

WOODWORKER'S GLUE GUIDE *SEE CHART ON p.39*

WOODCRAFT[®]

Projects, Techniques, and Products magazine

Outdoor Table & Bench *p.44*

MORE TO BUILD

- **Arts & Crafts
Table Lamp**
- **Craftsman's
Tool Tote**
- **Kid-Built
Birdhouse**

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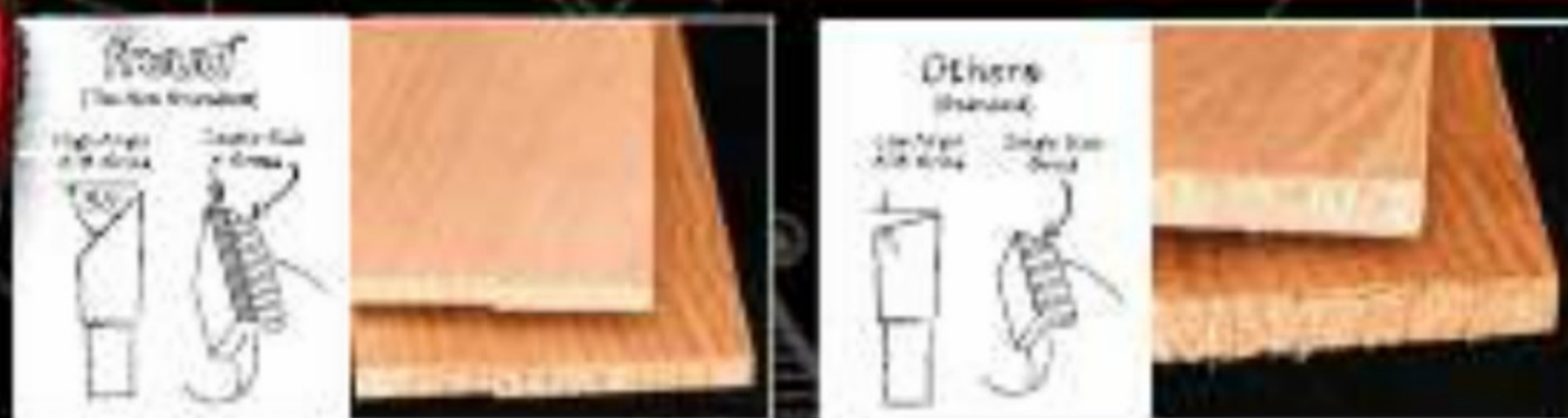
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Learn the basics of hand-cut dovetails and wedge-tenon joinery as you build this nicely styled woodworker's toolbox. Designed by Mario Rodriquez of the Philadelphia Furniture Workshop, it measures 25¼" long, 7⅞" wide, and 12" high.



30 Arts & Crafts Lamp

Display quartersawn surfaces on four sides of the lamp shaft, and create a light, elegant mica shade following the techniques and precision machine setups by seasoned woodworker Tom Svec.



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Enjoy your backyard spaces with this cedar dining set by craftsman Ken Burton. The plans include instructions for a 62"-long table and a 60"-long bench and feature loose-tenon joinery. You'll build a mortising jig that should prove useful for other projects as well.



60 Kid-Built Bluebird House

Start a youngster in woodworking with this simple project. Instructions are divided up so that the mentor completes the more challenging steps, leaving a variety of tool use and assembly experiences for the student.

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Introducing “Projects for Kids”

During our last yearly issue-planning, the staff expressed an interest in providing a few projects in the magazine that help teach woodworking to kids. On page 60, you'll find the first of several projects we have scheduled in a new series entitled “Projects for Kids.” It's a bluebird house, just in time for spring. Of course, all of the



projects will require an adult mentor with safety being first and foremost, and that's where you come in. Ultimately, you want the young student woodworker—in our story, Collin Kidd of Parkersburg, West Virginia—to enjoy success using a variety of hand and power tools. More importantly, you want the student to end up with a finished project.

As you'll see in

the story, we use building steps in two colors to divide up who does what, with the more challenging tasks going to the mentor. In my experience, I found it helpful to have a good handle on the building steps in advance, and to do the necessary prep work so the student does not stand around and lose interest. One thing that helped was milling the stock to thickness, width, and length where appropriate. It also helped to tell the student how the whole assignment would play out in broad strokes at the start.

Once you get into the various operations, make sure he or she wears the appropriate safety gear for the task at hand—goggles, ear protection, gloves, and so on. Tuck long hair under a cap. Also, make sure the student does not wear loose or baggy, long-sleeved shirts, or jewelry such as a watch; these can pose a hazard. Stand by the student every step of the way, offering counsel when needed. However, when it is the student's assigned task, avoid the temptation of taking over the work. Kids learn by doing.

One final note: Should you work with a young woodworker to build something, send in a photo or two and name names, as well as a line regarding your experience. I'll see if I can post it either in “Mailbox” or on our Facebook site. Good luck.

A handwritten signature in black ink that reads "Jim Harrold".

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Safety First! Working wood can be dangerous. Always make shop safety your first priority by reading and following the recommendations of your owner's manuals, using appropriate guards and safety devices, and maintaining all your tools properly. Use adequate sight and hearing protection. Please note that for purposes of illustrative clarity, guards and other safety devices may be removed from tools shown in photographs and illustrations in this publication and others.

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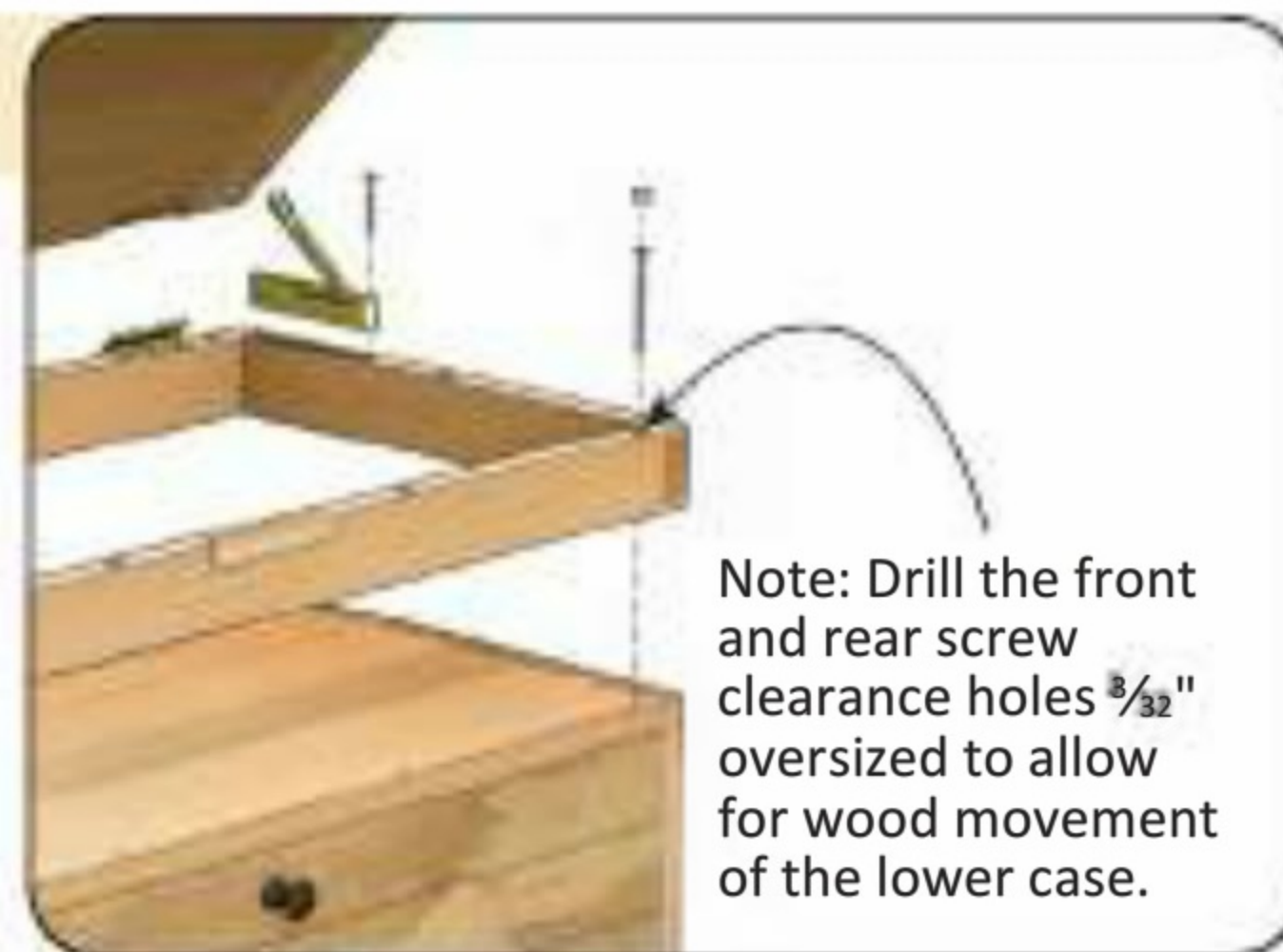
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Giving the Tool Chest Room to Move

I read Paul Anthony's articles on building a tool chest and making breadboard end joints in the Feb/March 2013 issue, #51. The chest is a very handsome and craftsman-like project. There's a mystery here, though. Mr. Anthony points out that breadboard end joints (used on the lid) are one of woodworking's slickest solutions for managing cross-grain wood movement. However, I notice that the upper case is simply screwed to the lower case, with the sides of the upper case running cross-grain to the lower case. At first, I thought that perhaps the screw holes in the upper case

sides were elongated to allow wood movement, but there was no mention of doing this. Am I missing something?
—Ray Newman, Roy, Washington

Ray, thanks for the good words. As for the attachment of the upper case to the lower case, the screw clearance holes that run through the upper case front and back are about $\frac{3}{32}$ " oversized to allow for cross-grain wood movement appropriate to the maple used for the project. Unfortunately, that small but important piece of information was omitted in the article.
—Paul Anthony, senior editor



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—Jim Harrold, editor

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Sandy's surge leaves a rust nightmare

I can really relate to the article in the Feb/Mar 2013 issue of *Woodcraft Magazine* entitled "Rust Busters." Superstorm Sandy provided the right combination of salt water and sand to test any of the rust busters you featured. I moved much of my equipment to higher ground and prepared as best I could for what I hoped would be no more than a foot or so of flood water. However, 45 inches of salt water was way beyond what anyone expected. Even the tools I moved onto the workbench weren't high enough. To add to this, we couldn't get to the house for three weeks. By then

everything contained a coating of heavy rust, muck, and corrosion. I held off disposing of the big power tools, hoping I can resurrect them. Most are only a few years old. Do any of the rust buster products come in 55-gallon drums?
—Charlie Battler, Long Beach Island, New Jersey

Charlie, I am really sorry to hear about your loss. To answer your question, Evapo-Rust and a few of the other products mentioned in my story are sold in large containers. I've read about guys who have employed large tubs of



the stuff to restore engine blocks. Selective chelants won't make your tools shiny, but they should stop the corrosion in its tracks.

If you can snag a plastic drum or tub (even an old plastic wading pool), you could rig a large-scale electrolysis tank. For hand tools, consider restoring them with a grinder equipped with a fine-wire brass wheel.
—Joe Hurst-Wajszczuk, senior editor



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Tester: Kent Harpool



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Tester: Joe Hurst-Wajszczuk



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Tester: Brian Renner



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Tester: Peter Collins

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Tips & Tricks

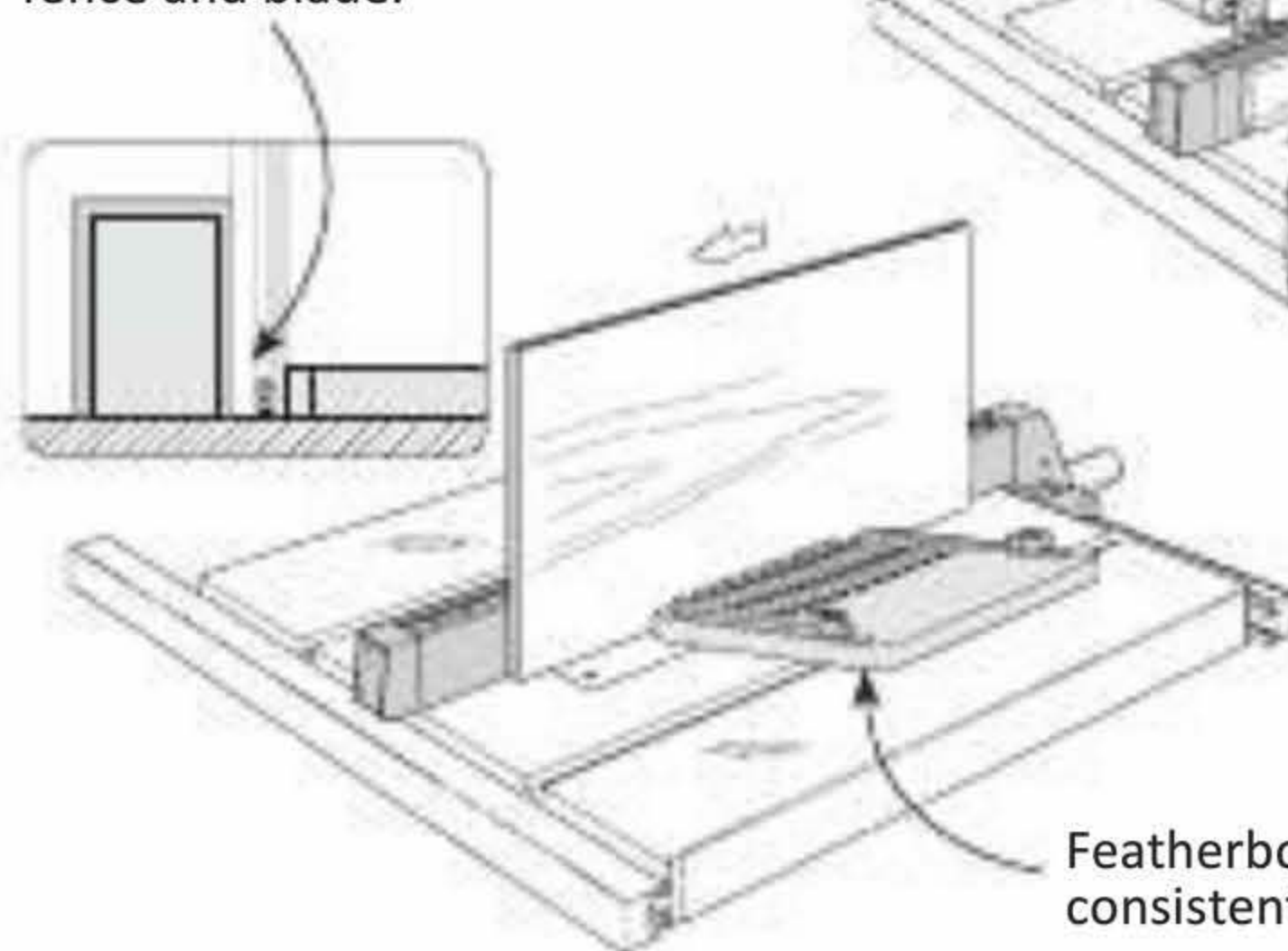
TOP TIP

Perfect tongue-and-groove fits

Project plans often call for rabbeting the edges of a panel in order to create a tongue that slips into a drawer or rail groove. This is often done with a router bit or tablesaw dado head, with the work fed flat on the table. Unfortunately, done this way, any inaccuracy in the thickness of the stock is transferred to the thickness of the tongue, creating an ill fit in the groove.

One way to ensure a perfect tongue-and-groove fit is to create the rabbet by making two intersecting cuts on the tablesaw, feeding the edge to be rabbeted

1. Saw tongue to thickness with tongue between fence and blade.



2. Complete rabbet by sawing tongue to final width.

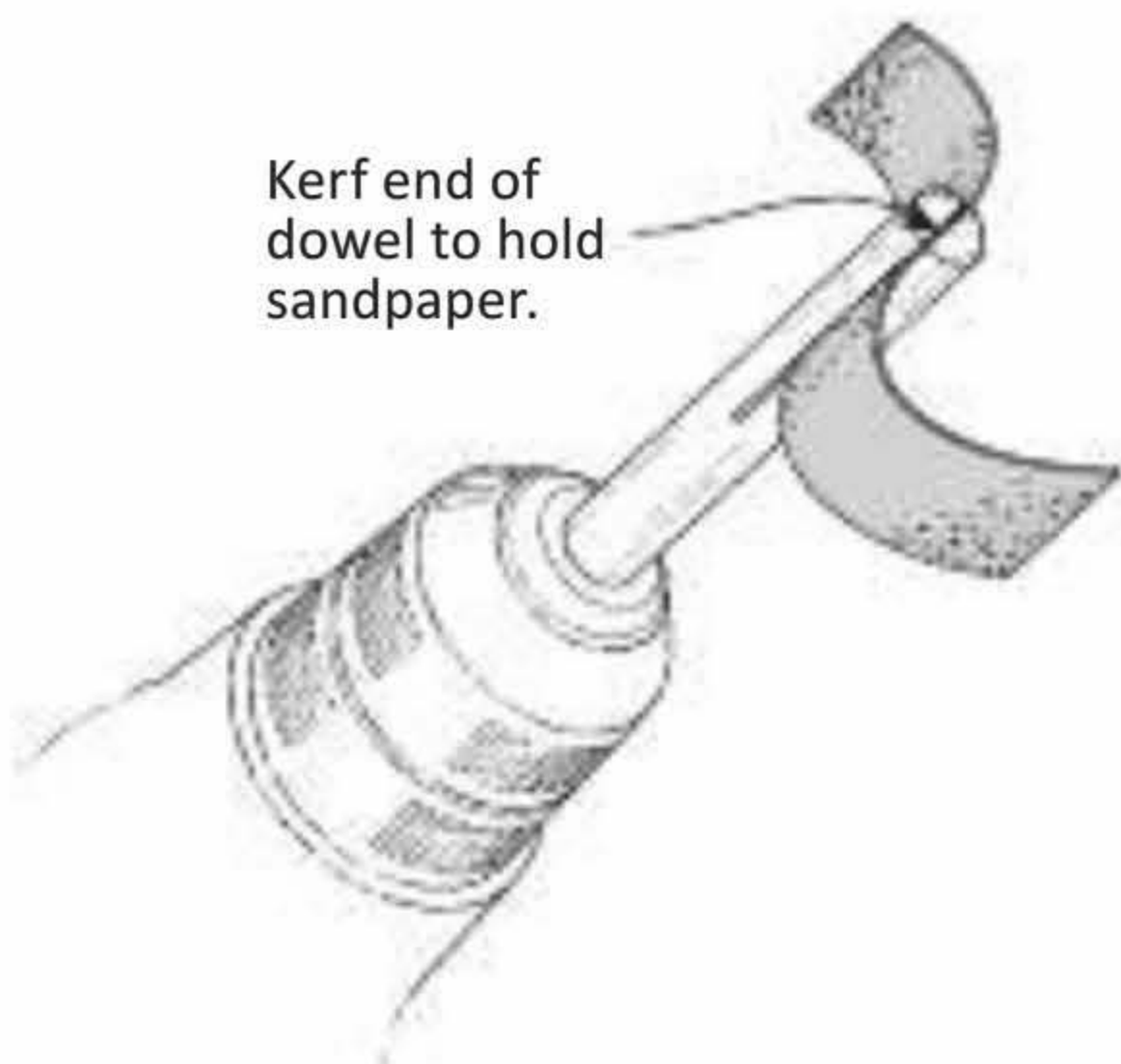
Tunnel under auxiliary fence prevents trapped offcuts.

Featherboard ensures consistent cuts.

against the fence. Set up the first cut to rip the tongue to thickness, feeding the panel on edge with the tongue face against the fence. Use a featherboard to ensure consistency of cut. Now set up to make the intersecting cut against

a thick auxiliary fence, raising it enough to create a tunnel for the freed offcut to fall away without being pinched between the blade and fence, eliminating violent ejection of the piece.
—Harvey Mickelson, Reno, Nevada

Kerf end of dowel to hold sandpaper.



Dowel as mini drum sander

When smoothing concave edges, particularly in confined areas, I find that a dowel wrapped in sandpaper and chucked in a drill

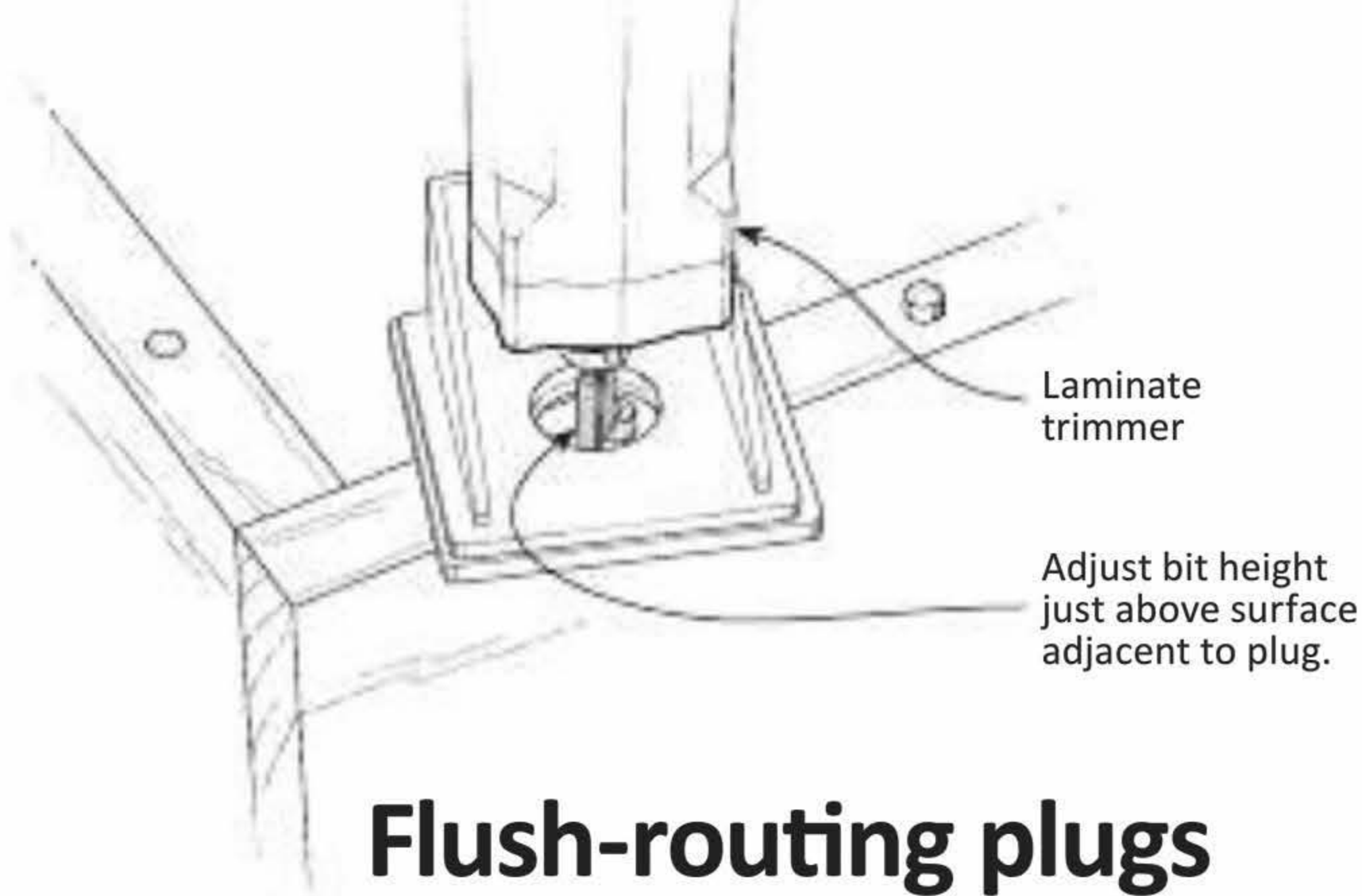
serves as a great mini drum sander of sorts. To make one, bisect one end of a short length of stout dowel using a bandsaw or handsaw, and insert a strip of sandpaper into the kerf. Then chuck the other end in a drill. The rotation of the drill as you work causes the paper to wrap around the dowel, creating the drum sander effect. The real beauty of this is that, when the paper wears, you simply tear off the used section to expose new grit and quickly get back to work.

—Bob Howard, Saint Louis, Missouri

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Here's your chance to help someone become a better woodworker and get rewarded for the effort. Next issue's **Top Tip** will receive a **Rockwell BladeRunner**, along with the **Picture Frame Cutter and Circle Cutter accessories** for a total value of **\$243.00**. Runners-up will receive **\$125** for an illustrated tip; **\$75** for an unillustrated one. Winning entries become the property of *Woodcraft Magazine*. Send your original ideas to: **Tips & Tricks, Woodcraft Magazine, P.O. Box 7020, Parkersburg, WV 26102-7020** or email editor@woodcraftmagazine.com. Important: Please include your phone number, as an editor will need to call you if your trick is considered for publication.





Flush-routing plugs

I've found that a router equipped with a straight or spiral flute bit does a much faster (and free of tear-out) job of cutting plugs flush than does the old saw-and-chisel approach. I simply adjust the tip of the router bit shy of the workpiece surface by about the thickness of a sheet of loose-leaf paper, and then tilt the router to lower the spinning bit onto the end of the plug. The few thousandths of an inch of

plug projection that remains is easily sanded or scraped away.

A laminate trimmer works best because of its maneuverability and small footprint. However, sometimes adjacent plugs prevent setting the subbase completely onto the work surface. In that case, you may have to trim a few plugs the old-fashioned way to create a landing pad for the base.

—George Aspinall,
Tacoma, Washington

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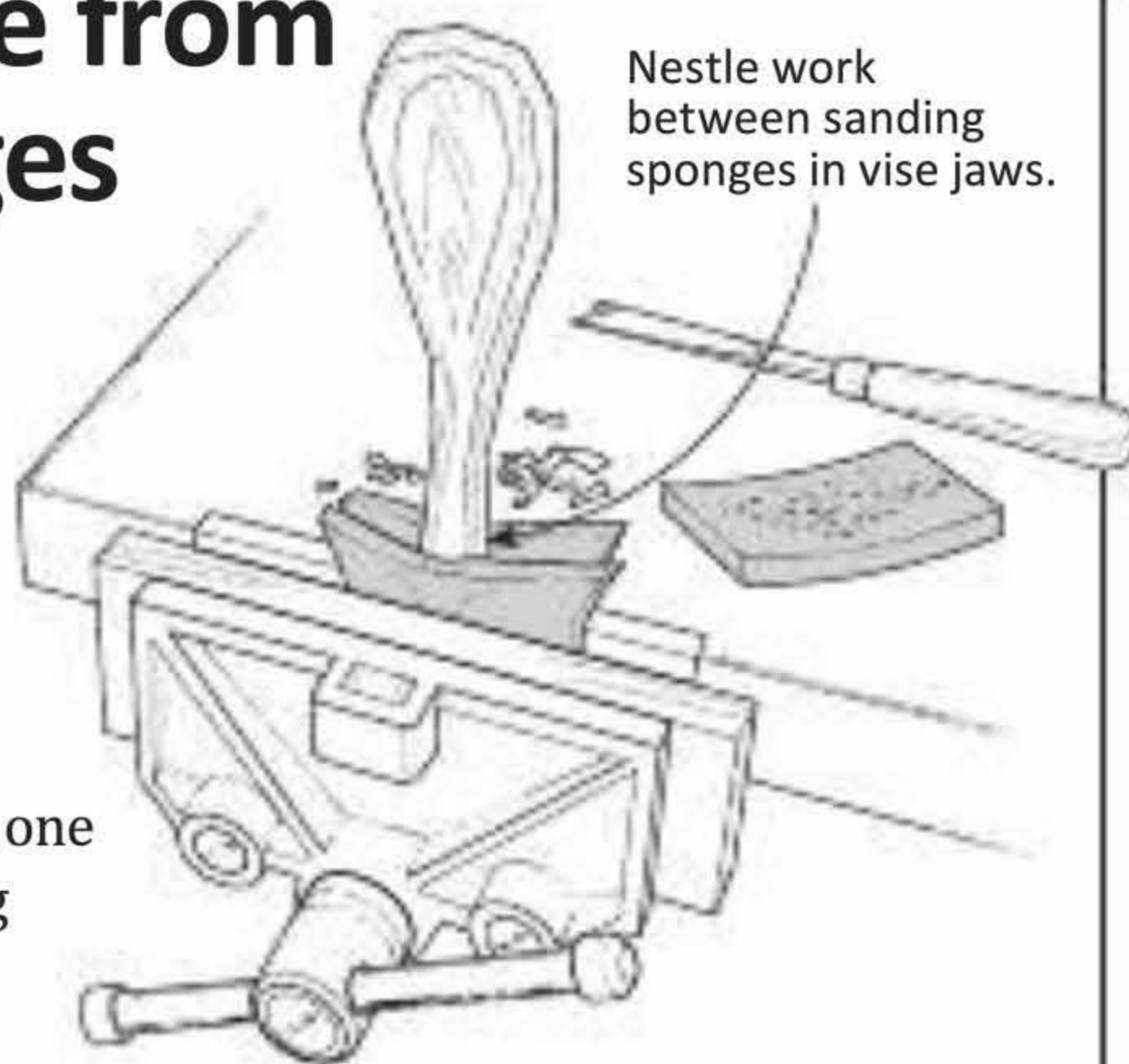
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Tips & Tricks

Vise-assistance from sanding sponges

When I started making wooden spoons using gouges, spokeshaves, and a drawknife, the biggest problem was clamping the curved spoon blanks in my vise for shaping. As I was smoothing a completed spoon one day, I realized that the sanding sponge I was using might do double-duty to help hold the workpiece in the vise. Sure enough, I found that sandwiching the spoon blank between two sponges (grit against the wood) considerably increased the grip of the vise on the work. Sponges



with grit on both faces work even better. Obviously, this technique can help when clamping any number of odd shapes in a vise.
—Alejandro Balbis,
Longueuil, Quebec

Cozy winter glue-ups

During cold weather, I rely on space heaters to keep my garage shop comfortable. When I turn off the heat, the temperature quickly drops to outdoor levels. Since many glue-ups fail when done in temperatures below 50°F, I cover end-of-day assemblies with an old electric blanket. Running the blanket is safer and much cheaper than heating the whole shop overnight for the sake of a few boards.
—Jeff Day, Perkasio, Pennsylvania



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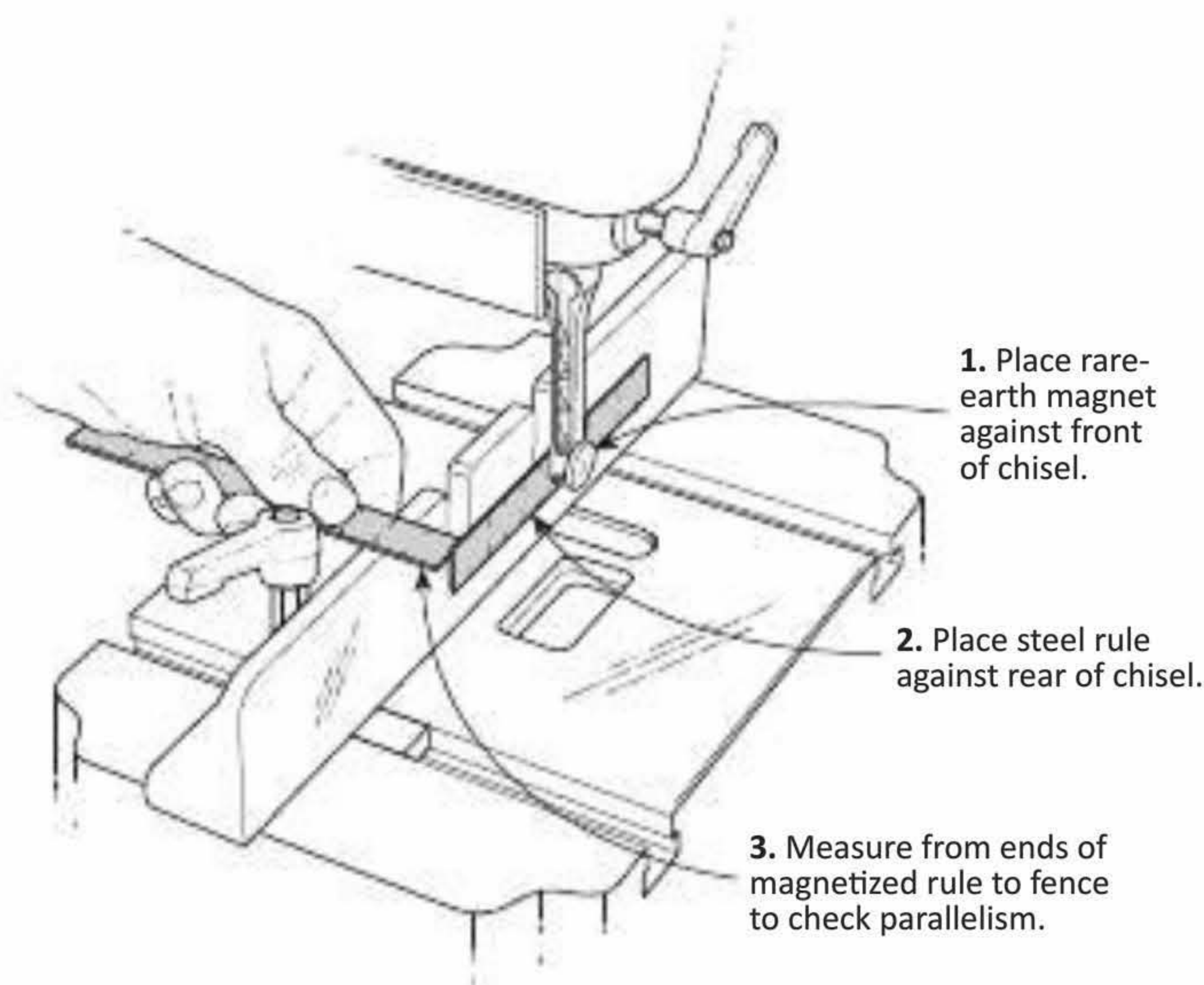
Squaring up a hollow chisel

When setting up a hollow chisel mortiser to make a cut, it's important that the chisel be set square to the machine fence. If it's cocked, your mortise wall won't be flat and smooth, compromising the strength of the joint. To set larger chisels, it's easy enough to press a small machinist's square against the fence and chisel to check the angle. However, getting a read on a smaller chisel this way can be difficult, especially for weak or mature eyes.

Instead, try this: First, secure your fence at the desired distance from the chisel, and place a small rare-earth magnet

against the outward face of the chisel. Then place a steel 6" rule against the inward face. The ruler serves as a long reference surface for gauging parallelism (and thus square)

to the fence. Simply measure to the fence from each end of the ruler, rotating your chisel as necessary to bring the rule and fence into perfect alignment. —Paul Anthony, senior editor



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Overall dimensions: 25¼"w × 7½"d × 12"h

Craftsman's Tool Tote

Hone your hand skills building a box you'll be proud to cart around.

By Mario Rodriguez

Many of us remember Dad's toolbox and how it always seemed to have everything needed to repair a broken chair or hang a screen door. Wanting to build my own all-purpose tool tote, I decided to take Dad's nailed-together box up a notch to ensure that it will be around for the grandkids.

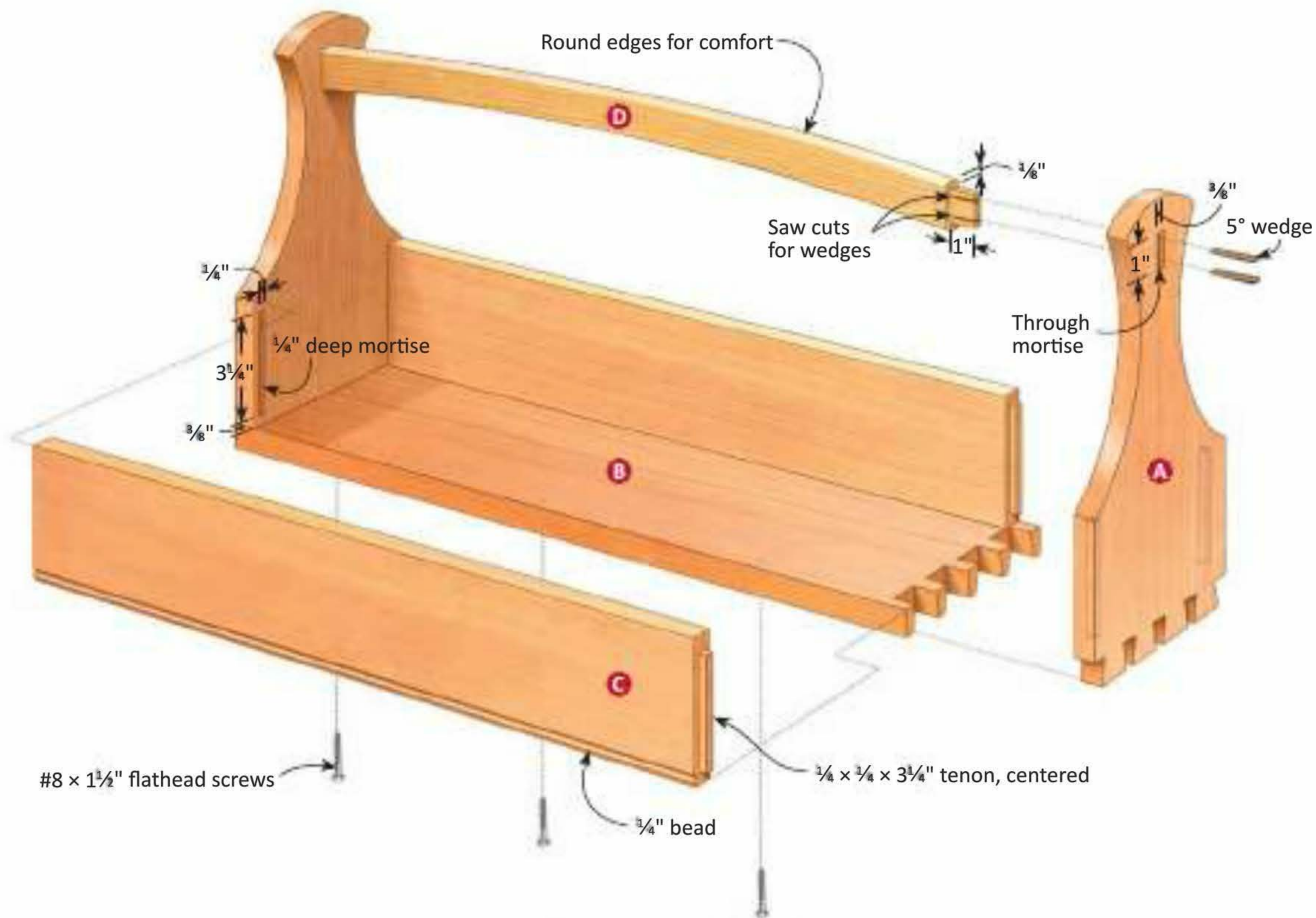
Aside from its obvious utility,

this box offers several low-risk opportunities to practice traditional joinery, including through dovetails and wedged tenons. If you make a mistake when cutting the dovetails, don't fret. Just use the metal template to retrace your tails on a new piece and try again. If you mess up the pins on the bottom board, cut them off and give it another

shot. You can shorten the sides and handle to compensate.

I chose mahogany for the body of the box because it's a friendly and forgiving wood—perfect for hand-cut joinery. As an added bonus, it takes on a beautifully rich, deep color as it ages. For the handle, I chose red oak, not only for strength, but also because it offers a nice contrast.

Figure 1: Tool Tote Exploded View



Start with the ends

1 From $\frac{3}{4}$ "-thick stock, cut the ends (A) and bottom (B) to the sizes listed in the **Cut List**. Also cut $\frac{3}{4}$ "-thick material for the sides (C) and handle (D), but leave these parts oversized in length for now. (You'll trim them to final length after cutting the dovetails.)

2 Using the pattern on page 28, make a half-pattern of the end (A) from ½"-thick plywood. Use it

Tip Alert

To prevent the pattern from slipping, drive a few finish nails through the plywood, and then nip the nails so that only a small tip remains.

to lay out the first half of the end profile, as shown in **Photo A**, then flip the pattern and trace

the opposite half. Now lay out the location of the through-mortise for the handle (D).



Lay out the ends of the tote using a half-pattern, which guarantees perfect symmetry.



B Score the baseline with a utility knife, and then cut the tail cheeks using heavy-duty scissors. The waste should snap off with a little bending.



C Trace the tail pattern onto the bottom of both end boards. A marking knife produces a crisp line.

Cut the dovetails

1 Make a master template of a single pin socket from aluminum flashing to suit your desired angle and pin width. (You may also use the pattern provided on page 28.) Using this master template, make a full-width dovetail template on a 7½"-wide strip of aluminum flashing (available at home supply stores). Then carefully cut the template, as shown in **Photo B**. (Note: Tracing is faster and easier than individually laying out the

tails on both ends. The template also allows testing the look of the dovetails without wasting wood.)

2 Set a marking gauge about ¼" wider than the thickness of your stock, and then scribe baselines on both faces of the end (A) and bottom (B) boards. Next, align the dovetail template with the scribed line on the outside face of an end and trace the tails, as shown in **Photo C**. Use a square to extend the tail lines across the end grain. Now repeat the process with the other end board. (For better

visibility, you can run a fine-tipped pencil over the knife lines.)

3 Clamp the board at a comfortable height in a face vise and cut the tails, as shown in **Photo D**. Focus on executing clean cuts that are perpendicular to the face of the board. (Because you will use this piece to lay out the mating pins, it's OK if your vertical angle is a little off.)

4 To remove the waste between the tails, change saws and start by sawing most of it away, as shown in **Photo E**. Next, clean out the remaining material with a freshly-honed chisel (**Photo F**). (You may also want to use a knife to clean out the corners.)

5 Clamp the bottom (B) vertically into a vise, position the end board (A) on top, and then lay out the pins, as shown in **Photo G**. Make sure that the edges of both pieces are flush and that the baseline on the end aligns with the inside face of the bottom. (For reaching between the tails, I prefer using a thin-bladed carving knife.) Remove the end board, and then use a small square to extend the pin marks down to the baseline on both faces.



D As you saw to the layout lines, let your dovetail saw do the work. Stop just a hair shy of the baseline.



E Use a jeweler's saw to remove the bulk of the waste between the tails. Stay just above the scribed baseline.



F Finish the tails with a chisel. When paring down to the baseline, rest the back of the chisel against your non-dominant hand, as shown.

6 Clamp the bottom (B) in your bench vise and saw the pins. As before, use a dovetail saw to cut down to your baseline, remove the bulk of the waste with a jeweler's saw, and then pare away the remaining wood

to the baseline. (I prefer sawing my pins a bit fat, and then paring them for a perfect fit.) Test the fit, make any needed adjustments, and then repeat the operation on the opposite end.

(Note: Don't assemble/disassemble more often than absolutely necessary. Too many test-fits can create gaps or cause damage to a pin or tail.)

Wedged To Perfection

If you discover a gap or two in your dovetail joints, don't fret—there's an easy fix. First, glue up the joint. After the glue dries, saw along the offending gap.

Next, cut a strip of wood from a matching piece of scrap to fit the kerf. Glue in the strip, allow time to dry, and then trim it flush. (For a super-tight patch, cut the filler piece slightly oversize in thickness, and compress it in a vise. It will swell up in the gap when you add the glue.)



Tip Alert

When laying out the pins and when test-fitting the joint, be sure to use the matching end panel.



G Use the tails to lay out the pins on the bottom. Make sure that the edges of both pieces are flush.



H Drill overlapping holes to establish the mortise for the sides. Use a fence to keep the holes aligned.

Lay out and cut the mortises

1 Using a marking gauge, lay out the side mortises on the inside faces of the end boards (A). Chuck a $\frac{3}{8}$ " brad-point or Forstner bit in your drill press, and remove the bulk of the waste for the sides (C) and handle (D), where shown on **Figure 1** and as seen in **Photo H**. When drilling the $\frac{1}{4}$ "-deep holes for the sides, use a fence to ensure perfect alignment. Position a backer board under the end to prevent blow-out when drilling the through mortise for the handle.

2 Using freshly-honed chisels, clean up the drilled mortises in the ends (A). To pare the sides of the shallow blind mortises, I used a 1"-wide chisel, as shown in **Photo I**, and a $\frac{3}{8}$ "-wide chisel to pare the mortise ends. To clean up the through mortise for the handle, clamp a guide block against your layout line, as shown in **Photo J**.

3 Cut the curves on each end board (A) separately on the bandsaw, staying slightly



I Rest the chisel's corner on the scribe line, and pivot the tool to create a clean-walled mortise.

outside your lines. Next, stack the two end pieces together using double-faced tape to keep them aligned, and then sand the pair on an oscillating spindle sander.

Custom-fit the handle and sides

1 Crosscut the sides (C) and handle (D) to fit your tote. Adjust the length of the handle so that the shoulder-to-shoulder distance is equal to the tote's inside dimension, and the tenons protrude past the ends by $\frac{1}{8}$ ".

2 Using a table-mounted router and beading bit, rout the bottom edge of the side panels (C), where shown in **Figure 1**. (Even though this is a light cut, I routed the profile in two passes to prevent tear-out.)

3 Using the pattern provided on page 28, create a half-pattern for the handle, and then trace the curve on your stock. Double-check the shoulder-to-shoulder length for a tight fit.

4 Outfit your tablesaw with a dado head, and cut the tenon shoulders on the handle (D).



J Use a block to guide your chisel and to prevent it from cutting past your layout lines.

(I prefer cutting my tenons a bit fat, and then trimming the cheeks to fit with a shoulder plane.) At the bandsaw, cut the curved profile and the kerfs for the wedges.

5 Use a spokeshave to remove saw marks on the handle, refine the curve, and round over the sharp edges. You can choose to leave tool marks, or if you wish, you can continue smoothing the handle with a scraper and sanding blocks.

6 You're now ready to dry-fit your tote. The trick here is to take your time. Starting with one corner, attach one end (A) to the bottom (B) and carefully drive the dovetails just short of home (**Photo K**). (Work slowly while watching and listening closely for any splitting.) Next, insert the sides (C) and handle (D) and then test-fit the opposite end (**Photo L**).

7 Carefully disassemble your tote. If you're so inclined, now's the time to sand the inside surfaces. Just remember to go easy around the joinery to avoid introducing any gaps.



K

Use light taps when attaching the end to the bottom. If the parts require too much persuasion, remove the end and pare the offending pins.



L

Set the sides and handle in place before attaching the opposite end.

Assembly and finish

1 Make a few 5° wedges from scrapwood. Now, apply glue to the tails, pins, and tenons, and reassemble your tote. Pull the assembly together with clamps, and leave them in place until the glue cures. Brush glue in the handle kerfs and tap the wedges into the handle (B). Finally, secure the sides to the bottom with countersunk 1½"-long screws where shown in **Figure 1**.

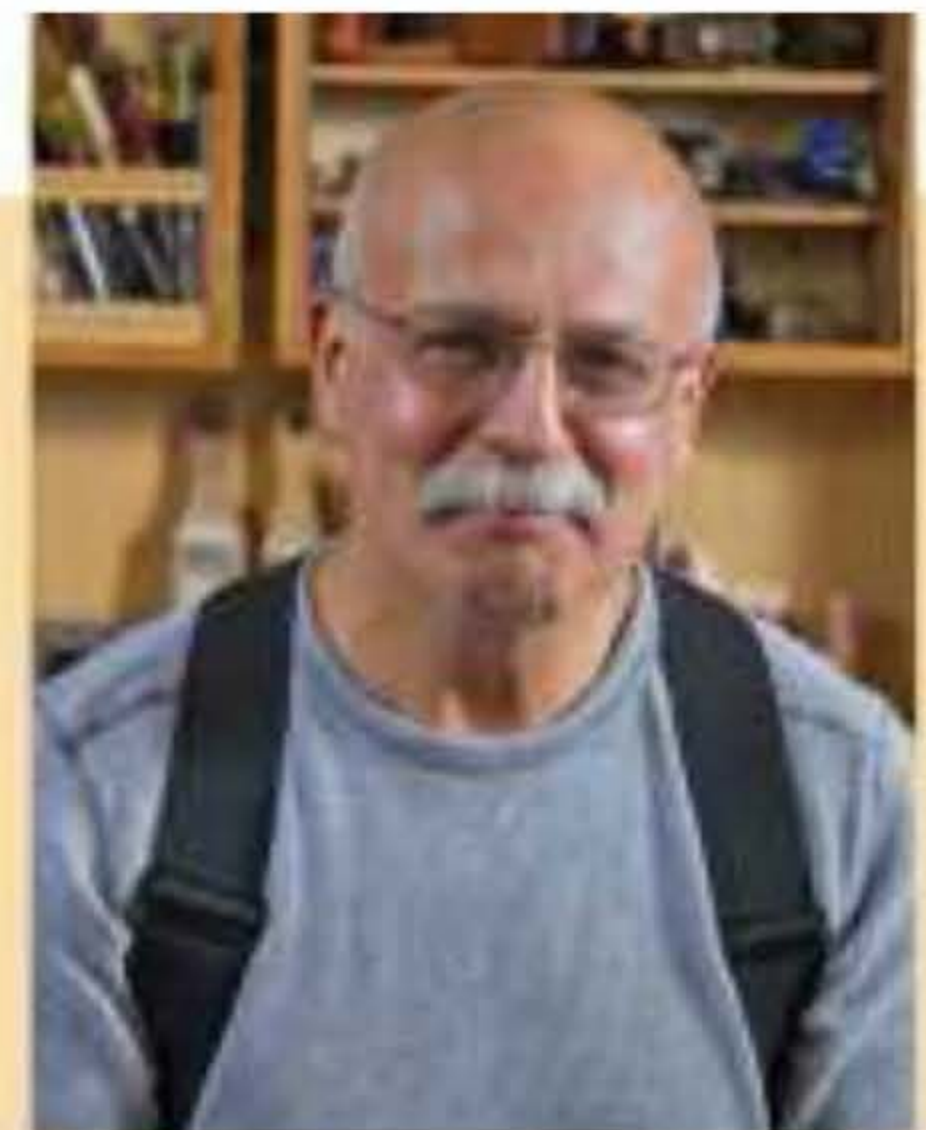
2 Trim the wedges with a flush-cut saw, and then smooth the dovetail joints and handle ends with a block plane. Work carefully, taking light cuts until the surfaces are perfectly flush. Finally, finish-sand the outside of the tote through 220 grit.

3 Finish isn't necessary, but it shows off your work and offers a little extra protection. I applied three coats of Waterlox, allowing the finish a few days to cure before rubbing it out with 0000 steel wool. Finally, I applied a coat of wax.

4 Pack your tote with tools, and tackle the next chore on your list. ■

About Our Author

A custom furnituremaker for over 35 years, Mario Rodriguez now spends much of his time teaching aspiring woodworkers at the Philadelphia Furniture Workshop. He is the author of *Traditional Woodwork* and *Building Fireplace Mantels* (Taunton Press).



Craftsman's Tool Tote Cut List

	Part	Thickness	Width	Length	Qty.	Mat'l
A	Ends	¾"	7½"	12"	2	M
B	Bottom	¾"	7½"	25¼"	1	P
C*	Sides	¾"	4"	24¼"	2	M
D*	Handle	¾"	2"	25¼"	2	RO

*Indicates parts that are initially cut oversized. See instructions.

Materials: M=Mahogany, P=Plywood, RO=Red Oak

Hardware: (6) #8 × 1½" flathead screws, aluminum flashing

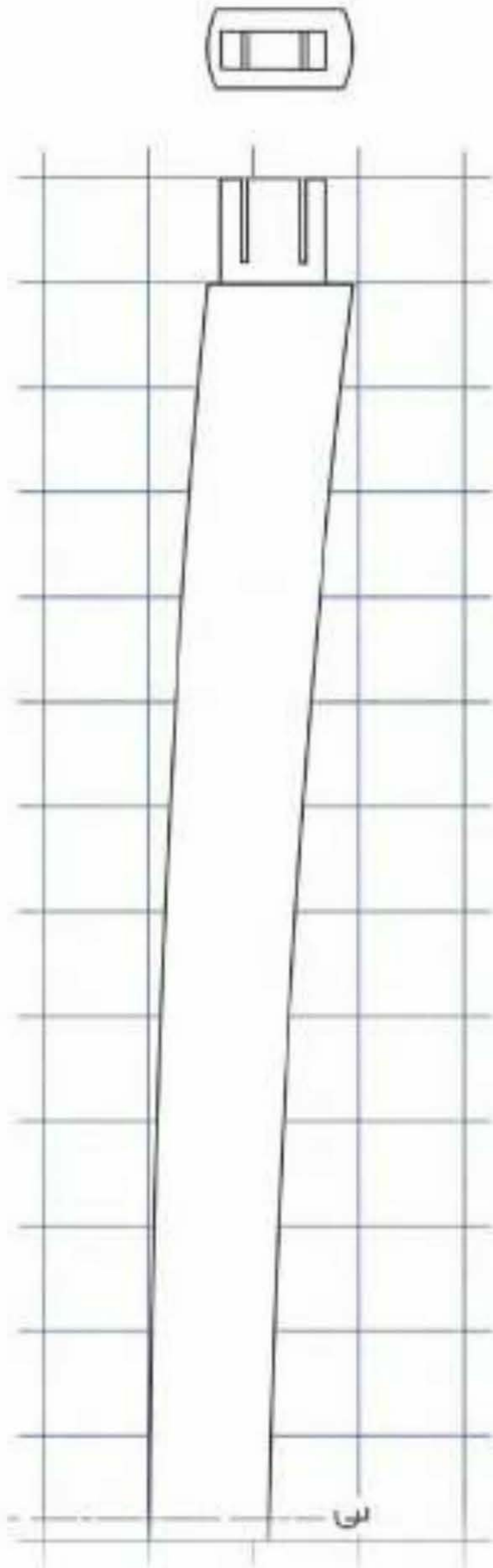
Convenience-PLUS BUYING GUIDE

☐ 1.	Whiteside Edge Beading Router Bit ¼" bead (½" SH)	#814384	\$36.49
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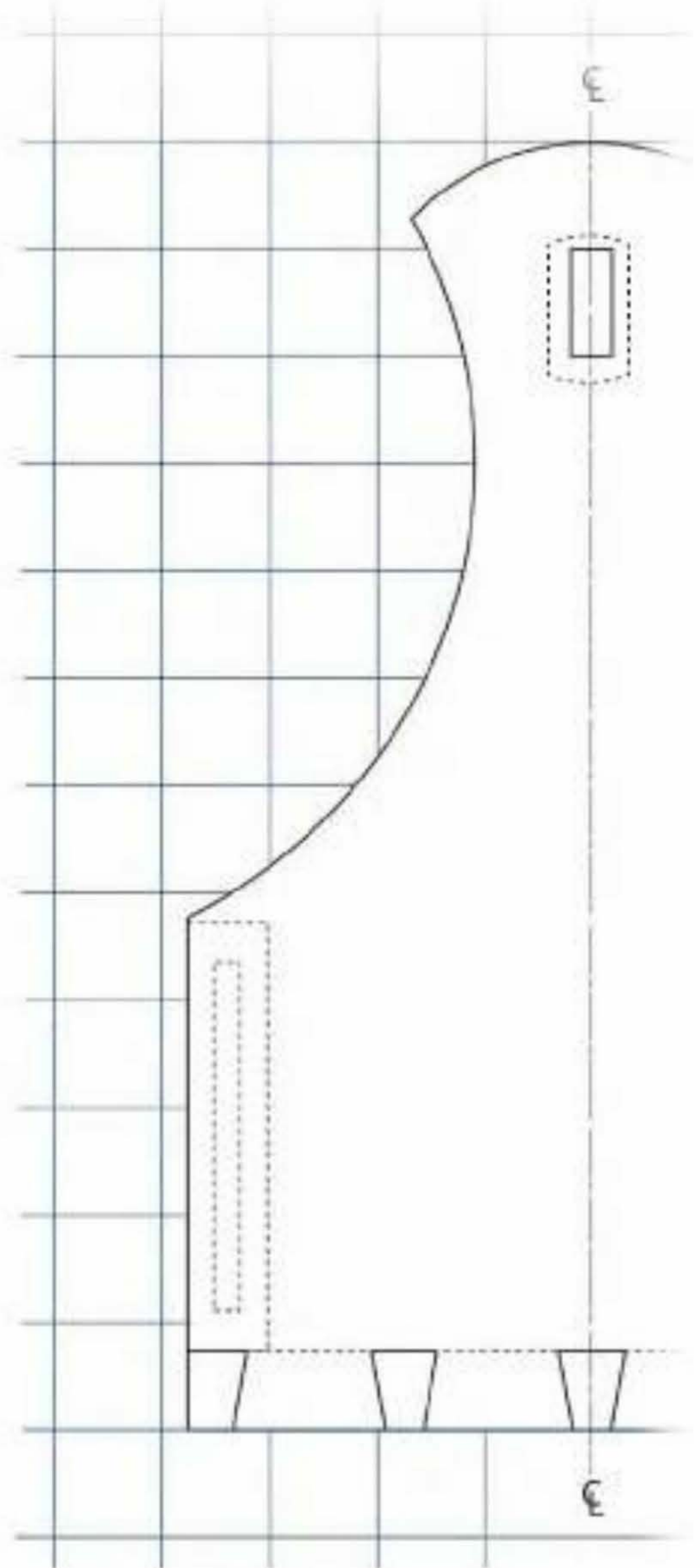
Above items are available at Woodcraft stores, woodcraft.com or by calling (800) 225-1153. Prices subject to change without notice.

Patterns

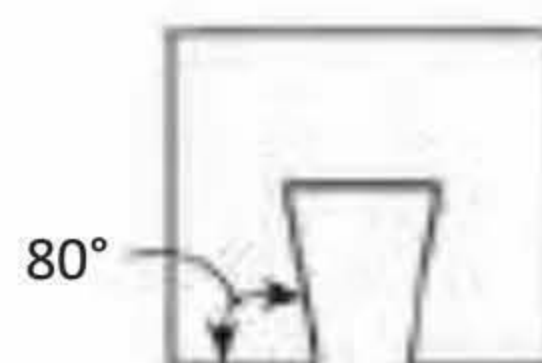
Handle Pattern Half-sized



End Pattern Half-sized



Dovetail Master Half-Sized



Enlarge 200% 1 square = 1"
Full-sized pattern available for download
on woodcraftmagazine.com/magpatterns.

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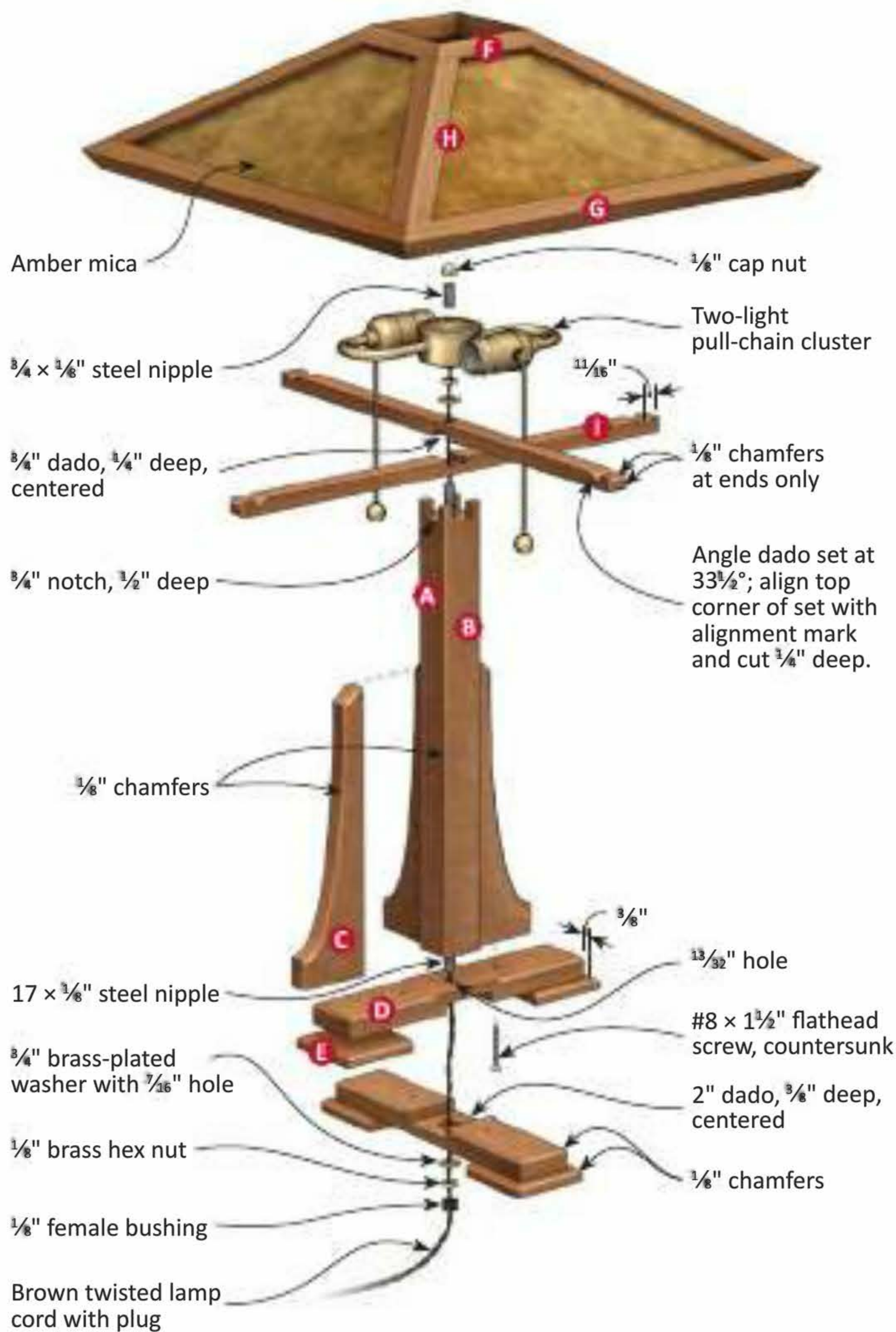
Shed light in a study, main living area, or bedroom, and on a special era of 20th-century craftsmanship with this classic home accent. Made from quartersawn red oak, this pleasing project consists of several duplicate parts, which speed construction. A pattern for the corbels and shop-tested setups and jigs helps in making the identical parts and assemblies. For the shade, which sits neatly on a pair of crossbar supports at the top of the lamp base, I used thin panels of amber mica that I cut and installed with clear silicone caulk in the rabbeted shade frames. If this is your first lamp, you'll find the diagram on page 36 a helpful reference for safe and simple wiring.

Arts & Crafts Set

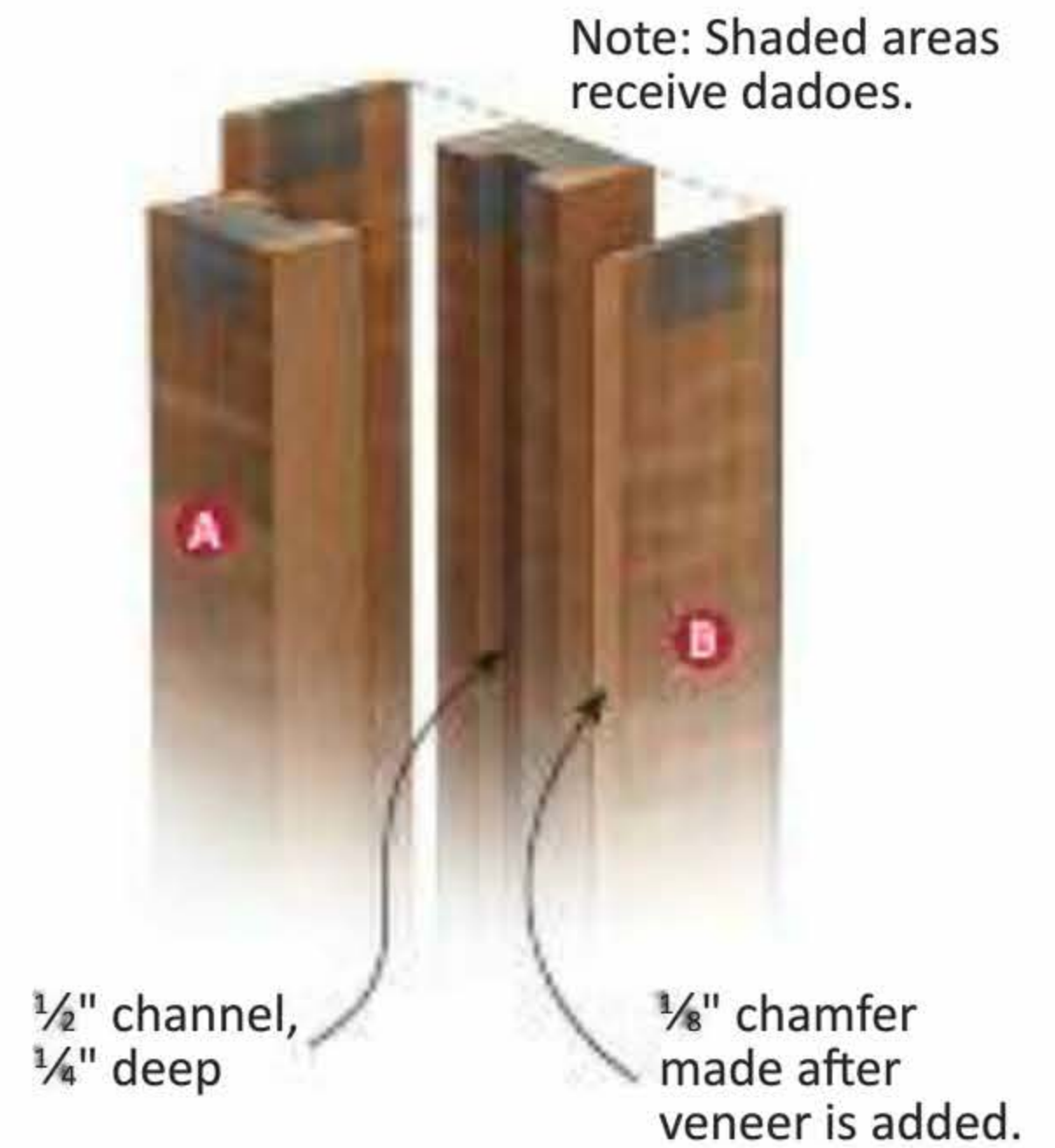
This lamp project complements other pieces in the magazine's Arts & Crafts line, including coffee and end tables, a TV stand, and a bookcase. Find these designs as paper plans or downloads at woodcraftmagazine.com.

Overall dimensions: 17"w × 17"d × 21⁵/₈"h

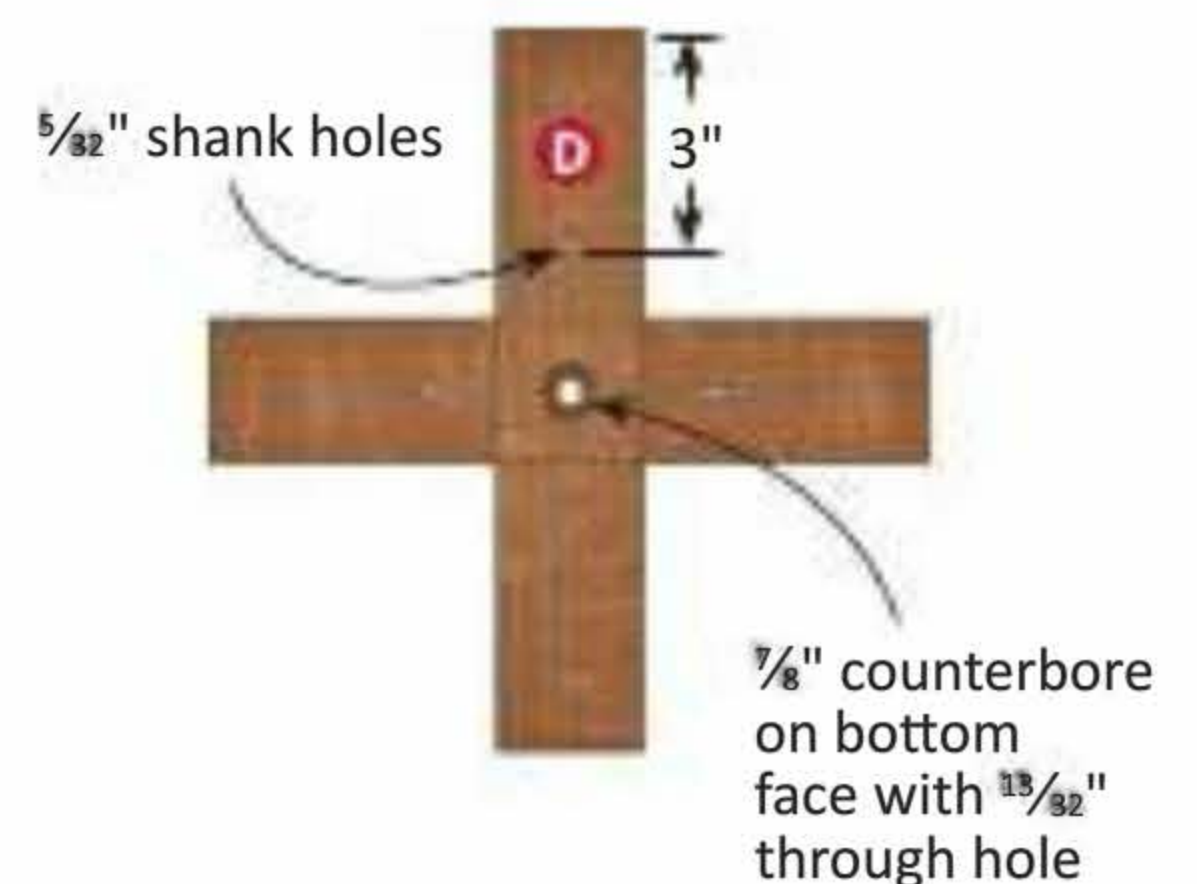
Figure 1: Lamp Exploded View



Shaft Detail



Leg Detail



Build the base first

1 Mill enough quartersawn oak stock for the shaft halves (A), corbels (C), legs (D), and feet (E) to the thicknesses in the **Cut List**.
2 Cut two $\frac{3}{4}$ "-thick pieces to $1\frac{3}{8}$ " wide $\times$ 16" long for the shaft halves (A). Now, rout $\frac{1}{2}$ " channels $\frac{1}{4}$ " deep on one face of each piece where shown in the **Shaft Detail** in **Figure 1**. Glue the pieces face

to face, aligning the channels. Wipe off any squeeze-out. Let dry, and then joint and plane both glue-joint faces to end up with a $1\frac{1}{4} \times 1\frac{1}{2}$ " shaft blank.

3 Resaw and plane two $\frac{1}{8}$ "-thick shaft veneers (B) from quartersawn oak stock. Laminate the veneers to the glue-joint shaft surfaces. (See the **Shaft Detail** in **Figure 1**.) Now, sand

the edges of the veneers and shaft halves flush. Your goal is to achieve a $1\frac{1}{2} \times 1\frac{1}{2}$ " shaft that displays quartersawn figure all around. Cut the lamination to the final shaft length.

4 With a dado set and miter gauge extension fence, cut the centered $\frac{3}{4}$ " notches $\frac{1}{2}$ " deep in the top end of the shaft (A/B) as shown in **Photo A**. Make one cut,



A

Use a triangular scrap piece to keep the shaft snug to the fence while cutting the notches.



B

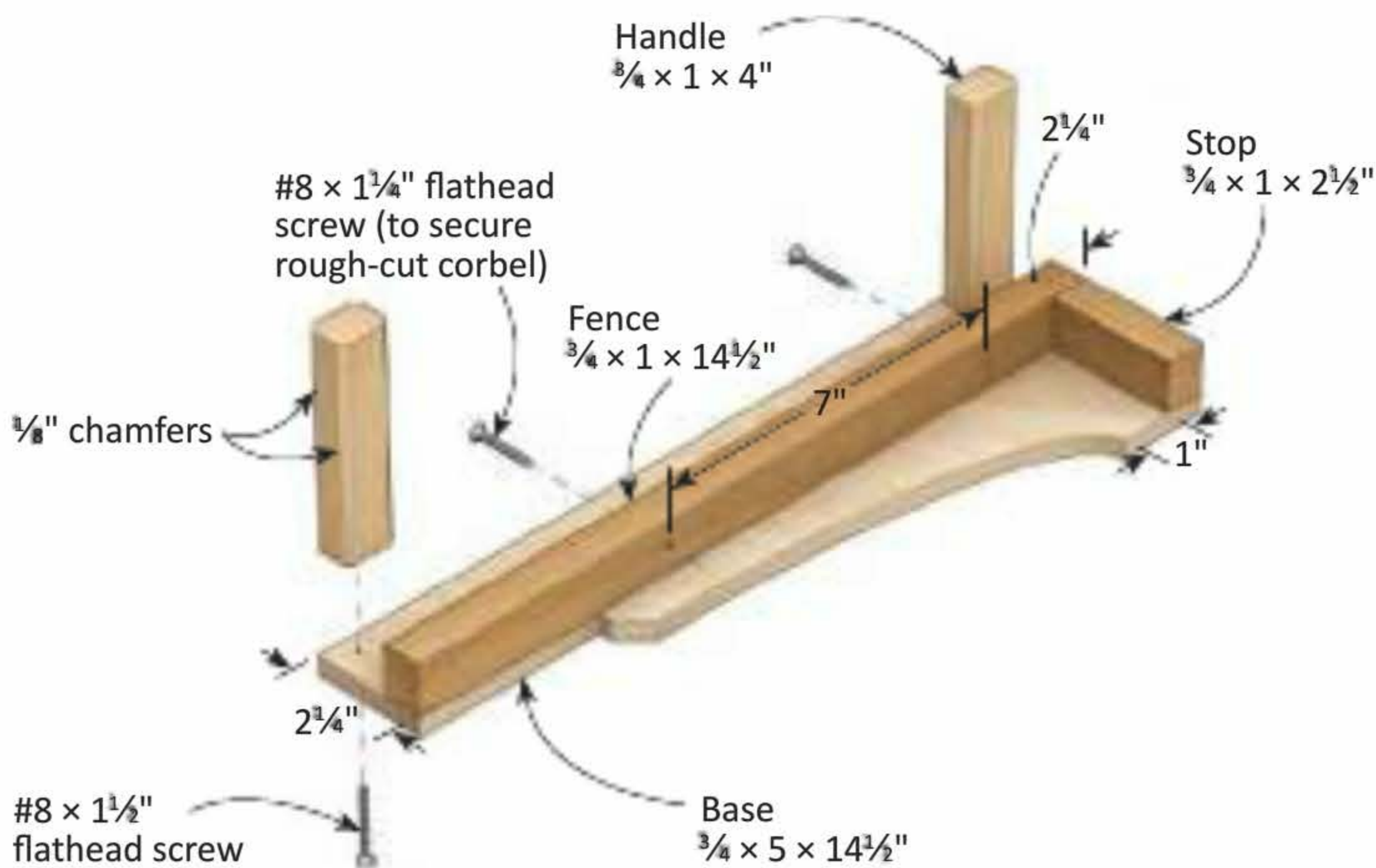
With a $\frac{3}{8}$ " blade, stack-cut the corbels at the bandsaw, staying just outside the line.



C

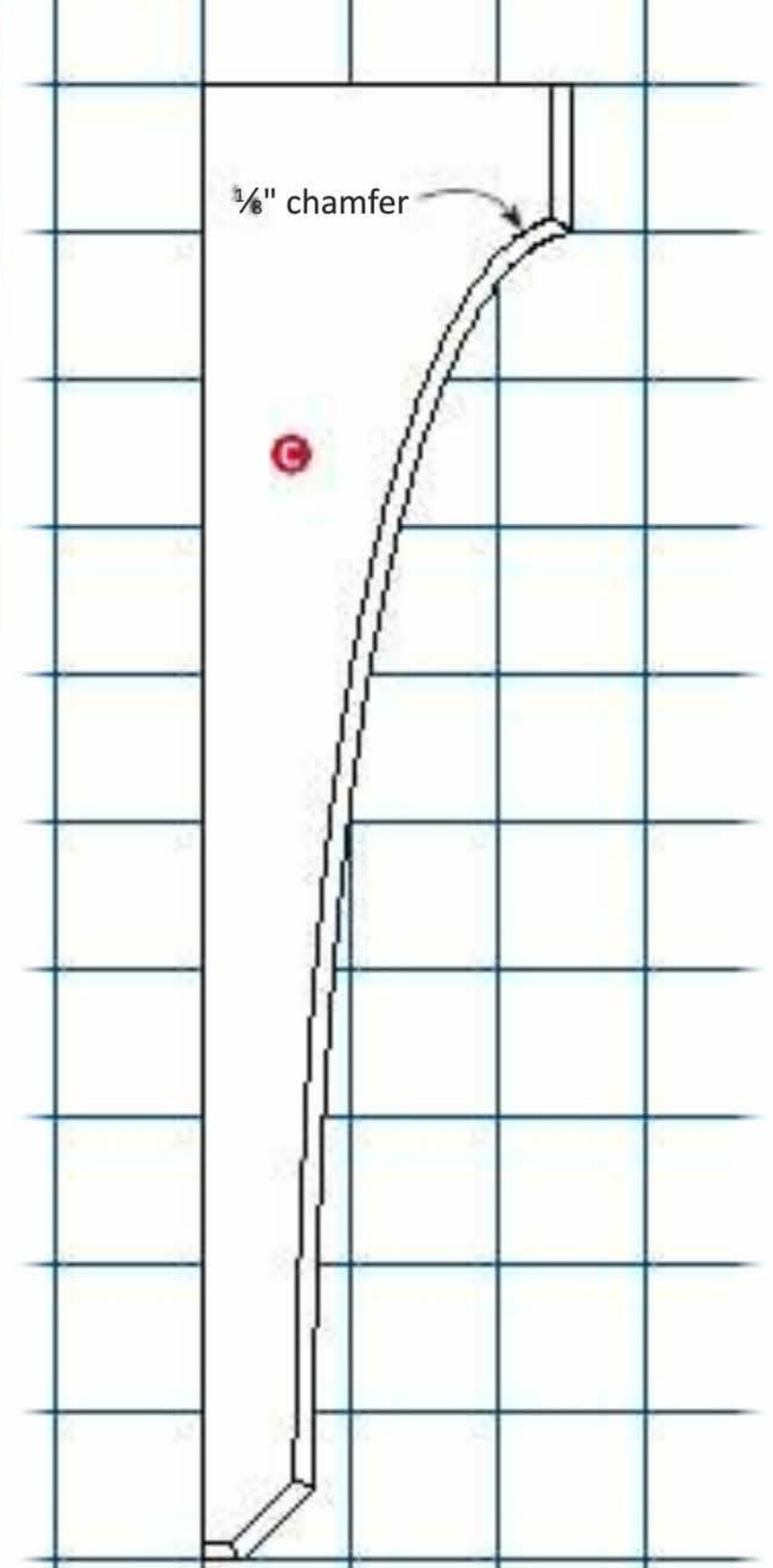
Use the jig handles to safely move the curved base against the bit's bearing as you flush-trim the corbel, cutting with the grain.

Figure 2: Corbel Jig



Note: Use corbel pattern to scribe and cut curve.

Corbel Half-Sized Pattern



Enlarge 200% 1 square = 1"

Full-sized pattern available for download on woodcraftmagazine.com/magpatterns.



Spacer with rabbet

Employ a pair of customized spacers to hold the corbels in place during the gluing and clamping operation.

turn the shaft 90° so an adjacent face is against the fence, and make the second cut. Note that the extension fence prevents tear-out on the trailing shaft face.

5 Cut four pieces of $\frac{3}{4}$ "-thick oak to 3×11 ". Stack the pieces together using double-faced tape, aligning the ends and edges. Either adhere a copy of the **Corbel Pattern** on the top piece aligning it at one end and one edge, or cut out the pattern and scribe it onto the piece as I did. Now, stack-cut the corbels (C) to rough shape at the bandsaw, as shown in **Photo B**.

6 Make the **Corbel Jig** in **Figure 2**. First, transfer the **Corbel Pattern** along one edge of a $5 \times 14\frac{1}{2}$ " base piece where shown and bandsaw it to rough shape. Now, sand to the line at the oscillating spindle sander for a smooth, clean edge, replicating the pattern exactly. Cut the other parts. Drill the holes in the fence where shown and glue and pin-nail the fence and stop to the base. Screw on the handles.

7 Separate the four corbels (C), and screw one of them in the jig for a firm hold. Now, with a top-bearing flush-trim bit, flush-trim the corbel at the router table (**Photo C**). Repeat for the

remaining three pieces. Use the corbel shape in the jig's base to lay out the narrow chamfered ends of the corbels. Finally, bandsaw and disc-sand the ends to the line.

8 Cut two legs (D) to size from $\frac{3}{4}$ "-thick oak. Using a dado set and miter gauge extension fence, cut the 2" cross-lap dadoes $\frac{3}{8}$ " deep in the legs, where shown in **Figure 1**.

9 Drill centered $\frac{5}{32}$ " shank holes in the legs (D), where shown in the **Leg Detail** in **Figure 1**, countersinking the holes on the bottom faces for #8 screws.

10 From $\frac{3}{8}$ " stock, cut four feet (E) to size, and then rout $\frac{1}{8}$ " chamfers along three of four top edges, where shown in **Figure 1**. Leave the chamfering setup for **Step 12**.

11 Return to the drill press and, using a $\frac{7}{8}$ " Forstner bit, drill a $\frac{1}{2}$ "-deep counterbore centered in the bottom face of the unglued feet assembly. Switch to a $\frac{3}{8}$ " brad-point bit, and drill a through hole at the same location. Enlarge the hole to $\frac{13}{32}$ " using a twist bit. (If your brad-point bit collection includes the less common $\frac{13}{32}$ " bit size, skip drilling the $\frac{3}{8}$ " hole and drill the $\frac{13}{32}$ " hole with it.)

12 At the router table, cut $\frac{1}{8}$ " chamfers on the outside or



Drill pilot holes in the lamp corbels while guiding off the shank holes in the legs.

exposed edges of the base parts (feet, legs, shaft, and corbels), where shown in **Figure 1**. Center and glue the feet (E) onto the legs (D) so they extend $\frac{3}{8}$ " beyond the edges and ends. Now apply glue in the cross-lap dadoes and clamp the legs together.

13 With a pair of $\frac{5}{8}$ "-thick spacers that have $\frac{5}{16}$ " rabbets $\frac{3}{8}$ " deep along one edge, glue and clamp the corbels (C) onto the shaft (A/B), ensuring the parts are centered and flush at the bottom end (**Photo D**). Use a moderate amount out of glue to avoid squeeze-out. Let it dry.

14 Clamp the shaft/corbel assembly (A/B/C) upside down in a bench vise. Add the legs/feet assemblies (D/E) at the bottom end of the shaft. Now, insert the threaded steel nipple in the shaft, and temporarily add the washers and hex nuts at the top and bottom of the lamp base to clamp the assemblies together. Align and center the top faces of the legs over the corbels, and tighten the nuts. Guiding off the countersunk holes drilled earlier, drill $\frac{3}{32}$ " screw pilot holes in the corbels, as shown in **Photo E**. Remove the hardware. The two assemblies will be screwed together later after finishing.

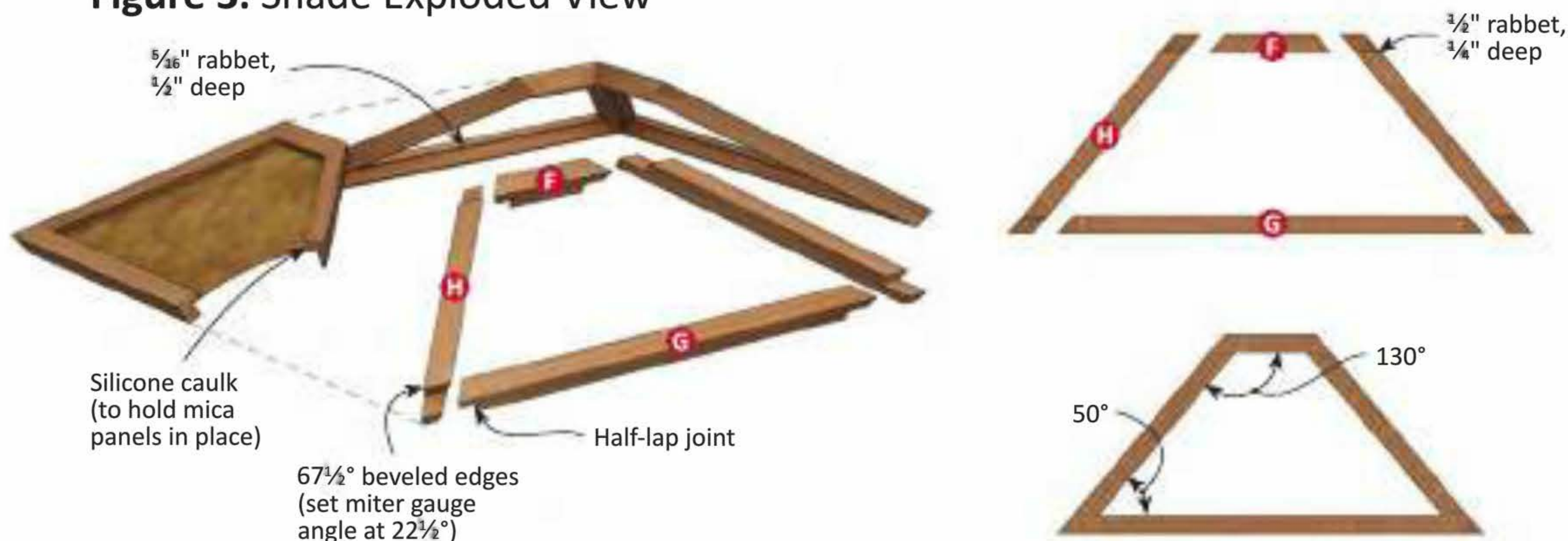


Test-cut rabbets in the ends of the mating frame parts, using a notched hold-down stick and stop to safely control the part during the cut.



Hold two mating frame pieces together, rabbet to rabbet, to confirm a flush half-lap joint.

Figure 3: Shade Exploded View



Build the shade

1 Mill enough stock for the upper rails (F), lower rails (G), side rails (H), and shade supports (I) to the widths and thicknesses in the **Cut List**. Mill enough extra material for test cuts and setups. Precision is critical here. *Note: Prior to cutting the 50° miters on the shade parts, orient the cutting stock to*

Tip Alert

Bevel the inside end of the miter gauge extension fence at 50° for zero-clearance support at the saw fence. Dado-cut the frame parts twice to counter any deflection.

display quartersawn figure on the parts' outside faces.

2 Lock in the miter gauge and extension fence to 40° from 90°. Referring to **Figure 3**, miter-cut the shade frame pieces—plus extras—for the upper rails (F), lower rails (G), and side rails (H). Use stops and make test cuts on the extra pieces to sneak up on the exact part lengths.

3 Install a dado set in the tablesaw, and raise the blade to 3/8". Set the saw fence 1/64" from the dado set to prevent gouging its face. Using a miter gauge extension fence, cut test rabbets on the scrap pieces to the needed width and depth, as shown in **Photo F**, adjusting the

miter gauge 40° to the right or left of 90° as needed. Hold two mating pieces together, as shown in **Photo G**, to test the fit. Adjust the rabbet depth and/or the saw fence if needed. Then, proceed rabbeting the shade frame parts (F, G, H), cutting one end of each piece at one setting. Then adjust the miter gauge angle to rabbet the opposite ends.

4 Build the **Shade Frame Clamping Jig** in **Figure 4**. Apply glue in the rabbets, and clamp an upper rail (F), lower rail (G), and side rails (H) together in the jig to create one shade frame, as shown in **Photo H**. Wipe away any squeeze-out with a clean, moistened rag. Let the



H Fit the frame parts in the clamping jig, and use a pair of spring clamps to hold them tightly in place. Then use C-clamps to snug the half-lap joints



I Set up the depth stop and a beveled fence stop on your drill press, and bore out the lower corners in the rabbeted frames.



J With the saw set up precisely, fit the shade frame against the stop—outside face up—and bevel-cut the left-hand edges of the shade frames.



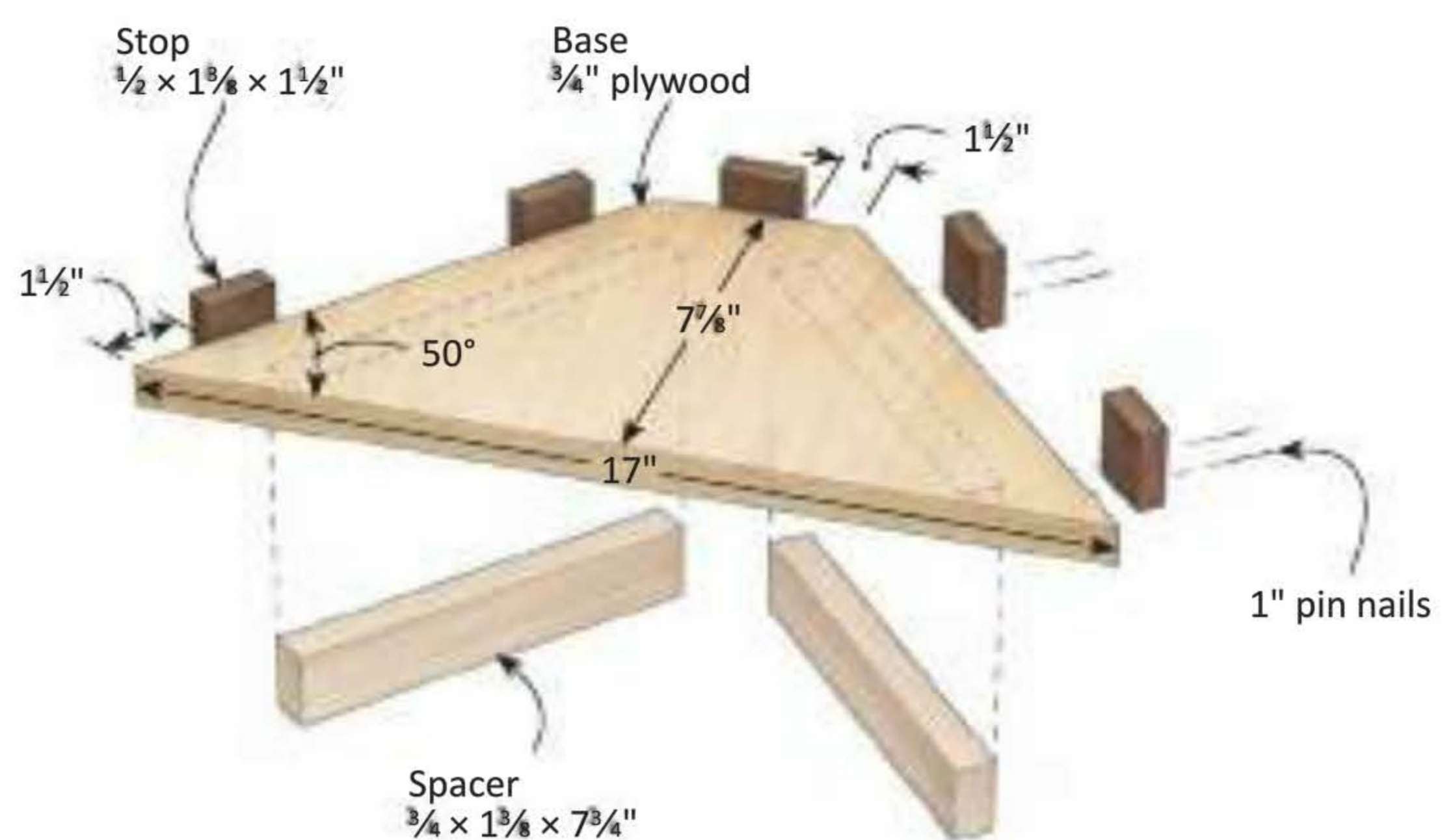
K Using a stop with a compound cut against the frame's beveled edge, bevel-cut the opposite side edge.

glue dry, and repeat the process to make the other three shade frames. Sand the joints smooth.

5 Using a rabbeting bit and bearing having the appropriate diameter, rout the $\frac{5}{16}$ " rabbets $\frac{1}{2}$ " deep in increments around the inside faces of the shade frames (F/G/H). Clean up the lower rabbeted corners with a $\frac{3}{4}$ "-diameter Forstner bit, as shown in **Photo I**. Clean up any unevenness in the corners with a chisel.

6 At the tablesaw, tilt the blade at $22\frac{1}{2}^\circ$. Using a 40° angled stop and a stiff, long, miter gauge extension fence angled at 40° from 90° in the appropriate slot, bevel-cut the left side edges of

Figure 4: Shade Assembly Clamping Jig





L Apply glue along the beveled shade frame edges, and hold the frames snugly together using spring clamps (and pin nails if needed).



M Use a utility knife and the plywood template to cut out pieces of sheet mica for the lamp shade.

the shade frames as shown in **Photo J**. Here, you want to keep the outside faces up and make sure the blade cuts right along the outside corner of the side (H).

7 Working from the other miter slot and using the same miter gauge setting and blade angle, flip the frames top to bottom, placing their outside faces down. Now, bevel-cut the frame's opposite side (H), as shown in **Photo K**.

8 Working on a flat surface, apply glue to the beveled edges of the shade frames (F/G/H),

and assemble the lamp shade as shown in **Photo L**. Wipe up any squeeze-out. After the glue dries, sand the shade assembly smooth.

9 From $\frac{1}{2}$ " stock, cut the shade supports (I) to size. Cut $\frac{3}{4}$ " dados, $\frac{1}{4}$ " deep at the center on the opposing faces of each piece. Temporarily assemble the supports, and place the shade on the assembly, centering it. Mark exactly where the shade contacts the supports. Next, angle the dado set at $33\frac{1}{2}^\circ$ and adjust the height to cut $\frac{1}{4}$ " deep.

Make the cuts in the top faces of the shade supports, where shown in **Figure 1**, keeping the short legs of the notches to the outside ends. Note that the bottom angled edges of the shade's lower rails (G) must seat in the corners of the notches established by the marks.

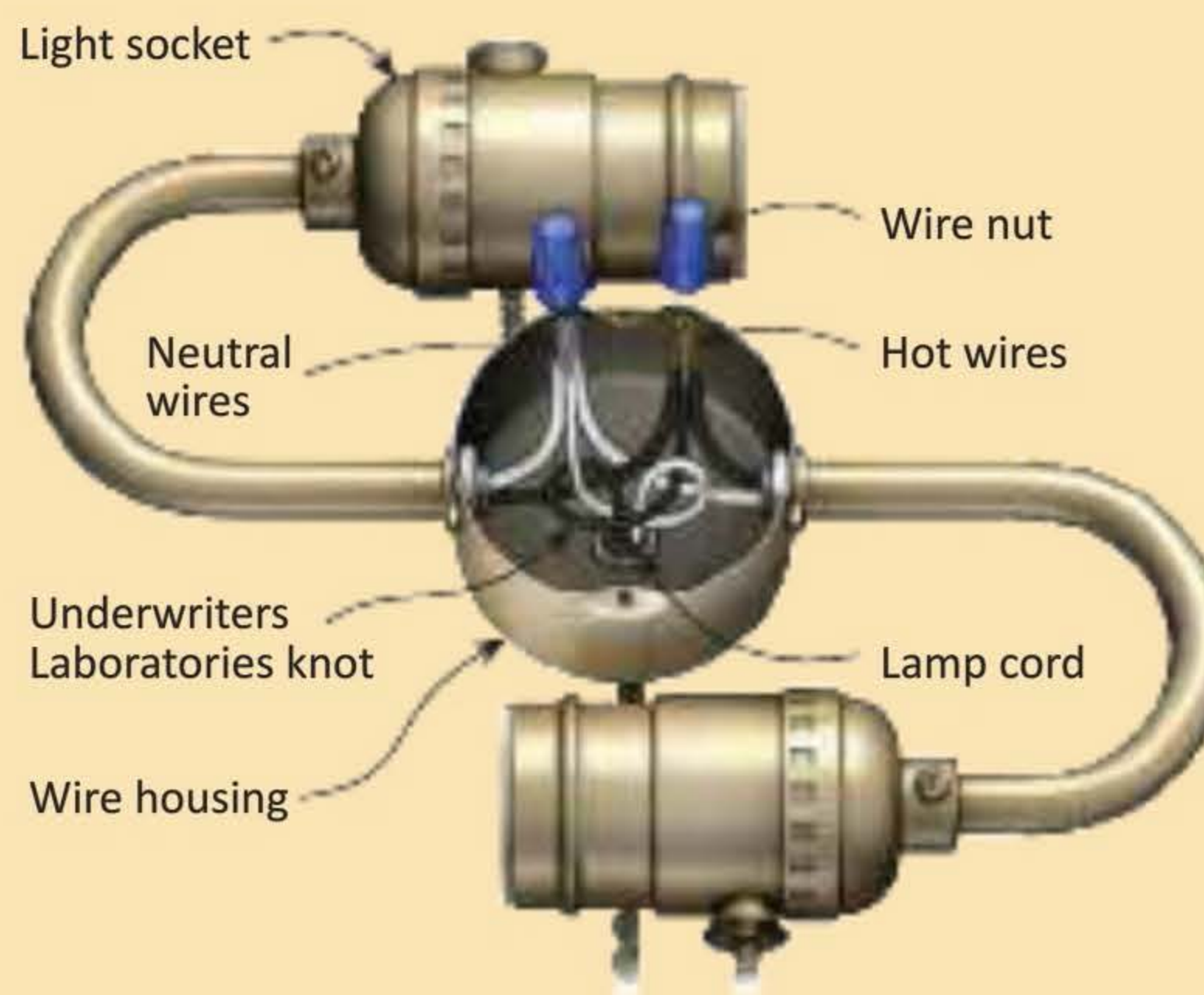
10 Disc-sand $\frac{1}{8}$ " chamfers on the ends of the supports (I). Temporarily fit the pieces together, and test their fit in the notches at the top end of the shaft. Rest the shade assembly

How To Wire Your Lamp

To wire your lamp, cut the threaded steel nipple to 17", and then insert it into the shaft. Add a washer, hex nut, and bushing at the bottom. Fit on the shade supports (I) over the protruding nipple and into the notches at the top of the shaft. Add another washer and hex nut and screw on the two-light pull chain cluster. Remove the lid to the wire housing exposing the wires for the light

sockets. Insert the lamp cord through the nipple and into the housing. Now, as shown at right, strip 1" of insulation off the neutral braided wires and the hot braided wires. Twist the wire ends clockwise—hot to hot, neutral to neutral—creating two groupings. Cap the connections with wire nuts. Add the lid. Top it with the $\frac{3}{4}$ " steel nipple and brass nut. Add two 40-watt bulbs and test the lamp.

Lamp Wiring Diagram



on the supports. Carefully sand the pieces as needed.

11 Glue the shade supports (I) together. After the glue dries, use a brad-point bit to drill the centered $\frac{13}{32}$ " through hole, where shown in **Figure 1**.

12 Finish-sand, stain, and finish the lamp assemblies. (I used General Finishes Water-Base Stains in black cherry and mahogany in a one-to-one mixture and three coats of a satin lacquer finish.) Assemble the base.

13 Measure the size of the rabbeted opening in the shade frames, and cut and sand a piece of scrap plywood to fit in the opening. Now, use the plywood template and a guide to cut out four pieces of sheet mica, as shown in **Photo M**. Round the corners of the mica at a disc sander. Next, lay down beads of silicone and fit the pieces in the rabbeted shade frames (F/G/H). **14** Wire the lamp as described at left. Then find a place for this charming home accent. ■

About Our Designer/Builder

Since 1980, custom furniture

maker Tom Svec has maintained a workshop and studio on Great Island, just east of Lock Haven, Pennsylvania. It's here where he creates and builds his signature lines of

tables, benches, beds, and home accents, many in the contemporary style, using local hardwoods. For more, visit his website at tomsvecfurniture.com.

Arts & Crafts Table Lamp Cut List

	Part	Thickness	Width	Length	Qty.	Mat'l
Base						
A*†	Shaft halves	$\frac{3}{4}$ "	$1\frac{3}{8}$ "	$15\frac{5}{8}$ "	2	QRO
B	Shaft veneers	$\frac{1}{8}$ "	$1\frac{1}{2}$ "	$15\frac{5}{8}$ "	2	QRO
C	Corbels	$\frac{3}{4}$ "	$2\frac{1}{2}$ "	10"	4	QRO
D	Legs	$\frac{3}{4}$ "	2"	10"	2	QRO
E	Feet	$\frac{3}{8}$ "	$2\frac{3}{4}$ "	$2\frac{3}{4}$ "	4	QRO
Shade						
F*	Upper rails	$\frac{3}{4}$ "	$\frac{3}{4}$ "	$4\frac{13}{16}$ "	4	QRO
G*	Lower rails	$\frac{3}{4}$ "	$\frac{3}{4}$ "	17"	4	QRO
H*	Side rails	$\frac{3}{4}$ "	$\frac{3}{4}$ "	$11\frac{1}{16}$ "	8	QRO
I	Shade supports	$\frac{1}{2}$ "	$\frac{3}{4}$ "	$17\frac{1}{2}$ "	2	QRO

Materials: QRO – quartersawn red oak

*Indicates parts that are initially cut oversize. See instructions.

† Shaft halves combine with the shaft veneers to make up a $1\frac{3}{8} \times 1\frac{3}{8}$ " square shaft.

Hardware/Supplies: Silicone caulk; (6) #8 × $1\frac{1}{2}$ " flathead screws;

(2) #8 × $1\frac{1}{4}$ " flathead screws.

Convenience-PLUS BUYING GUIDE

1.	Freud 7-Pc. Rabbeting Bit Set w/Bearings, $\frac{1}{2}$ " CL ($\frac{3}{2}$ " SH)	#828705	\$57.47
2.	Freud Top Bearing Flush Trim Bit, $\frac{3}{4}$ " D, 1" CL ($\frac{1}{2}$ " SH)	#845409	\$35.47
3.	General Finishes Water-Base Stain, Black Cherry, 1 qt.	#818821	\$15.99
4.	General Finishes Water-Base Stain, Brown Mahogany, 1 qt.	#812153	\$15.99
5.	Watco Lacquer, Satin, Spray, 16 oz.	#146950	\$8.50

Above items are available at Woodcraft stores, woodcraft.com or by calling (800) 225-1153. Prices subject to change without notice.

☐ 6.	$\frac{1}{8}$ " IPS Brass Hex Nut, 2 needed	NU424	\$.10 ea.
☐ 7.	$\frac{1}{8}$ " IPS Female Bushing	BG201B	\$.10
☐ 8.	$\frac{3}{4}$ " × $\frac{7}{16}$ " Hole Brass-Plated Washer, 2 needed	WABP0-3/4	\$.07 ea.
☐ 9.	10' Brown Twisted Cord Set w/Molded Plug	WICT10BR	\$10.00
☐ 10.	$\frac{1}{8}$ " IPS Hex Head Acorn Cap	FI1/2HEX	\$.38
☐ 11.	Two-Light Pull Chain Cluster, Antique Brass	CLSAB2PW	\$10.00
☐ 12.	$\frac{3}{4}$ " × $\frac{1}{8}$ " IPS Steel Nipple	NI0-3/4X1/8	\$.10
☐ 13.	18" × $\frac{1}{8}$ " IPS Steel Nipple	NI18-0X1/8	\$1.95

Above items are available at Grand Brass Lamp Parts, www.grandbrass.com or by calling (212) 226-2567. Prices subject to change without notice.

☐ 14.	Mica, Amber, .030"-thick, 18 × 36" sheet	\$28.00	
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Above item is available at Asheville-Schoonmaker Mica Co., www.ashevilemica.com or by calling (800) 385-7311. Prices subject to change without notice.

QuikBENCH™ Portable Workbench

The portable QuikBENCH™ is a lightweight, easy to set up workbench capable of holding up to 300 lbs. Convert two QuikBENCHES™ to sawhorses, and together they will hold up to 2,000 lbs. Two benches can be connected together to form a workstation; in fact, you can connect as many benches as necessary to create a bench sized to your specific needs. The QuikBENCH work surface measures 30" x 24" and is 32" in height. Each bench has a 24"-wide by 3½" opening vise and a 15-amp, circuit protected, three-outlet power strip, plus four plastic bench dogs.



Quick And Easy Setup
Weighs Just 23 lbs.



Connect And Create Large
Worksurfaces To Suit Any Need



2,000 lb. / Pair Capacity

154760

Complete Guide to Woodworking Glues

Use the match-maker chart for all of your glue-up needs

By Joe Hurst-Wajszczuk

Unless your woodworking projects are limited to knockdown furniture and timber-frame barns, you are already quite familiar with a variety of tubes, bottles, bags and jugs of this sticky stuff. Over the years, you've probably grown used to working with a few favorites, and even learned some tricks to deal with less-desirable qualities.

Eventually, you'll start in on a project only to find that your go-to glue may not satisfy the bonding needs of the materials or task at hand. When that happens, you'll find yourself at the mercy of catalogs and home centers looking for the perfect product.

There are dozens of choices, but selecting a suitable adhesive needn't be dizzying. I've divided the woodworking glues into a few basic categories and provided a side-by-side comparison to help you quickly weigh your options. In addition to the quick-reference chart on page 40, you'll find adhesive advice focusing on common problems, as well as valuable suggestions destined to stick with you.



Woodworking Glue Chart



Glue	Simple (uncompounded) Polyvinyl Acetate (PVA)	Compound PVA	Compound PVA	Compound PVA	Dry Hide Glue
Pot Life	N/A	N/A	N/A	N/A	Several days
Open Time	10 minutes	5 minutes	5 minutes	10 minutes	1 minute +
Clamp Time/ Cure time	60 minutes/ 24 hours	30 minutes/ 24 hours	30 minutes/ 24 hours	30 minutes/ 24 hours	Clamping not needed (glue sets as it cools) / 24 hours
Color when dry	Clear	Yellow	Yellow	Light brown	Amber
Cleanup	Water	Water	Water	Water	Water
Water Resistance	Low	Low	Very Good (Type II)	Excellent (Type I)	Low
Shelf Life	2 years	2 years	2 years	2 years	Indefinite
Cost	\$5 for 16 oz.	\$6 for 16 oz.	\$8 for 16 oz.	\$10 for 16 oz.	\$15 for 1 lb.
Notes	Good for crafts, but not ideal for woodworking. Vulnerability to heat and moisture makes it suitable for instances requiring reversibility.	Best all-around choice for joinery and casework on interior projects.	Water resistance makes it a good choice for projects likely to face exposure to moisture or bad weather.	Best PVA for projects that might get stressed when wet, but not suited for constant submersion. Additional working time a plus for large/complex glue-ups.	Fast initial tack; favorite choice for veneer. Reversibility a plus for antiques and musical instruments. New glue bonds to old. Must mix with water in glue pot and heat to 140°-150°F.

+Varies because of product formulation and outside factors, including temperature, wood species, and the wood's moisture content.

Glossary:

Pot life: The maximum amount of time you have to apply two-component glues to your work after they have been mixed.

Open time: The maximum amount of time glued pieces can be left open to the air before assembly.

Clamp time: The minimum amount of time required before you can remove the clamps from a glue-up assembly. (Note: PVAs and hide glue offer only 30-50% of full strength at stated time. If a joint is under stress, maintain clamping pressure for the full cure time.)



Liquid Hide Glue	Polyurethane	Epoxy	Urea Formaldehyde	Cyanoacrylate
N/A	N/A	4-50 minutes+	2-4 hours+	N/A
10 minutes	15-30 minutes	5-30 minutes+	5-30 minutes+	1 minute+
30 minutes/ 24 hours	1-4 hours	15 minutes-15 hours+	5-15 hours+	1 minute+
Amber	Amber	Clear to Amber	Tan	Clear
Water	Mineral spirits	Lacquer thinner, acetone, denatured alcohol, vinegar	Water	Acetone
Low	Excellent (Type I and II)	Excellent; stable in temperatures up to 200°F	Excellent; stable in temperatures up to 180°F	Low
1 year	1 year	2-3 years	1 year	1 year
\$13 for 16 oz.	\$11 for 12 oz.	\$52 for 48 oz.	\$25 for 4½ lbs.	\$12 for 2 oz.
Same benefits as hot hide glue, minus the quick tack.	Best choice for wet woods, and for bonding wood to non-wood. Moisture required. Glue can stain skin. Foam produced during curing process complicates cleanup.	Good for laminations, outdoor furniture, marine applications, and gap-filling. Skin contact can trigger allergic reactions. Wear gloves, glasses and respirator when mixing and sanding. Requires mixing hardener with resin.	Good for veneering and bent laminations, but not suited for constant submer- sion. Contains formaldehyde. Gloves, glasses, and respira- tor required when mixing, using and sanding. Available in powder and liquid.	Best for quick repairs. Use an accelerator for instant bonds. Keep a bottle of debonder handy for accidental spills.

Cure time: The time it takes for a glue joint to achieve full 100% bonding strength.

Shelf life: The period of time that glue remains useable. (Note: Excessive heat, humidity, or repeated freeze/thaw cycles will cause

glues to spoil prematurely. Under ideal conditions, adhesives remain useable for longer time periods. If a glue appears abnormal, test first, or toss it in the trash.)

Glue-Choosing Considerations

Under the ideal situations, all woodworking glues are capable of creating bonds stronger than the wood. Selecting the “best” adhesive depends on other factors, including temperature,

working time, and weather resistance. Here’s a quick-pick guide to help you select the right glue for new work or old, indoors or outside, and the variety of materials woodworkers use.

In some cases, several glues can fit the bill. Study the working properties of each glue in the chart to see if you can use what you have on hand, or if it’s time to go shopping.



Flexibility/Creep

A little plasticity is necessary to allow for some wood movement, but slipping or stretching (often the result of constant long-term loads) that doesn’t snap back is called *creep*. In smaller projects, creep means visible glue lines and laminations that lose their shape. In larger structures, creep can spell joint failure.

Avoid: White glue. It creeps the most, but most PVAs can stretch under long-term loads.

Try: Urea formaldehyde and epoxy are the safest choices, but polyurethane is more convenient, and suitable for non-structural projects. In the PVA category, Titebond Extend offers the best creep resistance. CA glue bonds are stiff to the point of brittle; the bond can be broken with a hard rap.

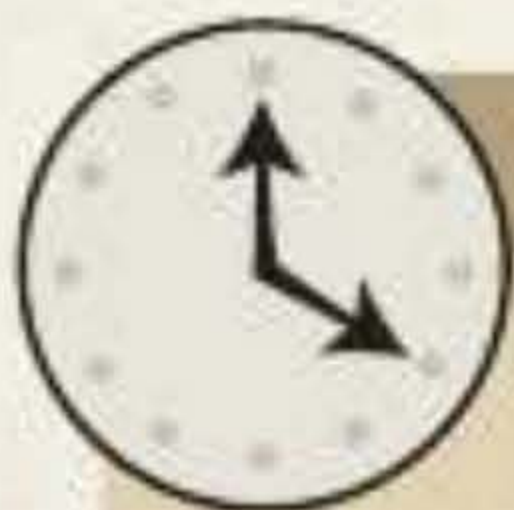


Toxicity

Gloves, respirators, goggles, and good ventilation provide decent defense, but if you are concerned about the effects of long-term exposure, or if you are chemically sensitive, steer clear of adhesives containing problematic chemicals, including those requiring solvent-based cleaners. (If in doubt, get a Material Safety Data Sheet [MSDS] from the manufacturer.)

Avoid: Urea formaldehyde. It contains formaldehyde, a skin and lung irritant, and possible carcinogen. Polyurethane and epoxies contain sensitizers that can trigger allergic reactions. CA fumes irritate eyes, nose, and lungs.

Try: PVAs. These are nontoxic and clean up with water. Hide glue is made from skins and hooves. You wouldn’t want to eat the stuff, but you needn’t worry if your dog happened to find your glue pot.



Working Time

Open time, working time, and curing time all relate to how long it will take to glue up a project from application to maximum bonding. Depending on the project, speed can be an ally or enemy.

Fast: Hot hide glue tacks in minutes, but with the aid

of an accelerator, CAs bond instantly. If you can afford a few minutes, fast-curing epoxies cure in minutes, but offer considerable strength.

Slow: Titebond III and liquid hide glue offer more time for complex or multi-stage glue-ups. For even more time, try Titebond Extend (see sidebar,

right). Polyurethane allows a comfortable working time for complicated glue-ups, but keep the clamps on until final cure or the foam can cause joints to open. You can double epoxy’s working time with slower hardener. (Lowering the temperature will also buy more time.)



Temperature Sensitivity

Woodworking in poorly heated spaces during winter months often leads to glue failure. If the temperature drops below a certain point, or if the stock was cold to start with, some glues can't cure (or stick) like they should.

Avoid: PVAs. Most of these require a temperature above 50° F to work. When yellow glue dries white, it means that the temperature fell below the glue's chalk temperature and that the joint will likely fail.

Try: Epoxies. These cure best at 70° F, but some mixes work in temperatures as low as 35° F. (In chilly conditions, you can use a heat lamp or hair dryer to help the epoxy kick in.) Titebond III can be used as low as 45° F. Liquid hide glue begins to gel at 50° F, but if you keep the bottle warm, it can be used in colder weather.



Water-Resistance

There's a difference between waterproof (Type I), water-resistant (Type II) and constant immersion. Type I testing involves several boiling/backing cycles and then testing the samples while they're still wet. Type II testing involves three soaking cycles and three drying cycles before the samples are tested. Despite type ratings, all PVAs will soften in a constant marine environment.

Avoid: White and hide glues. Their bonds can be undone with hot water. (This can be an

advantage when expecting repairs. Conservators prefer hide glue because new glue reactivates old.)

Try: Epoxy is the only adhesive suited for constant water contact but for typical outdoor projects, Titebond II, polyurethane, and urea formaldehyde will all hold their own. For projects that might be exposed to hot water, consider Titebond III. (Boiling water activates Titebond III crosslinking polymers, improving Titebond III's bond. At temperatures above 200° F epoxy and urea formaldehyde lose stability.)



Gap Filling

If a joint is slightly less than perfect, you may not need to worry. As long as 50% of the joint faces are in contact, most glues will hold tight. (In such cases, consider leaving the clamps on through full curing to keep mating surfaces as snug as possible.) Bad craftsmanship and poor clamping practices are another story. If you have a bridge joint with visible gaps, or a tenon that slides around within its mortise, you need a gap-filling specialist.

Avoid: Polyurethane glue. It foams as it cures, but the dry froth has no significant strength. PVA might also seem like a quick fix, but that gap-filling puddle will shrink as it dries. In both cases, the adhesives create a film that seals the cell walls, complicating a future fix. (PVAs work if you can pack the joint to establish direct wood-to-wood contact.)

Try: Epoxy is the best choice for structural, gap-filling repairs. You can build epoxy fillets around joints for additional reinforcement.

Custom PVA Blends

Special-blend PVAs possess certain abilities that have made them shop favorites. With a 15-minute open time (twice as long as regular Titebond), Titebond Extend is useful in complex glue-ups. For cabinetry, try Titebond Melamine. As the name suggests, this PVA sticks to melamine, and also vinyl, high pressure laminates (and wood). Titebond No-Run, No-Drip stays put and grabs quickly, making it perfect when installing molding and trim. Glue-lines shouldn't show, but when they might, Titebond II Dark can prevent the lines from standing out on darker woods.



Outdoor Table and Benches

Just in time for dining alfresco

By Ken Burton



Table: Overall dimensions: 62"w × 38"d × 29"h
Bench: Overall dimensions: 60"w × 14¼"d × 17½"h

There are few things that compare with the simple joy of sitting down for a nice meal outdoors with the sun shining and a gentle breeze blowing. While this alfresco dining set can't do a lot to guarantee you the perfect weather, it does provide a great place to enjoy it.

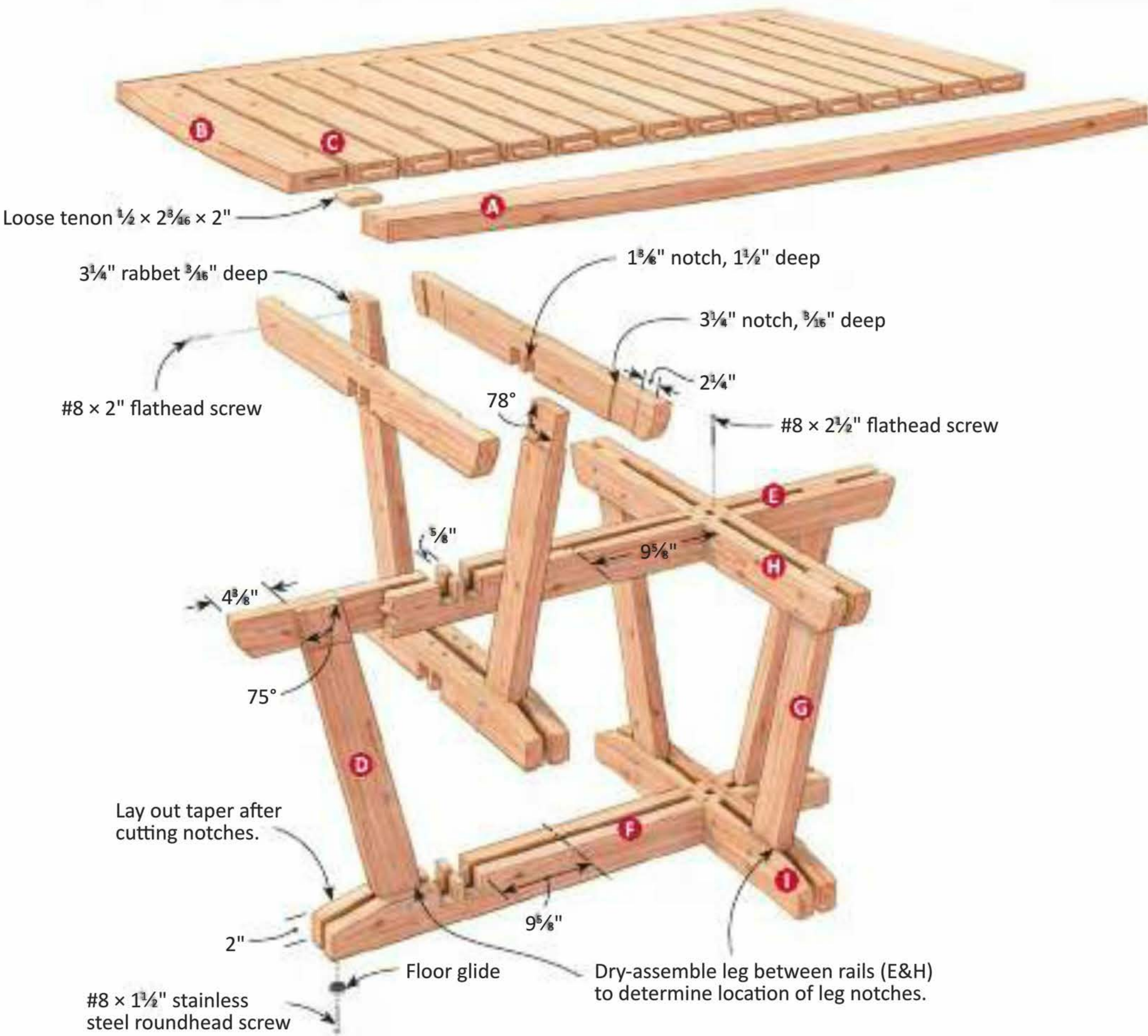
When my client approached me with this commission, the goal was to design a dining table-and-bench set that would accommodate up to eight people

without appearing oversized or undersized. She wanted something with the kind of subtle grace that is usually lacking in commercial outdoor furniture, and made of material that would withstand the elements and accommodate the kind of extreme movement that wood encounters outdoors.

To suit the bill, I designed the top to allow a variety of seating arrangements (some requiring extra chairs in addition to the

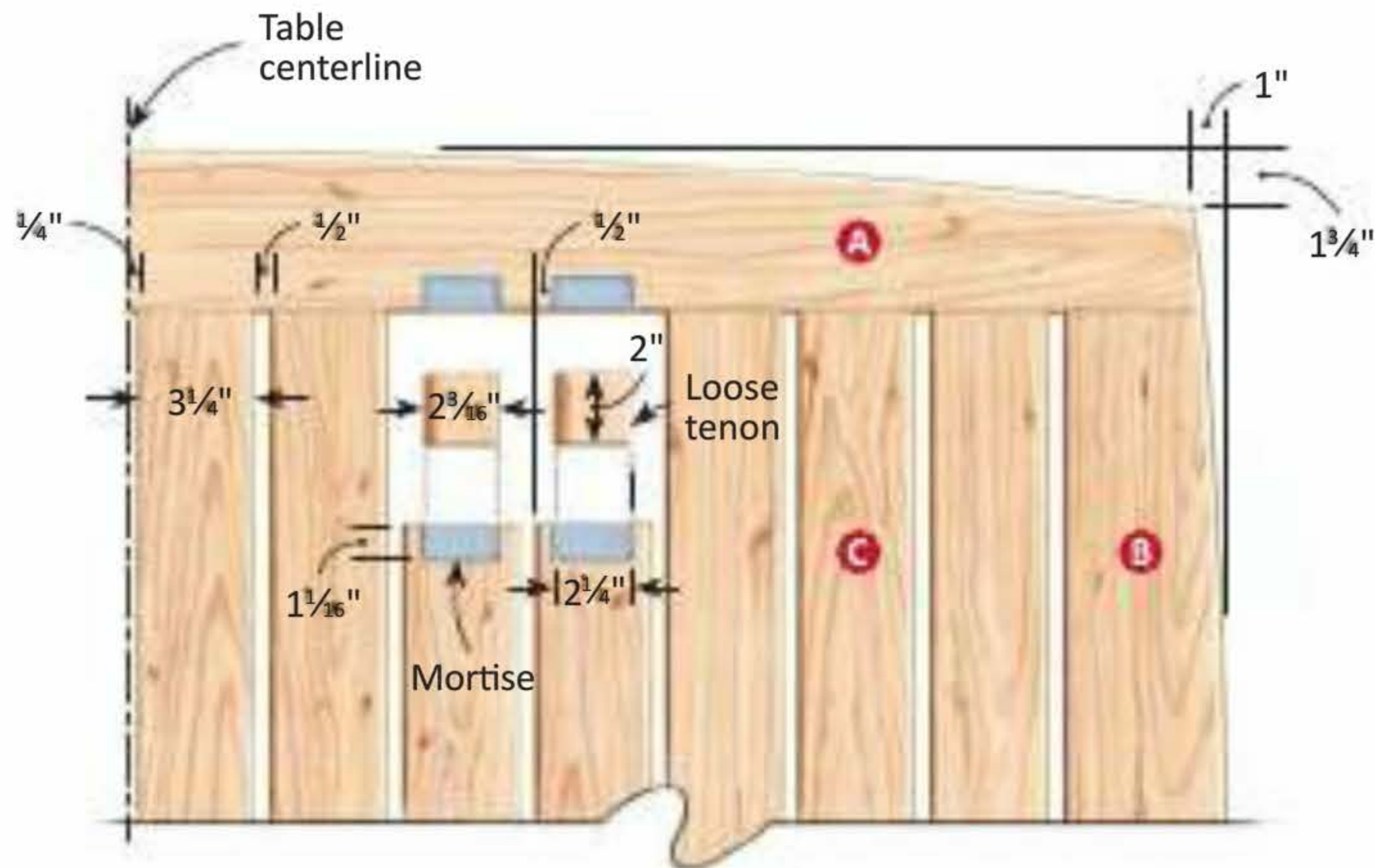
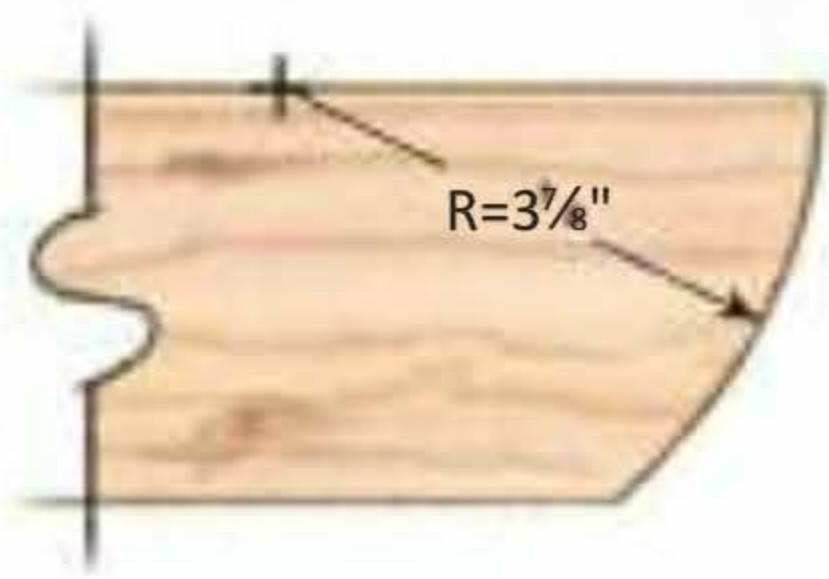
benches shown here) while incorporating gentle curves and inward slanting legs to provide comfort and a touch of style. To ensure durability, I used naturally weather-resistant cedar, joining the parts with strong, but easily made "loose" tenons fixed in place with waterproof glue. Topping all this off with a tough finish guarantees that this furniture will be part of the family for a long time to come.

Figure 1: Table Exploded View



Tabletop Mortise Layout Detail

Rail Curve Detail





Mark out the long rail edges with the locations of the crosspieces and the widths of the mortises.

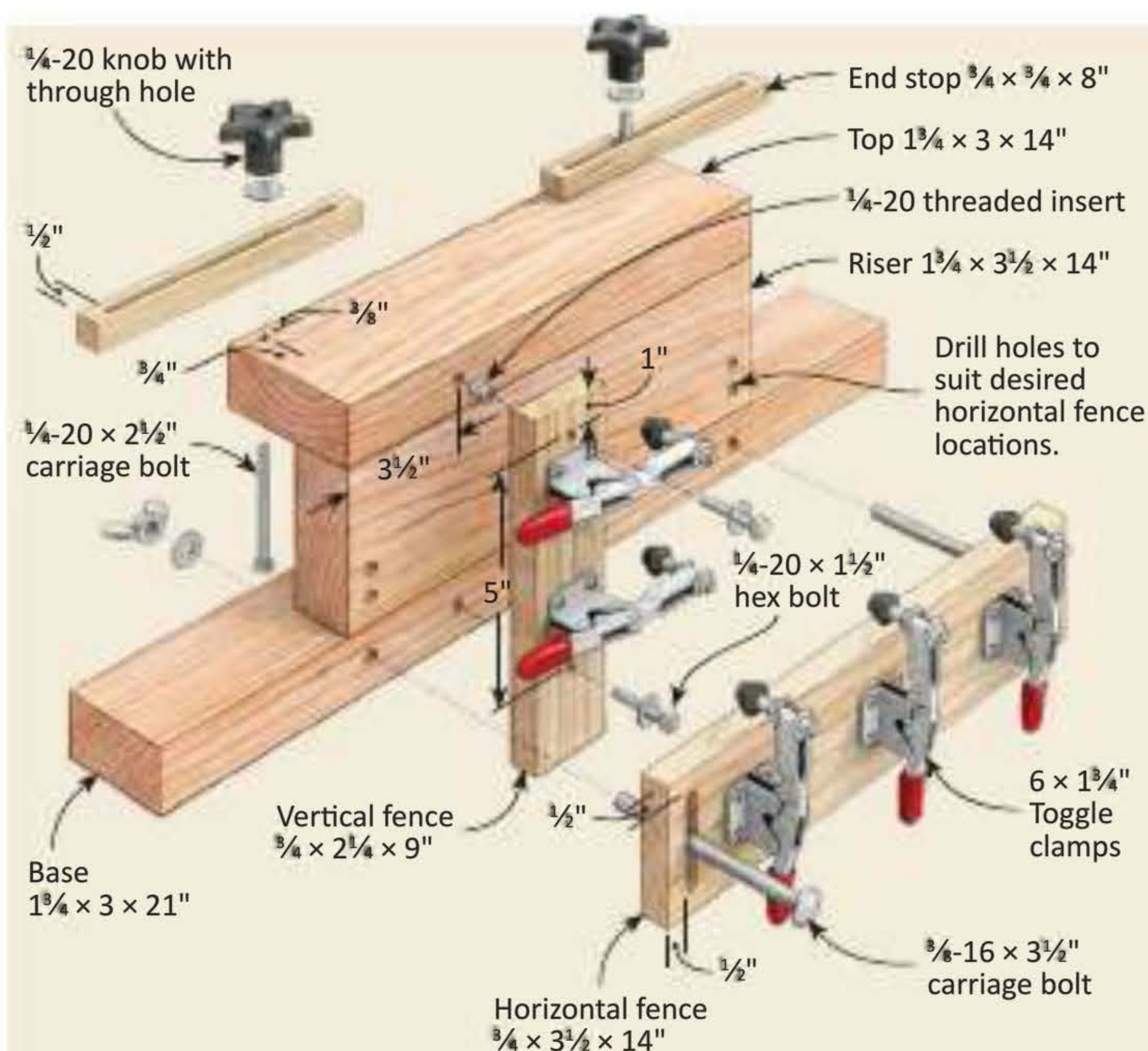
Make the tabletop

1 Lay out your nicest looking stock for the long rails, end rails, and crosspieces (A, B, C). As both cedar and redwood are most commonly available as 2× lumber for the construction trades, the parts for this table were designed to make the most of these dimensions. Keep in mind that you can hide any waney edges by orienting them downward.

2 Cut the pieces (A, B, C) to the sizes shown in the **Cut List**.

3 Clamp the two long rails (A) together with their better faces (the “show” faces) oriented outward, as shown in **Photo A**. Mark these faces with an “X” to identify their orientation later. Now lay out the mortises as well as the end rail (B) and crosspiece (C) edge locations where shown in **Figure 1, Mortise Layout Detail**, working from the center of the long rail outward.

4 Make the mortising jig shown on this page. Install its horizontal fence, and attach toggle clamps along its length. Outfit your plunge router with an edge guide and a $\frac{1}{2}$ " spiral upcut bit, adjusting the router's depth stop for a $1\frac{1}{16}$ "-deep cut.



Mortising Jig

This mortising jig will hold workpieces horizontally or vertically to allow edge- or end-mortising for making loose tenon joints. It is equipped with toggle clamps for securing the pieces and adjustable stops to control the length of the mortises. The jig is designed to work with a plunge router equipped with an edge guide.

Make the jig as shown, but don't sweat the exact dimensions or precise placement of the various holes and slots; they aren't critical. There are only two crucial criteria: First, make sure the jig's face and top surface

are square to each other. To do this, run the glued-up top/riser/base assembly face down over your jointer to ensure the front face is all one plane. Then run the jig upside down with the front face against the jointer fence to square the top surface to the face. Second, run the whole jig upside down through your tablesaw to ensure the rear edge of the top is parallel to the jig's face. *Note: Disregard the $\frac{1}{2}$ x $\frac{1}{2}$ " strip screwed to the back edge of the jig's top in the photos. It was a modification for an accessory not used here and can be omitted.*

5 Clamp one of the long rails (A) to the jig with the marked “show” face oriented inward. Adjust the router's edge guide to center the cut across the thickness of the rail, and set the stops to control the mortise length. Once you're set up, extend the mortise reference

lines onto the top of the jig for positioning of subsequent cuts. Then rout the mortises, as shown in **Photo B**, beginning the cut with the router positioned against the right-hand stop (as viewed from the face of the jig), and pulling it toward the left-hand stop.



Rout the mortises in several passes, retracting the bit at the end of the cut before moving the router against the opposite stop to begin the next pass.



When routing end mortises, be sure the end of the workpiece is flush with the jig's top surface. Use a cover of scrap to protect against clamp damage.

6 Mount the second long rail (A) onto the jig with its show face oriented inward, and rout all of its mortises.

7 Lay out the mortises on both ends of both end rails (B), and one end of one crosspiece (C), where shown in **Figure 1**. Mark the show face of each piece with an "X".

8 Swap the jig's horizontal fence for the vertical fence, and screw toggle clamps to the fence. Clamp the marked-out crosspiece (C) in the jig with the show side facing inward, and reposition the stops to suit the mortise location. Leave the edge guide set as it was.

9 Rout the mortise in the end of the crosspiece (C), as shown in **Photo C**. Then unclamp it, rotate it end for end in the jig, and rout the other end, still keeping the show side against the jig. Repeat for every crosspiece.

Tip Alert

When cutting mortises with this jig, apply firm pressure with your left hand to keep the router flat on top of the jig and the edge guide riding along the jig's edge.

10 The mortise on one end of each end rail (B) will align with the setup you just used to mortise the crosspieces (C). Cut mortises in those particular ends of both end rails. Then reposition the stops to mortise the two opposite ends.

11 Mill at least 64" of $\frac{1}{2}$ "-thick $\times 2\frac{3}{16}$ "-wide stock for loose tenons. (When thicknessing the stock, ensure that it fits snugly in the mortises without force.) While you're at it, cut the same amount for each bench you're making. Bullnose the edges of the stock using a $\frac{1}{4}$ " round-over bit in a table-mounted router. Then crosscut the individual tenons to 2" long.

12 Enlist someone to help you with the glue-up, as there is a lot of glue to spread and a lot of pieces to align. First, perform a complete dry-assembly to check the fits of the joints, to set up your clamps, and to rehearse your assembly procedures.

13 When you're ready to glue up, begin by spreading glue in the mortises of one of the long rails (A). Then spread glue on that rail's tenons, and tap them home. Spread glue in the mating

mortise on one end of each end rail (B) and crosspiece (C), and slide them in place, aligning their edges with the reference marks on the long rails. As you work, be sure to keep the show sides of all the pieces properly oriented.

14 With the assembly standing on edge, spread glue in the opposite mortises of the end rails (B) and crosspieces (C). Spread glue on the rest of the tenons and tap them in place. Finally, spread glue in the mortises of the second long rail. Start attaching the rail at one end, working your way along its length. When all the joints are together and properly aligned, add clamps to pull the assembly tight. (Don't worry about protecting the edges from clamp damage, as you'll be cutting them away later.)

15 Referring to the **Tabletop Mortise Layout** in **Figure 1**,

Tip Alert

Orienting each workpiece "show" face against the mortising jig ensures that the assembled show surfaces align regardless of an off-center machining setup.



D Drive in a finish nail outside of the laid out table corners to serve as a backstop for a fairing strip.

mark the location of each of the four corners of the top. Then drive a finish nail $\frac{1}{4}$ " outside each of those marks, as shown in **Photo D**.

16 Bend a strip of $\frac{1}{4}$ "-thick, straight-grained wood against the nails, and trace along it to lay out the curves, as shown in **Photo E**. Cut to your layout line with a jigsaw, and sand the curves fair and smooth. Round over the edges with a $\frac{1}{4}$ "-radius round-over bit in a handheld router.

Make the table base

1 Mill the pieces for the legs (D, G), rails (E, H), and runners (F, I) to the sizes listed in the **Cut List**.



E Bend the fairing strip against the finish nails. Trace along the inside of the strip to lay out the tabletop's curved edges.

2 Crosscut both ends of the two end legs (D) to 75° , as shown in **Figure 1**. Crosscut one end of each of the side legs (G) to 78° .

3 Set up a dado head on your tablesaw, configuring it for as wide a cut as possible. Adjust the height to $\frac{3}{16}$ ". Use a miter gauge set at 75° to feed the end legs (D) over the blade to create the 3"-wide angled rabbets shown in **Figure 1**. Reverse the miter gauge angle to cut the opposite sides, as shown in **Photo F**.

4 While you have the dado head set up, cut the mating notches in the center rails (E). Locate these notches $4\frac{3}{8}$ " in from ends of the stretchers. After you cut

the four notches, clamp the end legs (D) in place between them. Then hold the center runners (F) in place to mark them for their notches, and then cut the notches using the same dado head setup.

5 Increase the height of the dado blade to exactly half the width of the rails and runners (theoretically $1\frac{1}{2}$ "). Referring to **Figure 1**, lay out pairs of mating notches where the center rails and runners (E, F) intersect the cross rails and runners (H, I). The distance between the notches should be equal to the distance between each pair of runners (and rails) with the legs clamped in place

Woods That Weather Well

The type of wood you choose for outdoor furniture will largely determine how well it holds up. In the U.S., classic domestic choices include various species of cedar, cypress, and redwood. These decay-resistant softwoods are fairly lightweight, which is important if you move your pieces a lot. The downside with these woods is that, because they are relatively soft, they

dent easily. For a domestic wood that's both tough and weather-resistant (but a good deal heavier), consider white oak.

Exotic species that do well outdoors include teak and ipe. Both are extremely rot-resistant but have drawbacks. Teak is relatively soft and only moderately heavy, but it contains silica, which quickly dulls non-carbide cutting tools. Ipe, on the

other hand, can be hard to work because of its density. It also makes for very heavy furniture. Nonetheless, both woods make beautiful outdoor objects.

Whatever the wood, outdoor furniture will eventually gray without a good weather-resistant finish on it. Even then, you'll need to maintain that finish to keep the pieces looking good. See the main text for my recommendation.



F Make overlapping passes across the dado head to create the wide rabbets at the ends of the legs. Use the rip fence as a stop to ensure consistency.



G Position the rip fence as a stop to help you keep the spacing of the notches consistent on the various pieces.

(theoretically $\frac{5}{8}$ "). Saw the notches, as shown in **Photo G**.

6 Referring to **Figure 1**, lay out the notches in the cross rails (H), inseting them $2\frac{1}{4}$ " from the ends. Change the dado height back to $\frac{3}{16}$ ", angle your miter gauge to 78° , and use the setup to saw the notches in the cross rails (H). Also, saw the rabbets on the angled ends of the side legs (G).

7 Set up the table base with the end legs (D) clamped in place between the center rails (E) and runners (F). Fit one cross rail and one cross runner (H, I) into their notches in the center rails and runners (E, F). Clamp the side legs (G) in place, mark them to length, and mark the rabbet shoulders at the lower end of the leg (**Photo H**). At the same time, mark one cross runner (I) for the locations of the angled notches that will accept the side legs (G). Use this cross runner as a guide to mark its companion. Repeat the process at the other end of the base.

8 Saw the rabbets on the bottom ends of the side legs (G) and the notches in the cross runners (I), using a dado head as before. Then revert to a standard saw blade and cut the legs to length.

9 Lay out the bevels on the ends of the runners (F, I), where shown in **Figure 1**. Then cut the bevels on the bandsaw. Clean up the saw marks with a hand plane.

10 Lay out the curves on the ends of the rails (E, H). Make the cuts with a bandsaw or jigsaw, and clean up with a sander.

11 Using an exterior glue, such as Titebond III, glue and screw the end legs (D) in place between the center rails and runners (E, F). Temporarily place one of the cross runners (I) in its notches to help the assembly stand upright on your bench as you glue and screw the cross rails and runners (H, I) to the side legs (G) at the opposite end of the base. As you do this, be sure that the cross runners (I) extend through the opening between the center rails and runners (E, F). When assembling all of these joints, clamp the pieces together to hold them tight as you predrill the holes and then drive the $\#8 \times 2$ " screws home.

12 Once the side legs (G) are attached to the cross rails and runners (H, I), glue and screw the cross rails and runners into their notches in the center rails and runners (E, F) with $\#8 \times 2\frac{1}{2}$ " screws.



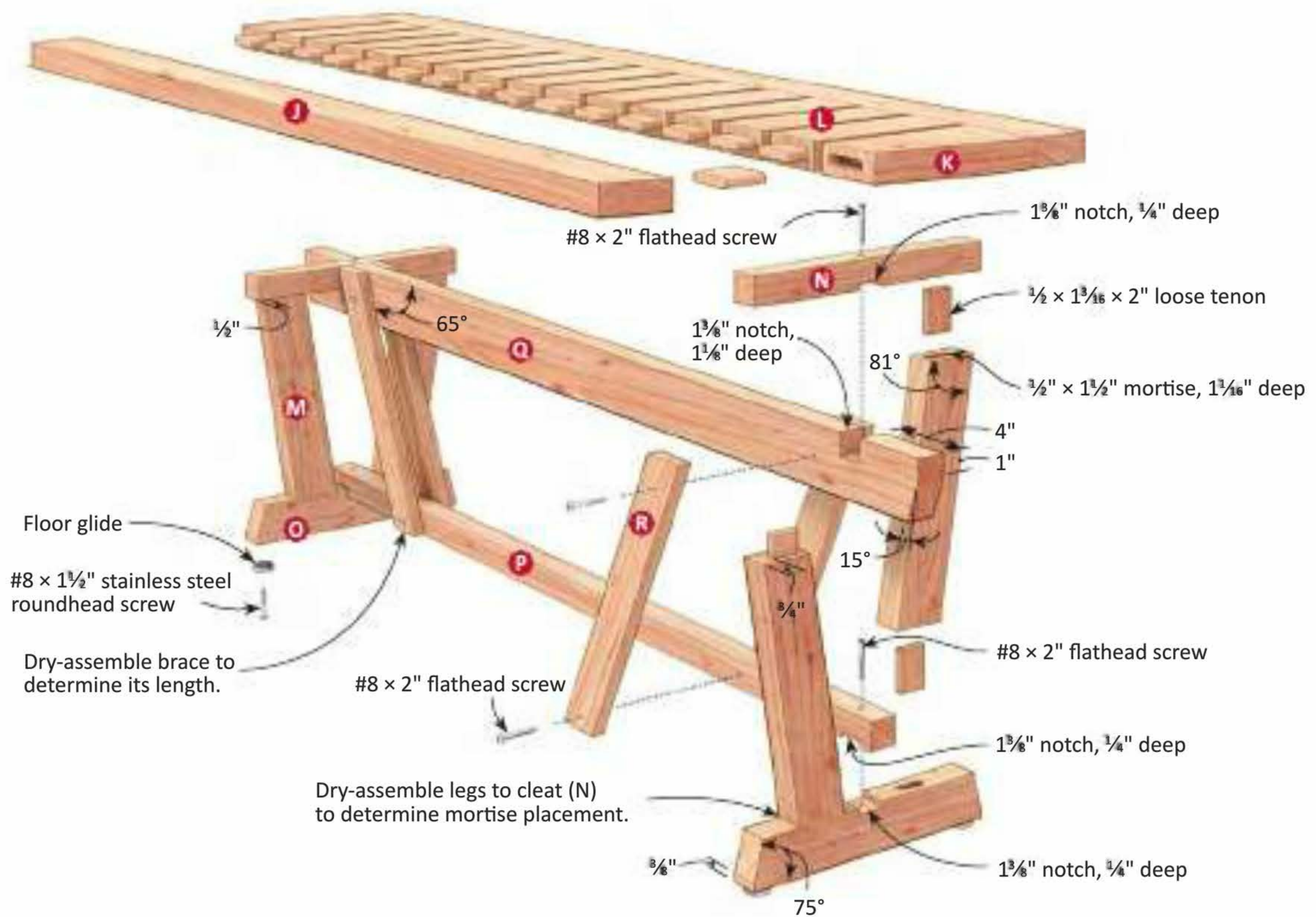
H Clamp the top of each side leg in its upper notch, and mark out where the leg intersects the cross runner.

Make the Benchtops

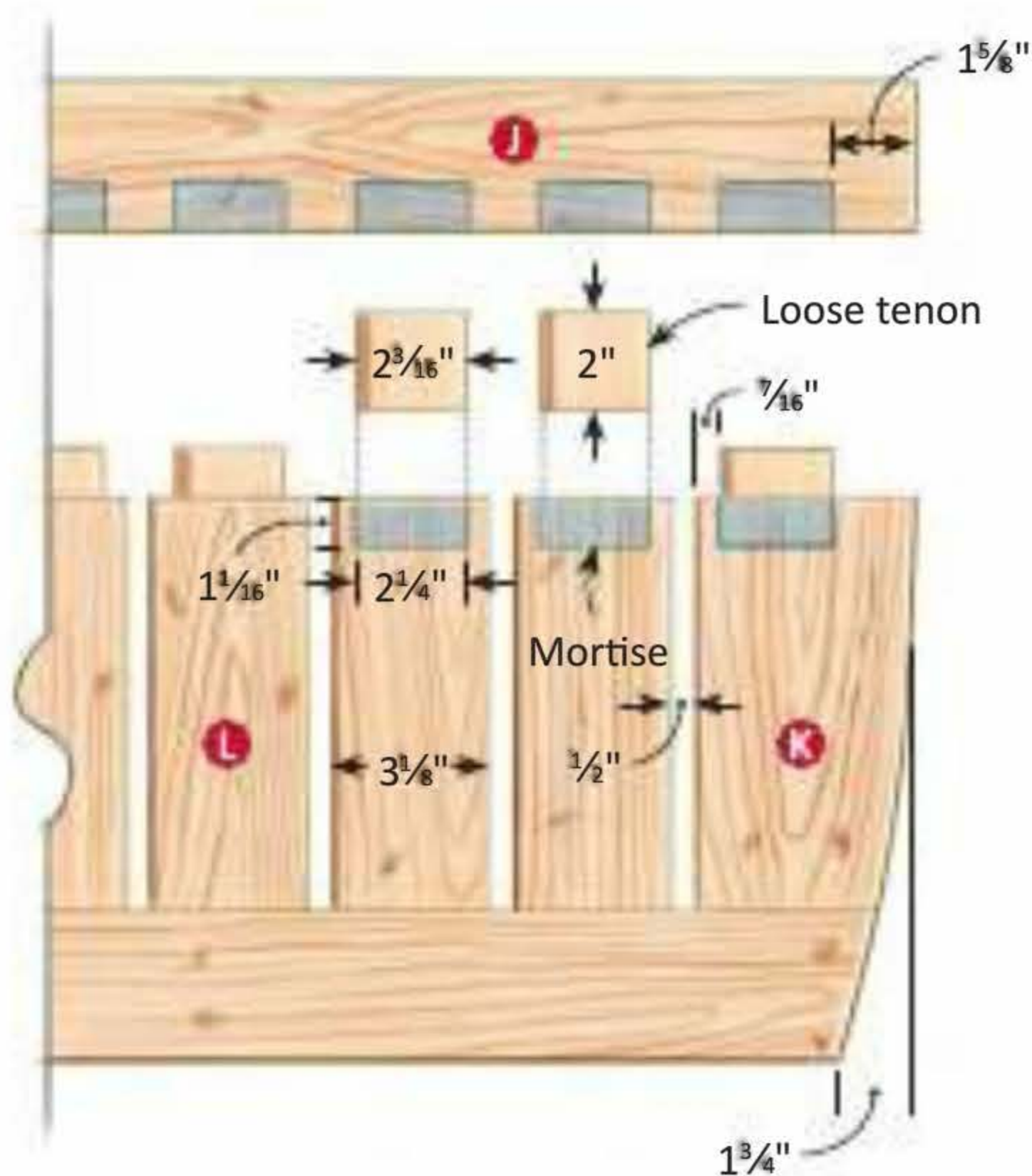
1 Make the parts for the long rails (J), end rails (K), and crosspieces (L) to the sizes shown in the **Cut List**. When milling stock for the crosspieces, work with lengths that can be safely fed through the planer, crosscutting the individual crosspieces to final length as the last step. Mark the show face of each piece with an "X".

2 Clamp the long rail (J) pairs together, and lay out the

Figure 2: Bench Exploded View



Benchtop Mortise Layout



mortises as you did for the tabletop, but referring to the **Benchtop Mortise Layout** in **Figure 2**.

3 Rout the mortises in the long rails as you did those in the table rails, orienting the show face against the jig.

4 Lay out a mortise on one end of one crosspiece (L), and on each end of the end rails (K). Use the marked pieces to set up the mortising jig to rout the crosspieces and the end rails in the same manner as you did for the tabletop. Remember to keep the show face against the jig.

5 Crosscut tenons from the stock you milled when making the table. Using waterproof glue, assemble the benchtops in the same manner as described for the assembly of the tabletop, and as shown in **Photo I**. Like the tabletop, each of the benchtops involves a lot of pieces to align and glue to swab, so you may want to enlist a helper.



I Fit all of the crosspieces and end rails in one of the long rails, and then add the second long rail, starting at one end and working your way across.

6 Once the glue dries, lay out the curves on the ends of the benchtop using your fairing strip. The benchtop is narrow enough that there's no need to support the strip with nails. Simply brace the strip against your leg, and bend it with one hand as you trace with the other. Round over all of the edges with a $\frac{1}{4}$ " round-over bit.

Make the bench bases

1 Cut the legs (M), cleats (N), and runners (O) to size. Crosscut the ends of the legs to 81° . Arrange the parts for each end assembly (M, N, O) in their final orientation, as shown in **Figure 2**. Then mark what will be the exterior face of each part with an "X" for orientation in the mortising jig.

2 Lay out the mortises on one of the cleats (N) and on the upper end of each of two paired legs (M), where shown in **Figure 2**.

3 Cut the mortises in the undersides of the cleats (N) using the horizontal fence on your mortising jig, as you did when mortising the top rails (J). Mount the pieces on the jig with the marked face oriented inward.

4 Change to the vertical fence to rout a mortise in the upper end of each leg. However, instead of

registering the leg against the fence, angle it so its end is flush with the top of the jig (**Photo J**).

5 Rip enough tenon stock to $1\frac{7}{16}$ " to use for joining the bases, and then crosscut them to fit the mortises you just routed. Working with each end assembly in turn, dry-fit the legs (M) to the cleat (N), put the runner (O) in place, and then mark out the runner mortises based on the positions of the legs.

6 Rout mortises in the runners (O) using the mortising jig outfitted with its horizontal fence.

7 Cut the stretcher (P) and beam (Q) to the sizes shown in



J Mount each leg with its top end flush with the top of the jig. Scrap protects against clamp damage.

the **Cut List**, and saw the bevel on each end of the beam.

8 Set up a dado head on the tablesaw and cut $\frac{1}{4}$ "-deep notches in the center of each cleat (N) and runner (O), where shown in **Figure 2**. Cut mating $\frac{1}{4}$ "-deep notches in each stretcher (P), and $1\frac{1}{8}$ "-deep notches in each beam (Q).

9 Glue the leg assemblies together, as shown in **Photo K**.

10 Glue and screw each stretcher (P) and beam (Q) in place with #8 $\times$ 2" screws.

11 Cut the braces (R) to the thickness and width listed in the **Cut List**, but leave them a couple



K Clamping a keystone-shaped wedge between the legs can help even out the pressure and allow the joints to draw up tight.

inches oversized in length for now. Hold one of the braces in place at a 65° angle, as shown in **Photo L**. Mark the piece for length, and then use it as a guide as you cut all the remaining braces on the tablesaw. Glue and screw the braces in place with #8 × 2" screws.

Finishing

1 Apply a clear finish that is formulated for outdoor use. The pieces in the lead photo were treated with Cabot's Australian Timber Oil. I've found that a yearly recoating with this product will keep your table and benches looking good, despite whatever Mother Nature dishes out.

2 After the finish is dry, fasten the table base to its top with #8 × 3½" roundhead screws counterbored ½" deep into the underside of the center rails and cross rails (E, H). Attach the bench bases to their tops in the same manner, but with #8 × 2" roundhead screws.

3 Screw plastic glides to the undersides of the runners on both the table and benches to elevate the wood above the ground or deck. ■



About Our

Designer/Builder

Ken Burton has been working with wood for more than 30 years and writing about it nearly as long. Check out his

website at www.wrwoodworks.com. You can take classes with Ken this summer at Peters Valley Craft Center in Layton, New Jersey, and at Yestermorrow Design/Build School in Warren, Vermont.



The braces add needed strength to the benches while echoing the table's angled legs.

Outdoor Table and Benches Cut List

	Part	Thickness	Width	Length	Qty.	Mat'l
Table						
A*	Long rails	1⅜"	4½"	62"	2	C
B	End rails	1⅜"	4½"	29¼"	2	C
C	Crosspieces	1⅜"	3¼"	29¼"	14	C
D	End legs	1⅜"	3¼"	28¾"	2	C
E	Center rails	1⅜"	3"	56"	2	C
F	Center runners	1⅜"	3"	43"	2	C
G*	Side legs	1⅜"	3¼"	28¾"	4	C
H	Cross rails	1⅜"	3"	36"	4	C
I	Cross runners	1⅜"	3"	28"	4	C
Benches (Quantity for two benches is provided.)						
J	Long rails	1⅜"	3"	60"	4	C
K	End rails	1⅜"	4⅝"	8¼"	4	C
L	Crosspieces	1⅜"	3¼"	8¼"	28	C
M	Legs	1⅜"	2½"	12¾"	8	C
N	Cleats	1⅜"	1⅜"	13"	4	C
O	Runners	1⅜"	2¼"	13"	4	C
P	Stretchers	1⅜"	1½"	49½"	2	C
Q	Beams	1⅜"	3"	56"	2	C
R*	Braces	⅝"	2"	18"	8	C

Materials: C=Cedar

*Indicates that parts are initially cut oversized. See instructions.

Supplies: (20) 1½" stainless steel (SS) roundhead screws for attaching glides; (32) #8 × 2½" SS screws: 16 for half laps in table base, 8 for attaching benchtops, 8 for attaching cleat and beam to bench legs; (60) #8 × 2" roundhead SS screws: 48 for attaching runners and rails to legs, 12 for attaching braces to benches; (4) #8 × 3½" roundhead SS wood screws; (20) 1" round plastic floor glides

Convenience-PLUS BUYING GUIDE

☐ 1.	Toggle Clamp, 6 × 1⅝", qty. 5	#143938	\$14.19 ea.
☐ 2.	Knob, 5 Star with through hole; ¼"-20 insert, qty. 2	27R13	\$1.50 ea.
☐ 3.	Carbide Spiral Bit ½"D, (½"SH)	03K35	\$56.99

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Restoring Outdoor Projects

Add years to the life of your lawn and patio furniture.

By Marlen Kemmet

Year after year outdoor furniture pieces take a brutal beating from Mother Nature in the form of intense sunlight, temperature extremes, moisture, windblown dirt and pollen, and insects. To wage the good fight and extend the life of these cherished pieces, follow along as I take you step by step through the rehab of an Adirondack chair, solving common problems that afflict most outdoor projects, and extending its useful life.

Can this project be saved?

In spite of your love affair with a favorite garden bench that you built years ago, you may find it's time to part company with it and start anew. Over time, all wood projects reach the point of no return. But, in the case of this Adirondack chair, it was worth the time and effort for me to restore this weathered old friend. How can you tell if an outdoor project has passed its prime? Conduct a quick and simple evaluation.

For starters, check for severe wood rot, warping, or large checks or cracks in individual parts. Looks can be deceiving. At first blush, the Adirondack chair looked destined for the landfill. But underneath the grit, lichen, and grime was a perfectly functional piece in need of a little TLC. Although the wood appeared badly weathered, a little sanding and scraping

on the bottom side of a seat slat revealed sound lumber.

Next, check the joints for further rot, looseness, and hardware issues that undermine the project's structural integrity. Are replacement parts or new hardware in order? With seating of any kind, these are critical for safety. Is the finish flaking or otherwise compromised? Luckily, all the problems with our example proved fixable.



If what you are facing is a lost cause, you may find it cheaper and far more time-saving to simply build a sturdier replacement.

Common fixes for failing furniture

After assessing your furniture piece and deciding that it's worth saving, develop an action plan. Use these strategies to remedy a variety of problems.

Clean the piece

Problem

Lichen, mold, weathering, and encrusted dirt have attacked the project, detracting from its appearance and leading to decay.

Solution

Depending upon the severity of the degradation you have two choices. For projects like the chair, I recommend pressure-washing the entire piece at a low setting using a wide-nozzle tip on the wand, as shown in **Photo A**. Rinse the entire piece first. Then, power-wash it with a commercial solution to clean and brighten the wood. Or, save a few bucks by mixing your own solution. I used one quart of household bleach, one-third cup of powdered laundry soap, and three quarts of water. A raincoat, safety glasses, and gloves come in handy for protection against splatter.



A

For badly damaged pieces, a power-washer and a cleaning solution provide the first step.

If you don't have access to a power washer, spray the piece down with a garden hose and scrub the grime off, as shown in



B

A stiff-bristled brush and lots of elbow grease clean entrenched grime at little cost.

Photo B. Avoid a wire brush as the hard stiff bristles may cause deep scratches in the wood, which will have to be sanded.

When power-washing outdoor furniture, start with the lowest setting, hold the nozzle end of the wand about 18" away to start, and move closer if necessary. Too high of a pressure setting or a tip held too close can damage the wood, much like sandblasting. Power-washer spray tips come in different spray patterns, with the range spanning from 0° to 40°. The wider the angle, the more surface area covered, but with less impact.

Disassemble for a complete restoration

Problem

Grit and grime have infiltrated joints and other hard-to-get-at nooks and crannies. In some cases, a part or two may need to be replaced. Disassembly may be your best course of action, but getting all of the parts back in their proper location may be an issue.

Print a digital image of the furniture piece, and label important measurements for later reassembly. You can also use pieces of blue painter's tape affixed to chair parts for quick reference later.

Solution

Many outdoor projects, such as the Adirondack chair, are simply screwed together, making disassembly easy. But this could result in a jumble of similar pieces. To reattach the parts later without puzzling over where they go and for proper screw-hole alignments, grab a camera and take numerous reference photos before you take the project apart. Label the parts, and transfer the labels onto printed copies of the photos. Also, keep a tape measure handy to record key part locations on the photos, as shown in **Photo C**. Re-mark any sanded parts.



C

Measure and record important spacing dimensions for ease in reassembling the chair later.

Level rough wood surfaces

Problem

Raised grain surfaces that are rough and full of ridges due, in part, to the different wear rates of earlywood and latewood softwoods.



Rely on a palm sander to smoothly sand curved edges, such as this leg part.

Solution

After the furniture piece has thoroughly dried (I left the chair in direct sunlight for two days), it's time to smooth rough surfaces. Since the chair disassembled easily, sanding the individual parts proved much easier than trying to sand the assembled chair. It also allowed me to sand mating areas and edges. To minimize sanding time, you can use a variety of portable sanders to tackle different tasks. For larger flat surfaces, use an orbital sander to cover a lot of ground fast. For curved edges, a palm sander is my tool of choice, as shown in **Photo D**. For tight areas on an assembled project, hand-sanding may be your only choice.



A putty knife helps you push and smooth the filler into minor splits and checks. Sand the area smooth.

Fill cracks and gaps

Problem

Moisture in the wood of an outdoor piece causes the fibers to swell and then contract as they dry out, resulting in cracks and checks along the grain and at the ends of parts.

Solution

The best way to avoid cracking and checking is to seal the wood project properly during construction to keep moisture out, and then reseal it regularly. When cracks occur on weathered pieces, fill them as shown in **Photo E**, and then sand the pieces smooth once the filler dries. For minute cracks filler will do, but for damaged areas requiring repair or buildup, use a two-part epoxy-based putty. Note, the closer you can shape the putty to the original surface, the less sanding you'll have to do after the putty hardens.

For optimal results, choose putty that dries hard with minimal shrinkage, such as a two-part epoxy-based putty developed for exterior use.

Use a moisture meter for an accurate reading of an outdoor project's dampness level before attempting to sand or apply finish. Woods, such as cedar and redwood, should be 12% (or less) moisture content.

Outdoor Screws

Considering the number of screws needed for an outdoor furniture piece, it doesn't make sense to skimp on quality. Stainless steel is by far your best choice, though more costly. For many exterior applications, the maintenance-free service life of stainless steel screws makes it relatively easy to justify their higher cost compared to plated products. While brass screws look good, they

break more easily than other screws. For ACQ (alkaline copper quaternary) pressure-treated lumber, stainless steel or multi-coated screws are a good choice. The treated wood can accelerate corrosion of galvanized fasteners.

1. Stainless Steel Screw (bugle head, square drive)
2. Solid Brass Wood Screw (Phillips flathead)
3. Triple-Coated Deck Screw (two layers of coating over a galvanized undercoating, star drive)
4. DECKMATE (polymer-plated, flathead, star drive)
5. Kreg Protec-Kote Deck Screws (flat-bottom head, self-tapping, square drive)



Replace suspect hardware

Problem

Rusty or broken screws, as well as stripped screw holes, cause joints to fail; hinges can wear out requiring full hardware replacement.

Solution

Extract broken or rusty screws using a screw extractor, as shown in **Photo F**. When replacing old hardware, don't skimp on the quality of screws, hinges, and other metal fasteners.



To remove a broken screw, use a screw extractor to minimize damage to the surrounding wood.



A flush-trim saw works best for trimming plugs even with the surrounding surface.

To eliminate exposed screw heads that are both unsightly and serve to collect water, counterbore the holes and plug the screws, as shown in **Photo G**.

If replacing old screws and stripped holes, go up a gauge when returning to the holes. Go with a #10 gauge instead of #8 for a tighter fit.

Replace damaged or rotted parts

Problem

While salvaging your outdoor project, you encountered parts that proved beyond repair.

Don't let a few badly damaged pieces prevent you from salvaging the project.

Solution

For the chair, the horizontal armrests took the brunt of weathering. I could have spent a fair amount of effort and materials filling and sanding the badly damaged pieces, but it proved more economical to simply create new armrests.

To make identical part replacements, I removed the old armrests and used one (they're mirror images of each other) as a template to trace its shape onto $\frac{1}{2}$ " plywood. I bandsawed the plywood to shape and sanded the edges smooth to create a routing template. I then traced the armrest's outline onto two $\frac{3}{4}$ "-thick pieces of cedar, as shown in **Photo H**, and bandsawed

the armrest blanks to shape. I adhered the template to a rough-cut armrest with double-faced tape. Using a flush-trim

pattern cutting bit at my table-mounted router and guiding off the template, I cleaned up the edges, as shown in **Photo I**.

To mark a blank slightly larger than the needed finished shape of the replacement piece, hold the pencil perfectly upright, riding the shank of the pencil against the original furniture piece, as shown in **Photo I**. This will mark the blank $\frac{1}{8}$ " larger than the original and provide just enough extra edge stock to be routed when using the template to rout the armrest to final shape.



Mark the blank slightly larger by holding the pencil upright when running it along the original part.



Rout the replacement part to final shape with a pattern cutting bit and plywood template.



J

To protect feet bottoms from future rot, soak them in a container of preservative prior to finishing.



K

Milk paint (here, acrylic latex) is self-sealing and does not require a primer. If your project allows it, painting individual parts yields the best results.

Seal and finish for long life

Problem

Unsealed wood absorbs moisture, resulting in a whole host of deterioration issues, from rapid graying due to intense sunlight, to moisture penetration and accelerated rot and decay.

Solution

Now that you've replaced parts, filled cracks, and sanded the project smooth, finish the project

to protect it from the elements and to keep it looking good. Soak the ends of parts that are in direct ground contact with a preservative such as penetrating oil finish, as shown in **Photo J**.

Now, check out the finish selections in the box below and finish your piece. I applied two coats of General Finishes Sage Green Milk Paint, as shown in **Photo K**.

With a disassembled outdoor project, seal and finish the parts before reassembling them, as shown in **Photo K**. If the parts of a project are glued together and cannot be removed, do the needed prep work and apply the finish to the assembled piece.

Outdoor Finishes

Even the best outdoor finish will need to be refreshed every few years. The best finishes are those that protect against the effects of the sun's rays and moisture. Typically, they will have UV inhibitors and

water repellants. Exterior finishes either penetrate the wood or form a film on the surface. Penetrating finishes tend to give a more natural look to wood than film-forming finishes, and they are usually easier

Clear Water-based Finish
(Brand: Sunnyside)

Penetrating Oil Finish
(Brand: Penofin)

Spar Urethane
(Brand: Helmsman)

Outdoor Glues

For high-stress areas in an outdoor project, such as a seat/leg chair joint that is destined to receive a lot of weight and stress, add extra holding power in the form of an exterior-grade glue. One such glue is Titebond III Ultimate Wood Glue, a water-resistant polyvinyl acetate (PVA) product that cleans up easily with water. A second glue is polyurethane-based Gorilla Glue, a product that chemically reacts with moisture in the objects being glued or air to create a rigid, lasting bond. When applied, the glue expands, providing an exceptionally strong bond. It can be messy and sticky to work with. For mating dissimilar materials or for small projects, two-part slow-set epoxies work great, but ounce for ounce are more expensive than the other exterior glues. For more on woodworking glues, see page 39.



Convenience-PLUS BUYING GUIDE

☐ 1.	SculpWood Putty, 8 oz.	#153781	\$15.99
☐ 2.	Screw Extractor, 5/16"	#124211	\$12.99
☐ 3.	Japanese "Kugihiki" Flush-Cutting Hand Saw	#12F24	\$31.99
☐ 4.	Flush Trim Router Bit, 3/8"CD 1"CL (3/4"SH)	#819071	\$17.99
☐ 5.	General Finishes Sage Green Milk Paint, 1 pt.	#825767	\$13.99
☐ 6.	Redtree Onyx White China Bristle Brush, 2"	#153813	\$9.50

Above items are available at Woodcraft stores, woodcraft.com or by calling (800) 225-1153. Prices subject to change without notice.

About Our Author

A founding member of the San Diego Woodworking Association, Marlen Kemmet's career in woodworking and woodworking publications stems back to the early 1980s. He likes building furniture and home accents in the Greene and Greene style for his home in rural Dallas County, Iowa.

to reapply as they don't need to be stripped first if they were used as the original finish. Film-forming finishes such as paint last the longest, but can be the most time-consuming to repair if the original coat is

cracked and flaking. In such cases, removing the finish to expose bare wood is required before refinishing. Shown below are five types of exterior finishes, with the longevity of the finish increasing from left to right.



Three-Coat Finish
(Brand: Sikkens,
Cetol 1 and 2/3)



Water-Based Milk
Paint (exterior
acrylic latex by
General Finishes)

Build a Bluebird House

A great plan for teaching woodworking

By Jim Harrold and Collin Kidd

Overall dimensions: 9"w × 9½"d × 11"h

I enjoy Nature and woodworking. Building the birdhouse let me combine my interests.

Collin Kidd

In this—the magazine's first installment in teaching woodworking to kids—11 year-old Collin Kidd from Parkersburg, West Virginia, and I make a bluebird house out of decay-resistant cedar. In the process, I introduce him to a variety of tools and show him how to use them safely. I separated the tasks so that the more challenging steps (work done at the tablesaw and jointer, for instance, and shown here in blue) are the ones I performed while Collin did the rest.

Make the parts

- 1 Mill a ¾" × 8" × 4' cedar board to ½" thick. Mill a 2'-long piece to ¼" thick.
- 2 From ½" cedar, crosscut two pieces for the ends (A) to 10½" long.

- 3 Stick a couple of small pieces of double-faced tape on one end piece, and stack the second piece on top, making sure the ends and edges are even. Cut out a photocopy of the **Bluebird House End Pattern**. Spray the back of the pattern with adhesive, and carefully adhere it to the top of the stack.

- 4 Now, bandsaw along the pattern cutlines to make the ends (A), as shown in **Photo A**. Sand the edges smooth with a sanding block and 100-grit sandpaper.

- 5 Use the marks along the edges of the pattern to drill ⅜" nail pilot holes through the ends (A) at the drill press. Pilot holes keep the nails from going in crooked and the cedar from splitting. Now, pry the ends apart.

- 6 Using the pattern, drill two ¼" holes in the door opening.

At the scrollsaw, poke the blade through the hole and cut out the opening. With the same drill bit, drill the ventilation hole in the back end where shown in the pattern.

- 7 Crosscut a ½" piece of cedar to 12½" long. Bevel-rip one edge at 35° and the other at 76° to achieve a final width of 6⅜". (See **Figure 1**.) Then, crosscut sides (B) to 6".

- 8 Add pieces of masking tape to the front and back ends (A). Now, apply glue to the ends

Tip Alert

Because of the defects common in cedar, start with an 8'-long board and cut around the knots and other defects to get the clearest pieces possible.



A

Cut along the outside edge of the cutline, making sure your fingers are safely away from the blade on both sides.



B

Guide off the holes drilled earlier in the ends to drill straight pilot holes in the sides.

of the sides (B) and tape the pieces (A, B) together ensuring they are flush. Drill pilot holes for nails with a cordless drill, as shown in **Photo B**. Next, tap nails into the assembly to secure the ends. Set the nail heads.

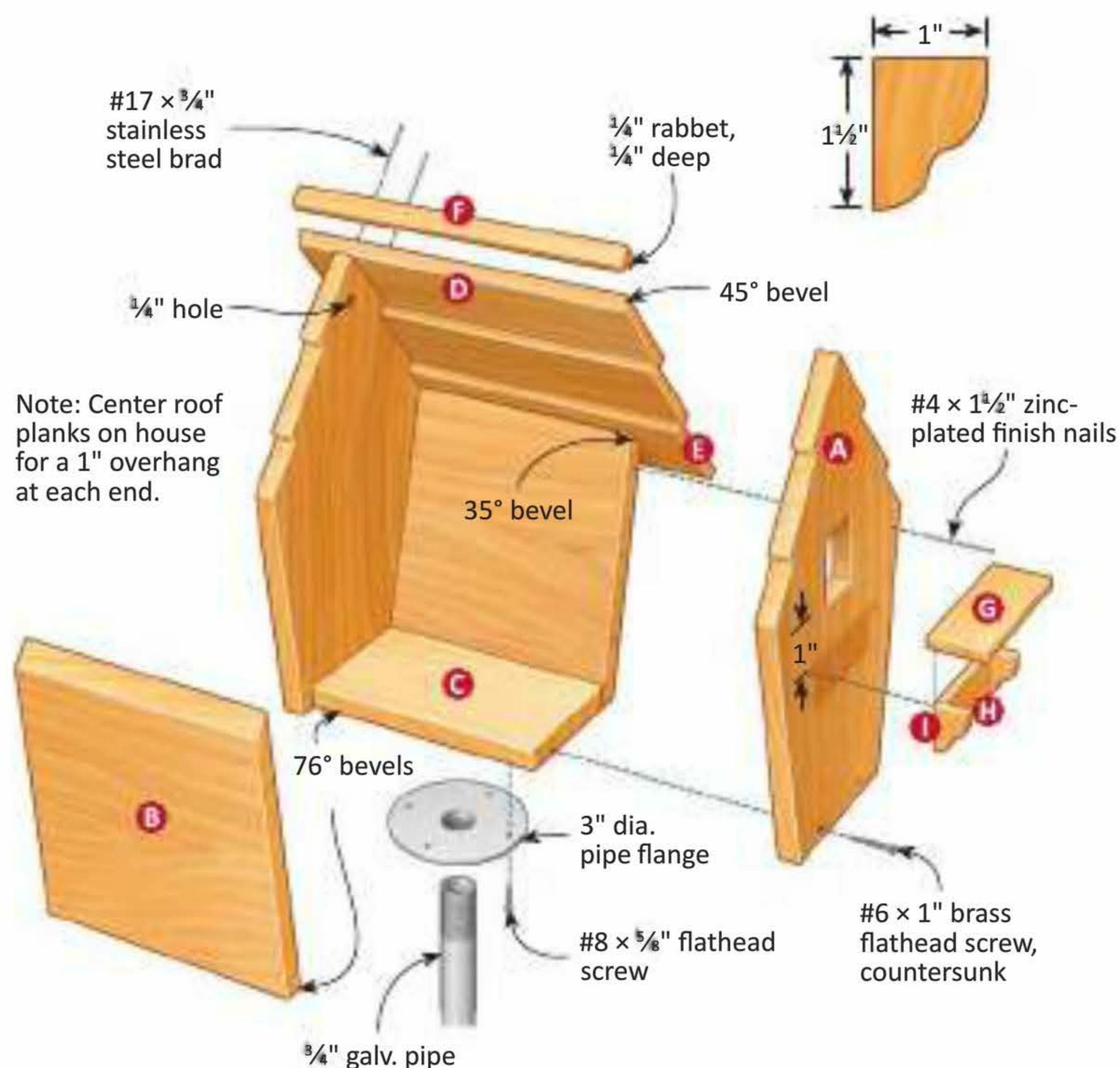
9 Measure the opening at the bottom, and check it against the **Cut List** and **Bluebird House End Pattern**. Now cut the bottom (C) to size, beveling the edges at 14° from 90°.

10 From 1/4" stock, rip and crosscut the top roof planks (D) and lower roof planks (E) to size. Bevel the edges of the wider top planks at 45° so they join at the roof peak. Working from a 1/2" piece that is 9" long, rout a 1/4" rabbet, 1/4"-deep on one edge. Rip the rabbeted edge free, cutting in 1/2" to create the roof ridge (F), as shown in **Figure 1**.

11 Scrollsaw the perch (G). Glue and clamp the perch assembly (G/H/I) together, making the back edges even. Let the parts dry; then sand. The back of the perch assembly needs to be smooth and even to glue securely to the birdhouse.

Figure 1: Birdhouse Exploded View

Bracket Pattern (Full-Sized)



Projects for Kids



Glue and nail on the roof planks, starting at the bottom; use a spacer to make sure the planks overhang equally at the front and back ends.

Add the bottom, roof and perch

- 1** Fit the bottom (C) in place. At the drill press, drill countersunk pilot holes through the ends (A) and into the bottom. You also need to drill clearance holes through the ends, or you will split the wood. Screw the bottom in place with #6 × 1" brass screws. The bottom is removable so you can clean out the birdhouse as needed.
- 2** Drill pilot holes 1¼" in from the ends of the roof planks (two at each end), and then secure the planks with #17 × ¾" stainless steel brads and glue, as shown in **Photo C**. Set the nail heads.
- 3** Apply glue to the perch assembly (G/H/I), and clamp it 1" below the door opening and centered.
- 4** Fill the set nail holes with an exterior-grade putty. Let dry, and then sand the surfaces smooth. Finally, apply an exterior finish. (We used Watco's Exterior Finish to seal and protect the wood.) ■

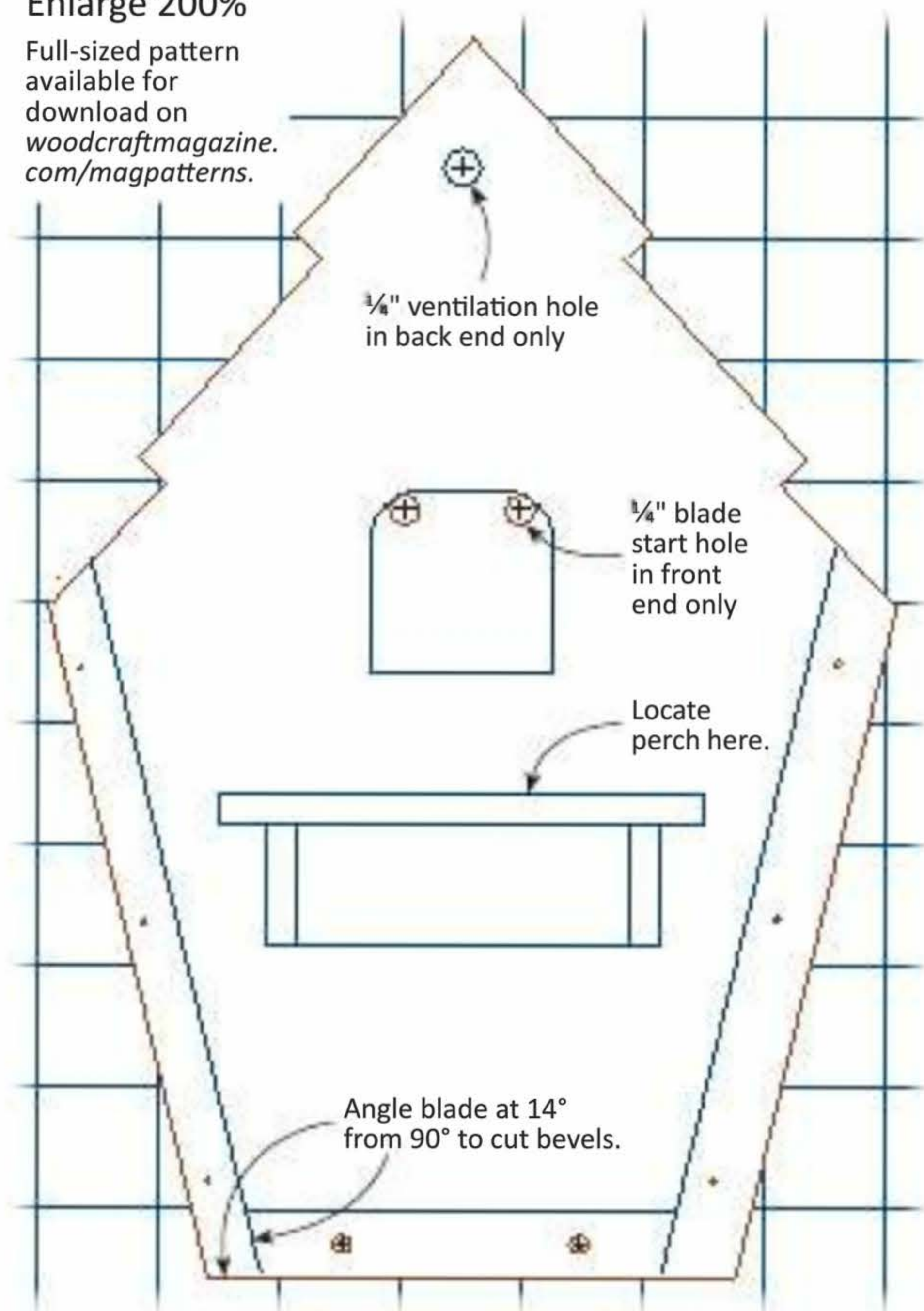
Tip Alert

Mount the bluebird house 4' to 5' above the ground on a 3"-diameter threaded galvanized pipe flange that you screw to the bottom. This, in turn, screws onto a ¾" threaded galvanized pipe that is sunk in the earth or a concrete footer.

Bluebird House End Pattern

Enlarge 200%

Full-sized pattern available for download on woodcraftmagazine.com/magpatterns.



Bluebird House Cut List

	Part	Thickness	Width	Length	Qty.	Mat'l
A	Ends	1½"	7"	10¼"	2	C
B	Sides	1½"	6⅜"	6"	2	C
C	Bottom	1½"	3⅝"	6"	1	C
D	Top roof planks	1¼"	2¾"	9"	2	C
E	Lower roof planks	1¼"	2½"	9"	4	C
F	Roof ridge	1½"	1½"	9"	1	C
G	Perch	1¼"	1½"	4"	1	C
H	Perch cleat	1¼"	1"	2¾"	1	C
I	Perch brackets	1¼"	¾"	1"	2	C

Materials: C=Cedar

Hardware/Supplies: (12) #4d × 1½" zinc-plated steel finish nails; (24) ¾" × 17 stainless steel brads; (4) #6 × 1" flathead brass screws; Titebond III waterproof wood glue; exterior-grade wood filler.

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Tackling Tear-Out at the Tablesaw

6 simple steps for cleaner cuts

By Paul Anthony



Working wood can be a messy business. And I'm not referring to the sawdust, wood chips, and shavings left behind in the wake of a project. I'm talking about the rough, scarred surfaces remaining on the work itself if you're not careful to prevent tear-out during cutting procedures. And the damage can happen when performing just about any kind of cut, including sawing, routing, jointing, and planing.

One potential arena of tear-out destruction is the tablesaw. Boards and sheet goods that pass through this machine can

emerge either ratty or ready, all depending on how you handle them. Here, I'll show you how to guard against tear-out on the tablesaw, whether you're making a simple crosscut

or performing some fancier maneuver using a special jig. These simple preventative measures yield big results in the way of clean looking projects, and time saved fixing errors.

Know Your Enemy

Tablesaw tear-out occurs as the saw teeth exit the work, breaking through and pushing aside the outermost layer of wood fibers rather than severing them cleanly. Tear-out is not really an issue when ripping; it's cuts made across the grain that see damage. Truth is, tear-out from sawing is unavoidable. Look at a "clean" crosscut under strong magnification, and you'll see tear-out, although minute. And that's the idea—to keep it to a minimum.

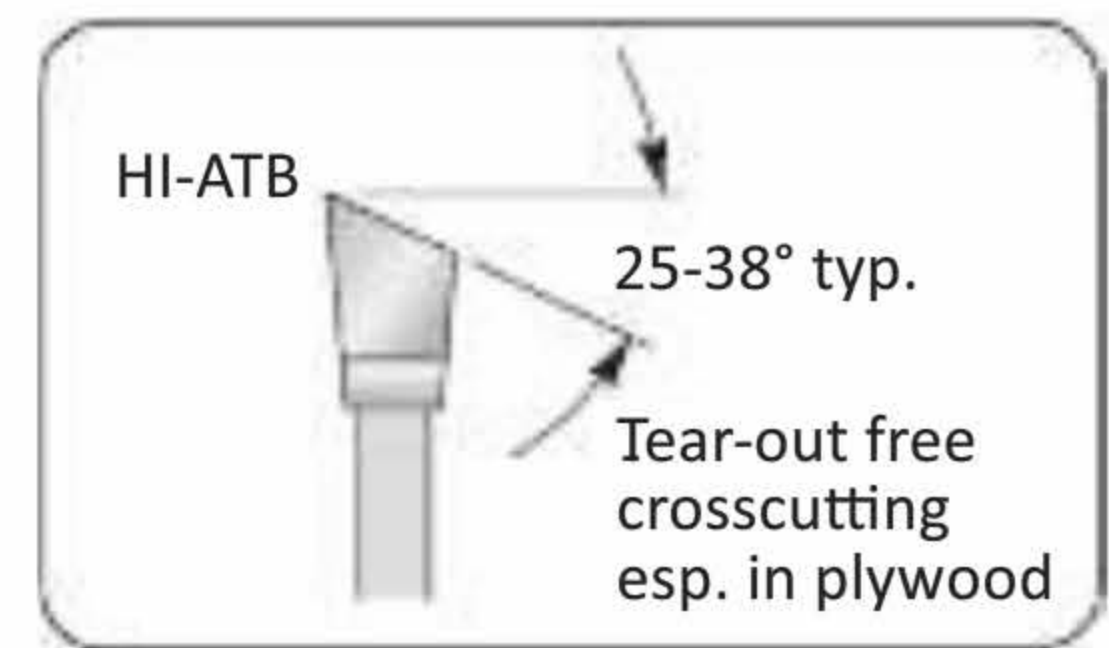
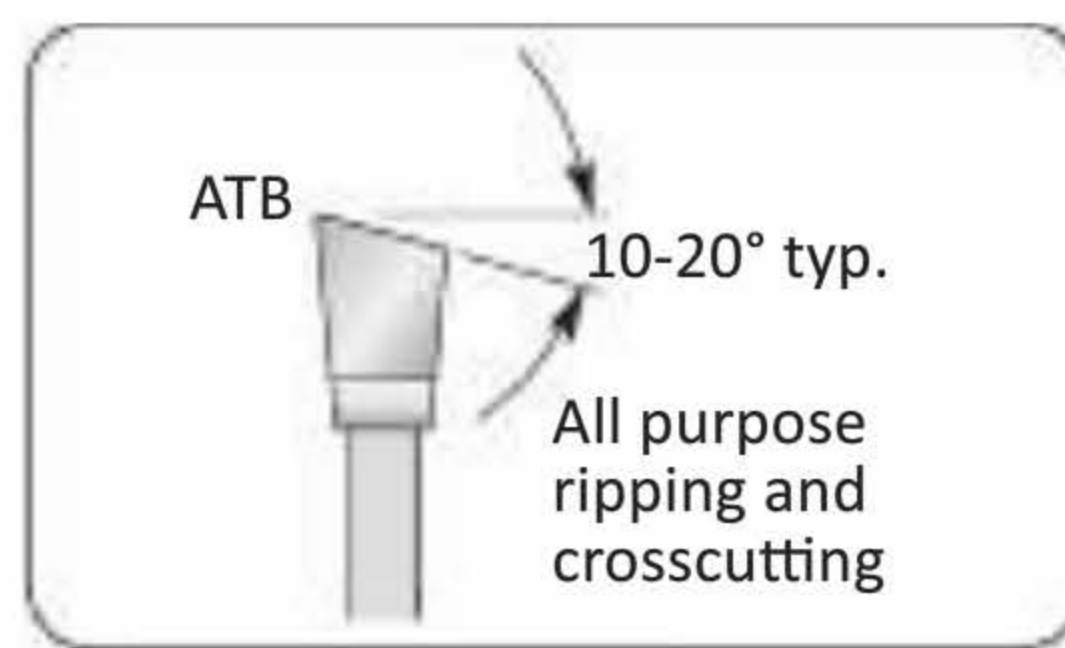
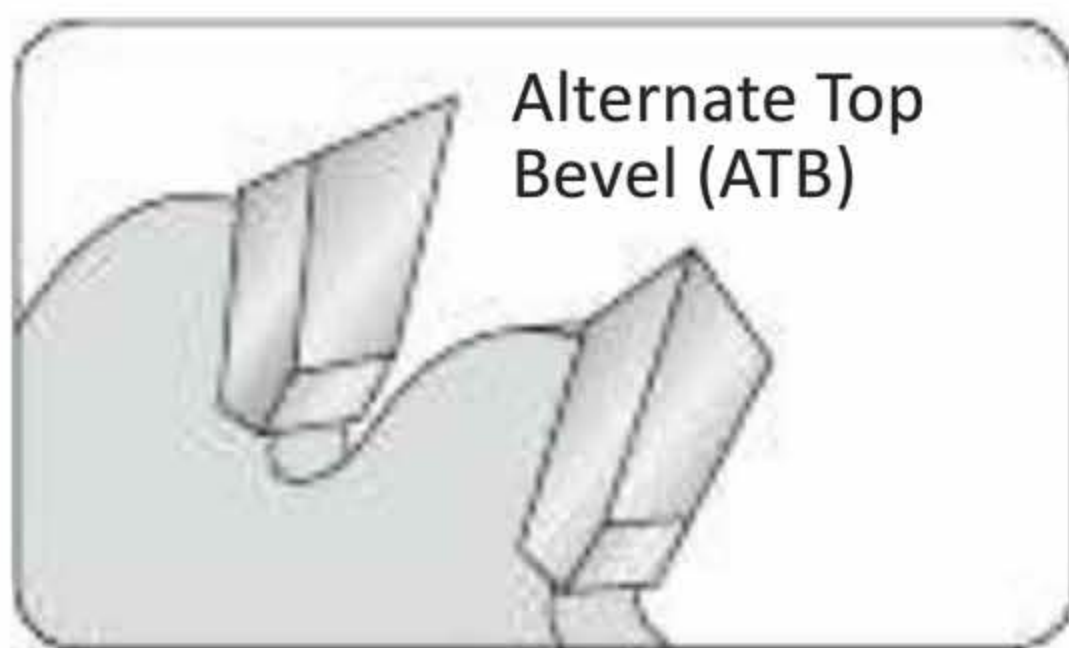
1. Use the right blade for the job

To minimize tear-out, use a tablesaw blade with alternate top bevel (ATB) teeth. The tooth bevel creates a tip that shears cleanly through wood fibers, reducing tear-out. The bevel angle may be low or high, with steep angles designated by some manufacturers as “High-ATB” teeth. The trade-

off is that, although a steeper tooth angle produces a cleaner cut, the tip of the tooth may dull faster. Theoretically, the cleanest crosscuts will come from a blade with at least 60 ATB teeth, but note that a premium quality 40- or 50-tooth blade may cut cleaner than a mediocre 60- or 80-tooth blade.

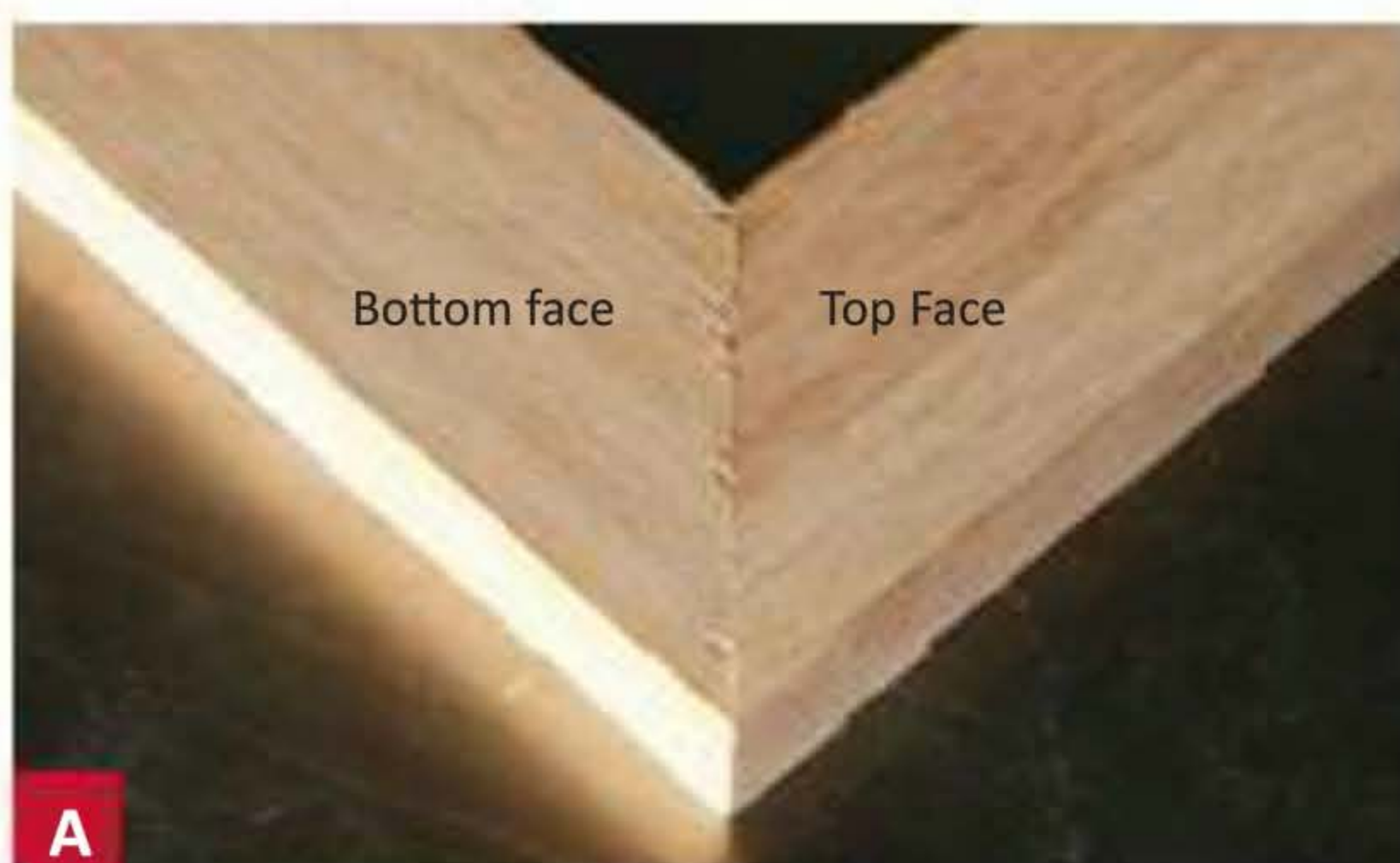
Tip Alert

Before sending a blade out for sharpening, try cleaning it first. Even a little build-up can compromise the cutting edges of a good blade.



2. Put your best face forward

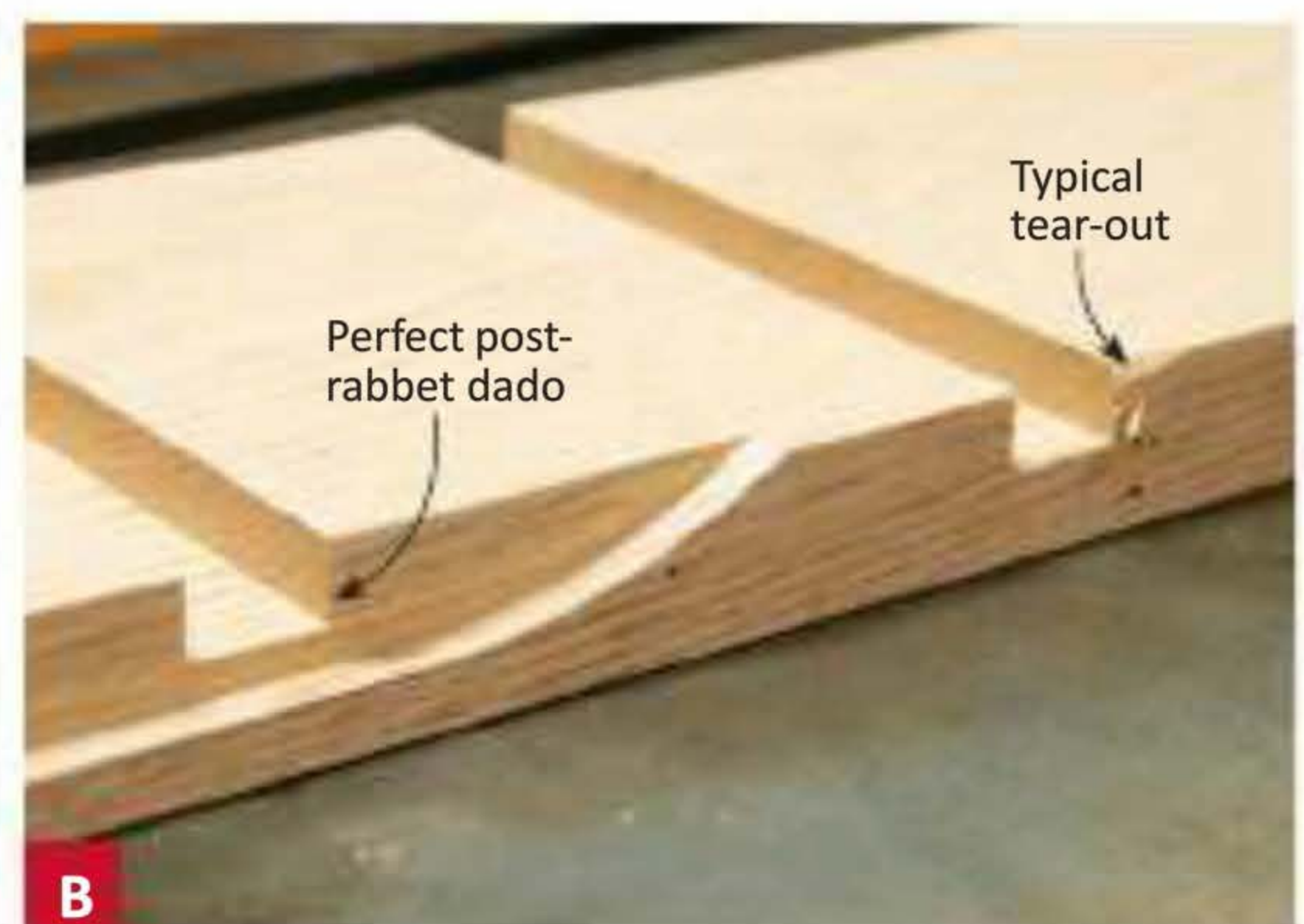
The simplest way to deal with tear-out is to orient it so it will be hidden in the finished project. Learn to handle your workpieces so that the saw teeth will enter the face of the stock that will be the most exposed in the finished project. For example, when cutting drawer fronts to length, orient the drawer face upward so any tear-out will be on the underside/inside of the piece. The same holds true for miters or any other end cuts that will butt against another piece (**Photo A**).



The cleanly cut right-hand half of this miter joint was sawn with the show face upward, while the left-hand half suffered tear-out from being cut upside down.

3. First cuts first

Sometimes you can remove tear-out when making a subsequent cut. A perfect example of this is when cutting joints in a cabinet side. In that case, dados are often used to join shelves and other horizontal members to the case side, while a rabbet is usually cut into the rear edges to accommodate a back panel. The exit side of a dado (which is a crosscut) will often produce tear-out. In this case, the wound is easily removed by making the long-grain rabbet cut afterward (**Photo B**).



A well planned cut sequence can eliminate tear-out completely. In this case, a rabbet removes the exit tear-out from the previously cut dados.

4. Drop in a ZCI

A *zero clearance insert (ZCI)* is an inexpensive accessory that will stand constant guard against excessive tear-out (**Photo C**). The slot on a ZCI is made by the blade itself, leaving virtually no gap between the saw teeth and the sides of the slot. This means that the wood fibers are fully supported on the exit side of the kerf, resulting in cleaner cuts. (As a bonus, narrow rippings can't drop into the throat plate gap.)

You'll want a variety of zero-clearance inserts to suit various cutters, including standard and thin-kerf blades, as well as dado heads set up for cuts of different widths. ZCI blanks are available commercially in a selection of materials including UHMW (polyethylene plastic), phenolic, and laminated plywood.

Tip Alert

A ZCI prevents saw blade tilt, so don't throw away your stock throat plate, as you'll need it when making angled cuts.



A ZCI provides workpiece support right up to the edges of the blade, greatly minimizing exit tear-out.

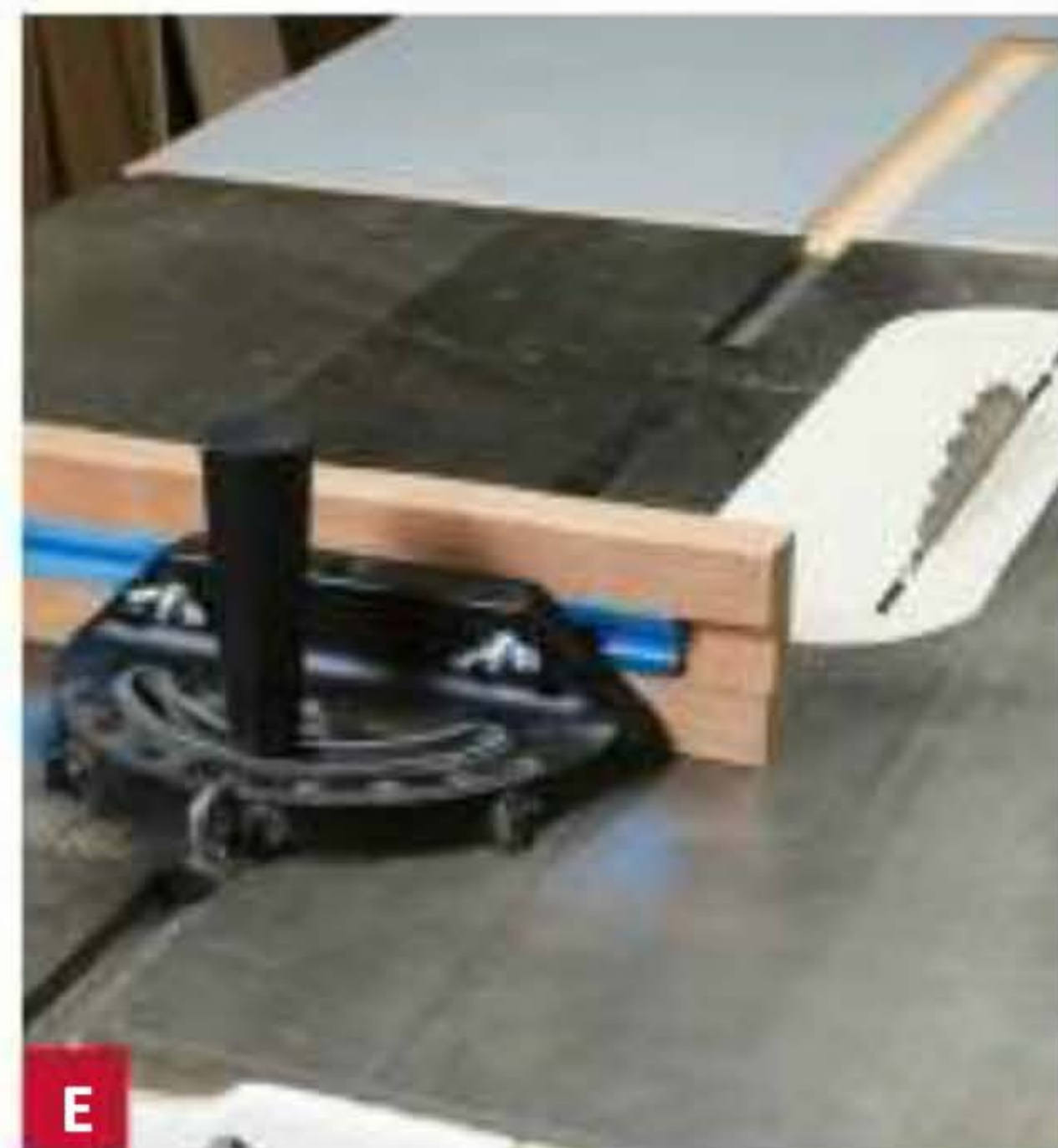
5. Fit backup to your miter gauge

Outfitting your miter gauge with an auxiliary fence will reduce tear-out when the fence extends all the way to the blade, as shown in **Photos D** and **E**. In this case, the fence prevents tear-out at the rear edge of the "keeper" piece, which is held against the fence. If you want a clean

cut on the offcut side because you need that piece, simply extend the auxiliary fence past the blade (**Photo F**). The end of an auxiliary fence that abuts the blade (or the kerf in a fence that straddles the blade) will also serve as a blade path reference for quick cut setup.



An auxiliary miter gauge fence that abuts the blade prevents tear-out at the rear edge of the workpiece.



A fence attached with T-track, cap screws, and wing nuts allows easily abutting the fence to the blade.



A long auxiliary fence that straddles the blade reduces tear-out on both sides of the cut and allows pushing small offcuts past the blade.

6. Built-in backup

The same backup principle that makes zero-clearance inserts and auxiliary miter gauge fences so effective can be easily incorporated into almost any tablesaw jig. For example, I always use a backer on my shop-made tenoning jig. It's particularly important to back up heavy, wide cuts like the open mortises shown in **Photo G**, because the wood fibers at the cut's exit can really take a beating. In this case, the jig's fence is simply a short, well dressed, perfectly aligned length of wood designed to accommodate

a replaceable sacrificial backer (**Photo H**). Outfitting other jigs just takes a bit of thought and a few scraps of wood. For instance, a commercial tenoning jig used to slot a miter should include a backer with a mitered end, rather than a squared end (**Photo I**). In the case of something like a spline miter cradle, design the jig to accommodate a sacrificial $\frac{1}{4}$ "-thick plywood backer (**Photo J**).

When cutting joints using a crosscut sled, the sled bottom serves as a zero-clearance

insert. However, the kerf slot may widen over time from using different blades, which somewhat compromises support of the wood fibers right next to the blade. To reestablish zero-clearance tolerances, cover the sled with a thin plywood or hardboard panel. ■

About Our Author

Senior editor Paul Anthony is the author of *Taunton's Complete Illustrated Guide to Tablesaws*.



G The unbacked fibers at the end of the open mortise at the bottom tore away. The mortise at the top was backed during the cut.



H The easily replaceable backer on this tenoning jig attaches with two screws driven through the rear of the fence.



I Suit the backer to the cut and workpiece. For example, miter a backer's end to provide full support for a workpiece's mitered end.



J The rear wall of this splining cradle is covered with a thin plywood backer that can be shifted to a fresh section when necessary.

Spotlight on Birch

North America's do-it-all lumber

By Pete Stephano
Technical Consultant: Larry Osborn



The commercially important birch species found in North America are but a few of the 50 types of birch found around the world—from Japan to Scandinavia to Russia. The native birches most used by the U.S. and Canadian forest products industry are yellow birch (*Betula alleghaniensis*), sweet birch (*B. lenta*), and paper birch (*B. papyrifera*). Of lesser importance are river birch (*B. nigra*), gray birch (*B. populifolia*), and western paper birch (*B. papyrifera* variety *commutata*).

Although somewhat similar in appearance and grain texture, the wood of yellow and sweet birch tends to be heavy, hard, and strong, with good shock resistance while that of paper birch weighs less, and is softer and not as strong.

Throughout history, the domestic birch family of hardwoods has made countless contributions to Native Americans, European explorers, early settlers, trappers, pioneers, and present-day populations of the United States and Canada.

History in woodworking

Native Americans looked to the paper birch's bark for the sheathing of dwellings and canoes. From the tree's sap came sweet syrup. Its young twigs provided medicine (the salicylic acid in them was the precursor to aspirin). The bark of black birch proved to be a tough, enduring material for woven baskets.

Early woodworkers used yellow birch for cooperage, wagon hubs, cabinets, chairs, and desks. In the 1950s, popular blonde "Scandinavian" furniture was built from it.

Today, most yellow birch becomes boxes, cabinets, cooperage, furniture, woodenware, interior trim, flooring, doors, and millwork. The wood is also joining ash and maple as stock for baseball bats. As plywood, yellow birch serves as flush doors, TV cabinets, and office furniture. Despite changes in taste and fashion, birch has been in demand for furniture and cabinetry for almost a century.

You'll find paper birch the common material for

turned products such as Shaker pegs, dowels, and buttons. It also shows up in wooden toys, matchsticks, toothpicks—even chopsticks!

Where the wood comes from

The largest domestic source of birch lumber and veneer is the yellow and sweet birch that principally grows in the Northeastern and Great Lakes states. While you'll find paper birch in abundance in the same range, it's not usually available as lumber. Yellow and sweet birch (frequently mixed and marketed together) are also found in the Appalachian Mountains as far south as northern Georgia.

What you'll pay

Due to its availability as lumber and plywood, yellow birch and sweet birch will be the focus here. FAS boards in 4/4 thickness usually cost less than \$5 per board foot, with Select and Better (S&B) running about 50 cents less per unit. Figured birch can reach \$8 and up per board foot.



The utility A-2 grade, $\frac{3}{4}$ " birch plywood runs about \$70 per 4×8' sheet at home centers. The higher face grade AA costs more; lesser faces, such as B and C, cost less. Most lumber outlets carry thinner stock, too, for use as panels in frame-and-panel cabinet doors. Baltic and Finnish birch plywoods are made in Europe of extra-thin ($\frac{1}{16}$ "") thickness of void-free alder and birch plies for the core and top-notch birch veneers for the faces. The Finnish variety utilizes exterior adhesive for outdoor use. Neither of these is available in 4×8' sheets, but rather 60×60" sheets and in thicknesses from 4mm ($\frac{1}{8}$ "") to 18mm ($\frac{3}{4}$ "") in approximately $\frac{1}{4}$ " increments. Apple-ply is the American-made version. It comes in 4×8' and smaller panels and standard thicknesses ($\frac{1}{4}$ "-1½").

How to select the best stock

Only specialty wood suppliers or lumber outlets offer yellow birch lumber. Birch hardwood plywood, however, is more widely available, although not all retail outlets will carry a wide selection of grades and thicknesses.

Normally, yellow birch has a light yellow to nearly white narrow band of sapwood. The heartwood ranges from cream to tan to reddish tan, and may even have tinges of gray or red. For projects, choose boards for color uniformity, avoiding those with both heartwood and sapwood as these can cause problems when color-matching. Because commercial demand for light-colored wood is so strong, birch, like maple, is often graded and sold by its color ("sap" or

"white"), meaning you'll pay a premium for color-selected stock. Note, too, that yellow birch from the northern part of its growing range will be heavier and contain a finer grain than wood from the southern region.

Birch plywood can also be graded and sold by its color, just like birch. The highest grade is white, followed by uniform light, and natural. Lower paint and shop grades cost less. At a home center, the mid-level grade stock will vary widely in appearance from sheet to sheet, and contain minor natural defects, varying amounts of heartwood and slightly less uniform core material. If you're able to sort through the stack for the best-looking sheets, you'll save some money compared to buying the top white grades at a hardwood lumberyard.

It's A Fact That...

The enormous flying boat nicknamed "The Spruce Goose" built by Hughes Aircraft of California in the mid-1940s wasn't really made of spruce. Due to its strength-to-weight ratio, North American yellow birch was the primary wood in its construction. Solid stock became wing and fuselage framing and veneer was laid up in laminations for all skin surfaces except those for control (ailerons, rudder, etc.), which were fabric covered. The giant seaplane had a 320' wingspan and weighed 400,000 pounds. It flew only once—over a mile 70' above Long Beach harbor on November 2, 1947.

Working yellow birch in the shop

Because yellow birch is nearly as hard as sugar maple, it dulls cutters, so if you don't presently use carbide-tipped blades and cutters, start now. Compared to maple, yellow birch machines better, because it doesn't tear-out during edge-jointing, or burn as easily. Due to its hardness, yellow birch



should be fed at a moderate rate when ripping to give the blade time to clear sawdust.

As we said, yellow birch's fine texture and generally straight grain translate to machining well and routing beautifully, but boards with wavy figure mean taking lighter cuts. Plane the wood at a slight angle to avoid surface chipping.

This wood will work with all adhesives, but its closed-pore density requires glue with a long open time to allow some surface penetration. Also, be sure to predrill for screws as the wood readily splits. Though hard, birch sands easily, and it turns like a dream.

Deciding on the right finish

Yellow birch takes all clear finishes equally well and holds paint nicely. For even staining, though, you'll first need a wood conditioner or two sealer coats before staining to reduce blotching. Dye stains are a better choice. The wood's close grain doesn't require filling.

Because yellow birch's grain closely resembles cherry, mahogany, and walnut, you can transform it with by stain as furniture and cabinet manufacturers have done for decades. ■

Birch Quick Take

Cost	Moderate
Weight	About same as sugar maple
Hardness	Slightly less than sugar maple
Stability	High
Durability	High
Strength	High
Toxicity	None
Tool Type	Power tools with carbide-tipped blades and cutters
Common Uses	Cabinets, chairs, flooring, furniture, and turnings

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Angle Masters

The right tools for playing all the angles

★ = Poor
★★ = Fair
★★★ = Good

They say the devil lives in the details, but woodworkers know the pointy-tailed imp's street address—the corner of Bevel and Miter. The problem with these angled cuts is that minute errors can multiply within an assembly. A fence, gauge, or blade that's off by even a fraction of a degree can

make the difference between a finished frame and firewood.

Armed with a few appropriate angle gauges, you can keep that devil at bay. The key to selecting the right tool is understanding the three different, but equally-important challenges faced by angle-setting instruments.

They include the ability to measure an angle, to transfer or lay out an angle, and to set machine components to specific angles. No tool excels in all three categories, but once you understand which type performs a job best, you know which one to reach for (or buy).



WoodRiver #154000, \$34.99

Bevel Gauge

A bevel gauge, or T-bevel, offers great flexibility in a strictly mechanical tool. The sliding blade can be adjusted to fit into tight corners and can be solidly locked for machine setup or joint layout. After making a cut, the bevel gauge can then be used to check its accuracy.

While this simple tool excels at transferring angles, it falls short when you have to set it to a specific angle, adjust an angle by a few tenths of a degree, or determine the numeric value of an angle that it's holding. For that, you need to read the angle of the gauge using a triangle, protractor, or square. To avoid that two-step procedure, many woodworkers these days are turning to digital gauges.

Measuring Angles – N/A

Transferring & Laying Out ★★★ Setting Machinery ★★



General Tools #153776, \$36.99

Digital Bevel Gauge

Incorporating an LCD readout into an otherwise typical bevel gauge brings a time-honored tool into the digital age of woodworking. The gauge can be used in traditional fashion for measuring and transferring angles, as well as setting machinery. However, unlike a traditional bevel gauge, determining the quantitative angle doesn't require outside assistance. Instead, you can read it on the tool's display (accurate to 0.3°). This allows you to set up a cut by simply angling your tablesaw blade, miter gauge, or power miter saw so that their scales match the angle reading on the T-bevel.

The digital readout also allows easy angle adjustments on the fly. For example, if you accidentally knock the bevel gauge blade out of its 47° position, it's easy to nudge it back in place instead of returning to the reference workpiece or taking a repeat reading from a protractor.

Measuring Angles ★★★ Transferring & Laying Out ★★★ Setting Machinery ★★★



Starrett Prosite #150770, \$24.99

Analog Protractor

This tool is designed to make your life a little easier when setting up your miter saw to cut angles for bisected miters. The dial's large arrow indicates the primary angle (the tool's leg splay). The smaller arrow notes the angle at which to set your saw, using the machine's scale. For example, to join two frame pieces at 135° , the protractor tells you to set your saw's pointer to $22\frac{1}{2}^\circ$, which will cut the complementary $67\frac{1}{2}^\circ$ angle on the workpiece. Cut two frame members at that angle, and join them to create your 135° frame angle.

This tool has the quantitative advantage over a standard bevel gauge, although digital gauges still have the edge on precision. For measuring and laying out, you'll still want a T-bevel, as the protractor's long arms can't fit into tight corners. Also, the tool lacks a locking knob. Although the arms are usually stiff enough to hold an angle, they can slip during layouts.

Measuring Angles ★★★

Transferring & Laying Out ★★

Setting Machinery ★★

Digital Angle Gauge

This magnetic gauge wins hands-down for easily and precisely setting the angle on machine components such as tablesaw blades, bandsaw and drill press tables, and jointer fences. Simply rest (or magnetically attach) the cube against a reference surface (e.g. the saw table), and press the reset button to zero-out the internal level. Then attach the gauge to the other reference surface (e.g. the saw blade), and set your desired angle, referring to the digital readout. The gauge is easy to attach and read, even in poor light. (Of course, when the battery dies or the electronics fail due to a hard fall from the bench, you're out of luck.)

Despite its advantages at setting machinery, this digital gauge isn't convenient for measuring angles on workpieces, and it's simply not suited to marking out joints.



Wixey #147281, \$39.99

Measuring Angles ★

Transferring & Laying Out – N/A

Setting Machinery ★★★

Double-Duty Drafting Tools

Odds are good that you already have some handy angle-setting tools sitting in a desk drawer. If not, you can buy them at an art store for a few bucks. Partner a plastic protractor (\$3-6) with a pencil and you can set your T-bevel with precision. With a built-in lock knob, adjustable triangles

(about \$10) are equally useful for providing precise measurements and transferring angles. Metal square head protractors are good for laying out angles on paper and stock. The long arm also works for measuring small angles, such as the bevels on chisels and plane blades.



General Tools Square Head Protractor #85045, \$20.99

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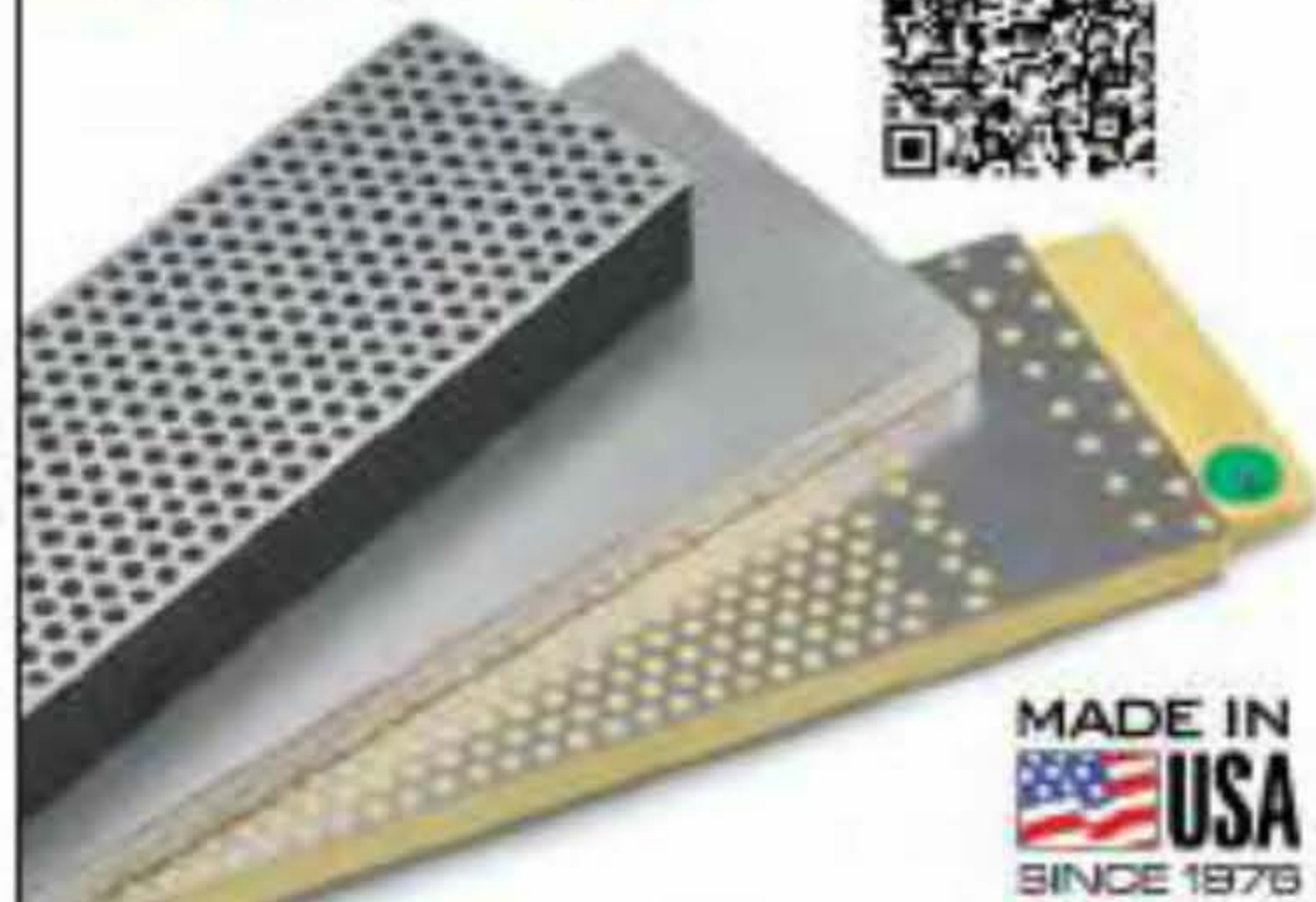
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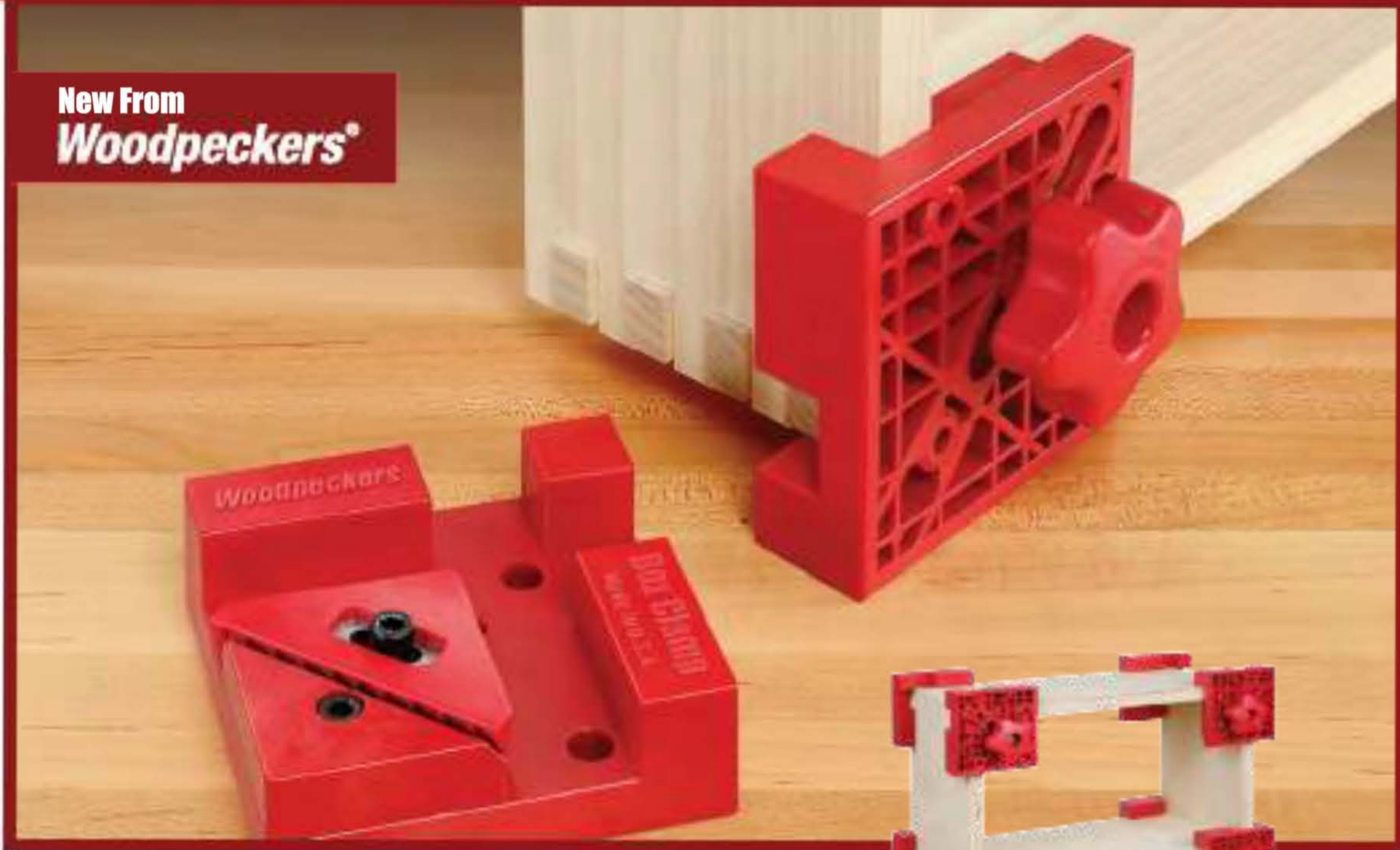
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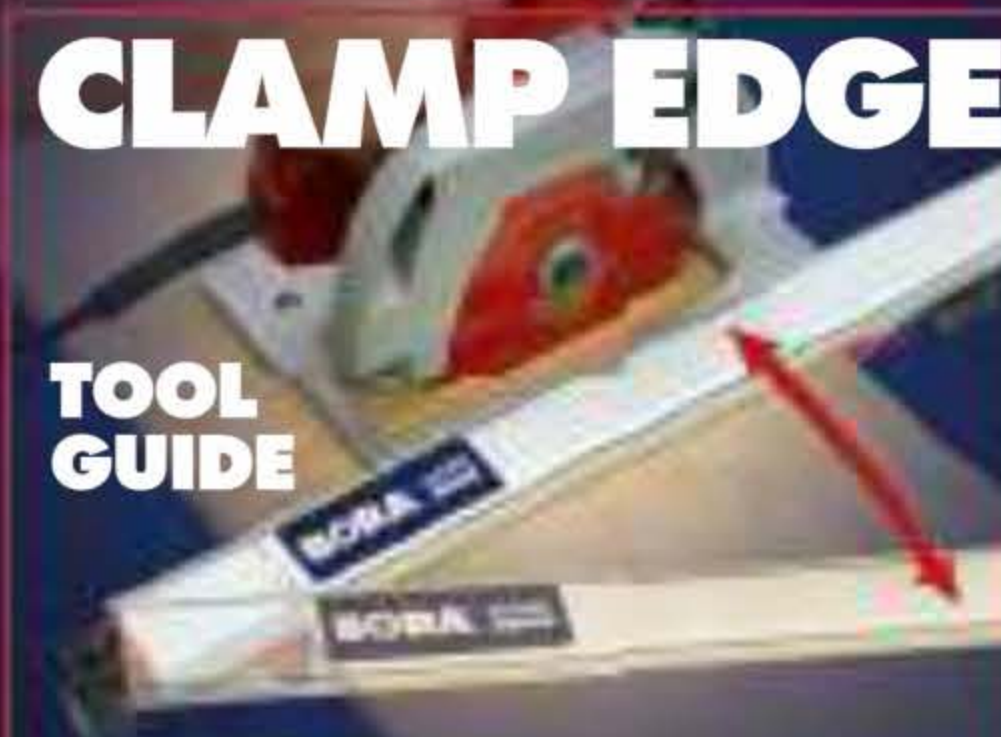
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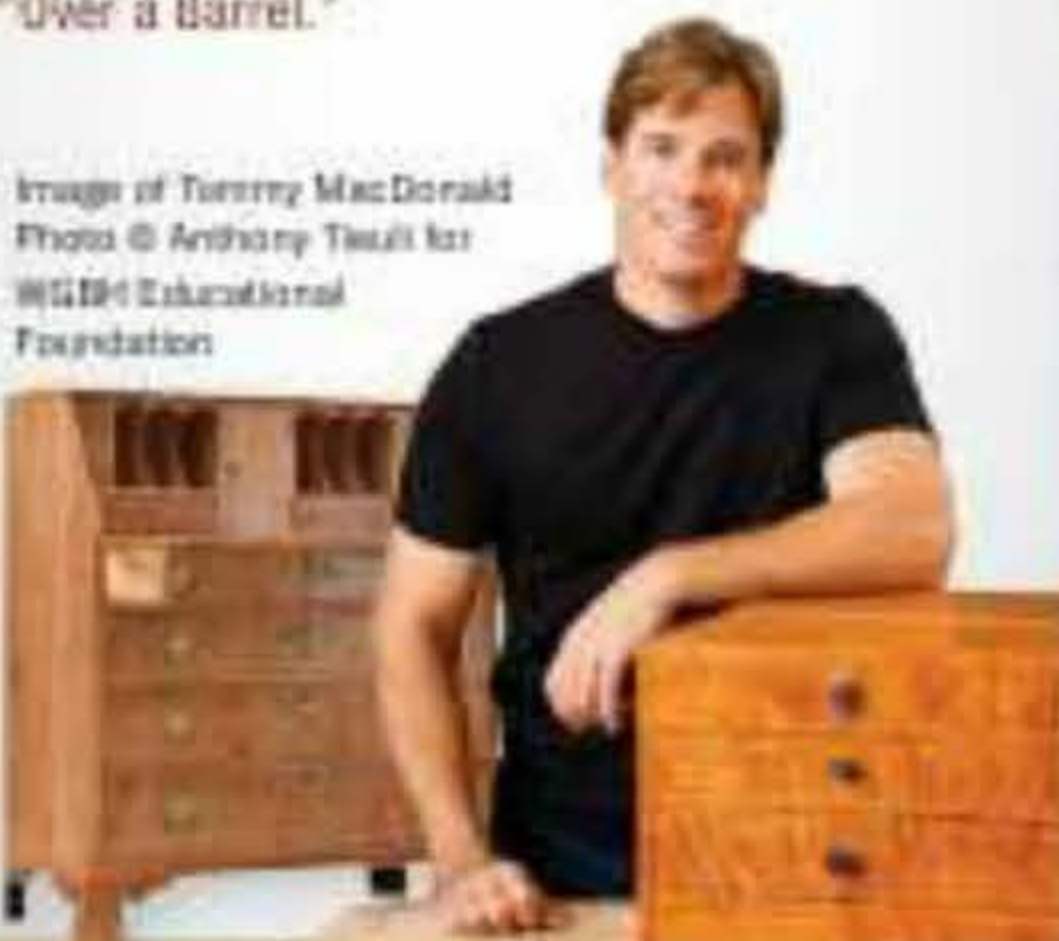
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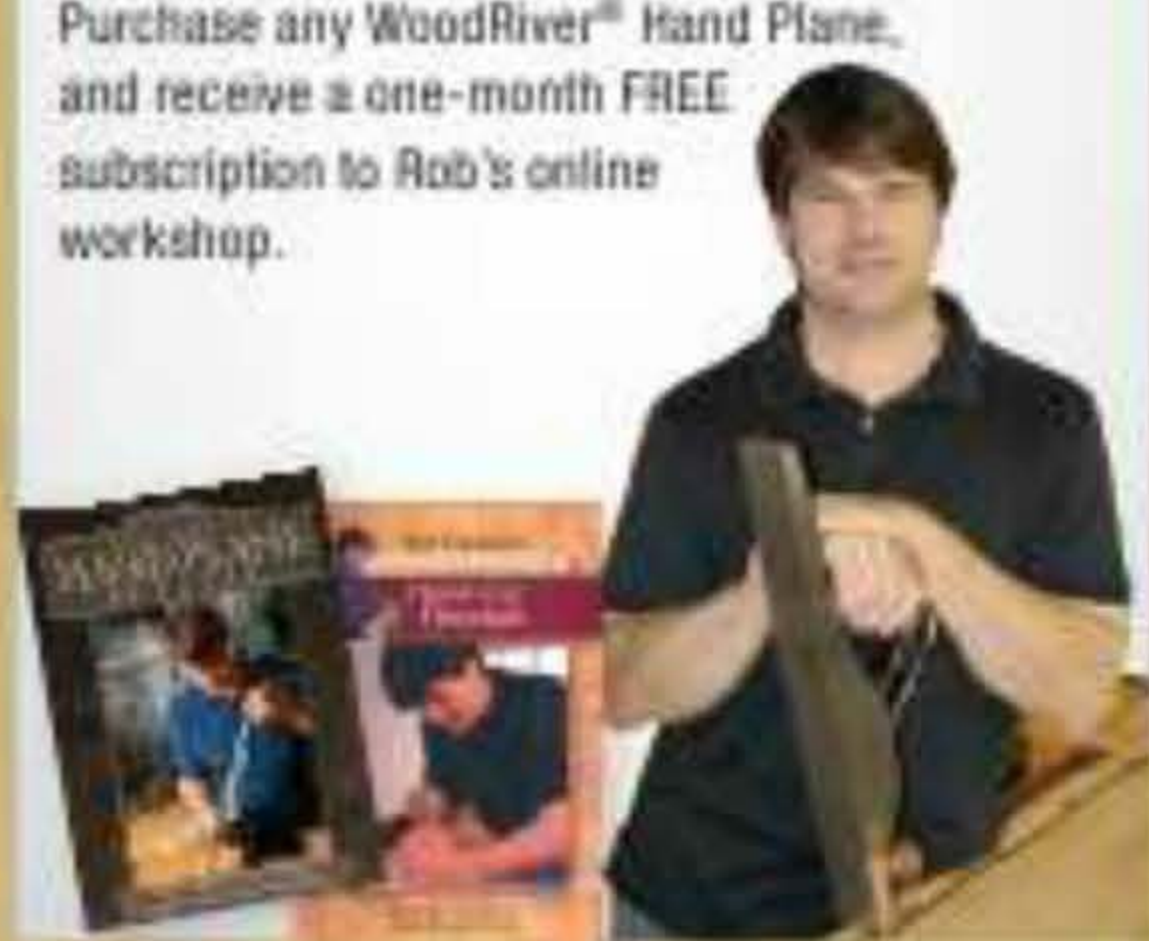
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INTRODUCING THE NEW 1221VS LATHE

60-3600 RPM
VARIABLE SPEED

**FORWARD TO
REVERSE**
SMOOTH TRANSITION

DIGITAL
READOUT

RAPID
BELT CHANGES



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350+ SERVICE CENTERS NATIONWIDE

INDUSTRY-LEADING WARRANTIES

EXPERT TECHNICAL SERVICE

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