machine unplugged, hold the head of your combination square against the gauge slot and check the distance to the blade at a single marked tooth, rotated to the front and then to the rear of the throat plate. You can adjust all cabinet and contractor-style saws to move the table into parallel with the blade.

A dial indicator measures runout

Runout is a measure of how true a rotating surface spins. If a surface wobbles or oscillates, then this runout will be magnified as you move away from the center of rotation. On a tablesaw, if the arbor is wobbling, then the end of its 10-in. blade will be rocking and rolling. This translates into rough, inaccurate, or dangerous cuts. The movement also wears on the bearings, shortening their life.

Sources of Supply

VERITAS STEEL 24-IN. STRAIGHTEDGE
$43; www.leevalley.com

MAGNETIC BASE DIAL INDICATOR
$35; www.highlandwoodworking.com

STARRETT 12-IN. COMBINATION SQUARE
$68; www.homedepot.com

A dial indicator measures movement such as runout with an arm mounted into a dial that usually reads 0.001-in. increments. The indicator itself must be held in place; the best way is to use a magnetic base to lock it into position. Then, on the tablesaw with the blade and throat plate removed, you can check the pressed-on arbor flange for runout. Set the magnetic base on the tabletop near the throat opening and tilt the arbor to 45°. Angle the dial's plunger to meet the surface of the arbor flange. Turn the arbor by hand to see whether the gauge registers any variation in the flange surface. A tablesaw arbor should have zero runout, but 0.001 in. of runout won't mean you have to trash your saw. Any more, though, and I'd send a new saw back to the factory or get a replacement arbor. On a used saw, I would remove the arbor and have it machined true.

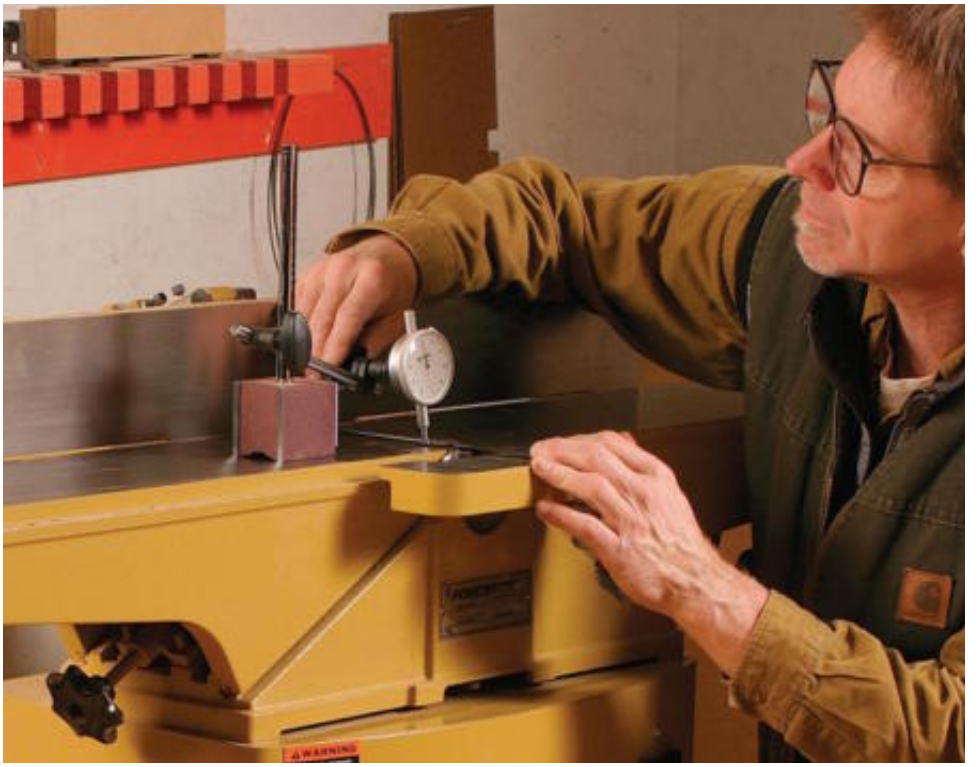
A drill-press chuck also should have nearly zero runout. Set the magnetic base on your drill-press table and align the dial plunger to touch a drill bit or a piece of straight unthreaded rod mounted in the chuck. Turn the chuck by rotating the drive-belt pulleys and watch for variations registered by the dial. Acceptable tolerance is 0.001 in. or less. Clean out the taper that holds the chuck. If that doesn't reduce runout, you may need to replace the chuck.

You also can use a dial indicator to check whether your jointer knives are all set to the same height. Set the base on the jointer table with the plunger riding the tops of the knives as you rotate the cutterhead by hand. Note and adjust for any variations in the maximum height of the blades.

SMOOTH

Check runout and blade height with a dial indicator

Check for runout. *Use a dial indicator to check the tablesaw's arbor flange. Any variations in the flatness of the piece can cause blade wobble, which leads to rougher cuts.*



Blades should be uniform. *The dial indicator also helps check whether jointer knives are set to the same height and are even with the outfeed table.*

Test cuts check accuracy

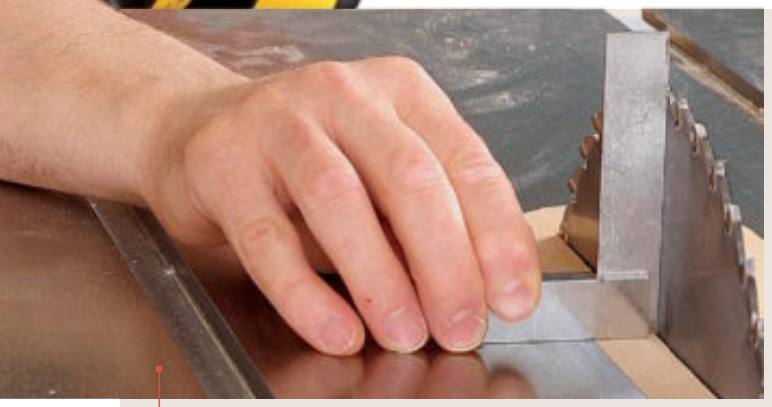
ELIMINATE ERRORS BY MAGNIFYING THEM

BY DAVID HYATT

Building furniture or other projects with strong, square-fitting joints requires woodworking machines that are set up to make accurate 90° cuts. Checking with an accurate square might seem like all that's needed, but it's really just the starting point.

Using a square alone, very small errors can be hard to see. To be sure your tablesaw and jointer are running true, you'll need to make some test cuts on scrap stock. These cuts are the final step in tuning up and checking the accuracy of your shop machines. The cuts make errors more visible by multiplying them. The photos on these pages show what to do.

Tablesaw: Square the blade and miter gauge



1 ***Start with a square.*** *An accurate square can help set the sawblade at a 90° angle. Keep in mind, however, that very small errors can be hard to see with a square alone.*

2 ***A test cut is more revealing.*** *Use two pieces of lumber or medium-density fiberboard (MDF). Stand the pieces on edge and cut them in the same pass.*

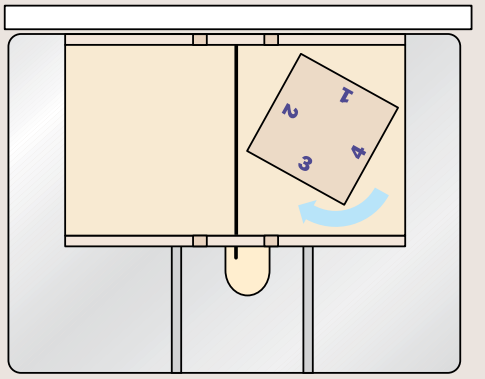
3 ***The moment of truth.*** *Butt the two cut ends together. Any error will reveal itself as a tapered gap between the two ends.*

4 ***A similar test for crosscuts.*** *Lay the boards flat to check the 90° stop on the miter gauge.*

A very reliable way to check a tablesaw blade for an accurate 90° angle is to cut two test strips and then check the squareness of the cut by placing them end to end.

Raise the blade to maximum height. Use two strips of sheet goods (I prefer MDF or ½-in.-thick melamine) that are slightly narrower than the height of the blade and 18 in. to 20 in. long. Hold the two strips together on edge and trim one end of them using a miter gauge. Open the two strips in a book-match (like opening a book) and place them on a known flat surface. Any deviation from 90° will show up as a tapered gap between the ends as they touch. Once the blade has been adjusted to 90°, the 90° stop can be set and locked in place. Lay the same two strips flat, trim the ends, and mate them again to check the 90° stop on the miter gauge. If the miter gauge is set at exactly 90°, there will be no gap between the ends of the test strips as they meet.

Tablesaw: Square your crosscut sled



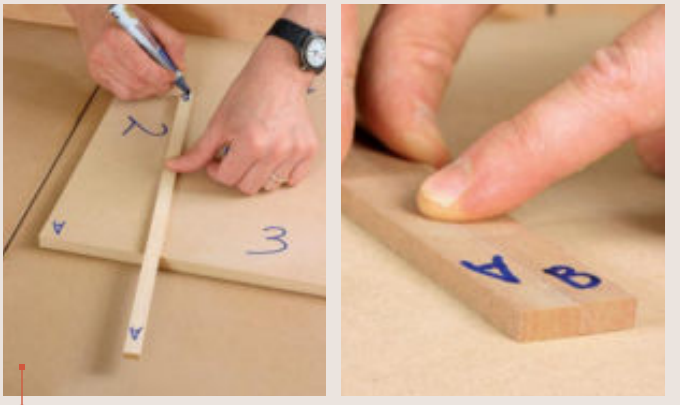
1 Make a test piece. *Number the edges on a square of MDF. With edge 1 against the sled fence, trim each side in turn, rotating the piece clockwise between cuts.*

2 Make five cuts in all. *Finish the sequence by taking a second, wider strip from edge 2.*

Larger pieces such as panels are usually crosscut on the tablesaw with a shopmade crosscut sled. The accuracy of these cuts can be checked with a large square, but a better and more accurate method is to use the "five-sided" test cut.

Begin with a piece of MDF or plywood that is roughly 18 in. to 24 in. sq. Number the edges 1 to 4, going counterclockwise. Place edge 1 against the fence of the sled and trim edge 2. Then place edge 2 against the fence and trim edge 3. Continue around until you have trimmed edge 1. Then place edge 1 against the fence and trim a ½-in. strip from edge 2. Label one end of the strip "A" and the other end "B." Snap the strip in half and place A and B side by side on a flat surface. If the sled is set square to the blade, then the strip will be exactly the same thickness at A and B. Even very small deviations from 90° will show up using this method.

If the sled does not produce 90° cuts, then you should adjust the fence on the sled until it cuts accurately.



3 Mark the ends of the strip. *This identifies the front and back of the final cut. Make corresponding marks on the MDF square for future reference. Snap the final strip in two, lay the pieces on their sides, and compare the thickness of the two ends. Any variation means the crosscut sled's fence needs adjustment.*

Drawings: Rodney Diaz

Tablesaw: Set up for accurate miters

1 ***Make a series of cuts.*** *Cut 45° miters at both ends of four pieces of stock, just as you would for a picture frame.*

A similar set of tests can help verify the accuracy of the 45° miter-cutting setups on a tablesaw.

Cut a 45° miter at both ends of four test pieces of equal length. Tape the four pieces together to form a picture frame. Any deviation from 45° will be apparent, as the last corner will not fit together tightly. Adjust your setup, and recut the four test strips until they form a frame with no gaps at the corners.

For standing miters, cut with the blade set at a 45° angle. For flat miters, cut with the blade set at 90° and the miter gauge set at 45°.

2 ***Tape the corners.*** *This helps hold the pieces in place as you assemble the frame.*

3 ***Look for the gap.*** *If the final corner doesn't fit snugly, it means the miter gauge isn't set at precisely 45° to the blade.*

Jointer: Check the fence

Prepare test pieces. *Joint the face and edge of two pieces of stock. On a flat surface, place the jointed edges down and the jointed faces together. A gap shows adjustment is needed.*

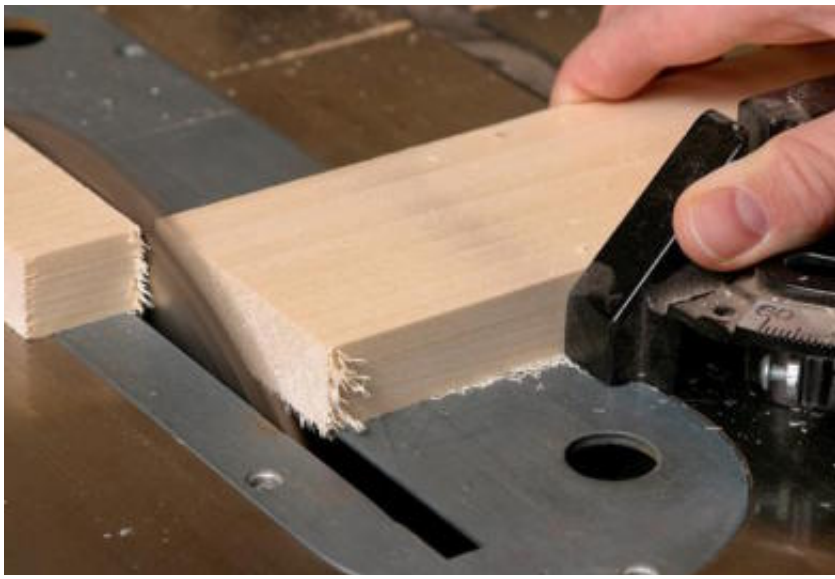
The fence on a jointer also can be set to 90° by using test cuts.

Take two 16-in. to 18-in. lengths of 8/4 stock and joint a face and then an edge of each piece. Set the two pieces on a flat surface with the jointed edges down and the jointed faces together. If the jointer fence is not set at 90°, then a tapered gap will be visible between the two faces. You can also check the jointer's accuracy by clamping the two pieces with the jointed edges together. Place a straightedge across the two jointed faces. If the jointer fence is not at 90°, then the straightedge will rock when placed across the jointed faces or it will show a gap where the two pieces touch.

These methods will work only if the jointer is producing a smooth cut. If the jointer blades have been nicked and are leaving small ridges, the test pieces will not sit flat. You might solve this problem by moving one jointer blade slightly to one side.

Taming tearout on the tablesaw

BY STEVE LATTA



One major factor that separates a good piece of furniture from a mediocre one is how cleanly it is constructed. Nothing will kill the look of a finished piece more than tearout.

Most tearout on the tablesaw occurs when the blade exits the stock and breaks the wood fibers rather than cutting them. As a result, splinters may show up on the underside, back corner, and back edge of a workpiece. This is especially relevant to crosscutting. But tearout is not hard to eliminate or manage. The first item to look at is the sawblade.

The correct blade is the first line of defense

A dull blade, or one covered with pitch, will produce a poor-quality cut. Crosscutting blades and many general-purpose blades have teeth with alternating bevels. The staggered teeth on these blades are beneficial because they score the fibers before hogging out the stock.

Avoid trim cuts—Sometimes tearout occurs by taking too light a trim cut. It often is better to have material on both sides of the blade; that way, the wood fibers are supported across the full width of the kerf and onto the offcut. This tension keeps the fibers from ripping away.

Raise the blade to reduce tearout—Safety declares that the blade should project above the surface about the height of a tooth. Regretfully, a low blade can lift fibers from the surface. Raising the blade higher than normally recommended transfers the forces of blade rotation so that the fibers are pressed into the surface, resulting in a cleaner cut. In many applications, I raise the blade at least an inch above the workpiece and take extra safety precautions, such as clamping the workpiece to a crosscut sled.

Use a zero-clearance insert

Another common cause of tearout when crosscutting is a tablesaw insert with a too-wide slot. It creates an unsupported surface for the material being cut. The hard edge where the workpiece finally becomes supported serves as a chipbreaker and allows the fibers to tear as far as the hard edge.

A zero-clearance insert ensures that the workpiece is fully supported as it passes across the blade.

Isolate tearout to hidden surfaces

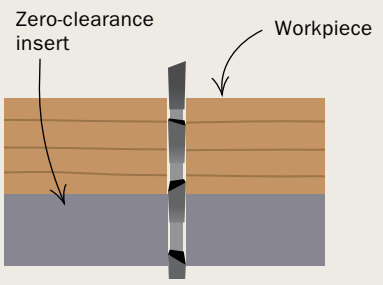
In my woodworking courses, nothing knocks down a student's grade faster than visible

SHOP AIDS TO PREVENT TEAROUT

Tearout mostly occurs on a crosscut when the sawblade breaks the wood fibers rather than splitting them. Once you understand the common causes of tearout, you can follow a few simple guidelines to prevent it.

INSTALL A ZERO-CLEARANCE INSERT

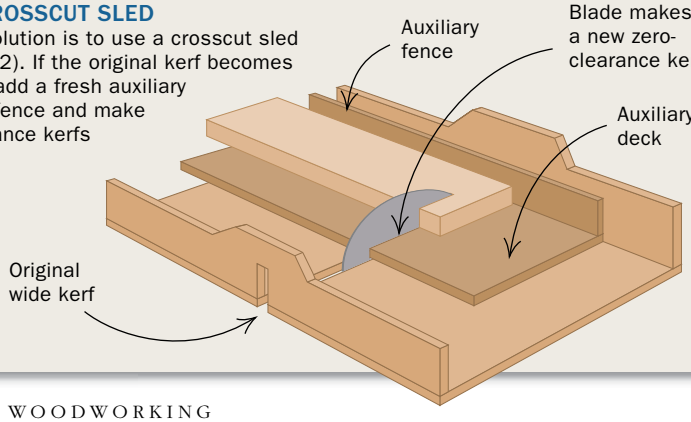
A zero-clearance insert increases the support area under the workpiece.



Inserts may be bought or shop-made. *Several manufacturers make aftermarket inserts that replace the one supplied with your saw. A wood insert also can be made in the shop.*

USE A CROSSCUT SLED

Another solution is to use a crosscut sled (see p. 102). If the original kerf becomes too wide, add a fresh auxiliary deck and fence and make zero-clearance kerfs in them.



Photos: Matt Berger; drawings: Kelly J. Dunton

ORIENT THE WORKPIECE TO HIDE THE TEAROUT

TABLE LEGS

Place the hidden sides of the leg against the fence and deck. *Orient the leg on the tablesaw so that the blade exits the workpiece on a surface that won't be visible on the finished furniture piece.*

DRAWER FRONTS

Orient drawer fronts so that tearout is restricted to the inside face. *Crosscut drawer fronts with the exposed face up (left). Then rotate, don't flip the drawer face to cut the other end (right).*

tearout on a finished piece. I've often seen this on the top of a table leg when it has been improperly cut to length.

You should have a good idea how the legs will be positioned on a table before you make any cuts. As noted earlier, the bottom face, back corner, and back edge of a workpiece are most susceptible to tearout. Therefore, orient table legs on the saw so that the outside faces make first contact with the blade. (Stack the legs with their exposed faces outward and mark the tops to identify the unexposed sides.) Cutting the legs this way, any tearout won't be visible once the table is assembled. This same concept can be applied to a cut on the miter saw.

When trimming a drawer front to length, position the front with its inside face against the tabletop so that tearout is isolated to the unseen face. After making the first cut, rotate the stock rather than flip it to cut the other end.

Cut end grain before long grain

In general, when a workpiece needs to be cut across the grain and along the grain, it's best to cut the end grain first. This rule of thumb holds true for most machining processes, from raising panels to rabbeting drawer bottoms. If tearout does occur from the blade (or cutter) exiting the end grain, the long-grain pass will scoop away any blowout that might have occurred.

Scoring and taping can help reduce tearout

Due diligence also will prevent tearout. For example, when working on large cabinet projects, I always make frame-and-panel doors slightly oversize, then cut them to fit the exact dimensions of the opening. For clean cuts, I have to deal with the back edge of the door stiles, where the sawblade cuts end grain.

Use a knife to score a line on the bottom side and back edge of the stile. That allows the fibers to break cleanly, before they have a chance to tear out.

Applying clear tape to an edge that is to be cut also works well to prevent tearout—if you peel off the tape in the direction of the fibers. If you peel in the other direction, the tape will lift the fibers. Sometimes a very light film of white glue will provide enough support to keep fibers from tearing. Just make sure that you've sanded or scraped off all the glue before you apply a finish. □

ORDER YOUR CUTS TO ELIMINATE TEAROUT

Which comes first, the dado or the rabbet? *The dado comes first, if you follow the general rule that end-grain cuts should be made prior to long-grain cuts.*

A rabbet will scoop away tearout caused by the dado cut. *Cut the rabbet deeper than the dado to ensure a clean edge.*

Tablesaw

The best ways to equip and work with the most dangerous machine in the shop

BY GARY M. KATZ

A short time ago, a good friend of mine cut off the tip of his thumb on his tablesaw. He's a good guitar player, too. We're the same age; both of us have been working in this business about the same amount of time. I felt terrible about the whole situation, but it just reinforced to me the importance of tablesaw safety. Reminders like this one have made me develop techniques to protect myself from mistakes. So far, those habits have saved me from disaster.

Any article on tablesaw safety would be remiss if the issue of blade guards weren't faced honestly. Of the carpenters I've met around the country, I'd say 99% never use a blade guard on their tablesaws. In more than 30 years of working on job sites, I've never seen anyone use a guard on a portable saw. But I've seen and heard about a lot of tablesaw accidents. Lots of numbers are batted around, but here's a conservative estimate: According to the Bureau of Labor Statistics, tablesaws caused more than 2,000 reported injuries during 2004, and most of those accidents probably could have been prevented if a guard had been in use.

Does that mean we're all going to start using the guards on our tablesaws? I doubt it, although some blade guards definitely work better than others. The guard found on most saws—from portables to cabinet saws—makes it impossible to rip narrow pieces, or to cut dadoes and rabbets. It's troublesome to take a measurement between the fence and the sawblade with the guard in place. A few saws, notably the SawStop (see "The safest saw gets smaller," p. 29) and the Powermatic PM2000, come with a riving knife that minimizes kickback but that doesn't interfere with your work.

This article highlights some of the most important tablesaw-safety techniques I use every time I turn on the tool. I start by listening to the little voice inside my head. When something feels wrong, I don't do it. I go get some coffee and think up another method. At the end of the day, I count my blessings on all 10 fingers.

ESTABLISH A SAFE WORK ZONE BEFORE YOU START TO CUT

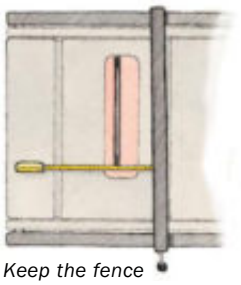
- **Be sure that the area around your feet is clear of cords, debris, and other material.**
- **Always use a saw stand coupled with an outfeed table or extension rollers (the continuous support of an outfeed table is better). It's also important that the table and stand be the exact same height, in this case, about 34½ in.**
- **Make sure that push sticks are within easy reach before you start the saw.**
- **Always wear eye and ear protection.**
- **Have a dust-collection system in place.**

Gary M. Katz is a contributing editor to Fine Homebuilding *and a tireless advocate of safe and efficient trim carpentry.*

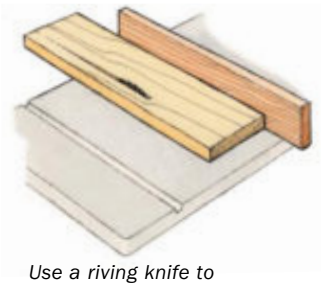
Photos: Charles Bickford; drawings: Heather Lambert

PREVENT KICKBACK AT ALL COSTS

Many tablesaw accidents are caused by kickback, when the blade catches and throws the stock back into your face or pulls your hand into the blade. Some major causes? When the rip fence isn't parallel to the blade, stock being ripped can be forced against the back section of the blade (see "Kickback danger zones," below). The same pinching can happen when an uneven edge runs against the fence, or when internal stresses in the wood cause the kerf to close as a board is being cut. The remedy? First, make sure the fence is parallel to the blade by checking the measurements between the fence and the miter slot at the front and rear of the saw table. When ripping, make sure the board edge guided by the fence is straight. If it isn't, you can cut a straight edge using a sled as shown on p. 28. Finally, always use a splitter or a riving knife to keep the kerf open.



Keep the fence parallel to the blade.



Use a riving knife to prevent blade-pinching.

Keep the stock against the fence, and stand to the left of the blade.

KICKBACK DANGER ZONES

As you move the workpiece into a spinning blade, the teeth push down as they cut. However, if the workpiece makes contact with the back of the blade, the force of the blade coming up out of the table can throw the stock back toward you. Because kickback can occur at any time, always stand to the left of the area between the rip fence and the blade. When ripping, always apply steady pressure against the fence.

A riving knife helps to eliminate kickback

A typical blade guard consists of a splitter, a blade cover, and antikickback pawls. I like a guard that can be removed and reinstalled quickly. The Porter-Cable 3812 and the Bosch 4000-07 portable tablesaws are two with guards that fill the bill. Even more important, these guards are mounted on the blade-carriage assembly rather than on the saw's chassis, which allows the splitter to move up and down with the blade.

On my own saw, I converted the splitter into a riving knife. Often seen on high-quality cabinet saws, a riving knife is a smaller splitter that follows the tilt of the blade; it always follows the blade into the stock, where it keeps the kerf from pinching the blade, a major cause of kickback. A riving knife is never in the way.

To make the riving knife, I removed the blade cover and pawls from the splitter, then cut down the splitter so that when it's bolted back onto the blade carriage, it's about ¼ in. below the height of the blade. This modification means that I can no longer use my blade cover and antikickback pawls. But on the other hand, a riving knife is always in place to provide protection whenever I use the saw.

Use the rollers behind you when cutting big panels

Horsing a full sheet of plywood onto a saw table can be strenuous at best, if not downright dangerous. I set up a roller stand behind my standing position, then pick up the sheet on edge. Setting it onto the roller, I can ease it onto the table (1), then lay it flat (2). With the back end of the sheet supported by the roller (3), I now can position the sheet against the fence and turn on the saw safely.

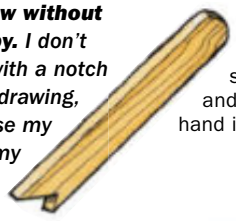
KEEP YOUR HANDS AWAY FROM THE BLADE

If you're using your hand to hold and press a board against the rip fence and kickback shoots the board across the room, in less than a microsecond your hand will be pressing on the spinning blade.

The only way to avoid this situation is never to place your hand in the danger zone (right). When ripping a board, keep your hand in front of the blade, use a tall push stick as the board nears the blade, and never reach over the blade to grab the waste.

SHOPMADE PUSH STICK

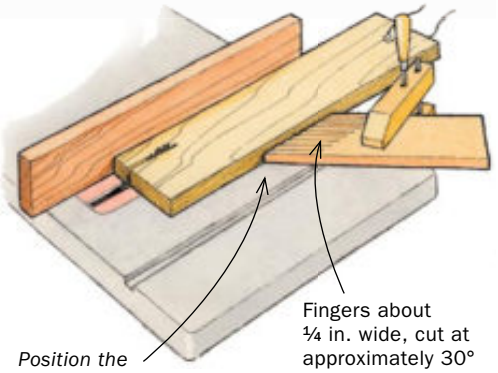
Never turn on a saw without a push stick nearby. *I don't use a simple stick with a notch cut in one end (see drawing, right), and I never use my hammer handle or my carpenter's square. Instead, I prefer a tall, wide push stick (see photo, above) that extends the reach of my hand by 12 in. and exerts pressure downward, forcing the stock against the table. The handle gives good control over the stock, whether I'm cutting a 10-in.-wide board or a ⅜-in.-wide strip.*



A notched stick can slip and lead your hand into the blade.

SHOPMADE FEATHERBOARDS

Shop- or factory-made featherboards greatly reduce the chance of kickback and help to make cleaner, straighter rip cuts. No matter which type you use, position the featherboards correctly. The flexible fingers should apply light, steady pressure on the workpiece, allowing you to push it through the blade without a lot of force. A table-mounted featherboard should be placed in front of the blade; never position it even with the blade because it might close the kerf, causing kickback. Featherboards clamped to the fence as hold-downs (below) must be positioned in front of and in back of the blade. I sacrifice a thinner piece of stock as a push stick to move the stock past the featherboards.



Position the featherboard in front of the blade.

Sacrificial push stick works with hold-downs in place.

FACTORY-MADE FEATHERBOARDS

Sometimes I need to rip a narrow strip from a wider board, and to keep the cut smooth, I use both featherboards and hold-downs. In this case, shopmade featherboards attached to the fence act as hold-downs, while a model from Bench Dog applies horizontal pressure that keeps the workpiece against the rip fence. Magnetic hold-downs and featherboards are available, too. Because it's so quick and easy to use, I prefer Grip-Tite, a magnetic hold-down system. A steel fence sleeve screwed onto a wooden auxiliary fence provides the attraction, so the hold-downs can be attached anywhere fore and aft of the blade. As the stock is pushed through, the hard rubber flaps and rollers hold the stock against the fence.

Bench Dog featherboards ride in the miter-gauge slot.

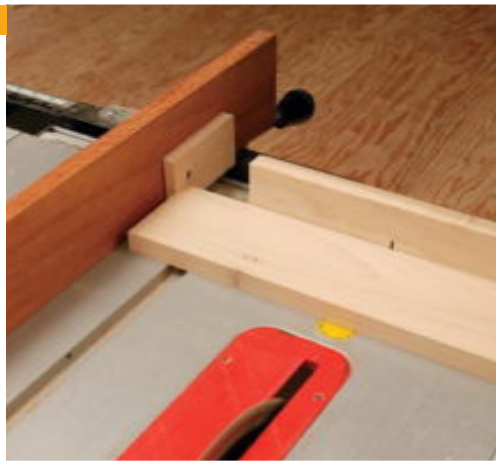
Grip-Tite magnetic hold-downs stick to a steel auxiliary fence.

JIGS AND FIXTURES HELP YOU WORK SAFELY

With all the specialty tools available these days, it's easy to forget how much you can do with a tablesaw. Dedicated jigs allow you to perform repetitive production tasks safely and accurately; they also transform riskier operations into a risk-free routine.

FENCE-REGISTERED STOP BLOCK

If I have to cut multiple pieces of the same size, I can screw a small block to the auxiliary fence that acts as a gauge. (I never use the fence itself as a gauge.) I slide the stock over until it registers against the stop, then make the cut. The stop block is far enough away from the blade that the piece isn't trapped between the block and the fence.

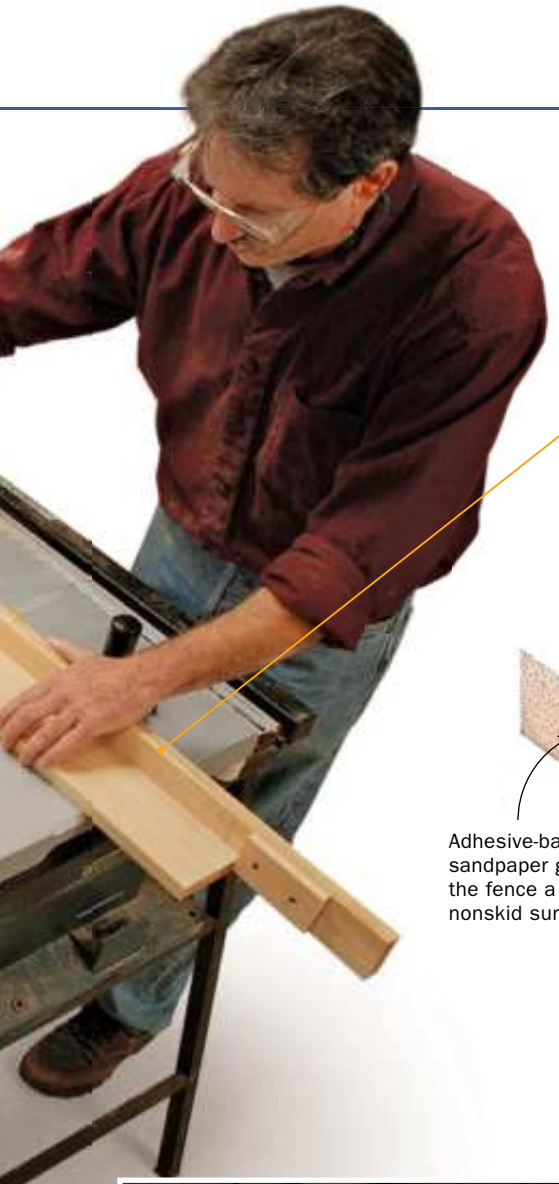


CROSSCUT SLED

Outfitted with two fences, the sled's guides ride in the miter-gauge slots and make wide crosscuts accurate and safe. A similar sled, used with a dado blade, allows you to cut wide grooves across the workpiece with no risk of kickback (see "Dadoes, Grooves, and Rabbets," pp. 60-65).

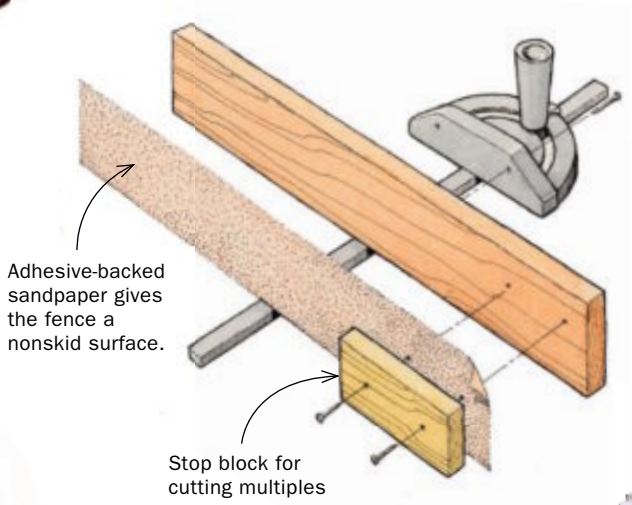
RIPPING SLED

Rather than run wany-edged hardwood through the jointer several times, I make a sled from a 16-in. by 96-in. piece of plywood. I screw two toggle clamps onto ¾-in.-thick blocks, then screw the blocks to the sled so that the wany-edged board projects an inch or so beyond and as parallel as possible to the edge of the sled. After clamping down the board, I run the sled along the rip fence, cutting just enough off the board to make a clean, straight edge.



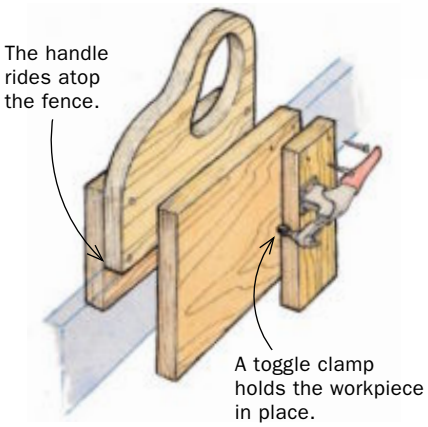
MITER-GAUGE FENCE AND STOP

I rarely use my miter gauge, but when I do, I always mount a wood auxiliary fence to it; the face of the miter gauge is too narrow to hold a board securely. Attaching a stop block to the wood fence gives you a foolproof way to produce identical-length parts. I use my right hand to pull offcuts away from the blade as they're cut.



TENONING JIG

Cutting tenons and chamfering the end grain on a narrow panel are dangerous jobs I frequently face. I never freehand these cuts. Instead, I make a tenoning jig from scrap materials and a toggle clamp. My tenoning jig rides on the top of the wood auxiliary fence attached to the rip fence.



The safest saw gets smaller

It's like an airplane that won't crash or a boat that won't sink. People were skeptical when SawStop's manufacturers (www.sawstop.com) first came out with a cabinet saw whose blade, they claimed, would stop within 5 milliseconds of contact with an operator's skin (see the demonstration video on their Web site). However unlikely, the SawStop works like a charm, and I'm going to buy one for my shop as soon as I can scrape up the money. Even better news is that the company is preparing to introduce a contractor's saw that employs the same finger-saving technology. The 10-in., 1.5-hp model saw (below) is

SawStop's contractor's saw

expected to have a cast-iron table with steel extension wings, a heavy-duty fence, a blade shroud to enhance dust collection, and a riving knife to prevent kickback. The company says it is finalizing some changes, based on feedback from field testing, and production may begin in mid-2007.

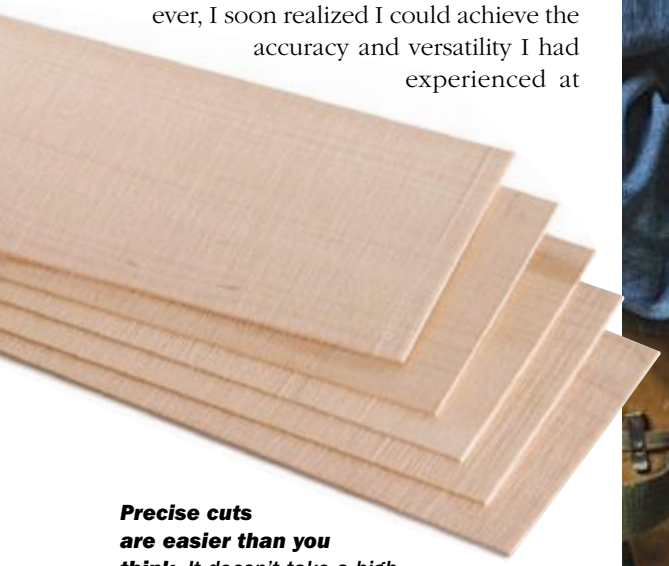
Bandsaw

Five no-hassle tips guarantee smooth, straight cuts on any bandsaw

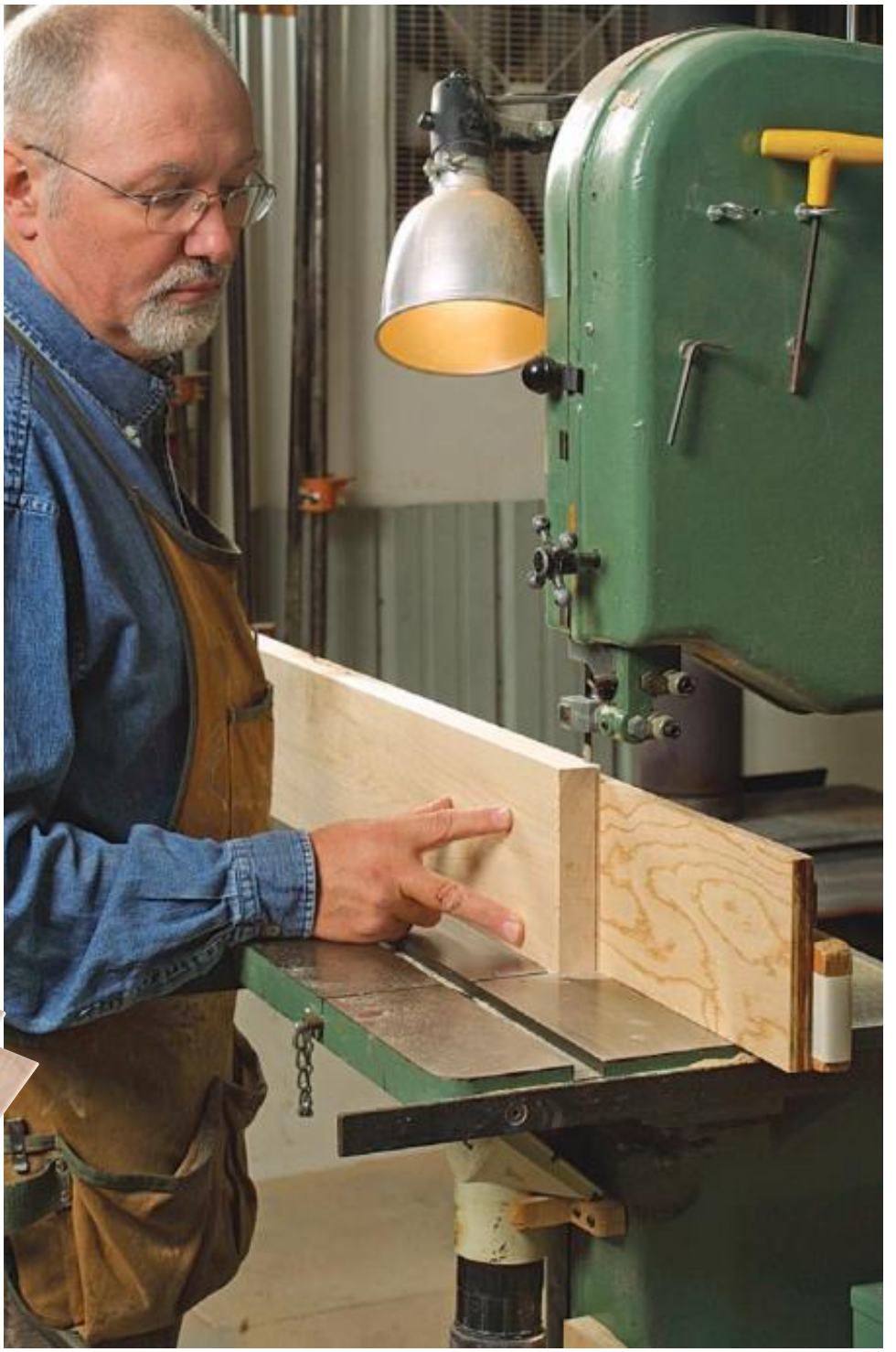
BY MICHAEL FORTUNE

In my first year of design school in the early 1970s, I remember the shop manager telling me that the bandsaw was the most useful piece of equipment in a woodshop. This struck me as a dubious statement, given that we were standing in a workshop filled with state-of-the-art European woodworking equipment. But time and again, he proved it.

After I graduated in 1974, my first purchase was a 15-in. General bandsaw. However, I soon realized I could achieve the accuracy and versatility I had experienced at



Precise cuts are easier than you think. *It doesn't take a high-end blade, high tension, replacement guides, or a special fence to get excellent cuts.*



Photos: Asa Christiana

school only if I set up the saw the way my shop manager did.

Once I figured out the keys to success, I came to rely on that bandsaw. With a single blade, I routinely cut smooth tenons, spaghetti-thin stringing for inlays, and perfect veneers that use the entire height capacity of my machine.

I also do all of my ripping on that 15-in. bandsaw. The task is safer and requires less horsepower than the tablesaw, and the narrow kerf consumes less wood. New employees and students are surprised at first by my preference for ripping on the bandsaw, but they are converted quickly. Although I have three excellent industrial tablesaws in my shop, they are used almost exclusively for cutting dadoes, squaring panels, and cutting shoulders on joints.

There are three key elements to getting the most from your bandsaw: blade type, blade alignment, and moderate tension. My approach contradicts some of the common advice for setting up bandsaws. It does not require high blade tension, special equipment, exotic blades, high horsepower, or continual fence adjustments to accommodate blade drift.

Start with a coarse blade

During teaching assignments, I run into many woodworkers experiencing difficulties with their bandsaws. They complain about the blade leaving a curved (cupped) kerf, a blade that seems to move out of alignment, or a saw that seems underpowered. Their bandsaws are relegated to cutting curves in thin stock.

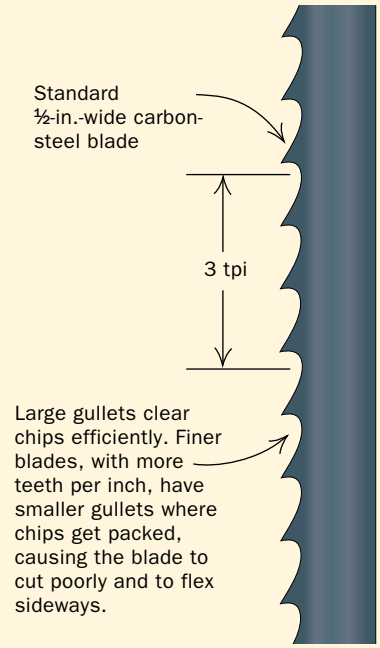
The number-one culprit behind all of these difficulties is a bandsaw blade that has too many teeth, with small gullets in between. Sawdust generated in the kerf must be removed efficiently. A tremendous amount of heat is created by the friction from the sawdust that is jam-packed in each small gullet right at the point where the wood fibers are being cut. The intense heat can cause the blade to lose its temper and dull prematurely. The heat and pressure buildup also can cause the blade to flex sideways and backward, creating a dished cut. A typical reaction here is to tighten the tension on the blade. But overtensioning the blade creates a whole new set of problems (see Tip 2).

My bandsaw does everything, every day: cutting joints, resawing wide laminates in exotic woods, making curved patterns in

Tip 1

A SINGLE BLADE CAN HANDLE MOST TASKS

A ½-in.-wide, 3-tpi blade—properly set up—will handle general ripcuts, resawing, and even cutting curves in thin stock, not to mention cutting precise tenons.



Tip 2

HIGH BLADE TENSION IS NOT NECESSARY

High tension eventually will groove the tires, pulling the blade out of alignment (for more on blade alignment, see Tip 3). High tension can even flex the machine's frame out of alignment.

Use less than the recommended tension. *For a ½-in.-wide blade, turn the tension gauge (above) to the setting for a ⅜-in.-wide blade. The first step in overhauling a bandsaw is to check the tires for grooves (right). If necessary, replace them.*

1⁄16-in.-thick stock. It is not practical to change the blade and the guide blocks for each situation, nor is it necessary.

With rare exceptions, a standard carbon-steel ½-in.-wide, 3-tpi, skip-tooth blade installed on my bandsaw performs all of the above tasks.

Blades are inexpensive, so keep a sharp one loaded—The blades I use are made by Starrett but are welded and distributed by BC Saw and Tool in Canada (888-251-2236; www.bcsaw.com). By delightful coincidence, these blades are relatively inexpensive. It helps that I buy them in groups of 10, which earns me a 25% discount. For example, at the end of 2006, 94½-in.-long blades, which fit a 14-in. bandsaw, sold for about $10 (U.S.) each, or $13.50 if purchased one at a time. This is one of the rare cases when inexpensive equals good.

Unfortunately, not all blade distributors weld bandsaw blades properly. A poorly welded, misaligned sawblade will not give you the smooth and effortless results you are after.

Simply using a 3-tpi blade, with its larger gullets, will eliminate many bandsawing problems. Even 4 tpi is too fine a tooth pattern for general woodworking and resawing. Although it seems counterintuitive, if you want a fine cut, use a coarse blade, even on thin stock. In my experience, the old rule of thumb about having two teeth engaged in the stock at all times is bogus. The reason I use a ½-in.-wide blade is that it is stiff enough to resaw but flexible enough to follow a curve down to a 2½-in. radius. A cautionary note: Cutting particleboard is extremely hard on carbon-steel bandsaw blades and can reduce their life by 75%.

High horsepower is another myth—For most 14-in. bandsaws with a ½-in.-wide, 3-tpi blade, a ⅓-hp motor is fine. The same saw with a riser block in the column could use a ½-hp motor for big resawing tasks, but anything larger is overkill. If the motor is bogging down, you are either forcing the cut or using a dull blade.

Don't overtension the blade

It is important that the tires on the bandsaw remain in excellent shape. Grooves in the rubber tire on either the upper or the lower wheel will make it impossible to keep the blade on the centerline, in line with the rip fence. And the most common cause of grooves in the tires is overtensioned blades. Very high tension can flex the saw frame out of alignment.

I slightly undertension my ½-in.-wide blade. Because of its excellent ability to clear sawdust, the blade is not inclined to flex, wander, or heat up. I adjust the tension scale to the setting for a ⅜-in. blade. If no scale is present on the machine, I tighten the adjustment knob (with the machine off and unplugged) until the blade deflects about ¼ in. to the side without making my fingertips go white.

A side benefit of lower blade tension is that I seldom have to release the tension on the saw, as is commonly recommended to prolong blade life.

Align the blade to eliminate drift

When I bought my bandsaw in 1974, I set the fence parallel to the miter-gauge slot in the table, and I haven't had to adjust it since. This is because I use the tracking adjustment on the upper bandsaw wheel to align the blade (see drawings, facing page). A

Drawings: Kelly J. Dunton

Tip 3

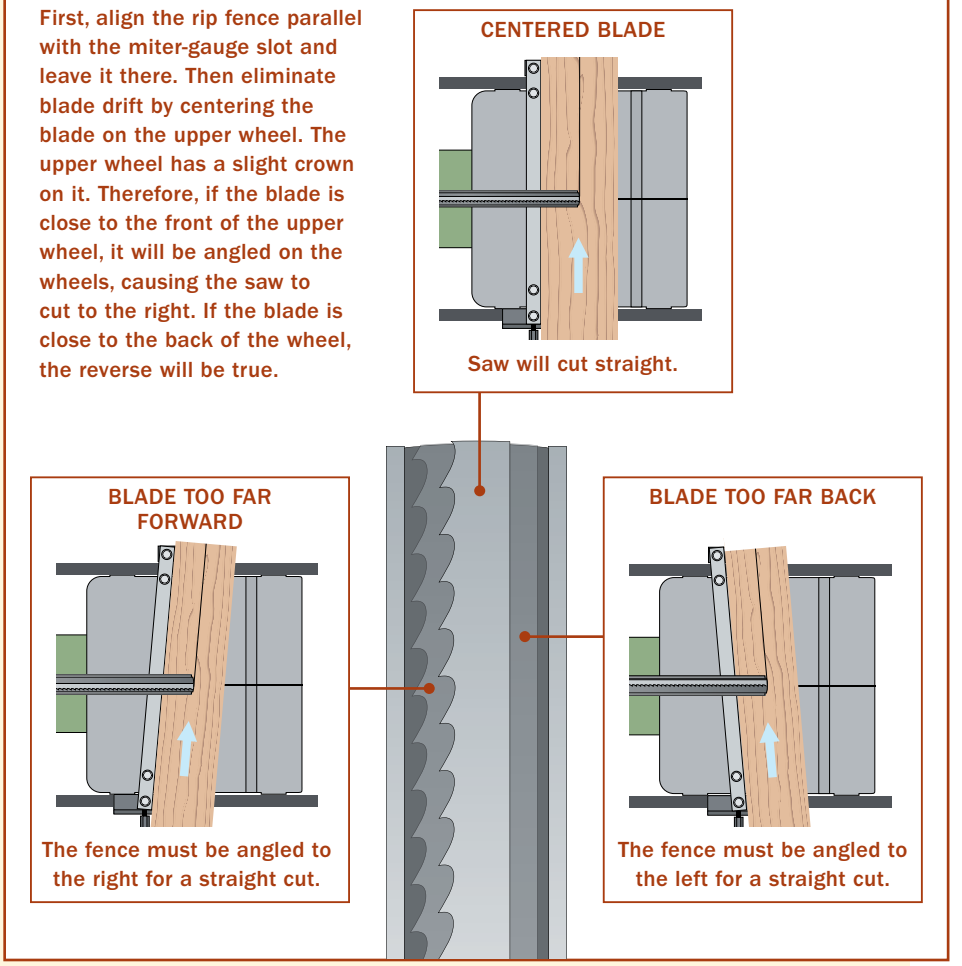
YOU CAN ELIMINATE BLADE DRIFT BY ADJUSTING THE TRACKING

Advice on blade alignment usually centers on the rip fence instead of the blade, but you can eliminate blade drift simply by adjusting the position of the blade on the upper wheel.

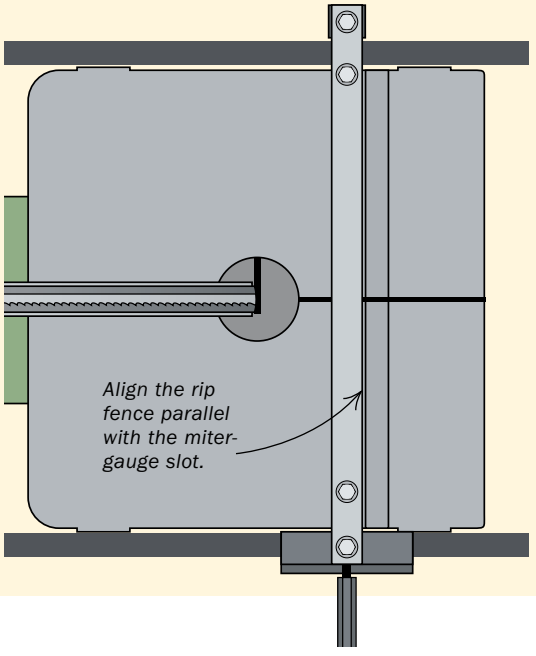
A simple adjustment. *Adjust the angle of the upper wheel so the blade rides at the center, which on most small bandsaws is crowned slightly.*

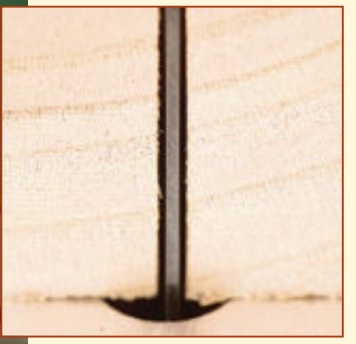
ADJUST THE ALIGNMENT OF THE BLADE, NOT THE FENCE

First, align the rip fence parallel with the miter-gauge slot and leave it there. Then eliminate blade drift by centering the blade on the upper wheel. The upper wheel has a slight crown on it. Therefore, if the blade is close to the front of the upper wheel, it will be angled on the wheels, causing the saw to cut to the right. If the blade is close to the back of the wheel, the reverse will be true.



ALIGN THE FENCE JUST ONCE





Now push gently and let the blade do the work. *Pushing too hard will make the blade flex sideways, which will cause it both to overheat and to drift off line. With the blade, fence, and guides properly aligned and adjusted, the back of the blade should be centered in its kerf (inset).*

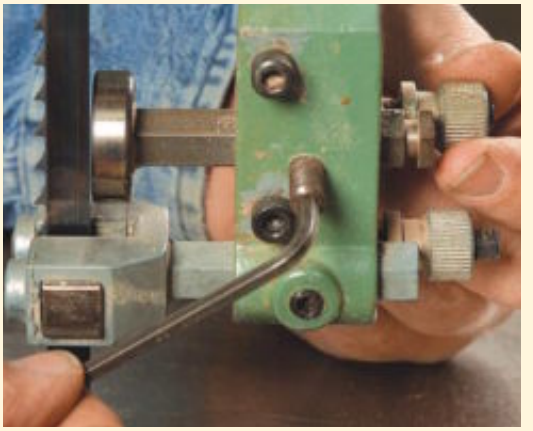
Tip 4

REPLACEMENT GUIDES AREN'T NECESSARY

A set of metal guide blocks will keep your blades on track for many years. The key is to set them very close to the blade and just behind the gullets.

Closer than you might think. *Many people use a dollar bill for setting the blocks, which keeps them 0.003 in. away from each side. Cigarette paper (or a feeler gauge) will set each block closer to 0.001 in. away, resulting in smoother, more precise cuts.*

The blade weld must be smooth. *A good sawblade company will weld blades precisely and grind the welded area flat. After you have set the guides, turn the wheel by hand to be sure the weld passes through the guides smoothly.*



Other important guide settings. *The guide assembly should be adjusted so that the metal blocks remain just behind the blade's gullets. Then the thrust bearing is set 1/32 in. behind the blade, as shown, so it contacts the blade only during use.*

nightmare of fence adjustments ensues if each new blade is allowed to track differently. Simply by keeping the centerline of the blade (regardless of width) in line with the centerline of the upper wheel, I can keep the blade aligned correctly at the blade guides.

The relationship between tracking the blade on the centerline of the upper wheel and having the fence aligned parallel to the miter slot should produce a kerf with equal space on either side of the blade.

Much has been made in books and articles of the alignment of the two wheels to each other. In my shop and in my travels, I have never found this to be a problem. Tracking the blade properly on the upper wheel has always been enough, except in the case of a severely damaged bandsaw.

Now square the table and align the fence—Once you have aligned the table with the cutting direction, it also should be adjusted so that it is square with the vertical line of the blade.

Last, the fence should be aligned parallel to the blade and square to the table. I use a 3½-in.-tall birch plywood rip fence screwed onto the metal fence. I have shimmed the plywood with masking tape to get it perpendicular to the table. Taller plywood fences can be screwed to the existing plywood fence, but I use these only when I am resawing to the maximum capacity of my bandsaw, about 6½ in.

Use metal guide blocks, set close

Again, simple is the way to go. When setting up my bandsaw in 1974, I took out the metal guide blocks and squared their working faces against the side of the wheel on my bench grinder, being careful to check the blocks for square. I have not had to replace them or resquare them since.

The sequence for setting the guide blocks is as follows. Unplug the saw, pull the guides well back, tension the blade, and then spin it a few times backward and forward by hand. Now turn on the saw and adjust the tracking of the blade to center it on the upper wheel.

Next, turn off the saw again, and bring the guide assembly forward so that the front of the blocks aligns with the back of the blade's gullets. Then adjust each guide block to within the thickness of cigarette paper, or 0.001 in., of the blade. The Allen screw might pull the blocks in or out when they are tightened, so this process

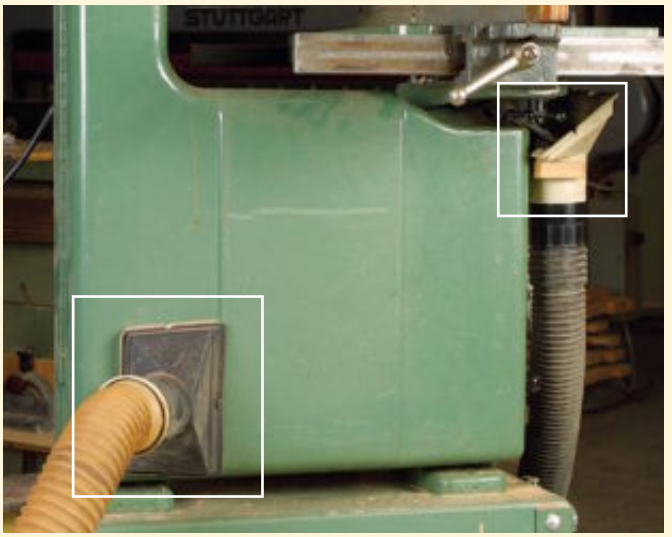
Tip 5

ADD DUST COLLECTION TO KEEP YOUR SAW RUNNING WELL

Sawdust extraction is very important. Wood dust will get compressed onto the lower wheel by the revolving blade. The resulting bumps will cause the blade to vibrate and wander off center.

Many saws provide for some dust extraction directly below the cutting area, but that isn't enough. Attach a second dust pickup at the lower left corner, where the air current generated by the lower wheel makes dust accumulate.

Also, attach a wooden brush with stiff natural bristles to the frame of the saw so that it continually cleans off the lower wheel. The lower dust port will catch the debris.



Collect dust at two points. *Many bandsaws have dust collection below the cutting area, but Fortune also recommends installing a vacuum port at the bottom left of the lower wheel. If dust and pitch build up on the tires, the blade will not track properly. Install a brush (right) to remove dust from the lower wheel.*

could require one or two attempts. With practice, you will be able to adjust the guides by eye, looking for the smallest crack of light between the blade and the guide blocks.

Last, bring the thrust bearing in the rear to within 1/32 in. of the blade. This bearing is the only part that requires replacing, when it becomes stiff or scarred. But it is a standard part and can be bought in most automotive- or bearing-supply houses.

With the guide blocks set this close, and with the back of the gullets just aligned with the front of the blocks, there is no room for the blade to twist or for the teeth to hit the metal guide blocks.

If I thought there was some advantage to replacing the guides or the blocks, then I would, but I find the original system gives me excellent results. With the blade and fence aligned properly, the metal guide blocks are not rubbing constantly against one side of the blade or the other and creating friction heat.

The lower guides are set in the same way as the upper ones, though I often leave them backed slightly away from the blade, unless I am resawing a particularly difficult piece of wood. I have worked in several shops in Europe, and none of the bandsaws I used there had lower bearing assemblies.

Feed stock with mild pressure

With the saw properly set up, it is necessary to place only two of your fingers against the workpiece: You should be able to use one finger to push the stock and the other to hold it against the rip fence. If you have to use the butt of your hand to push the stock, something is wrong—either the blade is dull or it is no longer tracking on the centerline of the upper wheel and is misaligned with the fence, causing the wood to bind.

Use mild but consistent feed pressure, allowing the blade to do the work. The sawdust must have a chance to be cleared from the kerf. For safety, once your pushing fingers are within 6 in. of the blade, use a push stick. □

Michael Fortune designs and builds furniture in Lakefield, Ont., Canada.

Drill Press

The right bits, jigs, and techniques add versatility

BY ROLAND JOHNSON

Originally designed as a tool for machinists, the drill press has become a standard fixture in woodworking shops. It is capable of drilling both small and large holes more accurately and safely than a handheld drill, and it has a built-in depth stop. The rack-and-pinion pressing action of the machine gives easy leverage for boring large holes in hard material. Throw on a simple, shop-built table and fence, and you add the ability to support and stabilize large and small workpieces in precise, repeatable positions.

Most woodworkers are familiar with the basic function of a drill press, but not everyone knows how to squeeze the greatest versatility and performance out of this woodworking mainstay.

The first step is to make sure the machine is drilling holes that are straight and true, perpendicular to the table. For basic troubleshooting on a drill press, you'll need an accurate square, a deadblow hammer, a dial indicator with a magnetic base, and a length of drill rod (available at machine shops and many hardware stores, as well as by mail order).

Photos: Asa Christiana

Tune-up is quick but crucial

A wobbly chuck can be corrected. *You'll need a dial indicator and some drill rod to test for runout. If you find more than 0.005 in. of wobble, use a deadblow hammer to knock the chuck free. Clean any gunk off the taper, and reinstall the chuck.*

Squareness is a must. *Again, the piece of drill rod is helpful. Drill-press tables include a side-to-side adjustment. If the table isn't square from front to back, you'll have to shim the shop-built auxiliary table (see drawings, following page).*

The most important factor for accurate drilling is the squareness of the table to the bit. Use the square to determine if the table is perpendicular to the chuck. If the table is out of square from side to side, fixing it is a simple matter of loosening the bolt that secures the table, making an adjustment, and tightening the bolt. If the table is out of square from front to back, the auxiliary table (an essential accessory for any drill press, shown on the next page) can be shimmed to compensate.

If you have a dial indicator, use it and the length of drill rod held in the chuck to check the chuck for runout. Any wobble should be less than 0.005 in. measured at 1 in. from the jaws. If there is any more wobble than this, bits will tear the rim of a hole upon entry and re-entry.

If the chuck is not concentric to the shaft, use a deadblow hammer to knock the chuck free of the shaft, and check the taper to make sure it's clean and smooth. Use a rag and some solvent to clean the taper. Anything more abrasive than steel wool will change the taper and weaken the bond. Replace the chuck and recheck the runout.

When reinstalling the chuck, you can angle the hammer blow to get it to seat properly on center. At that point, if you are still measuring too much runout, remove the chuck and check the

Auxiliary table is a must

This simple, shopmade table supports long workpieces and offers a number of ways to locate and secure them. It includes a sacrificial backer board to eliminate blowout on the backs of workpieces.

Fence, ¾-in. plywood, 3 in. deep by 2½ in. tall by 35½ in. long

Rabbet, ⅛ in. by ⅛ in., prevents debris from affecting workpiece alignment.

Ratcheting clamp handle

Triangular brace, glued and nailed

End stop, ¾ in. thick by 2½ in. wide by 4 in. long

Sacrificial board, ½-in. plywood, 4⅞ in. sq., ¼-in. radius at corners

T-track

Clearance hole, 1½ in. dia.

Bolts, ¼ in. dia., counterbored into table

Simple work stop, ¾ in. dia. by ¾ in. thick, glued onto ⅜-in. dowel

Numerous ⅜-in. holes for work stop

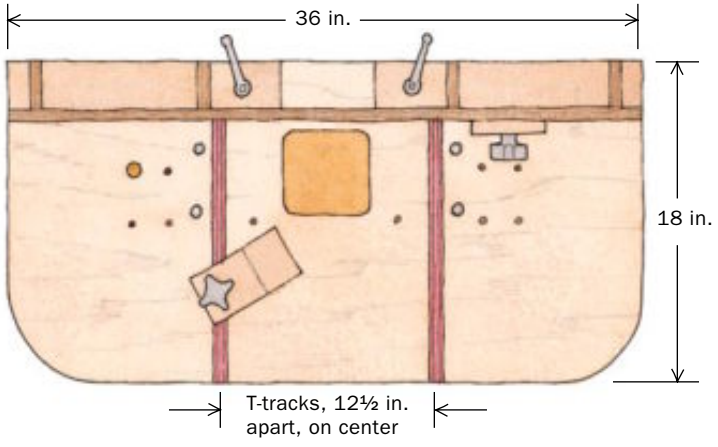
Table, ¾-in. plywood, 18 in. deep by 36 in. wide

6-in. radius at corners

Hardwood support brace, 1 in. sq. by 33 in. long, near front edge, keeps table flat.

Attachment cleats are designed to fit a specific drill-press table and allow the auxiliary table to slide easily on and off.

Clamp handles



USING THE TABLE

A pin is the simplest stop. *It offers a quick way to keep a workpiece from spinning (above). The fence works well for holes in a row (right). The T-tracks and clamp handles make for quick adjustment and a secure grip.*

Drawings: Jim Richey

taper itself. You might have to contact the manufacturer to replace that shaft.

If you are a bit more ambitious, the rest of the drill press comes apart for cleaning and lubrication, which will smooth out any sticky action. Also, if you notice excessive vibration when the press is running, it may be caused by poor-quality or old V-belts. These can be replaced with segmented belts.

Note to lefties: Many machines can be set up for left-handed crank operation simply by swapping the return spring and handle assembly side-for-side.

Drilling tip

For greatest accuracy when using brad-point and twist bits, use a center punch before drilling.

An auxiliary table is a must

Even though many drill presses are used exclusively for woodworking, they still are equipped with a machinist-oriented table that tends to be too small for many woodworking operations. An auxiliary table that bolts to the drill-press table greatly enhances versatility and safety. A wood or melamine surface is also kinder to workpieces. My version consists of a ¾-in. piece of veneer-core plywood, with aluminum T-tracks inset to accommodate a fence and various hold-downs.

Through-holes will tear out without a fresh backer board below the hole. I inset a small, sacrificial piece of plywood into the auxiliary table. For critical holes, flip or rotate the board to find a clean area, and replace it when it is riddled with holes. The replaceable insert also allows the bottom end of a sanding drum to be set below the table surface (see photo, below right).

Four basic settings

There are a few simple settings on a drill press. The most frequent adjustment you'll make is tightening and loosening the chuck. Use all three tightening locations to be sure each jaw is well-seated, especially with big bits. This also can help to center the bit.

To accommodate various thicknesses of workpieces and various lengths and types of tools, you'll adjust the table quite often. Usually this means cranking the table up and down a gear rack on the support column, and locking it in place. Most tables also can be tilted for angled holes.

It also is important to match the speed to the bit. For woodworking, this does not have to be an exact science. Basically, you should not run any bit faster than 3,000 rpm, and you should slow the speed considerably for bigger bits. For example, a 1-in.-dia. bit should run at 300 rpm to 500 rpm in hardwood. On moderately priced drill presses, you'll have to turn off the machine to change speeds by moving the belt(s) across stepped pulleys. Some heavier-duty machines offer infinitely variable speed that can be changed on the fly.

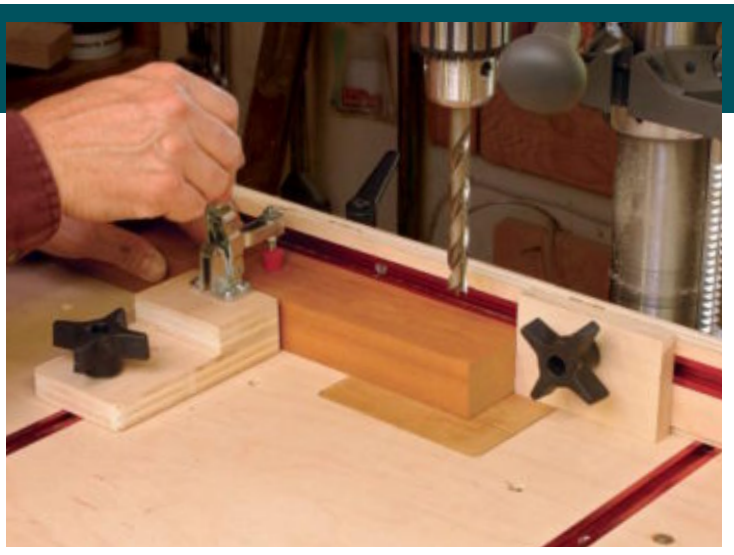
Last, you occasionally will use the depth stop. On many drill presses, this is a rotating collar located behind the feed handle. Higher-end machines have a better system: a vertical rod that travels with the quill, with stop collars setting the depth.

Safety: Spin and climb are the enemies

Two nasty events that can occur when drilling holes are spin and climb. If a bit grabs the wood—from too fast a feed rate, a dull cutting edge, or a sudden change in density of material (think plywood)—the work can go from zero to the drill's rpm in an instant, a potentially dangerous situation.

Almost any type of stop will prevent spin. I drilled a series of ⅜-in.-dia. holes in my auxiliary table, into which I simply drop a doweled stop. It works quickly for pieces of almost any size and shape. Just be sure that the work is against the stop when you begin. A fence will give the same protection, but it sometimes is not as quick or convenient to use, especially with odd-shaped pieces.

Drill-bit climb is another danger. This occurs as a large bit breaks through the back surface of the wood and jams in the hole, creating a reverse screw action. This causes the work to climb the



T-tracks add versatility. *Tracks in the table and fence make it easy to secure the fence, end stop, and various hold-downs.*

Sanding drums are good for curved work. *The cutout in this table allows the drum to contact the workpiece properly.*

Other drilling techniques

Make a V-block for round stock. *Use a hold-down for even more stability and accuracy.*

Tilt the table for end-grain and angled holes. *To drill into the ends of long pieces, turn the table to 90° and use the auxiliary table's fence, stops, and hold-downs to secure the work (above). For angled holes such as through-mortises in the top of a stool (right), tilt the table and use the fence as a work stop.*

drill bit until something stops it. If the workpiece clears the stop or fence, climb quickly can lead to spin. The cure is to clamp the piece to the tabletop. I use a small toggle clamp mounted to the T-tracks in my auxiliary table. I also use these clamps on special drilling jigs that I make for repetitive tasks. They can be mounted on tall wood blocks for clamping thicker or taller items.

Drilling clean, accurate holes

Experience will give you a feel for the proper feed rate, but as with any machine, don't push too hard. Let the bit cut, pulling on the crank handle just enough to keep chips coming steadily.

For deep holes and also for certain bits (such as Forstners), it is important to clear chips often. Do this by lifting the bit until it almost, but not quite, leaves the hole. Pulling the bit all the way out of the hole can tear the top edge on the way out or in.

For the ultimate accuracy in locating a hole, use careful layout with a sharp pencil, and then use a center punch to place a divot where the crosshairs meet. On most bits, the tip will gravitate to the center of the divot. When this happens, to avoid bending the bit or drilling a crooked hole, allow the workpiece to move slightly into a better position.

Use a V-block to drill round stock—A simple V-trough cut into a piece of heavy stock will keep round stock from rolling while being drilled.

Angle the table or make a jig for angled holes—If you angle the table, the small scale will offer a fairly accurate reading. If a precise angle is needed, make a setup block on the tablesaw at the exact angle, and use it to set the drill-press table to the desired angle with the drill bit. Forstner bits work best for drilling angled holes, because the cutting rim will keep the bit from wandering.

Pivot the table for end-grain drilling—To drill into the end grain of a long workpiece, such as when drilling bedpost sections, pivot the table to 90° and use hold-downs to attach the workpiece to the table. Twist bits work better than brad-point or Forstner bits for drilling into end grain.

Use the fence when drilling mortises—To bore the sequential holes that rough out a mortise, use a Forstner bit and overlap each successive hole by about 25% (see photo, p. 36). This leaves little to clean out with a chisel, creating a quick, accurate mortise without the need for a hollow-chisel mortiser.

Use hole saws for large diameters—To cut a large hole easily in materials up to 1½-in. thick, use a hole saw. Hole saws are pressed steel cups with sawteeth cut into the rim. They are available in many sizes, starting at ¾ in. dia. and increasing in small increments to over 5 in., and they mount on an interchangeable arbor with a centering drill bit. The assembly chucks into the drill press. Use slower speeds for these tools.

The trick for plug cutters—Plug cutters work great for cutting edge-grain plugs that cover screw holes. There are basically two types: One cuts a tapered plug and the other cuts a straight plug. The best way to cut plugs is to use stock that is thicker than the plug length, cut to the depth of the plug cutter, and then make a resawing cut on the bandsaw to free the plugs.

Drill presses are great for sanding

Sanding drums work well for edge-sanding, especially when the piece has an irregular or curved edge. For a smooth, fair curve, use as large a drum as possible, and keep the pressure light and the piece moving steadily. Drums are available in at least a couple of variations, one that takes cylindrical sanding sleeves and another that accepts flat sandpaper. □

Roland Johnson is a woodworker and tool enthusiast in Sauk Rapids, Minn., and a contributing editor to Fine Woodworking.

An essential set of bits

For most drilling tasks in wood, use brad-point bits. They have a center spur for accurate location, outer spurs for cleanly cutting the wood fibers at the rim of the hole, and helical flutes that quickly evacuate waste, allowing deep holes without constantly backing out the bit to clear waste. They also cut a relatively flat bottom.

With their straight leading edges and knife-edge or toothed cutting rim, Forstner bits cut even cleaner holes, with flatter bottoms, than brad-point bits. Because they register off their rim, these unique bits can enter angled surfaces and turned work cleanly and accurately. The only drawback is that they must be raised frequently to clear chips.

Twist bits are inexpensive workhorses that work well for boring end-grain holes and, when sharp, cut clean enough for many woodworking needs. They will keep a sharp edge when drilling hardwood, composite material, plastic, and soft or ferrous metals. One great feature of a twist bit is that it is relatively easy to sharpen on a bench grinder.

Straight holes aren't ideally suited to traditional wood screws. For better holding power, tapered twist bits also drill the countersink and even can drill a counterbore for plugging.

For countersinking alone, a Weldon-style countersink gives the cleanest results.


BRAD-POINT


FORSTNER


TWIST


TAPERED TWIST


COUNTERSINK

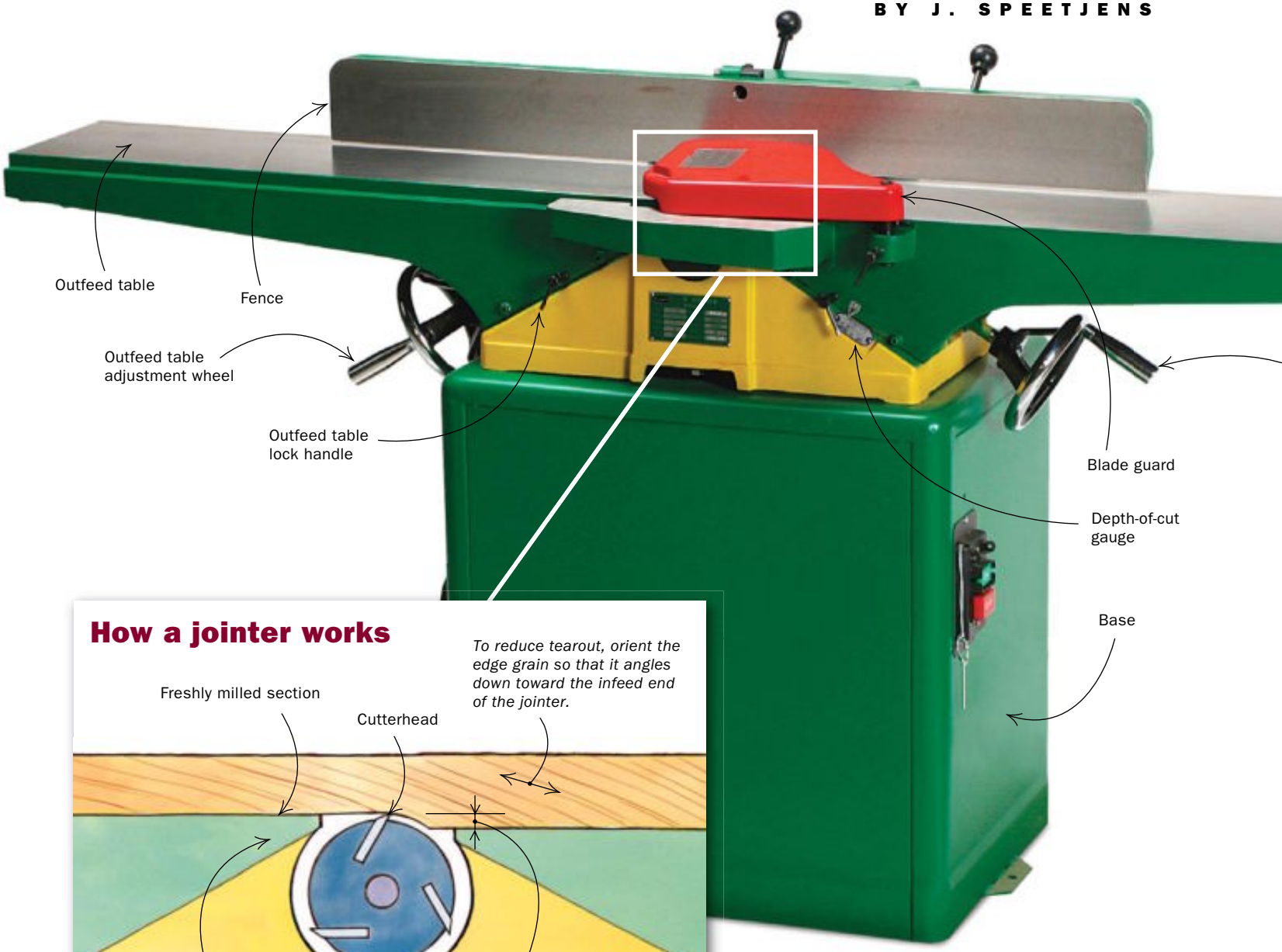
DRILL LARGE, CLEAN HOLES WITH A HOLE SAW

Drill from both sides. *With the workpiece secured safely, drill partway through the first side (1) so that the center bit pops through the back. Then flip the stock and find the center (2). Finally, finish the cut and remove the plug (3). Because it is only half-buried in the saw, the plug can be knocked free much more easily.*

Jointer

Use this shop mainstay to make straight, flat boards, plus tapers and roundovers, too

BY J. SPEETJENS

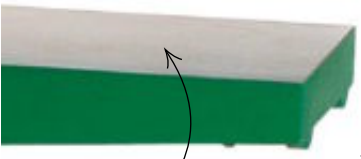


How a jointer works

Photos: Steve Scott; drawings: Stephen Hutchings

The first step in any woodworking project is to begin with straight, flat stock. It is the foundation of quality work. That's why the jointer—a machine designed to straighten and flatten rough boards—is central to everything I do as a woodworker.

A jointer consists of a horizontal cutterhead mounted between two dead-flat, cast-iron tables that sit end to end. A board pushed lengthwise across the machine passes over the cutterhead as it moves from one table to the other. The outfeed table is set to match the height of the knives, with the infeed side slightly lower. This height difference determines the depth of cut. The machine quickly creates a flat face on a rough board or a straight edge that is square to that flat face, both crucial steps in milling stock to be flat, straight, and square.



Infeed table

Infeed table adjustment wheel

But the jointer handles more than these core operations. It offers a convenient alternative to other tools that need special templates, jigs, or other lengthy setups to taper furniture legs, fit doors, and cut long chamfers, bevels, and roundovers. Here's how to get the most from this pivotal machine.

The fundamentals of clean, safe cuts

There are some basic guidelines for operating the jointer safely and for getting high-quality results.

For safety, keep the guard in place and use a push pad and a push stick whenever possible to keep your fingers away from the cutterhead. I use a push pad and a push stick for all face-jointing operations and a push stick for all edge cuts on boards less than 3 in. wide. The minimum safe length that can be cut on most jointers is 12 in. Use a roller stand or other support for long or heavy boards.

For most material, orient the stock so that the grain angles down toward the infeed side of the cutterhead. For woods with interlaced or curly grain, make light test cuts to determine the best feed direction.

Concentrate on applying light downward pressure to the surface of the board as you feed it over the cutterhead at a moderate, consistent pace. Apply only enough pressure to prevent the board from bouncing on the cutter. If you deflect the bow or cup during the cut, it will remain afterward.

Feeding stock into the cutterhead too quickly will cause tearout or a wavy surface. But if you go too slowly, you risk dulling the blades or burning the wood. Stopping in the middle of a cut will leave a burnished dimple or a burn mark.

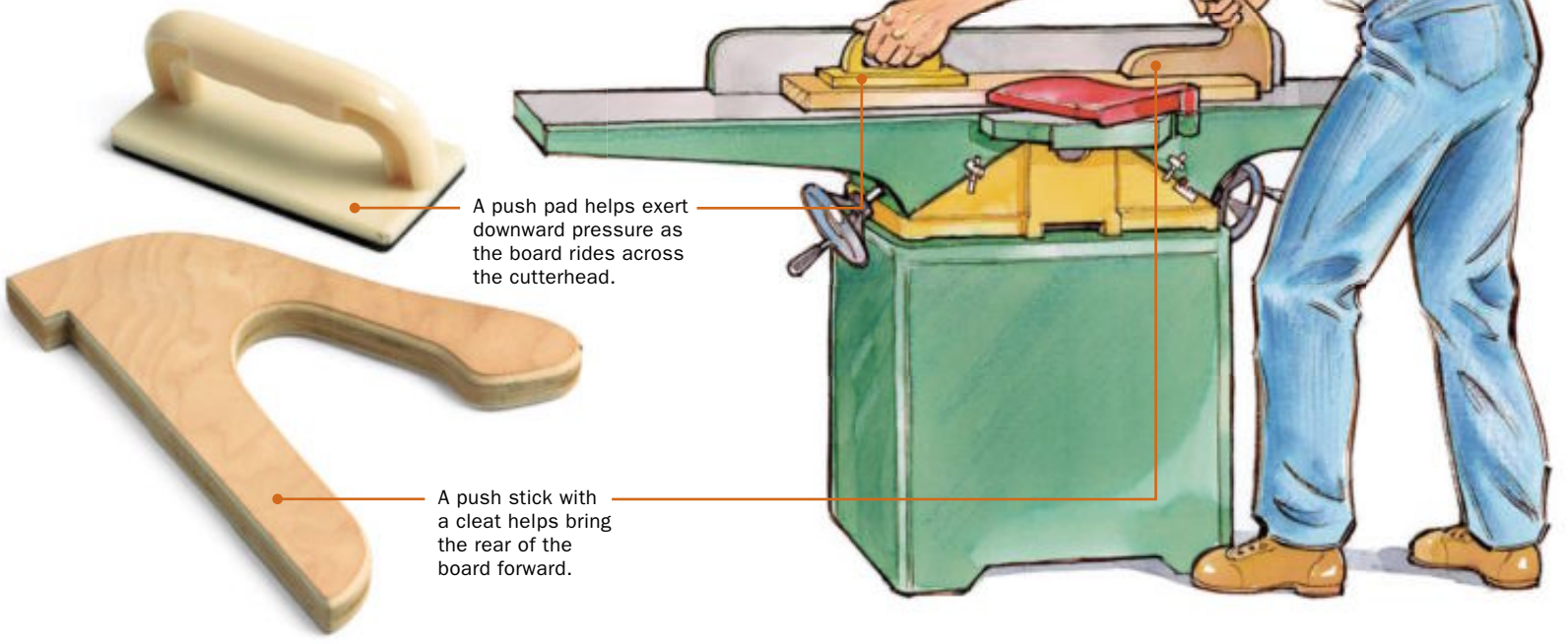
Jointing cupped, bowed, or twisted stock

After rough-cutting stock slightly oversize, the next step in creating dimensioned lumber is face-jointing. The goal is a flat surface that will ride on the planer bed when you use that machine to bring the stock to the desired thickness. For most boards, make your first jointer pass with the bow or cup facing down.

To face-joint boards shorter than 4 ft., stand near the cutterhead and use your left hand to apply light downward pressure with a push pad near the leading end of the stock. Hook a push stick over the trailing edge if you can reach it comfortably. If not, start the cut by feeding the board with your right hand and then switch to a push stick before your right

KEEP A STABLE STANCE AND PROTECT YOUR HANDS

Distribute your weight evenly and try to remain in one spot unless you're working with an especially long board. Keep a push stick and a push pad near the jointer and use them often, especially when working with small stock that will put your hands near the cutterhead.



A push pad helps exert downward pressure as the board rides across the cutterhead.

A push stick with a cleat helps bring the rear of the board forward.

Jointer basics: flattening the face and squaring an edge

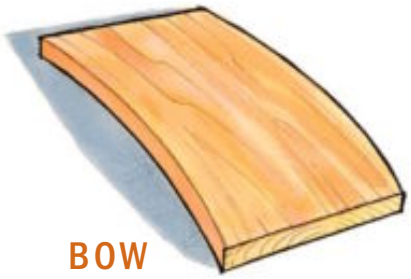
The jointer plays two crucial roles in squaring stock. After you cut stock to rough dimensions, use the jointer to flatten one face prior to thickness planing. Afterward, use the jointer again to straighten one edge before ripping the board to final width.

CUP

Cup refers to the curve across the width of a board and is most pronounced in flatsawn lumber. You can minimize waste in jointing by ripping rough stock beforehand into the narrower widths you'll use in your project.

Flatten a cupped board. *Mill with the concave side facing the cutterhead so that the board rests on the two "lips" of the cup. Don't press down hard in the middle. Exert just enough pressure to keep the stock from chattering as it crosses the cutterhead.*

The first pass shows results. *The edges that contacted the cutterhead are flat. Subsequent passes will widen this area until the entire board has been surfaced.*



BOW

Bow is the curvature of a board's face along its length. You can reduce bow in a piece of long stock—and minimize the waste in jointing—by cross-cutting it into shorter lengths.

Bow, like cup, should face the cutterhead. *To correct a bowed board, apply light pressure at the leading and trailing ends of the board. Do not press down in the bowed middle.*

The cutterhead joints the ends of the board first. *On subsequent passes, the cutter will take more of the stock.*

hand gets near the cutter. Keep the push pad in your left hand positioned over the first few inches of the outfeed table.

For longer boards, I stand at the trailing end to start. I feed the cut with my right hand, switching to the push stick as the cut progresses. I keep the push pad in my left hand as far forward as I can reach comfortably, exerting light downward pressure.

For pieces that are bowed and cupped on opposite faces, make the first pass with the bowed face down. Use the push pad to control rocking, removing the most material from the middle of the board's width.

Minor twists are not difficult to deal with, but large twists—if improperly identified and managed—can prevent you from getting the maximum thickness out of a piece. Place the board on a clean, flat surface. With three corners touching the table, gauge the height of the elevated corner.

For twist of ⅛ in. or less, use the push pad to rock the board so that two diagonal corners are touching the infeed table and the other two corners are elevated equally. Place the push stick at the rear corner that is touching the table to avoid deflecting the raised corners. Reassess the twist after the first pass.

For boards with larger twist, place a stack of small veneer shims, about ¾ in. by 1 in., under the high corner at the board's trailing edge so that the two high corners are elevated equally. Joint as if you had a minor twist. Make sure that you don't deflect the raised corner on the leading edge. One pass should reduce the twist enough that shims are not needed for the remaining passes.

Straightening crooked boards

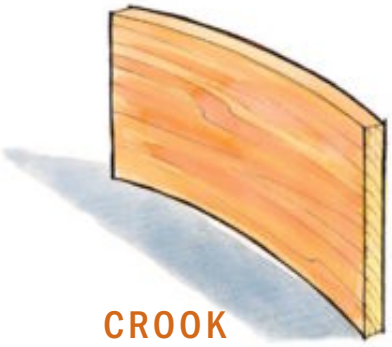
After you've jointed one face flat and used the planer to make the opposite face parallel, the next milling step is to joint

TWIST

Twist occurs where the two long edges of a board are bowed to varying degrees and so are not parallel. To maximize yield when jointing twisted stock, keep the board as level as possible as it rides its two low corners.

A little shimming can help. *Mill large amounts of twist out of a board by shimming the high corner in back to about the same height as the opposite high corner.*

The first pass yields two starting points. *The low corners touching the table are surfaced first. On subsequent passes, apply pressure on these corners to keep the board level and steady.*



CROOK

Edge-jointing straightens a board's edge by removing crook, a concave curve along an edge. The process also makes the edge square to one face. You can joint an edge before rough-cutting stock to create a reference surface for the saw's rip fence.

an edge to make it square with the two faces. Most of the time, I joint the crooked or concave edge.

For safety, I edge-joint stock that's between 1½ in. and 3 in. wide using the tip of my thumb and the side of the index finger of my left hand to guide the board and keep it against the fence. I feed the stock with a push stick in my right hand (see photo, right).

For wider boards, I feed and guide the cut freehand, but I make sure to hook a few fingers or a thumb over the top of the jointer's fence to prevent my hands from slipping toward the cutter. For pieces

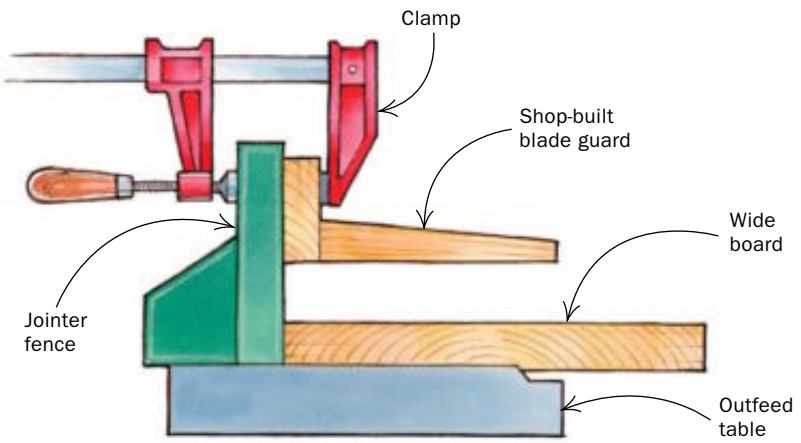
Edge-joint with the bowed or crooked side down. *Use a push stick at the back edge for any stock less than 3 in. wide, along with a push pad in front for anything narrower than 1½ in.*

Beyond the basics: wide boards, tapers, and profiles

FLATTENING WIDE BOARDS

Face-jointing boards wider than your cutterhead requires removal of the blade guard. Create a new blade guard before attempting this.

1 *The task is half finished.* *An initial pass surfaces one side of the board, but leaves the other rough. If the rough strip is narrow, clean it up with a handplane.*



2 *Joint the other side.* *The finished surface may still be somewhat uneven and require cleaning up with a handplane before it is ready for the thickness planer.*

narrower than 1½ in., I use both a push pad and a push stick.

The most efficient way to straighten a badly crooked board is with a series of cuts that start at the end and go to the point where the edge of the board clears the cutter; then reverse the board and joint from the other end. Do this until most of the crook is removed. Finish up with at least one pass that runs the length of the board.

After one edge has been jointed, you can straighten the second edge with a ripping cut on the tablesaw.

Make tapered cuts to shape or fit parts

Among other things, tapered cuts can be used to straighten convex surfaces, fit doors and drawer faces to their openings, or mill a tapered leg. Make a tapered cut by lowering the work onto the cutters while the machine is running. Carefully pull the blade guard back with your left hand or push it aside with the end of the board. Place the board's leading end about ½ in. over the near edge of the outfeed table and feed the cut as normal. The amount of the taper is equal to the depth of the cut. Depth settings of 1⁄16 in. or less reduce the risk of tearout. Multiple cuts make larger tapers.

The type of taper and the proportions of the piece to be tapered will determine the best way to lower the work onto the cutter. To mill a taper on the face of a board, on the edge of a long, narrow board, or on a board that will receive only a partial taper, place the leading end onto the outfeed table. Lower the near end of the board onto the infeed table.

To taper the edge of wide boards or cabinet doors, set the trailing edge on the infeed table and lower the leading edge carefully onto the outfeed table. Note that even a properly adjusted jointer will leave a small divot where the work was lowered onto the cutter. If the divot is significant, clean it up with a light pass over the entire length afterward.

You also can use tapered cuts to straighten the back side of a board that is bowed or to straighten the convex edge of a crooked board. Rock the board backward with the push stick, elevating the front edge above the cutter and onto the outfeed table. Ease up on the downward pressure on the push stick and lower the board onto the cutter. Feed the rest of the cut as normal. □

J. Speetjens makes furniture and cabinetry in Greensboro, N.C.

TAPERING A LEG

For a partial taper, place the leading end on the outfeed table and gently lower the piece onto the infeed side before passing the work over the cutter.

Tapering a leg. *Begin the taper by resting the workpiece on the outfeed table and lowering it onto the cutterhead.*

Take several passes. *Begin each pass in the same way. Soon enough, the taper becomes pronounced.*

CUSTOM PROFILES

Tilt the fence to easily chamfer the edges of a board along its length or to mill bevels up to 45°. Combine bevels to cut simple profiles.

BEVELING NARROW STOCK

Tilt the fence back to bevel narrow stock. *This allows clear access with push sticks and push pads. Take care—very narrow boards tend to slip away from the fence.*

BEVELING WIDE BOARDS

Tilt forward to bevel wider boards. *In this way, the stock is less likely to be levered away from the cutterhead as you make the pass.*

BULLNOSE PROFILE

Only a few passes are needed to create this bullnose. *Adjust the fence back and forth as needed to cut the various angles that are required. The multifaceted surface can then be handplaned, scraped, or sanded smooth.*

Dovetail Jigs

How to create a complex joint the easy way

BY ANISSA KAPSALES

I've been known to spend hours laboring over hand-cut dovetails. First, I fret over the layout, drawing half-pins at each end of the row and creating an attractive layout between. Once I'm satisfied, I move on to sawing and paring the pins, laying out the tails as precisely as I can, then more sawing and paring to sneak up on a good fit.

I enjoy the challenges and the satisfaction of cutting dovetails by hand. So when I decided to learn how to cut dovetails with a jig that guides a router, I began with a definite bias against any shortcut. By the time I'd finished my first drawer, I could appreciate the advantages that dovetail jigs offer.

A jig's greatest assets are speed and ease of cutting. After you go through a fussy initial setup, it takes very little time to cut a lot of perfectly fit dovetails, more than compensating for the setup time. A chest of drawers, a run of box parts, or drawers for an entire kitchen are ideal applications for one of these jigs. Once you dial everything in, you could easily cut all the joints you need in a couple of hours.

There's a learning curve with dovetail jigs, and every jig seems to have its own set of quirks. But in my experience, a careful trip through the instruction manual and a manageable period of trial and error are all it takes to successfully cut tight-fitting, attractive joints.

If you're a beginning woodworker and haven't mastered the hand-cut dovetail, a jig can allow you to use an extremely strong, attractive joint that you might otherwise have to leave out of your repertoire.

How they work

Dovetail jigs use one or more templates that resemble the spread-out fingers on a

Photos: David Heim

Half-blind dovetails

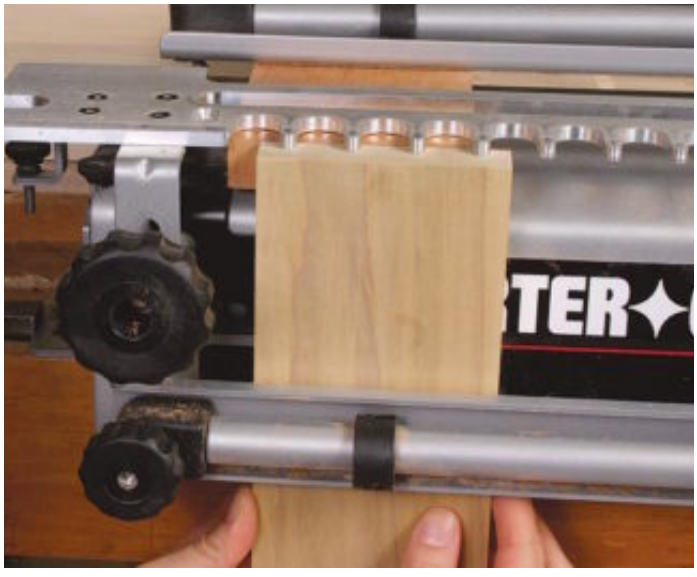
Lock up. *Cams on an adjustable locking bar secure the workpiece for the dovetail pins. A piece of scrap the same thickness as the workpiece will keep the jig's template in line.*

Align the template. *The small brass knob lets you align the template precisely over the pin board. The big knob locks down the template.*

Centering pins. *The pin board registers against an adjustable stop at the left edge of the jig. Once you center the board under the template fingers, you can slide the stop into place.*

hand; guiding a router into the spaces between the fingers creates pins or tails, depending on how the workpiece is clamped into the jig. There are separate templates for half-blind dovetails and through-dovetails. For half-blinds, both boards are cut at the same time; for through-dovetails, the tails are cut first. Some jigs are designed to cut only half-blinds, but I think it makes sense to invest in one that also can cut through-dovetails.

The Porter-Cable 4212 jig shown here (street price, $150), earned the Best Value distinction in a recent *Fine Woodworking* review. One of the easiest jigs to use, the Porter-Cable has fast-acting cam clamps to hold the boards, and it has setup lines and instructions etched into the router



Aligning tails. *The same stop that registers the pin board also registers the tail board.*

Half-blind dovetails (continued)

Half-blind bit depth. *An adjustable stop lets you set bit height precisely for cutting half-blind dovetails. Labels on the jig provide useful reminders for adjustments that yield a tight-fitting joint.*

A joint in one quick pass. *A template cuts both halves of a half-blind dovetail joint at once. A guide bushing on the router base makes it easy to move the bit in and out of the fingers.*

ADJUSTING THE FIT OF HALF-BLIND DOVETAILS

Raise or lower the bit. *Even with careful setup, joints can be too loose (top left) or too tight (left). The solution is to tweak the bit height (above)—lower to make the joint tighter, higher if pins and tails are too tight.*

templates. It also has a useful gauge to help you set the router-bit height.

Sweat the details for a better outcome

Simply using a jig doesn't ensure a well-made joint the first time. The wood needs to be positioned properly under the fingers of the jig, the template lined up evenly across the top of the wood, and the router-bit depth adjusted precisely.

There are a few things you should pay attention to that will ensure success with a jig. Just as you do when hand-cutting dovetails, you should mark the boards and keep track of their orientation to the jig. Note whether the outside or the inside of the board goes against the jig, and then mark the boards so you don't get things mixed up. Otherwise, you may well wind up with a board cut so that the face you wanted outside is now on the inside. Mill extra stock to use for the test cuts that are a necessary part of the setup.

Setting the depth of the bit can be the most time-consuming and critical part of using a dovetail jig. With many jigs (the Porter-Cable is an exception), you'll have to resort to trial and error.

If you're cutting through-dovetails, fit a tail board into the horizontal position of the jig, set the router on top, and adjust the bit to the depth of the wood plus a hair more. That will leave the pins slightly proud; trim them flush with a block plane.

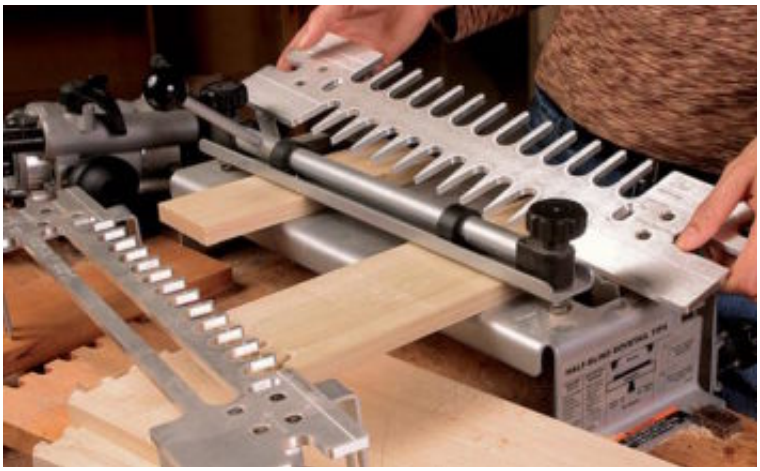
Setting the bit for half-blinds may involve more trial and error. Clamp the pin board in the jig horizontally, the tail board vertically, and set the router bit for the depth of the half-blind—or what you think the depth should be. I found that even with the Porter-Cable's bit-depth guide, it takes several test cuts to get the depth just right for a good, snug fit.

Expect the joint to look machine-made

No jig can produce the slightly irregular, super-thin dovetails that are the hallmark of hand-cut joinery. However, machine-cut dovetails are still attractive because they are neat and orderly, and they fit well. Some jigs let you adjust the spacing of pins and tails, up to a point. But most are uniform and fixed, and none allows a completely customized layout.

Jigs also limit the width and thickness of boards you can use. Generally, a dovetail joint should have a half-pin on each end. Because of the jig's spacing limitations,

Through-dovetails



Through-dovetail template. *Through-dovetails require a double-sided template and two router bits. The straight fingers guide the router to cut tails; the tapered fingers guide the cut for pins.*

The wood guides the depth. *The workpiece thickness determines bit depth. Set the bit a hair past the edge of the board, leaving the pins slightly proud. They can be trimmed flush later.*

Finished tails. *The dovetail bit supplied with the jig cuts the tails. To prevent tearout, use scrap to back up the workpiece.*

Beginning the pins. *Once you've cut tails for all the pieces, you need to flip the template to get ready to cut pins.*

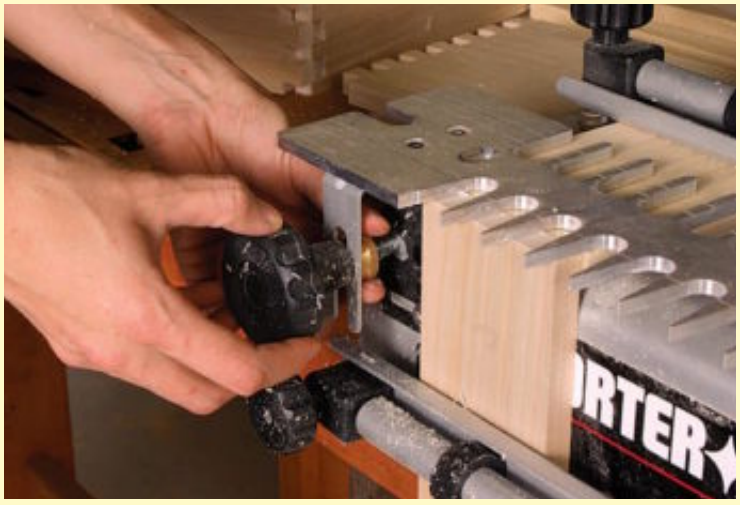
Finished pins. *The straight bit supplied with the jig cuts the pins. Here, too, scrap backs up the cut to prevent tearout.*

you can begin and end with half-pins only on boards of specific widths. For example, the Porter-Cable jig I used worked best with boards that measured 3¼ in., 4¼ in., 5¼ in., and so on.

I also learned from experience what can happen when you use stock that's too thin for a particular template and router bit. The half-blind joint was fitting together rather well and the layout was nicely symmetrical, but I had small crescent-shaped gaps on the inside of the joint. I had to check everything before I realized that the gaps were the result of using stock less than ½ in. thick. Once I recut the joint using thicker stock, everything worked. □

Anissa Kapsales is an assistant editor at Fine Woodworking.

ADJUSTING THE FIT OF THROUGH-DOVETAILS



Move the fence. *If the joint doesn't fit well, the solution is to use the locking knobs to fine-tune the position of the template: forward to loosen the joint, back to tighten it.*

Mortiser

Simple tips for setup, sharpening, and cutting make the tool a joy to use

BY ROLAND JOHNSON

A mortiser, also called a hollow-chisel mortiser or mortising machine, cuts mortises remarkably quickly and accurately. Indeed, this machine can cut a typical mortise for a table apron in well under a minute. Benchtop models are most common, although larger, freestanding machines also are available.

On the downside, mortisers define the word finicky. If yours isn't set up and used correctly, you'll wonder why you bought one.

Fortunately, mortiser-induced headaches can be treated with relative ease. Simply follow the steps outlined here, and you'll find that quick, clean, and accurate mortises become the norm, not the exception.

A sharp chisel and bit are a must

A mortiser won't work effectively when the bit and chisel are dull, so keep both parts sharpened (see photos, facing page). No need for a lot of tools, just a chainsaw file, a round and a flat slip stone, a little sandpaper, an abrasive pad, and some honing oil. Don't expect a brand-new bit and chisel to be adequately sharp. Almost all I've seen needed extra attention out of the box.

Hone the outside faces of the chisel—I begin sharpening by honing the four outside faces of the chisel. To ensure that I'm honing a flat surface, I use spray adhesive to mount P400- and P800-grit

KEYS TO SUCCESS

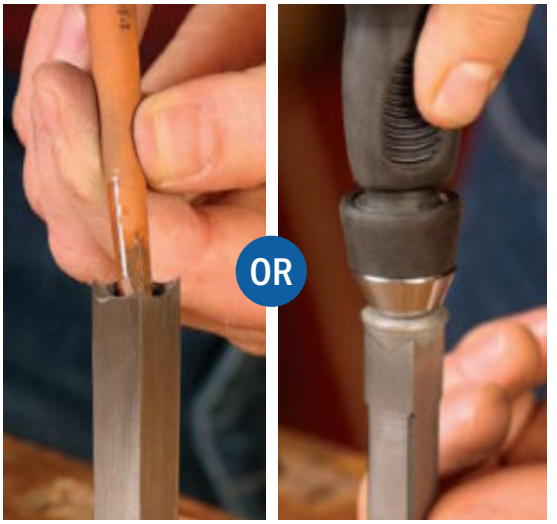
Mortisers require extra attention, but the payoff makes it all worthwhile. Don't ignore any of these steps.

Photos, except where noted: Tom Begnal; this page (bottom left) and facing page (top left): Kelly J. Dunton

Cutters need sharpening

Like any cutting tool, a mortising chisel and bit must be sharp to work well. A few minutes spent sharpening pays many dividends.

Smooth the outside surfaces of the chisel. *A chisel with rough outside faces can't be sharpened and won't be easy to plunge and retract. Use fine sandpaper on a flat surface to smooth all four sides.*



Hone the bevels. *A little work with a round slip stone (left) or a special, cone-shaped, diamond-coated abrasive (right) produces fresh, sharp edges that ensure a cleaner cut. Use a flat slip stone on the outer faces to remove the burr that results.*

sandpaper to a granite plate. A piece of plate glass glued to ¾-in.-thick hardwood plywood also makes a good, flat sharpening surface.

To reduce clogging, I spend time tuning up the bore. The smoother the bore, the easier it is for chips to slide up the auger bit. I use a chainsaw file to remove any internal burrs or machining grooves. A small, round, tapered slip stone works well for cleaning up the ejection slot.

Hone the bevels—A round slip stone is all that's needed to hone the bevels. Keep in mind that not all mortiser chisels have the same bevel angle. Clico, a British manufacturer, and Asian and Japanese sourced chisels use a 60° bevel angle, while Forest City, a U.S. maker, uses a 45° bevel.

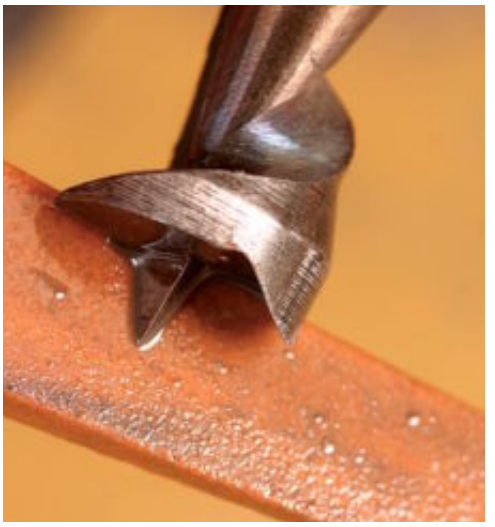
With the shank of the chisel secured in a vise, place the slip stone flat against a bevel and work it back and forth with a light touch. Be sure to wet the stone first with a few drops of honing oil. To avoid creating a groove, keep the stone moving from side to side along the bevel and don't stay in one spot for more than a few strokes. Try to remove about the same amount of material from each bevel.

If you prefer a process that's somewhat less fussy, there is a special cone-shaped tool (available from Rockler; www.rockler.com) that allows you to sharpen all four 60° bevels at once. If the chisel has a 45° bevel, tilt the cone and sharpen only a portion of the bevel at a time.

Honing the bevels will produce a burr along the outside edge of the chisel. To remove it, hold a flat slip stone flat against the outside face of the chisel and drag the stone lightly toward you.

Sharpen the bit—Depending on the manufacturer, the auger-style drill bits for mortiser chisels are either a single spur/flute brad point or a double spur/flute without a centering point. I find that the single spur/flute with its higher-helix flute evacuates chips faster than the double-flute bits. But any type you use must be sharp and burr-free.

In an auger-style drill bit, all the cutting gets done in just two places: at the spurs and at the flutes. So that's where



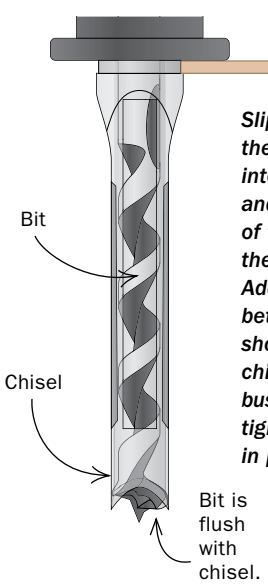
Sharpen the bit. *Use a flat slip stone to hone the bit in two places: the spur and the cutting edge. If your bit has a centerpoint (not all do), hone each of the three facets of the point, too.*

Add some lubricant. *To help reduce friction during cuts, spray both chisel and bit with dry lubricant after sharpening. Later on, when cutting mortises, an occasional squirt of lubricant on the chisel and bit will fight friction.*

Set the right gap

A sharp chisel and bit are not the end of the story. The two parts must be installed correctly to minimize friction and maximize chip removal.

1 TIGHTEN THE CHISEL IN THE BUSHING

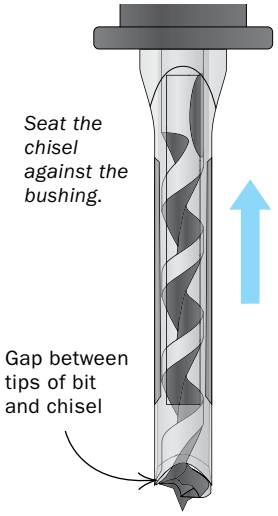


Slip the shank of the chisel into the bushing and the shank of the bit into the bit chuck. Add the spacer between the shoulder of the chisel and the bushing, and tighten the chisel in place.

2 TIGHTEN THE BIT IN THE CHUCK

While holding the spur of the bit about flush with the points of the chisel, tighten the shank of the bit in the drill chuck.

3 NOW READJUST THE CHISEL



Remove the spacer and raise the chisel until it butts against the bushing. A squaring board ensures that the chisel is square to the fence. Tighten the locking knob.

you need to sharpen. If the bit has a brad point, I usually sharpen the point, too. The machining process at the factory sometimes leaves ridges or burrs at the transition area between the spurs and flutes. Use a slip stone to smooth any you find. After that, polish the flutes with a medium-grit abrasive pad to create a slick route for the chips to follow.

Install the chisel and bit correctly

The installation of the chisel/bit in the mortiser should follow a precise sequence. If you do it properly, the chips will eject easily and the hole will be square to the workpiece.

Determine the gap—When installing the chisel and bit, it's important to have the proper gap between the chisel bevels and the end of the bit. I vary the gap based on the size of the chisel and the material. Softwood typically produces large chips that can clog the chisel quickly. Large mortise chisels and bits also make large chips, even in hardwood. I like to leave a 1⁄16-in. to 3⁄32-in. gap when using small (1⁄4 in. and 5⁄16 in.) and medium (3⁄8 in.) bits in hardwood. A little more clearance, about 3⁄32 in. to 1⁄8 in., is adequate for small and medium bits in softwood. For large bits (1⁄2 in. and larger) in hardwood and softwood, a full 1⁄8-in. gap works best. These clearances aren't carved in stone, so if you find the going tough or your chisel plugging frequently, try increasing the gap between the chisel and bit.

Set the gap—Knowing the gap that's needed, you can go ahead and install the bit and chisel. Be aware that the points on the chisel are very sharp, so use care. I usually wear a leather glove on the hand supporting the chisel and bit.

First, rip a piece of scrap stock to the thickness of the intended gap to use as a spacer. Then place a short length of board on the mortiser table to forestall any damage to the points of the chisel or the cutting flutes on the bit should either be dropped.

Insert the bit into the chisel. Then slip the shank of the bit into the bit chuck and the shank of the chisel into the mounting bushing. (Some machines require a sleeve sized to fit the chisel shank.) At the same time, place the spacer between the shank of the chisel and the bushing. Then tighten the chisel. After aligning the spur of the bit with the chisel points, tighten the bit.

To complete the gap-setting procedure, remove the spacer and raise the chisel until the shoulder is seated tight to the bushing. Tighten the chisel, and the offset will be correct.

The chisel must be parallel to the fence—Slip a flat piece of wood—I call it a squaring board—between the fence and the chisel. Next, loosen the fence and chisel and, keeping its shoulder tight to the mortise-head, rotate the chisel and pull the fence

Drawings: Kelly J. Dunton

Start cutting mortises

With the chisel/bit sharpened and installed, the general setup procedure is over. Now make the final machine adjustments for the mortise you want and follow a specific cutting sequence.

1 SET THE MORTISE DEPTH

After marking the mortise depth on the end of the workpiece, lower the chisel and bit to the marked line and set the depth stop on the machine.

forward until the chisel sits flat against the board. Then tighten the chisel.

Square the chisel to the table—Make sure the centerline of the chisel is square to the table in two directions; front to back and side to side. Use a square to do the checking. Don't panic if all's not well. Most mortisers have the mortising head and support column mounted to the table with bolts. It's a simple matter to loosen those bolts and shim (I use automotive alignment shims) the appropriate side of the column base to get the chisel square to the table.

Square the fence to the table—When the fence isn't square to the table, the mortise won't be square either. Check it with a square. If it's off more than say, 0.005 in. over 3 in., you'll need to shim the fence bracket where it attaches to the base or add a wooden fence that can be shimmed or beveled to square.

Hold-downs keep the workpiece on the table—Position the hold-down so that there is just enough clearance to allow the workpiece to slide under the hold-down without binding. I keep a 1/64-in.-thick strip of stock handy as a spacer.

2 ADJUST THE HOLD-DOWN

A thin, wood spacer creates a slight clearance between the top of the workpiece and the hold-down, making it easy to slide the workpiece sideways.

Avoid overlapping cuts

In the first cut by a bit and chisel, all four faces of the chisel will get equal support, so the bit is sure to stay square to the table throughout the cut. But if the next cut overlaps the first so that one side is unsupported, the chisel will tend to bend slightly toward that unsupported side. That causes the outside of the bit to rub against the inside of the chisel, which leads to friction, heat, and noise.

To avoid the overlap problem, make a pair of cuts, one on each end of the mortise. Then make a series of unconnected cuts to begin to remove the waste stock in between the ends. Leave a little less than a bit's width between these cuts. That way, the chisel is always fully supported. After that, go back and make cuts as needed to clean up the mortise. □

3 CUT EACH END OF THE MORTISE FIRST

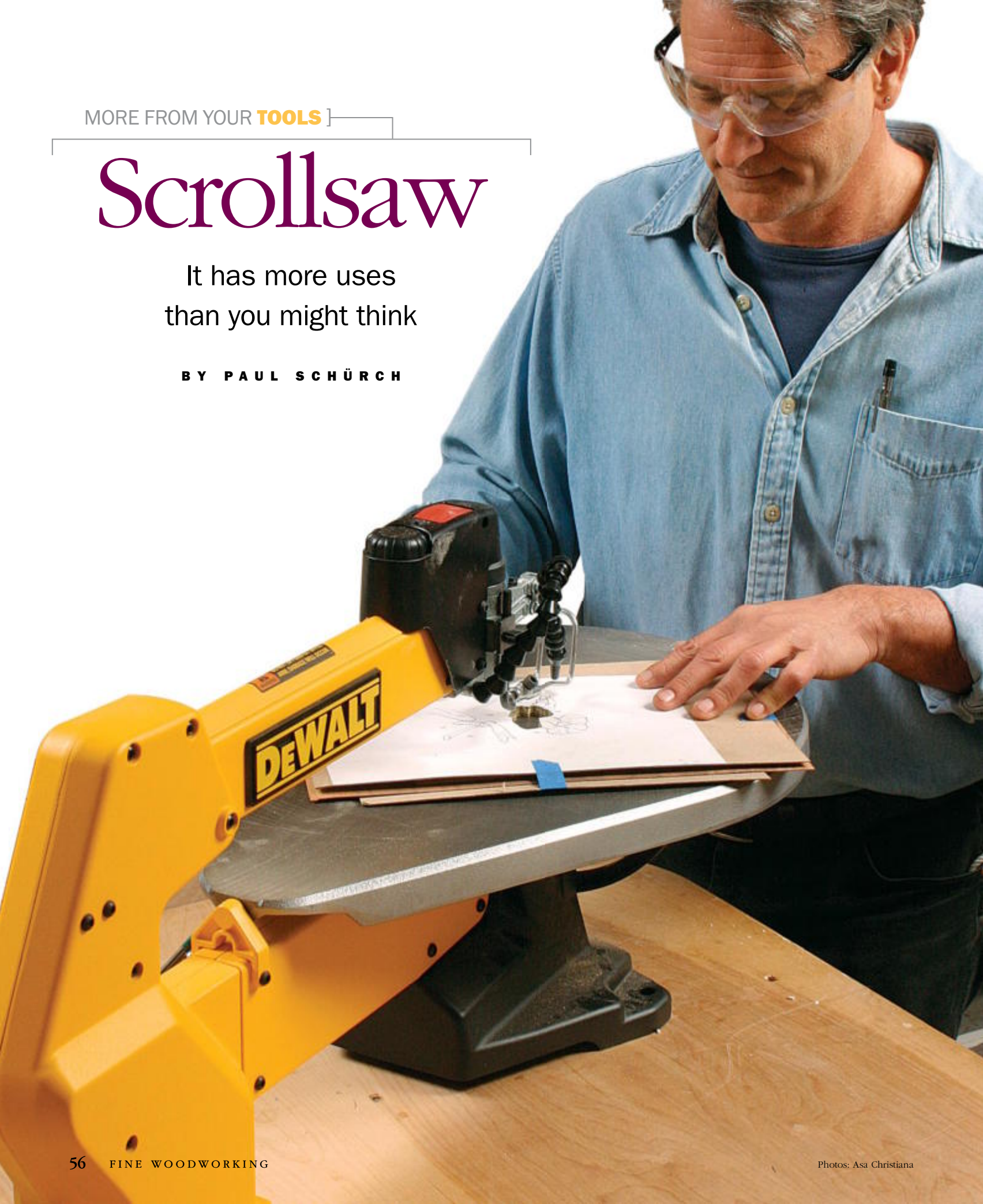
Make two cuts, one at each end of the mortise (left). Then make a series of cuts, leaving a web of wood in between each cut. Last, make cuts (above) to clean out the webs.

Roland Johnson is a woodworker and tool enthusiast in Sauk Rapids, Minn., and a contributing editor to Fine Woodworking.

Scrollsaw

It has more uses than you might think

BY PAUL SCHÜRCH



Photos: Asa Christiana

The scrollsaw holds extremely fine blades under tension, allowing it to do jobs that no other motorized saw can do. Unfortunately, many woodworkers think that a scrollsaw is only for hobbyists who make fretwork, bookends, whirligigs, and knickknacks. As a professional furniture maker, I've found the machine much more useful than that, and I believe it makes a valuable addition to any woodworking shop.

I use a scrollsaw to rough out dovetails, to cut mortise-and-tenon templates, to make small mock-ups of furniture I am designing, and to make cuts particular to marquetry, such as cutting "packets" of multiple layers of veneer. I've also cut material such as shell, bone, sheet brass, pewter, and copper for decorative hardware and inlay. It is even possible to cut ⅛-in.-thick glass for a curvy door panel using a barbed diamond-wire blade, or to perform detail sanding and polishing using small belts attached to the scrollsaw like a blade.

It is true that most scrollsaw users don't focus on furniture making. But decorative fretwork and intarsia (a picture made of various woods, of various thicknesses) certainly qualify as woodworking. Some professionals also make a living gluing pictures onto seven-ply, ¼-in. aircraft-grade plywood and scrolling beautiful puzzle patterns. If these areas interest you, there are clubs devoted to scrollsawing, and scores of books and magazines that contain useful information, project ideas, and patterns.

Inlay, marquetry, and beyond

For inlay and marquetry, a scrollsaw is indispensable. The machine gives you an easy and accurate means of cutting highly detailed inlay pieces to add to your furniture. Whether it's a bellflower on a period table leg or a mother-of-pearl square to be used as a decorative element, the process is straightforward. Draw the design onto the inlay material—usually between 1/16 in. and ¼ in. thick—and cut it out on a scrollsaw with the table set at a slight 2° to 4° angle, beveling each edge of the material inward a bit. This is called a conical cut. Then place the inlay onto the background, scribe around the outline with a knife, and hollow out the recess with a small router and a small chisel. Clamp and glue the inlay firmly into place, and then level it with the background after the glue has set. The bevel-cut edges will ensure a tight fit with the surrounding wood.

With a decent scrollsaw, you can step past inlay into the world of marquetry, which involves making detailed pictures by joining multiple pieces of veneer. Panels of marquetry can elevate the look of your furniture and casework. Most midrange saws will perform the basic marquetry cuts well, including the packet, contour, conical, window, piece-by-piece, and boulle methods.

Of all the features on a scrollsaw, the most important are the quick-release blade clamps and a tensioning system that you can access from the front of the saw. I don't like saws that accept only pin blades, because those blades aren't well-suited for cutting very intricate details. Also, look for a saw with an easy-to-reach speed-control knob; it's much handier than a stepped-pulley system.

For packet cutting, my preferred marquetry method, a good scrollsaw and a very thin blade make the job as easy as stacking and pinning together all of the veneers to be featured in the final picture, spray-gluing a drawing onto the stack, cutting out all of

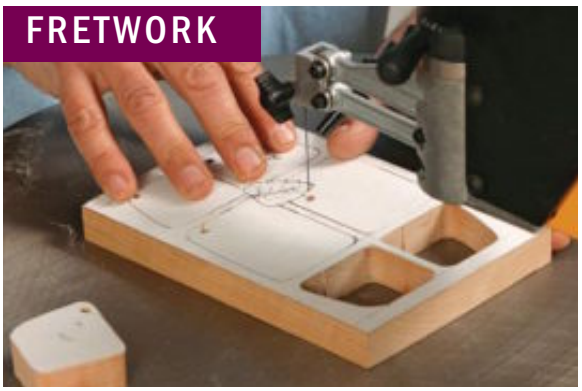
Scrollsaw uses in the shop

Indispensable for marquetry. *A scrollsaw can cut through a thick packet of veneers (facing page) with a very thin blade, cutting out all of the pieces for a picture in one shot.*

Perfect for dovetails. *After the initial cheek cuts are made, the tiny scrollsaw blade makes it easy to cut across the bottom of a dovetail socket and quickly remove the waste.*

An easy way to test designs. *With a scrollsaw, it's easy to cut small, intricate pieces quickly and assemble them using hot-melt glue. This 1/10-scale model is a reading podium.*

FRETWORK



Endless options for pierced work. *Schürch made this jewelry-box tray by cutting out small openings in solid wood and laying that fretwork onto a felt-covered plywood bottom. He detailed the carved leaf after the main vertical cuts were done.*

the pieces in one shot, then pulling the pieces apart and taping them into place. A #2/0 blade leaves only a 0.010-in.-wide kerf, which tends to close up in the final pattern.

Scaled mock-ups of furniture are very helpful in the design process, allowing a 3-D preview prior to drawing and building the actual piece. Models also are great for selling a design idea to a client. A scrollsaw is ideal for the detail work involved in building a model out of thin materials. The pieces can be put together very quickly using hot-melt glue.

I sometimes use a scrollsaw for cutting dovetails, roughing out the pins and tails before trimming them to the line with a sharp chisel, if need be. Other times I make the initial sawcuts with a dovetail saw and then use a scrollsaw to cut squarely across the bottom of each socket, removing the waste. If the blade is tensioned properly, the cuts will be accurate and need very little cleanup. I've seen other woodworkers make the initial cuts on a tablesaw, then use a scrollsaw to remove the waste.

Once you have a scrollsaw, you'll find that lots of odd cuts become easier. I've used one to create matching templates in ½-in. plywood for routing odd-shaped mortises and tenons where large furniture components join. The matching inside and outside templates are attached temporarily to the mating workpieces, where they can guide a flush-cutting router bit. I use this technique often when joining solid-wood legs directly to a top piece. On

Scrollsawing tips

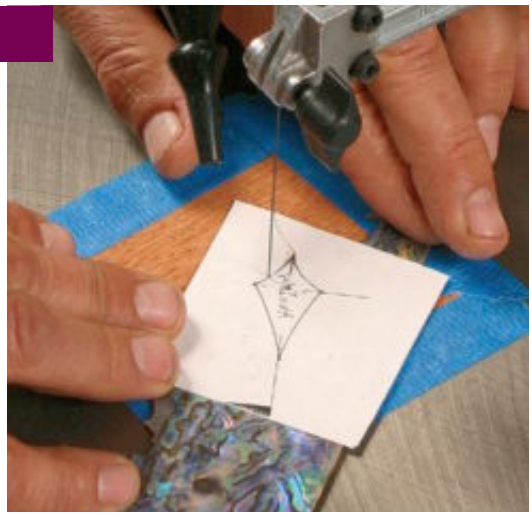
ADJUST FOR DRIFT TO CUT A STRAIGHT LINE

I have found that the toughest techniques to master are cutting straight lines and going around sharp corners. Many blades are milled in a way that can leave the blade slightly sharper on one side, so it tracks like a dull bandsaw blade. To cancel out blade drift when following a straight line, adjust the angle of the workpiece when pushing it into the blade. For best results, work in a series of short pushes, making small corrections as you go. As the blade dulls, the drift gets worse; keep blades well tensioned and change them often.

HOW TO TURN A SHARP CORNER

When cutting marquetry or finely detailed fretwork, negotiating sharp points and corners can pose a challenge. Essentially, you need to pivot the workpiece around the blade while the saw is running, reorienting it toward the new direction. This is accomplished by cutting up to the corner, then slightly pressing the workpiece against the side of the blade. This method stabilizes the workpiece without any unwanted cutting. Now maintain that pressure as you pivot the workpiece into the desired position, shifting the pressure onto the back of the blade as you go.

INLAY



Inlay becomes straightforward. *Tape the design to thin material and cut out the inlay. Then scribe around the inlay piece to lay out the recess. When cutting fragile materials like this abalone, make a zero-clearance plate from a piece of veneer.*

period furniture, I've used a scrollsaw to cut out carving blanks for applied decorative elements.

Setting up your saw

It's important for first-time users to realize that scrollsaw blades break regularly, especially thin ones. A #2/0 blade, for example, will break in five or ten minutes when cutting ½-in.-thick material. A broken blade can make a startlingly loud noise, but it doesn't necessarily mean you are doing anything wrong.

For best results, the blade should be tensioned to roughly an octave above middle C on the piano, or until a clear musical plucking sound is reached. If the blade is too loose, it will make a "thunk" sound when plucked and will tend to deflect in use, distorting the cut, fatiguing the blade, and causing it to break early. With too much tension, the blade will snap more often or slip out of the blade clamps.

A few modifications—I recommend making changes and adding accessories to any scrollsaw. A wider auxiliary table placed over the top of the standard table will support wider work. To turn the saw on and off, a foot-pedal switch (the electrical type that stays on only when the pedal is depressed) takes the panic out of scrolling detail work and stops the noise when the blade breaks. Also, I tape zero-clearance plates of thin cardboard, plastic, or veneer on the saw table to support fragile material and to keep small pieces from dropping through the throat.

I don't like the blade guards on a scrollsaw—they only get in the way—so I remove them. In my classes, with students ranging in age from 8 to 85, I've never seen more than a minor cut as a result. □

Paul Schürch, a furniture maker and teacher in Santa Barbara, Calif., specializes in marquetry.

Blade Sources

SCROLLSAW BLADES

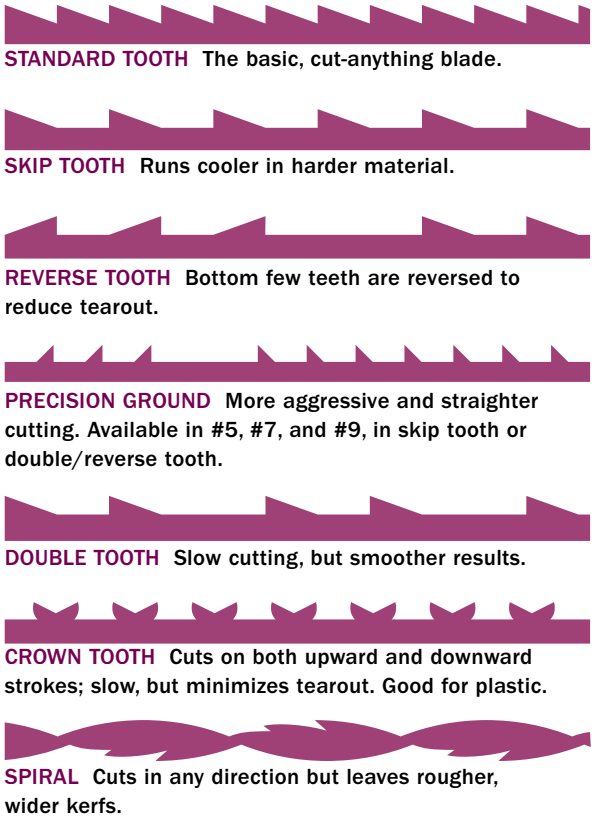
Wildwood Designs
www.wildwooddesigns.com
800-470-9090

Woodcraft Supply
www.woodcraft.com
800-225-1153

BARBED DIAMOND WIRE
for cutting glass and other very hard materials

Alpha Supply,
No. J0510B
www.alpha-supply.com
800-257-4211

Tooth patterns



MATCH THE BLADE TO THE TASK

Scrollsaw-blade sizes range from the smallest #8/0 (pronounced eight-aught) to the largest #12 (sometimes called #0/12), with the most common for woodworking between #3/0 and #8. Thinner blades have more teeth per inch. The orientation of the teeth also is important (see chart at right). For more blade information, check out the excellent chart at www.olsonsaw.com/scroll_chart_1.html.

AN ESSENTIAL BLADE KIT

These are the blades Schürch uses most often, with Olson item numbers in parentheses.

#12 skip tooth (453): Heavy-duty blade for cutting straight lines in thicker material such as plywood.

#5 precision ground, reverse tooth (495RG): Used for straighter-line fretwork.

#5 skip tooth (446): Thinner depth than the precision-ground #5; turns tighter corners. Good for more detailed fretwork, as well as dovetails.

#2/0 skip tooth (440): Used for marquetry and other very finely detailed work. Kerf is only 0.010 in.

#1 metal-cutting (479): For metal, shell, and bone.

Dadoes, Grooves, and Rabbets

The handiest joints are the easiest to make

BY ASA CHRISTIANA

Dadoes, grooves, and rabbets are humble joints, all variations of a simple square recess. But they are also extremely versatile and, with the right techniques, very easy to cut accurately.

For those reasons, you'll find dadoes, grooves, and rabbets almost everywhere in furniture, boxes, cabinetry, and carpentry work, joining everything from big plywood cases to diminutive drawer boxes.

Dadoes and grooves are actually the same in cross-section. Grooves run along the length of a board, going with the grain; dadoes run across a board or panel, going across the grain. A rabbet is like a dado or groove, but open on two sides.

The cuts for all three joints can be made either on a tablesaw or with a router. The ends of the cut can help you decide which tool to use. In general, the tablesaw is best for through-cuts—dadoes, rabbets, and grooves that go from end to end on a workpiece—and the router is best for stopped cuts. The small rounded corners at the end of a stopped cut can be squared up easily with a little chisel work if need be.

Like any woodworking joint, dadoes, grooves, and rabbets need to fit precisely. The best way to fine-tune the fit is to make test cuts on scrap stock before cutting into your real workpieces.

Watch out for bowed stock when cutting these joints on a tablesaw or router table. It doesn't take much of a bow to raise the stock away from the table, making the depth of the slot vary widely. If that happens, use a push stick to try to press down on the panel

Photos, except where noted: David Heim; facing page (router table): Kelly J. Dunton

where it passes over the blades. Or, set up a featherboard to do the job more consistently (see "Featherboards," pp. 90-93). As an alternative, use a handheld router. The short router base will follow the bow in the workpiece, keeping the depth of the cut consistent. Any slight curvature usually disappears when you glue and clamp the piece into an assembly.

Grooves are the easiest

Grooves are the easiest to cut, for two reasons. They usually are very close to a parallel edge, and because they go with the grain, they don't tend to chip out or blow out at the end when you are cutting them.

Through-grooves? Use the tablesaw— If a groove is not stopped, such as down the bottom edge of a drawer side, cut it on the tablesaw, simply running the boards against the rip fence. The tablesaw blade, with its large diameter and dozens of teeth, cuts much more efficiently than a router bit. However, it's not well-suited for stopped cuts because it leaves a long curved section to be cleaned up.

If you have a dado set and lots of grooves to cut, it is worth the time to stack the blades and fine-tune the width with test cuts. Otherwise, just make multiple passes with a standard sawblade. The bottom of the groove won't be as smooth as one cut with a dado set, but this area is usually hidden and isn't an important glue surface.

For smooth and accurate results, get a high-quality stacked dado set, the kind with separate flat blades and thin shims that go between them to fine-tune the width (see photo, next page). Avoid the cheaper, wobble-type dado sets.

When you make any of these blind cuts on the tablesaw—whether for grooves, dadoes, or rabbets—the blade will emerge suddenly from beneath the stock. So be very aware of that exit point and keep your hands well away.

Stopped grooves? Use a router—Use a standard straight bit with straight flutes. In some applications, the rounded corners at the end of the cut won't be seen, so just cut the slot a little longer to allow a square-edged piece to fit in.

Most of the time, a handheld router is your best bet. You can see exactly where to stop, and with a plunge-type router, you can make a series of shallow passes without shutting off the tool.

If the workpieces are very short or narrow, clamp down a workpiece of identical thickness nearby to support the router base. Use the router's edge guide to set the distance between the edge of the workpiece and the edge of the slot.

Router-table tips—The router table is especially good for cutting grooves in narrow or short pieces, but it's best used only for grooves that are open at one end. With grooves stopped at both ends, you'll have to lower the workpiece onto the spinning bit.

In most cases, you should move workpieces from right to left on the router table, so the cutting action of the bit keeps the work pressed against the fence. (A featherboard also helps keep the

Grooves

CUT THROUGH-GROOVES ON THE TABLESAW

Steady pressure. *When cutting grooves or rabbets, press down on the workpiece to ensure that the cut has a uniform depth. Keep hands away from the blade's exit point.*

USE A ROUTER TABLE FOR STOPPED GROOVES

Start and stop. *A pair of blocks clamped to a router-table fence makes it possible to begin and end a stopped groove. The blocks help steady the work as you lower and then raise it.*

Dadoes

A DADO BLADE MAKES FAST WORK OF DADOES ON THE TABLESAW

Go wide. *To use the rip fence when cutting dadoes on a tablesaw, begin with wide stock and rip it to size afterward. To avoid kickback, keep the workpiece tight against the fence. Also, keep your hands clear of the exit point.*

Go sledding. *Use a dedicated crosscut sled to dado narrower pieces. It eliminates the risk of kickback and also backs up the cut to minimize blowout.*

The best type of blade. *A stacked dado set is best. Thin shims let you fine-tune the width of the cut, and the specially designed blades produce a smooth, flat-bottomed cut.*

MAKE A SIMPLE T-SQUARE JIG FOR ROUTING DADOES

A quick router guide. *Two pieces of straight stock, joined at a right angle, make a simple but effective router guide for cutting dadoes.*

Easy to align. *A dado cut into one arm of the router guide makes it easy to align the jig. Just be sure to line up the dado on the correct side of your layout line.*

Quick passes. *Routing dadoes is a simple matter with the T-square jig clamped in place. Router bases aren't always concentric, so don't rotate the router as you cut.*

work in line.) Mind you, not all grooves stop at the more convenient end.

Dadoes are trickier

Because they run across the grain, dadoes are prone to chipout at the end of the cut, whether you're using a tablesaw or a router. You can always use a piece of scrapwood to support the fibers as the cutter exits the workpiece, leaving a perfect cut. But sometimes you can leave the workpiece wider than you need and cut away the chipped-out edge on the tablesaw.

Be aware that sheet goods like plywood usually run a bit thinner than their stated nominal dimension, so standard router bits will cut oversize dadoes. Fortunately, slightly undersize bits are available.

Tablesaw is faster but can be unsafe— For accuracy's sake, I like to cut dadoes in one pass with a dado set, without moving the fence. The safest way is to use a crosscut sled (see photo, left), the type that runs in the miter slots on the saw table. A sled will support very big workpieces, and it is a much safer way to guide the workpiece than running the far end against the rip fence. Of course, the dado will cut a big slot in your sled, so you'll probably need to dedicate the sled to the task. The sled's fence also prevents blowout at the end of the cut. Just tack a new piece of wood onto the fence before cutting.

The other option is to run the end of the board or panel against the rip fence. This involves less hassle, but beware: Unless the conditions are right, this approach can lead to catastrophe. If the end of the workpiece is shorter than about 12 in. or

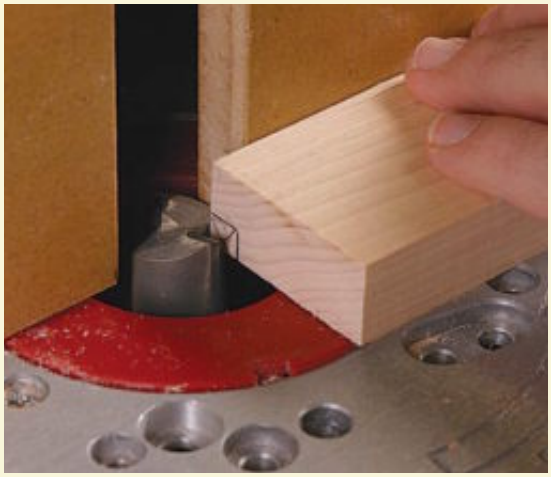
Photos, this spread: Kelly J. Dunton (dado set); William Duckworth (crosscut sled); Thomas McKenna (rabbeting a frame)

Rabbets

A DADO SET ALSO WORKS WELL FOR RABBETS

Sacrifice. *When cutting narrow rabbets, it's best to clamp a sacrificial fence to the tablesaw fence and raise the dado set into the fence until it reaches the desired height.*

MANY RABBETS FROM A SINGLE STRAIGHT BIT



Infinite variety. *Whether on the router table or with a handheld router, one bit can create many sizes of rabbets. Set the bit to the desired height, and adjust the fence or edge guide to find the desired width.*

if the dado is not close to that reference edge, the panel or board can very easily rotate sideways, kicking the workpiece at you at 100 mph.

One trick for plywood bookcase sides is to cut the dadoes while the two sides are still one big panel, ripping them to width afterward. This not only leaves a long edge to be run safely against the rip fence, but also allows you to simply rip away the blown-out end of the dado after the cut is made. When dadoing this way, you'll have to keep your eyes on two places at once: the rip fence, to be sure the workpiece isn't drifting, and the point where the dado blade will exit the cut.

A simple fence for the router—A handheld router is the safest and most versatile way to cut dadoes. It is the best way to cut a stopped dado, which is used when the front edges of a cabinet will be exposed. You'll need a fence to guide the router base. The router's edge guide won't work, because dadoes usually are made so far from the nearest reference edge. But you can whip up a simple, effective jig in minutes.

The T-square dado jig is simply one long piece of wood screwed and glued to another at a right angle. The beauty of this jig is that the router cuts its dado right across the fence, making it easy to align the jig with layout marks. Just be sure you are cutting the dado on the correct side of your mark. From past mistakes and repairs I've learned to mark a little squiggle beside my layout marks to show where the dado will go.

To make the jig accurately, apply glue and then clamp the long fence to the shorter fence. Check it with an accurate square and adjust the angle before adding another clamp to lock in the setting. If you have placed your clamps strategically, you can now screw the pieces together.

Before routing your first dado, make a pass over just the jig itself to rout a shallow dado in it for aligning with the stock. To use the jig, move the router from left to right. This way the cutting action of the bit will tend to push the router base against the fence for accurate results. If you need to make a dado that is wider than the bit you have, you'll have to lay out both sides of the dado and move the jig to make a second pass.

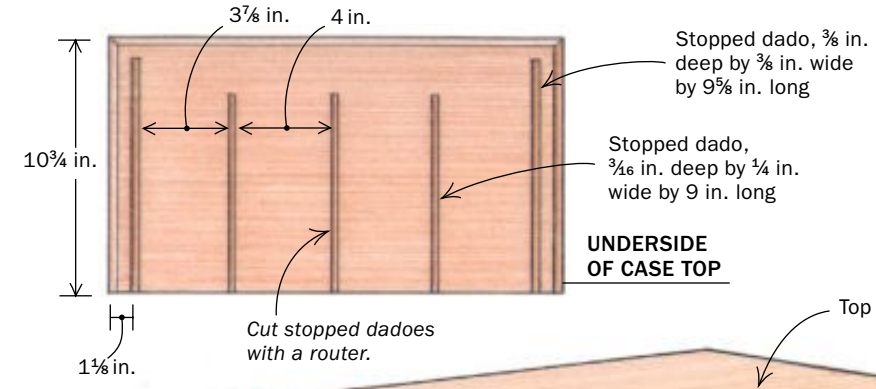
TO RABBET A FRAME, USE A BEARING-GUIDED BIT

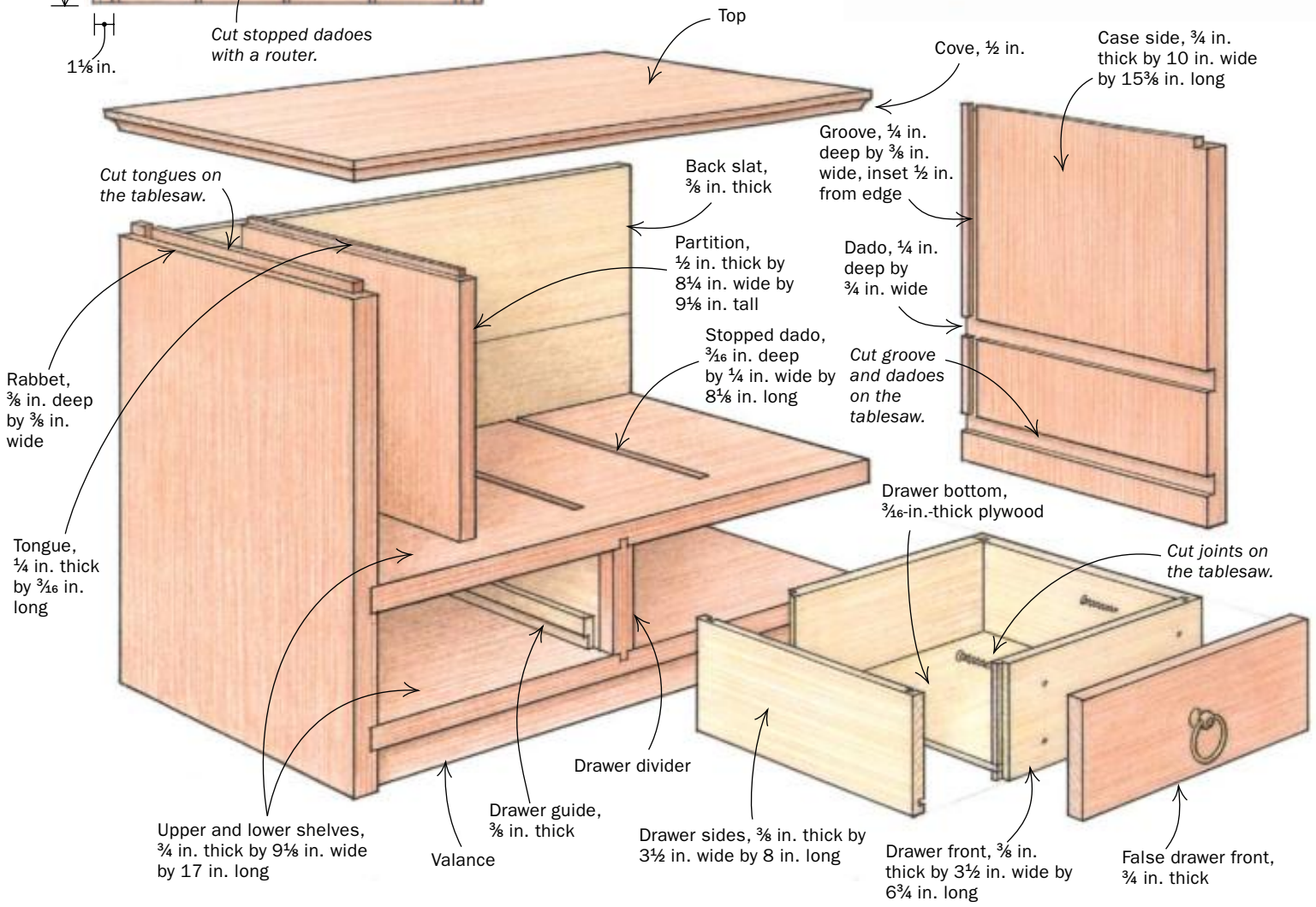
Bearing down. *A bearing-guided rabbeting bit allows you to make a few different cuts, depending on the size of the bearing you use. This type of bit makes it easy to rabbet a glued-up picture frame, although you'll have to clean up the corners with a chisel.*

Rabbets are open-sided

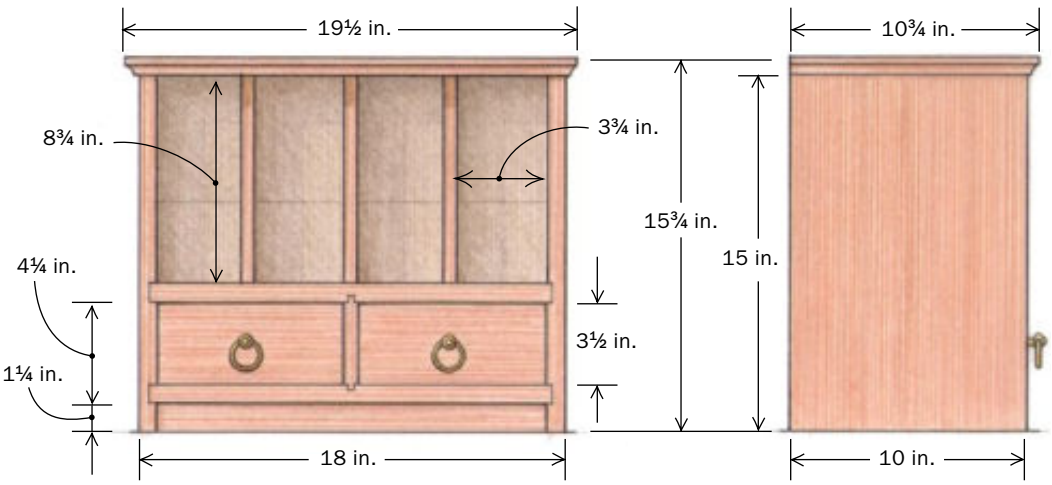
When a panel has to go in after a box or frame is assembled, a rabbet is used. Again, dado blades give the fastest results,

CASE MADE WITH RABBETS, DADOES, AND GROOVES





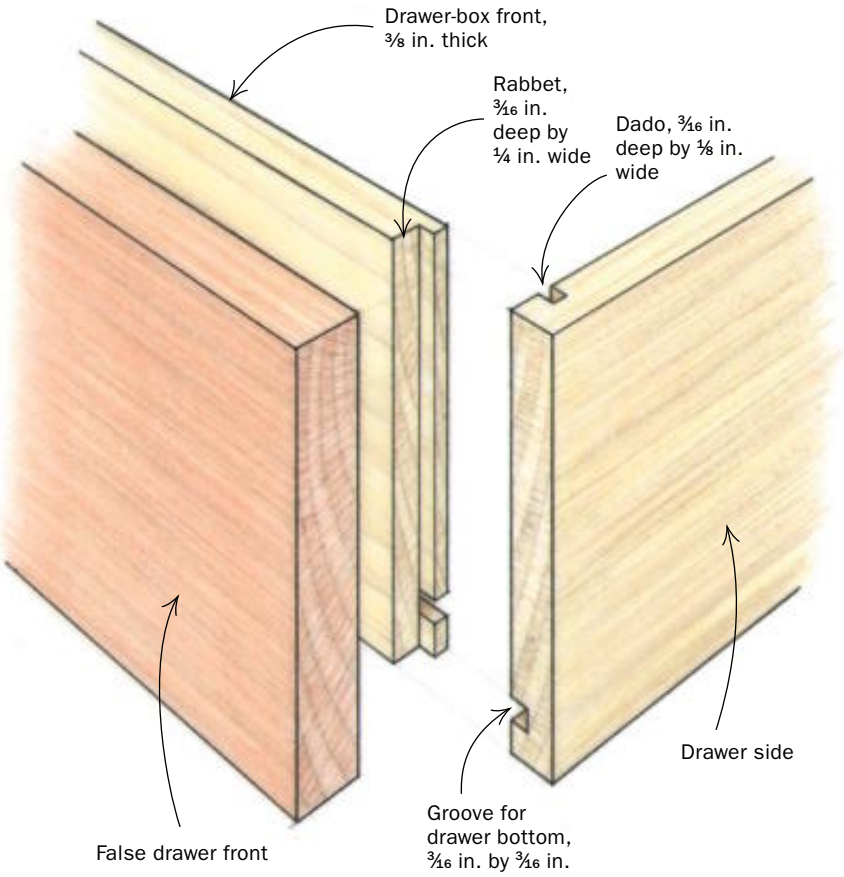
Red oak is the primary wood for this project because it is handsome, hard wearing, and not difficult to work. Pine was used for the drawer boxes and the back slats. Both woods are readily available at home centers at a moderate price. Most home-center lumber is milled to ¾-in. thickness, so the board's grain should be easy to see. Once you've cut the joints, assembling this piece is straightforward.



Drawings: Vince Babak

A QUICK AND STURDY DRAWER

The front, back, and sides of the drawer boxes are connected by dado and rabbet joints cut on the tablesaw. The false fronts are mounted with screws after the drawers have been assembled.



but the tablesaw doesn't work well for stopped rabbets. You'll need to bury the dado set slightly in a sacrificial fence attached to the rip fence. Fine adjustments to the width of the rabbet are just a matter of moving the rip fence and testing the cut on a piece of scrap.

Stopped rabbet? Again, use the router—There are special rabbeting bits that come with a number of guide bearings for various standard fractional-sized rabbets: ¼ in., ⅜ in., and so on (see photo, p. 63). The depth of the rabbet, of course, is variable, controlled by how far the bit sticks out from the router base.

Like everyone else, I bought a bearing-guided bit when I started woodworking. But now when I cut rabbets with a router, I often find myself using a standard straight bit. For one, the smaller diameter leaves less chisel work to do at the end of a stopped rabbet. And usually the board or panel I'm fitting into a rabbet is a bit under or over a standard size. Instead of the bearing, I use the edge guide (on a handheld router) or the fence (on the router table) to set the rabbet width. □

Asa Christiana is editor of Fine Woodworking.

Backup. *When cutting dadoes and rabbets on the tablesaw, back up the workpiece with scrap to avoid blowout at the end of the cut.*

Good fences. *For narrow pieces, use a miter fence to push the stock over the blade.*

Payoff. *With careful setup, you can easily cut tight-fitting dadoes and rabbets for a strong drawer box on the tablesaw.*

Mortise-and-Tenon Joints

Use the router, tablesaw, and a couple of jigs to make them foolproof

BY JEFF MILLER

The mortise-and-tenon joint is one of the strongest woodworking joints. For maximum strength, this joint needs good contact between long-grain surfaces—those on the sides of the mortise and the cheeks of the tenon. That means the long-grain surfaces must be flat, smooth, and parallel. Just as important, the fit between those surfaces must be snug.

I cut mortises with a plunge router, a straight bit, an edge guide, and a shop-made jig. Tenons are cut on the tablesaw with a tenoning jig. The machine work generally produces a fit that's right on. If it isn't, the final fitting is done with a few hand tools. All of the techniques are simple and efficient, and they result in perfect-fitting joints.

Cut the mortises first

In general, it's best to cut the mortises first and then cut the tenons to fit them.

Use a plunge router and a straight bit—A plunge router is pretty much a must to cut mortises. Any effort to tip the bit of a fixed-base router into a workpiece to create a mortise is dangerous, and it's also likely to produce an inaccurate cut.

Make a jig to guide the router—I use a very simple jig with three wooden parts: a body, a spacer strip, and a guide strip.

A pair of hold-downs made by The Adjustable Clamp Co., style No. 1600

CUT MORTISES FIRST

Once the jig is made, it takes little time to rout a mortise. A standard straight bit works just fine, although a spiral upcut bit does a better job of clearing chips from the mortise.

Clamp the workpiece to the mortising jig. *A pair of sturdy hold-downs anchors the workpiece to the jig.*

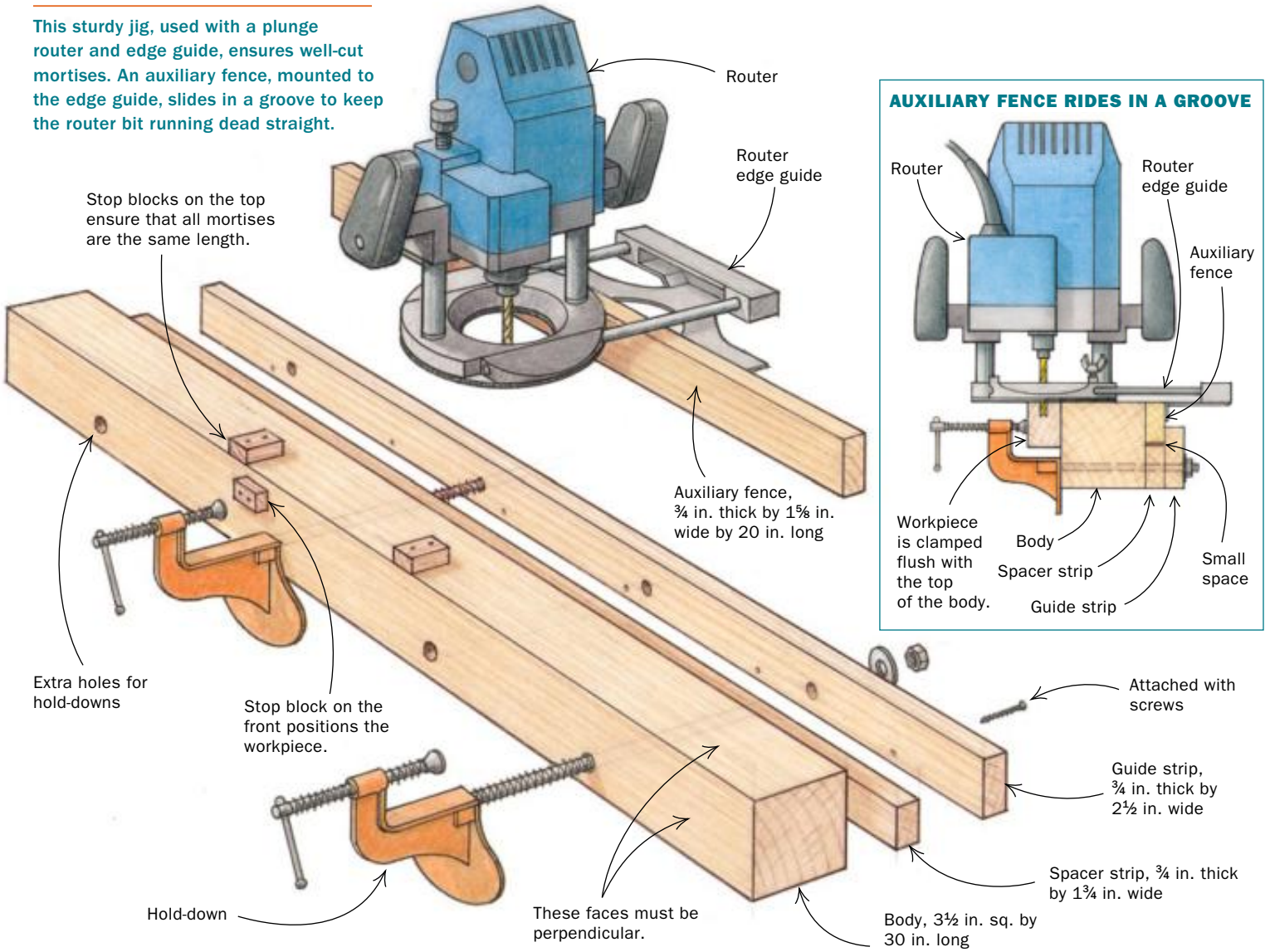
Set the bit depth. *With the desired mortise depth marked on the workpiece, adjust the bit depth on the router.*

Center the bit. *After marking the location of the mortise, adjust the edge guide to center the bit in the mortise.*

Drawings: Vince Babak; photos, except where noted: Tom Begnal; this page (top left): Kelly J. Dunton

A SIMPLE MORTISING JIG

This sturdy jig, used with a plunge router and edge guide, ensures well-cut mortises. An auxiliary fence, mounted to the edge guide, slides in a groove to keep the router bit running dead straight.



AUXILIARY FENCE RIDES IN A GROOVE

Stop blocks establish the mortise length. *Stop blocks on each side of the router base limit the travel of the base.*

Take light cuts until you reach the final depth. *To produce smooth, straight-sided mortises, make multiple passes with the router, with each pass removing no more than 1/32 in. of stock.*

Use the mortise to lay out the tenon

Butt the end of the piece to be tenoned against the mortise, then mark the tenon length (below) and thickness (right).

(312-666-0640; www.adjustableclamp.com), secure the workpiece to the body. With the hold-downs in place, the jig accepts stock up to about 2¾ in. wide. To work with wider stock, simply remove the hold-downs and secure the workpiece with a couple of C-clamps.

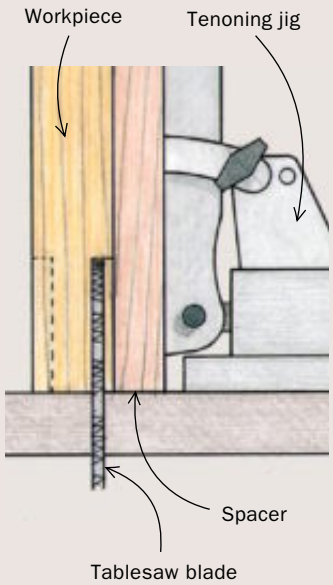
You'll also need to make a wooden auxiliary fence to attach to the edge guide of the router. The fence fits into a groove created by the spacer and the guide strips. It prevents the edge guide from shifting away from the body, and that means the router can't wander from a straight-line cut.

Using the jig to cut mortises—Start by laying out the location of the mortise on the workpiece. Then clamp the workpiece to the body of the jig. Make sure the top surface of the workpiece is flush with the top of the jig.

Adjust the plunge-router depth stop to establish the final depth of cut. Place the router on the body of the jig, with the auxiliary fence of the edge guide in the groove. Adjust the edge guide until the router bit is centered in the mortise.

CUT TENONS LAST

1 CUT THE FIRST CHEEK



Clamp the spacer in the jig and against the scrap stock in back. *Adjust the jig to line up with the tenon mark, then cut the first cheek.*

2 REMOVE THE SPACER AND CUT THE SECOND CHEEK

Spacer-free second cut. *After making the first cheek cut, remove the spacer and slide over the workpiece to clamp it directly against the jig.*

Next, screw two stop blocks to the top of the jig, one on each side of the router base, positioned so that the bit stops when it reaches each end of the mortise.

When cutting mortises in more than one workpiece, add a stop block to the front of the jig so you can quickly position each new piece to be mortised.

Now you're ready to start cutting. Try not to remove more than 1/32 in. of stock per pass. As you cut, move the router smoothly back and forth, using the stops to limit the mortise length. Continue cutting and lowering until you reach the depth-stop setting that represents the full mortise depth.

Cut tenons to fit the mortises

With the mortises cut, you can start working on the tenons. Almost any sturdy tablesaw tenoning jig will work, as long as its guide bar is snug in the miter-gauge slot. To help prevent tearout, back up the workpiece with a piece of scrap stock (see photo for step 2, facing page).

Key to this system is a shopmade wooden spacer that's used with the tenoning jig. The spacer is sized so that the thickness of the tenon is established in just two cuts: one with the spacer in place and one with it removed. The spacer automatically creates the tenon thickness you want. The thickness of the spacer should be a hair less than the width of the mortise plus the width of the sawblade kerf. Do the initial setup with a test piece of scrap stock.

Use one of the mortises to mark the tenon on the test piece. Raise the blade to equal the tenon length. Make the cut in a single, smooth pass.

After the first cut, remove the spacer and reclamp the workpiece with the working face against the jig. Then make the second cheek cut.

The shoulder cuts are made with the miter gauge. Set the blade height to cut just shy of the tenon cheek. Clamp a stop block to the rip fence to establish the distance from the end of the tenon to the shoulder cut.

The miter gauge also is used to make the shoulder cuts on each edge of the tenon. I then use a chisel or a tenon saw to make the two vertical cuts that establish the final width of the tenon.

Although you can use a chisel to square the mortise corners to match the tenon, it is much easier to round the tenon corners with a rasp. Finally, apply a light (1/32 in.) chamfer all around the end of the tenon.

Make adjustments to get a perfect fit

Despite my best efforts, I sometimes end up with a joint that doesn't fit as well as I'd like. When that happens, a little hand-tool work has the joint fitting just right.

One of the most effective tools for thinning tenons is a shoulder plane. When cutting with a shoulder plane, remove an equal amount of material across the full width of the tenon. It's not uncommon to remove little material at the beginning of a cut and too much material at the end.

Tenons aren't always too thick after they come off the tablesaw; sometimes they end up a bit too thin. When that happens, the joint usually can be salvaged by gluing a patch of wood to one or both cheeks. □

Jeff Miller builds furniture in his Chicago shop (www.furnituremaking.com). He also teaches and writes about woodworking.

3 CUT THE TENON SHOULDERS

Use the miter gauge and a stop block. *For consistent tenon shoulders, clamp the stop block to the rip fence and make the shoulder cuts using a miter gauge.*

Finish the tenon by hand. *Use a rasp to round over the edges of the tenon to match the mortise, then chamfer the end to minimize glue squeeze-out.*

Raised Panels

How to achieve great results at the router table or the tablesaw

BY MATTHEW TEAGUE

Frame-and-panel construction is among the woodworker's greatest inventions. Not only does it solve many of the problems we encounter with wood movement, but it also looks good, creating visual interest by adding shadow lines and reflecting light across different planes.

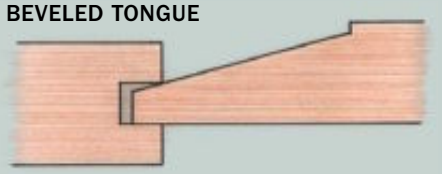
There are almost as many ways to cut raised panels as there are tools in the workshop. While the shaper is probably the most efficient, many woodworkers don't own a shaper. Depending on the piece I'm building and the number of panels I have to cut, I use a router table or a tablesaw outfitted with a panel-raising jig. Whatever method you choose, start with a panel that is sized to the opening in the frame plus the depth of the grooves—minus just a little in the width to account for wood movement.

Two methods at the router table

Raising a panel with its face on the table using a horizontal router bit is safe and efficient, but it calls for a variable-speed router.

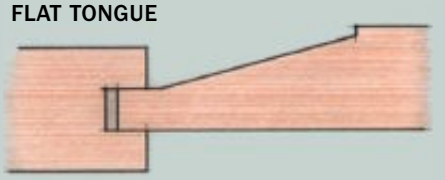
TWO TYPES OF TONGUES

BEVELED TONGUE



When cut with hand tools or on the tablesaw, the tongue is an extension of the bevel.

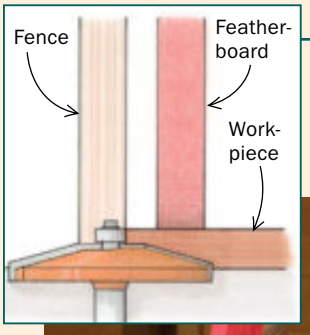
FLAT TONGUE



A raised panel cut with a router bit has a flat tongue, which allows the panel to shrink and expand more freely inside the frame.

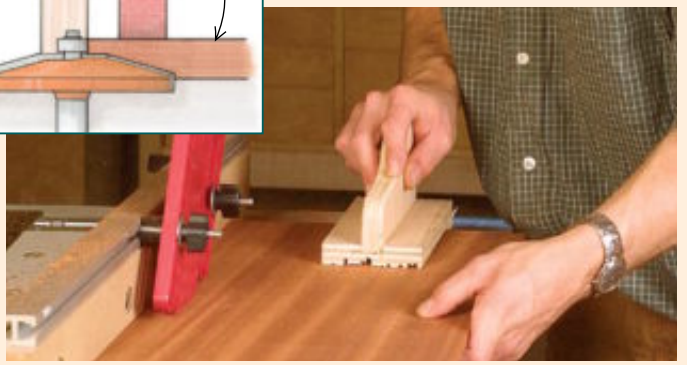
RAISE A PANEL AT THE ROUTER TABLE

Panel-raising router bits come in two styles, both of which create a flat tongue and a bevel. With each bit, take multiple passes and increase the depth of the cut with each pass.



HORIZONTAL ROUTER BIT

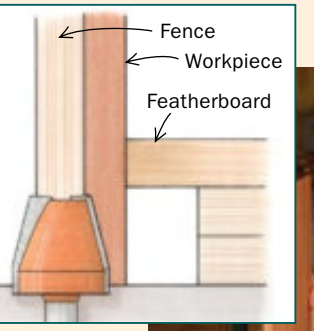
These large-diameter bits require a variable-speed router set at 10,000 rpm. Use a featherboard to keep the panel flat against the table.



Cut the long-grain sides after the cross-grain ends to clean up any tearout. *Use a push block and a steady feed rate on the final pass for a smooth finish.*

VERTICAL ROUTER BIT

These bits should be run between 18,000 rpm and 22,000 rpm. Use a featherboard to keep the panel snug against the tall fence.



Take light passes with a vertical panel-raising bit. *They tend to produce a rougher surface than a horizontal bit, but a card scraper or sandpaper will clean things up.*

Photos, except where noted: Matt Berger; this page (top left): Kelly J. Dunton; drawings: Vince Babak

Because these bits are so large in diameter, dial back the router to about 10,000 rpm.

If you're raising multiple panels, you need to mark out only the thickness to be removed on the first panel. The width of the bevel is determined by the bearing on the router bit. Scribe a line on the edge of the panel to indicate the tongue's thickness.

Start routing on the cross-grain ends and then rout the long-grain sides. Take three to five passes, depending on the density and thickness of the wood, raising the bit with each pass until you reach the final depth. If you're raising more than one panel, rout each panel in order before raising the bit. To guarantee a clean cut, make sure your last pass removes no more than 1/16 in.

Face against the fence—You can raise a panel at the router table using a vertical panel-raising bit buried in a tall auxiliary fence. This method requires you to take light passes, and your router should be running at 18,000 rpm to 22,000 rpm.

Again, cut the cross-grain ends before the long-grain sides and take several passes, moving the tall fence after each cut. For safety's sake, use a featherboard mounted high on the panel to ensure that the workpiece stays snug against the tall fence.

Panel-raising on the tablesaw

The tablesaw, used with a panel-raising jig, is the fastest way to raise panels. The jig can be used again and again. I also use mine to cut wide chamfers on small tabletops.

First, cut a test bevel on scrap material the same thickness as the panel. Aim for a tongue that fits in the groove and will leave some room inside the groove for the panel to expand. Then measure the width of the bevel to determine the location of the shoulder.

To establish the shoulder, set the tablesaw fence to the width of the bevel on your test cut, and raise the blade to about 3/16 in. Then run all four sides of the panel through the tablesaw. Next, clamp the panel to the jig and align the fence for the correct tongue thickness. Raise the blade so that it just reaches the shoulder and begin cutting. □

Matthew Teague is a woodworker and a writer in Nashville, Tenn.

Begin at the shoulder. *Make a 3/16-in.-deep cut on all four sides using the tablesaw.*

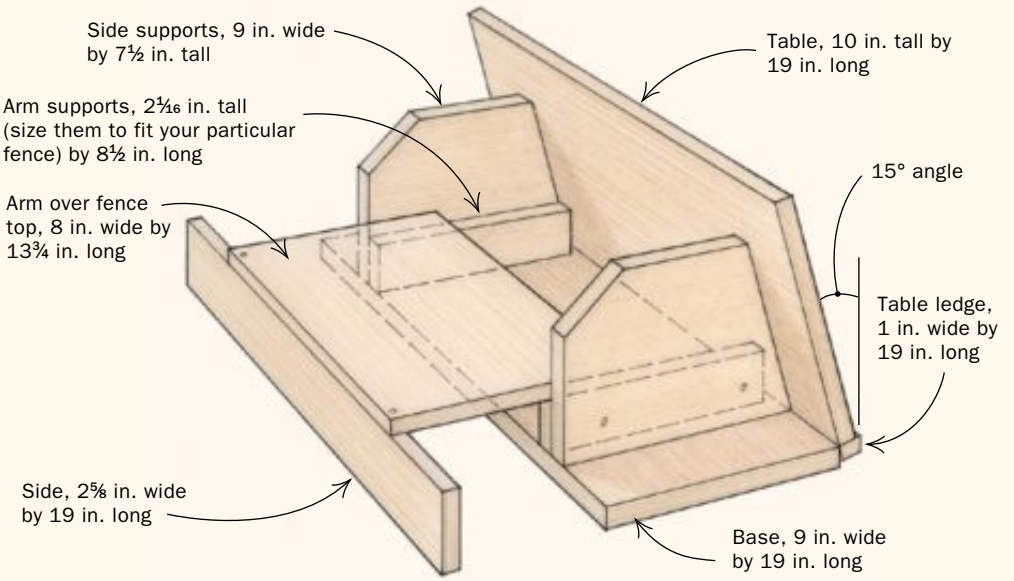
RAISE A PANEL ON THE TABLESAW

Set the tablesaw blade to 90° and build a tablesaw jig that holds the panel at an angle. In this case, a 75° jig creates a 15° bevel. Before cutting the panels, make test cuts with scrapwood.

Clamp the panel to the jig and cut. *Raise the blade so that it reaches the shoulder. Make the cross-grain passes before cutting the long-grain sides. A steady feed rate and a sharp blade reduce burn marks. Leftover marks can be cleaned up with a scraper.*

BUILD A PANEL-RAISING JIG

This jig is relatively straightforward and makes raising a panel at the tablesaw speedy and safe. It's made of ¾-in.-thick plywood and assembled with 1⅝-in. drywall screws. Build the jig first, then attach the arm so that it's snug over the tablesaw fence.



Unique Moldings

The secret is combining multiple router profiles in a stack of pieces

BY ALAN CHARNEY

My shop is small, with only the most basic equipment. I also have limited sources of hardwood, confining me to ¾-in.- or 1-in.-thick stock. However, these obstacles haven't stopped me from tackling ambitious projects, such as the crown molding on a secretary I built. Lacking thick slabs of wood and a shaper, I built up the molding from smaller strips, which I profiled individually using a router. When glued together, the individual strips formed a molding that looked like it was milled from one piece of solid stock. Following my approach, using just a basic router, a few router bits, and a router table, you can create moldings of almost infinite variety, which will enhance the appearance of your work.

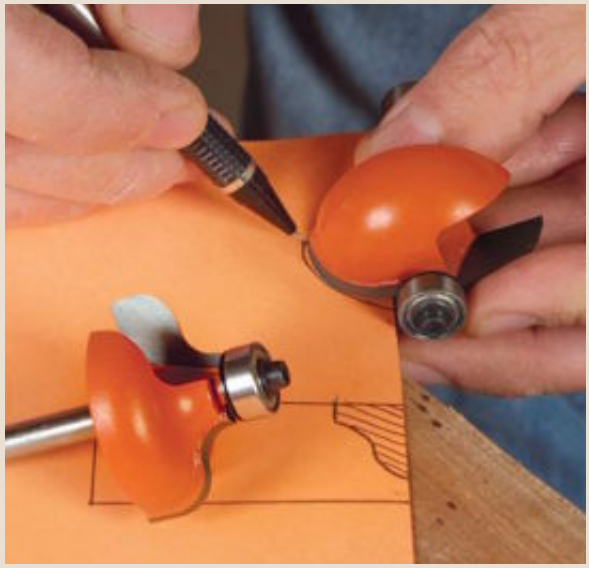
Make templates from the router-bit profiles

There are two ways to choose appropriate moldings for a project. One way is to research the moldings traditionally used on the style of furniture you are building and to make something similar. The second way is to create your own design. A deep molding creates an elegant concave profile suitable for more formal, detailed furniture. A convex shape makes a bolder statement more suitable to heavier, country-style furniture.

After you have a general design, draw a full-scale rectangle that matches the height and depth of the molding. Then lay the router bits you intend to use against some thin cardboard and trace their profiles with

Photos, except where noted: Mark Schofield; this page: Rodney Diaz; drawings: Chuck Lockhart

DESIGN THE MOLDING



Make templates. *Trace the profile of each router bit on thin cardboard to create templates for the molding.*

a pencil. Cut out each profile to create templates that can be arranged on the full-scale rectangle until you arrive at a design that matches your goal.

Play with the depths of cut and the positions of each cut, and also try flipping some bits by 90°. The most useful router bits are S-shaped: They follow a curve, going from thick to thin. These include edge-forming bits, such as ogee, roundover, and cove bits, plus panel-raising bits. Round-nose and V-groove style bits also work well for creating profiles.

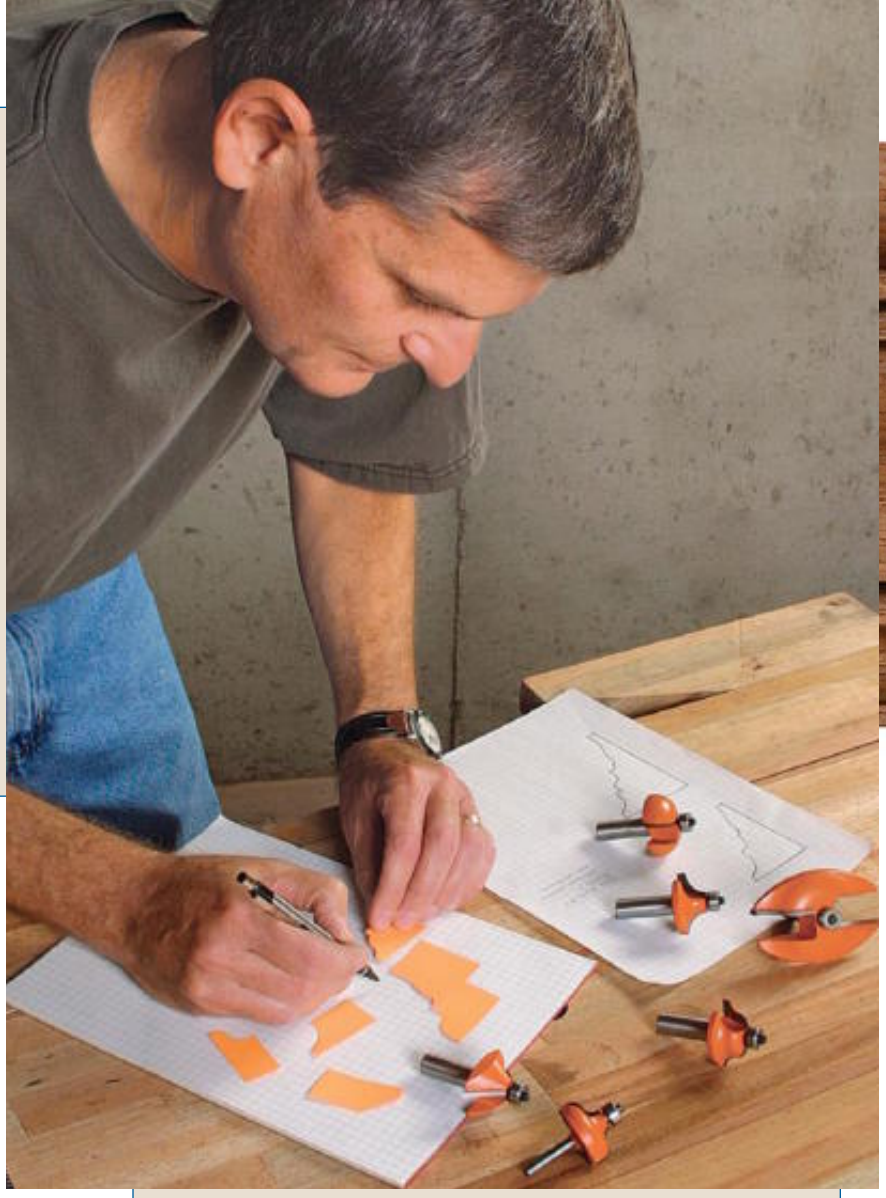
Choose stock with uniform grain and color

To make the molding look as if it were created from a single piece of wood, the strips need to match in color and grain pattern. The easiest way to achieve this is to take all of the strips from one wide board that is uniform in appearance. Another way is to use boards that were cut from the same tree, preferably in sequence.

Some router bits, such as panel raisers, have longer profiles and sometimes require a thicker board than I have on hand. If you need to join together two boards, matching the grain is crucial. Cut a straight-grain board in half, and then flip over one of the halves onto the other to create two adjacent layers with matching grain and color. You can use the same trick with figured boards, but because perfect grain-matching is almost impossible, you may have to rely on small steps, or reveals, between layers of molding to conceal contrasting grain patterns.

Cut profiles on the router table

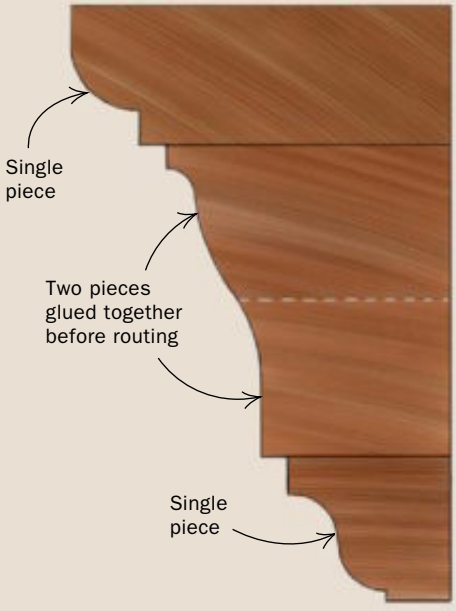
There is no need to buy an expensive or sophisticated router table. Mine has short legs that allow me to place it on top of my bench when in use and store it away when I'm done. Most of the bits I use have bearings, and often I use them without a fence. For safety's sake, however, you can use a fence for the first few intermediate cuts and then move it just beyond the bearing for



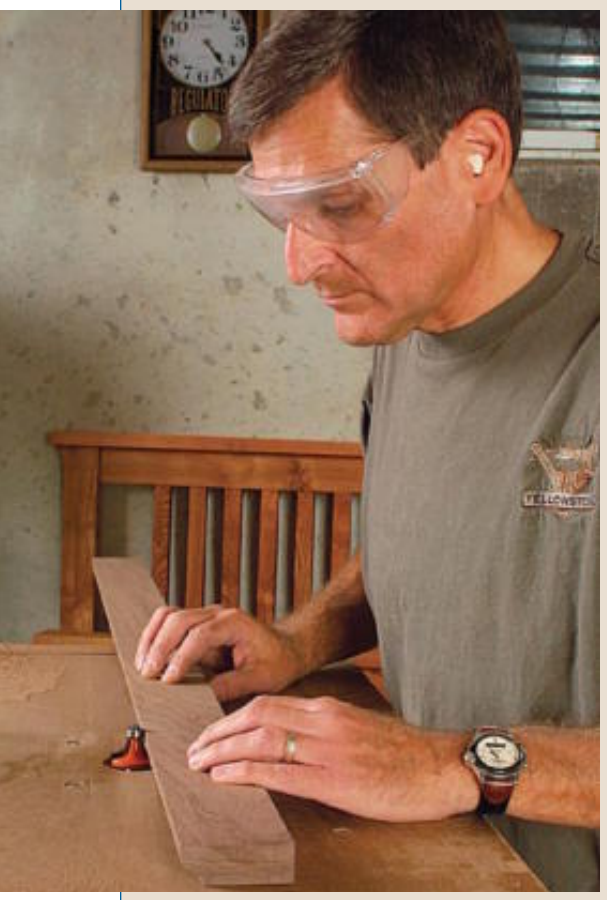
Use the templates to build up different molding designs. *Experiment with a combination of profiles to arrive at the perfect design for the molding.*

DIVIDE THE DESIGN INTO SECTIONS

Divide the molding into slices that each router bit can cut. Solid lines divide the pieces routed separately, and the dashed line shows where two boards must be glued together to create the necessary thickness for a large router-bit profile.



ROUT THE PROFILES



Rout the first section. *The top section of the molding is a piece of wood large enough to be cut safely without the addition of a scrapwood backing block. For safety's sake, though, you can use a fence for the first few intermediate cuts; then move the fence beyond the bearing for the final cut.*

Feed the stock from right to left when facing the router. Guide the workpiece freehand, making several passes to remove only small amounts of wood each time. On only the last cut or two is the wood guided by the router bearing.

WIDE PROFILES

Align the workpiece and router bit. *Instead of lowering the bit and creating a large hole in the router table, raise the workpiece by running it across a thin sheet of medium-density fiberboard (MDF) or hardboard clamped to the table.*

NARROW PROFILES

Small boards need backing blocks. *Because the lowest section of the molding is so narrow, attach a piece of scrapwood to keep fingers away from the router bit.*

THE IMPORTANCE OF BACKING BOARDS

Because of the amount of wood to be removed by the panel-raising bit, this section requires that several pieces of scrapwood be glued to it for stability and safety during routing.

Any wide piece of scrapwood can be used as a backing board for a narrow molding. But make sure the molding is held in the correct orientation to the router bit.

the final cut. Make sure you have enough depth adjustment on your router, once it's mounted under the table, to get the profile you want.

Tips for router safety—To prevent the small strip from being thrown from the router with your fingers inches from its 25,000-rpm spindle, glue scrapwood to the back of the workpiece.

If you use a fence with the router table, a pair of featherboards will help keep narrow stock aligned as it passes over the bit (for more, see pp. 90-93). Also, don't cut the full depth of the profile at once; take several passes. Use earplugs and all required safety equipment. Make sure the router bit is tightened. And never push your fingers toward the spindle; make sure they push parallel to the wood's movement. This allows them to go past the spindle and not into the bit if the wood should shoot out suddenly.

Assemble the strips into one molding

After cutting the profiles, rip away the scrapwood backing pieces. Don't worry about getting an even surface on the back of the molding; that will come later.

Refer to the full-size drawing to determine the depth of the reveal between layers of molding. It is important that this small overlap be uniform along the length of the molding. The best way to ensure this at glue-up is to place a length of scrap on the bars of the clamps to shim one section of the profile (see photos, facing page). Also, put the glue bead toward the back of the overlapped surfaces to avoid squeeze-out in the reveal in front, where it is hard to remove.

Never glue up more than two pieces at once. This way you can concentrate on one overlap at a time to prevent mistakes. As you tighten the clamps, make sure the pieces don't slide out of alignment. Use as many clamps as necessary to prevent an unsightly gap from appearing in the middle of the molding.

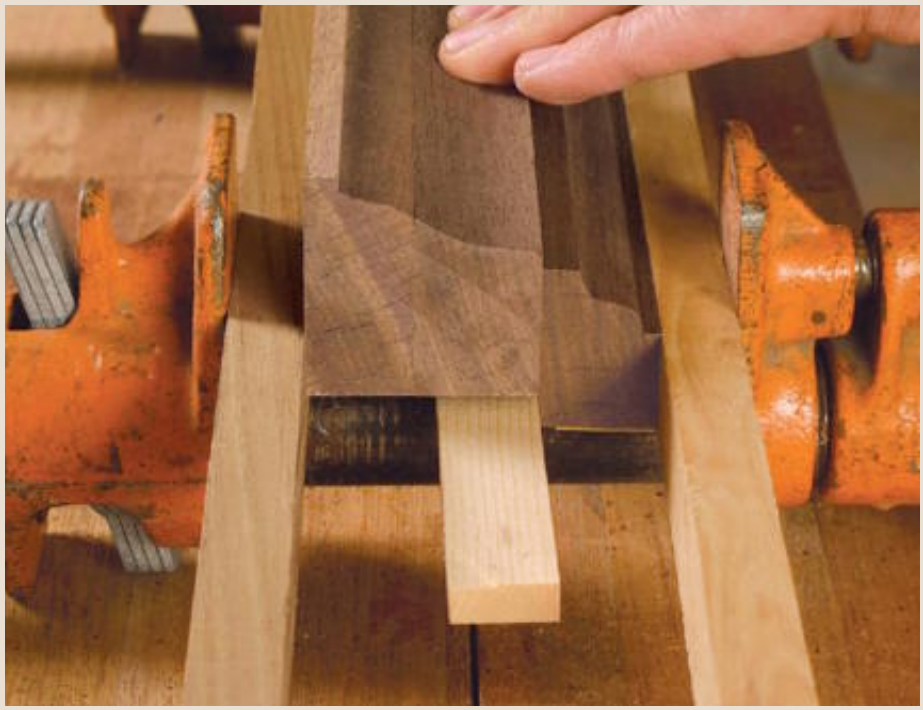
Last, rip the finished molding to the correct width shown on the original drawing, establishing a flat back that can be glued or otherwise attached to your project. □

Alan Charney is an engineering manager and an amateur woodworker who lives near South Bend, Ind.

GLUE UP THE STRIPS

Before the strips of molding are glued together, rip away the scrapwood backing blocks. Then proceed as shown.

One step at a time. *Glue together only two sections at a time (above) and check the joint carefully as pressure is applied. To establish the reveal between two sections of molding, use a spacer of the correct thickness (right).*



Continue adding sections. *Because any gaps between sections of molding will be conspicuous, use numerous clamps to apply even pressure over the whole length.*

Router Templates

These guides let you create elegant curves and furniture parts

BY DOUG PETERMAN

When the talk turned to tools at a recent woodworkers' meeting, I surprised myself by naming router templates as my favorite. Don't get me wrong: I love hand tools and use them constantly, but my work would be less efficient and less profitable without these simple but versatile jigs.

Making the template itself allows me to create and fine-tune furniture forms before cutting into expensive stock. Templates let me see the design full-size and in relation to the other parts of a piece, not to mention that they make it easy to reproduce identical parts.

Almost all template-routing operations require only a handful of tools, including a router, two common bearing-guided bits, a bandsaw, a sander, and a shopmade template. With those items and a few drawing tools, such as a compass or even french curves, you are fully equipped to tackle any template-routing job.

Making a template

Templates can be made from any stiff sheet material with enough strength and thickness to guide the bearing on a router bit. In a pinch I've even used scrap wall paneling and old crate lumber, but there are better choices. Mainly, I use ⅛-in.-thick Masonite for one-offs and ¼-in.-thick Baltic-birch plywood for production templates that need to last. Both materials have the basic characteristics of dimensional stability and consistency (no hard or soft spots), and are readily available.

Draw the pattern—Trusting your eye is the quickest route to getting the shape you want in a template, but drawing tools will help.

I usually begin by sketching the template pattern directly on the surface of the workpiece, especially when I'm working to preserve the grain in a particular board. Once I'm satisfied with the shape, I transfer it to the template stock.

When drawing the pattern on the template, it's a good idea to add at least 1 in.

Photos: Matt Berger; drawings: Vince Babak

MAKING A SMOOTH TEMPLATE

Cut and sand the template. *After roughing out the template on the bandsaw—cutting 1/16 in. outside the line—smooth the template to its final shape using a belt sander (left) for flat or convex areas and a drum sander (right) for inside curves. Subtle irregularities are difficult to see, so inspect your template for dips and bumps by running your hand across its edge.*

Glue scrap blocks to the template. *The blocks prevent the bit from chipping away the corner of the workpiece upon exit and entry.*

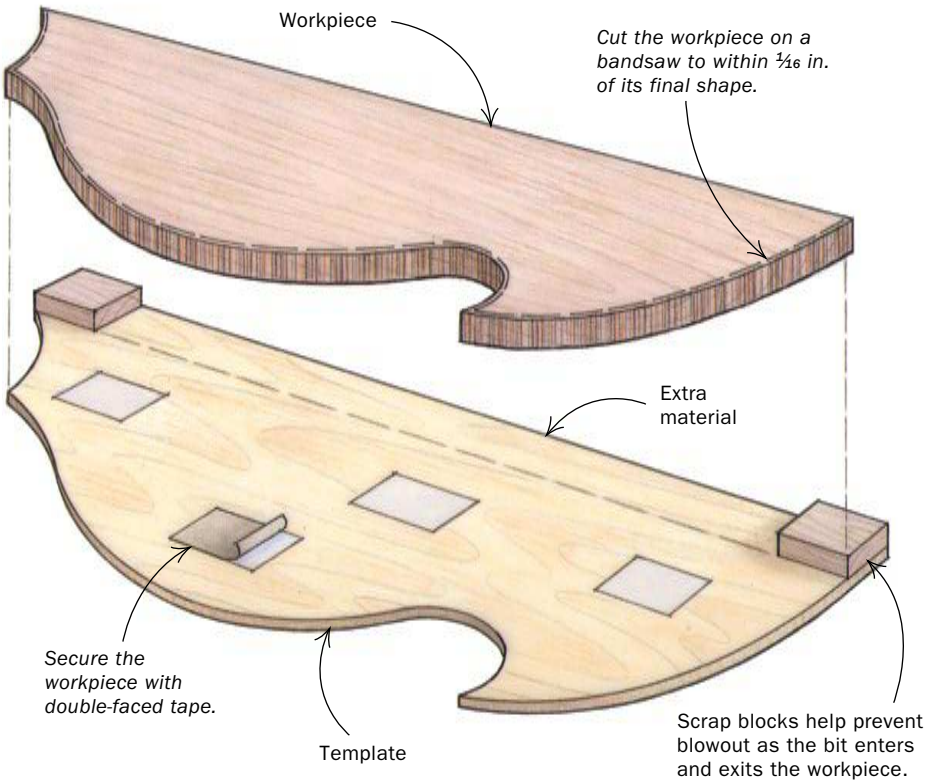
of material lead-in and exit beyond the workpiece edge wherever possible. Without it, the bit can catch as you try to make the first corner of the template meet the bearing. Believe me, I've done it.

Whether you draw a pattern freehand or with drawing tools, you often will be left with bumpy lines and rough transitions that need to be smoothed out. The trick to achieving a smooth, or fair, curve is to get your eyes right down near the drawing surface and look along the line. Bumps and dips are easy to see, but also look for transitions that are too abrupt. Work your way along the line, refining it until the curves are fair.

Rough-cut on the bandsaw, then sand—When rough-cutting the template, keep the blade about 1/16 in. from the pencil line to leave enough stock for sanding and final smoothing.

To get to the final shape, use a stationary belt sander. I use two—a 6-in. belt and a 1-in. belt—and run both with the table perpendicular to the vertical belt. For tight inside curves, a sanding drum mounted in the drill press is ideal.

Power sanding to a line involves a few simple rules. First, keep the material moving smoothly with even speed and light pressure. Never let it stop. Second, for optimal control, try to have the waste come off so that you hit the line just as the template passes the trailing edge of the belt or the center of the drum. This gives you one spot to watch and the comfort that the rest of the abrasive belt is safely cutting waste. Finally, work on bumps and dips by sanding the areas around them. Start before the fault, sand smoothly through it, and carry on a bit beyond.



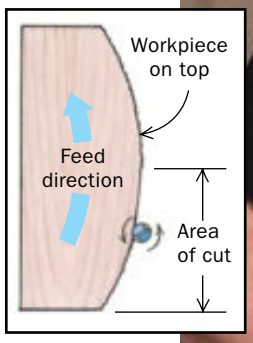
If you don't have power-sanding equipment, templates can be smoothed by hand, using either files or sandpaper. I prefer files because it's easier to keep a square edge with them. Use a flat file along the edge on convex curves, and a half-round or round file pointed diagonally across the template but still moving along the edge for concave areas. Sand as the last step if you must, but use a very firm or hard block to avoid rounding the edge. To check your work, slide your hand over the finished piece to

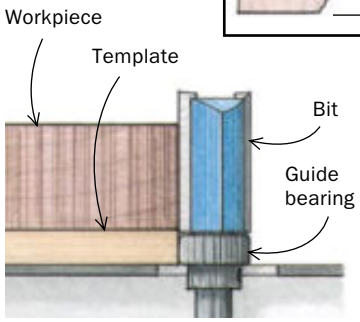
TEMPLATE ROUTING

To avoid tearout when the grain changes direction on a workpiece, flip the piece onto its opposite side to reverse the direction of the cut. Instead of removing the template and remounting it on the other side, switch from a pattern bit to a flush-trimming bit.

BEGIN WITH THE TEMPLATE ON THE BOTTOM

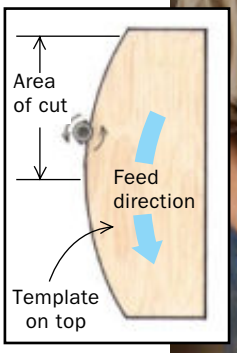
With the template on the underside of the workpiece, use the pattern bit to rout all of the areas where the bit is cutting in the same direction as the grain. Leave the remaining areas uncut.

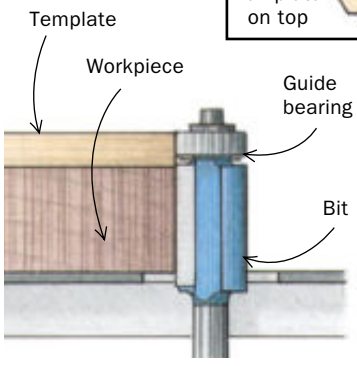


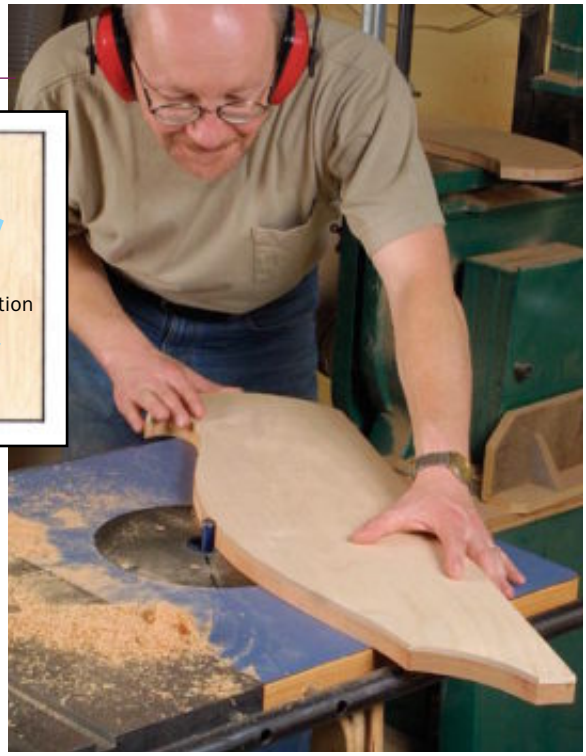


FLIP THE WORKPIECE AND CHANGE THE BIT

With the template on top of the workpiece, use the flush-trimming bit to rout the remaining areas in the opposite direction.







find any bumps or dips. Smooth them out as needed.

Using the router templates

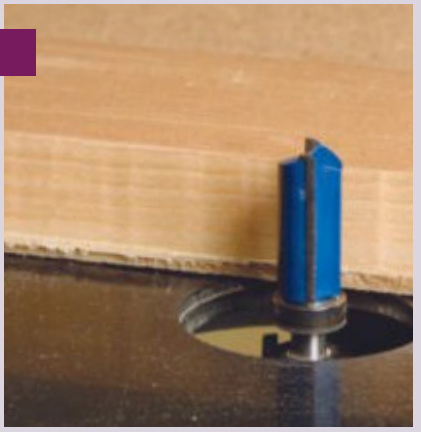
When routing a workpiece with a template, I use bearing-guided straight bits that are known as flush-trimming bits when the bearing is on the tip, and pattern or template bits when the bearing is on the shank. You need one of each type; mine are ½-in. bits with a cutter length of 1 in. When using these straight bits with templates that are exactly the size of the finished piece, there's no need to add offset for a bushing, and no worries that a bushing may be off center.

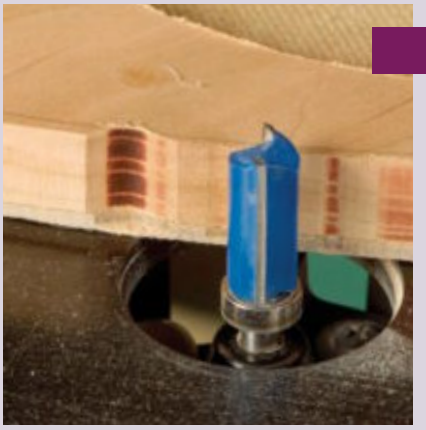
The bearings should be the same diameter as the cutter path to produce a flush cut. To test them, make one pass with only the bit riding on the template edge, then a second pass with the bearing riding on the surface that was just cut. There should be no step between the first cut and the second cut. If the bearing has left an impres-

Troubleshooting common problems

BUMPS

Bumps occur when the template loses contact with the bearing. This often is caused by chips impairing the edge of the template. Also, make sure the bearing is running against the template and not the workpiece, and then take another pass.



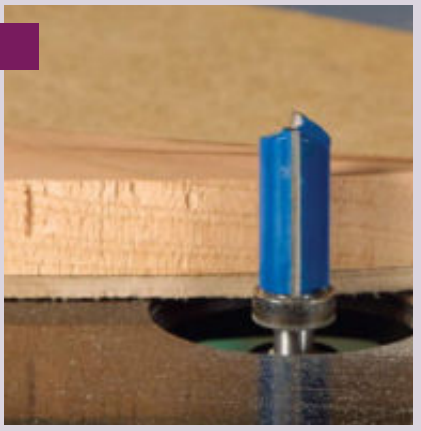


DIPS

If the router bit slips, the bearing will lose contact with the template, and the cutter will dig into the workpiece. To avoid this tough-to-repair mistake, make sure the router-bit height is locked securely, and keep steady pressure on the workpiece while cutting.

TEAROUT

Tearout results from cutting against the grain, when the bit lifts fibers and breaks off small chips. Routing with the grain is the simplest solution. When routing highly figured wood, you can avoid tearout by changing the cutting direction more frequently.



BURNING

Burn marks are left when the workpiece moves too slowly past the bit; they show up worst on end grain. To avoid burning the finished edge, move the workpiece more quickly past the bit for the final pass.

sion where it rolled along the cut surface, it means your router has excessive runout, you have a bad bearing, or the bit does not run true. In all of these cases, the bearing is acting like a hammer as it swings around just off the center of rotation.

Secure the template to the workpiece—For quick one-off routing, attach a template with double-faced tape or a few globs of hot-melt glue.

If I have to make several parts with the same template, I try to use clamps (shop-made cam, wing nuts or knobs, toggle clamp, etc.) to hold the work. Vacuum clamping works well for production pieces where you need 360° access to the piece. Special needs call for creativity: Templates can be made into two-sided jigs or jigs that box in a piece—anything to get the template securely in place.

Trim the waste on the bandsaw—With the template attached to the workpiece, use a bandsaw to cut away the bulk of the waste. Cut to about 1/16 in. from the line all around to reduce routing time. I used to leave more wood and hog it off with the router, but those heavy cuts sometimes raised chips that ran into the grain below the template edge. For quick trimming—especially handy when producing multiple copies of a template—I attach a finger guide to the bandsaw tabletop to keep the template 1/16 in. from the bandsaw blade. This also ensures that the cut stays on the waste side of the workpiece.

Use a router table and two straight bits—I do as much template routing as possible on the router table. Only when the workpiece is too large to be coaxed across the table will I take the router to the piece. Setup is very simple: Just mount the bit and raise or lower it until the bearing is lined up with the template.

As much as possible, rout with the grain. If you think of the grain as a stack of paper, the cutter should be making the edge of each sheet lie down, not lift up. This is why you need both types of bearing-guided router bits. To rout with the grain on all edges of the workpiece, you must flip over the workpiece and alternate between the two bits.

Starting with the pattern bit in a router table, rout all of the areas that you can without lifting the grain. Change to the flush-trimming bit, flip the workpiece so that the template is on top, and rout the remaining uncut areas, going with the grain. If you have trouble keeping track of grain direction, draw arrows on the worksurface that point in the direction of the grain.

Avoid climb cutting, which is when the bit spins in the same direction as the workpiece is being fed. This is dangerous and should be attempted only where almost all of the waste has been trimmed off. Even so, always anticipate the workpiece being pulled forward into the cut, and keep your hands out of the bit's path. □

Doug Peterman makes custom furniture in his home workshop in Stratford, Ont., Canada.

BETTER **TECHNIQUES**

Router Jigs

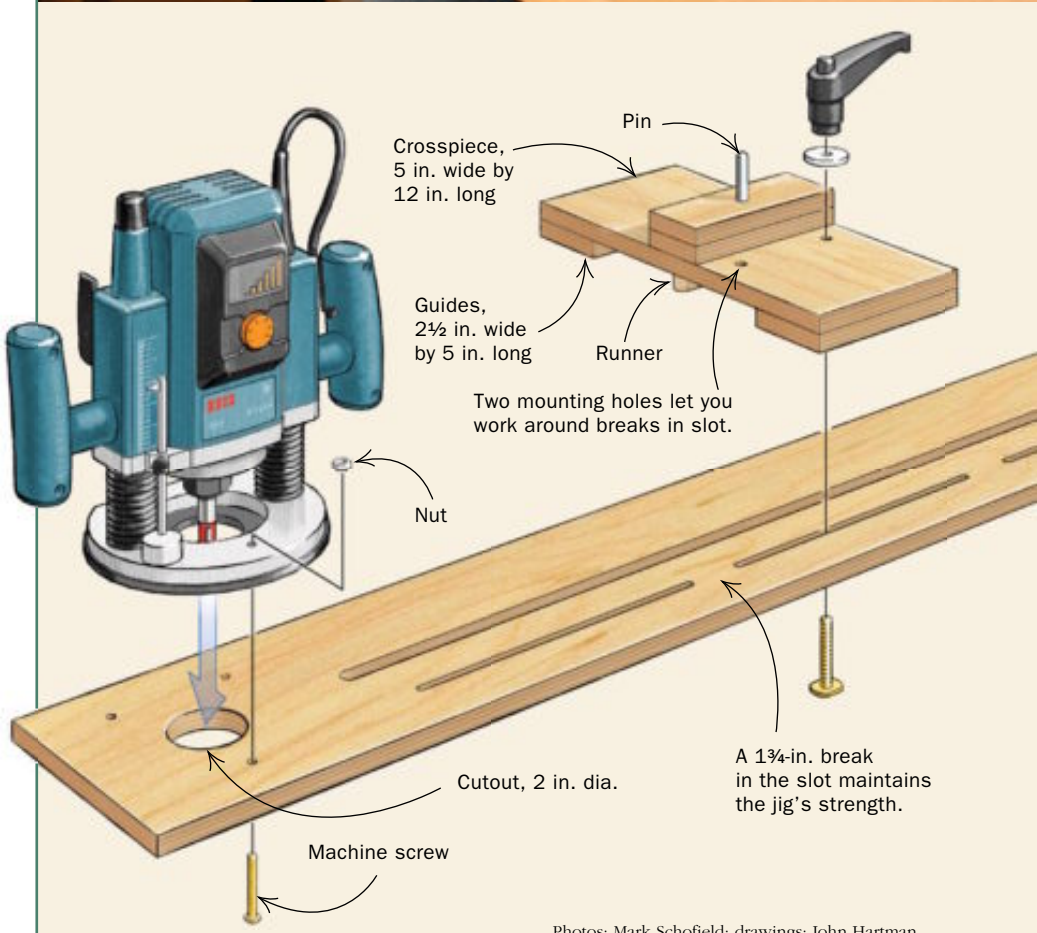
Get much more from your router with easy-to-make accessories

BY YEUNG CHAN

Few woodworkers enjoy the luxury of a spacious shop, and I'm no exception. Lacking the space for many large machines, I rely on my router when building furniture. However, used on its own, the router is limited in its abilities. More often than not, I use it in conjunction with various shopmade jigs that increase its ability to quickly and accurately cut circles, make edge profiles, and trim edge-banding.

The four jigs illustrated here are all made from plywood or medium-density fiberboard (MDF)—both are inexpensive and stable—and require only a few pieces of hardware. You can obtain any specialized handles or bolts from retailers such as Lee Valley (www.leevalley.com; 800-871-8158) or Rockler (www.rockler.com; 800-279-4441). And these router jigs are as easy to use as they are to make.

Yeung Chan builds custom furniture in Millbrae, Calif.



Photos: Mark Schofield; drawings: John Hartman

Cut perfect circles and arcs

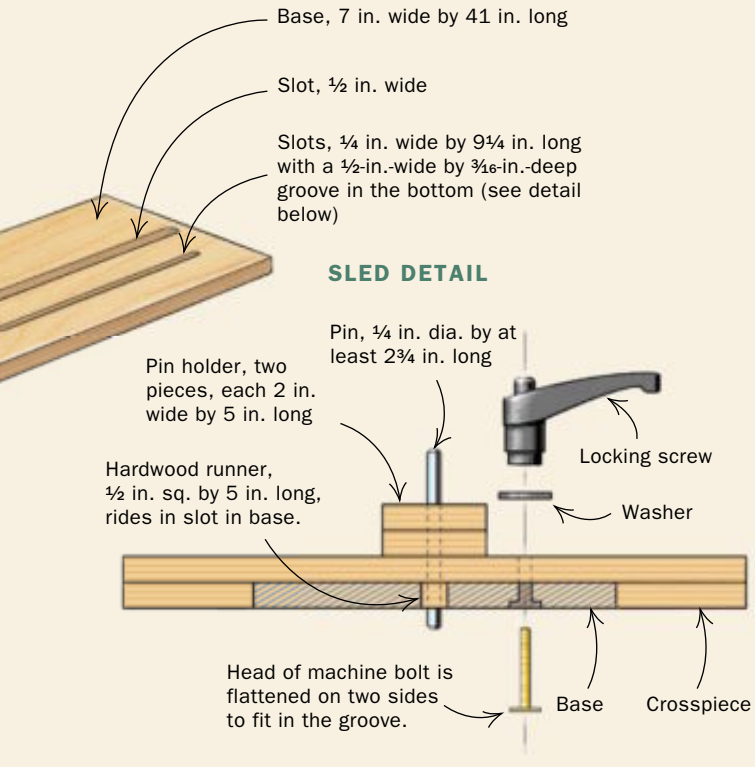
This jig can be used to rout circles and partial circles with a maximum diameter of 72 in., but the design can be modified for other diameters. For circles, first drill a ¼-in.-dia. hole, ¼ in. deep, in the middle of the workpiece. If you don't want the hole to show, work on the underside. Next, mark a point on the desired edge of the circle, place the sled over the base, and fit the jig's pin in the center hole. Move the base in or out until the bit is on the mark, then lock the sled.

Turn on the router and plunge down to start an initial cut of less than ⅛ in. deep, just enough to define the circle. Use a jigsaw to cut away the outside pieces, leaving about ⅛ in. outside the final size. This enables you to support the corners as they are cut off. With most of the waste removed, the router has to make only a light final cut. On solid wood, pay attention to the grain's orientation and the bit's rotation. Climb-cut—move the router right to left, opposite the normal left-to-right pattern—when necessary to avoid tearout.

Set the size of the circle. *With the pin registered in the center of the workpiece, move the jig's base until the inside edge of the router bit is aligned with the desired outside edge of the circle.*

Make a shallow cut to define the circle. *The initial cut made with the router should be only about ⅛ in. deep.*

Remove the waste. *Following the track left by the router, saw away the waste.*



The final cut. *The router now has to remove only a small amount of material, creating less dust and leaving a clean cut.*

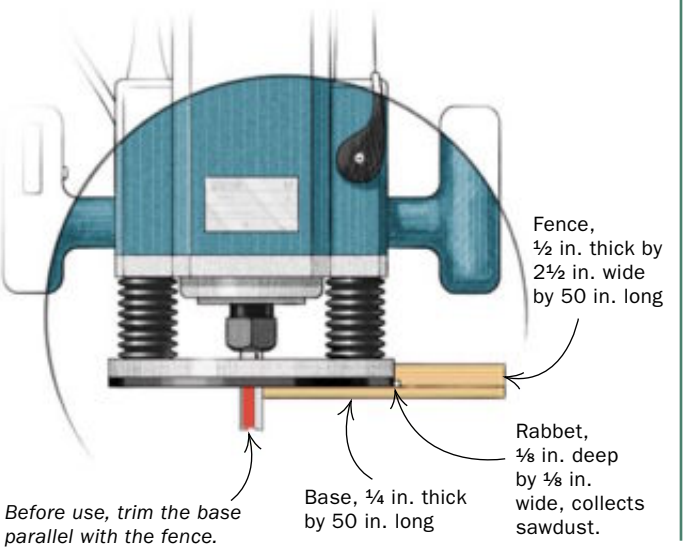
Trim or cut large panels

It can be difficult to cut a large panel on a tablesaw. This simple jig can be used to cut out a section from a full sheet of plywood or MDF or to clean up a rough cut made by a jigsaw or a circular saw.

Once you've assembled the jig, run the router along the straight edge of the fence to create a matching straight edge on the base. To use the jig, clamp it at both ends of the workpiece with the edge of the jig aligned with the desired cut.

Always use the same-diameter router bit with this jig. A smaller bit will cut wide of the jig's edge, while a larger bit will eat into the jig.

Straighten edges. *Rough-cut the panel, then clean up the cut with this straight-edge jig.*



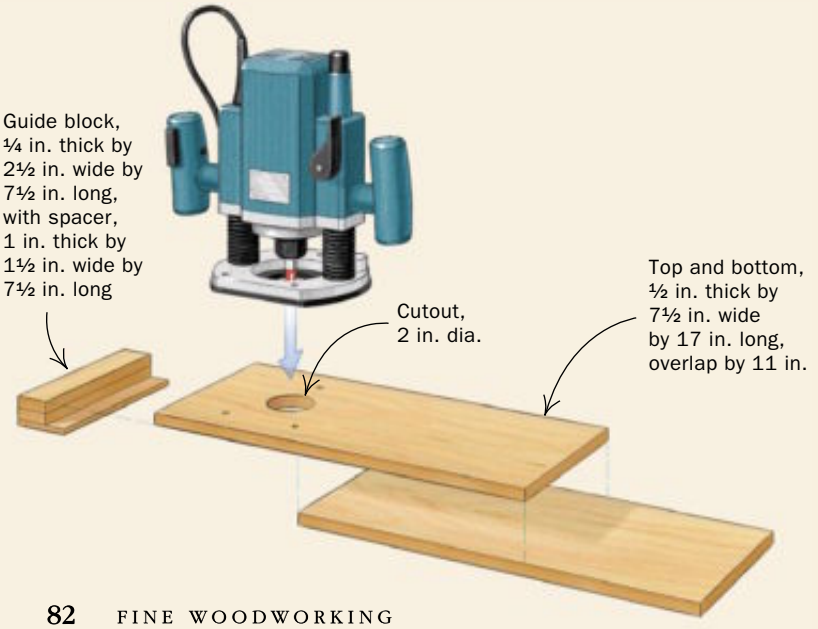
Trim edge-banding quickly and cleanly

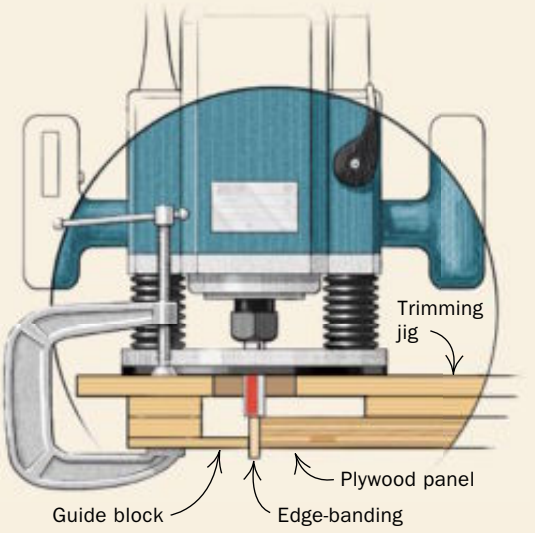
One of the hardest parts of using solid wood to edge plywood or laminate panels is trimming the edge-banding flush. If you use a plane, you risk cutting through the thin plywood veneer, and sanding can leave cross-grain scratches on the plywood. This router jig enables you to quickly and flawlessly trim the banding flush.

Mount the router on the jig, and set the depth of the bit so that it just clears the plywood surface. Adjust the guide block to align the bit so that the carbide tips extend just a hair over the plywood. Clamp the guide block tight, and you're ready to start routing.

To avoid tearout, you want to do a climb-cut with the leading edge of the bit rotating toward the workpiece. This can be dangerous if the bit pulls the router forward uncontrollably. But because the amount of wood being removed is so small, you should be able to control the router easily.

Flush-cut edge-banding. *This jig allows you to cleanly cut solid-wood edge-banding flush with a plywood panel.*





Make turnings with a router

This jig allows you to shape round columns and posts using a router. To use the jig, first drill a 5/16-in.-dia. hole, 1½ in. deep, in each end of the workpiece, then insert a steel rod to hold the workpiece inside the jig. Lock a drill stop on each end of the rod where it enters the jig to prevent the workpiece from shifting as you cut. Clamp two wood guide pieces to the edges of the router subbase to restrict the router's side-to-side movement.

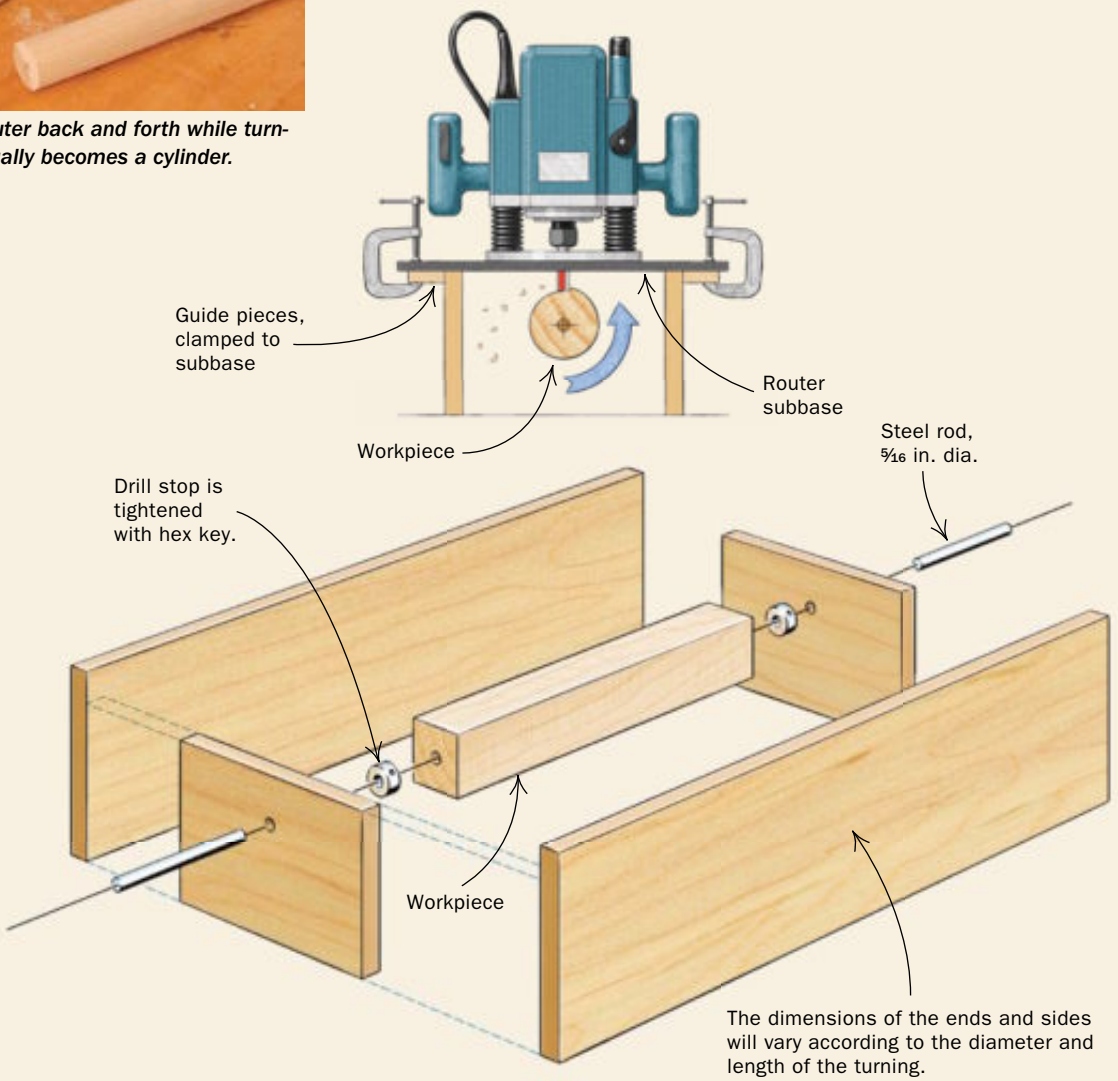
Turn on the router, slowly plunge down, and move the router halfway up and down the jig as you slowly rotate the workpiece. As you increase the depth of cut, you'll create a cylinder. Then repeat the process on the other half of the workpiece. Throughout the process, make small cuts for a better finish and a safer operation.

You can adapt this jig to create different turnings. Offset the hole at one end of the jig to make tapered turnings, or clamp blocks to the long sides of the jig to produce stopped turnings. If you design the jig with gently curving sides, the workpiece will become football shaped as it is turned.

Router-cut turnings. *By guiding the router back and forth while turning the workpiece, a square blank gradually becomes a cylinder.*

Tapered turnings. *Lower the hole at one end of the jig to taper the turned workpiece.*

Stopped turnings. *Clamp a stop block to the side of the jig to leave a square section on the turning.*



BETTER **TECHNIQUES**

Bandsaw Jigs

How to make precise tapers, circles, wedges, and curves

BY MICHAEL FORTUNE

The wall next to my bandsaw is festooned with jigs that expand the versatility of the basic machine. Though simple to build, each jig quickly and safely delivers the precise results I depend on. This overview presents five of my favorites.

Build these jigs from Baltic-birch plywood or medium-density fiberboard (MDF), and adjust dimensions to fit your bandsaw. For the jigs to work correctly, the bandsaw's blade must cut parallel to the fence. To achieve this, I check that the bandsaw's tires are in good shape (no grooves or ridges), then set the fence parallel to the miter-gauge slots. Next, I adjust the angle of the upper wheel. If the blade's centerline aligns with the centerline of the upper wheel, it will cut parallel to the fence.

Check by ripping some scrap. You'll know it's right when the back of the blade is centered in its kerf. For more on bandsaw setup, see pp. 30-35.

Michael Fortune designs and builds furniture in Lakefield, Ont., Canada.

Photos: Marcia Ryan; drawings: Jim Richey

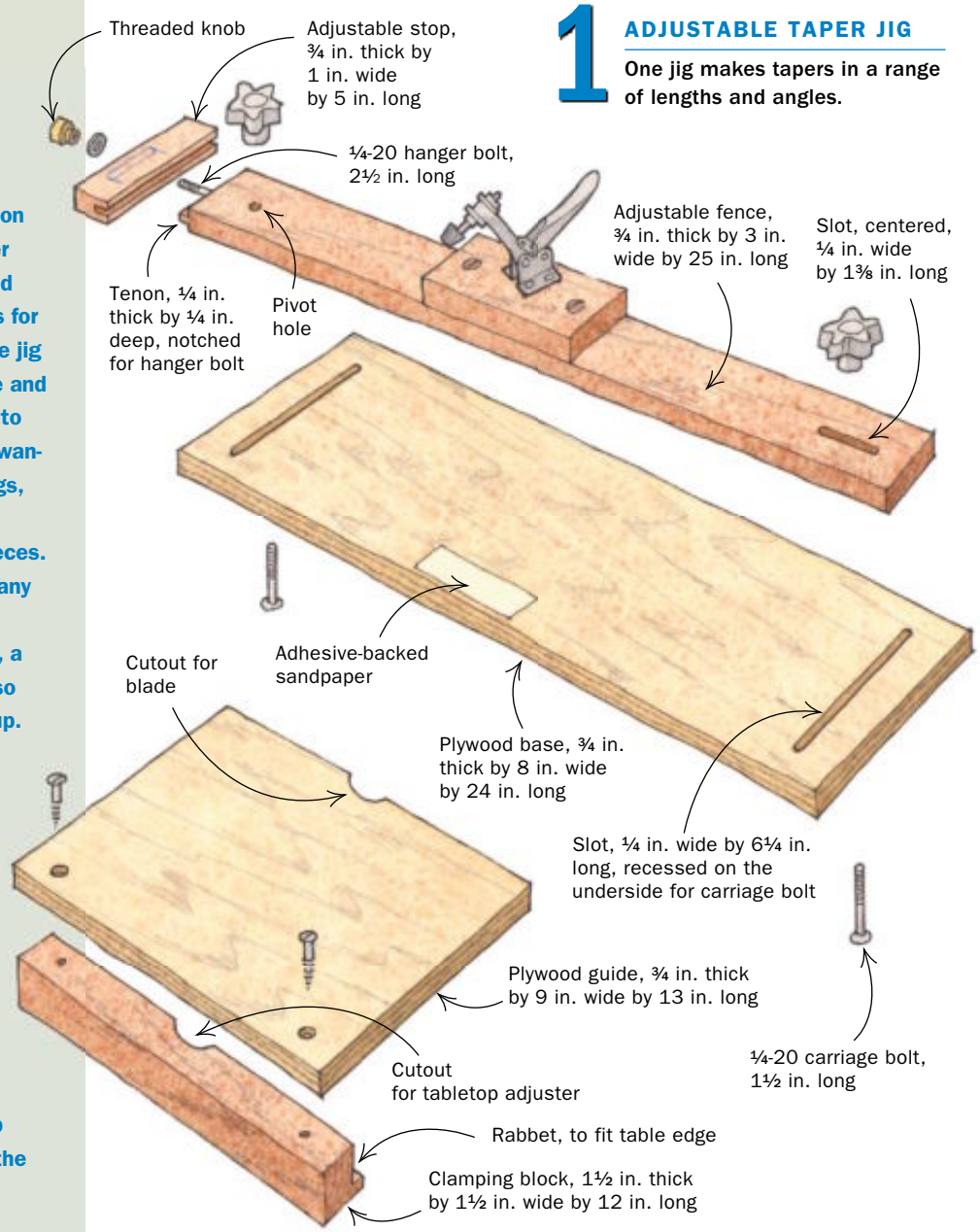
Rip tapers at any angle

A lot of woodworkers cut tapers on a tablesaw, but I think it's safer and just as fast on the bandsaw. And unlike a tablesaw, a bandsaw allows for stopped tapered cuts. My adjustable jig slides between the bandsaw's fence and a plywood guide, which is attached to the table and prevents the jig from wandering into the blade. Two similar jigs, one 24 in. long and one 48 in. long, accommodate different-size workpieces. Toggle clamps can be used to hold any length of workpiece securely.

When tapering four sides of, say, a table leg, always rotate the stock so that the newly tapered side faces up. This way, for the first two cuts, the workpiece's flat sides bear on the jig and its fence. Rotating the leg for the third cut places a taper against the fence, but an offcut between the two will keep the leg straight. For the fourth cut, an offcut at the fence and another placed between the leg and the bed of the jig will support the leg. The offcuts are taped into position slightly forward of the stop to accommodate the wood lost to the bandsaw kerf.

1 ADJUSTABLE TAPER JIG

One jig makes tapers in a range of lengths and angles.



Jig setup. *Adjust the rip fence so that the jig is almost touching the blade. Then clamp down the plywood guide, which should just allow the jig to slide.*

Locate the taper's end. *Marks on the stock align with the edge of the jig, which is the cut line. After fixing the outfeed knob, adjust the stop to clear the blade.*

Locate the taper's start. *Align the beginning of the taper with the edge of the jig and tighten the infeed knob.*

Make circles of all sizes

This is a useful jig that's also fun. The workpiece turns on the jig's pivot point and cuts circles and arcs with a wide range of radii. I thread the jig with a ¼-20 tap, so it will accommodate any size pivot point I care to grind from a bolt. They can range from the full ¼-in. diameter for heavier pieces to a needle point for delicate work. To avoid a center mark on the stock, attach a sacrificial surface to the underside of the workpiece with double-sided tape.

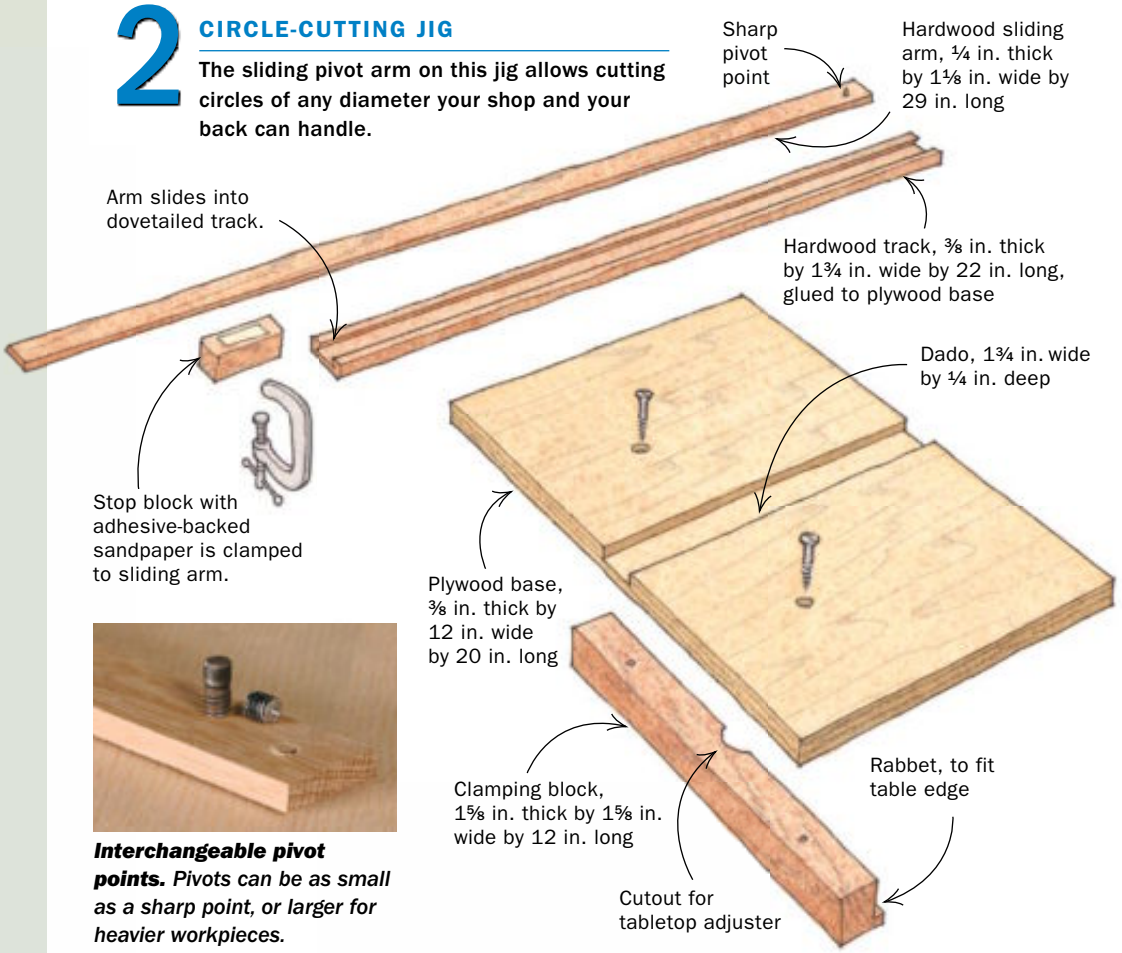
The pivot point is in a sliding arm dovetailed into the body of the jig. This arm can be moved gently forward while you rotate the stock into the blade, initially creating a spiral-shaped cut. A stop block clamped to the outboard end of the arm hits the body of the jig when you reach the correct radius, and only then does the blade begin to cut in a circle.

Make the track and sliding arm of a hard and stable wood. The sliding arm and track are dovetailed so that the arm does not tip out of the track, and the bearing surfaces are waxed. The track could be dovetailed directly into the body of the jig, but it is easier and will remain more accurate if a strip of hardwood is dovetailed, then set into a dado.

Keep in mind: The bandsaw blade must be narrow enough to cut the desired radius, and the cutting edge of the teeth must align with the centerline of the pivot point on the sliding arm. If the pivot is forward or back of the teeth, the blade will not cut freely and the circle will not be true.

2 CIRCLE-CUTTING JIG

The sliding pivot arm on this jig allows cutting circles of any diameter your shop and your back can handle.



Interchangeable pivot points. *Pivots can be as small as a sharp point, or larger for heavier workpieces.*

Attach the stop. *After measuring the distance from the pivot point to the blade (circle radius), clamp the stop on the underside of the arm at the end of the guide track (above left).*

Spiral into the circle. *With the saw running, gently push the arm forward while rotating the stock into the blade (above right). Once the stop reaches the end of the guide track, the blade starts to cut the actual circle (right).*

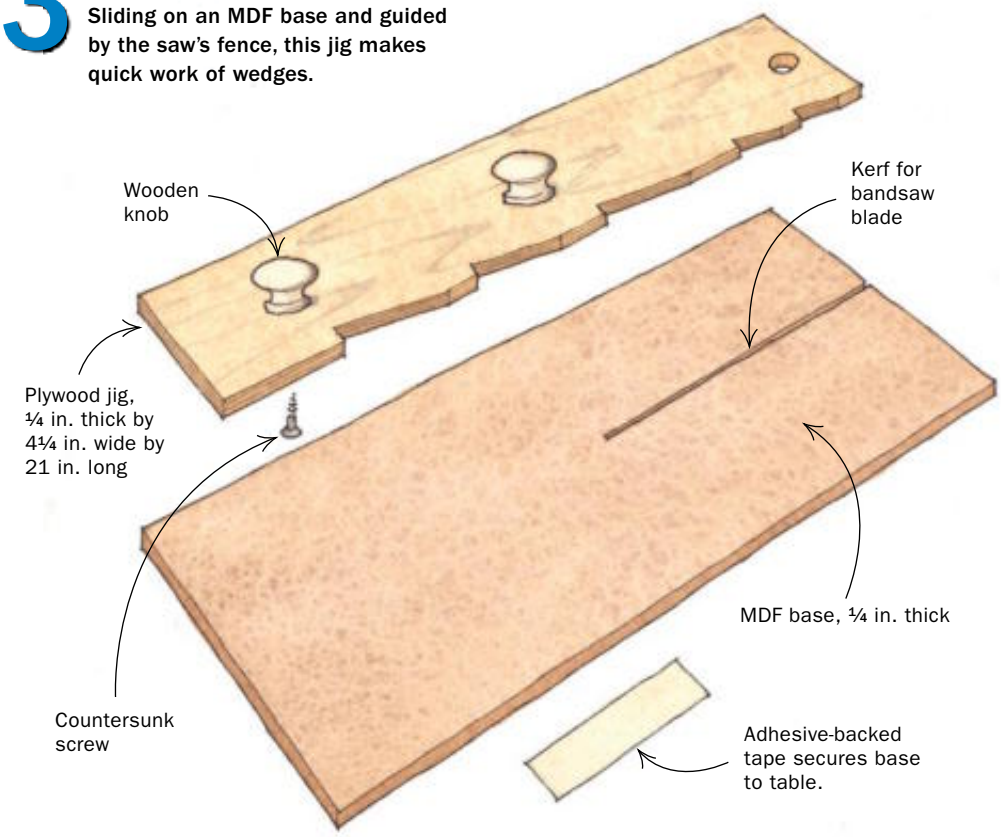
Cut small wedges safely

This simple and safe jig allows the cutting of identical wedges. The jig rides against the fence, which is set so that the blade just misses the jig. Notches the size and shape of the wedges are cut in the jig, and they hold the stock as it's cut. As a new size of wedge is needed, I add a new notch to the jig. For repeat projects, each notch is labeled with the project name and the dimensions of the wedge.

I start with a piece of stock that's crosscut to the length of the wedge, and flip the blank over with every cut. The MDF base serves as a zero-clearance throat plate that stops the wedges from binding in the bandsaw's more open throat plate. When the stock gets too small to handle safely, I switch to a new piece or use a push stick.

3 TENON WEDGE JIG

Sliding on an MDF base and guided by the saw's fence, this jig makes quick work of wedges.



Cut notches on the jig freehand. *Draw the wedge on the jig, by tracing it or by determining its angle or its length and width. Clearly mark these measurements on the jig.*

Small wedges require a zero-clearance throat plate. *Attach a piece of ¼-in. MDF on the table with double-sided tape to prevent pieces from getting trapped in the throat plate.*

The Wedge-o-matic. *Place the long-grain end of the stock against the long edge of the notch. Flip the stock forward with each pass.*

Safely reproduce curved shapes

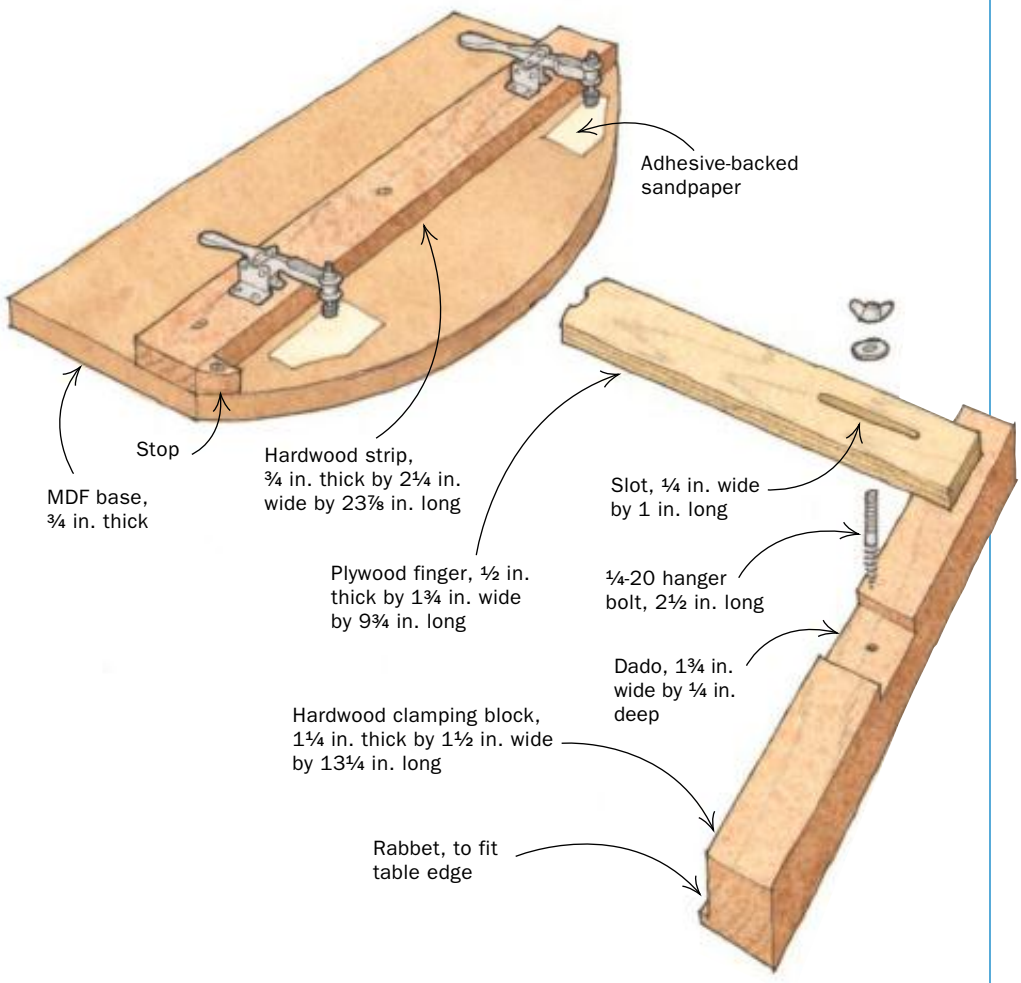
Finger jigs are used to guide carefully made patterns on the bandsaw. The finger spaces the pattern just slightly away from the bandsaw blade, leaving a small amount of material to be worked by hand, or as I frequently do, shaped by a router outfitted with a flush-trimming bit. The pattern works with both the bandsaw and the router. This is a great technique for making multiples of curved chair parts such as rails or stretchers.

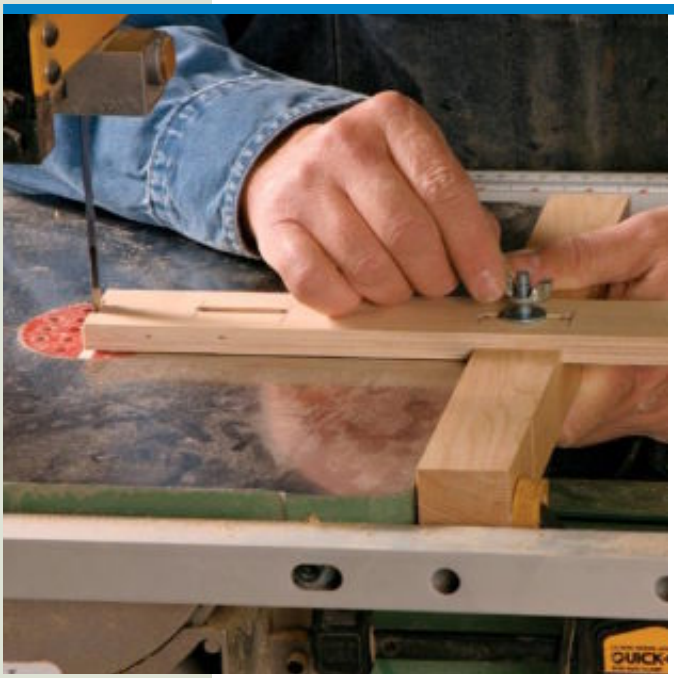
The blade is positioned within the notch at the end of the finger. The distance the finger protrudes past the blade determines the amount of wood overhanging the edge of the pattern when the cut is complete. The ends of the finger should be curved slightly tighter than any curve on the pattern.

Simple, shallow curves can be bandsawn by clamping the finger jig directly to the table, and affixing the stock above the pattern (see photos, below). For complex curves, it is better to position the pattern and the finger jig above the stock so that the contact between the finger and pattern is visible (see facing page). It's a little trickier to secure the stock to the pattern in this case. If you don't mind the holes, screws through the face of the stock can be used. If holes are a problem, hold the stock to the pattern with wedges or dowels.

4 JIG FOR SIMPLE CURVES

A notched plywood finger clamps to the table to guide a pattern, which has the workpiece clamped onto it.

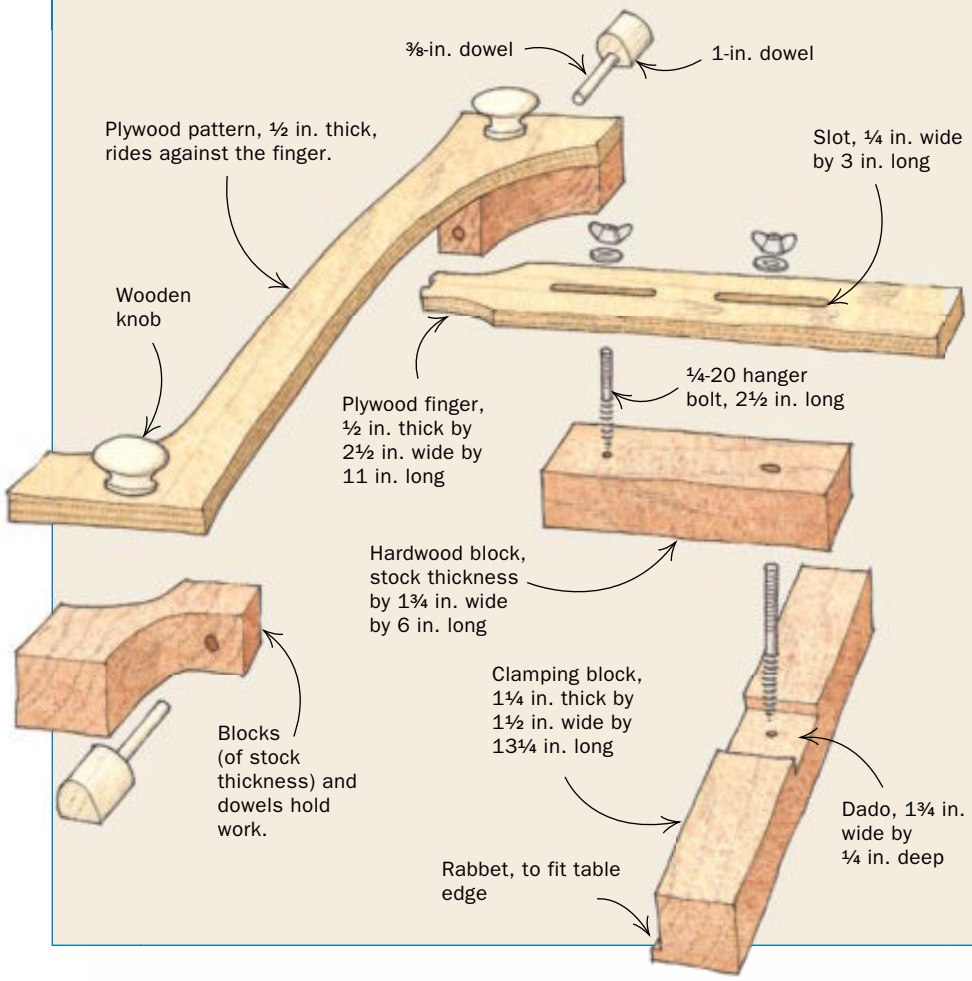




The notched finger jig surrounds the blade. *For simple curves, the finger rests on the table, and a short bolt holds it in the dado of the clamping block.*

5 JIG FOR COMPLEX CURVES

Raising the guide finger and the pattern makes complex curves easier to cut.



Raise the finger to cut complex curves. *Adding a block to raise the finger jig, and placing the pattern atop the workpiece, makes it easier to keep the pattern on track.*

Quickly clean up the bandsawn edges. *A pattern-routing bit rides along the pattern, trimming the workpiece to its final shape.*

Toggle clamps secure the work. *The pattern rides along the finger jig to guide the cut. The notch in the finger jig accommodates the blade and protects the pattern from damage. The finished cut overhangs the pattern (above). The distance from the end of the finger to the teeth determines the width of the overhang.*

Featherboards

These extra hands make cuts safer, cleaner, and more accurate

BY ROLAND JOHNSON

Keeping my fingers attached to my hands and in good working order is a high priority in my woodworking shop. Featherboards help me do it.

A featherboard is simply a board with a series of slits cut into an angled end, forming a row of flexible fingers that move much like the barbs of a feather. The fingers provide constant pressure to hold stock firmly against tabletops and fences, and the angle allows stock to pass in one direction but resists movement in the opposite direction. They do this especially well at the tablesaw and router table.

But featherboards also increase the quality of router, tablesaw, and even shaper cuts. They maintain pressure exactly where it is needed to keep the workpiece moving in an unwavering, straight line. They are especially helpful for controlling thin stock safely, a particular problem when feeding stock by hand.

This guide will show you how to make a featherboard, and then outline some

Shopmade or store-bought?

I like making featherboards because I can do so quickly and cheaply and I can tailor boards to specific tasks. That said, the manufactured featherboards offered by popular woodworking catalogs offer their own advantages.

Ease of adjustment and setup are the biggest assets. Most models are made of high-grade plastic and lock quickly, anywhere along a standard miter slot. A slot cut into the featherboard allows rapid adjustment for stock width and finger pressure. Some models (left) also offer an optional hold-down attachment, a feature that varies in usefulness depending on the width and thickness of your stock. The Bench Dog Feather-Loc (center) preserves its setting when removed from the miter slot.

Magnetic featherboards (right) offer the added advantage of infinitely adjustable setup without the need for clamps or miter slots, although a metal surface is necessary.

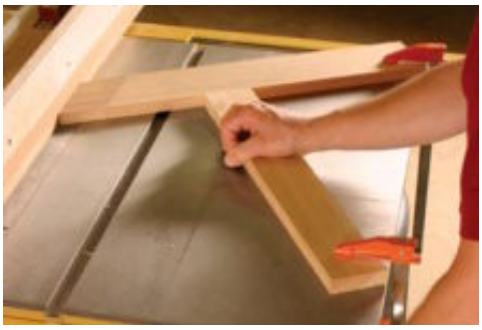
Store-bought models offer ease of use. *Some attach with miter-slot adapters (left) for easily repeatable setups. A magnetic featherboard (right) can be placed anywhere on a metal tabletop.*

Photos: Steve Scott; drawing: Vince Babak

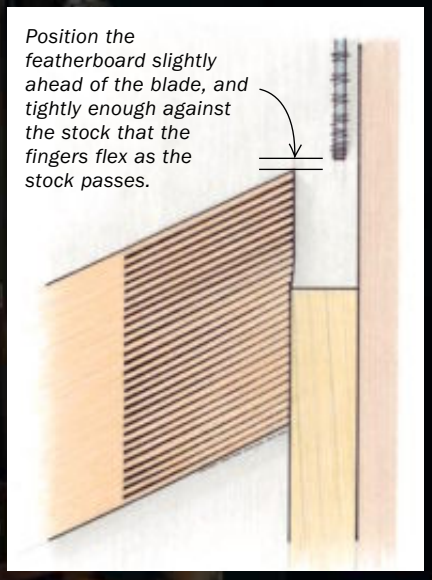
A simple setup for ripping narrow stock

Start by marking the fence. *Use a pencil line to indicate the front end of the blade. Align the featherboard so that it doesn't reach beyond this line, where it could pinch the blade.*

Clamp the featherboard in place. *Lower the blade and place the stock between the fence and the featherboard. Snug the featherboard against the stock as you tighten the clamp.*



A brace keeps the featherboard from pivoting. *Push this board snugly into position against the featherboard as you tighten the clamp.*



essential featherboard setups on the machines where they are used most often.

Featherboards are easy to make

There are a huge variety of store-bought featherboards, but I like to make my own.

Scrap hardwood provides a ready source of material. Flexible woods like ash or hickory make the best featherboards, but any defect-free hardwood will work well. You could use a softwood like pine, but you'd want to make the fingers slightly thicker. Avoid plywood or medium-density fiberboard (MDF); thin fingers of these materials break too easily.

I make most of my featherboards from ¾-in. stock. This is thick enough to support most workpieces that require a featherboard. I sometimes use ½-in. stock for lighter-duty applications. I vary the length and width of the boards according to my specific needs, but I rarely need a board wider than 8 in. Longer boards are good for mounting to a table—you'll want the board to reach to the far side of the table so you'll have access with a standard clamp. Shorter boards work better in applications where they'll be clamped to a fence.

The bandsaw is ideal for making the stopped cuts needed for featherboards, because you can back work easily out of the cut. A tablesaw blade creates a wider kerf than I like between the feathers. Of

Holding stock against a fence

Simple side pressure helps keep the workpiece secure against the fence on the router table (below) or the tablesaw. To raise featherboards off the table for panels or other tall stock (right), secure them with wood screws to a long clamping block. Make sure the boards sit no higher than the top of the auxiliary fence.

course, you can cut featherboards by hand: Just mount the board in a vise and use a backsaw to cut a series of parallel kerfs.

To make a featherboard, start by cross-cutting the business end of the board at an angle. I find that an angle of about 30° offers the best combination of continuous side pressure and kickback resistance. Cutting the feathers into the board's end grain gives them long-grain strength and flexibility so that they don't snap under pressure. Make the feathers no longer than 3 in.

Keep the feathers thin and the spaces between them narrow. Experiment with what works best for you; I find that the thickest practical feather is about ⅛ in. If the feathers are made any thicker, the bending action becomes too stiff, and it is difficult to feed the stock past them. A thinner feather doesn't give you as much pressure, but on most cutting operations the pressure doesn't need to be great. It just needs to be consistent.

Proper setup yields smooth, safe cuts

On any machine, start by placing the stock against the fence or on the tabletop. Position the featherboard firmly against the stock, with the angled end pointing in the feed direction. Secure it to the fence or tabletop with clamps or a miter-slot hold-down. The featherboard should be placed firmly enough to keep the stock against the fence or tight to the tabletop, but not so firmly that it makes it difficult to feed the stock into the cutter or blade. Give the stock a test push to be sure.

Position featherboards as close to the cutter as possible without putting pressure on the cutter itself. In most cases, placing a featherboard directly opposite the blade or cutter can cause the piece to jam dangerously or even kick back, or the cutter to take too deep a cut.

Here are some essential featherboard setups.

The tablesaw—Featherboards allow straighter, safer cuts when ripping long, narrow stock, when cutting rabbets or plowing dadoes in narrow stock, or when cutting tall stock like door panels that might rock against the top of the fence.

For ripping, I apply side pressure with a long featherboard that I clamp to the tabletop. Downward pressure comes from a push stick. Apply side pressure only on the infeed side; pressure on the outfeed side will cause the stock to pinch the blade.

When cutting rabbets, I clamp two featherboards onto an auxiliary fence to apply downward pressure at the dado cutter (breaking the direct-pressure rule) and on the outfeed side of it. If your saw has a Biesemeyer-style fence, be sure to clamp down its back end, because the fence's tendency to lift slightly will relieve pressure on the featherboards and could result in a cut of uneven depth. For dadoes (across the grain) or grooves (with the grain) in narrow stock, I use a single fence-mounted featherboard to apply downward pressure on the infeed side of the cutter. I also use a table-mounted featherboard to keep the stock tight against the fence.

Stock that is taller than the fence needs side pressure both before and after the cut to prevent it from pivoting away from the blade. But applying that pressure with tabletop featherboards can cause the stock to tip away from the top of the fence. The solution is to lift the featherboards a couple of inches above the table with a clamping block (see photo, above).

Holding stock against a table

Fence-mounted featherboards apply pressure from the top down. This keeps stock firmly against the table for tasks like rabbeting an edge on the tablesaw (right) or cutting a molding profile or edge treatment on the router table (above).

The router table—If the stock is too narrow, wide, or short to work comfortably—in short, if controlling the stock will put fingers close to the cutter—featherboards can make the setup safer. Of course, it's best to make router cuts on wide boards, and then rip off the pieces you need. But sometimes narrow or thin stock is unavoidable.

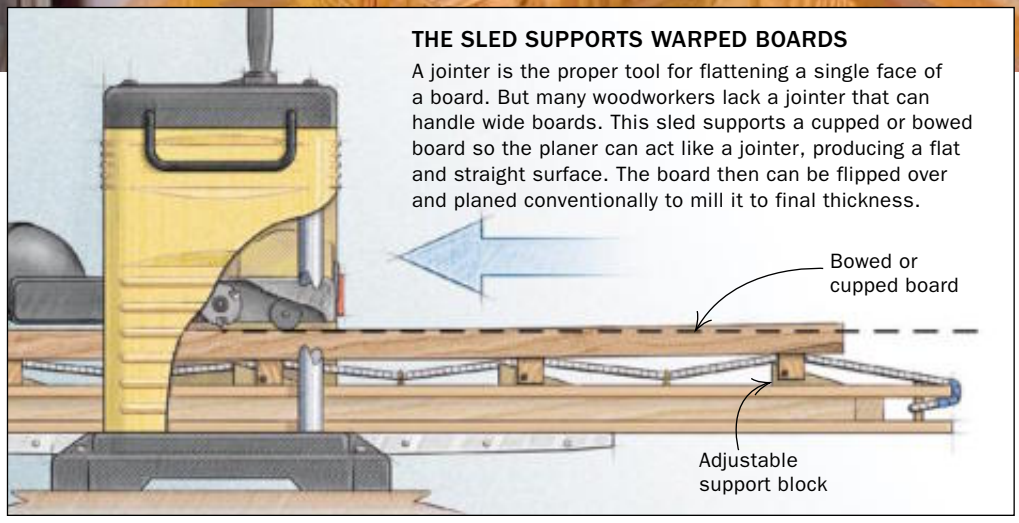
Attach the featherboards to the tabletop and fence to apply downward pressure and side pressure on the infeed side of the cutter. Apply either downward or side pressure after the cutter, depending on how well the table or fence supports the stock. Keep the infeed featherboards as close to the cutter as possible. The outfeed pressure can be less than on the infeed side; just keep the stock from vibrating or "fluttering" after the cutterhead. If a second pass is needed on a router table to cut a molding profile, such as a raised panel, don't apply downward pressure near the cutter on the second pass, or you'll tip the work into the cut. □

Roland Johnson is a woodworker and tool enthusiast in Sauk Rapids, Minn., and a contributing editor to Fine Woodworking.

Small stock needs both types of support

Top and side featherboards increase safety and accuracy when working with small, narrow stock. The setup ensures a straight, flat-bottomed dado on the tablesaw (right) and a cleanly cut molding or edge detail on the router table (below).

Sled Turns Planer into a Jointer



THE SLED SUPPORTS WARPED BOARDS

A jointer is the proper tool for flattening a single face of a board. But many woodworkers lack a jointer that can handle wide boards. This sled supports a cupped or bowed board so the planer can act like a jointer, producing a flat and straight surface. The board then can be flipped over and planed conventionally to mill it to final thickness.

Get a flat face on wide lumber

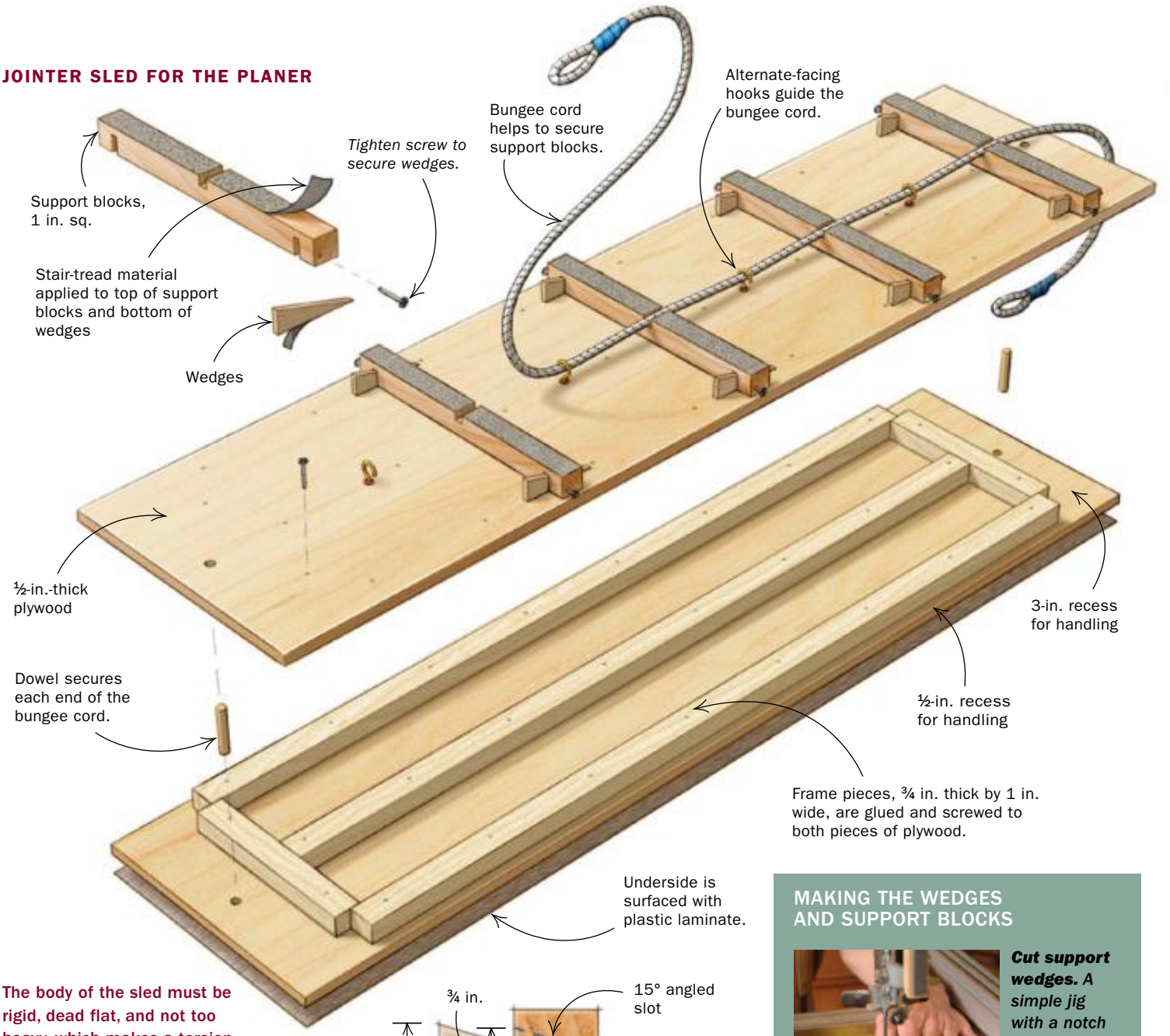
BY KEITH RUST

Working with wide lumber is a joy: The figure and color are seamless, just as it came off the log. But many woodworkers face a problem when it comes to flattening one side of a wide board. We can rip the board into narrower pieces, use a 6-in. or 8-in. jointer, and then rejoin the parts, but a perfect match is not always possible. The alternative is to handplane one side flat.

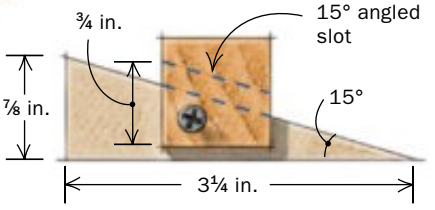
Now, I like handplaning as much as the next guy, but I prefer to save my energy and let machines make lumber flat, straight, and square. So I designed an adjustable sled that allows me to face-joint lumber with a thickness planer. The sled is reliable and quick to set up and adjust without using any tools. To make it, you first need to determine the maximum width the bed

Photos: Mark Schofield; Drawings: John Hartman

JOINTER SLED FOR THE PLANER



The body of the sled must be rigid, dead flat, and not too heavy, which makes a torsion-box design the best choice. The rough board that needs flattening rests on a series of supports that are adjusted to fit the board using sliding wedges.



WEDGE DETAIL

of your planer will accept and how long a sled you want. My 12½-in. portable planer could handle a sled of the same width, but to avoid having too tight a fit, I opted for a 12-in.-wide sled.

The sled's body must be flat and rigid

I had a sheet of 5-ft.-sq., ½-in.-thick Baltic-birch plywood, so I ripped two 12-in.-wide pieces the full length to create the upper and lower bed sections. If you work alone, resist the temptation to make the sled too long and unwieldy. Build it on a flat surface, such as a workbench or outfeed table, to ensure it will be flat.

The frame pieces, ¾ in. thick by 1 in. wide, were cut from a couple of dry 2x4 studs. I recessed the pieces ½ in. on the sides and 3 in. on each end so I could grip the sled easily. The frame pieces are glued and screwed to the upper and lower bed sections.

The top of the sled has a series of supports made of hardwood milled to 1 in. sq. To

MAKING THE WEDGES AND SUPPORT BLOCKS

***Cut support wedges.** A simple jig with a notch in it allows Rust to band-saw multiple 15° wedges.*

***Cut angled slots in the support blocks.** Use a sled angled at 15° to cut a slot in the underside of the support block.*

SLED SETUP

Place the board on the sled. *If it is cupped, rest it with the concave side facing down. Rock the board to locate high spots.*

Adjust the support blocks. *Slide the wedge until the block just touches the board. Then tighten the drywall screw by hand to lock the wedge in place.*

determine their length, measure your planer's inside clearance, keeping in mind that the supports will have about ½ in. of a drywall screw sticking out each end. My planer allowed for 11½-in.-long supports with no danger of a screw head touching anything on the way through.

In use, the supports are raised or lowered using 15° wedges made from ¼-in.-thick medium-density fiberboard (MDF). To keep the supports parallel to the sled's surface as the wedges are inserted, cut a slot ¾ in. from each end of the support blocks, also with a 15° slope. This is done on the tablesaw with a dado set, using a sled that carries the support block at a 15° angle. While the dado set is on the saw, cut a square dado in the top of each support for a bungee cord. The cord secures the supports when the sled is in use and when it is stored vertically. I stretch the cord across the top of the sled, securing it at each end with a dowel (see drawing, p. 95).

To hold the wedges in place, drill a hole in each end of the support blocks for a 1¼-in. drywall screw. Just tightening the screws by hand keeps the wedges from moving once they are in position.

When I first built the sled, I had problems with the planer pulling boards out of position as the sled went through. To solve that, I put self-stick plastic stair-tread material on top of the supports. I avoided sandpaper because of the likelihood of grit breaking off and getting in the planer. I also put a coarser stair-tread material on the bottoms of the wedges to keep them from slipping. Last, I put plastic laminate on the bottom of the sled to reduce drag through the planer.

Setting up the sled for use

Loosen the support screws by hand and slide the wedges back so that the supports all rest on the sled. Orientation of the board is important: If the board is cupped, place the concave side down so that the edges rest on the supports. Do this even though you may now have a board that bows up at each end. Space the supports to have one at each end and two or three along the rest of the board.

Find the high corners of the board by putting pressure on opposite corners and rocking it. Use the wedges to raise the supports that need it, trying to raise each one an equal amount, and tighten the screws by hand. It takes only a little pressure for the fine point of the drywall screw to bite into the MDF and secure the wedge. Test to see if the rocking is gone. Now go down the length of the board and find loose supports. Use the wedges to raise the ones that need adjusting, but don't come up too high. Doing so can cause other gaps to appear.

Roller stands at each end of the planer and a removable support arm attached to the box my planer sits on help support the sled. The arm has a top of heavy plastic that reduces the friction of sliding the sled across from the outfeed to the infeed side. Several products are available from Woodcraft and other retailers, including ultrahigh-molecular-weight plastic.

Using the planer as a jointer

Once the board is stable, raise the cutterhead high enough to accept the entire

package and, without turning on the power, slide everything into the planer to find the highest point. Pull it back out, crank down a bit, and you're ready to joint the board. This is one of those cases where describing the process takes far more time than doing it. It's easy to put a board on the sled, adjust the supports, and be planing in 30 to 45 seconds. It helps to know the combined thickness of the sled and supports so that you can have the planer opening set to the approximate thickness.

After the first pass, check to see if anything has shifted and adjust the wedges as necessary. Send the sled over the fixed arm and back to the input roller, lower the head, and make another cut.

I recently built a chest of drawers with bent-laminated drawer fronts and had no trouble using this sled to flatten 11-in.-wide hard maple to make drawer-front plies. This is a jig that has proven to be worth far more than the original time invested in designing and building it. □

Keith Rust is a woodworker in Arlington, Texas.

USING THE SLED

With the planer turned off, slide the sled through to check for obstructions and to determine the highest point on the board (above). After the first pass, check and adjust the wedges (left), if necessary. Once you have flattened one surface of the board (below), you can dispense with the sled and run the other side of the board through the planer to thickness it.

Using push sticks

SHOPMADE HELPERS ARE A CHEAP WAY TO STAY SAFE

BY PETE SCHLEBECKER

At the Center for Furniture Craftsmanship, where I teach and also manage the woodshops, showing students how to safely operate power equipment is one of our first tasks. The lesson always includes push sticks.

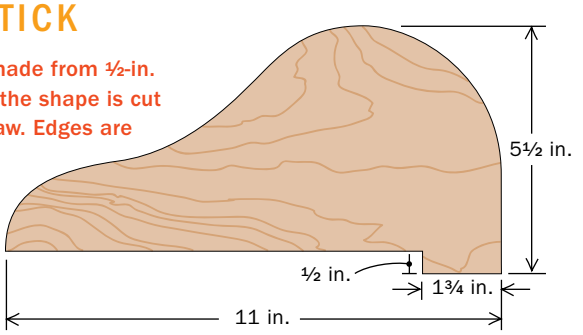
A push stick is a shaped length of wood or other material that helps control the movement of a workpiece. It is most needed at the tablesaw, jointer, router table, and bandsaw.

Using a push stick keeps hands away from blades and cutters. It also helps maintain an even pressure and feed rate, reducing the risk of kickback and producing a smoother cut. In our shops, we keep extra push sticks handy, and there is always one sitting on top of a machine table or hung on a hook nearby. We encourage students to get in the habit of looking for the push stick before they turn on the machine.

There are many well-designed push sticks for sale, but shopmade sticks are easy and inexpensive to make from scrap. A well-made push stick will hold the work securely with a notch, cleat, or nonslip surface. It will feel right in the hand—an awkward handle can be unsafe if it forces you to shift your hand for a better grip. And it will be easy to make, because shopmade sticks are meant to contact the blade at times and eventually to be replaced. Here's a look at a variety of shopmade push sticks in use where they're needed most.

TABLESAW: SHOE-STYLE PUSH STICK

This stick is made from ½-in. plywood, and the shape is cut on the bandsaw. Edges are rounded over with a rasp or router.



A simple plywood cutout for safe ripping

Many projects require ripping stock to width, a task done most quickly and cleanly on the tablesaw. But ripping stock on the tablesaw also can be dangerous.

A workpiece that's not properly guided through the cut can veer into the back side of the blade and be kicked back at the operator. This is especially true if the splitter is not in place. When ripping narrow stock, the fingers can come too close to the blade, leading to tragedy in an instant. For these reasons, we teach students to use a push stick when ripping to a width

Always keep a push stick handy. *Store it within easy reach (above). Push between the blade and the fence (right) and make sure that the workpiece clears the blade when the cut is finished.*

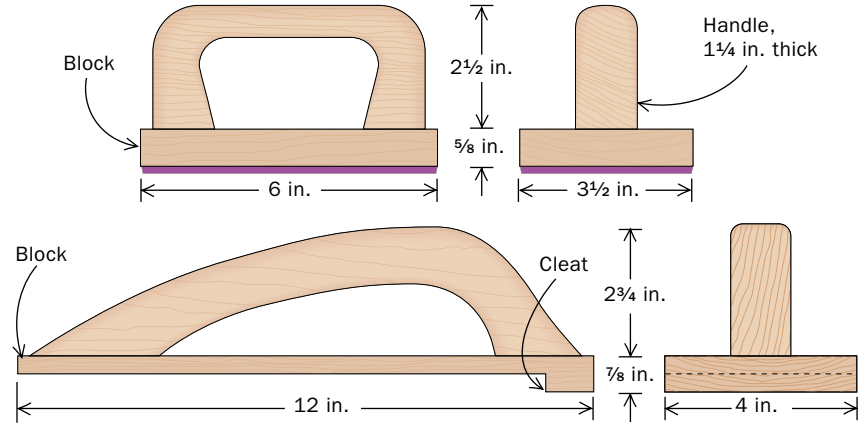
Don't spare the stick. *If the wooden push stick won't fit between the blade and fence, it's safe to drive it through the blade (observe precautions on blade height) and complete the cut.*

Photos: Steve Scott; drawings: Kelly J. Dunton

JOINTER: PUSH BLOCKS

The cleated design is used in the right hand, at the board's trailing edge, to feed the work into the cut. The cleated block's handle can be very simple, but the sloping shape pictured here shows which end has the cleat on it.

The padded block is used in the left hand, to keep the board from bouncing as it crosses the cutterhead. For the rubber-grip surface, Schlebecker used spray contact adhesive (3M Super 77) to attach a piece of an inexpensive yoga mat. Bandsaw the handle from a scrap of solid wood.



***Easy to assemble.** A cleated push block can be made in less than 15 minutes. Because the glue joint is long grain to long grain, screws are not needed.*

of 6 in. or less. With the stick in your right hand, place the notched end at the rear of the workpiece between the fence and the blade. Use the stick to feed the piece all the way past the back of the blade.

If you need to drive the push stick into the blade, be sure to keep the push stick parallel to the fence, and be prepared for increased resistance as the blade cuts through the bottom of the stick. To minimize this resistance, and for safety reasons, set the blade height so that it doesn't cut very deeply (¼ in. or so) into the stick. Once you've cut through your push stick in this way a few times, it's a good idea to trim back the frayed surface with a bandsaw or discard the stick and make a new one.

To rip longer pieces that extend past the leading edge of the table, leave the push stick within reach on top of the rip fence. Start the cut by pushing the rear of the piece by hand until it reaches the edge of the table. If you use the stick before this point, you may place downward pressure on the back end of the board, lifting the front end away from the blade.

When flattening boards, use a broad, flat push block

Using a jointer to flatten a board's face or to straighten an edge on narrow stock can bring the operator's hands dangerously close to the machine's horizontal cutterhead.

Guiding the work with push sticks helps keep your hands out of danger. It also helps achieve a clean cut by ensuring that the work doesn't bounce or "chatter" as it crosses the cutterhead.

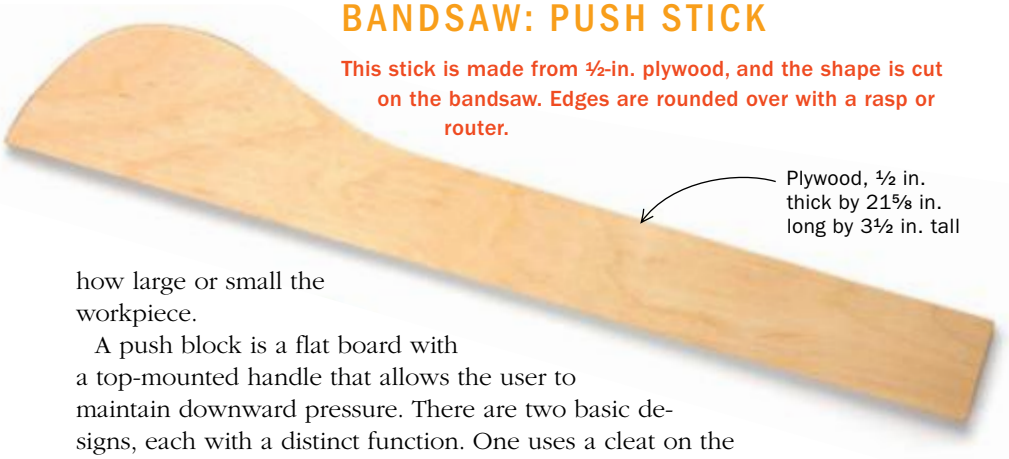
For face jointing, a flat style of push stick known as a push block works best; we ask that students use them no matter

***Use a pair of push blocks for face-jointing.** It's best to have a non-skid block at the board's leading edge and a cleated block at the rear.*

***The shoe-style stick is excellent for edge-jointing.** It works especially well with narrow stock that is tall enough to clear the blade guard but too short to clear the fence.*

BANDSAW: PUSH STICK

This stick is made from ½-in. plywood, and the shape is cut on the bandsaw. Edges are rounded over with a rasp or router.



how large or small the workpiece.

A push block is a flat board with a top-mounted handle that allows the user to maintain downward pressure. There are two basic designs, each with a distinct function. One uses a cleat on the back to grip the trailing end of the stock. The other, used at the leading end of the workpiece, has no cleat but grips the stock with a nonslip rubber pad.

To use them, take the cleated stick in your right hand and the rubber-soled block in your left to maintain downward pressure at the leading end of the workpiece.

A notched board with handles helps guide stock on the router table

The safest way to get a routed profile on a narrow workpiece is to cut the profile on the router table first, before ripping the stock to final width. Working with wider stock allows you to feed the work past the bit without putting your fingers in harm's way.

Occasionally, though, you might need to rout a shape onto a piece that's already quite narrow. Featherboards will help hold the piece firmly to the table surface, but you'll need a push stick to guide the work snugly against the fence.

An effective push stick is a simple piece of plywood with a notch cut into one end. The strip lies flat on the router table, with the notch at the trailing end. Two vertical handles, mounted with countersunk drywall screws and glue, make the push stick easy to grab. For the handles, I use scraps from our wood-turning studio, but a large dowel or rounded square stock will do fine.

Use a long push stick at the bandsaw. *This allows the user to push the workpiece from behind the fence without risk of running thumb or fingers into the blade.*

A long reach keeps fingers safe when resawing

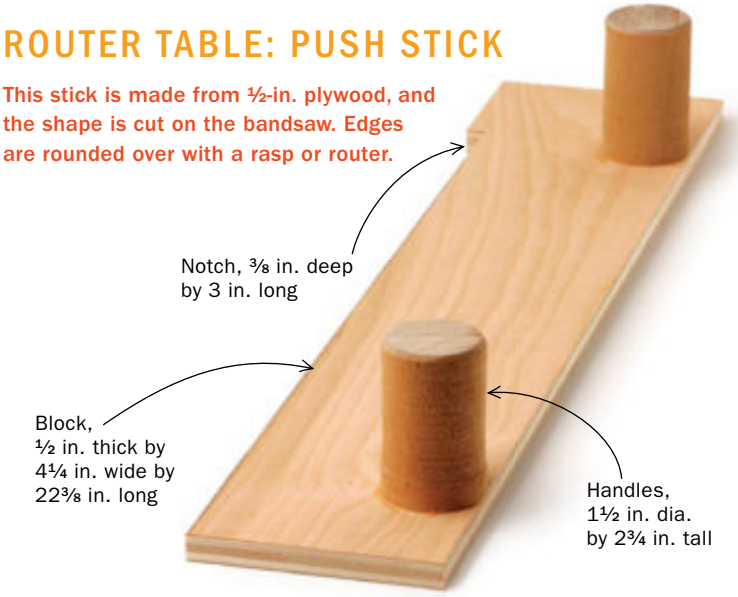
Resawing—or slicing stock along its face to make thinner boards—is a great reason to have a bandsaw. But the operation requires care, especially when the fence is close to the blade. The trick is to push the stock from the rear at an even rate all the way through the cut, and keep your fingers out of the way as the blade emerges from the tail end of the workpiece.

Almost any length of scrap will work as a push stick for this task, but it's nice to have one with a comfortable grip nearby.

The dedicated stick we use in our shop is easy to make—just another shape cut out on the bandsaw. Make sure the stick is long enough so that the front end reaches just past the blade while the rear is still a couple of inches behind the fence. This way, the fence won't interfere with your grip as you finish the cut.

ROUTER TABLE: PUSH STICK

This stick is made from ½-in. plywood, and the shape is cut on the bandsaw. Edges are rounded over with a rasp or router.



Rout narrow stock without fear. *This notched stick keeps hands away from the cutter. Featherboards apply downward pressure.*

Build a simple crosscut sled for the tablesaw

ESSENTIAL JIG ENSURES SQUARE CUTS

BY GARY ROGOWSKI

Every saw needs one. *A shopmade sled makes it easier and safer to make accurate crosscuts on the tablesaw.*

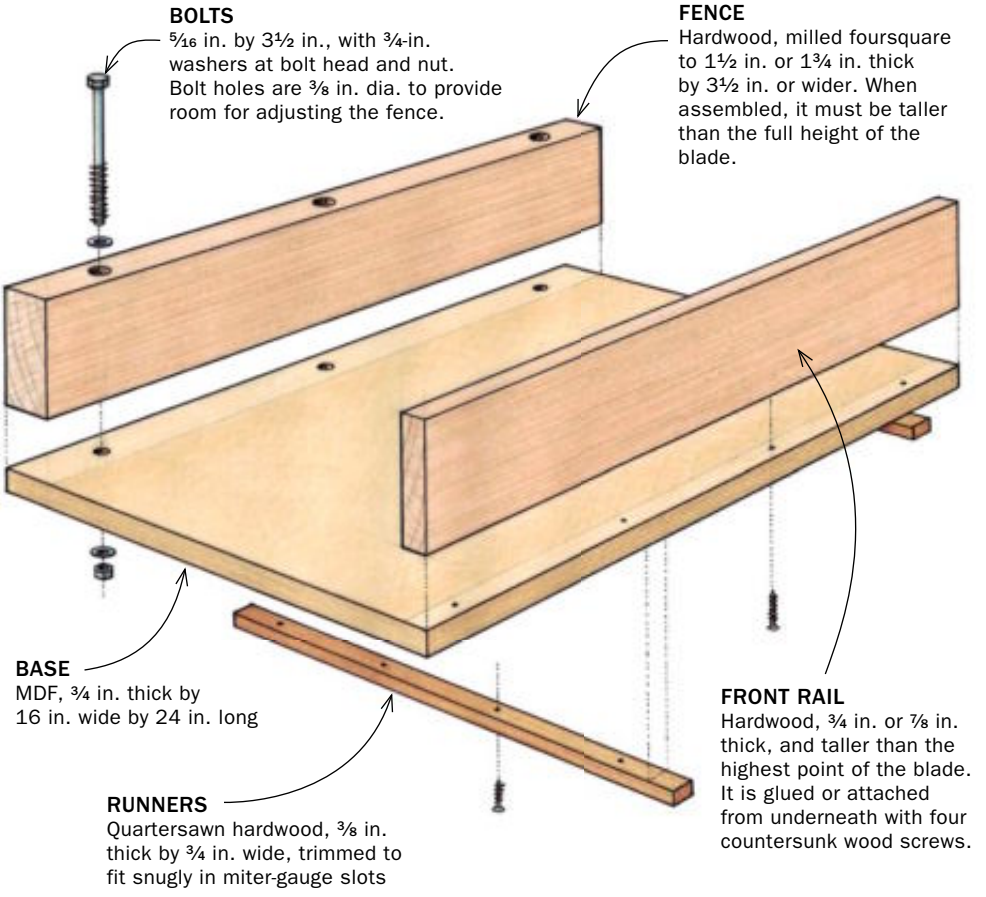
It's a euclidean world, darn the luck. Woodworking goes better when angles are precise, true, and above all, consistent. "Consistently off" may be how your work has been going until now, but making a tablesaw sled can fix many crosscutting woes.

My sled is a focal point of my shop. With it, I can produce square ends on stock. I can clamp on a stop block or make a pencil mark for repeat cuts. I can use the sled as a platform for other jigs to cut precise angles and to cut a variety of joints. And I can do all of this work safely and with greater accuracy.

A crosscut sled provides support from two directions (behind and underneath)

ANATOMY OF A SLED

A crosscut sled is a versatile tool with just a few carefully assembled parts. Its accuracy relies on close-fitting runners and a square fence.



1. Attach the fence

Use bolts, not screws. *This makes it easier to adjust the fence so that it is square to the blade.*

Photos: Steve Scott; drawing: Vince Babak

and so holds a workpiece more securely than most stock miter gauges. This is especially helpful when crosscutting wider pieces, where a sled is a much safer option than running a workpiece against the rip fence, a recipe for kickback.

The sled is accurate in part because its twin runners ensure that the stock moves in a straight line past the blade. The stock is registered against a back fence that is carefully set at 90° to the blade. The fence is adjustable, so it can be reset and retightened if it gets knocked out of whack.

Start with a square piece of MDF

You can build any size sled, but I strongly recommend starting small. I've learned that it pays to make your first sled for 99% of cuts, that is, boards less than 13 in. wide. The sled will be easier to make, easier to move, and easier to adjust. For any cut wider than 13 in., I have another sled at 37 in. wide.

There are several keys to an accurate sled: a flat base, straight runners that fit snugly in the miter slots, and a flat and square fence. Make the base out of ¾-in. medium-density fiberboard (MDF) about 16 in. wide by 24 in. long. Attach a front rail that is taller than the fullest height of the sawblade. Its job is to hold the front of the jig together.

Make fence and runners of hardwood

I make the fence out of hardwood, milled foursquare about 1½ in. thick and taller than my tallest cut. I make it this thick so I can fasten it to the baseplate with bolts and washers.

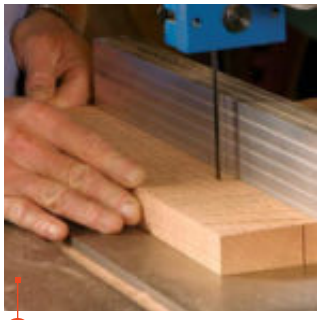
I built my first sled with screws, and they just don't hold up to the banging around this jig gets in an active shop. If your MDF is relatively square, bolt on the fence so that its rear face is aligned with the back of the base. You'll adjust it later to square it with the blade.

For this sled, I used 5⁄16-in. bolts and drilled ⅜-in.-dia. holes. This gives me room to adjust the position of the fence.

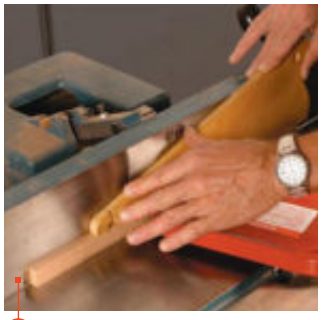
The runners are critical to the success of the jig. They need to move without play in the miter-gauge slots. If they don't, your jig will ride sloppily, your

2. Install the runners

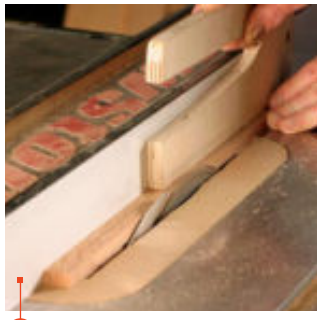
Make the runners of quartersawn hardwood. With the grain oriented in this way, seasonal wood movement will cause the runners to shrink or swell in thickness, as opposed to width. This means the runners won't bind.



1 ***Bandsaw to rough dimensions.*** *Set the fence using measurements taken from the tablesaw's miter-gauge slot.*



2 ***Joint two faces.*** *These will serve as reference surfaces for final trimming of the runners to fit in the miter-gauge slots.*



3 ***Trim to final width.*** *Take light cuts and check the fit in the slot as you go. You also can use a planer or a handplane.*

4 ***Attach the runners.*** *Assembling the sled with the runners in their slots helps ensure they'll be parallel and properly spaced when you're done. Attach the runners with wood screws driven into countersunk holes.*

5 ***Trim the high spots.*** *Push the completed sled back and forth in the slots a few times. Any places where the runners rub against the sides of the slots will darken. Trim these areas with a scraper, then wax the runners and the bottom of the sled to reduce friction.*

3. Square the fence to the blade

The sled won't make accurate crosscuts unless the fence is precisely perpendicular to the blade. The oversize bolt holes in this fence make it possible to adjust the angle until test cuts yield square results.

1 *Make the kerf.* *Set the blade to its full height and cut through the sled.*

2 *Make a test cut.* *Crosscut a piece of wide stock to gauge the fence's accuracy.*

3 *Check the cut with a square.* *Any gaps will help you determine the direction and amount of adjustment the fence requires.*

4 *Mark your starting place.* *Before adjusting the fence, mark its original location as a reference point.*

5 *Tighten the fence.* *When you're done adjusting, crank the bolts home and you're ready to make crosscuts.*

cuts will be inconsistent, and your salty vocabulary will grow at an alarming rate.

I recommend making the runners of hard-wearing quartersawn stock such as oak or maple, about ⅜ in. thick, or slightly thinner than the depth of the gauge slots. You don't want the runners bottoming out in the slots and lifting the baseplate off the saw table.

Make the runners to fit snugly in width, trimming them with a handplane to fit into the gauge slots. Next, drill four countersunk holes in each runner for flat-head screws to hold it in place.

Mount the runners and adjust the fence

Place the runners in the slots, lay the assembled base and fences on them, and push the package to the rear of the saw table so that one set of countersunk holes is visible. Make sure the jig's fence is relatively parallel to the saw's back edge. Mount two screws into the sled, one in each runner. Then slide the assembly back to the front edge of the saw table so that two more holes are visible. Mount these screws, flip the sled over, and drill and mount the four remaining screws.

Place the sled in the slots and try to push it. The runners will probably be too tight. Wax them and the bottom and see if the sled will slide. If not, check for black spots on the runners that show where they're rubbing. Use a scraper or shoulder plane to trim those areas, rewax, and try again. The sled should move effortlessly in the slots with no side-to-side play.

Now you're ready to start working. Make the first cut in the sled by raising the blade just enough to slice through the baseplate. Then raise it for a higher cut. Place a piece of scrap on the sled and crosscut it, checking the results with a square. Adjust the fence accordingly. You can also make a through crosscut and flip the pieces to see if they line up perfectly (see p. 20 for the technique). Lock down the fence with the bolts when you're cutting square.

Remember to always set the jig down so that it's not resting on its fence. You don't want it knocked about. Also, be very aware of the sawblade's exit point. Mark this zone to remind yourself never to place your fingers close to it. □

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Q&A

Don't shape curved panels with vertical bits

Q: I have been using a vertical panel-raising bit for safety for many years, and now I'd like to make a panel with the top curved. Can I make a jig that would work for this?

—ROBERT REDINGER, Shorewood, Ill.

A: ROUTING A CURVED PANEL with a vertical panel-raising bit isn't practical or safe. The fixture for this application is so complicated and risky that it does not justify itself. The work has to be rotated past the cutter while on its edge against the fence. It's unsafe at any speed because there's poor workpiece control.

However, curved panels can be raised with a router using a horizontal cutter. It requires bearing-guided panel-raising bits of 3 in. dia. or more. With these large cutters, making deep cuts in one pass is hazardous. So cut in stages by moving the bit up in increments. Note: Large-diameter bits must be run at much slower speeds.

—Pat Warner is author of The Router Book *(The Taunton Press, 2001).*

VERTICAL BITS WORK FOR STRAIGHT EDGES

A tall fence and featherboard support the panel in the vertical position. Make the cut in several passes by gradually moving the fence backward.

SHAPE CURVED PANELS WITH HORIZONTAL BITS

The curve of the panel rides against the bearing on the router bit as the bit is raised gradually for successive cuts. The pin in the table allows the workpiece to be pivoted into the cutter to begin the cut.

Cutting round stock on the bandsaw

Safe cuts in round stock. *Clamp the stock in a sled screwed to a miter gauge. Be sure the clamp sits below the stock's centerline.*

Q: As I was pushing a 12-in.-dia. pillar through a ½-in. bandsaw blade against the fence, the blade suddenly went off track, chewing up the table insert and part of the door that covers the bottom wheel. What happened?

—BILL BALLEZA, Houston, Texas

A: MOST LIKELY WHAT HAPPENED WAS THE PILLAR ROTATED A BIT as you were cutting, snagging the back of the blade and pulling it forward out of the guides. For safety, you should stabilize the pillar by fastening it to a plywood sled; for long pillars, support the outboard end of the sled on a roller stand.

On a bandsaw, there is nothing restraining the blade from being pushed forward and out of the guides. It takes only a small amount of pressure on the trailing edge of the blade for it to shift forward. And a ½-in. blade needs to move forward only about ⅜ in. for it to push clear of the side blocks and damage the machine. That's why you should never try to back out of a cut with the blade moving.

—John White is shop manager for Fine Woodworking.

Photos, except where noted: Marcia Ryan; this page (top): Kelly J. Dunton; drawing (facing page): Vince Babak

Tablesaw-blade tightening technique

Q: It's hard to get a lot of leverage on the blade of my cabinet saw when I'm tightening it to the arbor. What technique should I use to tighten the blade so that it won't fly off while spinning?

—AARON GRAHAM,
Jamaica Plain, Mass.

Steady the blade with slight hand pressure. *Then a few quick raps on the free end of the wrench with a piece of hardwood are all that is needed to tighten the nut solidly (left). Loosen the blade the same way, but protect the tabletop from the loosened wrench (right).*

A: JAMMING A BLOCK OF WOOD against the blade's rim or clamping the blade can permanently distort a precisely made blade. The method I use doesn't put any stress on the blade. After you get the nut finger-tight against the blade, place the wrench on the nut, hold the blade with one hand, and strike the wrench with a block of hardwood, taking two or three moderate blows. This method simulates the action of an impact wrench, using the inertia of the saw's drive system to keep the arbor still while the nut is tightened. Because of the way a saw is designed, you don't have to worry that undertightening the nut creates a risk that it will come loose and allow the blade to fly off. The direction of the threads on the arbor run in the opposite direction of the arbor's rotation; so even a loose nut wouldn't spin off the shaft while the saw was running.

To remove the nut, reverse the procedure. Place a shop rag on the edge of the table-insert opening to prevent the wrench handle from dinging the table when the nut comes loose.

—*J.W.*

Keep a square edge while cutting with a jigsaw

Q: When using a handheld jigsaw, my cuts often deviate from perpendicular, especially when cutting curves in thick stock. What do you recommend?

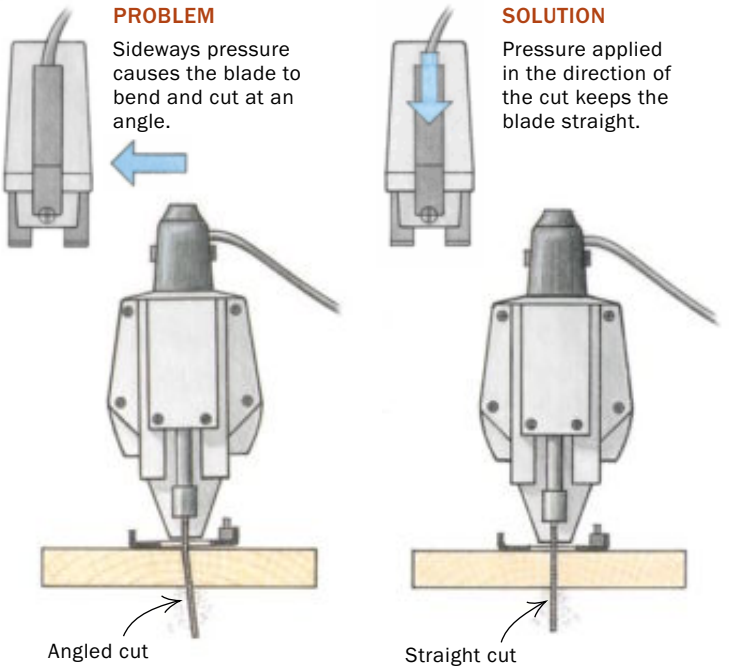
—LARRY ANDERSON,
Seattle, Wash.

Choose the right blade. *A narrow blade allows for cutting tight curves, and the more teeth per inch, the smoother the cut. The 20-tpi Bosch T101AO (top blade) is designed to cut tight curves in stock up to ¾ in. thick.*

A: CUTTING ACCURATE CURVES with a jigsaw requires the right blade, saw settings, and procedure. Once you've checked that the sole of the jigsaw is square with the blade, match the width of the blade to the radius of the cut: the tighter the radius, the narrower the blade. For tight curves in stock as thick as ¾ in., I use the narrow Bosch T101AO.

If your jigsaw has an oscillating-blade feature, use the lowest setting to cut curves. During the cut, apply pressure to the saw only in the direction of the cut. Side pressure will force the blade to tip or tilt, and the cut will not be square. Moderate to high blade speed and a fairly slow feed rate will help prevent side pressure.

—Roland Johnson is a woodworker in Sauk Rapids, Minn., and a contributing editor to Fine Woodworking.



Smoother cuts on the tablesaw

Q: When ripping with a carbide blade and a Biesemeyer fence, I cannot keep the rear of the blade from recutting what has already passed through the front of the blade. Is there a solution?

—DENNIS WALSH, Twin Peaks, Calif.

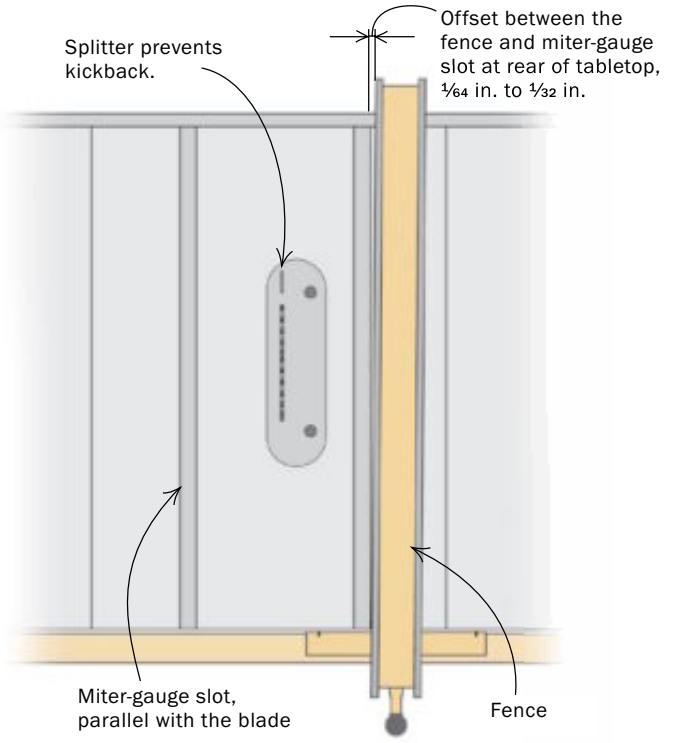
A: TABLESAWS NEED ACCURATE alignment to perform well. The miter-gauge slots must be adjusted parallel with the blade, and the rip fence should be adjusted slightly out of parallel by referencing off the miter slot. To keep the rear of the blade from recutting the stock when ripping, the rip fence needs to be out of parallel by 1/64 in. to 1/32 in. over its length.

In addition, use a splitter in the table insert or attach one to the arbor assembly to prevent the work from coming off the fence and into the blade (causing dangerous kickback) should it decide to bow on you during a cut. Most importantly, remember to reset the fence parallel to the blade whenever you move the fence to the left of the blade. If you don't, the work will bind in the cut.

—Gary Rogowski runs the Northwest Woodworking Studio in Portland, Ore.

OFFSET THE FENCE AND ADD A SPLITTER

For cuts free of burns and sawmarks, adjust the rip fence slightly out of parallel with the miter-gauge slot. A splitter keeps stock from drifting into the blade and catching.



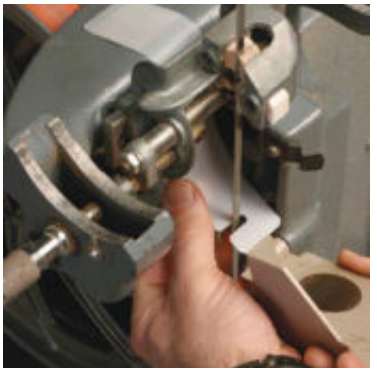
Keep bandsaw tires clean

Q: How do you clean embedded sawdust off bandsaw tires and minimize the dust from building up on the tires?

—MEL HALPERN, Richboro, Pa.

A: WITH THE SAW TURNED OFF AND UNPLUGGED, scrub off embedded sawdust with a brass brush. Spin the wheel by hand and hold the brush in place against the wheel. Avoid using oil-based solvents such as paint thinner because they may damage the rubber of the tire.

To avoid the buildup in the first place, you can make three simple modifications.



Install a dust deflector below the table. *Use a piece of flexible cutting board, found at hardware stores, and align it with the dust-collection port.*

Install a brush in the lower housing, against the wheel. *Iturra Design (888-722-7078) carries a brush that fits the Delta 14-in. bandsaw.*

First, install a deflector that will channel the dust toward the pickup chute. A piece of stiff rubber or flexible plastic can be attached with self-tapping screws or double-sided adhesive tape.

Second, install an additional dust pickup in the bottom left-hand corner of the lower housing, where a pile of dust tends to collect. You can use a metal-cutting hole saw to drill the hole. A sawdust pickup chute available from tool suppliers can be attached with screws over the hole.

Finally and most important, any remaining dust can be kept off the wheels by installing in the lower housing a stiff brush that cleans the lower wheel as it rotates. I use a wooden scrub brush with stiff natural bristles that I cut to size and attach with wood screws, inserted through holes in the metal casting.

With these modifications, I haven't had to replace the tires that came with my bandsaw 30 years ago.

—Michael Fortune is a furniture maker in Lakefield, Ont., Canada

Drawing (this page): Kelly J. Dunton

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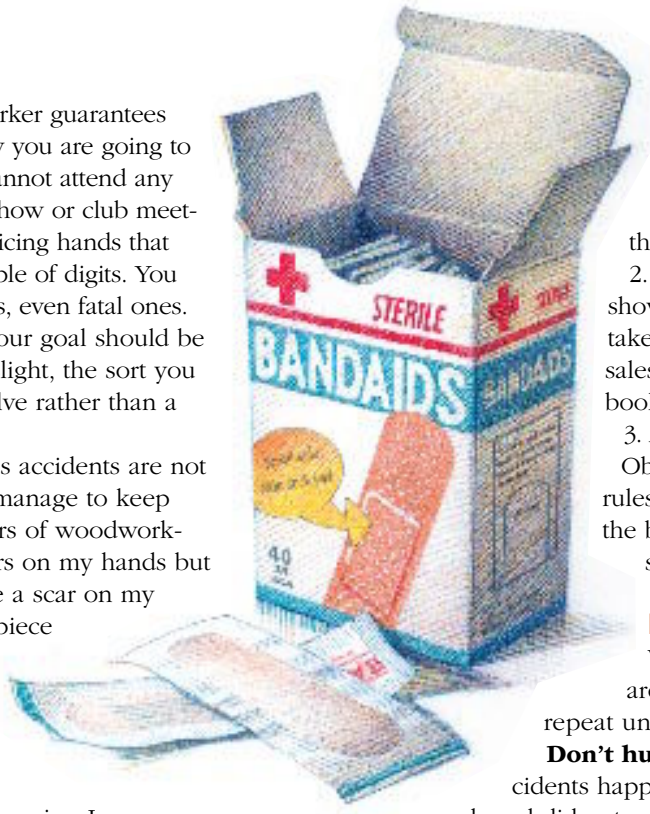
BY MICHAEL DUNBAR

Rule one: Avoid major injuries



Being a woodworker guarantees that periodically you are going to get hurt. You cannot attend any woodworkers show or club meeting without noticing hands that are short a couple of digits. You hear stories of horrible accidents, even fatal ones.

Accidents are inevitable. So your goal should be to ensure that any injuries are slight, the sort you can treat with bandages and salve rather than a trip to the hospital.

Amputations and other serious accidents are not inevitable. Most woodworkers manage to keep their bodies intact. After 30 years of woodworking, I have numerous small scars on my hands but can still count to 10. I also have a scar on my forehead where I was hit by a piece of wood that flew out of the lathe. I wish I had started using hearing protection a lot sooner. My doctor tells me I cannot regain my hearing, only protect the little I have left. Otherwise, I am as complete as when I entered the world. After 21 years of teaching some 3,500 people, only two have cut themselves badly enough to require a doctor's attention. I like to think it is because of the safety lecture I give at the beginning of every class and the reinforcement we give before every demonstration.

Although there are lots of safety rules for woodworking, safety is a state of mind. In other words, your best protection is learning to behave safely. Developing this state of mind requires embedding it in your brain so that a little voice screams every time you flirt with danger. You should create this state of mind while still a beginner, but it never hurts seasoned woodworkers to refresh and strengthen it.

The best reminders are simple, like the jingles Madison Avenue uses to embed product names in your mind. A former staff member, Dan Faia, never forgot the annoying little adage his high-school shop teacher used: "A clean shop is a happy shop. A happy shop is a fun shop. A fun shop is a safe shop." Although this corny ditty generated a lot of scorn from the teenage students, Dan is still influenced by it.

A local kindergarten teacher brings her class to our school every year for an introduction to woodworking, and we set up simple projects for the students to do. My safety instructions for them are the same I give to adults:

1. Tools are not toys. In other words, use them only for their intended purpose.
2. Never use a tool until you have been shown how to handle it properly. For adults, take time to learn to use a tool. Have the salesman give you some instruction, read a book on the topic, or take a class.
3. Always use a tool the way you were shown.

Obviously, there are other important safety rules, but the point is that you never outgrow the basic truths, and you're never too smart to slip up.

Rules to live by

While each tool has its safety rules, here are some general practices that you should repeat until they become ingrained habits.

Don't hurry, and don't work tired—Most accidents happen because the woodworker was in a rush and did not want to take the time to prepare for just one quick cut. The person knew the risk but figured it wouldn't happen this one time. When you are fatigued or otherwise impaired, get out of the shop.

If it makes you nervous, don't do it—After all the effort you go through to train that little voice in your head, listen to it. Trust it to warn you when something is unsafe.

Heed the manufacturer's warnings—We all know those safety instructions are there primarily to protect the manufacturer from liability. However, liability means someone has gotten hurt, so the warnings are there to protect you as well. This also applies to blade guards and shrouds. Sure, some of them are a pain, but an injury is worse.

Wear eye protection—Put on safety glasses whenever you are doing anything that can send even the smallest piece of wood or metal into the air. Don them whenever starting a machine or swinging a hammer or mallet.

My worst eye injury was temporary, but it sure hurt. It happened five years ago when I was trimming the end of a tenon with a gouge and mallet, and a chunk of wood popped upward. For 25 years, I had gotten away with doing this task without eye protection. With a hand over my throbbing eye, I

Drawing: Linda Fennimore

swore if I was still able to see when I took the hand away that I would wear goggles ever after.

Protect your hearing and lungs—The injuries we risk are not always as immediate as being hit in the eye or trimming a digit off a hand. You lose your hearing so slowly you don't notice, but eventually you end up as I have, cupping your hand behind your ear to hear even a normal conversation.

Newer earplugs and muffs are designed to let harmless levels of sound through, blocking only sounds that are dangerously loud. Some muffs even come with a built-in radio. There's no excuse for not using them.

Wood dust and other products we use can do cumulative damage to our lungs. Install dust collectors and air cleaners, and wear a quality dusk mask when doing anything that creates a lot of fine dust. Remember, the dust is there, even though you cannot see it most of the time. In the winter, when the sun is low and shines directly through your shop windows, notice the ever-present cloud of dust hanging in the air. The memory of this cloud should set off a little voice in your head that prompts you to turn on the air cleaner and put on a dust mask whenever you pick up sandpaper.

Keep the shop clean and uncluttered—I have heard of lots of accidents that involve tripping over clutter or tools falling into machines. These incidents are a lot less likely if you clean regularly. At our school, each student is instructed to immediately pick up any small pieces of wood that fall to the floor and place them in the burn barrel. Because the staff walks around the woodshop constantly, we have a vested interest in this. I have nearly fallen several times stepping on small cutoffs.

We have students put away their tools and clean the benches after every operation. We stop the class and clean the shop several times a day and before leaving for the night.

Clean and uncluttered also applies to your person. Remove jewelry, roll up sleeves, and tie up long hair. Any of these can get caught in a moving blade.

Prevent accidents, but prepare for them—This sounds a bit contradictory, sort of like the old Roman saying, "To preserve peace, prepare for war." But a quick response can head off a true disaster. Keep emergency numbers by the phone. Keep a medical kit in the shop. Display and maintain your fire extinguishers. Install a master kill switch for all of your machines. Keep hearing, eye, and dust protection at every workstation.

Protect your property—Finally, safety applies to your property as well as to your person. I know numerous people whose shops have burned to the ground. Dispose of oil-soaked rags properly. Keep flammables tightly capped and in a metal cabinet. Unplug battery chargers and portable power tools before leaving the shop for the night. □

BY AIMÉ ONTARIO FRASER

Listen to your tools

THEY MAY BE TELLING YOU THAT SOMETHING'S WRONG

Listen closely to your tools, and they'll speak volumes. The sounds a tool makes can alert you to a dull blade, an incorrect setup, or a faulty technique. If you learn their language, your tools will tell you about issues so you can set them right before they become problems.

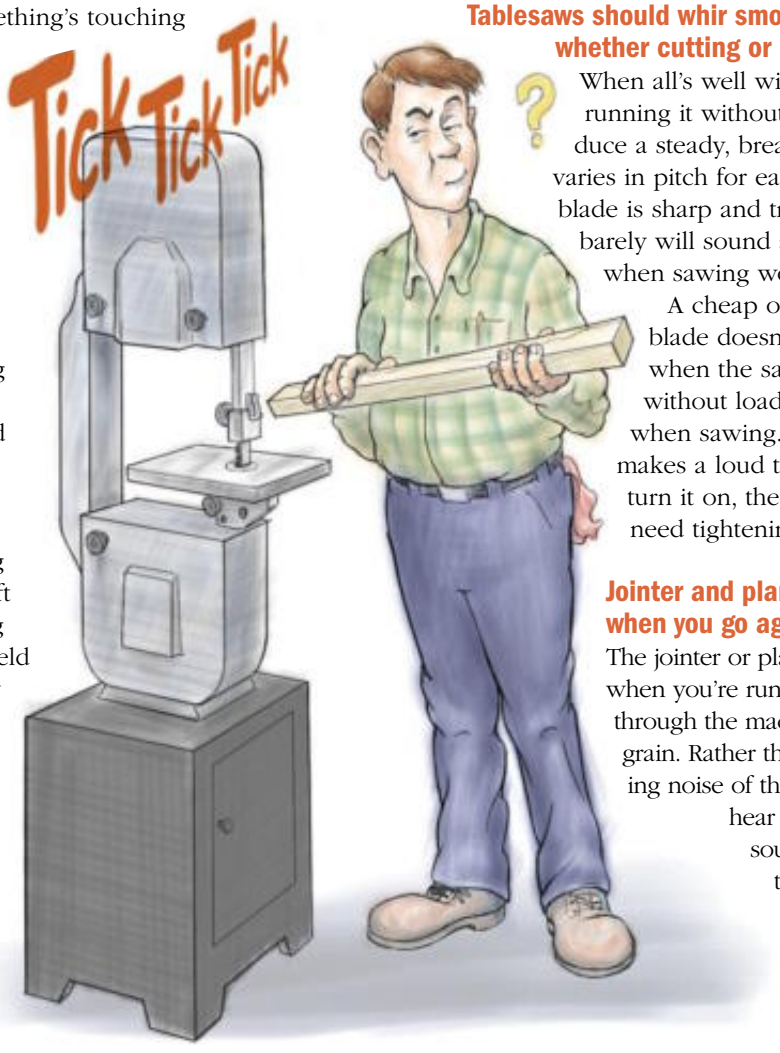
Bandsaws should hum

The bandsaw is one of the most vocal tools in the shop, so hear what it has to say before you start sawing. If all's well, you'll hear nothing but the motor's hum and the whirling wheels. If you hear scratching, something's touching where it shouldn't. Check for debris in the lower guide, or see if the blade guard is rubbing on the upper wheel or if the guides are too close to the blade. When the blade tension is inadequate, you'll hear a slapping sound just above the table on the left-hand side of the machine.

A rhythmic ticking means that one spot on the blade is hitting the guides. If it's a soft tick, it's likely nothing more than a rough weld on the blade; fix it by taking a file to the spot, but be careful not to damage the teeth or change their set.

A loud tick means there's a kink in the blade that could break at any moment. The kink may have formed when you tried to saw a radius tighter than the blade could manage. Next time you cut a tight curve, listen for the blade's wailing moan that says, "The blade is jammed against the guides. You've turned too far!" Forcing the turn beyond this point will damage the blade.

Learn when to adjust the feed rate by listening to the motor's pitch as you cut. When the pitch starts getting slower and deeper in tone, you've exceeded the speed limit. Back off the cut. Adjusting the feed rate based on pitch holds true for all saws—and just about every other power tool as well.



Tablesaws should whir smoothly, whether cutting or not

When all's well with the tablesaw, running it without load will produce a steady, breathy whine that varies in pitch for each blade. If the blade is sharp and true, the tablesaw barely will sound any different when sawing wood.

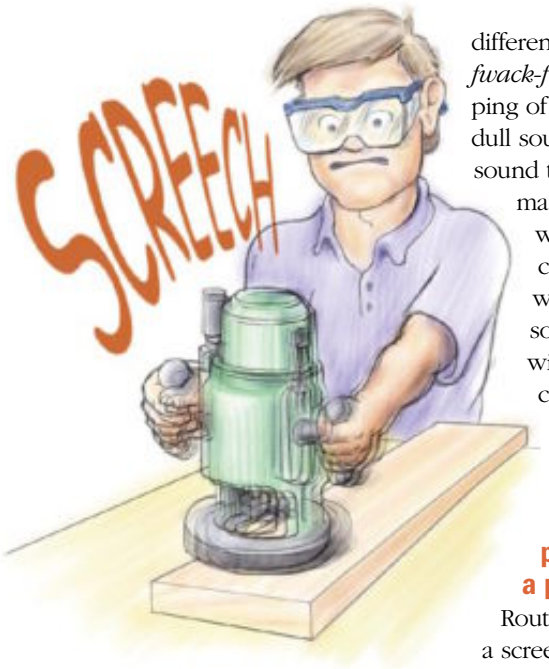
A cheap or badly balanced blade doesn't sound smooth when the saw is running without load, and it clatters when sawing. If your tablesaw makes a loud thunk when you turn it on, the belts probably need tightening.

Jointer and planer complain when you go against the grain

The jointer or planer will tell you when you're running the wood through the machine against the grain. Rather than the usual ticking noise of the knives, you'll hear something that sounds more like tearing, a kind of *kkkkkrrrrriiiick* as the chunks rip out. It's a

Drawings: Chuck Lockhart

WOODWORKERS MART



different sound from the *fwack-fwack-fwack* slapping of dull knives. This dull sound is similar to the sound the jointer and planer make when clogged with chips. If the dust-collection system isn't working, the slapping sound of the blades will be muffled by the chips lodged between the knives and the wood.

Routers change pitch when there's a problem

Routers whine a lot, but a screech or a wail means something's wrong—likely a bad bearing. A lower pitch means the router is taking too big a bite and bogging down. You should reduce the cut or feed rate.

When approaching a corner on the workpiece with an edge-trimming bit in the router, you can avoid tearout by listening for tearing undertones and backing off the instant you hear them. Take a light pass around the corner in the wrong direction to stop or at least reduce tearout. These backward, or climb, cuts feel funny—be prepared for the router to buck and squirm a little. Once you have cleared the way, go back to routing from left to right and complete the corner.

If you're using a router riding against a template to shape curved pieces, keep the amount you cut to less than the radius of the bit. If it's more, the router won't necessarily slow down, but you will hear tearing noises as the outer edge of the bit rips away little chunks of wood (though not always so little—watch out for debris).

Drills have their own language

Even a cordless drill has a distinctive vocabulary of noises. You probably know how it sounds when the battery is fully charged or when it's nearly dead. But can you tell when the bit is about to punch through the wood? Listen closely next time, and you'll hear a slight lowering in pitch as the drill labors through those difficult final rotations. In metals or hardwoods, you'll also hear a little screech that means it's time to ease off on your pushing and to prepare for that wrist-wrenching kick.

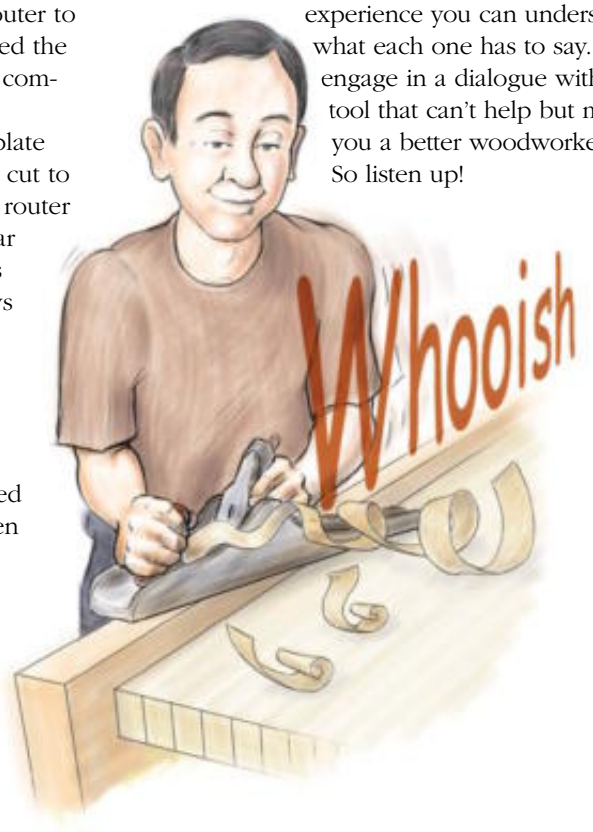
Drills make other helpful sounds. A pounding noise when driving screws means that the driver's not fully engaged—it's bouncing in and out of the screw head. Push harder to keep the driver engaged in the slot. A choppy whine means the speed switch is stuck between high and low. And, of course, there's the *brrrrripp* of the clutch release, which means the screw is in as far as it can go on that setting.

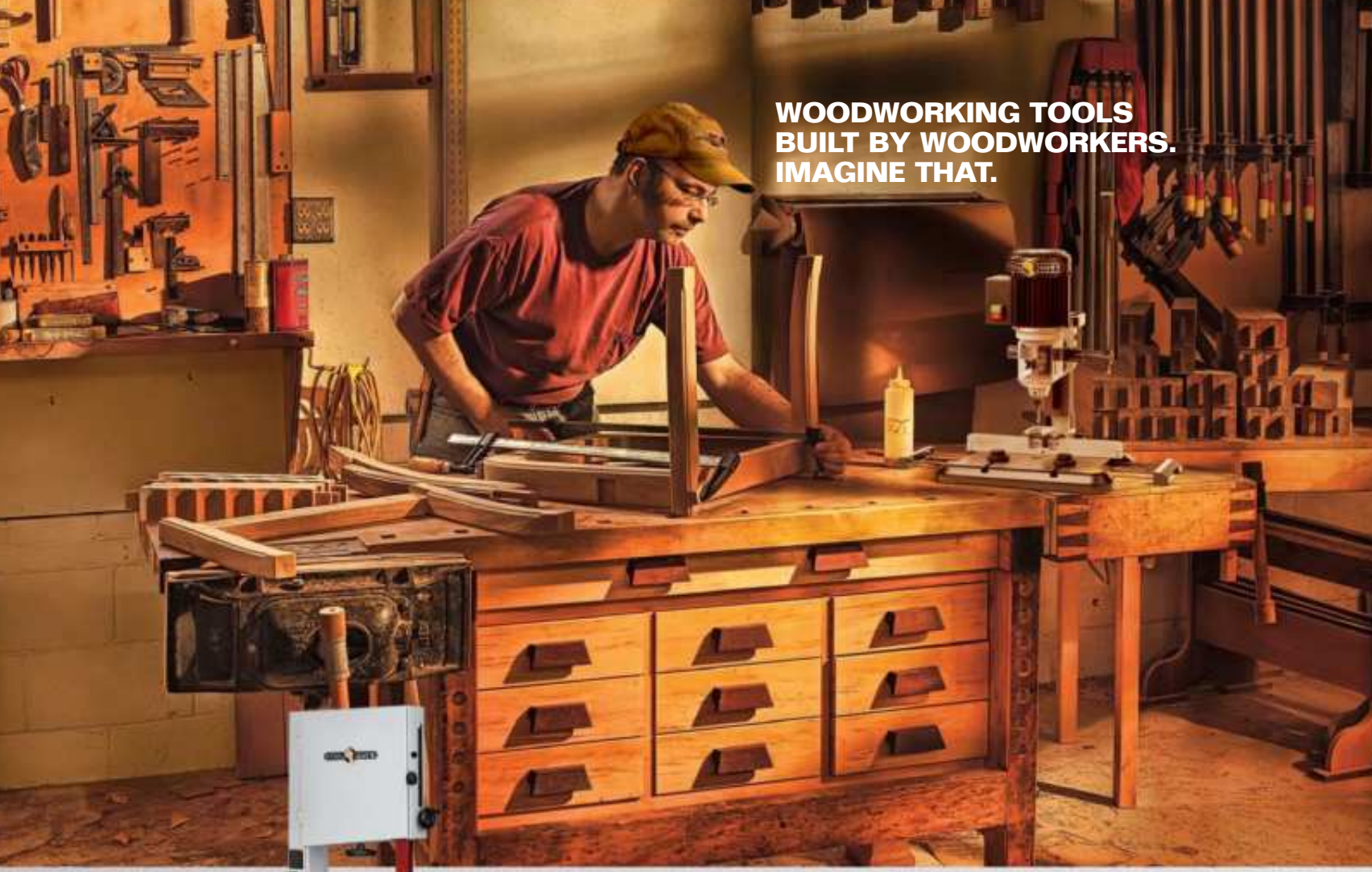
Hand tools tell you when they're happy

When all's well with a handplane, it emits a smooth *whooooissssh*, like the tearing of silk. A dull blade makes a series of *kwooooochhhh* noises, similar to the sound of someone getting ready to spit. When the iron is sharp, but you're planing against the grain, you'll hear an undertone of ripping as the fibers break off rather than get cleanly sheared.

If a handsaw is dull or is the wrong type for the job (such as ripping with a crosscut saw), you can hear it in the cut. Rather than the businesslike *voo-ba* of a good saw (or the *ba-voo* of a Japanese saw), you'll hear a less-accented *huff-ha*. If your saw is cutting well, maintain a steady rhythm. You may have to alter your stance and alignment until you get that sound for several seconds. Then you can let loose and saw right through.

Each tool has its own language, and with a little experience you can understand what each one has to say. You'll engage in a dialogue with the tool that can't help but make you a better woodworker. So listen up! □





A band saw constructed with heavy-duty steel ribbing and gussets that prevent vibration and flexing under heavy loads. A bench mortiser with a reconfigurable ratcheting handle that eliminates the need to reposition work for better leverage during cuts. A table saw with a titanium top that reduces friction and helps prevent galling, scratching and corrosion. We didn't just imagine them. We made them. This is what happens when woodworkers build tools.

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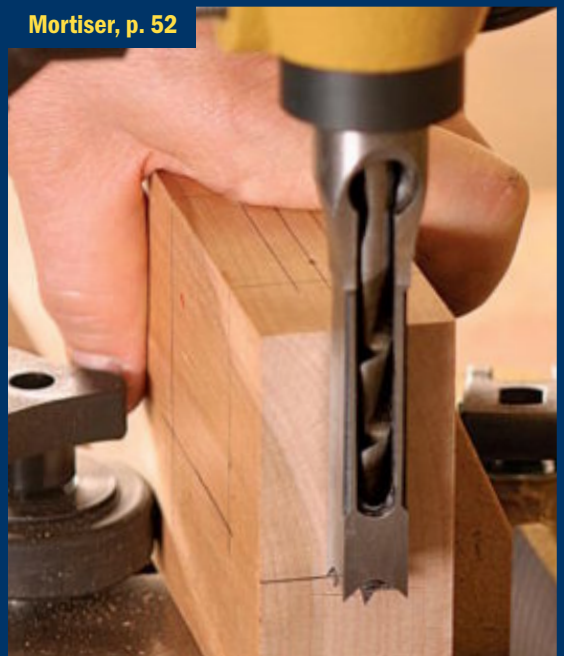

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