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magazine

Modern Trestle Table p.50

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- Fancy Chopsticks

SKILL-BUILDERS

- Smoothing Curves
- Installing Butterfly Inlays



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◀ **Front-End
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VOL. 9/NO. 53 JUNE/JULY 13

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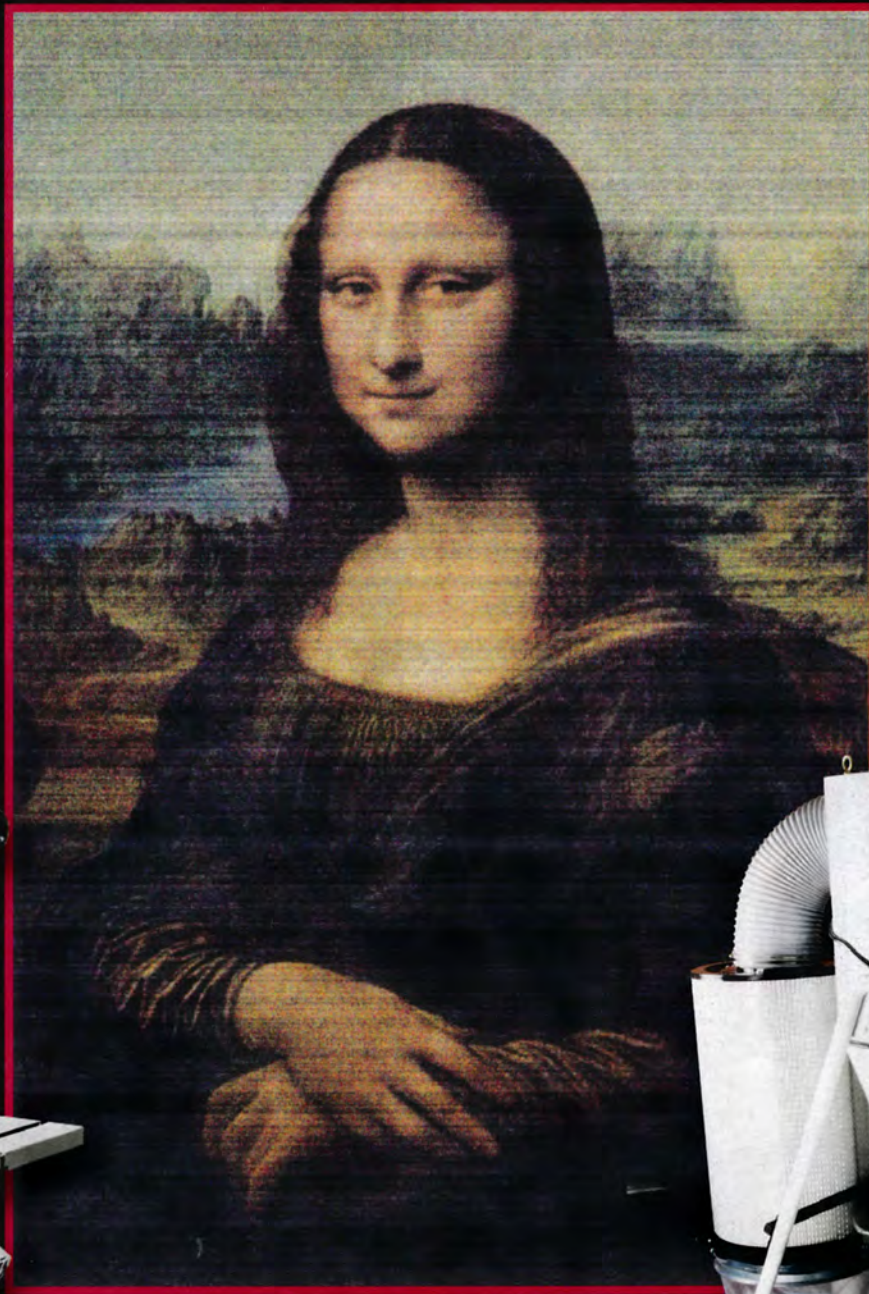
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Contents: Projects



24 Lathe Dust Collector

Does sanding at the lathe put your head in the dust clouds? Customize this plywood and PVC pipe fixture to your machine, and hook it up to your shop vac or dust collector to clear the air.



50 Coopers Leg Table

Build this slab-top table designed by Tommy MacDonald, host of public television's *Rough Cut – Woodworking with Tommy Mac*, and learn how to make the curved legs using techniques distilled from barrel-making.



34 Front-End Loader

Make a handsome, fully-functional construction toy for the young builder in the family. The front wheel frame pivots for easy steering, while the bucket raises and lowers for scooping up gravel, dirt, and more.



58 Adirondack Table and Footstool

Add comfort and convenience to your Adirondack chair with these companion pieces.



66 Exotic Chopsticks

Make four pairs of stylish chopsticks and rests from contrasting pieces of scrapwood.

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Contents: Tools & Techniques



28 The ABCs of ZCIs

Nip table saw tear-out in the bud by swapping out your saw's stock throat plate for a zero-clearance insert. Outfit the ZCI with a shop-made splitter to make cuts cleanly *and* safely.



44 Smoothing Curves

A pro offers straight talk on smoothing, fairing, and finessing curvy work using everything from spokeshaves and spindle sanders to a tricked-out belt sander and custom-made sanding blocks.



56 Butterfly Basics

Learn Tommy MacDonald's simple six-step strategy for stopping cracks and saving slabs using wooden splines.

Departments

06 Cutting In

08 Mailbox

12 Hot New Tools

- Jet Midi Lathe
- Tanos Systainer Storage System
- Festool Plunge-Cut Saw
- Oneida Super Dust Deputy

20 Tips & Tricks

70 WoodSense: Elm

74 Problem Solving Product: Noden Inlay Razor



SMART TAPERS.

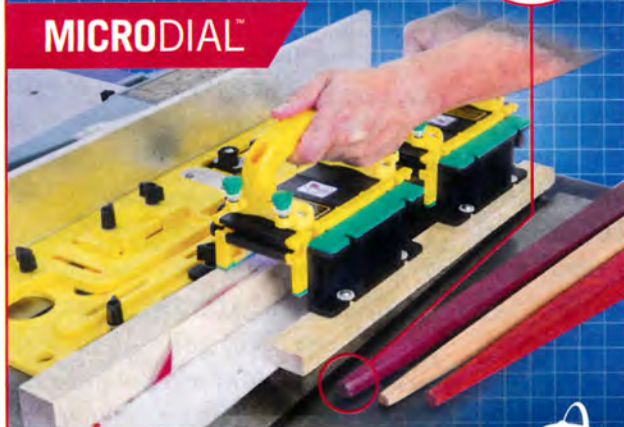
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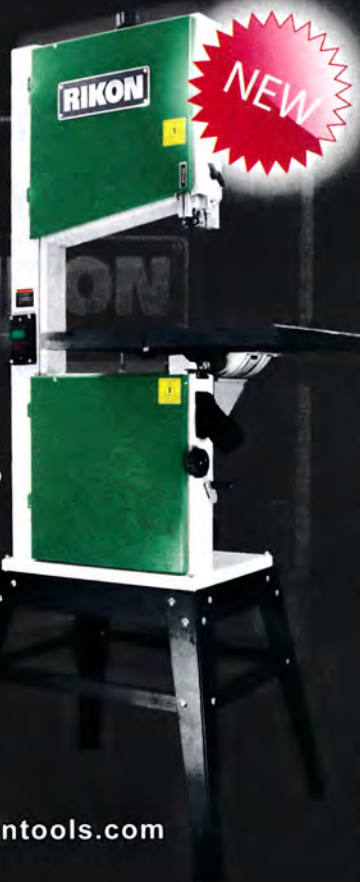
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June/July 2013
Volume 9, Issue 53

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If you built this project, then you may like ...

As the library of project designs at *Woodcraft Magazine* grows with each new issue, you may have wondered if some of the featured plans relate to others in style, scale, and/or method of construction.

The answer is "yes." In fact, this issue includes three projects that serve as set members to *previously* published projects. On page 58, project designer and builder Bill Sands showcases two companion pieces to the magazine's Adirondack project collection with his matching table and footstool. You'll find our Adirondack

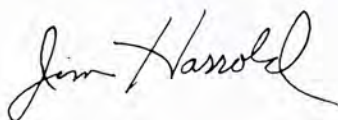
chair and glider available as downloads and paper plans at woodcraftmagazine.com under Classic Project Plans.

On page 34, you'll see Chuck Hedlund's maple and walnut front-end loader. This is the second project in the magazine's line of construction toys. The first piece is the dump truck in the Feb/March 2013 issue. It, too, is available online as a download. Down the road, Chuck will be designing and building a bulldozer and road grader.

The point is this: if you built the original project, then you may like making the other pieces in the set. Or, if you have not built any of the set pieces, you may still want to know that related pieces exist. In the case of the Adirondack furniture, you may have been searching for the plans for an entire ensemble of matching pieces to furnish a patio before visiting the lumber store.

While I point out the examples found here, be aware that we have other ongoing sets in popular design styles. For those of you in love with the Arts and Crafts style, we have plans for matching coffee and end tables, a TV stand, bookcase, and—most recently—a table lamp. That's pretty much a room full of furniture! We also have a variety of shop projects that play well together in our Classic Shop Projects collection. Should you ever want to know if other set projects exists, email us at editor@woodcraftmagazine.com.

We also would like to hear from you on project styles you want to see more of. We'll do our best to accommodate and to keep you woodworking.



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13WD07H

Important fixes for the Bluebird Birdhouse

The plan for the Bluebird House in the April/May 2013 issue of *Woodcraft Magazine* is likely to attract more house sparrows and European starlings than bluebirds. While it shows a perch, you should know that bluebirds do not use a perch. They prefer to "clutch" the entry opening. The proper opening is a round hole $1\frac{1}{2}$ " to $1\frac{5}{16}$ ", depending on the species of bluebird. Also, $\frac{3}{4}$ "-thick wood is preferred because it provides more adequate insulation during hot weather. For a look at several plans for bluebird nest boxes, visit the North American Bluebird Society website at www.nabluebirdsociety.org.
—Ronald L. Duecker,
Executive Director, retired
Ohio Bluebird Society

In addition to the above comments, here are helpful suggestions from two other readers:

Regarding your Bluebird House, you need drain holes in the bottom in case any rainwater gets in through the cracks. Also, have several (not just one) ventilation holes under the edge of the roof. In addition, bluebird houses should be cleaned out after each brood and rinsed

out with a 10% bleach solution to kill parasites. Therefore there has to be access to be able to remove the old nest and clean the interior.
—Joe B. Oates,
Little Rock, Arkansas

The inside dimensions should be 4×4 " for eastern bluebirds and 5×5 " for western bluebirds.
—Warren N. Cannon,
Acton, California

Ron, Joe, and Warren, thanks for helping right the wrongs of the magazine's kid-build bluebird birdhouse. While I plan to show the revisions to the illustrations online at woodcraftmagazine.com, here's a rundown of the fixes. For starters, the perch comes off. The entry hole will remain at $1\frac{1}{2}$ " but be circular (allowing you to drill it with a Forstner bit) and remain centered at 5" above the top face of the bottom or floor. (Go with a $1\frac{1}{8}$ " hole for western bluebirds.) Four $\frac{3}{8}$ " drain holes will be drilled in the bottom $\frac{1}{2}$ " in from the interior walls. Three $\frac{3}{8}$ " ventilation holes will be drilled in each side $\frac{3}{4}$ " below the roof. To ensure the right size for bluebirds, the sides and bottom will be reduced to 4"



long (5" for western bluebirds). Note that the screws in the front and back of the birdhouse allow for fast removal and clean out following the nesting season. Finally, avoid applying finish of any kind to the birdhouse. Instead, let it weather naturally. When installing outdoors, mount the birdhouse 5' to 7' above the ground. My humble apologies for the needed fixes, and to our fine-feathered friends, the bluebirds.
—Jim Harrold, editor-in-chief

Chime In

Have comments about the magazine, questions about an article, or something to share with your fellow *Woodcraft Magazine* readers? Send an email to editor@woodcraftmagazine.com or a letter to **Woodcraft Magazine, PO Box 7020, Parkersburg, WV 26102.**

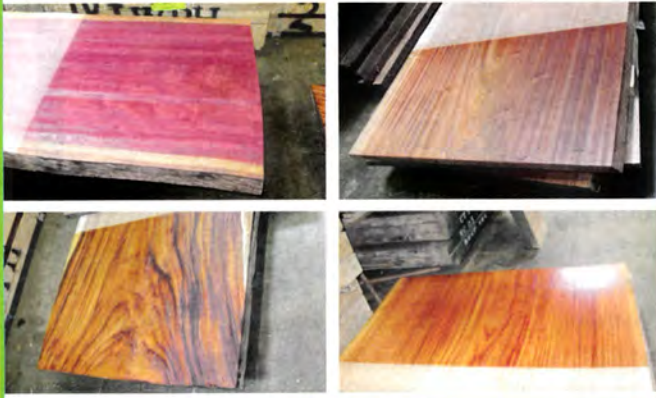
Errata

As careful as we are, errors occasionally find their way into articles. If you spy an apparent mistake, particularly in a project article, please visit woodcraftmagazine.com/corrections.aspx for corrections.

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Woodcraft project illustrations go 3-D

To provide the most comprehensive visual information for project plans developed by *Woodcraft Magazine*, we partnered with Sawtooth Ideas, Inc. to offer three-dimensional, 360° illustration views of the more popular projects in our plan library. Referred to as Ideas within IdeaRoom on the Sawtooth Ideas Web site, sawtoothideas.com the projects go beyond the included magazine write-up in PDF form by showing interactive views of the exploded illustrations, individual parts, and joinery from all angles on your iPad, iPhone, iPodTouch,

and, in general, Mac and Windows-based computers. You can even isolate parts to view specific cuts and measurements, and zoom in for the finest of details. In short, that translates into a fuller understanding of a project's construction, going beyond the photos and illustrations in the write-up. This is made possible via a woodworking app called IdeaRoom that you download when purchasing one of the plans on the Sawtooth Ideas site. If you have an iPad, you can get started right away



by downloading IdeaRoom at the Apple App Store. Then take your iPad or other device into the shop to serve as the ultimate project builder's resource.
—Jim Harrold, editor-in-chief

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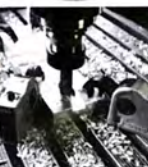
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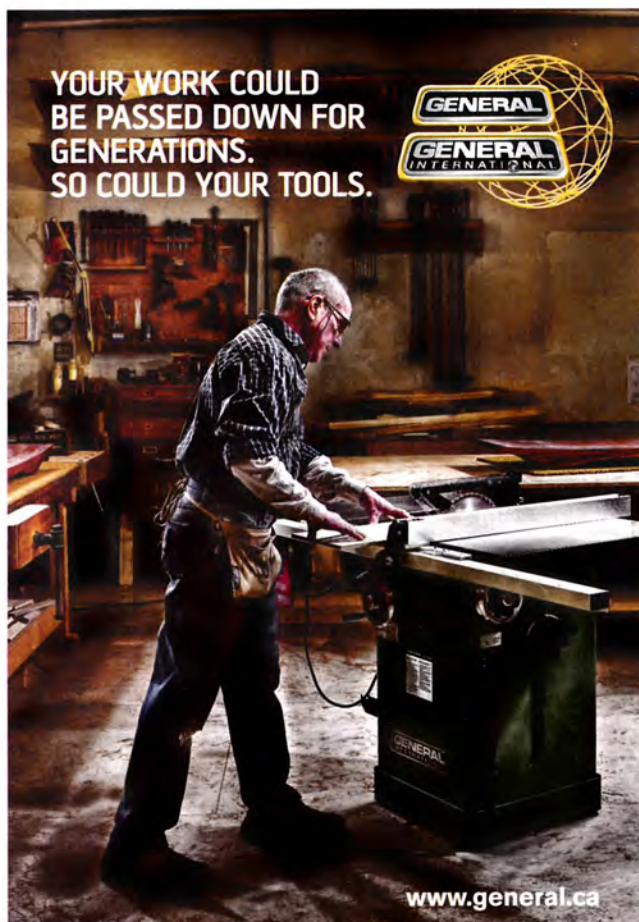


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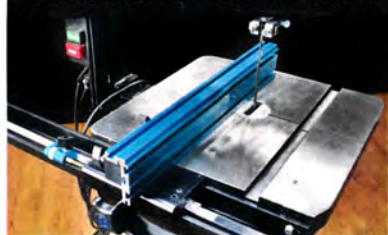
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Tips & Tricks

TOP TIP

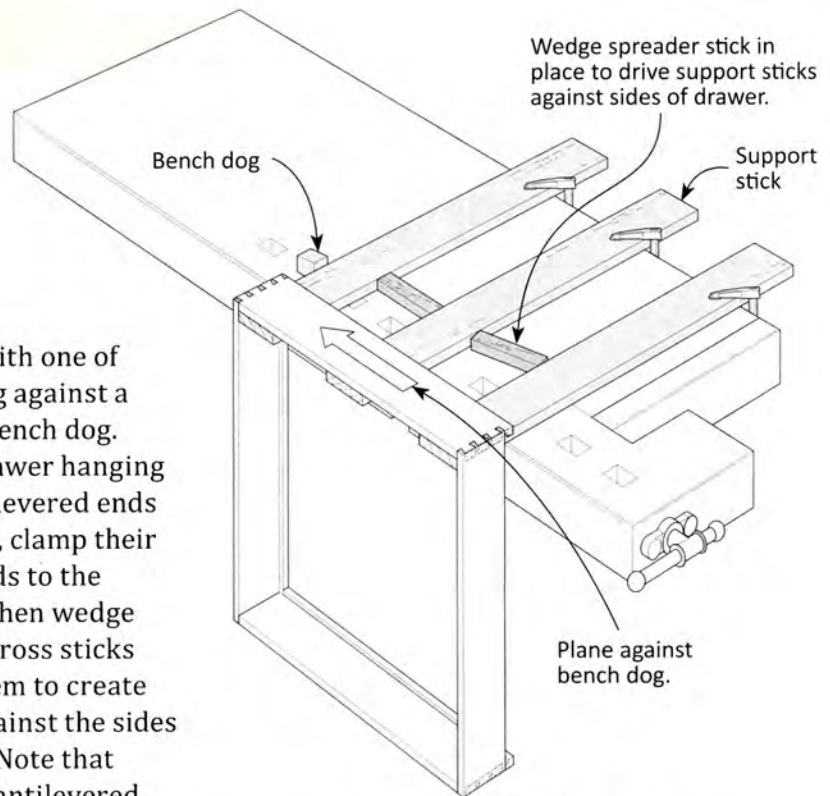
Adjustable drawer-planing perch

To plane a drawer side, you typically need to hang it on a support board that's cantilevered off the edge of your bench. The problem is that the work can shift around on a board whose width doesn't exactly match the inside dimension of the drawer box, and clamps can get in the way of planing.

Instead of a single board, I use sticks because they can be wedged to apply pressure against the sides of any sized drawer to secure it without clamps. To create the setup, extend three

as shown, with one of them resting against a projecting bench dog. With the drawer hanging on the cantilevered ends of the sticks, clamp their opposite ends to the bench, and then wedge a couple of cross sticks between them to create pressure against the sides of the box. (Note that the center cantilevered stick supplies support for full-length planing of the drawer side. If you're just cleaning up the joints at the corners, you can

omit it.) When planing, work in the direction of the bench dog.
—Philip Houck, Boston, Massachusetts



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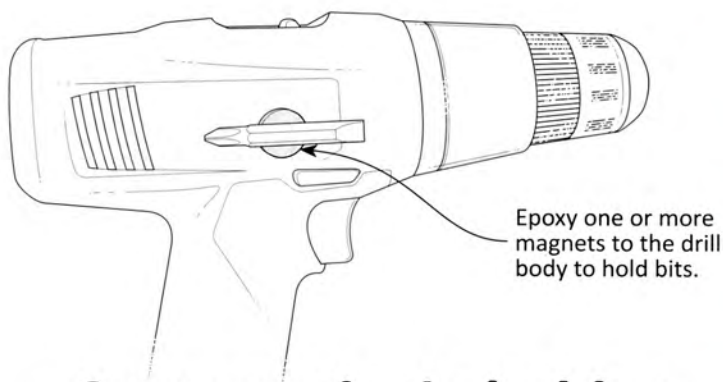
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A magnetic tip holder

My new cordless drill came with everything I needed except for a driver tip holder. I solved this problem by attaching a small rare-earth magnet to the body of the drill using epoxy. While you're driving screws, the magnet provides a great parking place for a bit in use. If you find yourself switching out several different bits for drilling pilot holes, clearance holes, and countersinks in sequence, consider attaching two or even three magnets to your drill to accommodate everything.

—Bill Wells, Olympia, Washington

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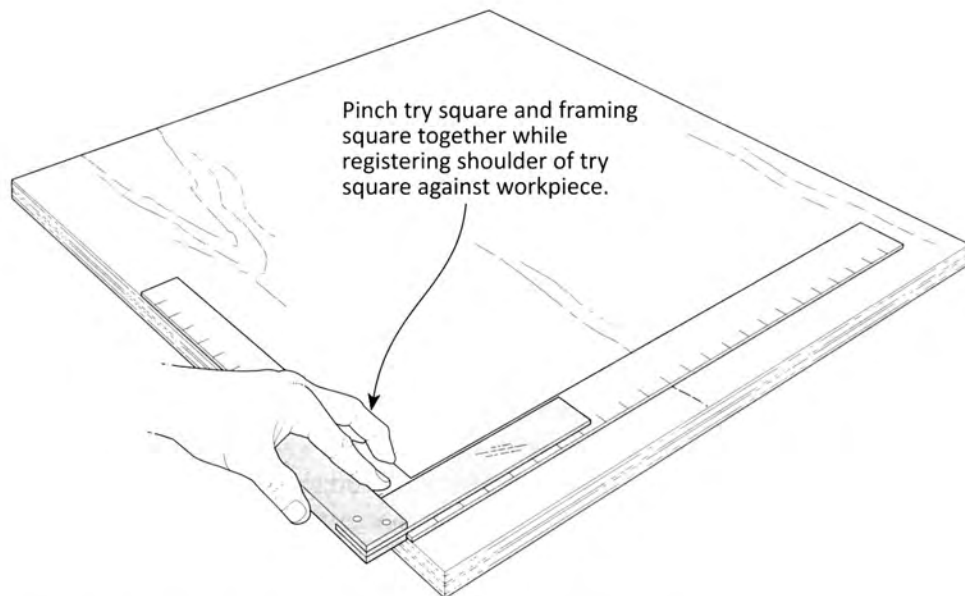


Tips & Tricks

Give a framing square the edge

A framing square can be useful for laying out large panels, but its lack of a shoulder makes it difficult to register a leg accurately against the edge of the workpiece. Sure, you can retract the square enough to drop the inside edge of the lower leg against the workpiece edge, but that raises one edge of the other leg off the workpiece, compromising layout accuracy. It also shortens the reach of the square.

My simple fix is to pinch the stock (the body) of a try square against the framing square leg



as I'm placing both against the workpiece edge. Obviously, the longer the try square stock, the better, but even the head on a 12" combination square

provides plenty of registration as long as you pinch the two squares together tightly.

—Alejandro Balbis,
Longueuil, Quebec

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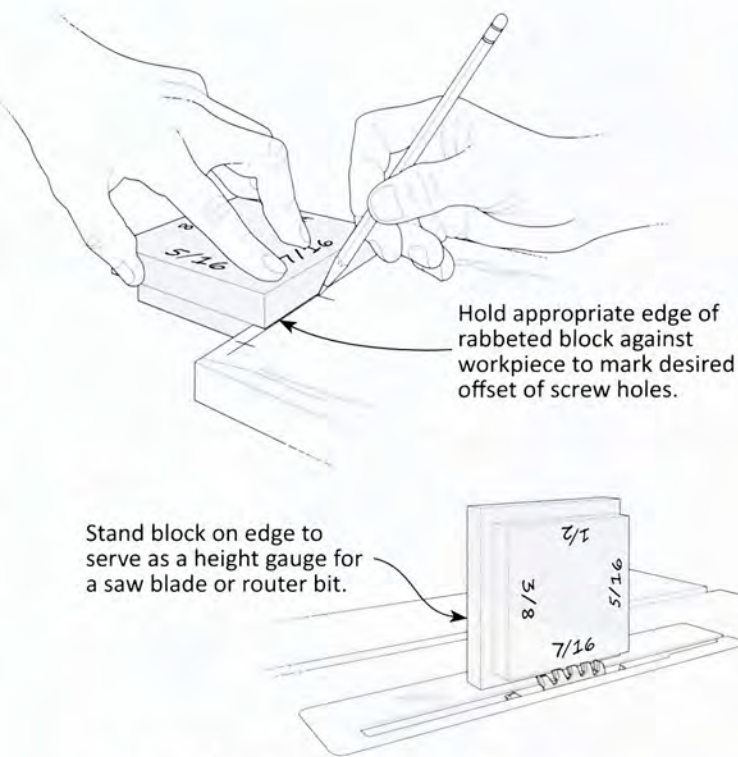


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Hold appropriate edge of rabbeted block against workpiece to mark desired offset of screw holes.

Stand block on edge to serve as a height gauge for a saw blade or router bit.

Offset and depth gauge block

When laying out screw-hole locations offset from the edge of a workpiece, I used to set a combination square to do the job. But then I remembered that I saw a carpenter once using a rabbeted block to mark the offset for his door and window trim reveals. I decided to make my block do quadruple duty by rabbeting all four edges to different commonly used offsets. When I found that the block also served as a great tablesaw and router depth gauge, I made a couple more to create a total of 12 rabbets, ranging through $\frac{3}{4}$ " in $\frac{1}{16}$ " increments.

—Serge Duclos, Delson, Québec, Canada

Tape overlay sketch pad

Whether it's a wooden handle for a small box, or the shape of a cutting board, it's amazing how hard it can be to make a curve appear simple, especially when you're working with unusual grain. Truth be told, most of my "organic" curves are carefully planned. To do this, I cover the face of the workpiece with a few strips of packing tape, or a clear plastic page protector, and then draw the shape on it using a grease pencil. Unlike an errant cut, mistakes can be wiped away with a rag.

—Joe Hurst, senior editor



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Lathe Dust Collector

Create a healthy turning station with this simple fixture.

By Jim Harrold with Jerry Bolin and Bill Sands

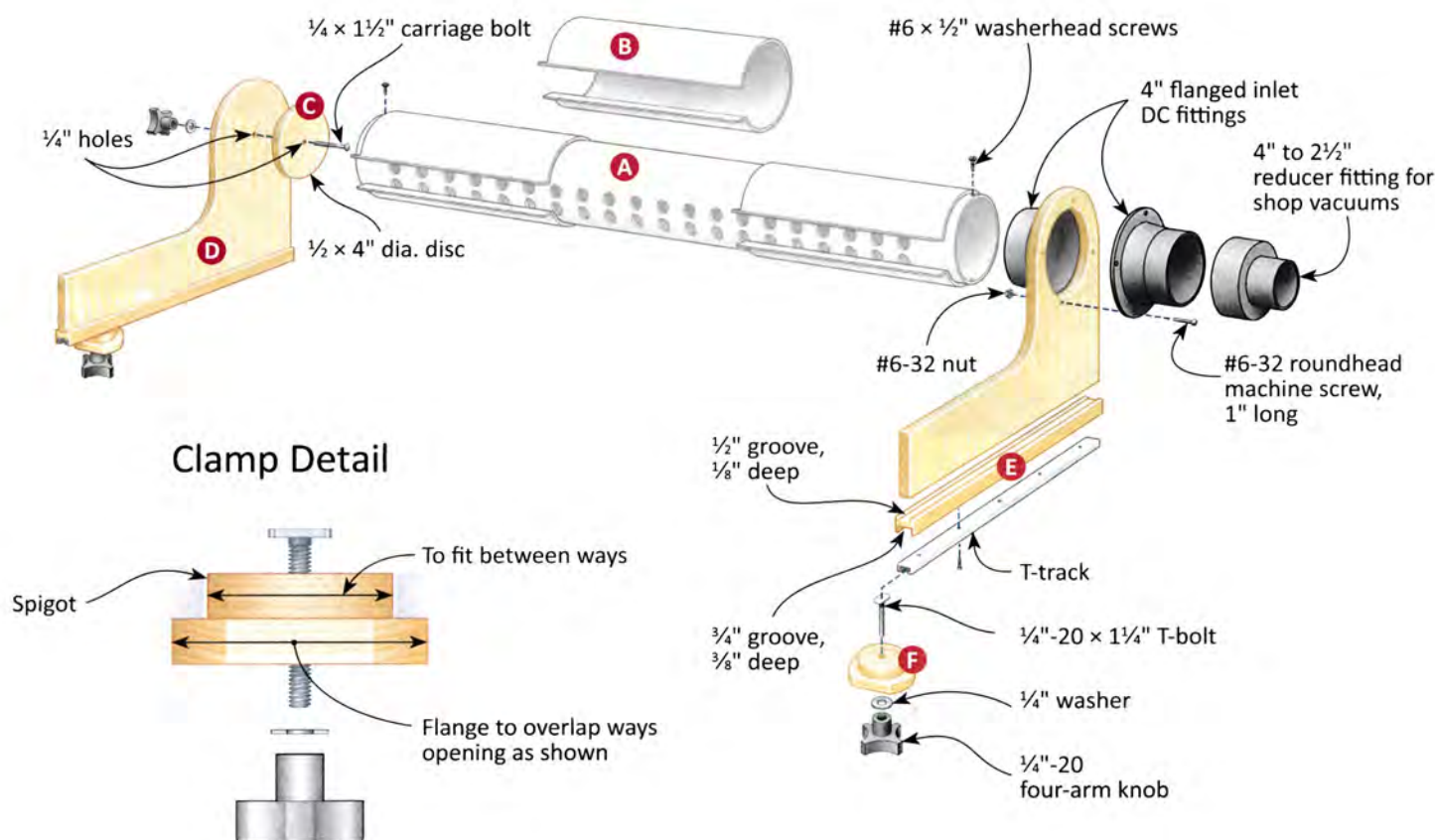
Reader Jerry Bolin of Prattville, Alabama, sent in this dust-collector idea for mid- and full-size lathes. It attaches to the ways via a pair of shop-made clamps. Convinced of its merit, I had contributing craftsman and turner Bill Sands build Jerry's collector and test it out, hooking it up to a dust collector, and then to a shop vacuum. While it was never meant to draw in large shavings and chips, it effectively

sucked in the fine, hazardous dust from scraping and sanding—the stuff that could otherwise end up in your lungs or cover shop surfaces. Of course the dust collector had more pull, but the shop vacuum also performed well.

The collector is simple to make, using $\frac{1}{2}$ " Baltic birch plywood, scrap hardwood, jig hardware, and 4" schedule 40 PVC pipe. The perforated collector pipe is secured to a

pair of base side assemblies that adjust in and out, depending on the turning's diameter. A trio of PVC sleeves (or shutters) fit and rotate over the collector pipe holes, allowing you to concentrate the suction to just the turning at hand, whether a bowl or long spindle. Before building the dust collector, be sure to size the parts for your particular lathe, using the formulas in the box at right.

Figure 1: Lathe Dust Collector Exploded View



Cut the collector pipe and shutters

1 Crosscut the 4"-diameter PVC pipes to length—one for the collector pipe (A), and the three for the shutters (B). (I used my 12" miter saw. Using a bandsaw, while supporting the PVC pipe with a miter gauge, also works.)

2 Using a metal rule, lay out two rows of $\frac{3}{4}$ " suction holes, starting 3" in from the ends of the collector pipe (A). Space the hole centers $1\frac{1}{4}$ " apart radially and linearly along the pipe. Using a $\frac{3}{4}$ " Forstner bit, drill the holes, as shown in **Photo A**.

3 Using spring clamps to securely hold a shutter pipe (B) to a right-angle jig, raise the tablesaw blade to $\frac{1}{2}$ ", and then safely cut a kerf in the

Sizing The Parts To Your Lathe

Because the makes and sizes of mid- and full-sized lathes differ, adjust the dimensions of selected parts based on your machine, referring to **Figure 1** and these formulas:

- **Perforated collector pipe (A) (4" PVC):** Length = maximum center to center distance for your lathe.
- **Shutters (B) (4" PVC, 3 needed):** Length/shutter = $(\text{length of collector pipe} - 1\frac{3}{4})/3$.
- **Base sides (D) ($\frac{1}{2}$ " plywood; 2 needed):** See Base Side Template; for larger lathes extend length for appropriate clearance, considering the maximum swing of your lathe.
- **Base side rails (E) (hardwood, 2 needed):** Size = $\frac{7}{8} \times 1" \times \text{length of base sides (D)}$; for larger lathes, extend lengths to match extended base sides (D). Do the same for the T-track.
- **Turned clamps (F) (1"-thick hardwood, 2 needed):** Outside diameter = gap between ways + overlap; spigot length = thickness of ways; spigot diameter = gap between ways $- \frac{1}{4}$ ".



A Hold the pipe to the drill press fence as you bore each suction hole at the marked locations.



B Clamp each shutter pipe to a right-angle jig to hold it firmly and then rip along its length.



C Move the heat gun along the shutter pipe; when the plastic becomes pliable, bottom out the edge in the kerf and roll the pipe over.

pipe, as shown in **Photo B**. Cut kerfs in the remaining pipes.

4 Make a PVC bending jig by cutting a $\frac{1}{2} \times 4\frac{1}{4} \times 16$ " piece of hardwood scrap. Cut a centered $\frac{1}{8}$ " kerf, $\frac{1}{2}$ " deep along one edge. Clamp the jig in a bench vise. Now, insert one ripped edge of a shutter pipe (B) into the jig's kerf. Using a marking knife, cut along the jig's edge to score a line $\frac{1}{2}$ " up from the ripped edge. (Doing this helps with the bending when

heat is applied.) Raise the pipe $\frac{1}{4}$ " to expose the scored line and use a heat gun to apply heat evenly along the pipe length. Now press the pipe edge fully in the kerf, and bend the pipe flanges, as shown in **Photo C**. While the pipe remains hot, burnish the heated bend with a block of wood to form a 90° flange. Use only enough heat to soften the PVC for bending. Repeat for all ripped shutter edges.

Make the base sides, end cap, and clamps

1 Lay out the end cap (C) on $\frac{1}{2}$ " plywood. Using a lathe, form the cap to fit snugly in the headstock end of the collection pipe (A). Test-fit the piece. Remove it and drill a centered $\frac{1}{4}$ " hole in the cap. Insert a $\frac{1}{4} \times 1\frac{3}{4}$ " carriage bolt in the hole, and fit the cap in the pipe, flush with the end. Drill a pair of opposing pilot holes, where shown in **Figure 1**, and secure the pipe to the cap with #6 $\times \frac{1}{2}$ " washerhead screws.

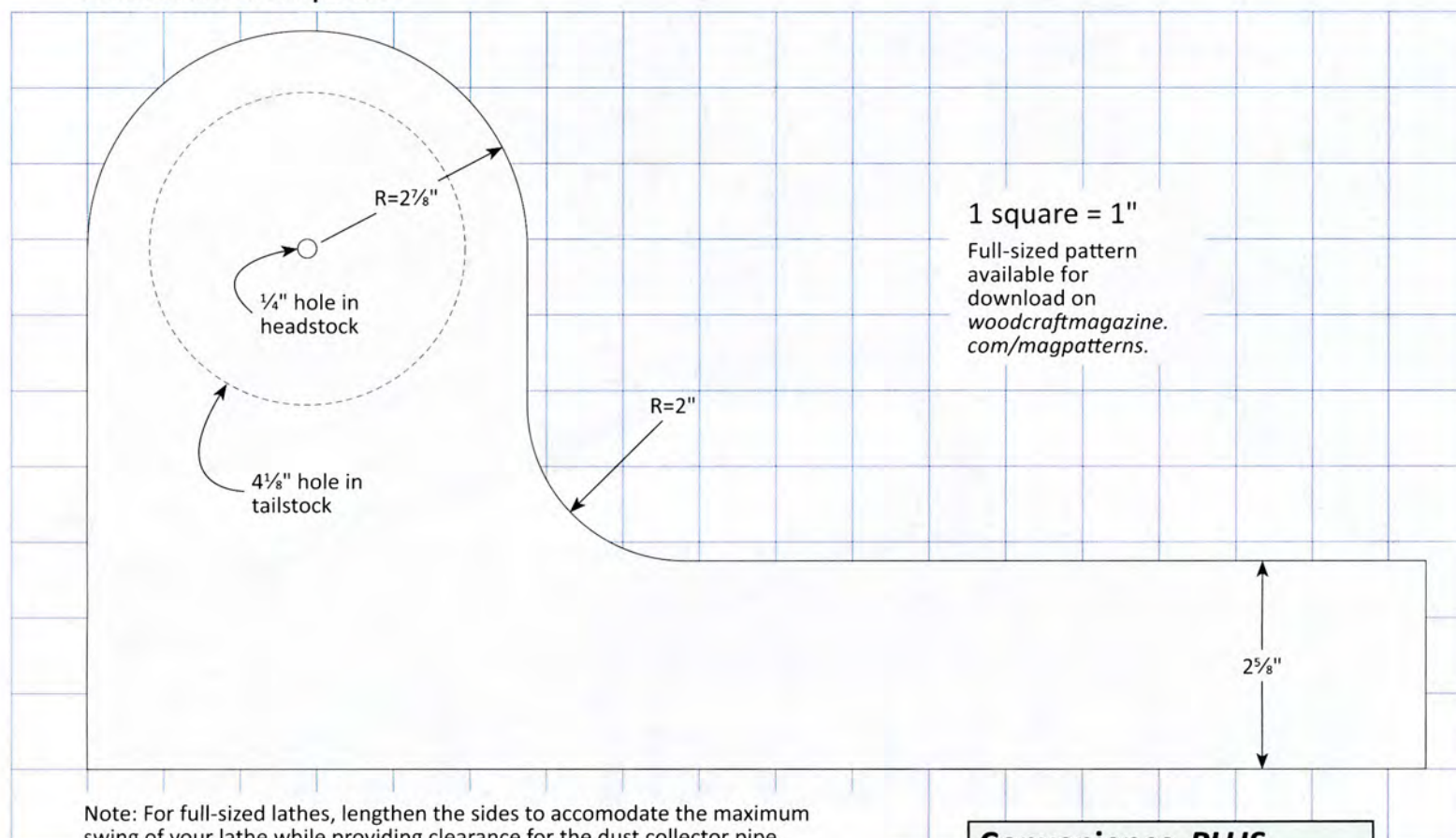
2 Referring to the **Base Side Template**, lay out a side on a piece of $\frac{1}{2}$ " plywood, tack or tape a second piece of plywood underneath, and then bandsaw both sides (D) to shape. Drill a $\frac{1}{4}$ " hole in the headstock base side for securing to the end cap (C). Scrollsaw a $4\frac{1}{8}$ " hole in the opposing (tailstock) base side. Now attach the flanged inlet fittings to the tailstock side with machine screws and nuts. Note that a full-sized lathe may require longer sides.

3 Cut the rails (E) to size, and then, using a dado set, cut the grooves shown in **Figure 1**. Glue the rails to the bottom edges of the base sides, flushing the ends. Cut and screw in the T-Track, flushing it with the rail ends.

4 From 1"-thick scrap hardwood, cut and then turn two clamps (F) to size, as shown in **Photo D**. (See the **Clamp Detail** in **Figure 1** for a look at the completed part.) Ensure that the grain, when the clamps are installed, runs perpendicular to the ways. The spigot should fit between the ways. Drill the $\frac{1}{4}$ " hole in the center of each clamp. Add the hardware.

5 Using the hardware and plastic dust-collection fittings

Base Side Template



Note: For full-sized lathes, lengthen the sides to accommodate the maximum swing of your lathe while providing clearance for the dust collector pipe.

shown in **Figure 1**, slip the shutters on the pipe, assemble the base sides to the pipe, and then to the lathe. Give your dust collector a trial run. (Consider adding a blast gate

if the connection will be a permanent part of a full-shop dust collection system.) If using a shop vacuum, fit on a 4" quick-connect fitting that reduces to the diameter of your hose. ■



Turn the clamps to shape at the lathe, and then test-fit the clamp parts to your ways.

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The ABCs of ZCIs

A zero-clearance insert puts your stock throat plate to shame.

By Paul Anthony

Your tablesaw has a big mouth, and it may be getting you into trouble. Here's the problem: The stock throat plate that came with your saw has a large opening to allow the blade to tilt. That's good for making beveled cuts, but the wide opening means that there's no underlying support for the wood fibers. So, the wood tends to tear away at the sides of the kerf as the blade teeth come crashing through the underside of the stock, leaving a nasty looking cut that comments rather profanely on your workmanship.

Fortunately, there's an easy, inexpensive fix—switching out your stock throat plate for a zero-clearance insert (ZCI). These replacement throat plates

are available commercially in a variety of materials (phenolic laminate is among the best), or you can make your own. Regardless of the type of ZCI you use, the basic installation and working principle is the same: After placing the unslotted ZCI in its opening, the saw blade is raised up through it, creating a slot that perfectly hugs the sides of the blade, offering workpiece support to prevent exit tear-out.

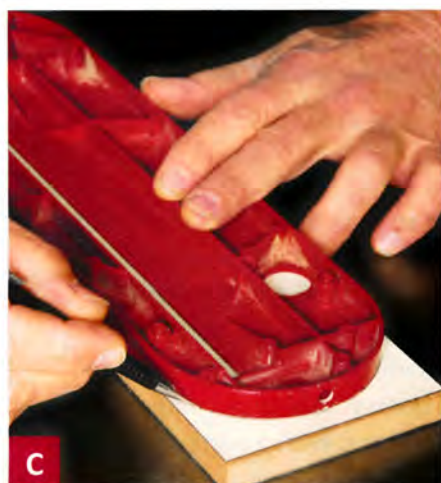
In addition to improving cut quality, the tight slot in a ZCI serves as a convenient cutline reference and prevents narrow offcuts from jamming in the blade opening. Perhaps more importantly, a ZCI affords a platform for mounting a shop-

made or aftermarket splitter, in case you “lost” or dislike the stock splitter that came with your saw.

You'll want a dedicated ZCI for every cutter of a different width that you use regularly. That may include one for regular-kerf blades, one for thin-kerf blades, and perhaps several for common dado head configurations. I have one ZCI that I use for 45° miter cuts, but I bring my stock throat plate back into play for any intermediate angles.

Whether you make a dead-simple solid-wood ZCI, or a batch of perfectly flat, height-adjustable, splitter-accommodating versions, you'll be glad for your saw's new tight bite. Expect kind words about your work.

Making a ZCI



The simplest approach to making a ZCI is to thickness-plane a piece of straight-grained hardwood to match the depth of your throat plate opening, and then shape the wood to fit. Unfortunately, a wooden ZCI can warp, compromising accuracy. It can also break if dropped, and it tends to wear over time at the intersection of the blade teeth and the front end of the slot. Plywood is more stable, but not necessarily dead flat. For the flattest, most stable shop-made ZCI's, I use 1/2"-thick MDF (medium-density fiberboard) covered on both sides with plastic laminate, which also provides a low-friction surface.



Cut an MDF blank about 1/2" wider and longer than your saw's throat plate recess. Also cut two pieces of plastic laminate the same size. Apply the plastic laminate to both sides with contact cement, pressing it firmly in place with a roller or bullnose board (**Photo A**).

Rip just enough from one edge of the blank to flush up the laminate and the MDF. Then mark the blank for width. A snug side-to-side fit in the recess is critical, so mark directly from the insert opening, then make a nibble cut and test the fit (**Photo B**). After ripping the blank to width, use the stock throat plate to mark the rounded ends (**Photo C**). Also drill a finger access hole. Use a bandsaw or jigsaw to cut a bit proud of the lines, and then finish up with a disc



Mastering The Shape

Rather than sanding the curved ends of each plate, you can finesse one perfectly fitting "master" blank and dedicate it as a template-routing pattern. Attach it to another rough-bandsawn blank with double-sided tape or hot-melt glue, and finish up the curves using a flush-trimming bit in your router table.



or belt sander, testing the fit with the saw blade removed.

You may need to rout away the areas on the underside that contact the metal tabs or lip at the bottom of the recess (**Photo D**). If you overcut, either shim as necessary with masking tape or install leveling screws.

Slotting a ZCI



Sawing the slot on a ZCI involves raising the spinning blade up through the insert. However, on many saws, the teeth of an installed full-size blade reach nearly to the saw table surface, which may prevent a ZCI from fully seating in the recess. Most commercial versions include a starter slot to accommodate the top end of the blade, but shop-made ZCIs require a different approach.

To cut the slot, first back off the height-adjustment screws on your stock throat plate. This will create a shallow recess into which you can place your shop-made ZCI (**Photo A**). Clamp a strong,



A Clamping Bridge

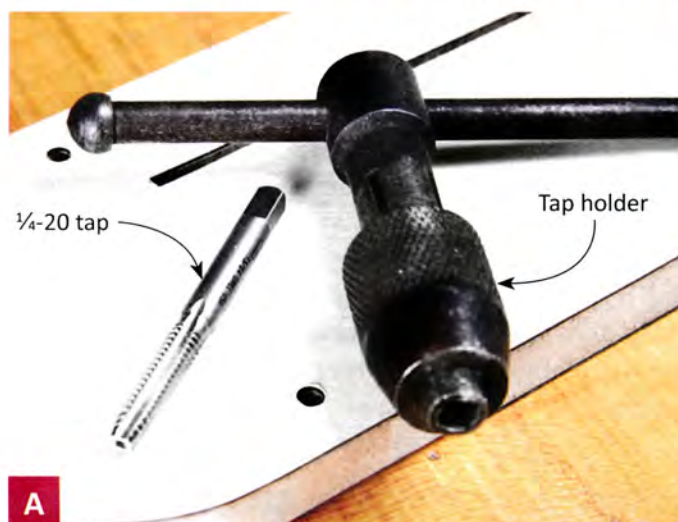
Clamping a beam across your saw top to hold down a ZCI for slotting can be kind of a hassle, especially if an outfeed table abuts your saw. Instead, you can make quick and easy work of securing the ZCI by using a simple hold-down. Just grind opposing flats on a $\frac{3}{8}$ "-dia. barb-less T-nut so it slides in a miter gauge slot, and then make a simple wooden bridge with a center hole to accommodate a short section of $\frac{3}{8}$ "-diameter threaded rod with a wing nut.



straight beam across the blank to one side of the blade location, and then slowly raise the spinning blade until it just peeks through the surface (**Photo B**). Lower the blade, remove the stock plate, and install the zero-clearance blank. Again, clamp it down with the beam, and slowly raise the blade

to complete the slot (**Photo C**). Finish up by cutting the splitter slot with a jigsaw (**Photo D**), or as shown in **Photo C** on page 33. *Note: If fitting a shop-made ZCI to your particular saw requires routing the full length of the edges on the underside, do that after cutting the slot as described above.*

Installing leveling screws



For my shop-made ZCIs, I prefer Allen-head set screws. They're easy to install, allow for fine height adjustment, and don't create large recesses in the surface to trap sawdust and other detritus. For the typical throat plate, 1/4-20 by 1/2"-long set screws work nicely. For thinner plates, use shorter screws.

For accuracy, a ZCI (or even a standard throat plate) must sit perfectly level with the saw table top. Otherwise it can compromise the intended depth of cut for joints or impede workpiece travel. Although you can shim a ZCI with tape or other materials to level it, a better way is with screws, and it's best if they're accessible from the top side of the plate so you don't have to remove it to make adjustments.

To install them, you'll need a 1/4-20 tap and a handle for it, both commonly available at hardware stores for a few bucks (**Photo A**). Using a 3/16" bit in the drill press, bore through holes at the appropriate locations on your throat plate (**Photo B**). Use the tap to cut the threads for the set screws (**Photo C**). If you haven't used a tap before, don't worry. It's as easy as keeping the tap relatively

plumb while applying good downward twisting force for the first 1/4" or so. After that, you just turn the handle to finish cutting the threads.

There is no need to use thread-cutting oil as you would when tapping a hole in a piece of metal. Just be sure to thread completely past the taper at the end of the tap (**Photo D**). Install the set screws using an Allen wrench, and you're done (**Photo E**).

ZCI-mounted splitters

Mounting a splitter

A splitter is crucial to tablesaw safety. Its primary job is to keep the workpiece against the rip fence and away from the rising rear teeth of the blade, which can otherwise catch the piece and violently kick it backward toward the operator. Unfortunately, the stock splitters on many saws—particularly

older models—were removed and often misplaced because they were so troublesome to attach and detach for making non-through cuts like dados.

A ZCI presents the perfect opportunity to install a splitter on a saw that's missing one. Micro Jig's MJ splitter (available from Woodcraft) is a good

commercial option for a ZCI-mounted splitter, or you can make your own from wood or aluminum. Whatever type of splitter you use, keep in mind that its effectiveness depends on proper alignment. Always mount it so that it aligns with the sides of the teeth facing the rip fence.

A wooden splitter

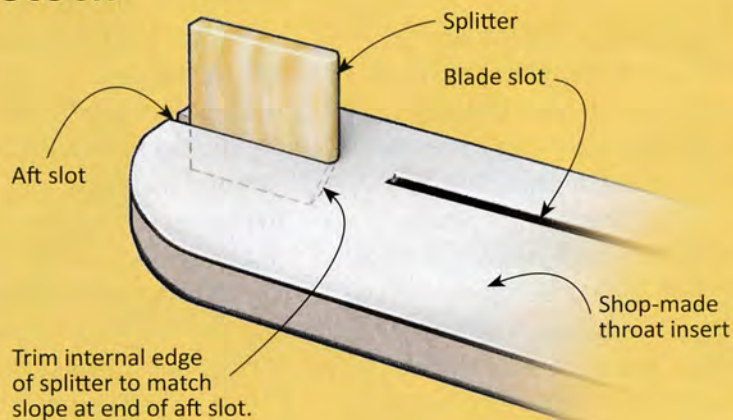
It's easy to install a wooden splitter in an MDF, wood, or plywood ZCI because the splitter is simply glued into the blade slot. When doing this, use a fresh ZCI, as the slot on a used one may have widened a bit over time.

Slot the ZCI, and then saw a splitter from the end of a piece of hardwood scrap to fit the width of the slot exactly. You can make the splitter whatever height you like. A projection of $\frac{3}{4}$ " or so is fine for general work. Cut the piece to about $1\frac{1}{4}$ " wide. Chamfer or round over the leading edge of the splitter, and then glue it in place (**Photo A**). Make a test rip to ensure that the workpiece doesn't bind between the splitter and fence. If it's a tight squeeze, sand the side of the splitter with fine sandpaper wrapped around a truly square wooden block (**Photo B**).



A Wooden Splitter For Thick Stock

The shortcoming of a splitter that's installed in the blade slot is that it's only good for ripping moderately thick stock. A blade raised past a certain point will start to cut away the splitter. For ripping thick stock, install the splitter in an aft slot cut, as shown in **Photo C** (opposite page). Trimming the bottom corner of the splitter to match the slope at the end of the aft slot will locate the splitter as close as possible to the blade while maintaining maximum strength of the ZCI.





An aluminum splitter

A splitter can easily be made from $\frac{1}{16}$ "-thick aluminum angle (available at hardware stores and home centers.) Install it in a separate slot aft of the blade slot. To cut the aft slot, flip the ZCI upside down and sideways, and slip it over the blade. Carefully slide the rip fence against the edge of the ZCI just enough to make contact without applying pressure against the blade (**Photo A**). With the ZCI upside down, mark a line $\frac{1}{2}$ " from the end of the blade slot (**Photo B**). **WARNING:** Unplug the saw when setting up to cut the aft slot.

Raise the blade fully in order to cut the end of the slot as perpendicular as possible. Use a blade guard, and clamp a featherboard to the fence. Saw to your line, keeping the ZCI pressed firmly against the fence (**Photo C**). Don't back away from the spinning blade; just hold the ZCI in place at the end of the cut, shut off the saw, and wait for the blade to stop before retracting the piece. Then, with the ZCI right side up, use a bandsaw to cut away the sloped section of the slot, which will allow the splitter to sit a bit closer to the blade (**Photo D**).

Cut a $1\frac{1}{4}$ " length of aluminum angle. (A carbide tablesaw blade will do the job nicely.) Drill clearance holes in one leg for mounting screws (**Photo E**). Press the splitter against the rip

fence side of the slot and mark for the screw holes, offsetting them slightly so they'll pull the splitter toward that side (**Photo F**). Drill pilot holes and install the screws. Flip the ZCI over, and make sure that the splitter is pressed entirely against the edge of the slot. If necessary, enlarge one or both holes to allow minor adjustment. Finish up by filing opposing chamfers on the leading edge of the splitter. Use thick paper to protect the ZCI (**Photo G**). ■

Tough-Enough Front-End Loader

Scoop a bucket-load with this hands-on construction toy.

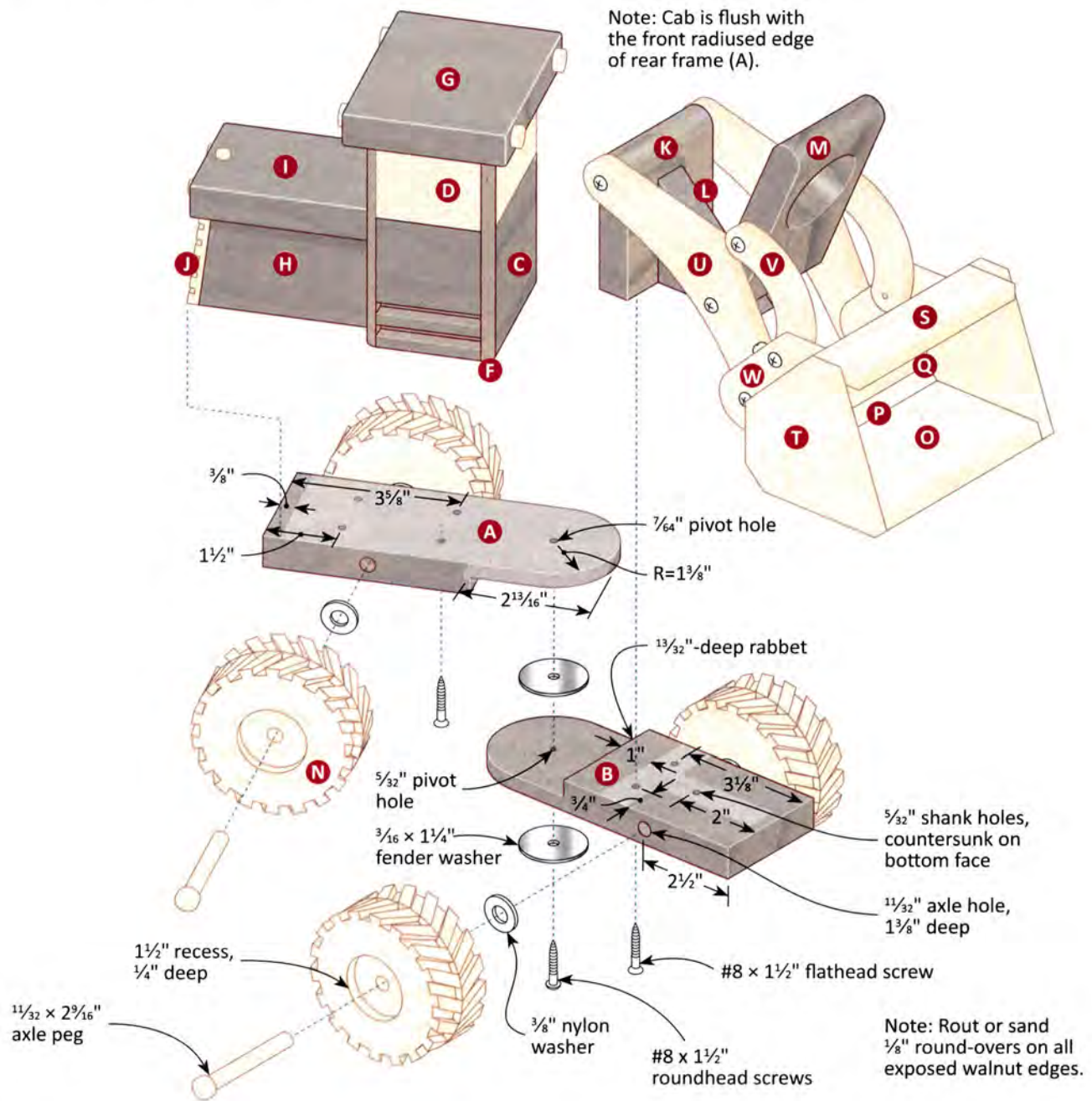
By Chuck Hedlund

Ordering the Dump Truck Plan

To purchase the Tough-Enough Dump Truck either as a download or an enlarged paper plan, go to woodcraftmagazine.com.

Overall Dimensions: 6"w × 17"l × 8"h

Figure 1: Front-End Loader Exploded View



Designed to go with the Tough-Enough Toy Truck from the February/March 2013 issue, this walnut and maple front-end loader features a lift handle for operating the bucket and depositing sawdust, dirt, sand, or gravel into the truck's dump box, as well as a pivoting front end. Here, you'll use the patterns to speed the building

time and learn a few tricks for safely cutting small parts. You'll also find out how to make the rugged V-tread tires at the drill press and tablesaw.

First, make the frames

1 From 3/4"-thick walnut, cut the rear frame (A) and front frame (B) to the sizes in the **Cut List**. Then mark the 1 3/8"-radius center

point which will be used later to bore the centered pivot hole. With your compass draw the radius line on each part. From the radiused end, mark the half-lap shoulder line at 2 13/16". (See the frame parts in **Figure 1**.)
2 Lay out the rabbet cuts on the frame parts (A, B) using a marking gauge. Set your tablesaw blade height to cut 13/32" deep, and



With the bandsaw fence set, cut the rabbet on a frame part, stopping at the shoulder cut.

then crosscut each part where marked on the bottom face of rear frame (A) and top face of front frame (B). Note that a $\frac{1}{16}$ "-thick fender washer fits between the two frame rabbets, making up the difference in the pivoting half-lap joint, as shown in **Figure 1**.

3 Set up your drill press with a fence and bore the $\frac{7}{64}$ " pivot hole in rear frame (A) and $\frac{5}{32}$ " pivot hole in front frame (B), where shown.

4 Bandsaw to the marked radius line on the rear and front frames (A, B). Then sand to the line, removing saw marks.

5 Set up your router table with a $\frac{1}{8}$ " round-over bit, and rout the edges of the rear and front frames (A, B).

6 Set up your bandsaw fence and to make a $\frac{13}{32}$ "-deep rabbet cut on each frame (A, B), as

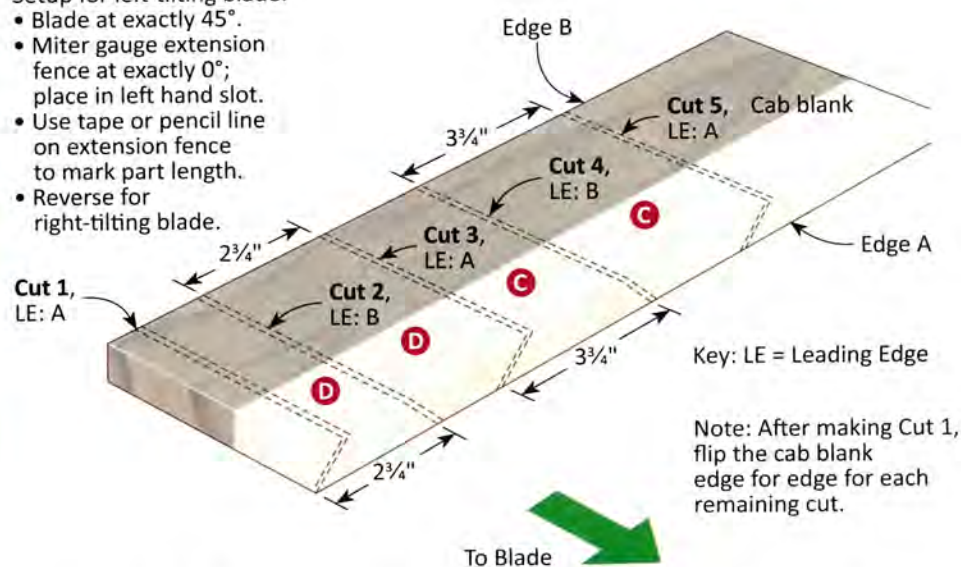
Tip Alert

Axle pegs come slightly undersized, but may change in diameter due to humidity. Check their fit in test holes having the sizes shown and sand if needed.

Figure 2: Cab Blank Cutting Sequence

Setup for left-tilting blade:

- Blade at exactly 45°.
- Miter gauge extension fence at exactly 0°; place in left hand slot.
- Use tape or pencil line on extension fence to mark part length.
- Reverse for right-tilting blade.



shown in **Photo A**. Sand the sawn surfaces smooth with a sanding block, and test the rabbet-to-rabbet fit, slipping a fender washer in between the parts. The surfaces should be flush.

7 On the side edges of the frames (A, B), lay out the axle peg holes where dimensioned in **Figure 1**. Set up your drill press with a fence and stop, and bore the $\frac{11}{32}$ " holes. Then drill and countersink all shank holes where shown.

Add the cab

1 Edge-glue a $\frac{3}{4} \times 1\frac{7}{8}$ " piece of maple to a $\frac{3}{4} \times 3\frac{1}{8}$ " piece of walnut to make a 5"-wide by 20"-long blank for the cab front/back (C) and cab sides (D). See **Figure 3: Cab Exploded View**. Remove the squeeze-out and let dry.

2 Miter-cut the cab front/back (C) pieces and the cab sides (D) to the lengths in the **Cut List**, following the blank cutting sequence in **Figure 2**. To do this, install a zero-clearance insert and attach an extension fence to your saw's miter gauge, placing it in the left-hand slot. (The

blade in my saw tilts to the left. Make the needed changes if your saw tilts to the right.) Angle the blade at 45°. Place the cab blank against the extension fence, and miter-cut one end. Measure in $2\frac{3}{4}$ " from the toe, and lay out the opposing miter-cut for the cab sides on the edges. Flip the blank to place its opposite edge (edge B) against the extension fence, and align the cutline with the blade. Mark the fence with a pencil line or piece of tape to the needed distance from the blade. Guiding off this mark with the toe of the first cut, make the second cut to free a shorter cab side (D). Flip the blank, align the toe with the mark, and make the third cut, freeing the other cab side. Make a second mark on the fence for the longer cab front and back (C), and similarly cut these pieces to length (here, $3\frac{3}{4}$ " long).

3 To glue up the mitered pieces (C, D), first align the parts end to end with the outside faces up and in the proper order. Apply three strips of tape across the joints with tape tails extending beyond one end part, as shown in **Photo B**.



With the cab parts outside face up and aligned along a straight edge, attach tape to the joints in preparation for the glue-up.



Apply glue and then fold the cab front, back, and sides at the mitered ends to form a box. Secure the open corner with the tape tails.

4 Turn the taped parts (C, D) over, and spread glue on the mitered ends. Now, starting at the edge with no tape tails, fold the mitered parts together to form a box, securing the open end with the tails (**Photo C**). Remove any glue squeeze-out at the corners. Let dry.

5 Cut the cab bottom (E) to fit at the inside bottom of the cab box. Apply glue and fit the piece into the box, making it flush with the assembly's bottom edges.

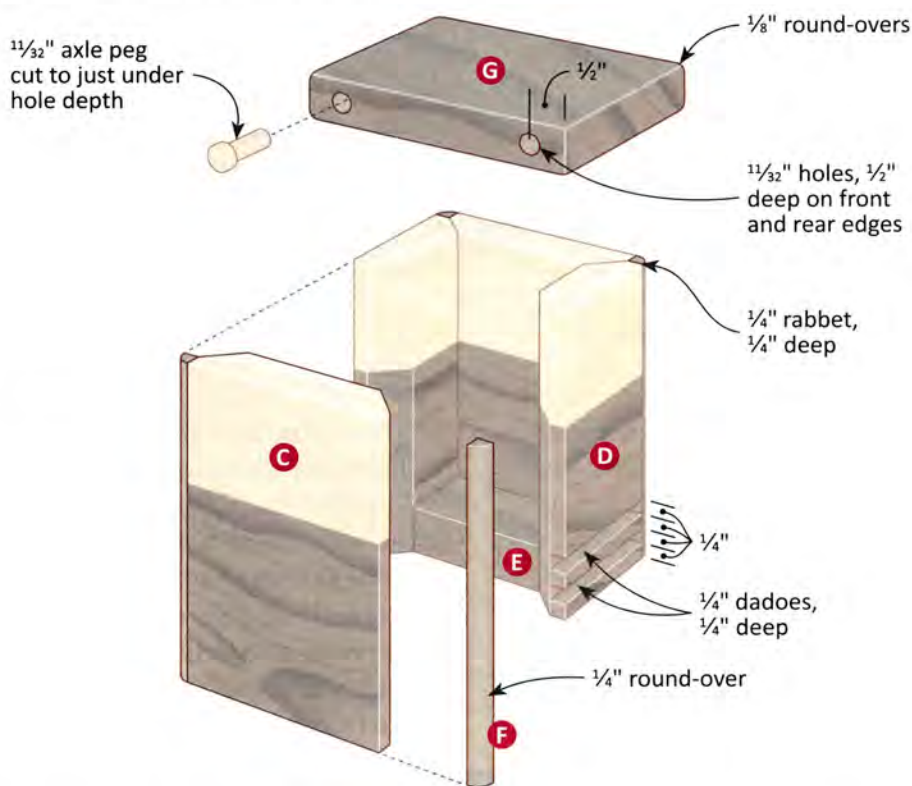
6 Set up a $\frac{1}{4}$ " dado blade at a height of $\frac{1}{4}$ ". Cut rabbets at the cab's mitered corners. Also, cut dados for the steps on the cab sides (D), where shown in **Figure 3**.

7 Next, rip a $\frac{1}{4} \times \frac{1}{4}$ " walnut strip 24"-long for the cab corners (F). Measure and cut the cab corners to rough length and glue them in place. After the glue has dried, sand the corners flush with the cab box.

8 Install a $\frac{1}{4}$ " round-over bit in your router table, set up your fence, and rout round-overs on the corners of the cab.

9 From $\frac{3}{4}$ " walnut, cut the cab top (G) to size. Rout a $\frac{1}{8}$ " round-over on all edges. On the front and back, edge bore $\frac{11}{32}$ " holes for the lights (**Figure 3**). Then finish-sand the cab parts. Add the lights. Center, glue, and clamp the top onto the cab box.

Figure 3: Cab Exploded View



Make the motor, hood, and grill

1 Laminate three pieces of $\frac{3}{4}$ "-thick walnut together to the size shown for the motor (H) in the **Cut List**. After the glue dries, bevel one end at the tablesaw using a miter gauge extension fence set at 90° and angling the blade at 7° . Finish-sand the motor. (See **Figure 4** for reference.)

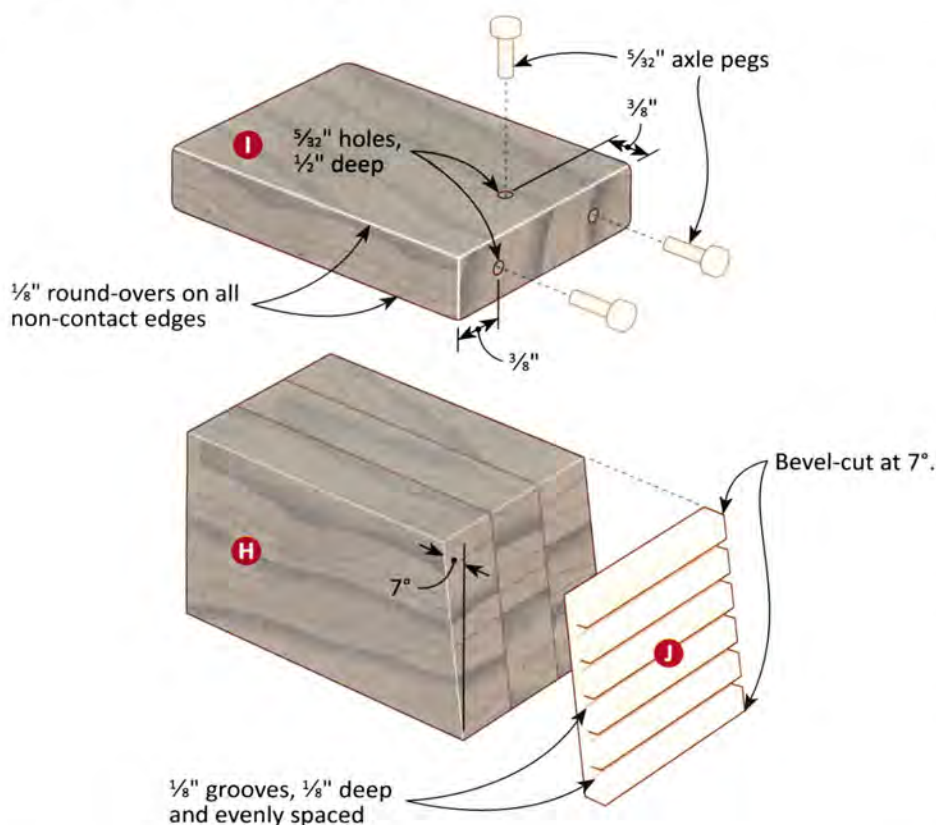
2 Next, cut the hood (I) to size. Then rout a $\frac{1}{8}$ " round-

over on all edges that don't contact the cab when in place. Finish-sand the hood.

3 Bore the $\frac{5}{32}$ " holes for the brake lights and radiator cap in the hood (I) and attach. Glue (H) and (I) together, keeping the ends that go against the cab flush.

4 From $\frac{1}{4}$ " maple, cut the grill (J), bevel-cutting the edges to match the profile of the motor. To cut the grill kerfs, install a zero-clearance insert in your tablesaw and raise $\frac{1}{8}$ ". Next, lay

Figure 4: Motor Exploded View



out five evenly spaced kerfs on one face. Adjust your saw fence to cut the outside kerfs. Using a pushpad to control the piece, cut one outside kerf, flip the piece end for end, and cut the other. Adjust the fence and similarly cut the neighboring kerfs. Adjust the fence one more time, and

cut the center kerf. Glue the grill to the motor and hood (H/I).

5 Glue the cab (C/D/E/F/G) to the motor assembly (H/I/J). Remove squeeze-out, with a moistened rag, rinsing it in clean water as needed. Let the assembly dry, and then sand it flat to fit the rear frame (A). Now,

glue and screw the combined assemblies to the rear frame with #8 x 1 1/2 inch flathead screws, keeping the front of the cab flush with the frame's radiused end.

Bucket support, brace, and handle

1 From 3/4 inch walnut cut the bucket support (K), brace (L), and handle (M) to size and shape, referring to the **Cut List** and **Figure 5**. (Cut the end of a 2 1/2 x 6 inch-long piece at 45 degrees, and then cut 2 1/2 inch for the brace.)

2 Using a drill press and circle cutter or Forstner bit, bore a 2 inch hole in the handle (M), where shown in **Figure 5**.

3 Set up your router table with a fence and a 3/8 inch round-over bit, and rout one end of the bucket support (K) and both ends of the handle (M).

4 Change over to a 1/8 inch round-over bit and rout where shown.

5 Set up your drill press with a fence, and drill centered pilot holes in the edges of the bucket support (K) and handle (M), where dimensioned. Switch bits and drill the countersunk shank hole in the bucket support.

6 Attach the bucket support (K) and brace (L) to the front frame (B) with screws in the countersunk shank and pilot holes, where shown in **Figure 1** and as shown in **Photo D**. Note that the bucket support is 1 inch in from the front frame shoulder.

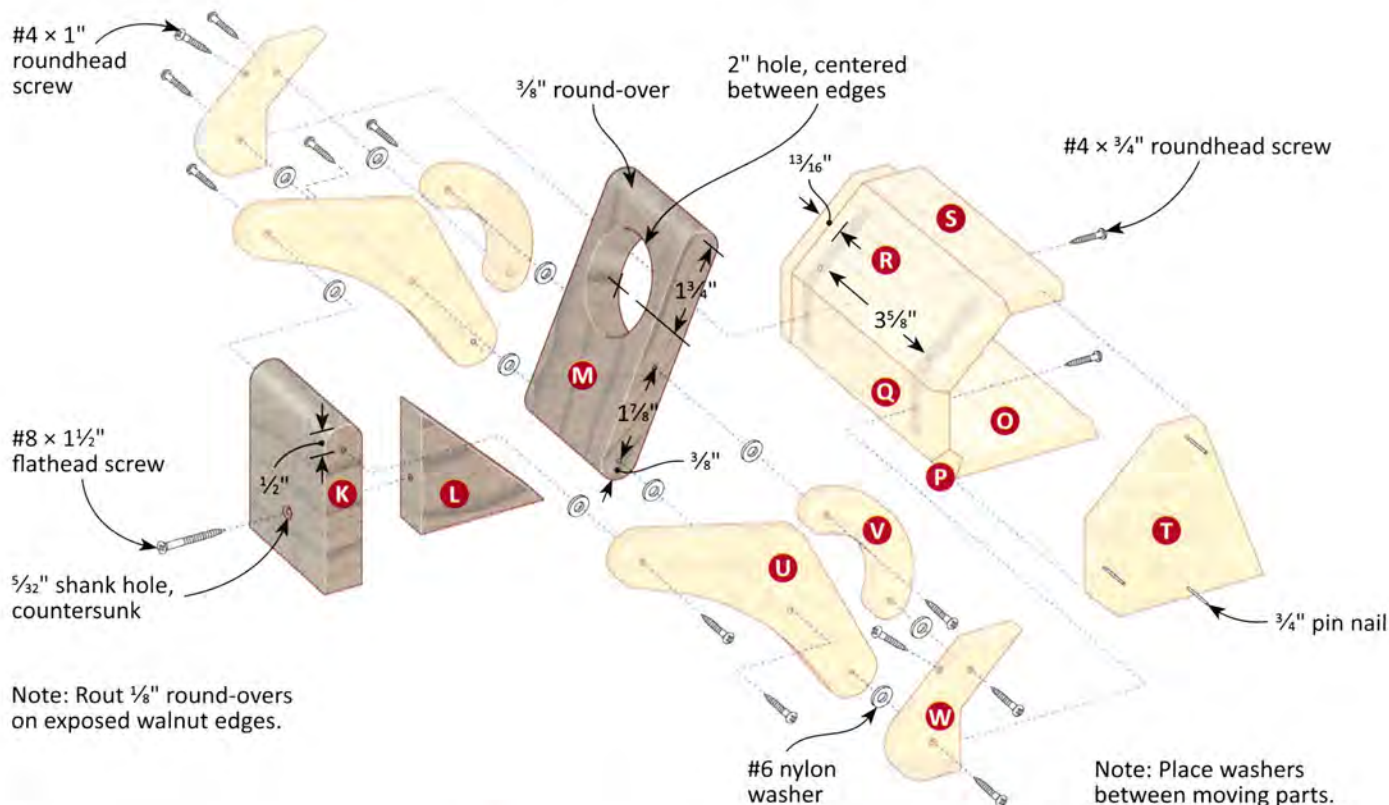
Make the tires

1 Lay out the center points for ten 3 1/2 inch-diameter halves for tires (N) on two 3/4 x 4 1/2 x 22 1/2 inch maple blanks. One blank will be for the inside tire halves and the other for the outside halves. (While you only need four complete tires [four inside and four outside halves glued together],



Secure the front frame in a bench vise. Then, using a 1 inch spacer, locate, glue, and screw the centered brace and bucket support to the frame.

Figure 5: Bucket Exploded View



use the extra inside and outside tire halves as test pieces).

2 Install a 1 1/2" Forstner bit in your drill press, adjust the fence to center the bit on the tire half center points, and bore a 1/4"-deep recess at each center point in the maple blank for the outside halves. (The other blank containing the inside halves will not be recessed.) Switch to an 11/32" brad-point bit, and drill a 1/8"-deep starter hole below the 1/4" recess. Next, switch to a circle cutter set to make a 3 1/2"-diameter cut. (Orient the cutter's bevel to face away from the center; the point of the cutter should be on the inside.) Clamp the maple blank to the drill press fence. Then, using a slow speed for safety (about 300 RPM), cut out the tire halves, as shown in **Photo E**, drilling a centered 1/4" axle hole at the same time. Use the circle cutter to cut the inside tire halves out of the remaining blank.

3 Install a 1/8" roundover bit in the router table. Then make a simple L-jig out of 3/4" scrap, drilling a 1" hole in the jig's inside corner. Adhere the jig to the table with double-faced tape, locating the bearing at the jig's inside corner. Round over all of the outside edges



E Cut out the outside tire halves with a circle cutter at the drill press using a low RPM.

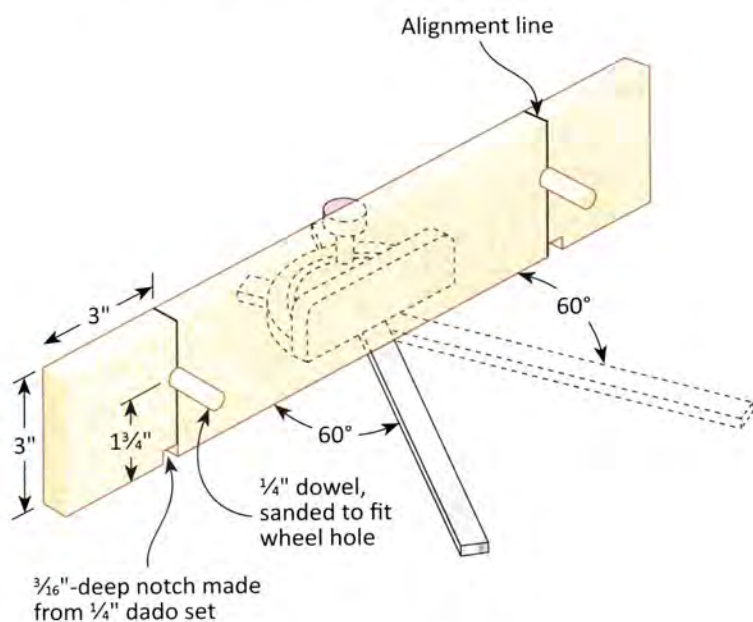
of the tire halves, rotating them, as shown in **Photo F**.

4 Next, referring to **Figure 6**, make ten copies of the **Tire Kerfing Template**, and cut them out. Adhere the paper templates to the inside face of each tire half. Make two groups of tire halves, one for the left tires (N),

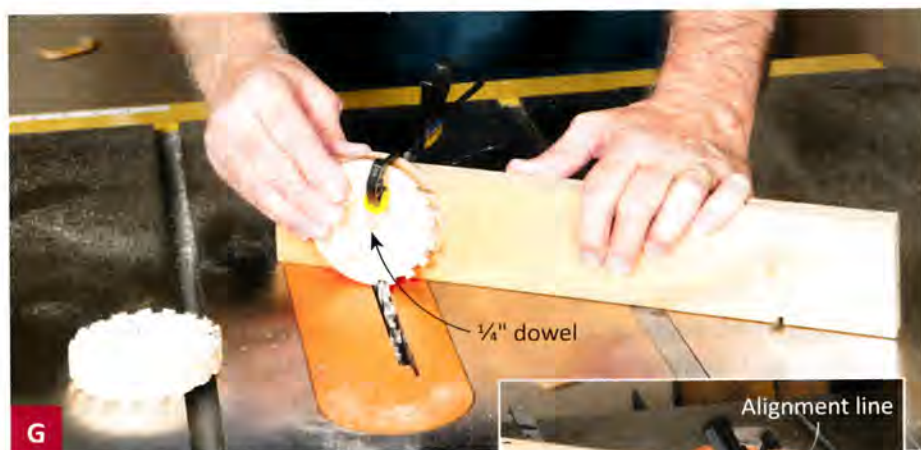
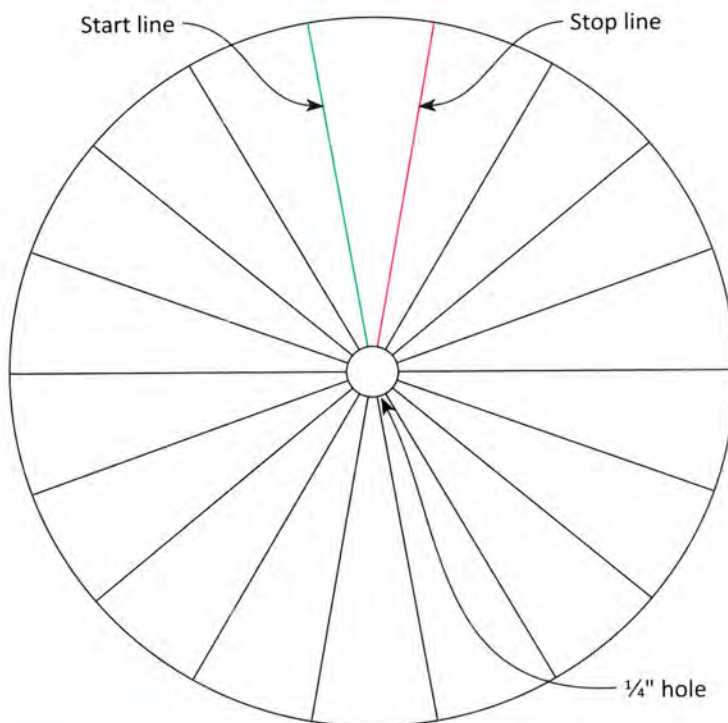


F Fit the tire half—outside face down—in the L-shaped jig and round over the edge as shown.

Figure 6: Half-Tire Kerfing Jig



**Kerfing Template
100% size**



Dado-cut the treads in the tire halves, using an angled kerfing jig. Align the template lines with the alignment line (Inset) for evenly-spaced cuts.

and one for the right tires (N). Later, when cutting the kerfs, you will use the miter gauge in the right slot or the left slot. Each group will have two *inside* tire halves and two *outside* tire halves. Keep the tires in separate groups to avoid confusion.

5 Make the **Half-Tire Kerfing Jig** in **Figure 6**, as shown, using a $\frac{3}{4}$ "-thick $\times$ 3"-wide extension fence. (Check to see if the tire

halves will turn on the dowels; if not, sand the dowels down.)

6 Install a $\frac{1}{4}$ " dado set, and raise it to cut $\frac{3}{16}$ " deep. Now, place the miter gauge to the left of the blade. Set it at 60° , as shown in **Photo G**. Position the jig fence on the miter gauge, aligning the marked alignment line with the inside edge of the dado set, and

attach it with screws. Slip a test half tire onto the dowel, aligning the pattern start line with the alignment line on the top edge of the jig. Use a small clamp to hold the half tire to the fence. Turn on the saw and cut the half tire's tread. Repeat by rotating and aligning the template lines for each kerf cut, making the final cut at the red stop line. Check the tread. The kerfs should be evenly spaced. Finish cutting the "right" group. To cut the "left" group of half tires, move the miter gauge to the left of the blade, and angle it to 60° in the other direction. Reposition the jig fence as described earlier. Cut the kerfs in the left group of half tires.

7 Remove the paper templates from the tire halves while keeping them in right and left groups. To bond the tire halves together, spread glue sparingly on the inside (unrounded) faces. You don't want glue squeeze-out at the joint lines. Next, insert a $\frac{1}{4} \times 3$ " bolt through a washer, the

hole in the tire halves, through second washer, and tighten the halves together with a nut, as shown in **Photo H**. (Doing this keeps the halves flush.) As you tighten, adjust the halves to create an offset V-tread pattern. Similarly glue and clamp the remaining tires for two left-hand and two right-hand tires (N).

8 After the glue dries, install the bolt of a tire assembly into the drill press chuck. Turn on the drill, and sand away any burn marks on a tire (N), using a sanding block with 80-grit sandpaper. Repeat for the remaining tires.

9 Install an $\frac{11}{32}$ " brad-point bit in the drill press and, using the tool's fence and stopblock, align it with a tire's $\frac{1}{4}$ " hole and $\frac{1}{8}$ "-deep recess hole made previously. Widen the hole so an axle peg can slip through it. Repeat for the remaining tires and finish.

Make the bucket

1 From two $\frac{3}{8}$ " maple blanks measuring 6" wide $\times$ 5 $\frac{1}{4}$ " long, cut the bucket bottom (O), small angle (P), bucket back (Q), large angle (R), and Top (S), referring to the **Cut List**, **Figure 5**, and the **Bucket Patterns**. Note that all the parts except the top have two bevel cuts at 22 $\frac{1}{2}$ °. The top has one 0° (or 90°) edge and one 22 $\frac{1}{2}$ ° edge. To make the cuts, use a miter gauge and extension fence, sawing similarly to how you cut the cab parts earlier by flipping the blanks. Here, lay out the edges of each cut to the needed toe-to-toe widths. (I laid out and cut the parts as follows: S, Q, R from the first blank and P and O from the second blank.)

2 To form the bucket shape, you'll need to make two spacers that will be cut to the bucket's interior size and shape, starting



Use a pair of wrenches to tighten the nut and washers on the glued-up tire halves. Make sure the treads create an offset V-pattern.

with a $\frac{1}{2} \times 2\frac{3}{4} \times 3\frac{3}{4}$ " piece of MDF. Make the cuts shown in the **Bucket Parts End View** in the **Bucket Patterns**. Tape the bucket parts (O, P, Q, R, S) edge to edge. Then fold them around the spacers to check their fit. Glue up the assembly (**Photo I**).

3 To make the bucket sides (T), place the assembly (O, P, Q, R, S) on end on a $\frac{3}{8}$ "-thick piece of maple and trace around it. Repeat the process on for a second side shape. Draw a diagonal line on each shape, where shown in the **Bucket Parts End View**. Bandsaw the sides, cutting just outside the lines.

4 Attach the bandsawn sides (T) to the bucket assembly (O, P, Q, R, S) with glue and $\frac{3}{4}$ " pin nails. Sand the proud bandsawn edges of the sides

flush with the bucket assembly, and break the edges.

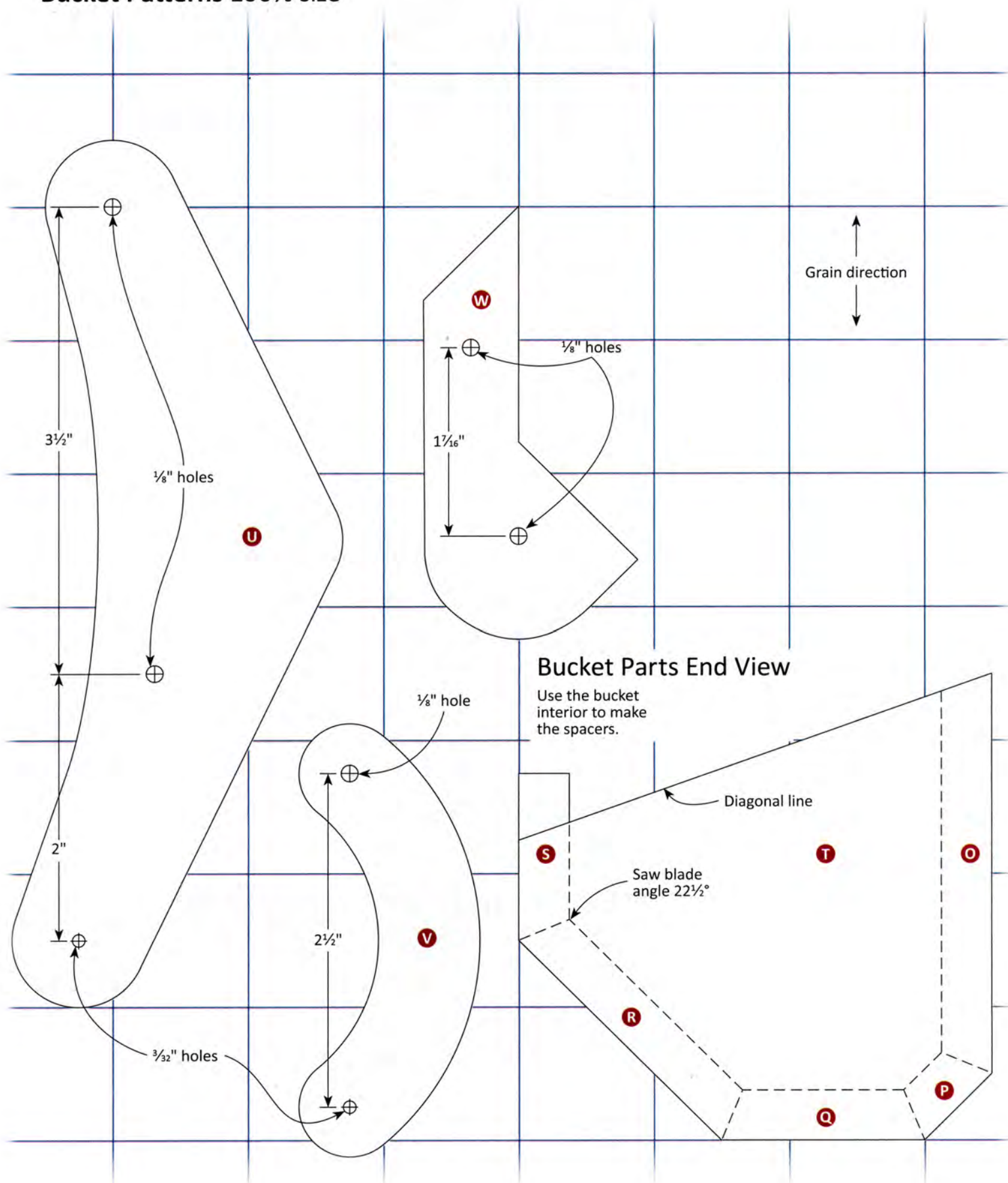
5 From two $\frac{3}{8}$ "-thick maple blanks, make the arm (U), knuckle (V), and bracket (W). To do this, make two copies of each full-sized pattern in the **Bucket Patterns**, and adhere them to the blanks. Then bandsaw or scrollsaw the parts to shape. When cutting the brackets to shape, double-check for a tight fit against the bucket shape. Sand or recut if needed. Drill the shank and pilot holes where indicated. Remove the patterns, and sand the sawn edges smooth, breaking any sharp corners.

6 Make an L-shaped spacer using two pieces of $\frac{1}{2} \times 2\frac{1}{2} \times 3\frac{5}{8}$ " MDF. Glue and pin-nail the pieces together to form the "L."



Clamp the taped and glued bucket parts to the custom spacers to create the bucket shape.

Bucket Patterns 100% size



Center and place the spacer on the bucket between the ends. Now, apply glue, position, and clamp the brackets (W) to the spacer, ensuring they're snug to the bucket. Drill pilot holes into the edges of the brackets, where shown in the pattern, and screw them in place (**Photo J**). Add two more screws from inside of the bucket. (See **Figure 5**.)

Finish-sand, apply finish, and assemble

1 Finish-sand all of the parts and assemblies to 220 grit. Wipe clean, and apply finish to the assemblies and unassembled parts. (I used Watco Satin Lacquer.) Apply finish to just the exposed ends (not the shanks) of the axle parts. Let the finish dry.

2 Assemble the two frames (A, B). To do this, place a fender washer between the two frames and on the #8 × 1½" roundhead screw before you drive it in place. (Tighten or loosen the screw to get the right pivoting action.)

3 Orient the left and right tires (N) so the recessed faces are



Center the brackets between the bucket sides, and glue and screw them in place, using a 3½"-long L-spacer.

on the outside. Place a small amount of glue in the axle peg holes, and then push the axle pegs through the tires. Fit nylon washers on the pegs, and then tap them into the frame holes, leaving a clearance equal to the

thickness of a business card for the tires to turn freely. Pin-nail the pegs to the frames (A, B).

4 Attach the bucket parts with roundhead screws and washers, as shown in **Figures 1** and **5**. Do not overtighten. ■

Convenience-PLUS BUYING GUIDE

□ 1.	#16N41	\$36.79
Large Circle Cutter		
□ 2.	#146950	\$8.50
Watco Satin Lacquer Spray, 16 oz.		
Above items are available at Woodcraft stores, woodcraft.com or by calling (800) 225-1153. Prices subject to change without notice.		
□ 3.	#AP3500	\$11.75
Axle Pegs, 2 9/16" L, 1 1/32" Tenons, 1/2" Heads, 100/pkg.		
□ 4.	#AP0900	\$3.50
Axle Pegs, 1 3/16" L, 5/32" Tenons, 5/16" Heads, 100/pkg.		
Above items are available at Woodworks Ltd., craftparts.com , or by calling (817) 581-5230. Prices subject to change without notice.		

Front-End Loader Cut List

	Part	Thickness	Width	Length	Qty.	Mat'l
A	Rear frame	3/4"	2 3/4"	7 1/4"	1	W
B	Front frame	3/4"	2 3/4"	7 1/4"	1	W
C	Cab front/back	3/4"	5"	3 3/4"	2	M/W
D	Cab sides	3/4"	5"	2 3/4"	2	M/W
E	Cab bottom	3/4"	1 1/4"	2 1/4"	1	W
F	Cab corners	1/4"	1/4"	5"	4	W
G	Cab top	3/4"	4 1/2"	3 1/2"	1	W
H*	Motor	3/4"	2 1/4"	3 3/4"	3	W
I	Hood	3/4"	2 1/2"	4"	1	M
J	Grill	1/4"	2 5/16"	2 1/4"	1	M
K	Bucket support	3/4"	2 3/4"	3 3/8"	1	W
L	Brace	3/4"	2 1/2"	2 1/2"	1	W
M	Handle	3/4"	2 3/4"	5"	1	W
N*	Tires	1 1/2"	3 1/2" dia.		4	M
O	Bucket bottom	3/8"	3"	5 1/4"	1	M
P	Small angle	3/8"	3/4"	5 1/4"	1	M
Q	Bucket back	3/8"	1 1/2"	5 1/4"	1	M
R	Large angle	3/8"	2 1/8"	5 1/4"	1	M
S	Top	3/8"	1 1/4"	5 1/4"	1	M
T*	Bucket sides	3/8"	4"	5"	2	M
U**	Arms	3/8"	2 3/4"	12"	2	M
V**	Knuckles	3/8"	2 3/4"	12"	2	M
W**	Brackets	3/8"	2 3/4"	12"	2	M

*Indicates parts are initially cut oversized. See instructions.

**Indicates parts are cut from two pieces of 3/8 × 2 3/4 × 12" maple.

#Indicates tires are made up of two opposing halves. See instructions.

Materials: W=Walnut, M=Maple

Hardware/Supplies: (16) #4 × 3/4" roundhead screws; (2) #4 × 1" roundhead screws; (1) #8 × 1½" roundhead screw; (8) #8 1½" flathead screws; (4) 3/8" nylon washers; (10) #6 flat nylon washers; (2) 3/16 × 1¼" fender washers; 3/4" pin nails.



Smoothing Curves

Trading lumps and bumps for fair lines

By Ken Burton

Incorporating curves into a piece of furniture can really delight the eye. The interplay between curved and straight lines can help ease transitions between sections and emphasize the overall form of a piece. Curves can also make elements appear visually lighter, more graceful, and even playful at times. Whether in the form of contoured edges, profiled moldings, or other shapely adornments, curves have a lot to offer your work.

However, they come at a cost. Curves take more time to cut than straight lines, and smoothing them demands a certain finesse. In fact, if not faired properly, curves can make a piece look worse rather than better. The last thing you want are bumps, humps, and other irregularities marring the otherwise elegant sweep of a leg or table edge. And, of course, curves must be clean and smooth as well as fair, without scratches, scorches, or machine marks calling attention to themselves.

The best approach to smoothing a curve depends on how well it was cut to begin with and whether a bandsaw, jigsaw, router, or some other tool was used for the job. In this article, I'll show you how to do the smoothing as quickly and efficiently as possible using common tools and shop equipment, as well as a few simple shop-made helpers.

Trimming with hand tools

A few particular hand tools can make short work of removing



A Flat-sole spokeshaves work well for convex curves, while curved-sole models are better suited to concave shapes.



B On convex curves, a block plane will serve to remove saw marks while fairing away lumps and valleys.

saw marks while smoothing out any lumps and bumps to fair a curve. Traditionally, woodworkers have turned to spokeshaves to handle this task (**Photo A**). A spokeshave is essentially a hand plane with a very short sole (either flat or curved), and handles that extend like wings out to either side of the blade. The short sole seats solidly against both concave and convex curves, and the handles allow either pushing or pulling the tool to suit the work. For convex curves, you can also press a block plane into service, as shown in **Photo B**. (For more on tuning and using spokeshaves, see *Woodcraft Magazine*, issue #38.)

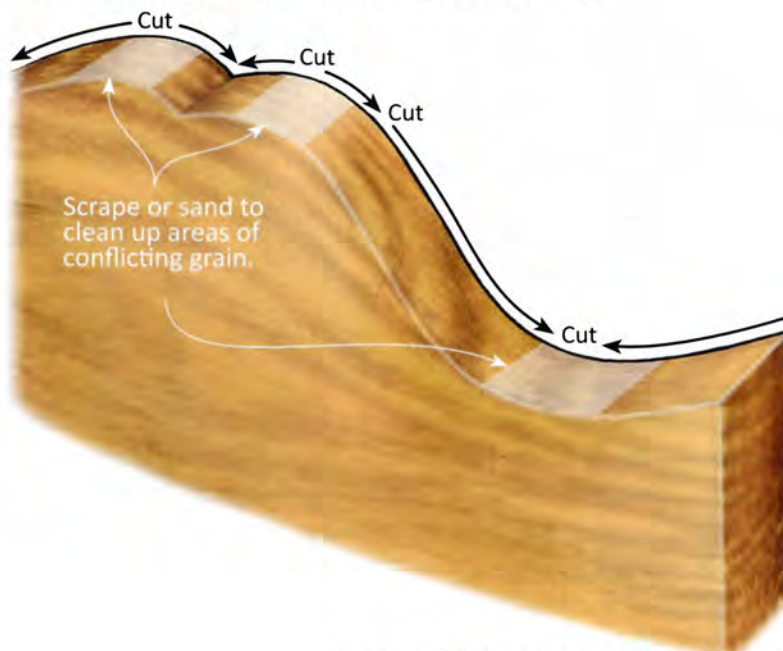
The trick to using these cutting tools effectively is to pay close attention to the grain direction. If you hold your workpiece in a vise with the grain running horizontally, cutting with the grain means cutting downhill, as shown in **Figure 1**. As the drawing indicates, the areas at the crest of a hill or at the bottom of a valley are problematic because it's here where the grain changes. Sometime a card scraper will help in these areas, or you may just have to sand away any tear-out.

Pave The Way With A Careful Cut

The cleaner and fairer a saw cut is to begin with, the less time you'll have to spend smoothing it, so learn to saw effectively. Regardless of whether you use a bandsaw, jigsaw, or scrollsaw to make a cut, keep a few key factors in mind:

First of all, use a sharp blade that is sized for the job at hand. For long, sweeping curves, a wide blade can help you keep the cut on track, while tighter curves demand use of a narrower blade. When cutting with a bandsaw or scrollsaw, push the workpiece with a smooth, sweeping motion rather than guiding it inch by inch. As you cut, stay about $\frac{1}{16}$ " outside your line to leave a little material for smoothing away the saw marks. If you veer too close to your cutline, don't suddenly veer away in correction. Instead, stop immediately, back up several inches, and then start feeding properly again.

Figure 1: Spokeshave Cutting Direction



How To Be Fair

A “fair” curve is one with a smooth sweep that’s free of visual or tactile humps and dips.

No matter what tools or techniques you use to fair your curves, make sure to continually monitor your progress as you work. Having a good layout line as a target definitely helps, but simply removing material to the line doesn’t necessarily guarantee a fair curve. To do that, you need to tune in with both sight and touch.

As you work, occasionally run your hand along the curve. You may be surprised at how receptive your fingers are to imperfections. Try using your non-dominant hand, which may be more sensitive than your dominant hand because it hasn’t been worked as hard. When irregularities start disappearing to the touch, scrutinize the curve from a low, raking angle, which will accentuate any remaining imperfections.



Sighting along the curve from a low, raking angle visually foreshortens it, rendering any lumps, bumps, or flats much more obvious.

Power sanding

As much fun as spokeshaves are to use, they do require a certain amount of finesse and patience. A quicker, if less elegant, solution is to turn to power abrasives. If you have the resources and space, a stationary belt sander or a belt/disc combination machine can do a lot of the grunt work of truing up curves. A benchtop model will work almost as well. For convex curves, simply hold your piece

flat on the table, and sand to your layout line, as shown in **Photo C**.

For concave curves, the ideal tool to use is an oscillating spindle sander (**Photo D**). Whether a floor or benchtop model, a spindle sander accepts drums of different diameters to suit a variety of curves. As opposed to the type of drum sander you might use in a drill press, a spindle sander rises and falls as it rotates. This makes for a cleaner, more

aggressive cut while virtually eliminating the chance of scorching or burnishing the work.

When using a spindle sander, choose the largest diameter drum that fits the curve you’re smoothing. The broader surface contact helps prevent you from sanding divots into the edge of the workpiece. As when working with any power sander, use a light touch and keep the workpiece in constant motion, feeding it against the rotation of the spindle as you work to your line.

Your stationary belt sander can also serve for sanding some concave curves. Although there are very few instances when you should use a machine without its guards in place, this is one of those times. Removing the top belt guard presents the machine’s upper drum for use as a sort of spindle sander (**Photo E**). The shortcoming is that you won’t have a table to help support your workpiece. All the same, the approach can be useful if you don’t have a spindle sander. Just make sure to stand off to the side of the machine to avoid a face full of dust.



C When sanding a convex curve on a stationary sander, keep the piece moving in a consistent sweeping stroke to fair and smooth the curve.



D To get the fairest curves and longest abrasive life from a spindle sander, use the largest drum that the curve will accommodate.



E When shaping curves on the drum of a stationary belt sander, hold the piece perpendicular to the axis of the drum, and check your progress frequently.



F A portable belt sander clamped sideways next to a raised platform on a bench becomes a stationary sander for smoothing both concave and convex curves.

If your budget and/or shop space doesn't allow for dedicated stationary sanders, you can sometimes trick out other machines to do the work. For example, try tipping a portable belt sander on its side and clamping it to your workbench. Then use scrap plywood to make a raised platform that sits at the level of the abrasive (**Photo F**). The drum at the tool's nose approximates a spindle sander for smoothing concave curves, while the flat platen

section works fine for convex edges. As you sand, move your workpiece in the direction opposite the belt rotation.

You can also use your drill press as a drum sander by mounting commercially available sanding drums into the drill chuck. Add a platform with a hole in the center so you can support your work perpendicular to the drum, as shown in **Photo G**. By raising or lowering the drill press table, you can adjust the point of sanding contact, thus maximizing

the life and effectiveness of the abrasive. Because the drum doesn't rise and fall, it's not as effective as a spindle sander, but it's the next best thing.

Alternatively, you can quickly throw together a shop-made mini-drum sander with nothing more than a 3" length of 1/2"-diameter dowel (**Photo H**). Cut a 2"-long slit down the center of the dowel, fold a 4 × 5" strip of sandpaper in half lengthwise, and insert it into the slit with most of the abrasive projecting to one side. Chuck the dowel in your drill press, set the machine for a slow to medium speed, and feed your workpiece against the dowel. The abrasive will wrap around the dowel, effectively creating a sanding drum. As the paper wears, simply tear off the used section to expose fresh grit.



G A boxed platform that accommodates a sanding drum substitutes for a spindle sander. A port in the side allows attachment to a shop vac.

Tip Alert

Sanding end grain with power tools can create enough heat to scorch or even crack your workpiece. To avoid this, use a light touch, keep the piece moving, and make sure to use sharp, clean abrasive.



H Insert a scrap of sandpaper into a slotted dowel to turn your drill press into a sort of mini drum sander.



I With a tablesaw-mounted sanding disc, work only off of the forward half of the disc, which is spinning downward into the saw slot.

You can convert your tablesaw into a disc sander using a commercially available steel plate designed for the job (**Photo I**). You'll also need PSA (pressure-sensitive adhesive) sanding discs to mount on the disc. One neat feature of these tablesaw sanding discs is that you can tilt them to sand bevels. Unfortunately, a tablesaw-mounted disc spins considerably faster than one on a typical disc sander, necessitating a very light touch to avoid burning your material.

Hand-sanding

Whether you've done the brunt of fairing and smoothing your curves with spokeshaves or power-sanding equipment, eventually you'll need to break

out the sheet sandpaper to finish up with hand-sanding. Whenever possible, the trick to hand-sanding curves is using a backer block that's shaped to complement the workpiece curve. This works best

Sanding Block Stock

A good sanding block should be firm, yet resilient. For working flat surfaces, a solid block of cork about 1" thick is ideal. You can provide this same resilience to a curved sanding block by gluing a layer of sheet cork to it. Another option for sanding block material is polystyrene, commonly available as rigid insulation for the building trade, inexpensive food coolers, and internal product packaging reinforcement. Both cork and polystyrene can be easily abraded to create sanding blocks that complement almost any curve.



J To refine the shape of a complementary sanding block, line the workpiece curve with sandpaper and rub the block against it.



K Even if the curve on an offcut is a bit lumpy, it will serve as a sanding block to fair the curve on the piece from which it was sawn.

Tip Alert

When hand-sanding curves, begin with the finest grit that will remove any spokeshave tool marks, saw marks, or power-sanding scratches before working your way up through the finer sanding grits.

when the curve you are dealing with is a true arc—a segment of a circle. Fortunately, many of the curves woodworkers deal with are true arcs or close to it.

To make a complementary sanding block, first establish the radius of the arc by using a compass or by tracing the workpiece curve directly onto the block. Then cut the block on the bandsaw, staying a bit proud of your cutline. Finally, sand away the saw marks to arrive at the line. In some cases, you can refine the sanding block by abrading it against a workpiece curve that's lined with sandpaper, as shown in **Photo J**.

Another option is to use the offcut from the workpiece curve as a sanding block. As long as you are reasonably careful when making the initial cut, the waste piece should be almost a perfect match to the curve you are trying to smooth. Wrap a piece of sandpaper around this scrap, and use it to refine the curve on the mother piece, as shown in **Photo K**. ■

About Our Author

Ken Burton has been working wood for over 30 years and writing about it nearly as long. He offers classes at his studio in New Tripoli, Pennsylvania. Visit www.wrwoodworks.com for details.

Sanding Profiles

Shaped profiles can be troublesome to smooth, so aim from the start to minimize the amount of cleanup they might need. When machining them, use sharp bits that cut cleanly and produce crisp edges. All the same, there will be times when you'll need to sand a profile at least somewhat.

Shaped profiles typically don't require fairing. In fact, as you sand, try not to deform the shape or dub over the edges. Toward that end, contour sanding pads can be a big help. Sometimes called "tadpole sanders," these resilient backer pads are available in a variety of profiles for detail sanding of all sorts (**Photo 1**). Pick a shape that matches a section of your profile, wrap it with sandpaper, and you're in business.

Another commercially available sanding accessory is a sanding mop, which is essentially a bundle of narrow strips of sandpaper attached to a mandrel for mounting in your drill press (**Photo 2**). As you hold your workpiece against the mop, the abrasive strips conform to the profile, smoothing it without altering the piece's shape.

Finally, you can make a custom sanding block that conforms to the workpiece profile, using a relatively soft material such as Homasote or polystyrene. Attach sandpaper to a sample of the profile using double-faced tape. Then rub your sanding block over the sample to cut the profile into the block, as shown in **Photo 3**. Then line the sanding block with sandpaper to smooth the workpiece.



Contour sanding pads allow you to smooth a complex profile by targeting one section at a time.



A sanding mop smooths molding profiles in much the same way brushes in an automatic car wash clean your vehicle.



Line a profile sample with sandpaper, and then rub a block against it to create a complementary sanding block.

Coopered Leg Table

Turn a curve with straight stock, one stave at a time.

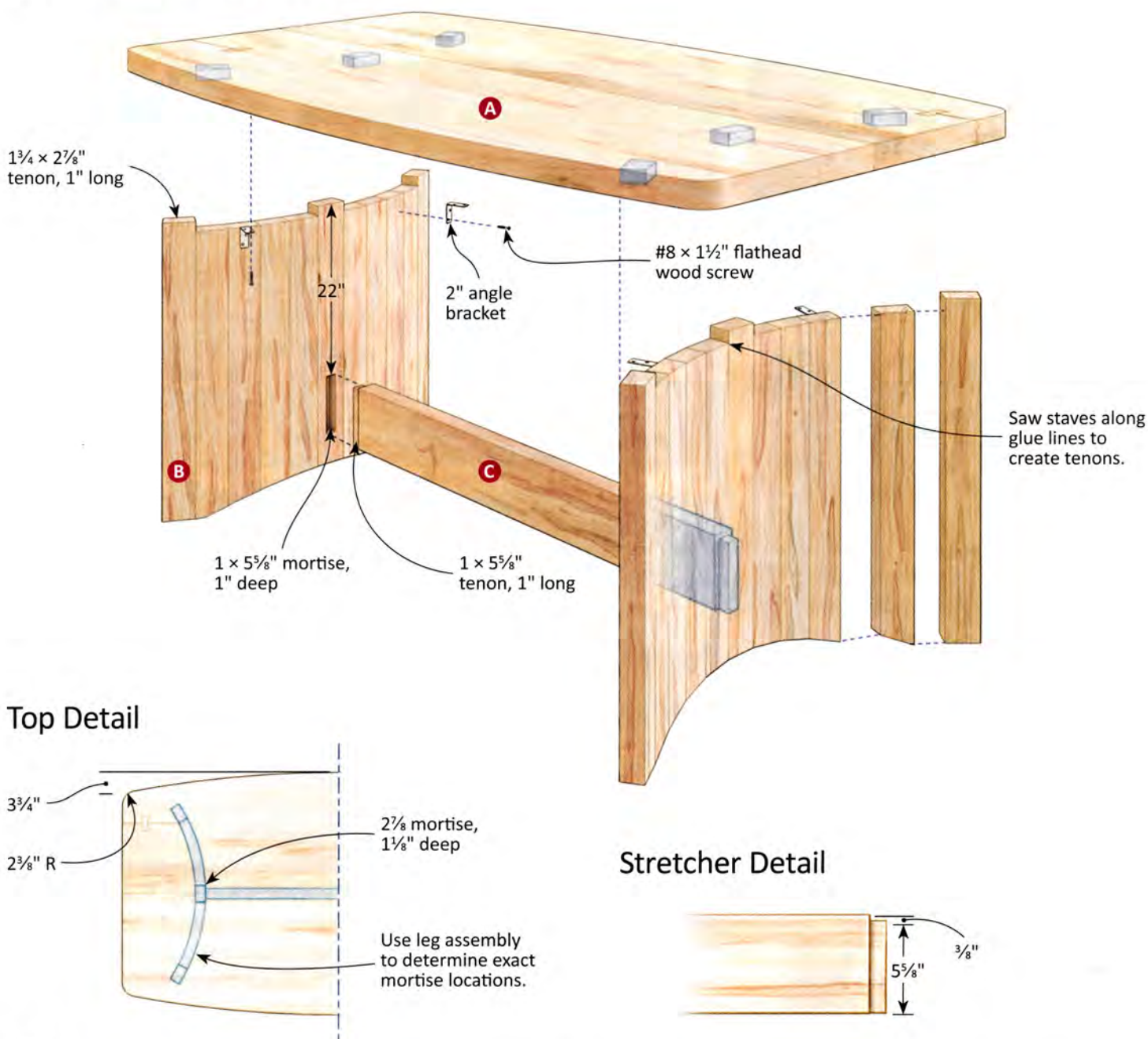
By Tommy MacDonald



**Read the story, watch the show,
build the table.**

If a picture's worth a thousand words, what's a half-hour video worth? To find out, go to www.thomasjmacdonald.com and watch the complete Coopered Leg Table episode from *Rough Cut Woodworking with Tommy Mac*, Season 3.

Figure 1: Table Exploded View



This dining table was inspired by a *Rough Cut* Road Trip to Napa Valley, California. The top, with its cask-shaped profile, only hints at the source of my design. However, the legs—made by beveling the edges of narrow stock and then assembling them edge to edge to create a curve—are an obvious tip of the hat (or glass) to the wine barrels of this celebrated wine region. Barrel making, or *coopering*, is a craft from which I

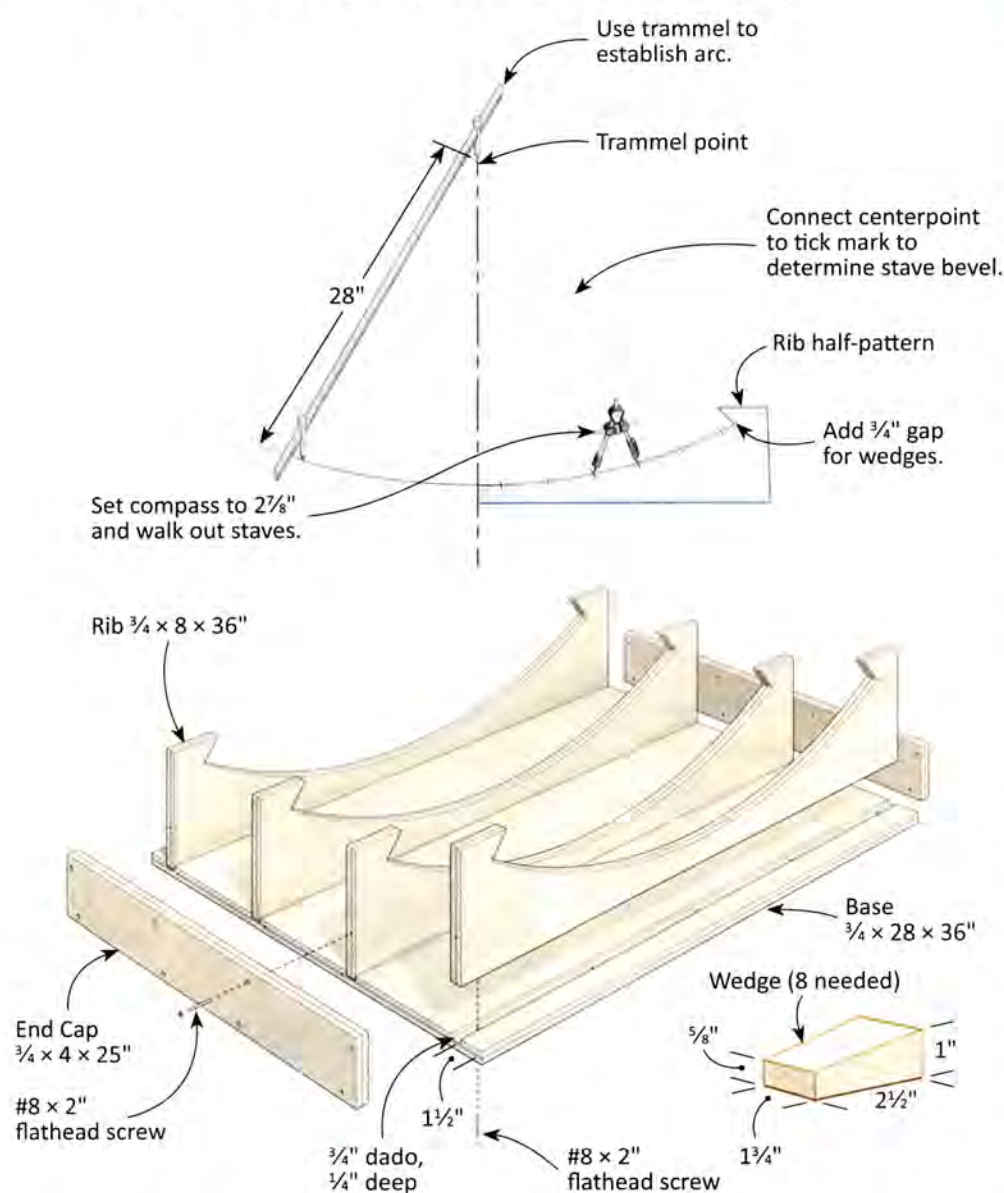
borrowed to make the legs for this table. To try your hand at stave work, all you need are some thick strips of stock, a full-scale layout, and a custom clamping jig. Once you understand the procedure, you can create stave-built arcs in a variety of shapes and sizes.

I chose ambrosia maple because the dark streaks on the light wood make for striking patterns on the legs and top. Straight-grained oak, cherry, beech, or clear maple

would make an equally handsome looking table. (Of course, the availability of thick stock in your area might ultimately influence your decision.)

Wide slab tops often have a few cracks or checks. You could trim off blemishes, but I think they add to the character of the piece, provided that they are kept under control. To learn how to stop cracks in their tracks, check out “Butterfly Basics” on page 56.

Figure 2: Curve Layout and Coopering Jig



Select your stock

1 Starting with $\frac{3}{4}$ " (2"-thick) stock, select your best-looking boards to make the 42"-wide top (A). (I made my top from two 12'-long $\times$ 16"-wide

Tip Alert

Ask your lumber dealer about skip, or "hit or miss," planing. This initial planing will not eliminate twist or cupping, but it will save you some work and offer a better look at the grain for initial layout.

boards. You may need to use a few more boards to achieve the necessary width.) Put those boards aside for now.

2 Rip the remaining stock to fit your jointer, and then thickness the boards to $1\frac{3}{4}$ "-thick to make the staves (B) and stretcher (C). Using the **Cut List** and **Figure 1** as a guide, cut these pieces a few inches longer and $\frac{1}{2}$ " wider than the final dimensions. (Note: Make a few extra staves for bevel angle setups. The extra pieces may also prove useful when composing the grain pattern on the leg assemblies.)

Cooper the legs

1 Using a trammel, lay out a 28"-radius arc on a piece of rosin paper or scrap plywood, as shown in **Figure 2**. To determine the width of the arc needed to make the ribs for the coopering jig, adjust a compass to $2\frac{7}{8}$ ", straddle the centerline, and then "walk" it along the arc five steps in one direction, and six steps in the other, making tick marks as you go. Add another $\frac{3}{4}$ " to both ends to allow space for clamping wedges.

2 Cut along the outside edge of your paper pattern, and use it to lay out a master rib on a piece of $\frac{3}{4}$ " plywood. Use a jigsaw to cut the curve, and then use this master rib as a pattern to make three more. Cut the remaining parts, and assemble the **Coopering Jig**.

3 Using your paper full-scale layout, draw a line connecting two adjacent tick marks and a second line connecting a tick mark to the arc's centerpoint. Using a bevel gauge, set the body against the short line, and align the blade to the long line to obtain the stave bevel, as shown in **Photo A**. The exact degree isn't critical, but the angle should be approximately 87° . (Note: Keep your pattern, as you'll use it again later to lay out the curves on the bottom ends of the leg assemblies.)

4 Using your previously set bevel gauge, angle the tablesaw blade, as shown in **Photo B**. Locate the rip fence the proper distance from the blade, with the blade leaning away from it. (On a right-tilt saw, the fence would be to the left of the blade.) Rip the bevel on one edge, rotate the stock end for end, and then rip the opposite edge (**Photo C**).

5 To check your angle, crosscut your test stave into a few 3"-long



A Set your bevel gauge on the full-scale layout to obtain the exact stave angle.



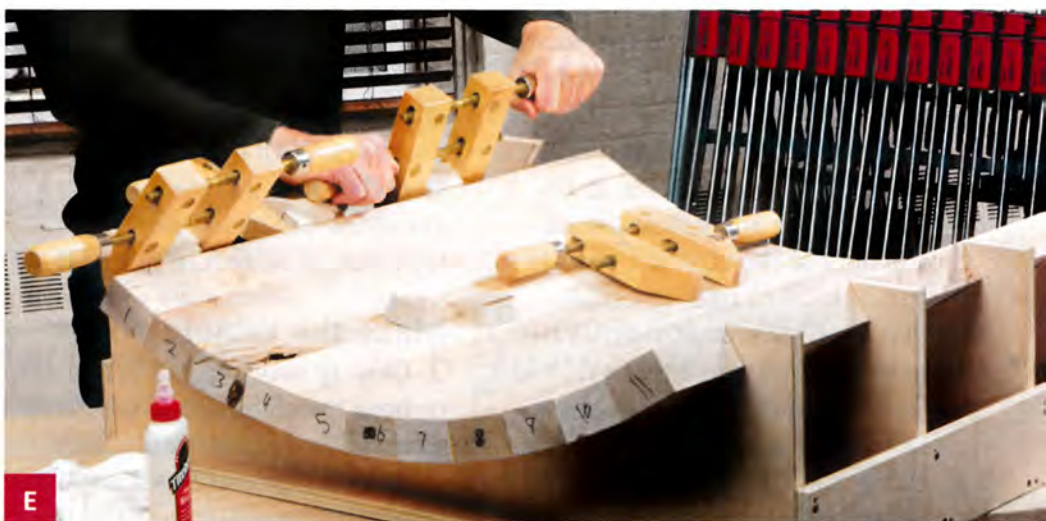
B Place the gauge between the saw teeth, and adjust the bevel angle until both blades touch.



C With the blade tilted away from the fence, bevel both edges of the test stave.



D Position the test slices on the jig to check the stave angle. Adjust your saw as needed for a seamless fit.



E Squeezing pairs of opposing wedges together with wooden handscrews directs clamping pressure across the curve of the jig.

slices, position them on a rib, and check for gaps (**Photo D**). If necessary, adjust the bevel angle and rip another test stave before ripping the remaining staves.

6 Working one leg at a time, arrange the pieces for best color and grain composition. When you're happy, record the stave positions numerically on the ends. Next, rehearse your glue-up procedures, inserting opposing wedges between the jig's rib shoulder and the edge of the outermost stave, as shown in **Photo E**. Check the edge joints for intimate contact, noting any gaps. Disassemble

the staves and use a hand plane to correct any ill-fitting joints or to remove any residual mill marks on the faces of the staves.

7 Apply glue to the inside edges of the three staves nearest the wedges. Align the ends of the staves, and clamp them together by sandwiching them between the wedges and the still-unglued staves. (If a stave starts to slip, tap the face into alignment using a hammer and wood block.) Allow time for the glue to set, and then continue the gluing and wedging process, adding two or three staves at a time until you have completed

the entire leg assembly. Repeat with the second leg assembly.

8 Square off one end of each leg assembly. Trim the end, as shown in **Photo F**, and then lay out a second line and cut the legs to final length.

9 Using the paper pattern you made earlier, trace the curve on the bottom end of both leg assemblies, as shown in **Figure 1**. Make the cut with a jigsaw. Then smooth the curve using files, rasps, and sandpaper.

10 Using your glue lines as a guide, lay out and cut the tenons on the top end of the legs, where shown in **Figure 1**. You can use



Use the coopering jig to steady the leg assemblies when trimming the ends. Remember to provide support for the jig at the end of the cut.

your bandsaw and coopering jig, or a jigsaw, to remove the waste.

11 Lay out the mortises for the stretcher (C), where shown in **Figure 1**. Using a handheld drill and 1" Forstner bit, drill overlapping holes to excavate the bulk of the mortise, and then use a chisel to pare the sides (**Photo G**). Alternatively, you could rout out the mortise.

12 Cut the stretcher (C) to the size shown in the **Cut List**. Using a marking gauge and combination square, lay out the $1 \times 5\frac{5}{8} \times 1$ " tenon on both ends. Outfit your tablesaw with a dado head, and cut the tenon. (If your tenon's fat, trim

the cheeks to fit with a shoulder plane.)

13 Apply glue to the stretcher tenons and leg mortises. With help, fit the stretcher into its mortises, and draw the base assembly together, as shown in **Photo H**.

Make the tabletop

1 Glue up your top (A). When dry, remove the clamps, and establish a centerline on the bottom face.

2 Using a piece of $\frac{1}{2} \times 22 \times 72$ " MDF or plywood, create a half pattern/template for your top. (To establish the curve, I flexed a metal rule and traced its edge.) Using a bandsaw or

jigsaw, cut the pattern just outside of your line, and then use a file or sanding block to establish a fair curve that's free of humps or divots.

3 Trace the outside edges on your top. Using a jigsaw with a fresh blade, cut about $\frac{1}{8}$ " outside of your line. Repeat the process with the remaining corners.

4 Using your pattern as a template, align its inside edge with the centerline, secure it with a few short screws, and flip the tabletop over. Outfit a handheld router with a 2"-long bottom bearing bit, and rout the edge, as shown in **Photo I**. Reposition and reattach the pattern as needed to finish shaping the remaining corners.

5 With the tabletop upside down on your bench, center the inverted base on top of it. Using a pencil or marking knife, scribe around the tenons, as shown in **Photo J**. Remove the base, and then excavate the mortises. (I hogged out most of the waste using a handheld drill and $1\frac{5}{8}$ " Forstner bit, and then used a chisel to pare to my layout lines.)

6 Fasten the leg assembly to the tabletop using 2" angle brackets and $1\frac{1}{2}$ "-long screws, where shown in **Figure 1**.



Pinching the blade affords more control than holding the chisel by its handle.



Apply even pressure along the sides and ends of the leg assembly. A gap along one shoulder indicates that one clamp is tighter than the other.



Use a template to tackle the curves. Increase your feed rate if your bit leaves burn marks.

Two Bits Are Almost As Good As One

If you don't have a router bit that's long enough to rout the full thickness of the tabletop edge in one pass, you can do the job with two shorter bits. Using the pattern as a guide, rout half the thickness with a top-bearing (pattern) bit. Then, flip it over and use a bottom bearing (flush trim) bit to complete the cut. Adjust the bit depth so that the bearing rides against the freshly cut section.

Finishing touches

1 To flatten the tabletop, I used a jointer plane, first working perpendicular or diagonally across the grain to level any high spots. Then, I worked from end to end along the grain using a smoothing plane. (*Note: There's a difference between "reasonably" and "perfectly" flat. Stop when it looks good. If*

For more information, see "Flattening Boards by Hand," at woodcraftmagazine.com/onlineextras



Center the base on the inverted tabletop, and mark the mortise locations. Make the mortises $\frac{1}{8}$ " deeper than the tenon's length to ensure contact with the top of each leg.

you aren't comfortable with the hand tool approach, you can flatten the top with a belt sander.)

Use a scraper to remove plane tracks and/or machine marks.

2 Inspect the slab for cracks or checks. To fill minor defects such as tight cracks and knots, I use five-minute epoxy. To do this, mix the resin and hardener, overfill the crack slightly, and then scrape it flush when cured. (Larger cracks require additional reinforcement, such as the butterfly keys shown on page 56.)

3 Detach the tabletop from the base. Finish-sand all surfaces through 220-

grit, then apply your finish.

(I sprayed on five coats of lacquer, sanding between coats with 320-grit sandpaper.)

4 Reassemble your table in its new home. ■

About Our Designer/Builder

Tommy MacDonald is a furnituremaker and host of *Rough Cut Woodworking with Tommy Mac* on public television (check local listings). He lives and works near Boston.

Coopered Leg Table Cut List

	Part	Thickness	Width	Length	Qty.	Mat'l
A*	Tabletop	1¾"	42"	72"	1	AM
B*	Staves	1¾"	2⅞"	29"	22	AM
C*	Stretcher	1¾"	6"	46"	1	AM

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

Materials: AM=Ambrosia Maple

Hardware: (16) #8 × 1½" flathead screws; (4) 2" angle brackets

Convenience-PLUS BUYING GUIDE

☐ 1.	Whiteside 2408 Flush-Trim Router Bit, ½" D, 2" CL, 4" OL (½" SH)	#24A74	\$28.99
☐ 2.	5-Minute Epoxy, ½ pt.	#124270	\$20.99
☐ 3.	Enduro Waterborne Pre-cat Urethane, satin, gal.	#843369	\$64.99

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



Butterfly Basics

Stop cracks in their tracks in just 6 steps.

By Tommy MacDonald

Wide slab tabletops are beautiful but, even when properly seasoned, big boards often include checks (splits along the ends). Gluing and clamping a crack might seem like a fast and easy fix, but any success will likely be short-lived as the internal forces that caused the crack will probably open it again or create another crack. Ripping the plank into thinner sections, jointing the edges, and reassembling the top will relieve the stress but, in addition to the extra work,

milling creates unsightly interruptions in your grain lines.

When I want to stop the crack and save the plank, I use butterfly keys. They are nothing more than custom-shaped splines that span the width of the opening. Despite their delicate-sounding name, they provide a sturdy means of limiting further separation.

Historically, keys were made from matching wood in order to conceal patches. These days, they are usually cut from a contrasting species, thereby turning a flaw into a decorative detail.



A Perfect Fit from a Router Bit

If you need to make multiple butterflies, or if you prefer a power-tool approach, you can make perfectly-fitting keys with a plunge router and inlay set (09116, \$48.99) and either a shop-made or store-bought template (146903, \$26.29).

To make the key, use the template guide and bit to rout the key stock. To excavate the mortise, position the template on your work, install the bushing on the guide to offset the bit, and then rout the mortise.

Note that the 1/8" bit is fragile. For large keys (and deep mortises), you might want to stick with my technique.

Creating custom keys doesn't require any special tools or jigs. To see how to save your next slab, follow the steps shown here.

Note: I'm not including a pattern because I think you need to let the piece determine the key's size and shape. A key should be large enough to limit further wood movement, but not so large as to become visually overpowering. (Keys typically range from 1/4" to 3/4" thick, depending on the slab's thickness.) For long cracks, two or three keys might be better than one.



After creating a paper pattern to suit the target crack, trace the shape onto a straight-grained piece of wood. Then bandsaw the key to shape, and clean up the edges with a sharp chisel.



Orient the key perpendicular to the crack, and lay out the mortise with a sharp-tipped pencil or marking knife. Apply a firm grip, or use a clamp to secure the key as you trace around it. (When making multiple keys, number each to ensure a match with its particular mortise.)



Excavate the bulk of the mortise with Forstner and brad-point bits. Make the mortise about $\frac{1}{8}$ " shallower than the key thickness. Wrap tape around the bit to serve as a depth gauge.



Using a sharp chisel, carefully chop up to your layout lines. (When test-fitting the key, be careful not to force it. Wiggling the key in and out may compromise the final fit.)



Chamfer the bottom edges of the key to ease its insertion and to create small pockets for excess glue at the inside bottom corners of the mortise.



Apply a thin layer of glue to the inside of the mortise, and then tap the key home. After the glue has dried, plane across the patch until it's almost flush with the top, and then finish up with a cabinet scraper and random-orbit sander.

Adirondack Table and Footstool

Add these companion pieces to your Adirondack chairs.

By Bill Sands



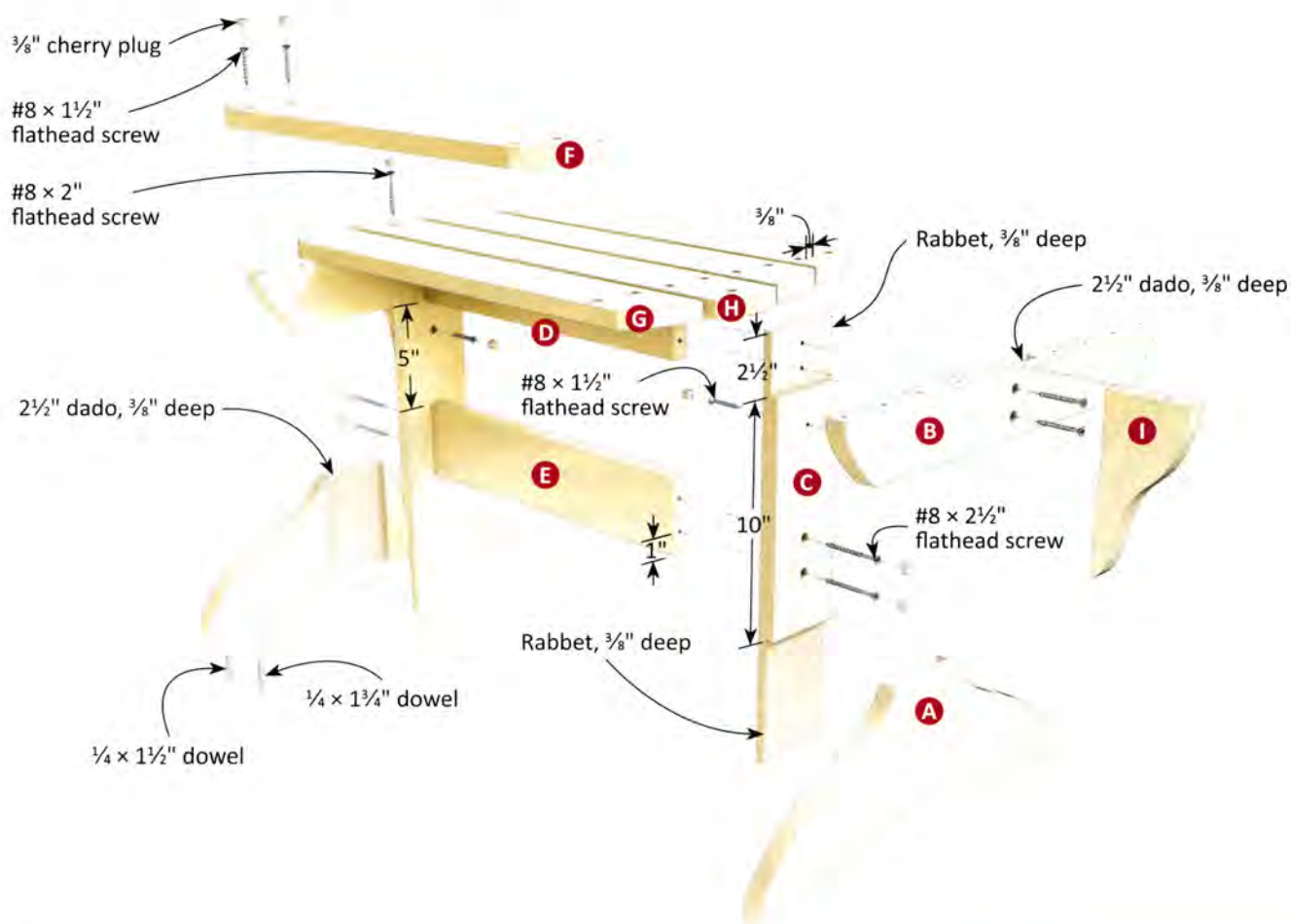
Ordering the Adirondack Chair Plan

To purchase the Adirondack chair plan either as a download or an enlarged paper plan with full-sized patterns, go to woodcraftmagazine.com

You've made an Adirondack chair and would like to complement it with a matching table and footstool. Well, you're in luck. Working from *Woodcraft Magazine's* Adirondack chair plan, I designed the easy-to-build pieces shown here. Using $\frac{3}{4}$ "-thick milled cedar, I'll show you how to make the table first, and then the footstool. You say you don't have the chair? No problem. Check out the box at left.

Adirondack Table

Figure 1: Table Exploded View



Start with the leg assemblies

1 Mill enough 3/4" stock for the table. (See the **Cut List**.) Use a wood that resists rot and decay such as redwood, cedar, or cypress. I used cedar.

2 Copy and enlarge the **Foot Half Pattern** in **Table and Footstool Patterns**. Cut it out and use it to make a whole full-sized foot template on a 6 1/2 x 18 3/8" piece of 1/2"-thick plywood, bandsawing the piece to shape and sanding to the cutline.

3 Joint the edges of the planed boards from **Step 1**. Now, lay the bottom edge of the template flush with a jointed edge and in a knot-free section. Trace

out two feet (A). Crosscut the board sections containing the feet outlines oversized.

4 Cut the blanks for the slat supports (B) to 2 1/2 x 18 3/8". Now, cut the blanks for the uprights (C) to 3 1/2 x 19 3/4".

5 To make the half-lap joints shown in **Figure 1**, you need a dado set, sacrificial miter gauge extension fence, stop, and spacer block. The spacer block—precisely made—helps establish the dado widths in the feet (A) and slat supports (B). First, crosscut the spacer block to 4" long. To establish the width of the spacer block, temporarily install your 3/4" dado set, and measure its exact width. Subtract that dimension

Tip Alert

When working with cedar, you'll likely find a lot of knots. Buy extra stock in order to use only the clearest wood to maximize structural integrity.

from 3 1/2"—the distance from your saw fence to the outside of the dado set once your saw is set up to cut the dados. Now, switch to a standard saw blade, and rip the spacer to width using the resulting dimension.

6 Reinstall the 3/4" dado set, and add a sacrificial extension fence to your miter gauge. Now, using two scrap pieces of the 3/4"



Place the test pieces on a flat surface rabbet to rabbet. Feel if the joint is flush. Recut if needed.

milled stock, raise the dado set to slightly less than $\frac{3}{8}$ ". Cut rabbets on the ends of the two test pieces, and check for a flush fit using your finger to detect any unevenness (**Photo A**). Raise the blade as needed to sneak up on a perfect half-lap joint.

7 Find and mark the centers of the feet (A) layouts on the board sections. Using these centers and the straight jointed edges of the boards, lay out the $3\frac{1}{2}$ " wide half-lap dadoes for the feet (A), extending the lines onto the edges of the boards. Set up a stopblock to align a dado layout line with the outside edge of the dado set. Make your first dado cut. Now, insert the spacer made in **Step 5** between the stopblock and the foot workpiece, and make a second shoulder cut, as shown in **Photo B**. (The distance between the shoulders of the dado cuts should be $3\frac{1}{2}$ ".) Remove the spacer block, and cut out the waste between the outside dado cuts. Repeat for the second foot. Set the feet aside.

8 Retrieve the slat support blanks for parts (B), and repeat the process to dado-cut the half-laps here as well. Relocate the stopblock as



Cut the second dado shoulder cut in a foot blank, using a stopblock and spacer block at the saw. Remove the waste between the shoulder cuts.

needed to ensure that the half-lap dadoes are centered.

9 Retrieve the two uprights (C), and lay out the half-lap rabbets, where shown in **Figure 1**. Note that the first layout line measures $2\frac{1}{2}$ " from the top end, and that the second is 10" from the first mark. Cut the rabbets, and remove the waste with the dado set.

10 Retrieve the foot template, and place it on a foot (A) blank, centering the template's top edge with the dado and flushing the bottom of the template with the straight bottom edge of the blank. Trace around the template, and bandsaw the foot to shape, cutting just outside the line. Repeat for the remaining foot.

11 Position and adhere the leg template to the feet with double-faced tape. Install a flush-trim bit with a top and bottom bearing in your router table. Flush-trim the edges of the feet, as shown in **Photo C**, adjusting the bit as necessary to always rout with the grain or downhill to prevent tear-out. This will require flipping the workpiece over to guide off each of the bearings as needed.

12 Use the lower portion of the foot template to trace the curved ends of the slat



Flush-trim the foot, cutting with the grain while guiding off the template with the bearing.

supports (B). Align the lines on the template with the edges of the half-lap dado. Bandsaw the ends to shape and sand them to the line at the disc sander.

13 Joint the edges of the two uprights (C) to fit snugly into the mating half-lap dadoes in the feet (A) and slat supports (B).

Tip Alert

After cutting the feet, drill $\frac{1}{4}$ " holes in the bottom edges with a doweling jig (see the **Leg Template Half Pattern**). Glue in $\frac{1}{4}$ " dowels to prevent breakage.

14 With the uprights (C) in place and flush with the top edges of the slat supports (B), temporarily fit the feet (A) onto the uprights. Mark and bandsaw the bottom ends of the uprights to just outside the marked lines to remove waste.

15 Glue and clamp the joints, using enough clamps and cauls to press the leg assembly parts (A, B, C) firmly and fully together. (Note that the moisture in the glue will cause the rabbeted ends to cup.) Remove any squeeze-out. Once the leg assemblies are dry, flush-trim the bottom ends of the uprights flush with the feet.

Add the rail and stretcher

1 Lay out, drill, and counterbore the screw holes on the outside faces of the leg assemblies (A/B/C), where shown in **Figure 1**.

2 Cut the rail (D) and the stretcher (E) to the sizes in the **Cut List**.

3 Clamp the rail (D) and stretcher (E) between the leg assemblies (A/B/C), where shown in **Figure 1**. (I built the assembly upside down on a flat work surface for ease of construction.) Guiding off the countersunk holes, drive the $\#8 \times 2\frac{1}{2}$ " screws to secure the parts in place. Install the plugs.

4 Using a flush-cut saw, trim the plugs a hair proud of the surface, and then sand them flush with a sanding block.

Tip Alert

To save time, I used store-bought cherry plugs rather than cut the plugs with a plug cutter.



After installing the center slat, use a pair of spacers to locate remaining slats, securing them with screws.

Cut and add the slats and corbels

1 From the $\frac{3}{4}$ " planed stock, cut the five tabletop slats (F, G, H) to the same width, and then to the lengths in the **Cut List**.

2 Make the slat screw-hole template with end profiles in the **Table and Footstool Patterns**. Note that each end of the template provides a different profile and screw-hole locations for the slats. Now, use the template to lay out the curves and screw-hole locations that index off the ends of the slats.

3 Bandsaw the slat curves outside the line, and sand to the line. Check that the marked hole locations center on the top frame edges. Then drill the counterbored holes where marked.

4 Screw the slats in place by locating the center slat (H) and screwing it to the slat supports (B) using $\#8 \times 1\frac{1}{2}$ " screws. Cut a pair of $\frac{3}{8} \times 2 \times 4$ " spacers from scrap to position the remaining slats. Now, using the spacers, attach the remaining slats (F, G), as shown in **Photo D**.

5 Make a routing template for the corbels (I) by enlarging the gridded pattern to full size and



Keep fingers out of harm's way by laying out the corbels on a longer workpiece to safely cut the curves.

applying it to a $\frac{1}{2}$ " piece of scrap plywood. Bandsaw and sand the template to shape. Next, cut a corbel blank to $\frac{3}{4} \times 3 \times 20$ ".

Lay out a corbel on each end of the blank using the template. Bandsaw the corbels to rough shape, as shown in **Photo E**. (The extra length of the blank allows for safe flush-trimming in **Step 6**.)

6 Use double-faced tape to adhere the template to one end of the bandsawn corbel blank, and flush-trim the curved edge of one corbel (I), flipping the blank as needed to always rout downhill. Flush-trim the other corbel. Remove the template, sand the corbels, and crosscut them to final length.

7 Locate and drill the counterbored holes for attaching the corbels in the center slat (H) and leg assemblies (A/B/C), where shown in **Figure 1**. Screw the corbels in place.

8 Plug all remaining counterbored holes and flush the plugs. Break the sharp edges of the parts with a sanding block, sand the piece through 220 grit, and apply a finish. (I applied three coats of General Finishes Milk Paint in buttermilk yellow.)

Adirondack Footstool



With a frame side clamped to the workbench, drive screws through the counterbored holes to secure the front and back; check the frame for square.



Plane the top edge of the front to match the curved sides.

Make the top frame first

1 Gather up enough $\frac{3}{4}$ "-thick cedar stock milled earlier for the footstool parts, referring to the **Cut List**.
2 Make a full-sized copy of the gridded **Side Pattern**. Adhere it to a $\frac{1}{2}$ " piece of plywood, and rough-cut it to shape. Sand the piece to the pattern lines to create the routing template for the sides (A).
3 Crosscut two pieces of 1×8 " cedar to $18\frac{1}{4}$ " long. Lay the side template on the cedar pieces, and trace the top and bottom curves on the parts. Bandsaw the curves, cutting just outside the lines.

4 Adhere the side template with double-faced tape, and, using a flush-trim bearing bit in a router table (I used a flush-trim bit with over-under bearings), flush-trim the curves on the side (A), cutting with the grain. Repeat for the other side. Set the parts aside.
5 Cut the front and back (B) to the size in the **Cut List**.
6 Lay out the counterbored screw holes on the front and back (B), where shown in **Figure 2** ($\frac{3}{8}$ " from the ends, and $\frac{3}{4}$ " from each edge with the third hole centered).

Here, drill counterbored holes for #8 $\times$ 2" screws and $\frac{3}{8}$ " plugs where marked.

7 Glue and screw the front and back (B) to the sides (A), as shown in **Photo A**. Check for square. Then use a block plane to trim the top edge of the front to match the intersecting curve of the sides, as shown in **Photo B**. Doing this will allow the front slat to fit the curved top edges of the sides.

Cut and add the legs

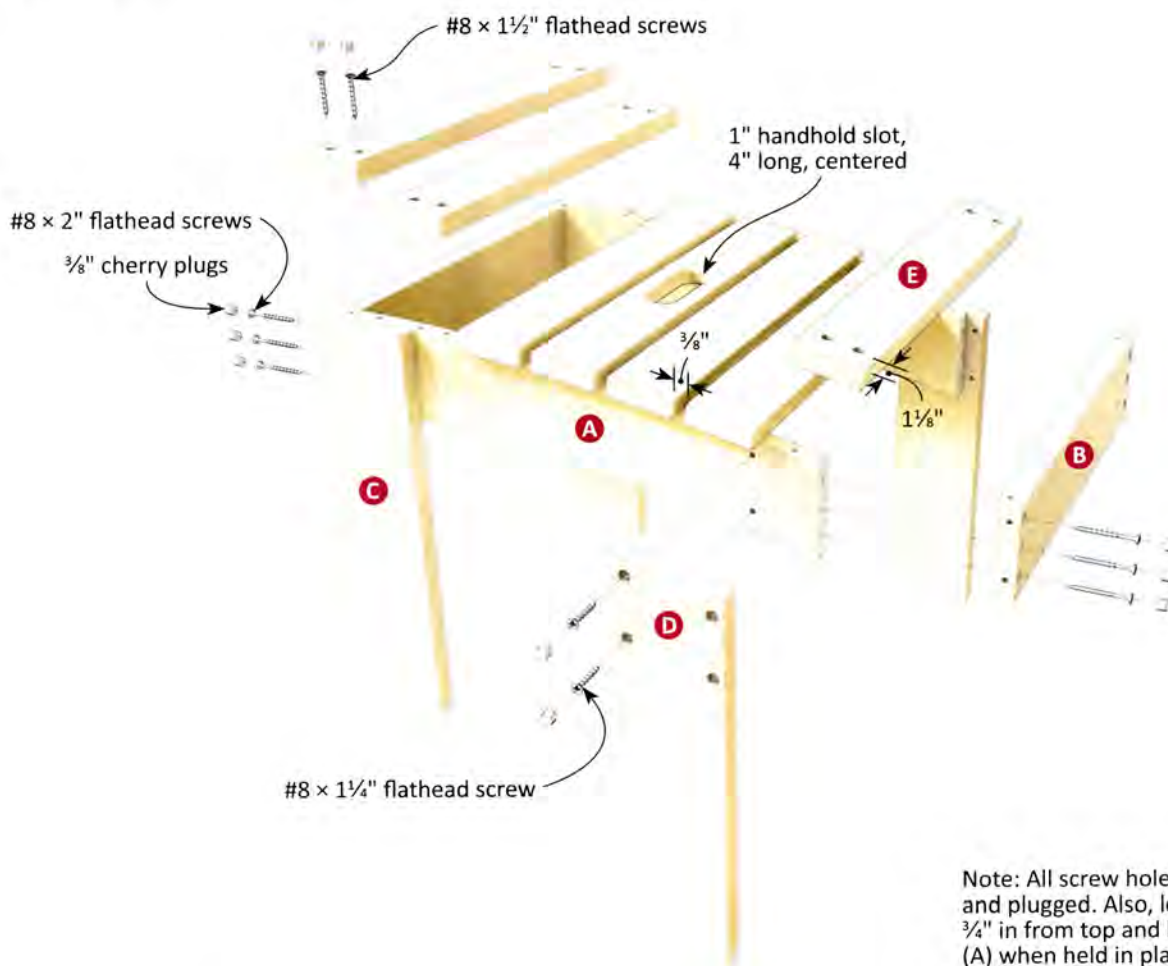
1 Cut the rear (C) and front (D) leg blanks to the sizes in the **Cut List**. Hold the blanks flush with the top edges and ends of the top frame (A/B). Locate the counterbored holes, as described in **Figure 2**. Drill the holes.

2 Clamp the top frame (A/B) to a flat work surface (such as a benchtop) with the back on the surface and the sides standing vertically. Place one of the rear leg blanks having counterbored holes against one of the sides, locating it so that the top end is flush with the top frame's top edge. Glue and screw it in place. Repeat for the other rear leg.

3 Clamp the rear leg/top frame assembly (A/B/C) to the benchtop with the legs upright. Now, as with the rear legs, fit the front legs (C) to the front corners of the top frame. Lay out and drill the counterbored screw holes, where shown in **Figure 2**. Glue and screw the front legs (D) in place, flushing the top ends of the legs with the top frame. Stand the footstool right side up, and check for any wobbling.

4 Take the leg/top frame assembly (A/B/C/D) to the router table, lay it on its

Figure 2: Footstool Exploded View



Note: All screw holes are counterbored and plugged. Also, locate leg screw holes $\frac{3}{4}$ " in from top and bottom edges of sides (A) when held in place to the top frame.

side, and flush-trim the top ends of each leg to match the curve perfectly, guiding off the top edge of the frame.

Cut and screw on the slats

- 1** Cut the seven slats to the size in the **Cut List**.
- 2** Lay out the counterbored screw holes and handhold opening, where shown in **Figure 2**.
- 3** Drill the counterbored screw holes. Now, use a 1"-diameter Forstner bit to bore out the ends of the handhold slot in one of the footstool slats. Strike cutlines between the holes, and use a scrollsaw or jigsaw to remove the waste. Sand the edges smooth.
- 4** Using a $\frac{1}{4}$ "-radius round-over bit in a handheld router,

round over the edges of the handhold opening.

- 5** Install the first slat flush with one end of the frame. Attach the rest of the slats using $\frac{3}{8}$ " spacers

for a consistent gap. Test-fit and trim the last two slats so the last slat ends flush with the frame.

- 6** Glue in plugs in all of the counterbored holes. As before,

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☐ 1.	Titebond II Waterproof Glue, 8 oz.	#08L43	\$7.50
☐ 2.	Whiteside Over-Under Flush-Trim Bit, $\frac{7}{8}$ " D, 1 $\frac{1}{2}$ " CL, ($\frac{1}{2}$ " SH)	#149528	\$36.49
☐ 3.	Flathead Combo Drive General Purpose Screw, #8 x 1 $\frac{1}{4}$ ", qty. 100	#607502	\$4.69
☐ 4.	Flathead Combo Drive General Purpose Screw, #8 x 1 $\frac{1}{2}$ ", qty. 100	#607503	\$5.50
☐ 5.	Flathead Combo Drive General Purpose Screw, #8 x 2", qty. 100	#607506	\$6.99
☐ 6.	Flathead Combo Drive General Purpose Screw, #8 x 2 $\frac{1}{2}$ ", qty. 100	#607508	\$7.99
☐ 7.	Plugs, Cherry, $\frac{3}{8}$ " D	#17T81	\$12.99
☐ 8.	General Finishes Milk Paint, Buttermilk Yellow, 1 pt./project	#825753	\$13.99/pt.

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

trim the plugs a hair proud of the surface, and then sand them flush with a sanding block.

7 Ease the edges with a sanding block, and sand the footstool to 220 grit. Apply your choice of finish. (I applied three coats of General Finishes Milk Paint in buttermilk yellow. ■

About Our Designer/Builder

An accomplished woodworker from Lubeck, West Virginia, Bill Sands is a regular contributor to *Woodcraft Magazine*, having built several shop projects.

In addition, he teaches woodworking classes at the Parkersburg Woodcraft store.

Adirondack Table Cut List

	Part	Thickness	Width	Length	Qty.	Mat'l
A*	Feet	3/4"	6 1/2"	18 3/8"	2	C
B*	Slat supports	3/4"	2 1/2"	18 3/8"	2	C
C*	Uprights	3/4"	3 1/2"	19 1/4"	2	C
D	Rail	3/4"	2 1/2"	16"	1	C
E	Stretcher	3/4"	3 1/2"	16"	1	C
F	Outside slats	3/4"	3 1/2"	20"	2	C
G	Inside slats	3/4"	3 1/2"	22 1/2"	2	C
H	Center slat	3/4"	3 1/2"	24"	1	C
I	Corbels	3/4"	3"	6 5/8"	2	C

Adirondack Footstool Cut List

	Part	Thickness	Width	Length	Qty.	Mat'l
A*	Sides	3/4"	6 1/2"	18 3/4"	2	C
B	Front and back	3/4"	3 1/2"	16"	2	C
C*	Rear legs	3/4"	3 1/2"	16 1/8"	2	C
D*	Front legs	3/4"	3 1/2"	14 1/2"	2	C
E	Slats	3/4"	2 1/2"	17 1/2"	7	C

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

Materials: C = Cedar

Hardware/Supplies: (1) 1/4" dowel rod

Table and Footstool Patterns

Footstool Side Pattern

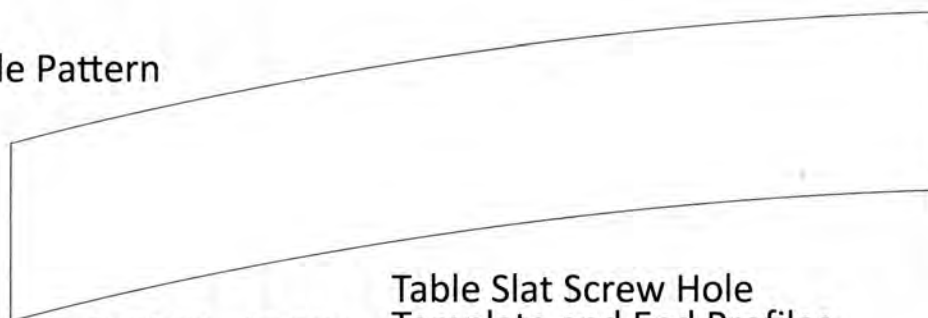
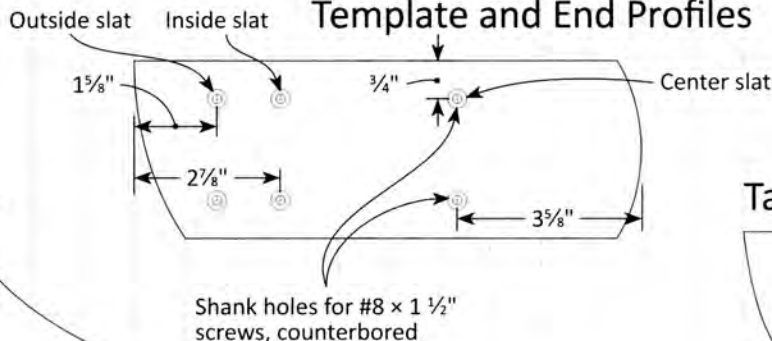


Table Slat Screw Hole Template and End Profiles



Foot Half Pattern

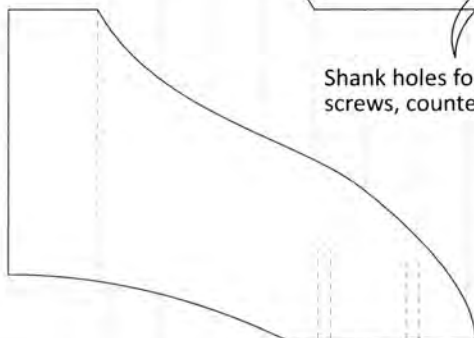


Table Corbel Pattern



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154025	10.5mm & 27/64" (.412")	154030	33/64" (.516")
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154027	3/8" (.372")		

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Exotic Chopsticks

Use scrapwood to elevate your next Asian-themed dining experience.

By Marlen Kemmet



The only thing that beats sitting down with friends to a tasty spread of Asian food is showing off your utensil-making skills. Here, I'll tell how to make four pairs of showy chopsticks and complementary rests that will surely start the dinner conversation.

Make the sticks

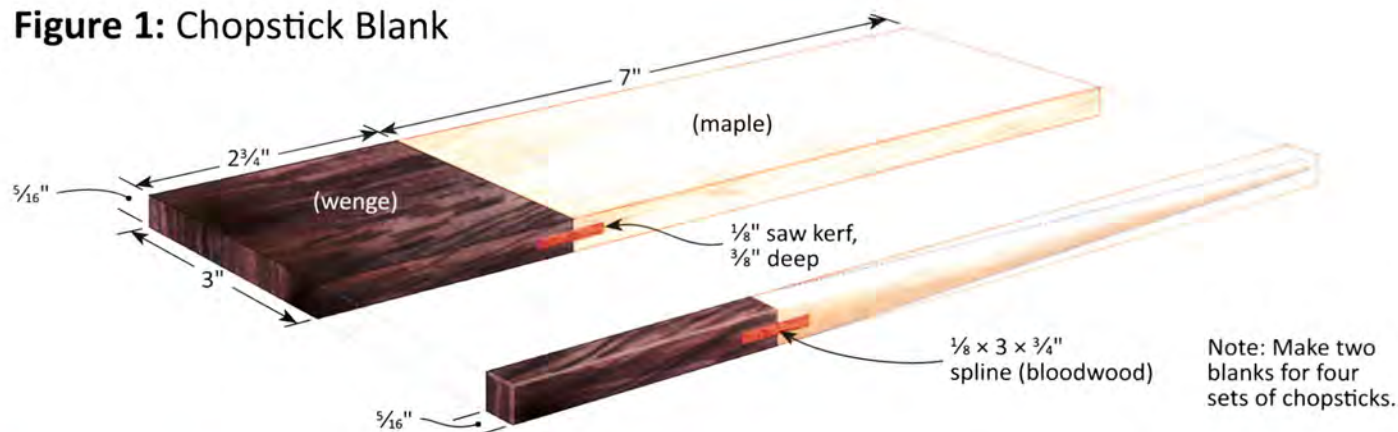
1 Resaw and plane $\frac{3}{4}$ "-thick $\times$ 12"-long boards of contrasting species to $\frac{5}{16}$ " thick. From the resulting resawn halves, cut two

chopstick top and bottom blanks to the sizes noted in **Figure 1**. (I chose wenge for the chopstick tops and figured maple for the bottoms. Note, also, that you need about 1" of width for each pair of chopsticks.) Cut scrap stock to the same thickness for test-cutting.

2 Using a *flat-top grind (FTG)* blade that delivers a *flat-bottom* kerf, cut centered kerfs $\frac{3}{8}$ " deep along one edge of the scrap stock to verify the kerf cut is centered before cutting the workpieces. Now, slot the mating edges of

the top and bottom blanks to house the spline, as shown in **Photo A**. (I taped a piece of hardboard to the saw table to serve as a zero-clearance insert and fashioned a custom pushblock with a $\frac{5}{16}$ " rabbet.) **3** From a third wood (I used a 3"-wide piece of bloodwood), cut a pair of $\frac{3}{4}$ "-long splines to fit the mating kerfs in the top and bottom blanks. The spline stock grain should be running the same direction as the blanks' grain. Test-fit the splines.

Figure 1: Chopstick Blank



4 Spread glue on the splines, in the kerfs, and on the mating edges of the top and bottom blanks. Insert the splines and lightly clamp the top and bottom blanks edge to edge. Wipe off any squeeze-out. Later, sand the glue-up surfaces smooth.

5 Using a glued-up blank as a guide, set the rip fence the same distance from the blade as the blank's thickness ($\frac{5}{16}$ "). Now, with a pushblock, rip individual chopsticks from the blanks, as shown in **Photo B**.

6 At the stationary belt sander, sand each chopstick face along the lower 6", as shown in **Photo C**, tapering this section from $\frac{5}{16}$ " to $\frac{1}{8}$ " at the end. Maintain soft flat surfaces while rounding or easing the corners. A caliper comes in handy for checking for consistency from stick to stick. Compare all chopsticks for uniformity in shape. Finish-sand each chopstick to 220 grit by hand, easing or softening the corners.

7 Apply finish to the chopsticks. (I used General Finishes Salad Bowl Finish. Refinish as needed, and remember to always hand-wash chopsticks; never run them through the dishwasher.)



Use a rabbeted pushblock to safely trap the blank against the fence when making the kerf cuts.



With the blade just above the top surface of the blank, rip the individual chopsticks to width.



To taper-sand each chopstick to uniform shape, use a strip of wood to safely press the stick onto the sanding belt.

Give 'em a rest

1 Cut a piece of hardwood stock to $\frac{1}{2} \times 2 \times 9$ ". (The extra width and length is for safety during this five-step operation. The stock should be at least

2" wide to keep fingers a safe distance from the saw blade.) Make a copy of the **Rest Pattern**, and adhere it to a piece of stiff cardboard or hardboard for a template. Cut it to shape.

Super Simple Projects

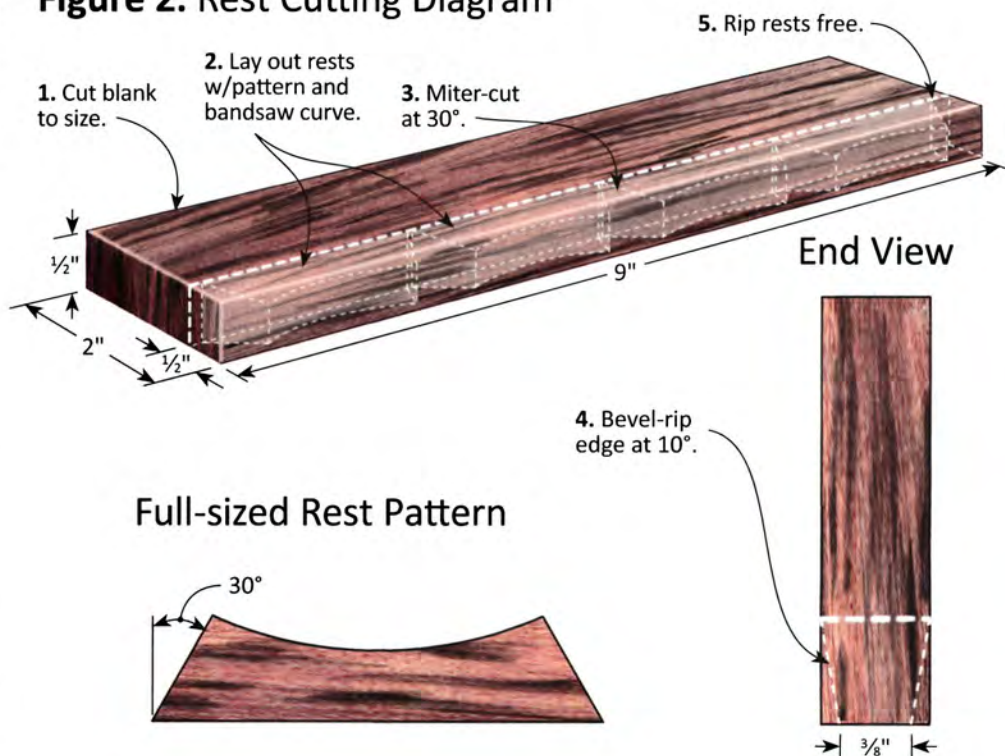
2 Use the rest template to lay out four rests along one edge of the workpiece. Bandsaw or scrollsaw the curves, cutting just outside the line. Sand each curve smooth with a drum or spindle sander.

3 Make the 30° miter cuts along the laid out edge of the blank, where shown in **Figure 2**. (I did this at the bandsaw, but a fine-toothed handsaw would also work.)

4 Using your tablesaw and a zero-clearance insert, bevel-rip the laid out edge 1/2" in on both faces at 10°, where shown in the **End View** in **Figure 2**.

5 Rip the 1/2"-wide tapered section from the edge of the blank to free the four rests. Sand each rest smooth and finish. ■

Figure 2: Rest Cutting Diagram



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Spotlight on Elm

The once-common commercial hardwood we almost lost

By Pete Stephano

Technical consultant: Larry Osborn

Elm may not be as conspicuous and popular as are many of the “cabinet class” wood species in modern-day furnituremaking and woodworking. After all, the three most common North American elms represent only about three percent of all commercially available domestic hardwoods. That’s mainly due to the fast-spreading Dutch elm disease of the 1950s and 1960s that devastated millions of stately elms from the East Coast to the Midwest, as well as in Great Britain and Europe, nearly wiping out the species. Since that crisis, disease-resistant elms have been botanically created and reintroduced to American woodlands.

The domestic elm species represented as lumber in the U.S. include American or gray elm (*Ulmus Americana*), red elm (*Ulmus rubra*) also known as slippery elm, and rock elm (*Ulmus thomasii*). Great

Britain’s most prominent one is English elm (*Ulmus procera*), which is called Carpathian elm in continental Europe.

No matter the individual elm species, the stock shares similar qualities, except that rock elm is harder and heavier. Flatsawn elm boards can sometimes exhibit a distinctive “W” or bird-feather grain patterns. The wood has open, coarse grain much like white ash that is most often interlocked, making it somewhat difficult to work. Although only moderately strong, elm bends easily, is shock resistant, and can take abuse.

History in woodworking

Elm’s woodworking roots go back thousands of years. The first written references to elm occur in the Mycenaean Period of early Greece—lists of military equipment mention the wood’s use in chariot parts. Centuries-old bows found in

Europe employed elm—even the famed English longbow was occasionally crafted of it when bowyers lacked the preferred yew. Elm was even favored for the keels of English sailing ships; in fact, much American elm was exported for that very purpose.

Surprisingly, elm resists decay when in constant contact with water, so bored-out elm (along with hemlock) logs ended up as below-ground city water pipes in 18th-century Europe and America.

In the United States, elm’s early usage included wagon wheels and hubs, barrel staves and hoops, children’s wagons and sleds (it won’t easily splinter), agricultural implements, tool handles, hockey sticks, boxes, and even baseball bats. In contemporary applications, the wood’s ideal for steam-bent chair parts as well as tabletops and cabinets.

Where the wood comes from

In North America, two of elm’s principal lumber species—American and red—grow from the Midwest to the East Coast and southern Canada to northern Florida. The smaller rock elm has a range roughly



It’s a fact that...

Elm’s interlocked grain adds difficulty to machining, but to some users, it was a blessing. In early America, tough elm was a favorite material for horse barn floors. The grain showed impressive resistance to the wear of horses’ hooves!



limited to the northern parts of the Great Lakes states.

English elm grows throughout Great Britain and the temperate regions of the continent. Some elm species also grow in Asia and Australia. Due to precautions against the transmittal of Dutch elm disease, you'll only find English elm burl veneer being sold in the U.S., and it's expensive.

What you'll pay

The National Hardwood Lumber Association (NHLA) grades for all elm except rock elm are somewhat complicated, but you can expect to find lumber graded from FAS (first and seconds, the highest) to Common grades (the lowest).

For rock elm, NHLA grades are similar to those for hickory and pecan in that they allow for narrower 4"- and 5"-wide boards compared to the minimum 6"-wide boards in the best grades. A 4/4 (one inch thickness) board of FAS elm will cost between \$4 and \$5 per board foot, with many sellers not differentiating between red and American elm. The much heavier and harder rock elm, though, is usually sold apart from the other elms and can cost a bit more. You may only be able to find rock elm lumber close to where it grows. Only some local

dealers in the range carry gray or red elm lumber, so be sure to call around before wasting gas. Don't expect to find it at big box stores and small urban lumberyards.

Paperbacked, rotary-cut elm veneer, both American and red, is available by the square foot (about \$5) or 4 × 8' sheet (\$170) in 10 millimeter thickness. Thicker veneer (22 mil.) costs more as does flat sliced and quarter cut. Scarce Carpathian elm burl veneer may top \$500 per 4 × 8' sheet in 10 mil. thickness.

Finally, while English and Asian elm is made into plywood and sold in Europe and Asia, you'll not find elm plywood made and sold in the United States.

How to select the best stock

Elm varies slightly in color from species to species. American and rock elm have a grayer cast to their natural tan heartwood color, while red displays a warmer orange-red color. The sapwood of all three is a very light tan. American and rock elm lumber can show some staining, which detracts from appearance. And all elm boards can have tiny bird pecks and pin knots, both of which are allowed in

grading because neither affects the wood's performance.

When selecting boards, be discriminate concerning quality. Improperly stored elm during seasoning may show warp and/or twist that may result in working problems and waste. After purchasing elm boards, be sure to store them in stickered fashion off the floor with evenly distributed weights atop the stack.

Elm Quick Take

Cost	Moderate
Weight	About 25% lighter than red oak
Hardness	50% softer than sugar maple
Stability	Moderate
Durability	Moderate
Strength	Moderate (but bends easily)
Toxicity	None
Tool Type	Hand and power tools
Common Uses	Cabinets, steam-bent seating, tabletops, tool handles and some small projects

Working elm in the shop

American and red elm species rank half as hard as sugar maple, and rock elm nearly as hard. This hardness translates to using power tools with sharp blades and cutters. Because elm contains interlocked grain, it makes splitting the wood difficult. Ripping, however, poses no problem. On the other hand, shaping with a router, jointing, and planing can prove challenging. Limit tear-out or chipping by making very light passes and using backers when cutting across the grain.

While predrilling pilot holes for screws is necessary, you'll discover that elm bonds well with all adhesives. The wood also

sands easily. Using progressively lighter grits will enhance its natural luster. Finally, elm's interlocked grain means taking a little more time and care when carving or turning it.

The flatsawn American (gray) elm shown here displays the bird's wing pattern.

Deciding on the right finish

Due to its open, coarse grain (think red oak and white ash), a glasslike top finish requires filling the pores. But other than that, the wood takes all dyes, stains, and finishes equally well. ■



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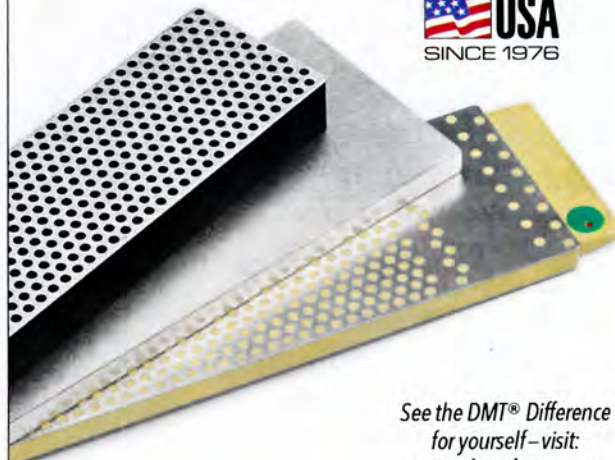
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Noden Inlay Razor

Previously, if you wanted to accent a project with inlay banding, you had two options: buying commercial banding, or making your own. Purchasing premade banding is the most popular solution, even though selection is limited and users tend to end up with pricey, unused excess. Some hard-core types make their own bandings, but the traditional approach—laminating and sawing veneers—is time-consuming and far from intuitive. Although learning to use it requires some patience, the Noden Inlay Razor offers a simple way to create custom inlay banding from shop scraps.

The tool's simplicity hinges on wood's willingness to split easily on end grain. Rather than being sawn, the inlay material is sliced from $\frac{1}{16}$ "-thick "wafers" cut on a tablesaw. It's a great way to use exotic offcuts too small for anything else.

The cutters are double-edged razor blades sandwiched between a pair of matching wooden blocks. You can design your own cutters by scrollsawing a block to shape and sandwiching a blade between the halves. (Sharp corners are trickier than curves, but if the blade can bend without breaking, the shape will work.) To provide a wider range of effects using the same cutter, the baseplate pivots to the right and left.



Using the inlay razor requires a bit of setup. First, cut a $\frac{1}{16}$ "-deep dado to match your inlay width (up to $1\frac{1}{4}$ ") in a piece of scrap softwood, and clamp this "softwood groove" to the tool's baseplate. Next, install a cutter in the arm at the desired

position, lay the wafer material into the groove, and start slicing. (An audible "click" indicates a completed cut.) To make pieces of consistent length, simply clamp stops into your groove.

Once you have enough pieces to complete your design, glue

them into the project's groove using slow-set epoxy. (Water-based glues would cause the pieces to expand, complicating assembly.) After the epoxy has cured, sand the inlay flush.

Chopping inlay piece by piece requires patience—a relatively simple design for a box lid might take almost an hour—but the process is as easy as it gets. Note also that razor blades dull eventually but, depending on the species of wood, one cutter can create enough banding to do the edges of a large tabletop.

If you're interested in building period furniture projects,



you may opt to purchase pre-made bandings. But if you're interested in designing your own bandings, including curved and circular inlays for instruments or turned work, this tool is for you. To see it in action and get a taste of what it will do, check out inlayrazor.com.

The kit comes with four cutters, tweezers, a starter pack of wafers, a softwood groove, and an instructional DVD.

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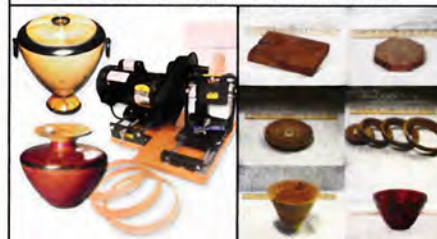
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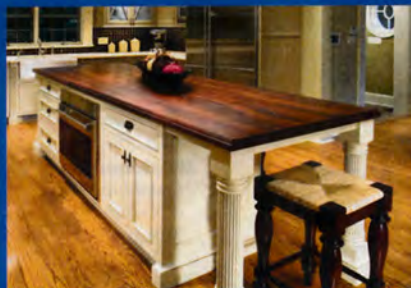
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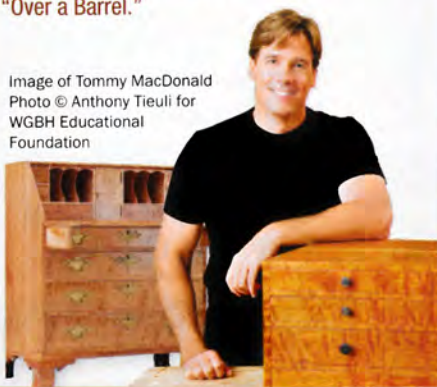
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Portland/Tigard:
503-684-1428

Pennsylvania

Allentown:
610-351-2966

Harrisburg:
717-939-6770

Philadelphia/
Downingtown:
610-873-5660

South Carolina

Greenville:
864-627-8760

Tennessee

Johnson City:
423-282-9973

Knoxville:
865-539-9330

Nashville:
615-599-9638

Texas

Austin:
512-407-8787

Dallas/Addison:
972-241-0701

Fort Worth:
817-569-0777

Houston:
281-880-0045

South West Houston:
281-988-9449

San Antonio:
210-545-5885

Utah

Salt Lake City/
South Jordan:
801-566-5652

Virginia

Leesburg:
703-737-7880

Norfolk:
757-466-1166

Richmond:
804-355-3945

Roanoke:
540-366-7144

Springfield:
703-912-6727

Washington

Seattle:
206-767-6394

Spokane:
509-892-9663

West Virginia

Parkersburg:
304-485-4050

Wisconsin

Appleton/Fox Cities:
920-730-9663

Madison:
608-273-8868

Milwaukee/New Berlin:
262-785-6770

The facts are hard to ignore.

Titebond® III outperforms polyurethane glues.

The image shows a white bottle of Titebond III Ultimate Wood Glue with a green cap and label. The label features a duck logo and the text 'WATERPROOF', 'Titebond III', 'ULTIMATE Wood Glue', 'Waterproof - Superior Strength', 'Outperforms All Other Wood Glues', 'Longer Open Assembly Time', and 'NET 8 FL. OZ. (237 mL)'. To the left of the bottle is a white 'Reference Guide' titled 'Glue comparison' with the subtitle 'What woodworkers need to know!'. The guide compares Titebond III and Polyurethane Glues across ten criteria. Titebond III is marked with green checkmarks for all criteria, while Polyurethane Glues are marked with black checkmarks for only three. The background is a workshop with a wooden workbench, wood shavings, and various tools like a hand plane and a saw.

	Titebond III	Polyurethane Glues
Higher Bond Strength	✓	✓
Exterior Use - Waterproof	✓	
Easy Water Cleanup	✓	
Much Safer To Use	✓	
Shorter Clamp Time	✓	
No Foam - Less Mess	✓	
Shorter Open Time	✓	✓
Doesn't Stain Skin	✓	✓
Bonds Most Materials	✓	
Bonds Oily / Exotic Woods	✓	
Lower Cost - Better Value	✓	
Longer Usable Shelf Life	✓	

Reference Guide

Glue comparison

What woodworkers need to know!

Woodworking Handbook 2007

8 FL. OZ. (237 mL)

As the leader in wood glues, we want you to know the truth about polyurethane glue and woodworking. A straightforward comparison between Titebond® III Ultimate Wood Glue and polyurethane glue tells the story.

Titebond® III is THE ultimate choice for bonding wood to wood. Period.

For more information and a detailed comparison, please visit www.titebond.com/TBIIIvsPolyurethane

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