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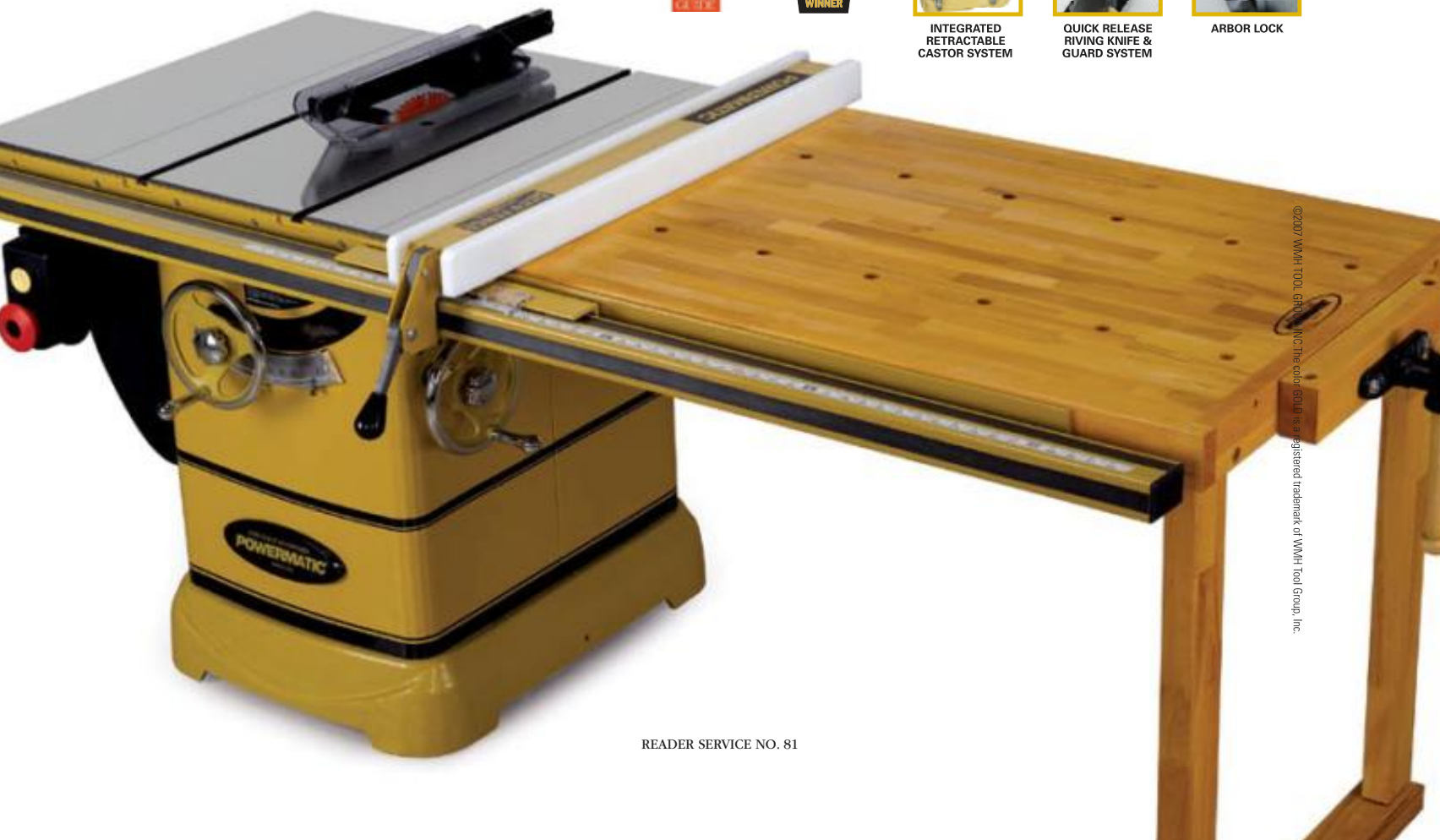

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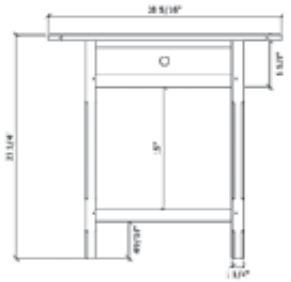

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8 Questions on Handplanes

Philip C. Lowe answers questions from readers about choosing handplanes, and demonstrates techniques.

Make a Danish-Cord Seat

Watch Mark Edmundson ("A Modern Bench") weave the cord seat on a bench inspired by a Danish design.

NEW

Finishing Recipes

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Tim Killen *("A Quick Course in SketchUp")* **is a third-generation woodworker who grew up in Ohio. He now lives and works near Berkeley, Calif., in a house filled with pieces he designed and built. Each room contains furniture from a different era, but Killen's favorite period is the 18th century. In addition to making and selling furniture, he teaches woodworking and is a frequent contributor to FineWoodworking.com's "Design. Click. Build." blog on using free SketchUp software to design furniture.**

Jeff Weiss *(A Closer Look)* **is the founder and president of Target Coatings (www.targetcoatings.com), maker of two lines of waterborne wood finishes. He oversees all the research and development, field-testing, and production scale-up of each finish formula. Weiss is also a licensed New York state wilderness guide.**

Jeff Gross *("Three Federal Legs")* **trained as an engineer at Rensselaer Polytechnic Institute. But after a few years working in what dot-commers call the telecom space, Gross realized he'd rather be in his shop space. Three years ago, he started J. Thomas Furniture, in Groton, Mass. His wife, another Rensselaer alum, still inhabits the telecom space.**

Tony Kubalak *(Master Class)* **lives in Eagan, Minn., with his family. A former software engineer, he now builds reproduction 18th-century American furniture. He says that his furniture-making career would have taken much longer to get started without the help of Gene Landon, with whom he has taken several classes. You can see some of Kubalak's period reproductions at www.tonykubalak.com.**

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letters

Spotlight

ISSUE NO. 193
October 2007
p. 58

DON'T UNDERCUT DOVETAILS

In "The Secret to Making Perfect Joints," the author incorrectly advises the reader to undercut (or back-bevel) the faces of dovetail pins and tails to give the appearance of a better-fitting joint. The dovetail joint's advantage is that it offers more long-grain surface to be glued than other joints. The integrity of the joint is a combination of glue and mechanics, with both relying on tight-fitting pins and tails.

So undercutting any part of the long-grain surfaces compromises the joint. A better solution is to cut the dovetails to fit—perfectly, or near-perfectly. Near-perfect fits are achievable by everyday woodworkers using time-proven methods: accurate layout, sawing to a line, and chiseling to a line.

I suggest taking the time and effort directed toward undercutting and applying it to practicing the three areas above. You will be amazed what patience and practice can produce.

—EARLE WRIGHT, Lenoir City, Tenn.

Bandsaw test used slow-cutting blades?

Upon reading the review of 14-in. bandsaws, "New Breed of Bandsaws" (*FWW* #193), I was very concerned with the results of your timed resaw test. I duplicated the tests at our offices and yours, using the same sled design and weights to apply feed pressure, along with blades commonly recommended for resawing. My resulting times were dramatically shorter. The 5-lb. test took only 43 seconds, the 7½-lb. test took 31, and the 10-lb. test took 17 seconds.

Closer inspection of the specific blade used in the test revealed that it is a skip-tooth design, not a hook-tooth as the article said. As you know, hook teeth help to feed the blade into the material being cut. This calls your resaw test into question.

—STEVE MANGANO, Rikon Power Tools

Editor replies: We were glad to have you stop by. We agree that a skip-tooth blade is not as aggressive as a hook-tooth, and that the blade we used probably increased resaw times and magnified differences among machines. However, we stand by the head-to-head rankings on the test.

We chose that particular skip-tooth blade from BC Saw & Tool because it performed well and was named best value in a past review of bandsaw blades (*FWW* #169). We did mistakenly call it a hook-tooth blade in the recent review.

Jet, Powermatic bandsaw misalignment is easily fixed

I would like to clarify the issue of wheel misalignment of the Powermatic and Jet bandsaws noted in the recent review of 14-in. bandsaws. This issue, when it occurs, is a problem with the riser-block kit and its locating pins, not the bandsaw itself, and can be easily resolved by contacting tech support at 800-274-6846.

—BARRY SCHWAIGER, WMH Power Tools

Will polyurethane stick to shellac?

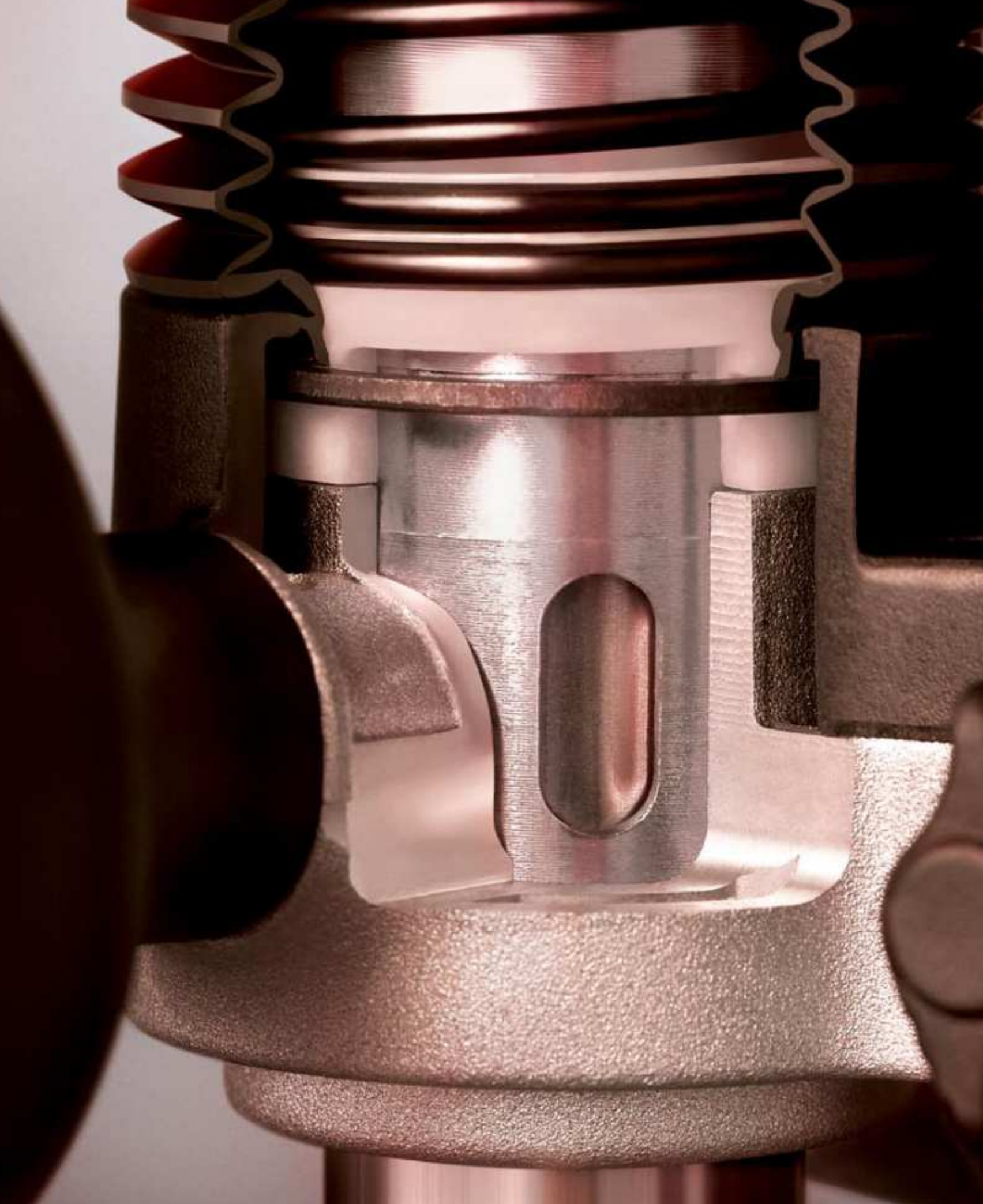
I'm writing about an inconsistency in the latest issue (*FWW* #193). In Tom Wisshack's article, "Best Finish for Pine," he warns against using polyurethane as a topcoat over shellac, suggesting that the waxy nature of the shellac would lead to poor adhesion. But in "Finish Line," Nancy Hiller uses that very same combination. They both cite Zinsser's Bulls Eye Shellac. Although I've read that Bulls Eye is dewaxed, the manufacturer makes no such claim on the label, and does not recommend the product for use under polyurethane. Is there a definitive answer?

—MIKE MORRISON, Sydney, N.S., Canada

Editor replies: Technically, Wisshack is correct. Dewaxed shellac is best under a polyurethane topcoat, and both Bulls Eye clear and amber shellac contain wax. The safer choice would be to use Zinsser's SealCoat dewaxed shellac. It is clear, so add a few drops of dye concentrate if you want an amber color. Practically speaking, though, Hiller has seen her finish last many years on very high-stakes jobs, and even in a bathroom. She says she abrades the shellac thoroughly and wipes away the dust before topcoating with polyurethane.

Clarification

Seth Deysach did not design the Eames-style table in Readers Gallery (*FWW* #193), though he built it. Janet Rooney designed it.



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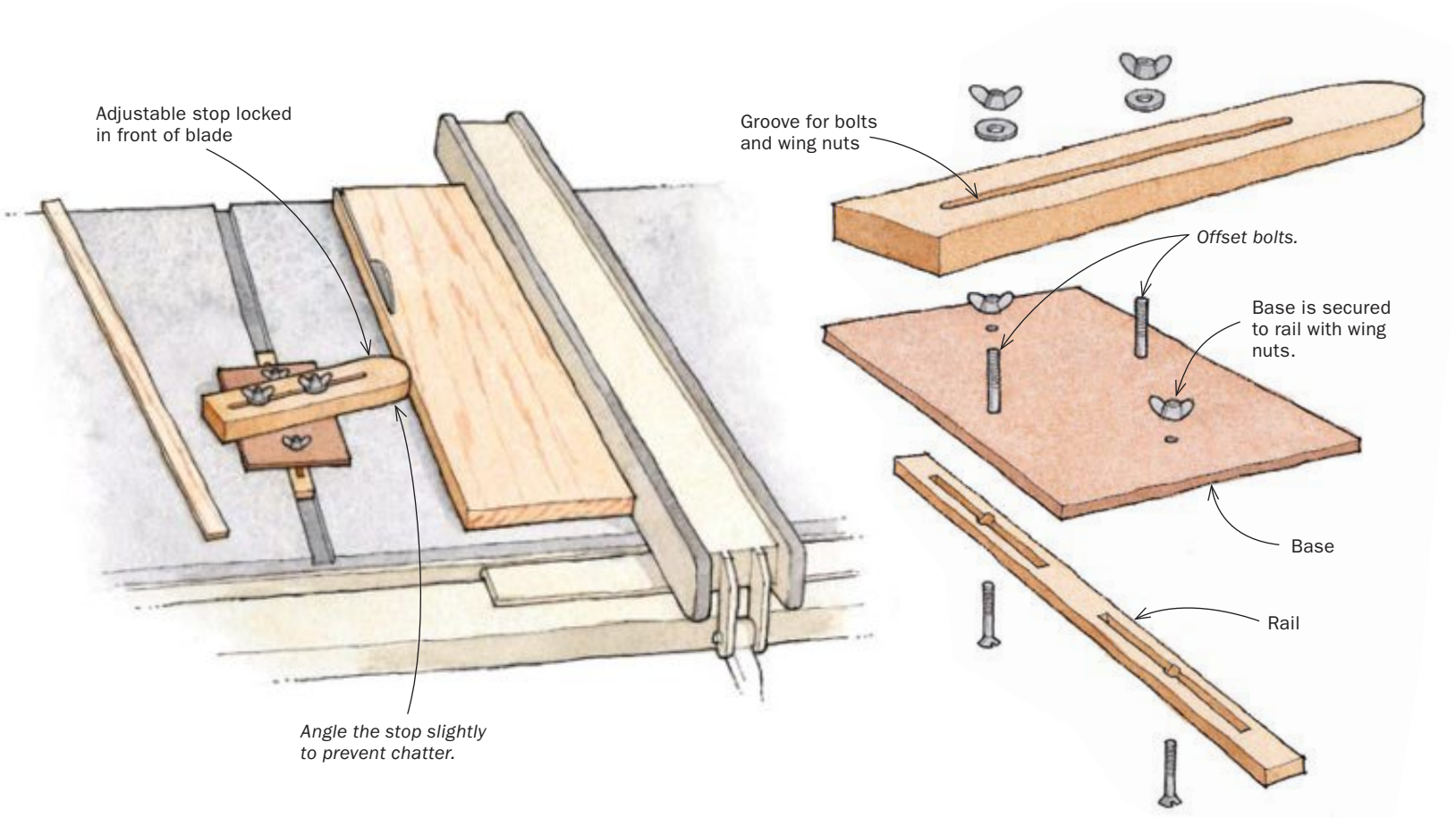


Best Tip Cutting thin strips on the tablesaw

When he's not working his day job as a physical science technician for the U.S. Army, David Diana builds Arts and Crafts furniture. He's currently working on a Greene-and-Greene-style hall table made from "some of the nicest curly cherry I have ever seen."

Sooner or later, we all need to cut thin strips on the tablesaw. The normal procedure is to set the rip fence to the width of the strip, but this creates a situation where the strip could be captured and thrown back at you, or scarred by teeth at the back of the blade.

A safer option is to put the bulk of the stock between the blade and the fence so the strip is cut to the left of the blade. The problem with this is that the fence must be adjusted by eye each time, and the results will never be uniform.

I built a jig with an adjustable stop that enables me to cut consistently sized, repeatable strips on the left side of the blade. The base of the jig locks into the miter slot with two wing nuts that expand the rail. The adjustable stop slides along the base and is locked in place with wing nuts.

To use the jig, I lock the base in place, with the adjustable stop loose. I snug the workpiece against the fence, then slide the piece and fence past the blade until it's set to cut a strip to the thickness I need. At that point I lock the fence in place, slide the adjustable stop against the workpiece, and lock it in place.

I then make a test cut. If the strip is the correct size, I slide the workpiece and fence against the stop again, lock the fence, and repeat the cut. If the cut isn't the right size, I adjust the stop's position and try again. Using this method, I can cut hundreds of strips that are all the same thickness.

—DAVID DIANA, Abingdon, Md.

A Reward for the Best Tip

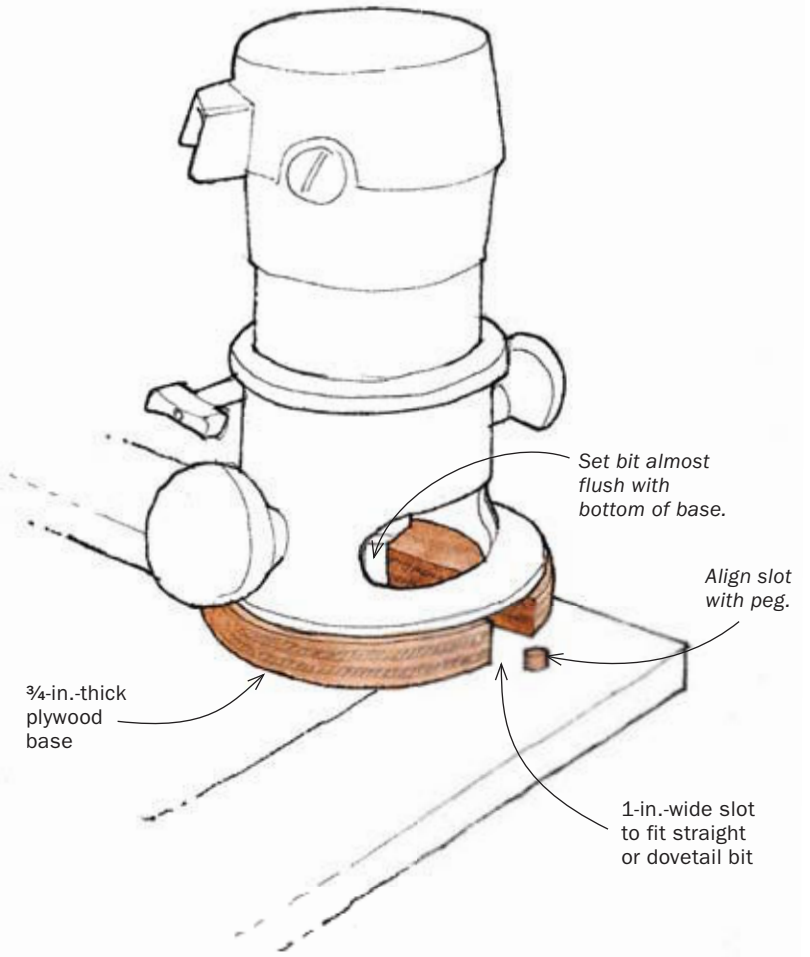
Send your original tips to Methods of Work, *Fine Woodworking*, PO Box 5506, Newtown, CT 06470, or email fwmow@taunton.com. If published, we pay $50 for an unillustrated tip; $100 for an illustrated one. The author of the best tip gets a pair of Brian Boggs spokeshaves (one flat, one curved) made by Lie-Nielsen Toolworks.

Paring exposed pegs with a router

The common advice for paring an exposed peg in a mortise-and-tenon joint is to use a chisel. Over the years, however, no matter how careful I was, the peg would inevitably chip out below the face of the wood when I used a chisel. I got around the problem by building a plywood baseplate for my router that has a slot cut in it about 1 in. wide.

I first cut off the peg to ½ in. or so with a dovetail saw. Then I select a straight bit or a dovetail bit, setting the bit depth just short of the bottom of the base. I align the baseplate slots with the peg, turn on the router, and trim the remainder of the peg. This leaves a good clean cut on the peg and also removes any glue protruding from the joint. I find it takes very little sanding to achieve a first-rate joint.

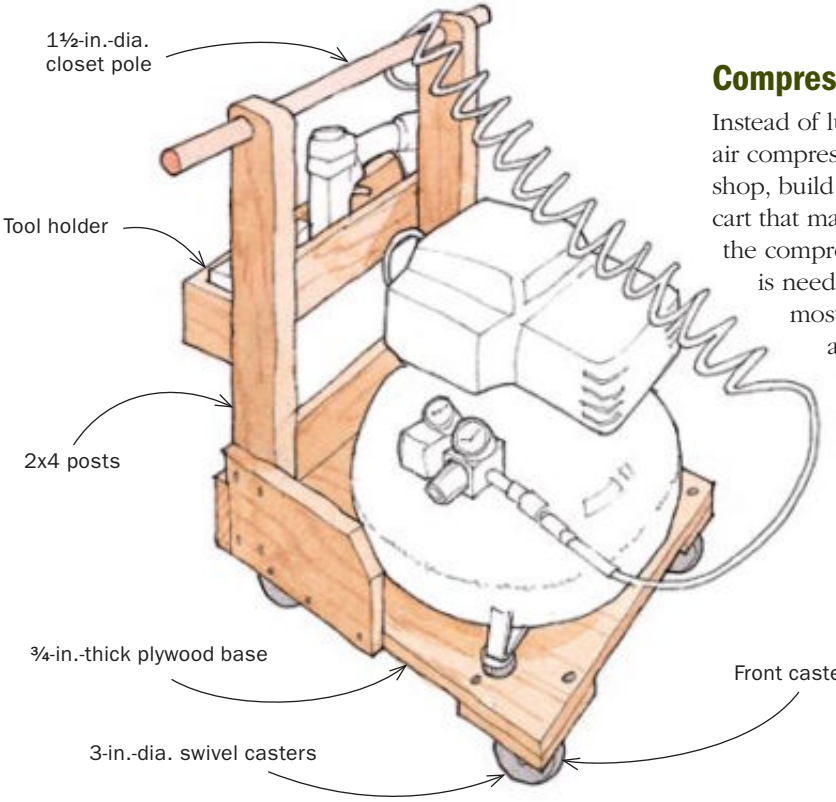
—DAVE WEVER, Greenwich, N.Y.



Quick Tip

By conditioning my work with mineral spirits before applying an oil stain, I reduce the color difference between the end grain and the side grain. First, rub the whole project with spirits. Then, using a foam brush, add a coat to the end grain. Before the spirits evaporate, stain the workpiece. The stain will go on evenly with virtually no color difference between the surfaces. I would not try this with water-based stains.

—BILL WILSON, Warkworth, Ont., Canada



Compressor cart

Instead of lugging your portable air compressor around the shop, build this small wheeled cart that makes it easy to roll the compressor wherever it is needed. The cart, made mostly of ¾-in. material, also provides handy storage for air tools, nails, lubricant, and other supplies.

—JIM LEEDS, Flippin, Ark.

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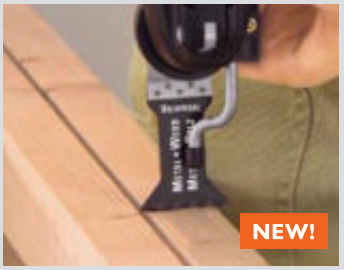

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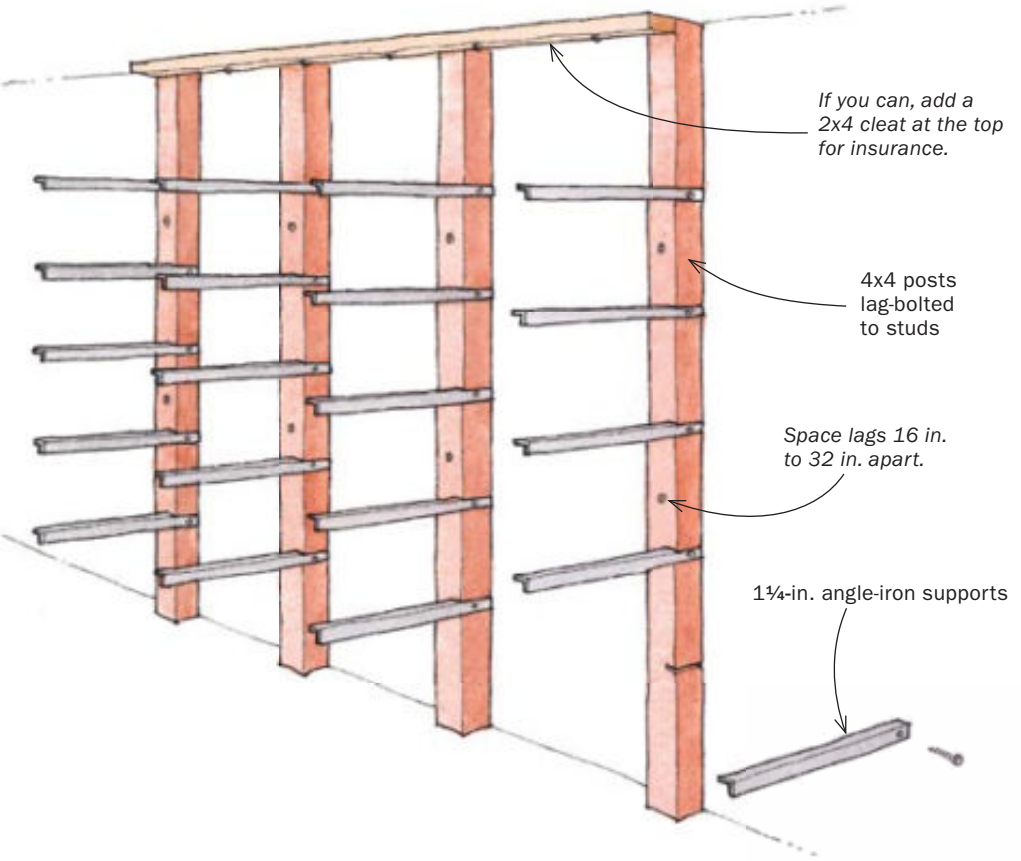
To make the rack, first clamp the 4x4s together and, with a circular saw, cut kerfs 12 in. to 18 in. apart to fit one side of the angle iron. Now lag-bolt the 4x4s to the wall. Cut the angle iron into convenient lengths and drill a hole in each piece for the lag screw that will hold the iron in the slot.

The beauty of this system is that because the angle iron is narrow and no braces are required, there is no wasted space.

—PHILIP HOUCK, Boston, Mass.



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TRADE SHOW

Manufacturers unveil new tools in Las Vegas

If you want to know what it's like to fly too close to the sun, visit Las Vegas in summer. Several *Fine Woodworking* editors learned firsthand about triple-digit thermometer readings after arriving in that desert city in mid-July, as afternoon temperatures topped out at 108°F. Thankfully, many Las Vegas attractions are inside, where air conditioners work 24/7 to keep everyone comfortable.

We were there to attend the biennial fair of the Association of Woodworking and Furnishings Suppliers (AWFS), held at the Las Vegas Convention Center July 17–20. During the four-day show, more than 30,000 members of the woodworking trade walked the 476,000 sq. ft. of floor space to visit over 900 exhibitors. Many manufacturers use the AWFS fair as a venue to introduce new tools. So for anyone with sawdust in their DNA, this was the place to be, with cool new tools making you forget how scorching it was outside. Here's a sampling of what we saw.

SAWSTOP CONTRACTOR'S SAW ON THE HORIZON

Three years after introducing the company's novel cabinet saw, Steve Gass, president of SawStop, said he's hoping to have a contractor's saw available sometime before early 2008.

Look for the saw to have a 1¾ hp motor, a true riving knife that moves with the blade, and, of course, the remarkable SawStop blade-stopping safety device. Wings are stamped steel, with cast-iron wings as an option. A mobile base is also optional.

The price isn't finalized, but at this point it's targeted at $1,500. For more information, check out www.sawstop.com.

(continued on page 24)

FINISHING

Great brushes for shellac, lacquer, and varnish

I recently used Gramercy Tools' new finishing brushes to apply shellac, varnish, and nitrocellulose lacquer. The results were outstanding.

The delicate ox-hair bristles are densely bunched and lay on an even coat of finish with every stroke. They're bedded in epoxy and tied to the unfinished wood handle with a stainless-steel ferrule.

Like all good tools, they aren't cheap but they'll last for years with proper care. The 1-in., 2-in., and 3-in. sizes sell for $20, $35, and $55 each. To order, go to www.toolsforworkingwood.com.

—Bill Duckworth writes and works wood in Woodbury, Conn.

Finishing brushes work great. *Gramercy Tools now offers ox-hair-bristle brushes that finish beautifully.*

Photos, except where noted: Tom Begnal; Michael Pekovich (top); Courtesy of SawStop (left)

■ ACCESSORIES

GraBit removes stripped or broken screws

The GraBit works with any reversible drill to remove screws with stripped heads, regardless of size or drive configuration (Phillips, star, square, hex, and more). It works on bolts with snapped-off heads, too.

The two-sided bits lock into the damaged screw head in two simple steps: Use the stubby drill-bit end to hollow out the screw head. Then use the threaded end of the bit, with the drill running in reverse, to extract the screw.

In our test, however, it didn't extract drywall screws. Those screws are hardened, so the GraBit couldn't cut into them.

A set of three bits handles screw sizes from No. 6 to No. 14. The set sells for $25 at www.shoppraziusa.com.

—Asa Christiana is *Fine Woodworking*'s editor.

■ SHOP HELPERS

An easier way to move sheet goods

A full-size sheet of plywood or other sheet good is both heavy and unwieldy, so it can be a bear to move around. The Gorilla Gripper makes that task considerably easier.

To use it, slip the jaws of the Gripper over the top edge of the plywood at midpoint along the length. Then bend your knees, lock your arm vertically, and lift by straightening your legs. The Gorilla Gripper lets you carry the load with minimum strain on arms, shoulders, back, and legs.

The Gorilla Gripper works on sheet goods from ⅜ in. to 1⅛ in. thick. It sells for $50 (www.gorillagripper.com).

—*Tom Begnal is an associate editor.*

Online Extra

To post ratings and reviews of the tools you own and to browse our free archive of editor reviews from the last five years of ***Fine Woodworking*** magazine, go to **FineWoodworking.com/ToolGuide.**

■ BLADES

FORREST BLADE SET MAKES ¼-IN. AND ⅜-IN. FINGER JOINTS

As a full-time box maker, I often use finger joints. So I was intrigued to learn that Forrest Manufacturing is now making a finger-joint set (part No. FJ0824) that cuts two common widths: ¼ in. and ⅜ in. The set has a couple of advantages over a regular sawblade or a dado cutter. First, it reduces tearout. And, second, it produces a flat surface at the top of the cut. Dado sets often create a less-than-square surface at the top of the cut, resulting in small gaps even after clamping.

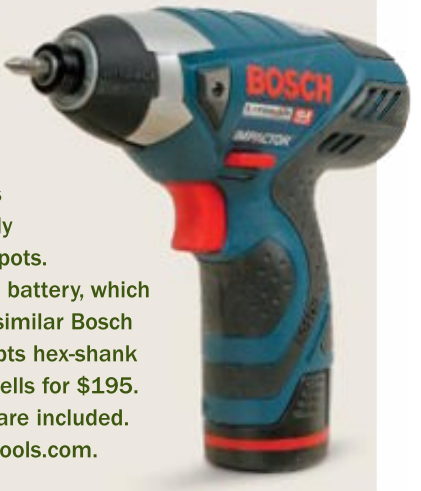
The set consists of two 8-in.-dia. blades that butt together side-to-side, with the teeth on one blade fitting into the gullet on the other. Switching from one cutting width to the other is done simply by changing the order in which the blades go on the arbor.

I made finger joints in heavily grained, brittle sassafras. The set produced a square cut at the top and little tearout. It sells for about $130. For information, go to www.forrestblades.com.

—*Doug Stowe of Eureka Springs, Ark., has been building boxes for more than 30 years.*

TRADE SHOW (CONTINUED)

COMPACT IMPACT DRIVER FROM BOSCH



At the Bosch booth, we spotted a new impact driver, model No. PS40-2, that looks to have been designed with woodworkers in mind. It weighs less than 2¼ lb., so you're less likely to grunt while using it. And, it's only 6½ in. long; ideal for getting into tight spots.

Power comes from a 10.8v lithium-ion battery, which packed a real punch in our tests of the similar Bosch screwdriver. A quick-change chuck accepts hex-shank driver bits and drill bits. Model PS40-2 sells for $195. A 30-minute charger and spare battery are included. For more information, go to www.boschtools.com.

STEEL CITY OFFERS A GRANITE-TOPPED TABLESAW

Visitors to the Steel City Toolworks booth were astonished to see a 10-in. cabinet saw, model No. 35915G, with a top and wings made from granite rather than the usual cast iron.

According to Steel City, granite has advantages over cast iron: It won't rust; it stays flat forever; and it is harder than cast iron, so it will wear better.

The nearly 2-in.-thick granite adds about 60 lb. to the saw. It also adds about $50 to the selling price.

On the downside, granite is brittle when compared to cast iron, and a dropped wrench could cause a chip. The surface could be repaired by filling the cavity with epoxy.

The Steel City saw also includes a riving knife, a valuable safety feature because it reduces the chance of kickback, a common cause of tablesaw injury. For those occasions when the riving knife must be removed for a cut, a quick-disconnect system makes it easy to remove and replace the knife.

A 3-hp, 220v motor generates the power. Rip capacity is 50 in. The saw, which will sell for $1,250, will be available in January. For more information, go to www.steelcitytoolworks.com.

BESSEY CLAMP STRETCHER

Bessey Tools (www.besseyclamps.com), maker of the K Body clamp, introduced a new clamp extender. Made from aluminum, it allows you to stretch the capacity of any two K Body clamps to create a longer one. And, it does not affect the clamp's strength and parallelism. The extender sells for about $15.

(continued on page 26)

MACHINES

Powermatic 15-in. planer has helical cutterhead

Powermatic now offers its venerable 15-in. planer with an insert-cutter helical head. Model No. 15HH ($2,200; www.powermatic.com) has carbide insert cutters arranged in a spiral pattern, with the front edge of each cutter aligned parallel to the spiral centerline to produce a shearing cut. Unlike straight knives, which can produce a lot of tearout on curly, bird's-eye, or other figured woods, a helical head with cutters set for a shearing cut will produce little, if any, tearout. Each cutter has four sharpened faces, so you can rotate it 90° to get a fresh edge. Effectively, then, you won't need to resharpen the cutters until all four edges are dull, and carbide holds an edge many times longer than steel.

I planed maple with switchback grain, swirls, bird's eye, curl, and other anomalies to less than ¼ in. thick with no blowout of the switchback and no significant tearout.

One drawback: Insert cutters produce a slightly furrowed texture. That said, the furrows were no deeper than 0.001 in. and sanded out very quickly with fine sandpaper.

—Roland Johnson is a contributing editor.

Cutterhead upgrade. *Powermatic's 15-in. thickness planer (top right) is now available with an insert-cutter helical head that reduces tearout and stays sharp longer.*

Photos, this page: Michael Pekovich (top left); Roland Johnson (top right); courtesy of the manufacturers (bottom two and p. 26)

TRADE SHOW (CONTINUED)

POWERMATIC INTEGRATES TABLESAW AND WORKBENCH

Most woodworkers can use an extra workbench, so Powermatic now offers one that mounts to the side of the PM2000 cabinet saw with 50-in. rails. Since the bench fits between the rails, it doesn't take up additional shop space. The bench, made from beech, adds about $300 to the cost of the saw. It includes an end vise and benchdog holes. Details can be had at www.powermatic.com.

RIKON ADDS A CABINET SAW WITH A SLIDING VERSION

The first cabinet saw from Rikon Tools has a 10-in. right-tilting blade powered by a 3-hp, 220v motor. And, in the "Why didn't somebody think of that before?" category, the saw includes a storage drawer near the cabinet base to take advantage of what mostly has been wasted space.

The saw, model No. 10-050, sells for $1,500. A sliding version, model No. 10-110, puts the sliding table close to the blade and sells for $2,000. For more information, go to www.rikontools.com.

GRIZZLY 10-IN. CABINET SAW NOW HAS A RIVING KNIFE

Grizzly's new 10-in. cabinet saw, model No. G0651 (above), has a couple of good safety features: a riving knife and a generously sized outfeed table. Kickback is less likely when a tablesaw has a riving knife, because it can be left on the blade for almost all cuts.

GRIZZLY G0651

The outfeed table supports stock after it passes through the blade. That means you don't have to bear down extra hard on the end of the board (just as your pushing hand is closest to the blade) to keep the stock from tipping off the table.

A 3-hp, 220v motor serves up the power. The saw sells for about $1,800. A 5-hp version, model G0652, has the same price. You'll find more information at www.grizzly.com.

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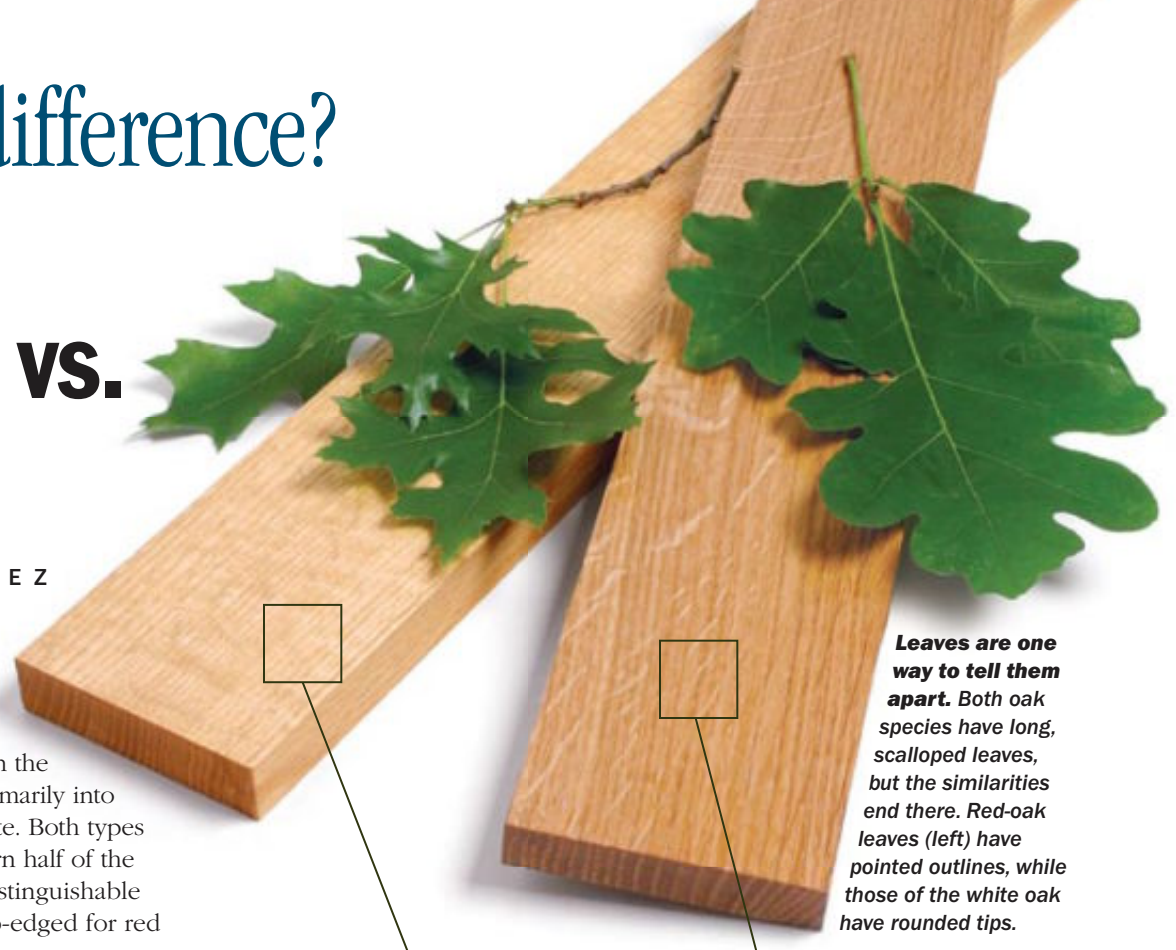
White oak vs. red oak

BY MARIO RODRIGUEZ



Leaves are one way to tell them apart. *Both oak species have long, scalloped leaves, but the similarities end there. Red-oak leaves (left) have pointed outlines, while those of the white oak have rounded tips.*

There are more than 60 species of oak growing in the United States, divided primarily into two groups: red and white. Both types grow mostly in the eastern half of the country and are easily distinguishable by their long, scalloped leaves: sharp-edged for red oak, round-edged for white.

Red-oak pores are large, and if you placed one end of a red-oak stick into soapy water and blew air through the other end, you would produce bubbles. Not so with white oak, which contains globular obstructions that block the easy passage of air and moisture. These globules, called tyloses, also fight bacteria, inhibiting decay and making white oak a better choice for outdoor projects.

Red oak is often very clear, straight-grained, and without defects. This makes it ideal for riven parts, such as the steam-bent arms and back bows of Windsor chairs. When milled, red oak has a warm, reddish cast that makes it a popular wood for a variety of household and office uses, from flooring to wall cabinets. However, largely because it is so common in public settings, red oak is less popular than white for fine furniture.

Milled white oak has a tannish cast. It ages beautifully, developing a tawny patina in a short time. When quartersawn, it's the wood of choice for Mission and Arts and Crafts furniture because of its distinctive figure, which features a beautiful ray-fleck pattern. Quartersawn red oak also exhibits a distinct, if more modest, ray-fleck pattern.

Lumberyard prices for flatsawn oak range from about $2.25 to $3.50 per board foot, with white oak usually the more expensive. This holds true for quartersawn oak as well, with white oak topping out at about $6 per board foot. □

Colors differ. *The reddish cast of red oak distinguishes it from white oak, but colors vary in tone, light to dark, even within each species.*

FURNITURE FRIENDLY

Both red and white oak are used in fine furniture. The organizer (left) is red oak. The tables are white oak, fumed with ammonia to darken the wood and bring out the ray-fleck pattern.

Photos: Charlie Reina (wood); Kelly J. Dunton (tables); Michael Pekovich (cabinet)

Q&A

Clean-cut dovetails

Q: I'm a novice at cutting dovetails and can get them only to the point of a rough fit. My problem is in cutting away the waste between both the tails and the pins. How do I do that to make the fit clean and sharp?

—JOE ZIANNO, Liberty Township, Ohio

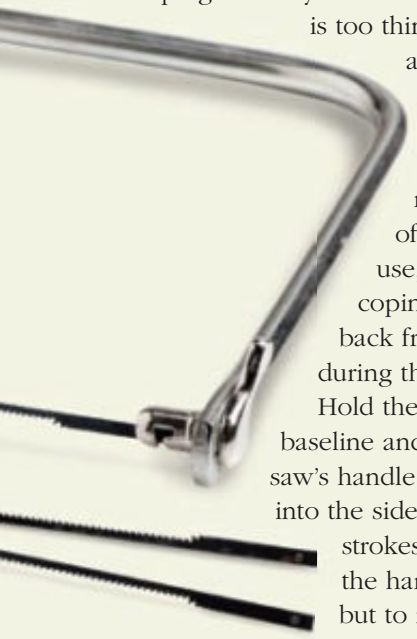
A: START BY DEFINING THE TAILS AND PINS with backsaw cuts. Then remove most of the waste between tails and pins with a coping saw. If you used a Japanese pullsaw and the kerf is too thin for the coping-saw blade, make a second cut with the pullsaw to remove a wedge, creating more space.

I use a Stanley #15-057 extra-narrow blade to cut away the bulk of the waste. Whatever blade you use, orient it 45° in relation to the coping saw's back. This helps keep the back from snagging on the workpiece during the cut.

Hold the blade about ⅛ in. above the baseline and begin the cut by twisting the saw's handle slightly so that the blade teeth bite into the side of the kerf. Then make several strokes back and forth while turning the handle—not to advance the cut, but to rotate the blade into a horizontal orientation. Then complete the cut.

Try to leave 1/32 in. to 1/16 in. of waste inside the baseline. That's just enough for the chisel to bite into as you complete the process by paring to the baseline. To keep the baseline really sharp, chisel halfway in from each face of the board, starting on the inside and finishing from the outside.

—Chris Gochnour is a frequent contributor.



Go narrow. *An extra-narrow blade, such as the Stanley #15-057, makes cutting waste with a coping saw easy.*

A backsaw makes the initial cuts. *If you use a thin-kerf, Japanese saw instead, you might need to make extra cuts to make room for the next step.*

A coping saw cuts out the waste. *Setting the blade at a 45° angle makes it easier to turn the sharp corner at the bottom of the backsaw cut and cut the waste away. Leave about 1/16 in. of material above the baseline. Pare it away with a narrow chisel to complete the process.*

Ask a question

Do you have a question you'd like us to consider for the column? Send it to Q&A, *Fine Woodworking*, 63 S. Main St., Newtown, CT 06470, or email fwqa@taunton.com.

Photos, except where noted: Charlie Reina

Lumber rack on wheels

Q: Is it possible to get further details about the sheet-goods rack shown in "Choosing and Using Casters" (*FWW* #190, pp. 76-81)? The article shows how to make the platform base. But there are no details on making the rack.

—ROB BLISS,
Winston-Salem, N.C.

A: I START BY ATTACHING a four-sided frame to the base assembly. I cover the frame with ½-in. plywood, then attach the sides, separating them at the top with a solid-wood strip. The outside edges of both the base frame and the top strip are beveled to match the slope of the sides.

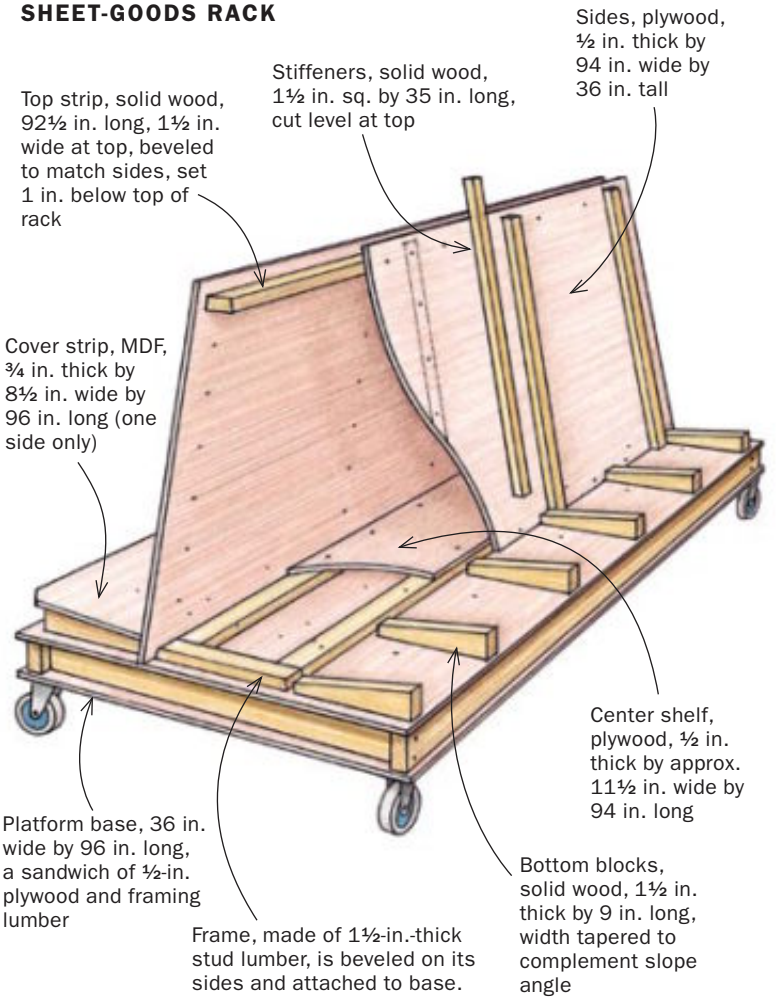
The tapered blocks at the bottom of the sloped sides leave space under the sheets for lifting. The taper of the blocks creates a 90° angle with the sloped sides. I added a cover strip to the blocks on one side in order to store smaller pieces of plywood.

The stiffeners are attached to the sides before the sides are attached to the top strip and the bottom frame.

I used drywall screws for most of the assembly, and no glue at all.

—John White is the FWW *shop manager.*

SHEET-GOODS RACK



More on shop noise

Q: David Heim's article (*FWW* #189) on shop noise gives figures on noise levels for various tools and noise reduction by several types of earplugs and muffs. How do I determine the noise level of two tools running together? And what is the noise reduction of earplugs and muffs worn together?

—JOHN RENNIE,
Knoxville, Tenn.

A: ACCORDING TO LES BLOMBERG, director of the Noise Pollution Clearinghouse, if one machine is at least 10 decibels louder, or twice as loud as another (decibels are on an exponential scale), then the noisier machine sets the resulting level. If the machines are about equally loud, then their combined sound level is a bit greater than the louder one. For example, two machines that each generate roughly 90 db. of sound produce 93 db. together, the equivalent of a 30% increase.

Two loud machines, one set of earmuffs. *This jointer/dust collector combination is noisy, but only a bit more so than the louder machine. One good set of muffs or plugs provides all the protection your ears need.*

Bear in mind that the louder the sound, the less time you safely can be exposed to it without protection.

As for combining hearing protectors, research indicates that the practice would serve little or no purpose for woodworkers. Earplugs with muffs, for instance, are only marginally superior to plugs or muffs alone.

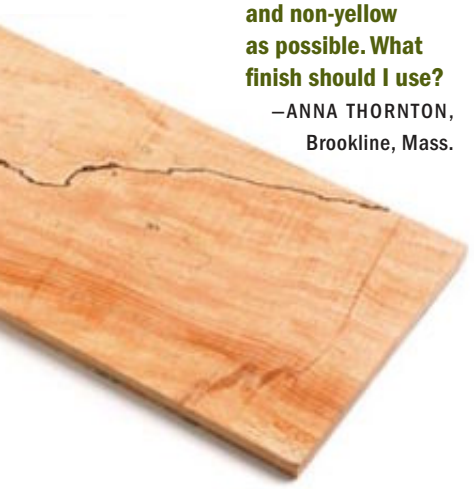
—David Heim is an associate editor.

Photo, bottom right: Steve Scott; drawing: Vince Babak

The clearest finish

Q: I want to keep my spalted maple looking as natural and non-yellow as possible. What finish should I use?

—ANNA THORNTON, Brookline, Mass.



Spalted or not, maple tends to yellow over time. *The question is: What finish minimizes the yellowing?*

A: Maple has a tendency to yellow over time no matter what finish is used. However, you have a choice of finishes based on how much handling the piece is likely to get.

If you want to give the wood some protection but still stay close to an in-the-wood look, I suggest you apply two or three coats of a non-gloss water-based finish, sanding with P220-grit sandpaper after the first and second coats.

If you look at Chris Minick's test of these finishes in *FWW* #187, you'll see that several of them, including Minwax's Polycrylic and Hydrocote's Resisthane Plus, produced a clear, non-yellow finish.

Brush on a waterborne finish. *Two or three coats of a clear, non-glossy, water-based polyurethane will give the spalted maple a protective coat but keep the wood's natural look.*

If a non-film oil finish is more important to you, try either Minwax's or Watco's Wipe-On Poly, both of which are among the clearest of this type of product. However, either one will yellow the wood more than the water-based finish, and you won't be giving the wood much protection.

—Teri Masaschi is a finishing expert and a frequent contributor.

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Get Serious About Clamping

Most woodworkers are underclamping their joints

BY ROMAN RABIEJ

A common saying among woodworkers is, "You can never have too many clamps." Turns out, it might be more accurate to say that you can never apply too much force. Most woodworkers have only the vaguest idea of how much clamping force to apply when gluing boards. Even those perfectionists who rely on dial calipers and feeler gauges when cutting and planing wood often judge clamping pressure simply by the amount of glue that squeezes out. The results are occasional joint failures and embarrassing gaps between boards on the ends of tabletops.

During my career in wood technology I've done scientific studies of glue joints using different types of glue, different clamping pressures, different species of wood, and even different grain orientations.

Rather than blind you with science and make your next glue-up even more nerve-wracking, I'll assume you're using yellow (polyvinyl acetate—PVA) glue and I'll try to answer the following questions: What is the optimum force when clamping soft and hard woods? How many

KEYS TO SUCCESS:

1. MATCH THE CLAMPING PRESSURE TO THE WOOD

2. MAKE SURE YOU HAVE ENOUGH CLAMPS

3. DISTRIBUTE THE PRESSURE EFFECTIVELY

1 Different woods require different clamping pressure

Both the wood species and the grain orientation affect the clamping pressure required for a strong glue joint.

WOOD TYPE

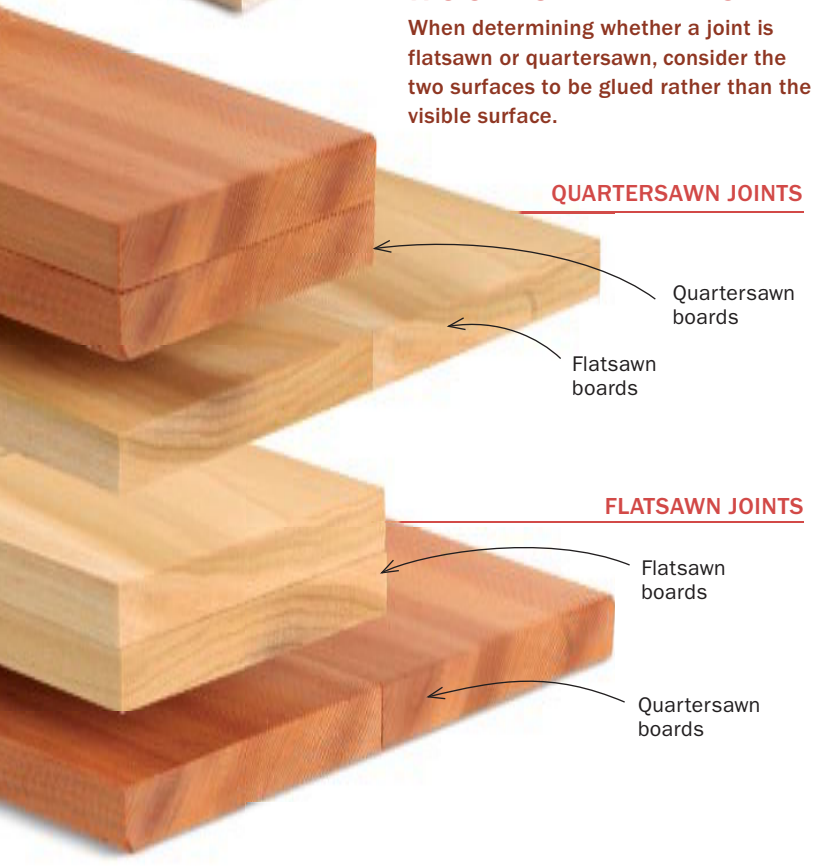
In general, dense and tight-grained woods require the application of greater force. On hardwoods, glue joints between radial or quartersawn faces require half the pressure of tangential or flatsawn face joints. This is because on hardwoods, the quartersawn face has half the compression strength of the flatsawn face, so the fibers are more easily crushed. On softwoods, the reverse is true, with the quartersawn-face gluelines requiring twice the pressure of the flatsawn-face gluelines.

RECOMMENDED CLAMPING PRESSURE (pounds per square inch)

Wood type	Quartersawn glue face	Flatsawn glue face
SUGAR MAPLE	600	1,200
RED OAK	450	900
BLACK WALNUT	300	600
BLACK CHERRY	250	500
PONDEROSA PINE	300	150

WOOD ORIENTATION

When determining whether a joint is flatsawn or quartersawn, consider the two surfaces to be glued rather than the visible surface.



clamps should you use and how should you arrange them? And last, how can you test a sample joint to see if you are getting good results?

Use this information to approach your next glue-up with new-found confidence, and the only thing under pressure will be the wood.

Why correct clamping pressure matters

Optimum clamping pressure creates strong glueline joints in several ways. First, it overcomes the viscous resistance of the glue and forces it into a thin, continuous film in contact with the wood, which is necessary for a strong joint. Second, as the glue releases moisture, causing the wood to swell, clamping overcomes this pressure and prevents the joint from opening up. Third, it overcomes minor surface imperfections between mating surfaces. And fourth, clamping holds parts in position until the glue cures.

Too little pressure will fail to achieve any of these benefits. Conversely, extreme pressure can produce weaker joints, although as I'll explain later, this is unlikely with common woodworking clamps. Because modern glues are stronger than the wood fibers, a good glue joint should break in the wood, a process known as wood failure, rather than along the glueline. So rather confusingly, the higher the percentage of wood failure, the better the joint. The

Photos, except where noted: Mark Schofield; wood and clamp photos: John Tetreault

2 Not all clamps are created equal

The force applied by each type of clamp varies greatly depending on the strength of the operator. We conducted a test using four different staff members; two *Fine Woodworking* editors, our female copy editor, and a brawny *Fine Homebuilding* editor. The numbers below are the average of the *FWW* editors. The copy editor in our test consistently applied about 60% of the average clamp pressure, while the hand strength of the *FHB* editor was about 40% higher.

PARALLEL JAW CLAMP
370 lb.

QUICK-GRIP CLAMP
470 lb.

ALUMINUM BAR CLAMP
680 lb.

¾-IN. PIPE CLAMP
1,050 lb.

"I"-BEAM BAR CLAMP
1,350 lb.

CALCULATING CLAMP REQUIREMENTS

$$\frac{\text{Glue surface (sq. in.) x Required clamping pressure (psi)}}{\text{Force applied by each clamp (lb./in.)}} = \text{Number of clamps}$$

EXAMPLE 1

Less pressure for pine. *These two pine boards have a glue surface area of 16½ sq. in. Because the glue faces are nearly flatsawn (see inset), the recommended pressure is 150 psi, requiring a total force of 2,475 lb. This can easily be met by using three ¾-in. pipe clamps.*

EXAMPLE 2

More pressure on maple. *The effective glueline area is the same as for the pine (even though there are three boards to glue instead of two). The glue faces are quartersawn (see inset), so the recommended pressure is 600 psi. This total force of 9,900 lb. requires nine pipe clamps.*

wood-failure percentage starts to diminish as clamping pressure is increased beyond a certain point, because excessive pressure begins to starve the joint of glue and also to compress the wood and reduce its ability to absorb the glue.

The chart simplifies the science

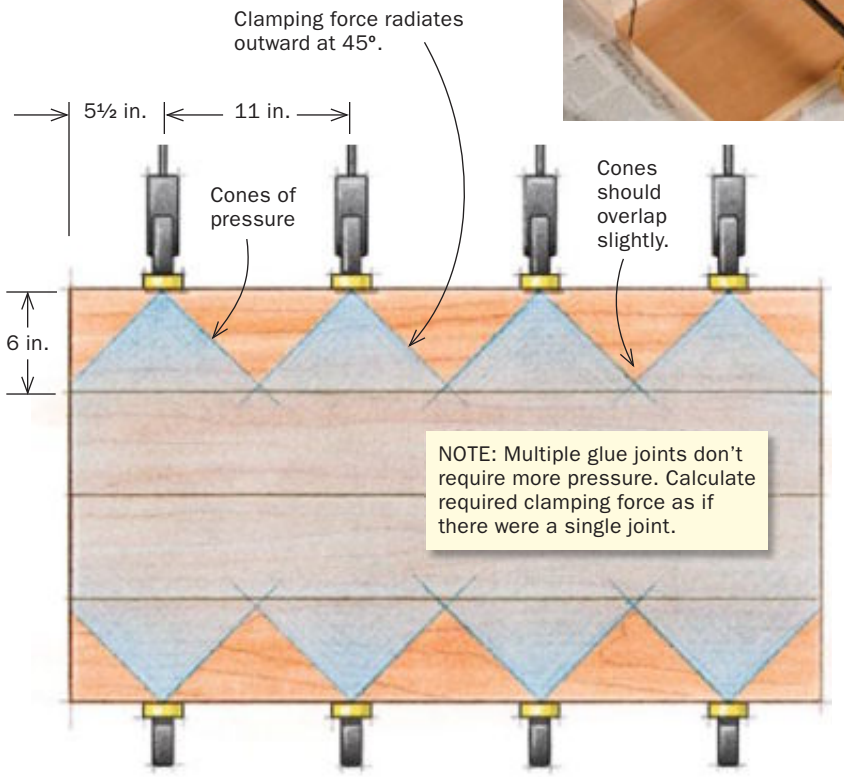
The chart on the facing page shows the recommended glueline pressure for selected furniture woods. The optimal pressure is roughly twice as high. This peak pressure is the point just before the glueline is starved or the wood fibers are crushed. For most hardwoods, however, normal woodworking clamps can't get close to these levels of force. But joints clamped at the recommended levels will be quite strong enough, with the glueline being

3 Put the pressure where you need it

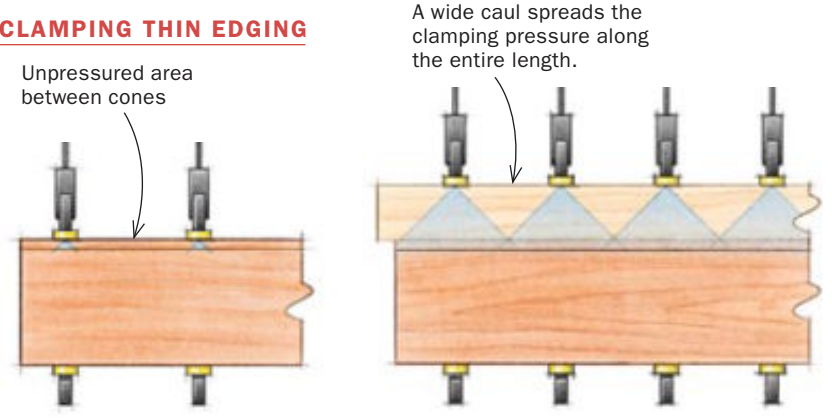
The force from a clamp spreads out in a 45° cone from each head. For the cones to overlap and the glueline to receive even pressure, the clamps need to be spaced correctly. The 45° angle makes the cones of pressure easy to measure. The force will radiate sideways in both directions the same distance as the clamp is from the glueline. So, in the example below, the 6-in.-wide board creates 12-in.-wide cones of pressure at the joint.

Cauls spread the force. *When clamping a narrow strip, the clamps have to be close together in order to have the pressure cones overlap (at right in photo). A solution is to employ a wide caul that spreads out the force before it meets the glueline (at left).*

CLAMPING WIDE BOARDS



CLAMPING THIN EDGING



Where the glueline is close to the clamp head, place the clamps very close together or use a wide caul. Otherwise, some parts of the glueline will not receive sufficient pressure.

stronger than the wood itself. You'll achieve a glueline thickness well under the recommended maximum, which is about 0.004 in. To give a point of reference, the cover of this magazine is 0.005 in. thick.

The next step is to find out how much pressure you are applying with each type of clamp.

We tested the common bar clamps

In his book, *Understanding Wood* (The Taunton Press, 2000), R. Bruce Hoadley illustrated that the amount of force applied by different types of woodworking clamp varies widely. He also found that the force of an individual clamp can differ by a factor of two depending on the strength of the operator.

To compare traditional bar and pipe clamps with newer designs and to see how the force they apply varies by user, *Fine Woodworking* rigged up a jig linked to a set of bathroom scales. The magazine's female copy editor represented one end of the strength scale, a brawny former builder at *Fine Homebuilding* represented the other, and a couple of *Fine Woodworking* editors fell in between (see p. 39). Generally, clamps with T-handles exert more pressure than those with round handles.

The first step when gluing boards is calculating the square inches of glue surface. For example, if you are gluing two boards ¾ in. thick and 36 in. long, a single glue surface equals 27 sq. in. Even if you are edge-gluing several boards, you still need to measure only one glue surface because the clamping pressure is transmitted across the width of the boards. If you are edge-gluing flatsawn red oak boards and wish

Photos, opening page and facing page (top right): Kelly J. Dunton; drawings: John Hartman

Wet both surfaces. *To ensure the uniform wetting of the wood that aids glue penetration, apply glue to both surfaces.*

Tips on gluing

It is important to get even, continuous glue coverage on the surfaces to be bonded, so apply yellow glue to both surfaces when you can. This provides instant wetting of both surfaces without relying on pressure and surface flatness to transfer the glue from one surface to the other. You will, however, have to work fast as the open time for yellow glue can be around five minutes at a temperature of 70° F (21° C) and relative air humidity of 50%.

How long should the joint be subjected to clamp pressure? The time varies from species to species, with woods that have an even density across the growth rings, such as maple, requiring less time. But in general, the glueline reaches around 80% of its ultimate strength after 60 minutes of clamping. After this, joints can be released from the clamps, but the full glue strength won't develop for about 24 hours.

to apply about 450 lb. psi, then 27 multiplied by 450 equals a force of 12,150 lb. that must be applied. Using the average of the editors' clamping forces, this could be supplied by around nine heavy-duty bar clamps, a dozen ¾-in. pipe clamps, or 26 quick-grip clamps. Obviously it would be hard to fit 26 clamps along a 36-in. board, so add some more powerful clamps if you have them. It's fine to mix and match types of clamp.

Just as important as the overall force is how it is distributed. You want even pressure along the whole glueline. This can be done in two ways. The force applied by a clamp radiates outward at 45° on either side, so you'll need to space the clamps so that the force from them just overlaps along the glueline.

When edge-gluing wide boards, such as for a tabletop, you can employ powerful clamps spaced widely, alternating the clamps above and below the workpiece to prevent the boards from bowing. If the glueline is close to the face of the clamp, such as when applying solid-wood edging to plywood, to avoid having a clamp placed every inch or two, you can use wide cauls that will spread the clamp pressure as well as protect the edge of the workpiece from the clamps. □

Roman Rabiej, Ph.D., is a professor of industrial design at Western Michigan University in Kalamazoo, Mich.

HOW STRONG IS YOUR GLUELINE?

Even if you have used the correct pressure, it is still reassuring to make sure that you are achieving well-glued joints. A simple test is to place a sharp chisel exactly on the glueline, and strike it with a mallet. A weak joint will split in the glueline, either because the glue was too thick or the glue didn't penetrate the wood correctly. The percentage of wood failure will be very low or nonexistent. A good joint will split mostly in the wood adjacent to the glueline.

Quick, Sturdy Bookcase

Learn to taper sliding dovetails for easier assembly

BY MARTIN MILKOVITS

In my home, bookcases show up in every room, serving not only as places to store our growing collection of books, but also as places to display art and other items of interest. This butternut-and-maple bookcase is a versatile piece, big enough to hold a good number of books and/or collectibles while small enough to fit in almost any room.

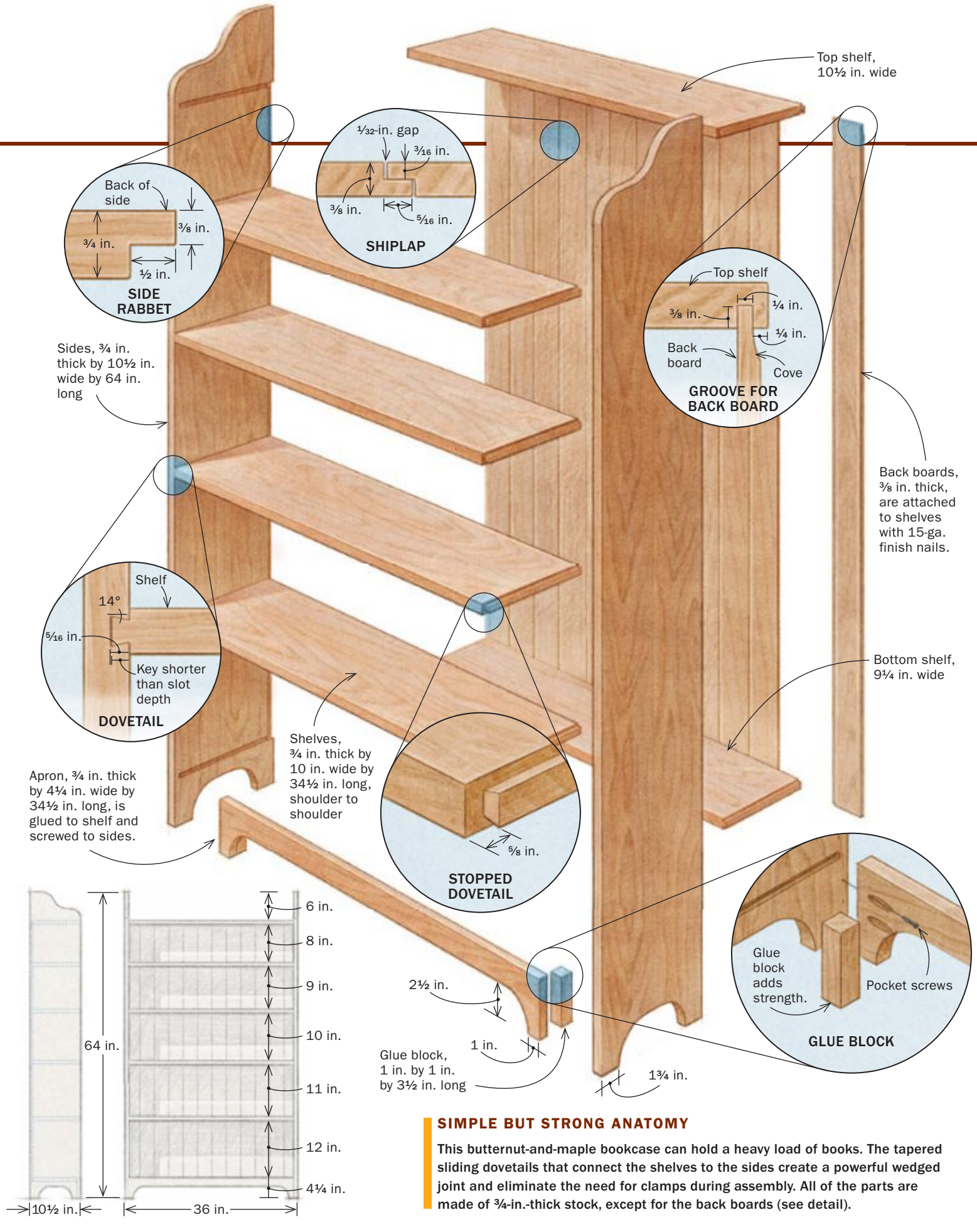
The design is understated, with bracket feet and gentle curves along the tops of the sides, and maple back boards contrasting softly with butternut sides and shelves.

But you can use this construction method to build a bookcase in any style. The shelves are attached to the sides with sliding dovetails, which provide a mechanical connection that will never pull apart. Sliding dovetails also are used to connect cabinet tops to bottoms, to join vertical partitions to shelves, to attach molding to case sides, to connect breadboard ends to tabletops, and to attach drawer fronts to sides. In this case, I stopped the dovetails for a clean look on the front of the piece. The back boards are shiplapped to allow for wood movement.

Why taper the dovetail?

A sliding dovetail has two parts: the slot and the dovetail key. Here the slots are routed into the case sides, and the keys are cut on the ends of the shelf. When you use this joint in wide stock, binding is a common headache during glue-up. The joint goes halfway home, then the glue makes

Photos: Thomas McKenna; drawings: John Hartman



SIMPLE BUT STRONG ANATOMY

This butternut-and-maple bookcase can hold a heavy load of books. The tapered sliding dovetails that connect the shelves to the sides create a powerful wedged joint and eliminate the need for clamps during assembly. All of the parts are made of ¾-in.-thick stock, except for the back boards (see detail).

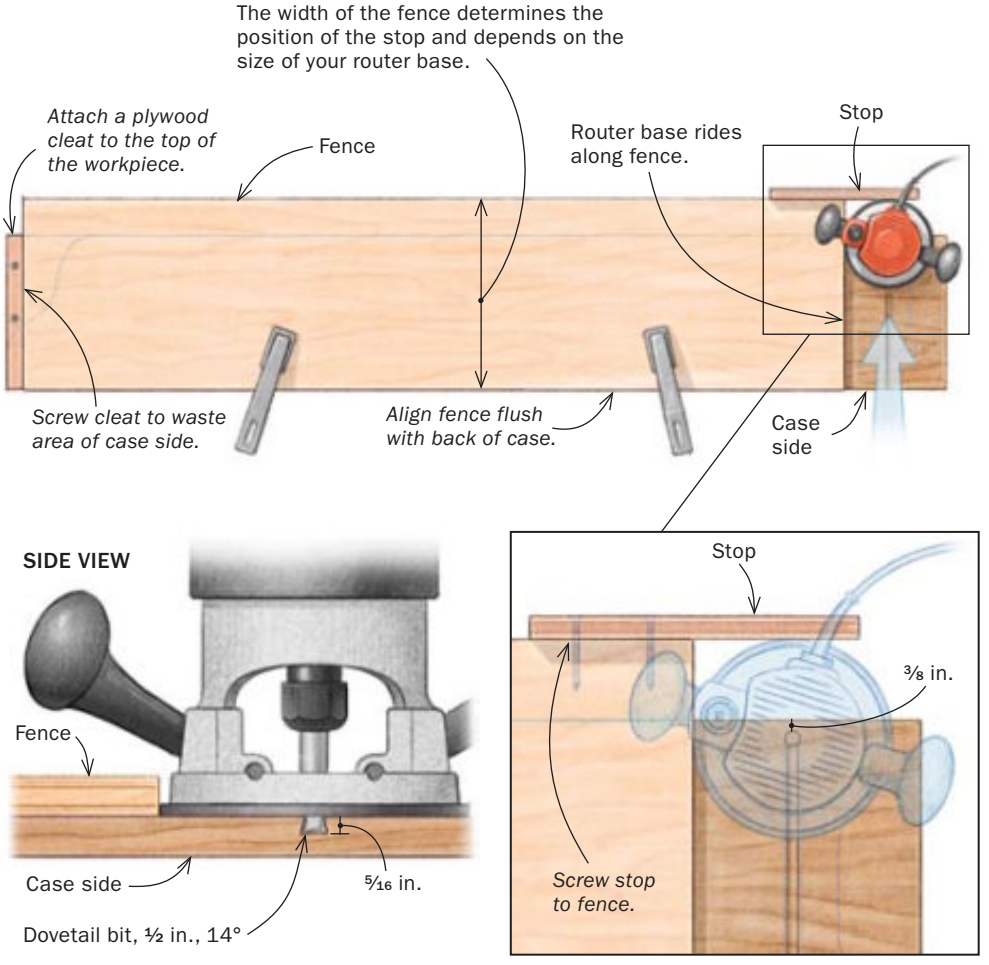
Tapered slots in two steps

To ensure consistent results, the slots for each shelf are routed using a long fence and a plywood cleat. After the first pass, add a shim between the fence and cleat, then use the same router setup to taper the slot.

FIRST PASS

Attach a cleat to each case side. *Screw the plywood cleat to the top of the inside case sides and perfectly square to the edges. Place screws in areas that will be wasted away when you profile the ends.*

Clamp the fence to the workpiece. *Align the front edge of the fence flush with the back of the case side and tight against the cleat at the top.*



the wood swell and the joint seizes. That's why I taper the joint slightly toward the front of the case. The taper—cut on one side of the slot and on the corresponding face of the key—makes it easy to slide the shelf in from the back without binding, and creates a wedging action in front as the shelf is tapped home.

The amount of taper is not that critical as long as it is consistent. I keep it to about 1/32 in. (about as thick as three business cards) per 10 in. of board width. With a taper like this, the joint can be almost completely assembled for trial fitting, and can be driven home with a few mallet blows.

Router method simplifies complex joint

Tapered sliding dovetails can be cut by hand, using saws and chisels, but this method can be imprecise and time-consuming. I prefer to use a router and a few simple jigs to do the job. The method is clean and allows you to dial in the fit of each joint. To avoid confusion, be sure to label mating parts as you work.

Cut slots with a handheld router—For strength, the slot should be no deeper than half the thickness of the side. Likewise, the thin part of the key should be at least half

Rout the slot. *Holding the router tight against the fence for control, cut until you reach the stop. Let the bit stop spinning before backing it out of the slot, or you could ruin the cut.*

the thickness of the shelf, and the length at least one-third the thickness of the shelf.

First, screw a ¾-in.-thick plywood cleat to the top of the case sides. Mark the shelf locations on each side, then make a ¾-in.-thick plywood fence to locate the slots in both sides. Cut the fence to a length that aligns the router bit with the lower shelf location, and rip it to a width that will place the router bit ⅜ in. from the front of the side. Screw a stop to the business end of the fence, and clamp the assembly in place (see drawing, facing page).

Set the router to make a 5⁄16-in.-deep cut and rout the slot across the side until you reach the stop. Next, remove the fence and place a shim between the rear edge of the cleat and the rear edge of the fence. Reclamp the fence in place, then pass the router through the slot to create the taper along the bottom edge. Repeat this operation in the opposite side of the case. Once you have both slots for the bottom shelf routed and tapered, trim the fence to cut slots for the next higher shelf and repeat all of the previous steps.

Now is a good time to cut the bracket feet on the bottom of the sides, as well as the profile on top. Clean up those edges before proceeding.

Cut keys on the router table—Place the same bit you used to cut the slots into the router table, and set the depth so that it's a hair less (0.005 in. or so) than the depth of the slots. This will create a tiny gap to make the sliding action easier. Using a test piece the same thickness as the shelves, adjust the fence and take light cuts on both sides until the test piece fits about halfway or more into a slot with hand pressure. Once you've reached that point, you are ready to rout the actual shelves.

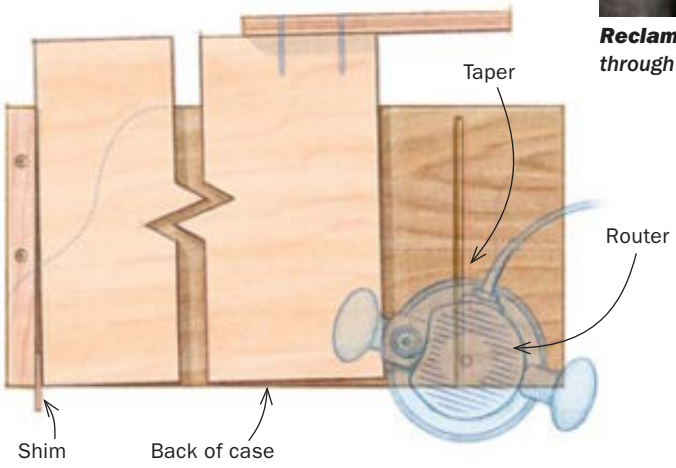
First, add a shim to the bottom rear of each shelf. The shim should be the same thickness as the shim used to taper the slots. Rout the top side of the key on each end of each shelf. Then flip each shelf to cut the bottom of the keys. At this point, each shelf should slide freely about halfway home but tight after that. To fit the shelves individually, make hairline passes

SECOND PASS

Shim out the back side. *Place the shim between the fence and the cleat. Veneer tape is the perfect thickness (1⁄32 in.) to create the desired taper.*

Reclamp and rerout. *With the shim in place and the fence reclamped, run the router through the slot to add the taper.*

ADD A SHIM TO TAPER THE SLOTS



Trim the fence. *After routing both slots for the bottom shelf, cut the fence down to repeat the process on the next set of slots.*

Taper the keys

The keys are cut and tapered at the router table using the same bit that cut the slots, adjusted so that its height is a hair under the slot depth. Use a tall auxiliary fence to keep the long workpieces stable.

Test piece gets you started. *Take light passes along both edges of a test piece, made from a shelf offcut, until it slides halfway or more into a slot with hand pressure.*

Shim out the bottom rear of the shelves. *Use a shim of the same thickness used to taper the slots. Veneer tape is great because you can iron it on and take it off easily.*

TAPER THE DOVETAIL KEYS

Shim the rear edge of the shelf bottom and rout both sides of the shelf end.

across the top, straight side of each key until the shelf slides to within 1½ in. of being fully home with only hand pressure (see photo, bottom right). Use a small, angled sanding block to dial in the fit.

Next, use a handsaw and a chisel to trim ⅝ in. from the front of the keys. Refine the fit with the sanding block if needed. Now rout a groove under the top shelf, ¼ in. from the back edge, for the back boards. Next, rip the lower shelves to size along their back edges, and trim an additional ¾ in. off the front of the bottom shelf to accommodate the apron. Finally, cut the rabbets that hold the back boards.

Glue in shelves, then add back boards

Once you have all the shelves fitted to the sides, the hardest work is done. Now's the

Fine-tune the fit. *Keep making hairline passes on the router table to get the key to slide closer to home. To micro-adjust the fit, use a sanding block cut to the same angle as the dovetail bit and attach adhesive-backed P120-grit sandpaper to it (top). The goal is to get the shelf to slide with just hand pressure until it is about 1½ in. from being fully home (bottom).*

Assembly: no clamps required

Once the shelves are fitted, mill up the back boards and the apron. Cut the shelves at the back to their final widths, then cut the groove under the top shelf for the back boards. Finally, after you've rabbeted the sides for the back boards, you can break out the glue.

Trim 5/8 in. from the front of the key. *Use a handsaw to remove most of the waste, and clean up the cut with a sharp chisel.*

Push and pound. *Stand the sides rear-edge up on an assembly bench. To install each shelf, place a spot of glue inside the corresponding slots near the front edge. Push in the shelf as far as you can by hand and fist, then rap the shelf home with a mallet. When installing the bottom shelf, put the apron in place to serve as a stop. Later you can screw the apron into place.*

Online **Extra**

For a full finishing recipe for this project, go to **FineWoodworking.com/extras**.

time to glue up the case and cut and fit the back boards and apron.

The maple back boards are ripped to random widths no wider than 3½ in. Once the boards are cut to final size, use a raised-panel cove cutter to rout a ¼-in. tongue along their tops. Then rout the rabbets along their sides to create the shiplap.

To glue in the shelves, stand the sides rear-edge up on an assembly bench. Place a spot of glue inside the corresponding slots near the front edge, slide in the shelf as far as you can with hand pressure, then tap the shelf home with a mallet.

After installing the apron and glue blocks, the piece is ready for finishing (the back boards are finished before final installation). For this bookcase, I sprayed on Deft clear lacquer.

After you have the back boards in place, the bookcase is ready for your collection of Russian nesting dolls. □

Martin Milkovits is a furniture maker in Mason, N.H.

Nail in the back boards in order. *Slide the top edges of the boards into the groove under the top shelf. To avoid misses, mark the shelf locations across the back, then nail each board to each shelf with 15-ga. finish nails.*

Three Federal Legs

Power tools speed the process, banding adds style

BY JEFF GROSS

CLASSIC LEGS—TODAY'S TECHNIQUES

Slender, tapered legs with beading and applied banding are a hallmark of Federal furniture. Shaping them usually requires a lot of careful work with hand tools. Those shown above are made mainly on the tablesaw, using a versatile shopmade jig.

Photos, except where noted: David Heim; drawings: Christopher Mills

Three years ago, I had the privilege of participating in the inaugural Three Month Furniture Making Intensive workshop offered by the North Bennet Street School in Boston. In addition to increased knowledge of the craft, wonderful experiences with the instructors, and new friends, I came away with an elegant Federal-style writing desk (see photo, facing page).

Making the square tapered legs required a fair amount of work with handplanes, spokeshaves, rasps, and files. After some experimentation, I figured out how to cut three styles of Federal leg using simple shopmade jigs. Once cut, the legs need only minor cleanup. One leg has a double taper. The other two are variations on a spade foot.

All three styles of leg use the same cutting sequence for the tapers. (For the spade feet, you first drill out sections that form the flares at the ankle.) Cut the long tapers first, then flip the leg end for end in the tapering jig. Readjust it for the tapers at the foot, then make those cuts.

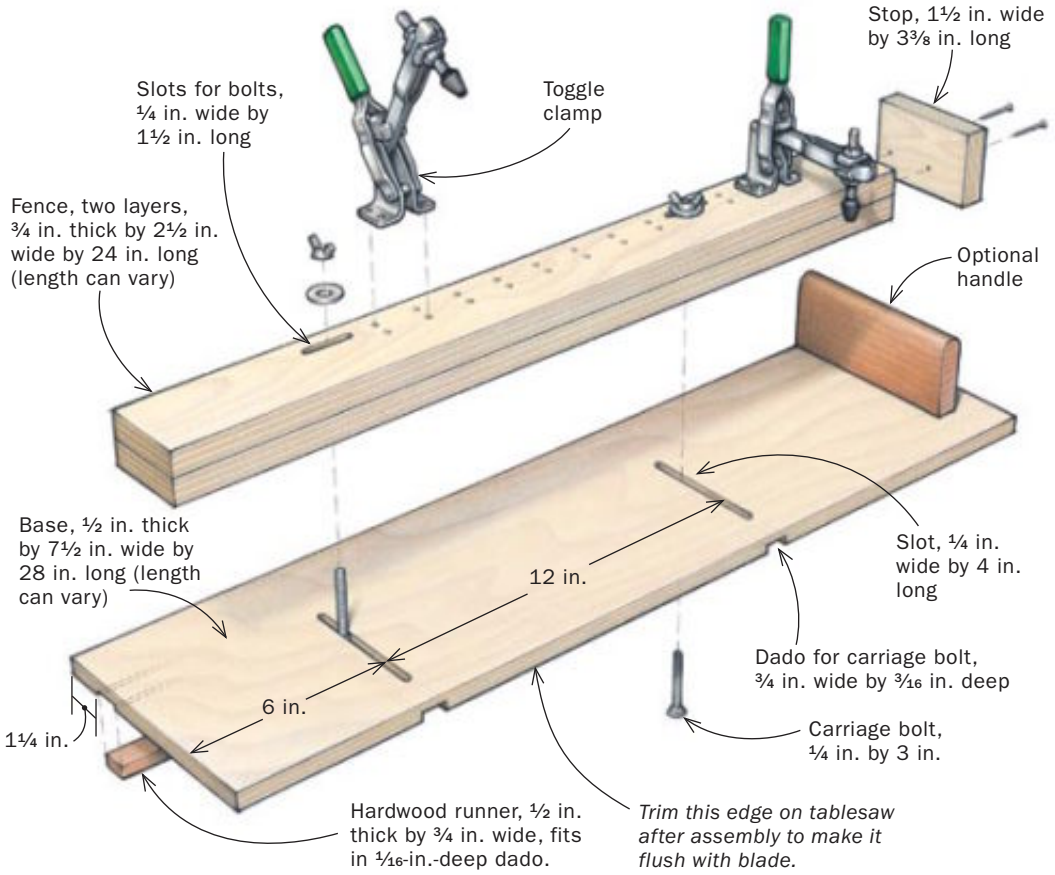
To make the legs shown here, mill blanks that are 1¼ in. sq. and 18 in. long. Mark the point near the top where the taper begins (it's 3 in. for these legs). Mark the ankle: in this case, 2¾ in. Mark two sets of reference lines on the bottom of the blank, at 3⁄16 in. and 5⁄16 in. from each face. These will help position the blank to cut the long and short tapers. If you wish to make legs of a different size, a full-size pattern will help you refine proportions and the angles of the tapers.

Jeff Gross is the proprietor of J. Thomas Furniture in Groton, Mass., and a member of the Society of American Period Furniture Makers.

Start with a tapering jig

I designed this tablesaw jig for cutting square tapers. Cut the base from ½-in.-thick birch plywood and the fence from a double thickness of ¾-in.-thick plywood. The length of the base and fence can vary. Rout dadoes and slots in the base and fence, as shown, to accommodate a runner for the saw's miter slot and the bolts that hold the fence in place. Screw a stop to the short end of the fence nearest the front of the tablesaw. Fasten two toggle clamps to the top of the fence. Drill extra sets of holes for the screws holding the clamps; the jig is handier if you can relocate the clamps. I screw a handle to the front of the jig, but it's not necessary.

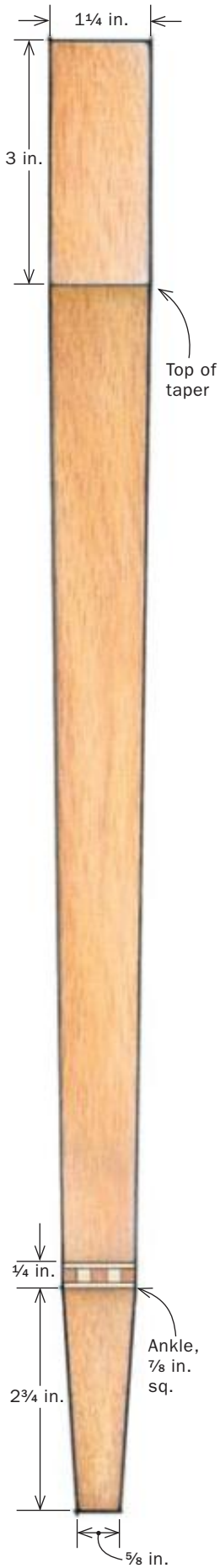
Secure the runner to the bottom of the base, slide it into the miter slot, and trim the edge of the base to align it with the blade.



RIFT-SAW FOR UNIFORM GRAIN

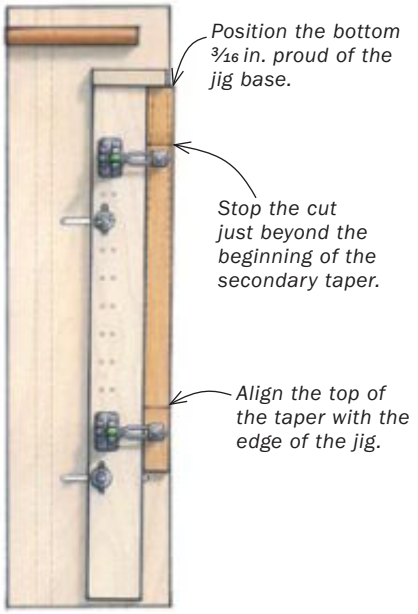
The 19th-century cabinetmakers who created the Federal style favored mahogany, but maple, cherry, and walnut also are appropriate. Use straight-grained stock and resaw it so that the end grain runs on the diagonal. The grain pattern, known as rift-sawn, creates uniform grain lines on the faces of the leg. Use a bandsaw to cut the first face at the correct angle. Use that face to mill the others.

Line up the grain. *From an index card, cut a window the same size as the leg's cross section. Set the window on the end of the stock and rotate it so that the grain aligns on the diagonal. Mark the window on the end grain. Then tilt the bandsaw table so that the blade aligns with one side of the leg.*



Shaping the double-taper leg

CUT THE LONG TAPER FIRST



Set up a stopped cut. *Clamp a hook-shaped stop to the fence so that you don't completely remove the waste from the long-taper cuts.*

This is the simplest style to make, because you use only the tapering jig. Banding at the ankle highlights the transition between the tapers. Stopped cuts for the long tapers keep the end of the foot intact, which simplifies the setup for subsequent cuts.

Start by loosening the jig's fence and snugging the leg blank against it with the foot against the fence's stop block. Align the blank to cut the long taper (see drawing, above).

Transfer the pencil line marking the leg's ankle to the edge of the jig base and take the blank out of the jig. Raise the sawblade as high as you can and slide the jig forward until the sawblade is about 1 in. past the pencil line on the base. Clamp a hooked stop to the tablesaw fence (see photo, above), then clamp the leg blank back in the jig and make the first cut. To keep the waste wood from splintering, shut off the saw and let the blade stop before sliding the jig back. Cut the next two sides, rotating the leg toward the fence each time. For the last cut, remove the stop and cut the full length of the leg.

Now cut the second taper, from the ankle to the bottom of the leg. Redraw the reference line for the ankle on the last face you cut. Keep that face toward the sawblade and flip the blank end for end so that the top rests against the jig's stop block. Bring the ankle reference line flush with the edge of the jig. Pivot the leg and the fence until the reference line on the foot is flush with the edge of the jig, leaving the foot ⅛ in. proud of the base. When everything is lined up, tighten the fence, clamp down the leg, and cut the taper on two faces.

To taper the third face, rotate the leg toward the fence and butt the untapered portion tight against the fence and the stop block. Align the reference line on the bottom and the ankle reference line with the edge of the jig. Clamp the leg to the jig. Adjust the jig's fence so that it meets the leg along the long taper. Tighten the fence, clamp down the leg, and make the third cut.

Rotate the leg and butt the long taper against the fence. Cut the last side. The last taper will be slightly different from the others because the last cut is referenced to the long taper. Nobody will notice.

Use a block plane to even out the line where the long taper and the foot taper meet. Don't worry too much about cleaning up the point at the top of the leg where the long tapers begin.

You'll have to hand-cut the recess for the banding at the ankle. To set the correct angle for the recess, lay a square against the square part of the top of the leg. On the opposite face, hold a bevel gauge against the long taper. Adjust the blade of the gauge until it butts the blade of the square. Then slide the bevel gauge down to the ankle and mark two sets of lines for the recess. Remove the wood with a chisel or a router plane.

Photos, facing page (bottom): Kelly J. Dunton

Saw the long tapers. *These cuts remove only a small amount of wood. You may need to adjust or reposition the toggle clamps to hold the stock firmly.*

Pause at the end. *Leave a chunk of waste here to help when setting up for subsequent tapers. Let the saw coast to a stop before moving the jig.*

CUT THE SHORT TAPER LAST

Short cuts clear up the leg. *Cutting these tapers removes waste from the first set of cuts. The finished leg should need only a minor touch-up with a handplane.*

BANDING ADDS A HIGHLIGHT

John and Thomas Seymour, masters of the Federal style, often used decorative banding on their legs. Two of these designs do the same. In both, ¼-in.-wide or ⅜-in.-wide banding is glued into a dado.

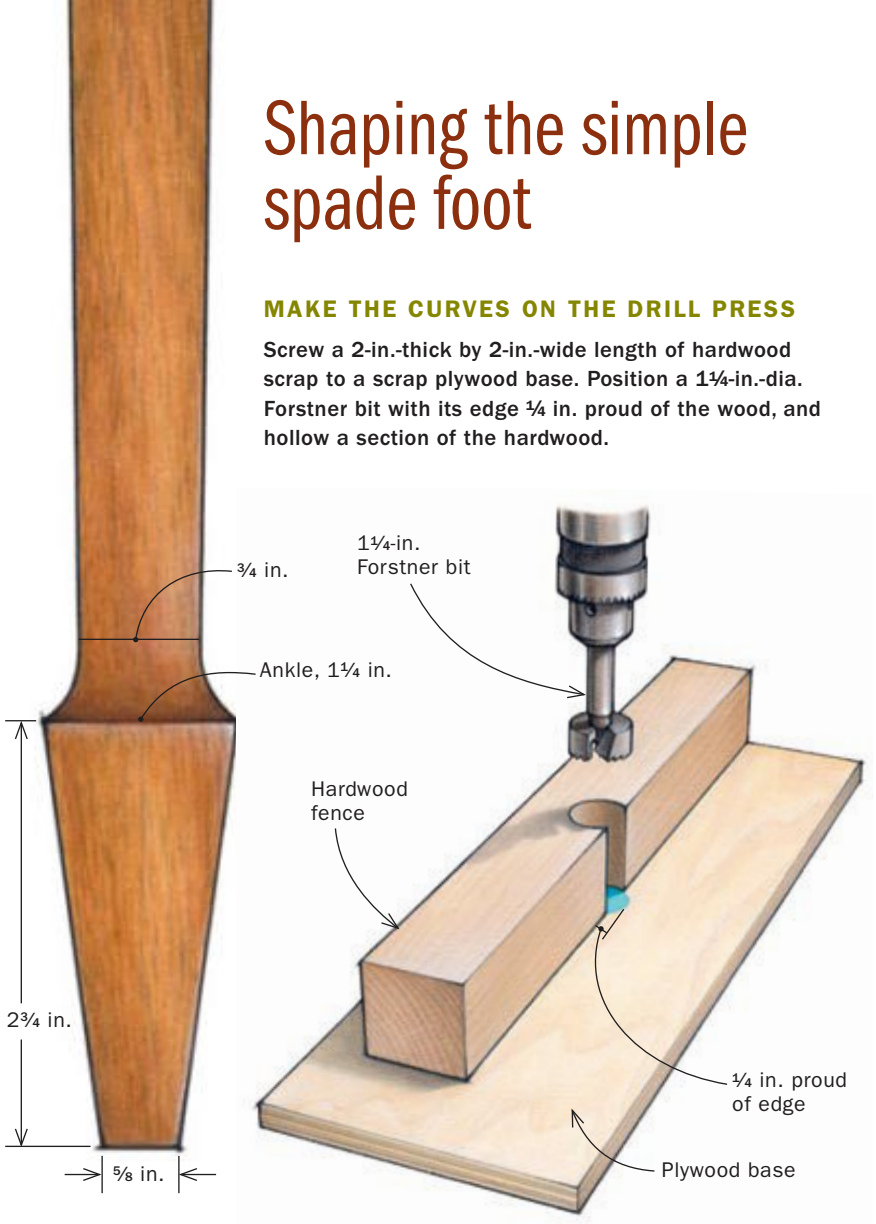
Mark the leg for banding. *Use a bevel gauge and knife to mark the position of the banding (above). Cut the slot with a router plane or chisel (right).*

Fit the banding. *Trim the banding to length and glue it into the recess. Match the pattern where the banding turns corners.*

Shaping the simple spade foot

MAKE THE CURVES ON THE DRILL PRESS

Screw a 2-in.-thick by 2-in.-wide length of hardwood scrap to a scrap plywood base. Position a 1¼-in.-dia. Forstner bit with its edge ¼ in. proud of the wood, and hollow a section of the hardwood.



Drill hollows in the leg. *Clamp a leg blank against the hardwood fence, aligning the ankle with the drilled-away edge of the fence. Drill a hollow in each side of the blank.*

Make the jig shown in the drawing above, clamp it to the drill-press table, and bore the holes. (You can make the jig at any time, but it's easiest when you're ready to cut the legs. This way you don't have to line everything up more than once.) You'll also need a short length of 1¼-in.-dia. dowel to help register the drilled leg blank on the tapering jig. I use a cutoff from a curtain rod.

To align the hollows, clamp a stop block to the drilled-out fence, then clamp the leg in place. Turn the leg blank toward you after drilling each hole so that the jig base backs up all but the last cut.

Now saw the long tapers. These will be stopped cuts, ending just short of the deepest part of the hollow. Put the blank in the tapering jig with the foot against the stop block. Pivot the blank and the fence until the point at the top where the long taper begins is flush with the jig's base. Fit the short length of dowel in the hollow and pivot the leg until the dowel touches the side of the jig base. Remove the dowel and mark the base where the deepest part of the hollow touches it. Set up the stop block on the tablesaw fence so the cut will end 1/16 in. shy of the mark.

Saw the tapers as for the double-taper leg, but leave the stop block in position for the last cut.

Cutting the short taper requires only one setup. Flip the leg blank so that the top rests against the stop block. Adjust the jig so that the cut begins at the reference mark on the bottom and ends about 1/16 in. shy of the hollow. This setup leaves a small flat on each face, just below the hollow, which helps keep the leg in alignment as you cut the tapers.

This leg requires more cleanup with hand tools. Use a handplane to work the short tapers until the small flat disappears. Then carefully saw away the waste wood so that the long taper blends into the flare. A flush-cutting saw or a Japanese-style crosscut saw works well. Use a chisel to pare away any remaining wood, and a cabinet file to blend the flare into the taper.

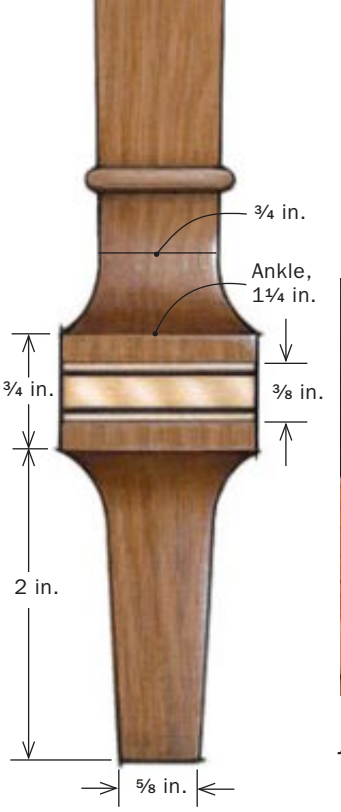
Keep the blade out of the hollow. *Stop the long-taper cuts just short of the deepest part of the hollow. The waste helps keep the blank square in the jig.*

Short cuts. *Short taper cuts begin at the bottom of the leg, with the taper stopping just short of the hollow.*

Saw away waste wood. *With the leg clamped to the bench, carefully saw away the waste. Use a light touch to ensure that the sawteeth don't mar the flare.*

Blend the taper into the flare. *A little work with a chisel and a file will blend the taper into the flare at the ankle.*

Shaping the complex spade foot



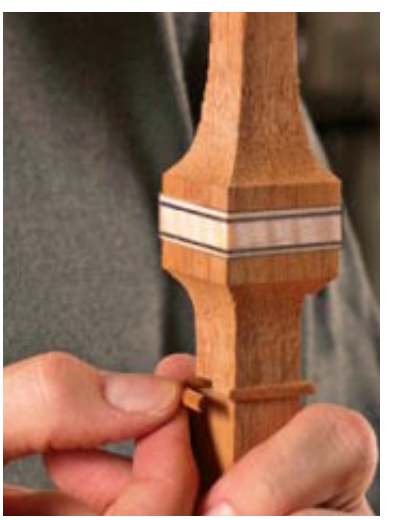
Use the dado to center the hollows. *On the drill jig, mark the edges of the dado for the decorative banding. Always align the leg on those marks to keep the dado centered.*

Begin by cutting the slot for the bead that's applied just above the ankle. Use a full-size pattern to locate this dado and set its depth. Then cut the shallow dado for the decorative banding that's centered on the square section at the ankle.

Next, drill the hollows above the square section. Mark the fence of the drill jig with the location of the dado for the decorative banding. This will ensure that the banding is centered in the square section. Remove the stop block from the fence, flip the leg end for end, and line up the dado with the marks you've made on the fence. Clamp the leg blank in place while you reattach the stop block, then drill the second set of hollows.

The long tapers are cut the same way as for the other styles of feet, ending just short of the top set of hollows. The easiest way to cut the second set of tapers is to flip the jig around without moving its fence and use it on the other side of the sawblade. Unscrew the runner from the jig's base. Move the saw's rip fence to the left side of the blade, setting it so that the jig's base just meets the blade. Cut to the lower hollows, then remove any waste wood still attached.

Switcheroo. *To cut these short tapers, remove the runner from the jig, move the rip fence to the opposite side, and align the jig with the blade.*



Finishing touch. *Shape the beading with a scratch stock, then miter the ends to fit in the recess.*

Furniture Kids Will Love

Follow your imagination but don't lose sight of safety

BY JEFF MILLER

Whether it's for your children, grandchildren, or the children of other family and friends, making things for the kids in your life can be uniquely satisfying. But there are challenges as well. How do you know what will be appreciated or what will be safe? Children's furniture differs from the adult variety in many ways, much as children themselves do.

A whole set of design considerations revolves around how children see and interact with furniture. But these are opportunities—new creative avenues for designer and builder. Kids' furniture also requires a special emphasis on safety that should guide you every step of the way.

Exercise your creative freedom

There are several approaches to designing furniture for children. All are fun in

WHIMSICAL OR ALL GROWN UP

Part of the fun in designing kids' furniture is turning the imagination loose. This anthropomorphic chest of drawers by Vancouver furniture maker Judson Beaumont experiments with storybook shapes. You also can create replicas of adult furniture, like these Arts and Crafts-inspired chairs by Sam Norris of Burlington, Vt.

Photos: Seth Janofsky (chairs); Storme (dresser)

Multicolored wall shelves. *Kids no doubt find plenty of ways to fill the nooks and crannies of these storage units by Beaumont.*

their own way. For example, children love having their own version of a special adult piece. It makes them feel grown up, even though they'll certainly use the furniture in some rather un-grown-up ways.

On the other hand, many successful designs have an element of whimsy, such as bold shapes and bright colors. I believe children see the world as bright, new, and exciting. This can be inspiring—and liberating—to adult designers. Just don't leave out a healthy measure of taste when you add in the whimsy.

You can't always know what sort of playful role a child will find for a piece, but you can certainly encourage one. This is the impulse behind things like a bed with a race car, animal, or castle theme, but the play element also can be more subtle. One of my more successful designs is a "Marble Chair," which has a back that is a marble race (see center photo, p. 59). It is endlessly entertaining, although definitely not suitable for children under 3 years old.

Some pieces serve new roles after the kids outgrow them: A play table

Quick and easy can be fun

Save the quilted maple. *Smaller kids especially are more likely to appreciate bold colors. Christiana made this bed from home-center lumber and finished it with latex paint.*

The last time I built something fancy for my kids was before I had any. The piece was a Colonial cradle in walnut, with classic lines and tricky dovetails on a compound angle (see photo, p. 56). I finished it the night my wife went into labor, in a last crazy burst of nesting instinct.

Like many pieces of fine children's furniture, I suspect, the cradle has been more useful in its second life as a hopper for stuffed animals. As a cradle, the heirloom soon lost out to a parade of plastic contraptions—vibrating chairs, automatic swings—that were ugly but very functional, and the baby outgrew it in a few months anyway.

Since then I've been a busy dad, and the kids have grown like weeds. If I were their retired grandfather, maybe I could keep them in little Windsor chairs, but I just don't have the time. I save my finest woodworking for full-size things we'll use for life. But I've also made at least a dozen kid items, from beds and storage to desks and chairs.

I think of kids' furniture as quick and dirty: It's got to be quick and it is going to get dirty—the chipped paint, crayon marks, and Elmo stickers are kiddie patina. And while my stuff is not ready for the Readers Gallery, I don't apologize for any of it. There is great fun in whipping up a mini Adirondack chair or a child's desk in an afternoon, and then seeing it give good service for many years.

Spend an hour measuring your child and sketching up a plan, and then bang it out in Baltic birch, using biscuits, router roundovers, and water-based poly. I also recommend paint-grade pine and acrylic paint. Paint covers mistakes, cheap lumber, and easy joinery, and kids love bright colors a lot more than bird's-eye maple, in my experience.

Call it "Pine Woodworking" if that makes you feel any better. I call it fun.

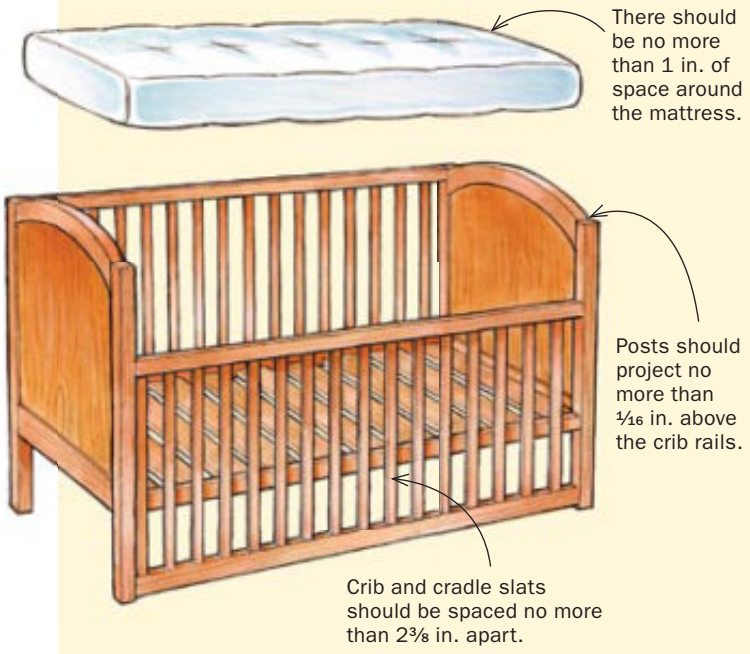
***—Asa Christiana is editor of* Fine Woodworking.**

Photos: Adam Greaves (shelves); Steve Scott (bed); Asa Christiana (box)

Cribs and cradles

Custom made for a lullaby. *Cradles like these by Miller (left) and Christiana (right) are especially popular projects for granddads. They share some safety concerns with cribs, from slat spacing to the fit of the bedding. Christiana made this dovetailed walnut cradle for his first daughter, but it soon became a repository for stuffed animals.*

CRIB AND CRADLE SAFETY



MATTRESS SIZES

Before building a crib, cradle, or youth bed, measure your specific mattress if at all possible. Variations from standard sizes are common. In a crib or cradle, this can be the difference between an appropriately tight fit and something that is either dangerously loose or too tight to fit.

Bed type	Mattress size
Cradle	15 in. by 33 in., or 18 in. by 36 in.
Crib	27 in. by 52 in.
Twin	39 in. by 75 in.
Double	54 in. by 75 in.

turns into a coffee table; a baby's changing table becomes a sideboard for the dining room.

Guidelines for safe construction

Foremost in your mind should always be the overall safety of the furniture. There should be no sharp edges or corners. I'm not fond of rounded-over edges, but in this case they're a very good idea.

The construction of the piece should be beyond question—the best possible joinery on strong components. A child is much smaller and lighter than an adult, but adults rarely drag their chairs all around the house and use them as step stools. Areas around joints must be almost as robust as on full-size furniture.

Consider using extra screws (and glue) for mattress-support rails, and corner blocks on chairs. Pin mortise-and-tenon joints if it will strengthen the structure. For children 3 and under, avoid loose parts small enough to cause a choking hazard.

Another issue related to younger children is the safety of the finish. Most finishes designed for furniture are considered food-contact safe once the solvents have evaporated or the various chemicals have combined. And even Consumer Product Safety Commission rules allow a little bit of lead (0.06%) in paint deemed safe for cribs. But I've seen how kids will gnaw on crib rails, and I, along with most new parents, would err on the side of caution and select finishes that are nontoxic.

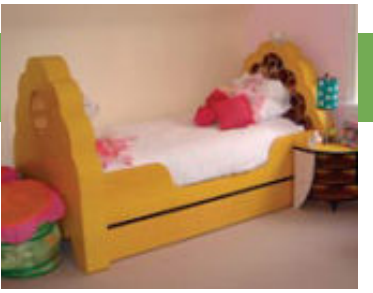
One of the most readily available safe finishes, shellac, is actually edible, and has been used for coatings on medicines and candies. For this level of "edibility" you should probably mix your own with shellac flakes and high-proof grain alcohol or denatured alcohol (the alcohol evaporates as the finish dries). Shellac may not be as durable or protective as some other finishes, but it is quick and easy to apply. There are other commercial finishes designed to be completely nontoxic. These include oils, waxes, paints, dyes, and stains.

So far, we've discussed general guidelines that apply to any piece. Here are some specific tips for the most popular types of children's furniture.

Photos: Tanya Tucka (cradle left, chest facing page); Steve Scott (cradle right); drawings: Stephen Hutchings

Beds

Quiet curves and color. *Craig Jentz of Minneapolis built this bed of ash and ash veneer over bending plywood. It features compound curves in the headboard and footboard.*



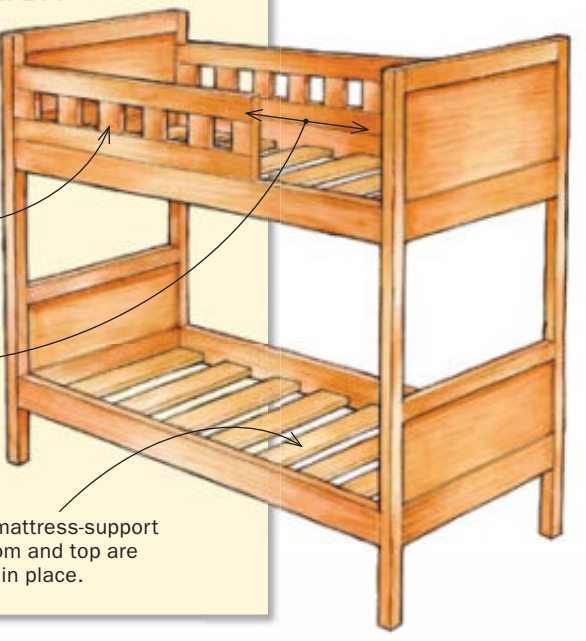
Comfier than a hive. *Themed furniture—trains, dinosaurs, cars, and nature, as in this bee bed by Judson Beaumont—is popular with kids. The honeycomb cutout in the headboard was made on a CNC routing machine. The materials are stained maple veneer and MDF.*

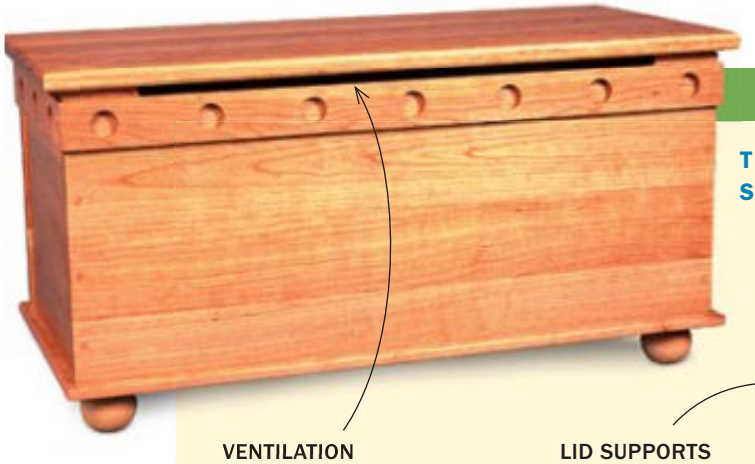
Cribs and cradles

Cribs and cradles are subject to many regulations, because babies are left unattended in them and safety is paramount. A rule that most people seem to be aware of limits the distance between slats or spindles to no more than 2⅜ in. This will prevent an infant's body from slipping between the slats (the head is bigger, and typically won't pass through). The slats also should be securely attached. Your best option is mortise-and-tenon joints pinned at every tenon, both top and bottom.

It is very important that the posts or legs on a crib or cradle stick up no more than 1/16 in. above the rails, headboard, or footboard. Anything projecting farther can snag clothing and create a strangulation hazard. An exception would be for high posts that project at least 16 in. above the rails (as with a canopied crib). It

BUNK-BED SAFETY

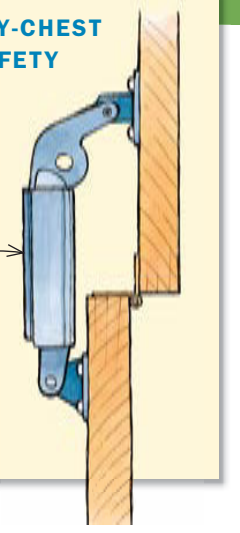




Toy chests

A toy chest is one of those pieces that lends itself especially well to a second life. Let's face it, the design—basically a big lidded box—is pretty flexible. The most obvious second use, perhaps, would be as a blanket chest. But the piece might also be used for out-of-season clothing storage or, depending on the child's (or dad's) interests, a tool chest. Christiana's chest, on p. 55, is whimsical. The piece shown here, by Miller, reflects a more serious approach to the form.

TOY-CHEST SAFETY



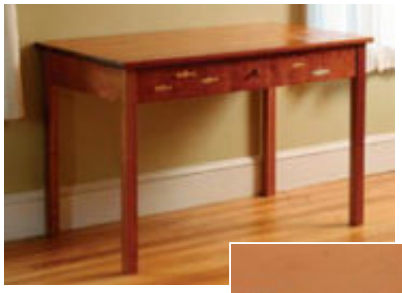
VENTILATION
A toy chest needs some form of ventilation, either a slot or holes, to allow a child to breathe if he or she climbs inside and closes the lid.

LID SUPPORTS
Use a spring-and-cam lid support for added safety. The support should hold the lid in any position.

Photos: Craig Jentz (ash bed); Mike Wakefield (hive bed)

TWO WAYS TO PLAY

Imaginative touches, both bold and quiet. *Kids' furniture can artfully meld eye-catching shapes and bright colors, as in this desk by Jay Jones of Greensboro, N.C. (top) Or it can be more subdued.* FWW *art director Michael Pekovich built a more traditional desk for his son, but enlivened it with trout inlaid in silver and secret compartments. Textured end grain on the top adds a distinctive tactile detail.*



would be extremely difficult for a child to get clothing snagged on posts this high. Likewise, any cutouts or shaped components must avoid potential for catching either the neck, body, or clothing. Check the size of the mattress if possible before you begin your project. It's important to fit the crib or cradle well to the mattress to prevent a child from getting trapped between them. For the same reason, joinery should be very secure, so there is no loosening of the rails that would create extra space between mattress and rails. Cribs or cradles that bolt together should be checked periodically for tightness.

Bunk beds

As you might expect, bunk beds have plenty of regulations. Any openings on the upper bunk must be less than 3½ in. in the smaller dimension. Guard rails are required on both sides of the top bunk, and these rails must be attached securely to the bed. The opening in the guard rail for the ladder should be 15 in. or less. It is also very important to secure the mattress support to the upper bunk side rails. Kids love to kick the upper bed from below; there should be no chance that the upper mattress support could come loose. The safety standards also strongly suggest that children under 6 not sleep on the upper bunk, and that a nightlight be installed in any room with bunk beds. Discouraging play on the upper bunk is also strongly suggested, but good luck in enforcing that rule.

Toy chests

Toy chests, or anything with a lid that lifts up, should be outfitted with special lid-support hinges. The spring mechanism in these hinges allows the lid to remain in any position without slamming down on heads, hands, or anything else. The specific hardware will have its own installation instructions, and will often be designed for a lids of a particular weight and size. Toy chests should also have ventilation holes or slots. Kids will climb into them and hide, and it's important that air can flow in and out.

A changing table that changed with the times. *This piece by Pekovich started life as an infant's changing table but now serves as a sideboard in his family's dining room. The key is a design that's basic enough to serve more than one need.*

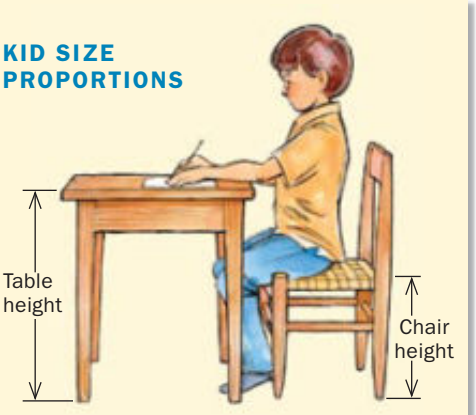
Kid-safe finishes

Because younger children will chew on anything within reach, Miller prefers nontoxic finishes. Shellac flakes, milk paint, and natural waxes are all good choices.

Photos: Scott Crowder (top desk); Tanya Tucka (plywood rocker, marble chair); Michael Pekovich (all others on this spread)

An old-fashioned play station. *Built for a toddler, this set by Pekovich pairs a lightweight but sturdy post-and-rung chair with a bombproof table that features pinned mortise-and-tenon joinery.*

KID SIZE PROPORTIONS



CHAIR AND TABLE HEIGHTS

Standard adult chair height is 18 in.
Standard adult table height is 28–30 in.

Age	Chair height (in.)	Table height (in.)
2–4	9–11	17–20
4–7	10–15	18–21
7–10	13–17	19–25
10–13	15–18	23–27
13+	18	24–30

Tables and chairs

Sometimes, safety requirements send you into uncharted waters. For example, high chairs should have both waist and crotch safety straps—not something a woodworker encounters every day. A trip to a camping-supply store (and some good sewing-supply stores) can outfit you with appropriate nylon webbing and buckles for making these straps (changing tables should also have safety straps to secure the wriggling baby). High chairs should also be built with enough splay to the legs so that they are harder to tip over during all of the writhing, twisting, and bouncing around that happen there. Kids love to test the limits. You don't want such an experiment to end with a fall.

The trick with tables and chairs is in building them the right size. Kids will outgrow tables and chairs almost as quickly as they outgrow their clothes. I usually make children's chair seats 12–14 in. high, but my chairs are made more for play. For writing or schoolwork, the range is much wider, depending on the age and size of the child. At my local primary school, writing-table heights range from 17 in. to 25 in. for 2- to 10-year-olds. Chair seat heights range from 9 in. to 17 in. for the same age range. Play tables tend to be 16 in. to 18 in. tall. □

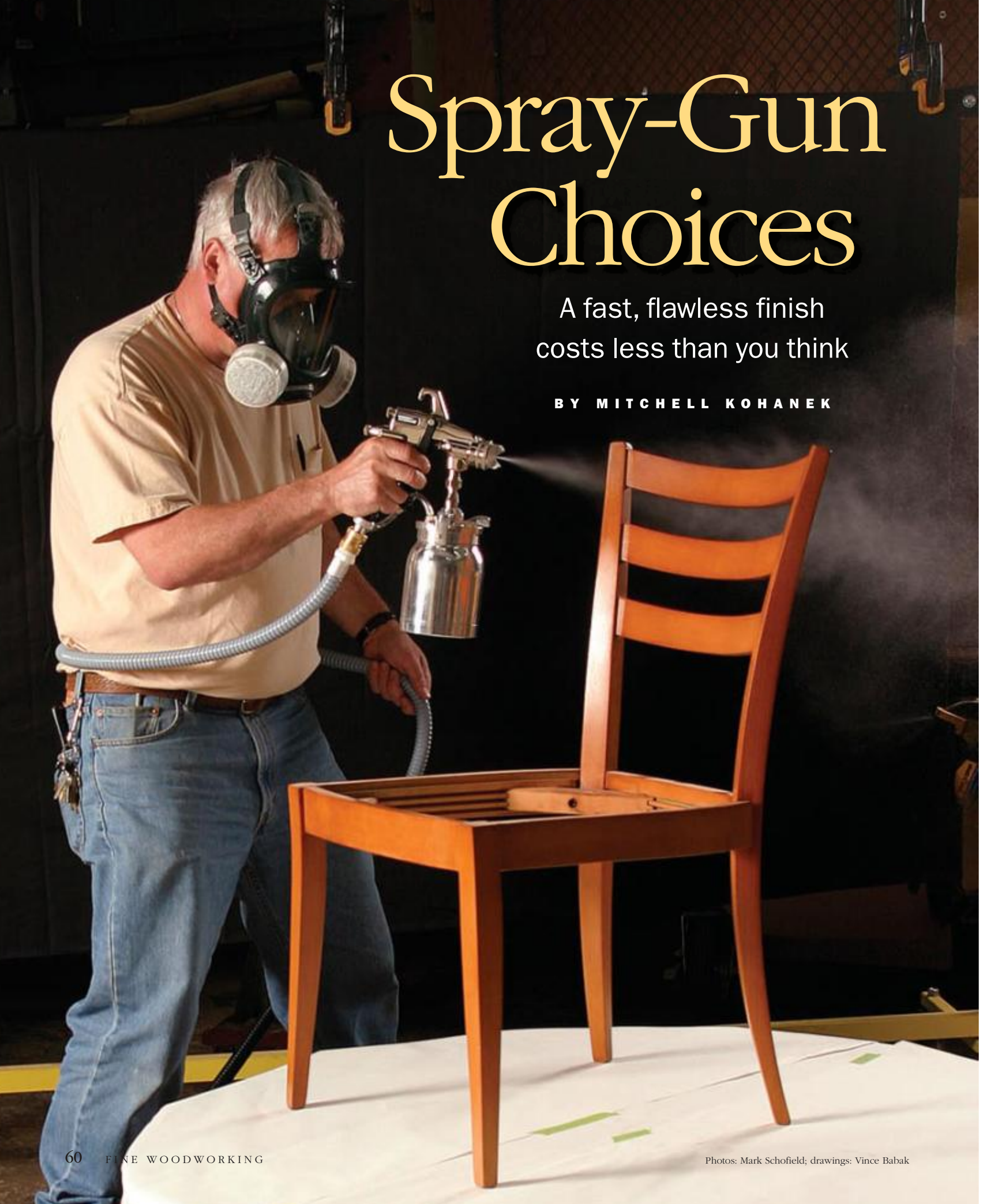
Jeff Miller is the author of Children's Furniture Projects *(The Taunton Press, 2002). The second edition of his book* Chairmaking and Design *was recently issued by Linden Publishing.*

Rocking and rolling. *Miller's plywood rocker (left) and Pekovich's Arts and Crafts version (right) both have runners with a 30-in. radius, just tight enough to rock without tipping. Miller's marble chair (above) features a built-in element of play. Grooves in the slats and uprights form a zig-zag track for a marble.*

Spray-Gun Choices

A fast, flawless finish costs less than you think

BY MITCHELL KOHANEK



Photos: Mark Schofield; drawings: Vince Babak

When professional finishers talk about an "off-the-gun finish," they are describing a finish so smooth that it doesn't require sanding. Achieving this state of finishing perfection requires practice and knowledge of finishes, but above all, the right equipment.

If you've been thinking about making the leap into spray finishing and have started to research equipment, it might seem that the choices are endless. In fact, the basic technologies are not that complicated, and they may be a lot easier to understand than some of those fancy dovetail jigs!

The two main types of spray gun are those powered by a turbine and those that run off an air compressor. I limited my search to guns that can get reasonable results when spraying a water-based finish, as most woodworkers don't own explosion-proof spray booths and thus are not set up to spray solvent-based finishes (see "Spraying water-based finishes safely," p. 64). Also, water-based finishes are among the most difficult to atomize, so if your gun can spray them well, it should be able to handle most solvent finishes. This requirement ruled out the $100 hardware-store spray guns, but I discovered that furniture makers can get a beautiful finish for around $500—and spend far more for inferior results. This article will help you zero in on the system that is right for you.

What happens when you mix air and finish

To understand spraying, you need to grasp two conflicting concepts: atomization and transfer efficiency. Atomization is forcing a liquid to become small, round particles; the smaller the particle, the better the look of the coating. Large particles can produce an effect known as "orange peel." There are many reasons for this pebbly look, but poor atomization is one of the most common.

Early spray guns used air at high pressure (45 to 90 lb. per square inch, or psi) at the tip of the gun to blast the liquid finish into a fine mist of tiny particles. This produced a beautiful, smooth finish, but only about 25% of the liquid ended up on the object being sprayed. The rest missed the target or bounced off because of the high air pressure. In order to improve on this 25% transfer efficiency, high-volume, low-pressure (HVLP) guns were developed. HVLP technology reduces to a maximum of 10 psi the amount of air needed to atomize liquid. This increases the transfer efficiency to between 65% and 90%, but it comes at a price: You spray more slowly and the quality of atomization varies among the various systems.

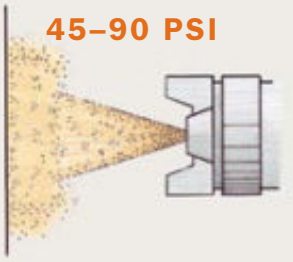
This conflict between optimum atomization and maximum transfer efficiency is particularly acute with water-based finishes, which are generally thicker and harder to atomize than traditional solvent-based ones. That's why budget-priced HVLP guns generally cannot achieve the atomization needed for a smooth water-based finish. However, water-based finishes continue to be improved

Choose a low-pressure gun

High-volume, low-pressure (HVLP) spray guns use enough air to atomize the fluid into small, even-sized particles, but not so much that the spray bounces off the target.

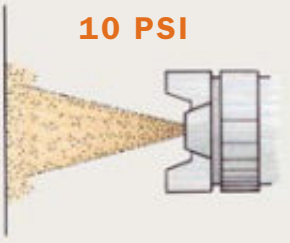
HIGH-PRESSURE GUNS

Old-fashioned high-pressure spray guns atomized the finish into a fine mist. This gave a good finish, but only about 25% of the liquid ended up on the workpiece.



LOW-PRESSURE GUNS

Sophisticated HVLP guns also give good atomization, but their lower pressure means that far more of the finish ends up on the workpiece.



Cheap gun equals bad finish

Budget-priced HVLP spray guns cannot properly atomize heavy water-based finishes. They spray a stream of large droplets, leaving a rough finish.

Two ways to propel the finish

Your first decision is whether to buy a turbine system or a spray gun that uses a compressor.

TURBINE: ONE-STOP SHOPPING BUT SLIGHT ORANGE PEEL

Turbines are rated by their number of fans (or stages), ranging from two to five. The higher the number, the greater the volume and the pressure of air they can pump out. All turbines are considered HVLP because they don't shoot more than 10 psi at the tip of the gun. A good-quality three-stage turbine with around 6 psi will spray the majority of water-based finishes and set you back around $750; a four-stage model with 8 psi gives you the flexibility to spray thicker water-based finishes and paints, and to spray faster, but costs about $200 more.

The turbine package. *The advantage of buying a turbine is that you get everything you need to start spraying, with good instructions.*

A newcomer in the turbine market is the two-stage Earlex HVLP spray station. Priced around $300, it comes as a handy little unit, but unfortunately, with a water-based finish it was tough to find an optimum fan pattern that didn't just spatter the finish.

Turbine technology demands larger, heavier guns and hoses than compressed-air guns, so consider the ergonomics of each type before you buy. The main advantage of turbines is that they come as complete spray systems—air source, hoses, and gun—so their instructions are far more comprehensive than stand-alone compressed-air guns.

An underpowered turbine. *This two-stage turbine doesn't produce enough air pressure to spray a water-based finish successfully.*

I tested three- and four-stage turbines from Apollo and Turbinaire, two leading manufacturers in this category, and could see little difference between the finishes. All the sample boards had very slight orange peel and needed a light sanding before the next coat.

COMPRESSED AIR: FLAWLESS RESULTS—GOT A COMPRESSOR?

If you already have compressed air in your shop, you probably will opt for a compressor-driven gun. The capacity of the compressor, in terms of how much air it can deliver in cubic feet per minute (cfm) at what psi, will determine which gun is compatible. A 2- to 5-hp, 20- to 25-gal. midsize model ($350–$600) is adequate for many guns, and I even used a Sata Minijet successfully with a portable 1.6-hp, 4.5-gal. compres-

A compressor-powered spray system. *A midsize compressor is enough for many HVLP spray guns, but you also will need a hose and a filter.*

sor (similar models cost $100 to $250). The compressor ran continuously but it never affected the spray pattern. An advantage of compressor-driven guns is that they generally have a greater maximum pressure at the tip than a turbine gun. This means you can increase the psi to achieve better atomization of thicker finishes, but at the cost of lower transfer efficiency. Using a midsize compressor, I've had good results from HVLP guns made by Binks, Kremlin, and Sata, among others.

Compressed-air guns also come in an LVLP (low-volume, low-pressure) category. Because they use less air, you can get by with a smaller compressor, but you generally pay the price in slower speeds. Better guns are constantly being developed, however. In the spray test, all the compressed-air guns received an A grade for producing excellent off-the-gun finishes.

You'll need the right supply hose ($10 to $50) to connect the compressor to the gun. The smaller the internal diameter (ID) of the hose and the greater its length, the more the pressure will drop between the compressor and the gun. It is recommended that an air hose with a 5⁄16-in. ID be limited to no more than 20 ft., a 3⁄8-in. ID hose to 50 ft., and a 1⁄2-in. ID hose to 100 ft. On many occasions the wrong hose size is to blame for a poor finish, not the gun or the coating. A good way to make sure that you have sufficient pressure is to attach a pressure gauge ($15 to $40) at the base of the gun. Alternatively, some guns such as the Sata Jet 3000 come with a built-in digital readout in the handle.

YOU'LL NEED A FILTER

Compressed air leaving the tank contains small amounts of water, oil, and other contaminants. If allowed to pass through your gun, they create unpleasant finishing defects. You need to invest in some kind of filter. Disposable filters attached between the gun and the air hose are worthwhile if you only spray occasionally ($27, www.pacificaircompressors.com). The crystals inside turn from blue to mauve as they become saturated (above). If you intend to spray regularly, invest in a coalescing filter (right) made up of a series of filters you change every six to 12 months depending on the amount of use. These run $75 to $175 depending on the specifications.

CHECK THE PRESSURE AT THE GUN

Long or small hoses cause the air pressure to drop between compressor and gun. To measure the exact air pressure at the gun, attach a pressure gauge or regulator.

Small investment for good results

If you don't mind spraying slowly, you can achieve a great finish for under $500 with a portable compressor and a small spray gun.

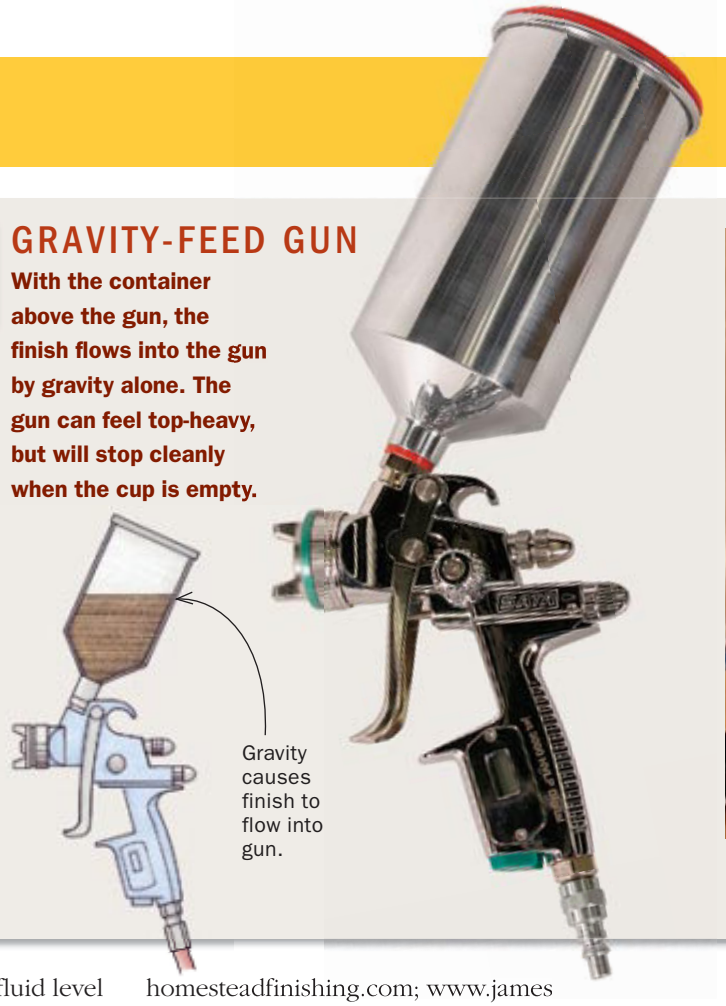
Three containers for finish

1 SUCTION-CUP GUN

The most common type of spray gun has the finish in a cup underneath. The fluid can be sucked into the gun or, as in this case, the cup can be pressurized by a plastic tube from the gun. This type tends to spit finish when it runs out.

2 GRAVITY-FEED GUN

With the container above the gun, the finish flows into the gun by gravity alone. The gun can feel top-heavy, but will stop cleanly when the cup is empty.



to make them easier to spray (see A Closer Look, pp. 102-104).

Different ways to contain the finish

Whether you choose a turbine or compressed-air system, you have a choice of where the finish is contained before it enters the gun. With either system, the most common container is a cup located underneath the gun, but when the fluid level gets low, the gun starts to spit the finish.

If you have the cup on top of the gun (gravity feed), the gun simply stops spraying when the fluid runs out. One way around this is to adapt a disposable 3M cup system that comes in three sizes. Called PPS (paint preparation system), these cups, starting at around $30, are quickly interchangeable so you can shoot your dye, sealer, and topcoat from different cups with minimal cleaning (www.homesteadfinishing.com; www.jamestowndistributors.com). The system allows you to use the gun in any position, even upside down.

Better still is to remove the cup entirely and have a hose leading back to a pressurized container (pressure pot). No longer will the cup on your gun bump into the project as you try to spray the inside of cabinets. Pressure pots also allow you to spray larger amounts of coatings without stopping to refill. A 1- or 2-qt. pot, costing

Spraying water-based finishes safely

Assuming that most of your spraying will be done in the garage, you'll want to set up a temporary spray booth. A good design was shown in *FWW* #169 (Finish Line, pp. 117-118). Wherever you decide to spray, you will need a method of drawing in fresh air and directing the fumes and overspray outside. Some novice sprayers assume that just because a water-based finish can be sprayed without the risk of an explosion, it is safe to breathe. Even though some solvents have been taken out and replaced with water, these finishes still contain serious chemicals and solids—and you need to protect yourself. Always wear a cartridge-style respirator rated for organic vapors whenever you are spraying.

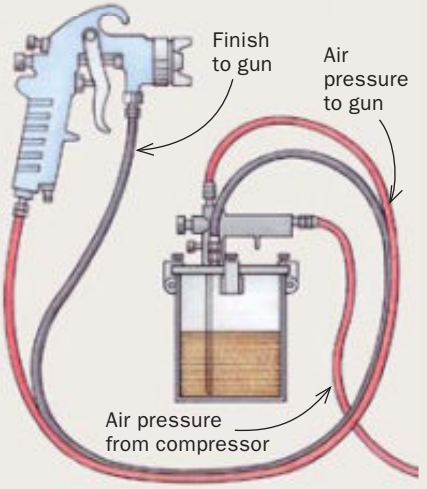
Online Extra

To learn how to make a simple spraying booth, go to **FineWoodworking.com/extras.**

Easy cleanup. *3M makes gravity-feed containers that have a disposable lining.*

3 PRESSURE POT

Without a cup of fluid attached to it, a spray gun is much more maneuverable and can access tight spaces. Small pressure pots can be carried or hung from a belt.



Pressurize the can. *When using a pressure pot, the finish can either be poured into the pot, or the can of finish can be placed in the pressure pot, which reduces cleanup.*

$100 and up, is common, while many of the cups hold a pint or less. Smaller pots can hang from your belt, while larger ones are on wheels.

A nice feature of some pots is that you can place the can of finish directly in the pot. When you are done spraying, remove the pressure in the pot and open the lid; place a rag over the gun's air cap, squeeze the trigger, and force the air back down through the fluid tube. Known as back flushing, this will push the finish out of the fluid hose and into the pressure pot.

Not much additional air power is needed as pressure pots normally operate at 2 to 5 psi, but by increasing the pressure you can atomize heavier finishes such as water-based types. You certainly should be able to supply a pressure pot and an LVLP gun using a midsize compressor. Turbines are not designed to divert their air via a pressure pot, so a separate source of compressed air is needed.

Making sense of this information

The first step is to decide if turbines or compressed-air guns are right for you. You may decide it's worth paying for a turbine system to get the simplicity of a whole system designed to work together. I recommend you save money and only go for a three-stage turbine. In my testing, I didn't see better results with a four-stager.

If you have a compressor, check its capacity and then have a retailer match it to a suitable gun. If you intend to spray only small projects, or a large piece in sections, you can team a small compressor with a low-air-consumption HVLP or LVLP gun such as the Sata Minijet IV (around $300) or Kremlin's M22 HTIG LVLP gun (around $400). If large tabletops are on your list of things to spray, use at least a midsize compressor and invest in a pressure pot. Whatever gun you choose, practice spraying on ¼-in.-thick plywood and sooner than you think you, too, will achieve an off-the-gun finish. Good luck and have fun. □

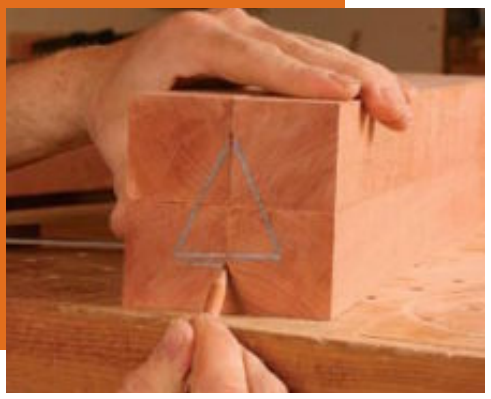
Mitchell Kohanek teaches at the National Institute of Wood Finishing near Minneapolis. We reveal this masked man on the Contributors page (8).

A Modern Bench

Straightforward joints, graceful curves, and a woven cord seat

BY MARK EDMUNDSON

SHAPE THE LEGS



Lay out the legs. *A cabinetmaker's triangle marked on the ends of the leg blanks helps keep them oriented properly (above). A template (right) not only gives you a pattern for the two curved faces on the legs, but it can also hold all the information you need to mark mortise locations on the leg blanks.*

This bench has been part of my entire woodworking career. I designed it as a student in the College of the Redwoods fine woodworking program. A chair by famed Swedish furniture designer Carl Malmsten inspired the shape of the armrests and legs; the Danish-cord seat adds texture. Over the years I've made a half-dozen benches like this one, and used the Danish-cord weave on many pieces.

The bench is a good project for mastering mortise-and-tenon joinery, for working with gently curved components, and, of course, for making a woven seat. You can get all the parts from one 8/4 plank that's 7 in. to 8 in. wide and 8 ft. to 10 ft. long. In a pinch you can use a secondary wood or sapwood for the seat rails because the Danish cord hides the wood completely.

Cut the legs, armrests, and lower side rails from the outside edges, where you'll have straight quartersawn grain. It's a good idea to have enough stock for an extra leg blank. Take the long seat-support rails from the middle of the plank.

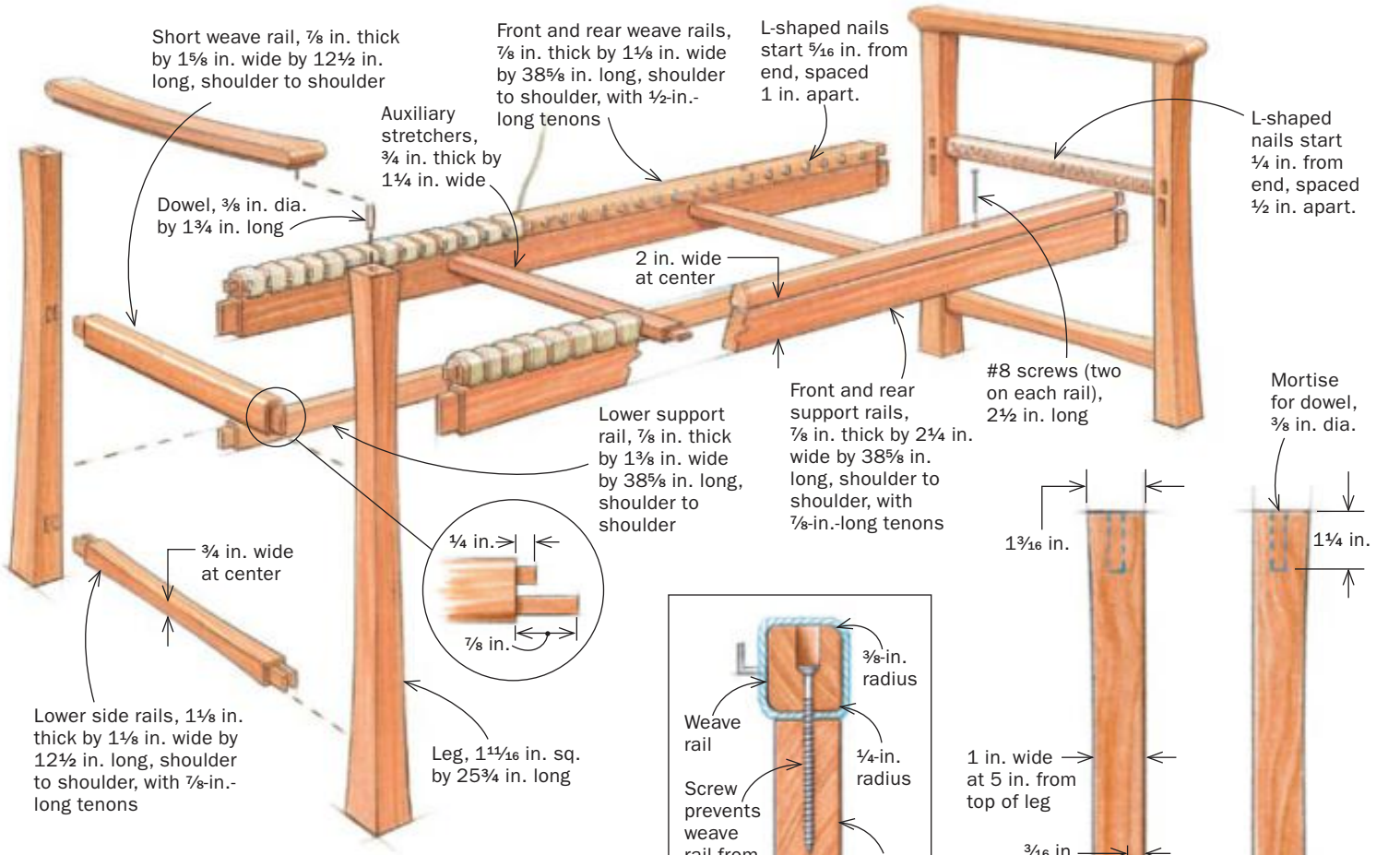
Legs are square where it matters

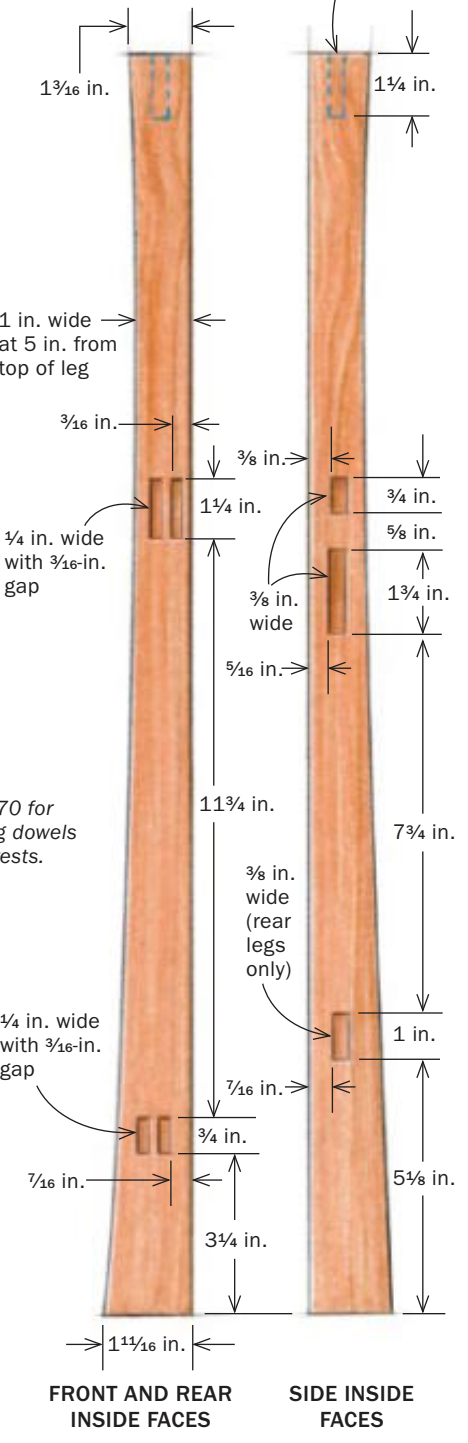
Using the drawing on p. 68 as a guide, make templates for the leg, the curved rails, and the armrests. It's imperative that you know which legs go left, right, front, and back, because of the way they're curved. Label them clearly.

Mark the leg template with the locations of the top and bottom of each mortise. Transfer the mortise locations to the leg

Cut the mortises. *If you use a plunge router with an adjustable edge guide, you can easily dial in the depth of the different mortises and their distances from the edge of the blank. Stop blocks clamped to the blank control the length of the mortises. After routing, use a chisel to square up the ends of the mortises.*

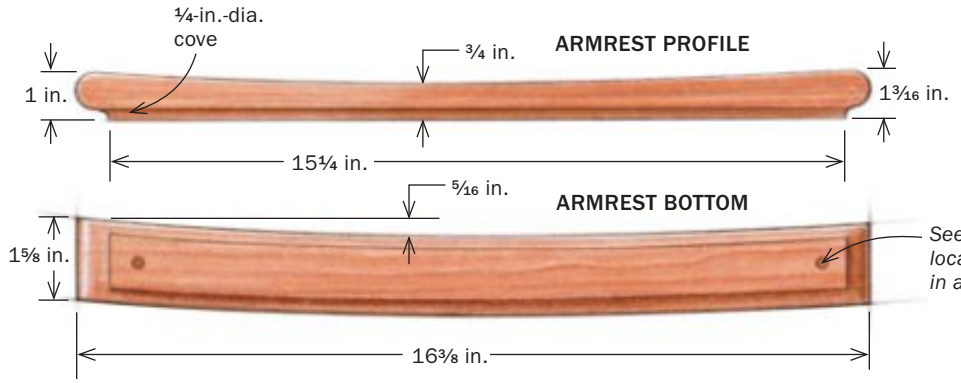
Bandsaw the curves. *Once you've cut the curve in one face, tape the offcut onto the blank. It will help keep the leg square on the bandsaw table as you cut the second curve. Use coarse sandpaper, a scraper, or a spokeshave to smooth the curves. Don't worry if the curves aren't identical; the eye won't pick up minor variations.*



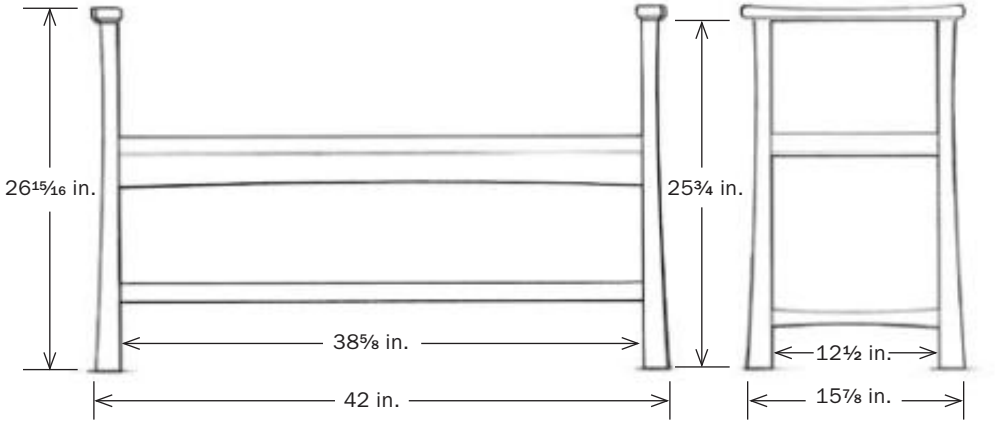


A SIMPLE MORTISE-AND-TENON FRAME

Only the two outside faces of the legs are curved; the inside faces are straight where the mortises for the rails are located. That keeps the joinery simple.



See p. 70 for locating dowels in armrests.

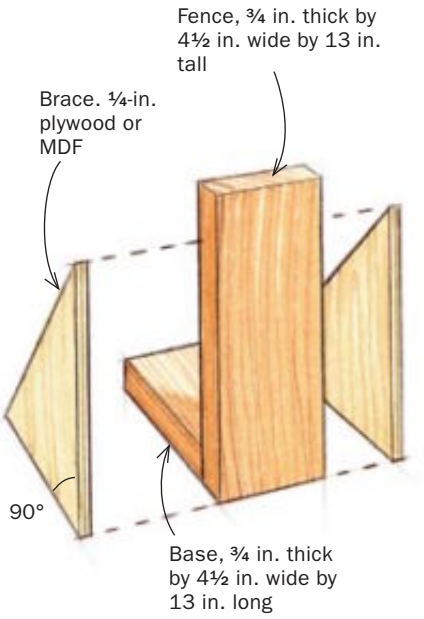


Photos, except where noted: David Heim; p. 66: Chris Guibert; drawings: Bob La Pointe

CUT THE TENONS ON THE RAILS

Cut tenon shoulders first. *Edmundson uses a narrow, shopmade sled to cut the tenon shoulders, with a stop block clamped to it.*

Add a tall fence to cut tenon cheeks. *An auxiliary fence clamped to the sled supports the work when cutting the cheeks.*



blanks, beginning with the side-to-side mortises. Remember not to mark mortises for a lower support rail on the front two legs. Similarly, transfer the locations of the front-to-back mortises from the template to the leg blanks, then trace the curve on the outside of each leg.

Refer again to the drawing for the widths of each mortise, the distances from the edge of the leg to the mortises, and the spacing between double mortises. Tenon lengths tell you the depth of each mortise. Transfer these measurements to each leg, then cut all the mortises, using a router or a hollow-chisel mortiser. If you use a router, chop the ends of each mortise square with a chisel.

Saw tenons on the stretchers

Dimension the rails and cut them to length, then mill the tenons. Use the tablesaw and miter gauge to cut the tenon shoulders first, and then use a tablesaw tenoning jig (see drawing, above right) to cut the cheeks.

To mill the double tenons, cut the tenon shoulders, then load the piece in the tenoning jig and saw away the 3⁄16-in.-wide space between the double tenons. I make one pass over the blade, then rotate the piece 180° and make another pass, checking it with the leg to see if the gap is tight.

CUTTING THE DOUBLE TENONS

Begin in the middle on the double tenons. *Once you've cut the shoulders, cut away the waste between the tenons in the middle of the stock (left). Cut the inside face of one tenon, then rotate the stock 180° for the second cut. Creep up on the right distance, using the leg to check the fit. Finally, cut the outside cheeks and ends (right).*

When the fit seems good, cut all the spaces between double tenons, then change the setup to cut the outside cheeks. Lower the blade to 1⁄8 in. above the table and make a cut, checking the results against the mortise in the leg. When it's to your liking, raise the blade so that it is just below the shoulder crosscut and make a pass. Rotate the work and cut the other side. You'll have to clean up a bit of wood between the tenons with a narrow chisel or file.

Finally, cut the two small mortises on the inside of the long support rails. These will house two short auxiliary stretchers. Wait to cut those stretchers until you have dry-fit the rest of the bench.

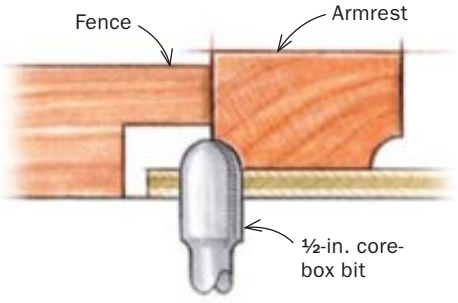
Dry-fit and cut the curves

Assemble one pair of legs and short rails, fit the long rails in place, then press the remaining legs and short rails in place. Pull the joints together with clamps to be sure the mortises and tenons seat properly.

Be sure there's at least a 1⁄8-in.- to 3⁄16-in.-wide gap between the long weave rails and the support rails below them. A

SHAPE THE ARMRESTS

Bandsaw curves. *Begin with the curve for the top of the armrests (above), then bandsaw the curves for the sides (right).*



Rout a cove on the underside. *The cove gives the thick armrest a lighter look. Edmundson uses a narrow shopmade guide that clamps to the router table and sits above the blade. It follows both the convex and concave sides of the armrests. Reset the stop for the end-grain cuts.*

Drill for dowels. *Use ⅜-in.-dia. dowels to connect the legs to the armrests. Drill the legs first, then use dowel centers (left) to locate the holes in the armrests. Position the armrest and press down (right). Now you can drill the mating hole in the armrest.*

smaller gap will make it hard to weave the Danish cord. Plane the support rail if you have to widen the gap between the rails. Also, be sure that the tenon shoulders on the long weave rails don't interfere with the tenon shoulders on the adjacent support rail.

If everything looks good, make the auxiliary stretchers to fit between the long support rails. After the initial dry-fit, cut the curves on the legs, lower side rails, and front rail on the bandsaw.

There are several tools you can use to clean up the bandsaw marks. I use a thin piece of wood wrapped in P100-grit sandpaper, a shopmade plane with a gently curved sole, a spokeshave, a scraper, and a block plane. Check your progress against the leg template. No two faces will be exactly the same, but that's all right. Just be sure the legs don't seem too bottom-heavy and that they flare out a bit at the top.

Finish shaping the legs by chamfering the corners. I also like to plane a gentle taper on the inside straight faces. Scribe a line 1/16 in. from the top inside edges. Plane from the top of the mortises to those scribe lines.

The top and bottom faces of the lower side rails have the same inside curve as the armrest. Align the armrest template 1/16 in. below the top and bottom faces of the rail, then trace the curve. You may want to plane the outside edge of the rail so it aligns with the edges of the legs. Chamfer the corners as you did the legs.

You also can use the inside curve of the armrest template to plot the gentle curve at each end of the long support rails.

Shape and join the armrests

When the legs and rails are to your liking, rough out the armrest on the bandsaw, and clean up the curves with sandpaper and a scraper. Use a router table and a core-box bit to cut a ¼-in.-radius cove on the underside. Finally, round over the ends of each armrest.

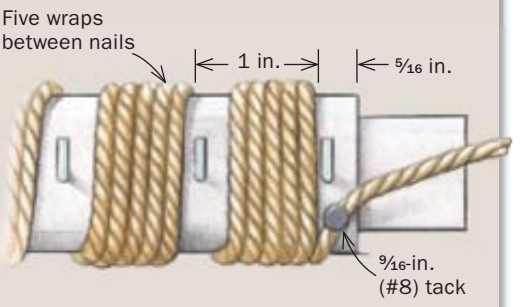
Join the armrests to the legs with dowels. Use dowel centers (see photos, left) to mark the locations of corresponding holes in the armrests.

Prepare the seat rails

Round over the four weave rails at the router table. The short ones have a ⅜-in. radius on all four edges. The long ones have a ⅜-in. radius on the top outside and

Attach the nails that hold the cord. *Drill pilot holes along the seat-support rails and hammer the L-shaped nails in place.*

ADD NAILS AND WRAP THE LONG RAILS BEFORE ASSEMBLY



Wrap the long rails. *Tack the cord to the end of the rail, then spin the rail to wind the cord. Wrap the cord five times between each nail, creating a gap at the nail that subsequent weaving will fill. Golf gloves reduce wear and tear on fingers.*

ASSEMBLE THE BENCH

Glue up the end frames. *Curved offcuts again make ideal clamping pads. Because Edmundson oils the components before glue-up, he puts leather scraps between the leg and offcut to protect the finish.*

Add the long rails. *Once the glued-up end frames are dry, connect them with the long rails. Then screw the weave rails to the support rails.*

lower inside edges and a ¼-in. radius on the other edges. That's partly for comfort, partly to make it easier to cinch the cord.

Finally, drill rows of 1⁄16-in.-dia. pilot holes in the weave rails and drive in the L-shaped nails to hold the Danish cord.

Also, drill a pair of holes on top of the front support rail for #8 2½-in. screws. They secure the weave rail to the support rail and keep it from bowing.

Prewrap the long weave rails with Danish cord. While the cord will cover the short weave rails, the front-to-back warp strands won't cover the long rails by themselves. The wrapping fills in the spaces (see photos and drawing, above).

Glue up the bench, then weave

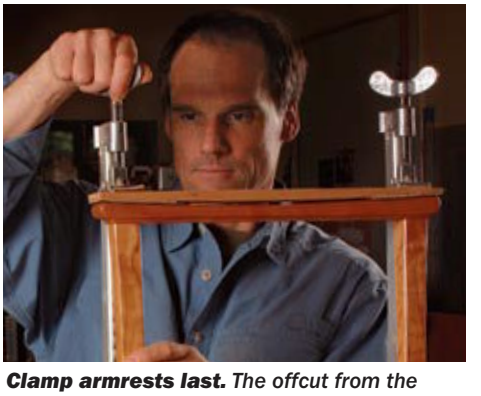
I finish all the pieces before glue-up. (You can find the finishing recipe free online at www.finewoodworking.com/extras.)

Glue the legs and short rails together first, using the leg offcuts as pads. Then attach the armrests.

Spread the cord on the long weave rails so it's evenly spaced over the screw holes in the support rails. Drive the screws until they begin to seat; stop before they pull the two rails together.

Weaving the Danish-cord seat is the final step (see pp. 72-73). It takes me about three hours. But if this is your first experience with a woven seat, allow more time until you get the hang of things.

Mark Edmundson builds furniture and cabinets in Sandpoint, Idaho.



Clamp armrests last. *The offcut from the curved top acts as a clamp pad. Use the edge of the bench to hold one end of the clamp, and tighten it directly over the leg.*

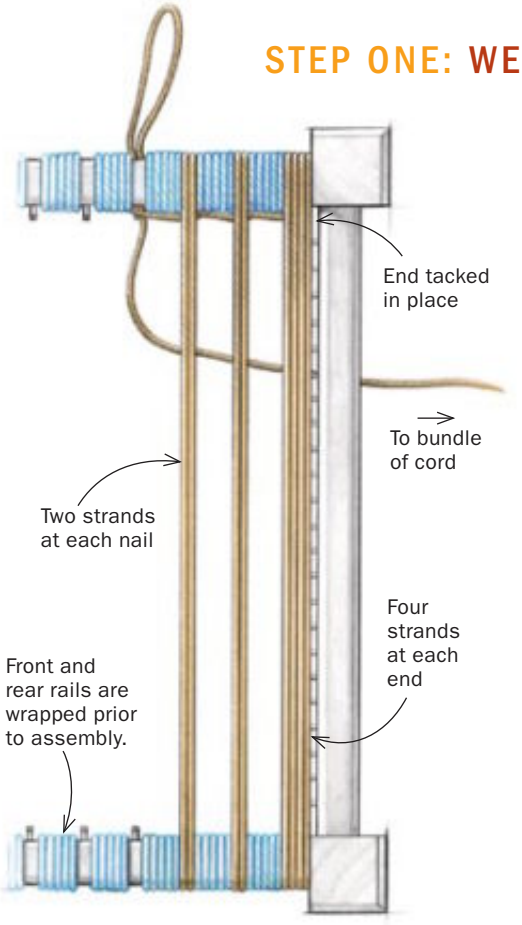
How to weave with Danish cord

Online Extra

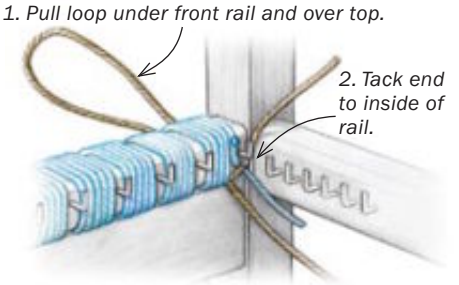
To watch a video of Edmundson weaving the seat and to get the finishing recipe for this project, go to **FineWoodworking.com/extras**.

Danish cord resembles thick hemp twine, but it's made from strands of tightly rolled paper. You weave the seat by looping the cord over L-shaped nails driven into the inside of the weave rails. The cord comes in 2-lb. bundles, about enough for a single chair seat, or in 10- to 11-lb. rolls, ample for two benches. You can order the nails and cord from several retailers, including www.caning.com, www.caneandreed.com, and http://catalog.countryseat.com. Before you begin, wrap the long weave rails with cord, as shown on p. 71. Then do the weaving in two stages: First, run warp strands from front to back; then, weave cord from side to side. No need to measure; you're always taking a loop of cord from the bundle, hooking it on a nail, passing a looped end to the other side of the bench, and hooking it onto a nail.

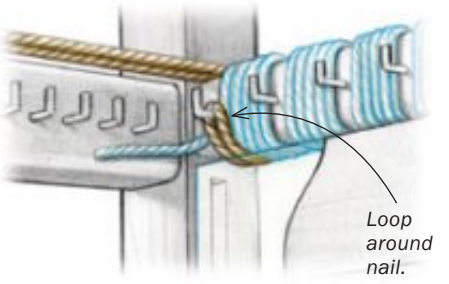
STEP ONE: WEAVE FRONT TO BACK



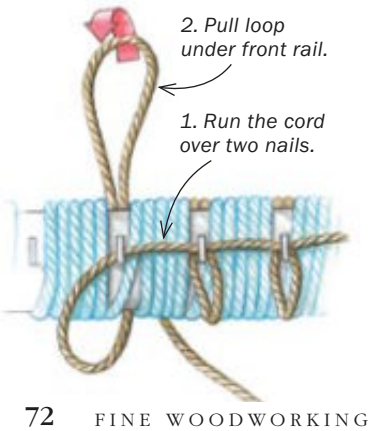
1. Start the warp. *Loop a length of cord, keeping the strand from the bundle toward the center of the bench. Push the loop under the front weave rail next to the leg.*



2. Bring the loop to the rear rail and hook it on a nail. *This makes the first two warp strands. Repeat for a total of four strands on the first nail.*

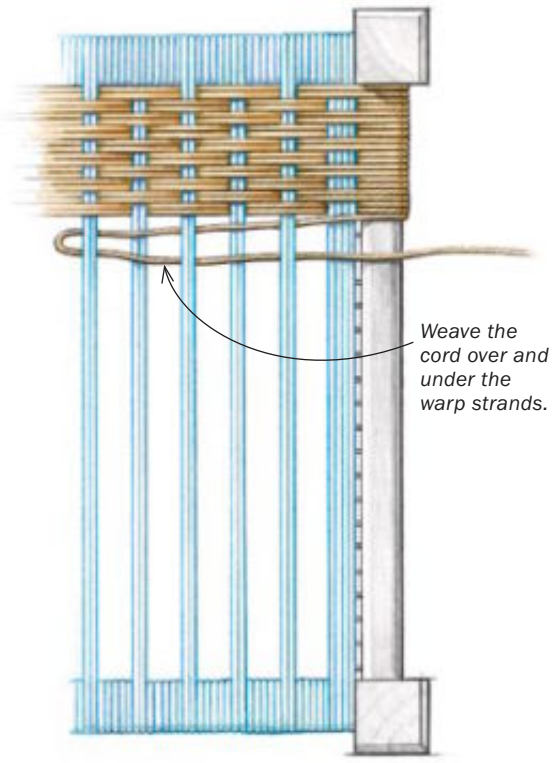


3. Hook the cord and drag it to the next nail. *Pull the cord taut and hook it over the first nail. Bring it across the top of the next nail. Make a loop with the strand from the bundle to the outside, and push it under the front rail.*

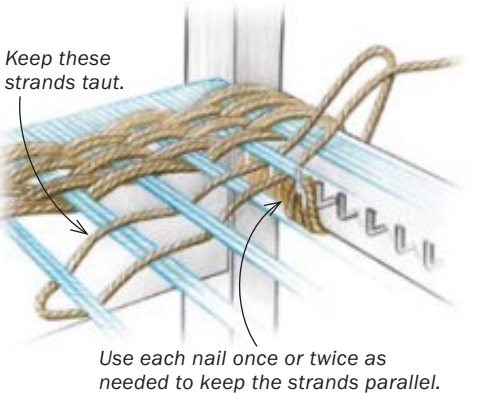


4. Continue running the cord from front to back*, with a pair of warp strands hooked over each nail. Finish with four strands at the end, twisting the loop so that the strand from the bundle is closest to the leg.*

STEP TWO: WEAVE SIDE TO SIDE



1. Begin the weaving. *Start at the rear of the bench, tacking the cord in place at the corner of a leg. Make a loop, and bring the cord over the short weave rail. Push the loop over the group of four warp strands, under the next pair, over the next, and so on until you reach the opposite side. Keep the weave strands snug, but not so tight that they make the warp strands flex up and down.*



2. Hook the cord and weave it again. *As you weave toward the front of the bench, hook the cord twice over each nail in the short rails. In order to keep the weave strands parallel to the long rails, you may need to hook the cord only once over some nails.*

3. Push each weave strand in line. *Each time you weave the cord through the warp strands, use your fingers to push the cord snug against the weave. When you're about halfway through the weave, sight down the length of the bench to be sure the weave strands are straight.*

4. Tack down the weave cord. *Turn the bench upside down and tack the end of the weave cord to the leg. Work the pigtails of cord at the corners out of sight, tucking them under the L-shaped nails.*

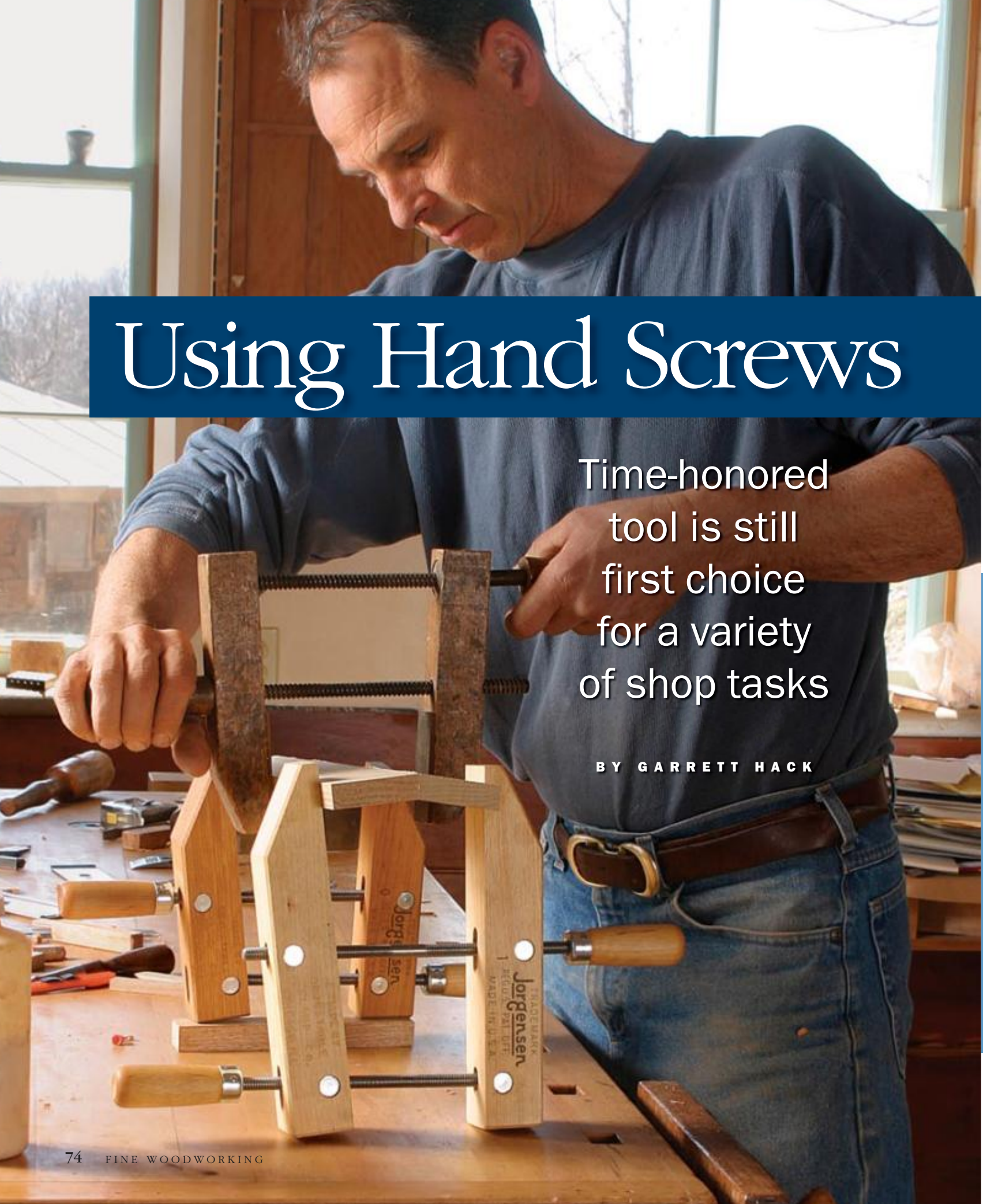
5. Clinch the nails. *Carefully tap the short leg of the L on each nail down over the cord. If you break a nail, use pliers to pull out the stub and tap in a replacement, making sure you catch all the loops of cord.*

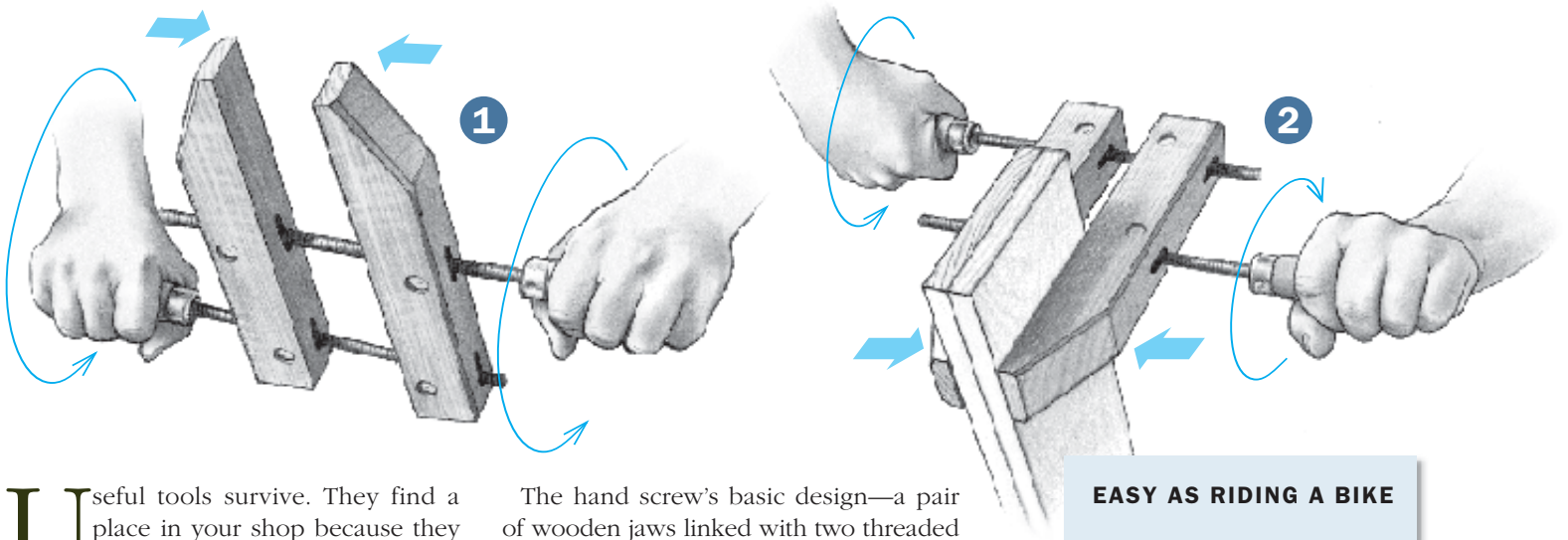
6. Straighten the weave. *Use a thin stick to push any wayward strands into alignment. Don't try to make everything perfect; it's better if the seat has some small variations to signal that it's been woven by hand.*

Using Hand Screws

Time-honored tool is still first choice for a variety of shop tasks

BY GARRETT HACK





Useful tools survive. They find a place in your shop because they do certain tasks easily or well. With all sorts of modern clamps available, simple hand screws might seem outdated—quaint reminders of woodworking past. Hardly. Their design is ancient, but hand screws are still my first choice for a variety of tasks. Their parallel screws let them grip where other clamps won't, and their large, flat jaws can act as built-in cauls. This lets them fill several roles in glue-ups and in securing small or oddly shaped work.

The hand screw's basic design—a pair of wooden jaws linked with two threaded handles that screw the jaws open or closed—probably came from the Romans. Modern versions feature steel screws threaded into nuts embedded in the jaws. On most, these embedded nuts also can rotate, allowing the jaws to be angled considerably for grabbing tapered work.

Hand screws are commonly available with jaws from 4 in. to 12 in. long. The reach—and the opening—of the jaws is usually half of the length. Hand screws can

EASY AS RIDING A BIKE

Hand screws operate with a simple "pedaling" motion. Pedal to close the jaws to the general opening size that you want (1), then firmly twist the handles to clamp the piece (2). With practice, you'll be able to clamp the jaws tight and parallel in seconds.

Gluing tricks

Skew the jaws. *By turning one screw more than another, the jaws can be adjusted for a tight hold on angled work such as these staves for a coopered panel.*

Good for a variety of glue-ups. *A small hand screw applies even pressure when gluing a piece of banding into place. The wooden jaws are less likely to mar the work.*

A positive grip, even on corners. *The hand screw's light weight and precise adjustability make it great for repairs like this chipped-out edge.*

Photos, except where noted: Steve Scott

Clamping panels

Keep glue off your clamps. *A quick coat of wax on the clamping surface of the jaws will keep glue from sticking.*

Straighten a bowed panel. *Adjust the hand screw to span the pipe clamp and the panel. Tightening pulls the panel into a straight line. Check with a straightedge.*

Keep edges aligned. *Straddle the joint with the width of the hand screw's jaws and tighten. Pressure from the flat, parallel jaws brings the adjoining surfaces flush at the gluelines.*

be frustrating to use at first. They seem to adjust slowly, and it's easy to get confused and find yourself opening one handle while closing another.

The trick is to grab both handles and pedal the jaws (just as you would a bicycle) open or closed to an approximate fit of what you are clamping. Place the clamp in position, and then close up the jaws by tightening both handles. It takes a bit of practice to know which handle to turn to fine-tune the angle of the jaws, but you'll soon get the hang of it.

A highly adaptable clamp

When gluing up panels, the stout and rigid jaws of a hand screw are particularly useful for keeping the boards flat and flush with one another. As you bring the boards together with bar or pipe clamps, it's common for the panel to bow slightly, especially if the stock is thin. I use a hand screw between the bowed face and the side of one of the bar clamps to pinch the panel flat, adjusting the clamp one-handed if I have to. Other clamps are much harder to use for this purpose, as it is difficult to get a grip on a round pipe clamp or the thin edge of a bar clamp.

Another common problem assembling a panel is slight misalignment of the faces of the boards. The large, flat faces of the hand screw's jaws act as wooden cauls, applying even pressure to both sides of the joint and bringing the boards flush. A little wax on the jaws keeps glue from sticking to them.

Smaller hand screws are ideal for delicate clamping such as furniture repairs, which always seem to involve odd angles or shaped parts. The twin screws pull the jaws together with the same sort of clamping action as the parallel jaws of a vise. As a result, they won't slip. It is also possible to apply pressure solely with the tips of the jaws by opening the rear screw more than the front.

Photos, this page (top left, far right): John Tetreault; drawings: Michael Gellatly

Use as a vise

Stand work securely on edge. *Blocks underneath the hand screw elevate its grip on the end of the piece to prevent tipping.*

Hold small work at the bench. *Held firmly in a front vise, a hand screw securely holds a small pull upright (right). Leather-lined jaws improve the grip (left).*

A small, portable vise

A hand screw makes it possible to hold work that would otherwise be challenging to grip.

If your bench has no vise, for instance, a hand screw allows you to hold a board lengthwise on the benchtop for edge planing. Grasp the end of the piece with a hand screw and secure the setup to the bench with a second screw or bar clamp. This is also effective for curved work that cannot be held easily in a side vise.

I often use a hand screw in my side vise to hold the round tenon of a knob I'm cutting an inlay into, or to hold a card scraper where the flat jaws guide me in filing a new square edge. Not only can the hand screw grasp odd shapes, but a slight twist of one of the handles releases the jaws, or quickly retightens them on the next part when working multiples. □

Garrett Hack is a contributing editor.

Tools

A handy jig. *Clamp the hand screw to the benchtop and use it to hold a card scraper on edge for filing.*

A simple stop block. *A hand screw takes the place of a clamp-and-block setup for indexing repeated crosscuts.*

A Quick Course in SketchUp

This powerful 3D drawing program is easy to use—and it's free

BY TIM KILLEN

For years I dreamed of using the computer to design furniture—being able to work out the proportions easily, preview the construction and avoid mistakes, even to see how the piece would look in the room. The 2D computer-aided drawing (CAD) systems I tried were OK but limited. For example, they didn't let me see a piece in perspective, the way a viewer would see it later, or create exploded views of assemblies, or design complex joints.

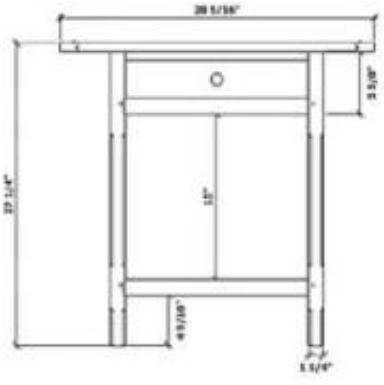
Then, two years ago, a breakthrough—I found Google SketchUp, a 3D drawing program from the company that operates the biggest Internet search engine. Better yet, Google offers a free version that's comprehensive enough to let you design very complex furniture. SketchUp Pro, a for-pay version that I use in my business, sells for $495 and includes features that I seldom use. Both versions run on Windows or Apple computers.

A half-day training course offered by the program's developer convinced me that SketchUp could let me render the necessary shapes, moldings, curves, and joinery I use when I design furniture (Google still offers the training). I was especially struck by the power of SketchUp's "component" tool, which treats the 3D shapes I draw like solid

A SCALE DRAWING . . .

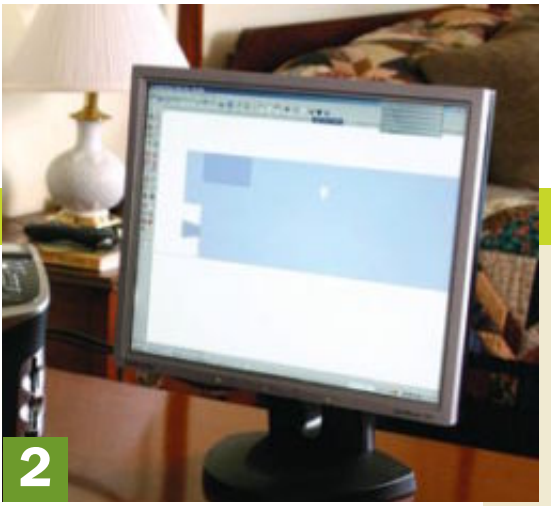
ALSO YIELDS AN X-RAY VIEW . . .

AN EXPLODED VIEW OF THE PIECES . . .



AND DIMENSIONED 2D VIEWS

Photos: Matt Berger; drawings: Tim Killen



FROM COMPUTER TO SHOP

Dial in a design. *Killen begins each project with a 3D SketchUp rendering of the overall piece (facing page). At this stage, he tweaks the drawing to make the proportions and overall aesthetics just right. Then he zeroes in on individual components, checking sizes and details of joints (1). Once he's sure that pieces fit together properly, he switches from 3D to 2D views (2), then prints out templates (3). In the shop, he uses the templates to lay out the separate elements of the real piece (4).*

objects, not just a collection of connected lines. Each component is rendered separately, then easily moved, copied, changed, rotated, and connected to others.

SketchUp allows you to produce an exploded view of all the components that go into a piece of furniture, use an X-ray view to model details of the joints, and produce detailed, dimensioned views of each component. Once I'm satisfied with each component in a design, I print full-size templates of the joints (see photo, right) to mark out the lumber in the shop.

I've heard people say that SketchUp is just a conceptual tool, good for quick design sketches but limited for making detailed construction plans. Not so. I've used SketchUp for precise, highly detailed renderings, including a Gothic-style cornice and compound-miter joints. I'll never go back to 2D CAD, nor will I go to the shop without first building a piece in SketchUp.

Sure, it's daunting to learn another computer program. But this one is worth it, especially for woodworkers. You can learn the basics of SketchUp in half a day, using tutorials available free on the SketchUp Web site. You may need a couple of long weeks of practice to gain a reasonable level of confidence, but the advice I give here will help you shorten that learning curve. And SketchUp will change and improve the way you design and build furniture.

Designing and building in SketchUp

Whether I'm working from a photo or designing from scratch, I begin by roughing out the shape and size of individual

Online Extra

To read and learn more about SketchUp from Tim Killen and other bloggers, go to **FineWoodworking.com/extras.**

The finished piece. *Time spent fine-tuning a design in SketchUp can make the actual construction go faster, with fewer slip-ups.*

Simple tools make building easy

parts, working only on the front view, usually. This very preliminary stage produces only surface planes. I don't worry about the third dimension at this point.

Once I have a rough drawing, I begin to flesh it out. Using SketchUp's "push/pull" tool, I give each element thickness, width, and length. Push/pull is probably the most used of SketchUp's unique tools; it turns a flat 2D shape into a solid object or a 3D recess with a click and drag. One rectangle becomes a leg; another, a full mortise.

I don't worry about joints at this stage. I'm only trying to get all the parts defined and connected into an attractive whole. For example, if I'm designing a case with a bracket foot, I'll simply draw in the basic outline of the foot. Later, I'll shape detailed joints.

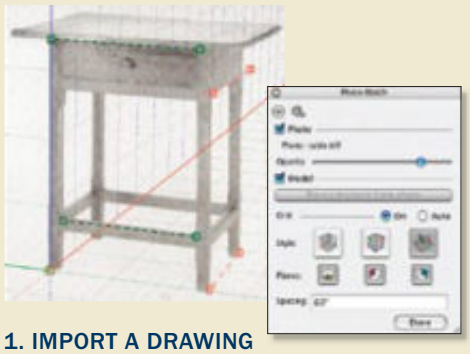
I also make many adjustments to the sizes, thicknesses, and positions of the components. Here, I use the tape-measure and protractor tools to check dimensions and angles, and to create on-screen guidelines showing where to place holes, pegs, mortises, and the like. Again, these elements start as simple shapes and then the push-pull tool pulls them out from a surface or pushes them in to make a hole.

With the joinery completed, I detail the moldings. For this, I use SketchUp's "follow me" tool. It allows you to profile a shape for, say, a turned leg or a cornice. From there, I create separate X-ray views to check the design of each joint, an exploded view of the components, dimensioned drawings, and full-size templates and patterns for the actual construction.

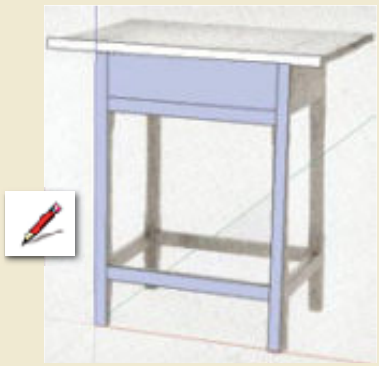
If I need to check a dimension or take a closer look at a detail, I go back to the computer. In some cases I may add dimensions to a file or add detail to the model. I continually update the SketchUp images as

STARTING A PLAN

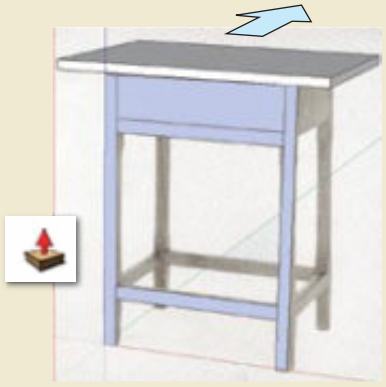
You can bring a photo into SketchUp and use it as the basis for a drawing. Killen often does this for his period reproductions. For an original piece, you can begin with a shape defining its top or face.



1. IMPORT A DRAWING
With a photo placed as a starting point, you can use SketchUp's "photo match" tool to keep the lines you draw properly oriented on the different axes and following the edges in the photo.



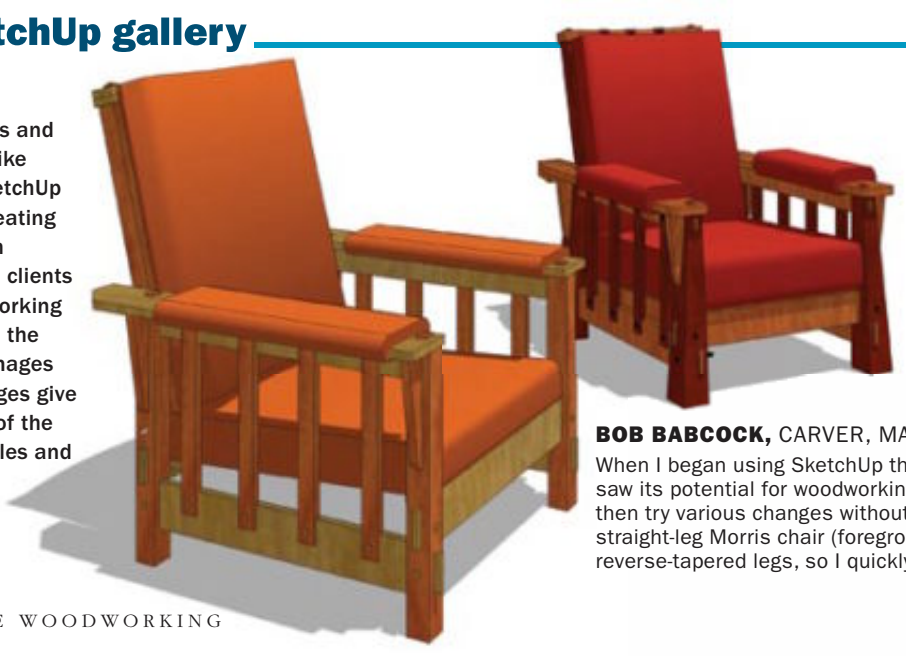
2. DRAW SIMPLE SHAPES
Draw rectangles to define legs, aprons, and other elements. Designate each rectangle as a component. That lets you modify it without affecting any other element.



3. GIVE EACH ONE THICKNESS
Select a component, such as the top of this table, and use the push/pull tool to give it the proper thickness. Work on one component at a time. Later, you'll duplicate identical components.

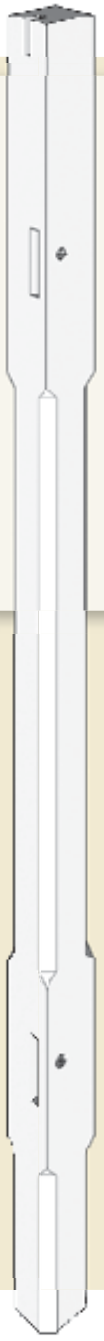
A SketchUp gallery

Professional woodworkers and hobbyists alike now use SketchUp regularly, creating presentation drawings for clients as well as working drawings for the shop. The images on these pages give you a taste of the furniture styles and shapes that you can render.



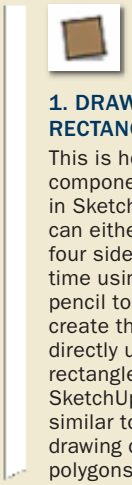
BOB BABCOCK, CARVER, MASS.
When I began using SketchUp three years ago at work, I immediately saw its potential for woodworking. I like being able to draw something, then try various changes without starting from scratch. I designed the straight-leg Morris chair (foreground), then the end table. I liked the table's reverse-tapered legs, so I quickly gave the chair tapered legs, too (center).

Gallery images courtesy of the contributors



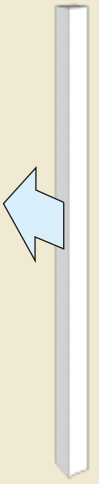
MAKING A COMPONENT

Using SketchUp to create a component like this table leg means using the computer to mimic tasks you'll do later in the shop—make the basic leg the correct height, width, and length; mark and shape mortises, dovetails, and chamfers. But unlike working in a shop, you only have to do things once. When you've drawn one chamfer, just copy and rotate it; the same goes for the completed leg.



1. DRAW A RECTANGLE

This is how most components begin in SketchUp. You can either draw the four sides one at a time using the pencil tool, or create the shape directly using the rectangle tool. SketchUp has similar tools for drawing circles and polygons.

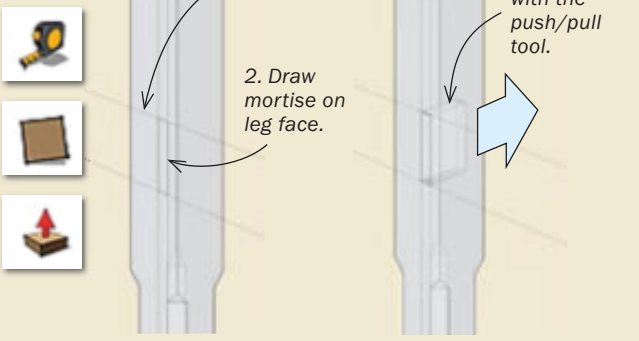


2. ADD DIMENSION

The push/pull tool lets you drag the rectangle along one axis, converting the two-dimensional shape into a 3D solid. The tape-measure tool lets you check the dimensions. You also can type in critical dimensions, entering the numbers in a small on-screen window called the Value Control Box.

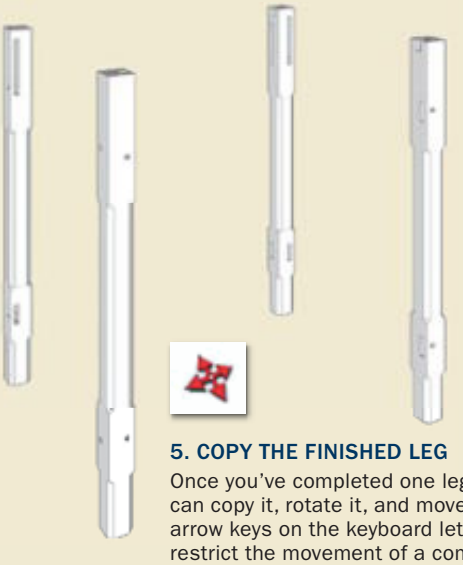
3. CHAMFER ONE CORNER, THEN REPEAT

Using the pencil tool, draw in the shape of the chamfer. Then erase the corners of the leg to create one chamfer. Finally, highlight the chamfer outline and copy it onto the other three corners.



4. LOCATE AND SHAPE THE MORTISES

The tape-measure tool lets you add guidelines to outline mortises. Draw a rectangle in the space defined by the guidelines and use the push/pull tool to "cut" the mortise. Working in the X-ray view lets you see what you're doing.

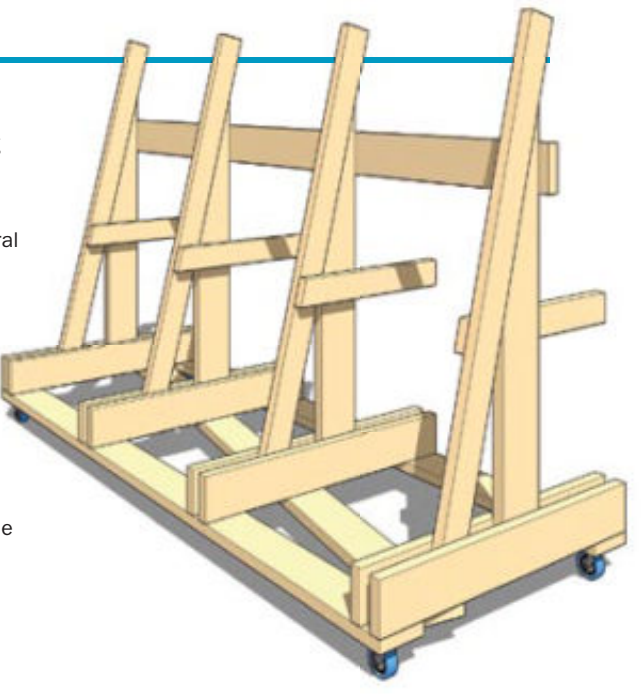


5. COPY THE FINISHED LEG

Once you've completed one leg, you can copy it, rotate it, and move it. The arrow keys on the keyboard let you restrict the movement of a component to one direction only—left or right, front to back, up or down—in order to keep similar components aligned.

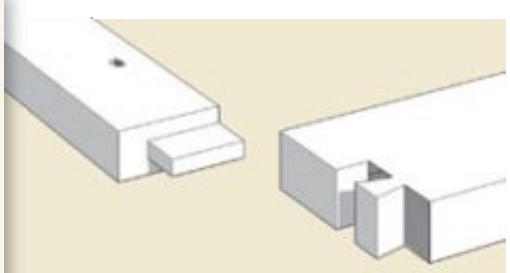
DAVE RICHARDS, ROCHESTER, MINN.

For the past several years, I've been helping other woodworkers around the world learn to use SketchUp. I've made a wide range of drawings, from tiny parts for medical equipment to large architectural projects. Sometimes I'll work from a photo, as I did for the front view of the dining table (left), where I worked out construction details. The female figure is a stock image in SketchUp, providing scale. Other times, I'll design from the ground up in SketchUp, as I did for the lumber rack (right).



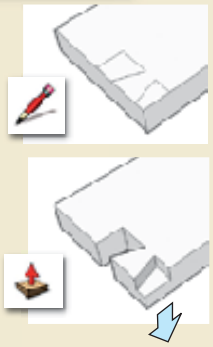
ADDING JOINERY

Create other components in a piece as you did the legs. Once you have given rails and stretchers the right width and thickness, you can draw in dovetails, mortises, and tenons.



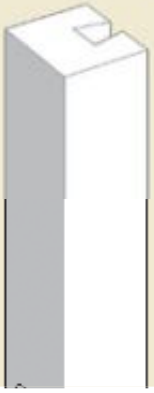
1. CREATE A DOVETAIL

Using the pencil, push/pull, and eraser tools, create the dovetail pins on the front stretcher. Then, as in real life, use the pins to mark the tails on the mating piece.



2. CHECK THE FIT

Once you've created the components, you can move them into position, fitting them together and joining them with the legs.



I build the actual piece, so that I have a high-quality document showing the piece as built.

For a piece like the table shown on these pages, where I'm working only from a photo, I might spend 10 hours working out initial design and construction details in SketchUp. Then I can comfortably begin work in the shop. If I need to check a dimension or examine a detail, I'll go back to the computer. I'll save all that SketchUp time and more when I make the piece for real. Plus, I know it will look great.

How to shorten the learning curve

Here are some pointers I've picked up in my two years' experience with SketchUp, which should help you jump in without difficulty.

Draw objects only once—With two-dimensional CAD programs, you draw separate front, side, and top views, drawing various pieces over and over. But in SketchUp, you work in a 3D view most of the time. That means you only need to draw something once. You can rotate it, zoom in for close-ups, or zoom out to see the whole. For the legs on the table shown here, for example, I needed to draw only one leg and the chamfers on one corner. I copied the chamfers and attached them to the other corners. Then I copied and rotated the completed leg to place the three other legs.

Make the most of the component tool—If you simply create shapes and bring them together on screen, you'll actually be creating one large, very complex shape. If you try to move or resize one part of it, you'll distort the entire design. So once you create any element, such as a table leg or chair arm, designate it as a component. Then you can change its size and shape without affecting any other element in the design.

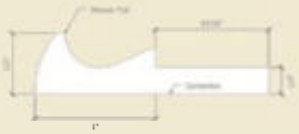
Whenever you have identical components—table legs, for example—you can draw one, designate it as

CREATING TURNINGS

SketchUp's "follow me" tool allows you to precisely render rounded or curved objects like this drawer pull. The tool translates a one-plane shape into a solid.

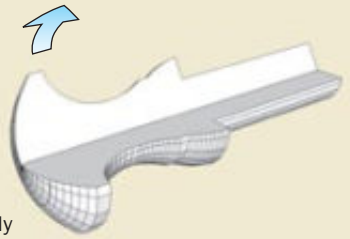
1. DRAW THE PROFILE

Use the curve and pencil tools to draw the basic outline of the drawer pull.



2. DEFINE THE SOLID SHAPE

Draw a circle, defining a path to follow. Highlight the circle, then click on the drawer-pull shape with the follow-me tool. SketchUp automatically extrudes the shape around the path. Moldings also are created this way.



SketchUp gallery (continued)

RUSS JENSEN, SUDBURY, ONT., CANADA

SketchUp has renewed my passion for designing furniture. I originally designed the desk (left) two years ago, but redrew it when I began using the program. To make my designs look realistic, I import images of different woods and manipulate the size, position, and orientation of the grain. For example, the sofa (right), will have walnut crotch veneer on the end panels. Once I add some shadows, I have a drawing that a potential customer can really sink his or her teeth into.

a component, then copy it. Any changes you make to that component will automatically be made in every copy of the component. Not only does that save you drawing time, it keeps the overall drawing consistent and precise.

Watch the axes—Objects in SketchUp are made up of a number of faces that usually align with two of three axes. Red, green, and blue guidelines define those axes. At first, I was careless about drawing lines on axes and connecting lines properly. SketchUp couldn't create the face or shape I wanted because my lines weren't in the same plane or didn't connect.

There are a number of aids to help you keep your drawing on-axis. For example, when you draw a line, its color changes to the appropriate axis color when it coincides with that axis.

The arrow keys on the keyboard also help keep shapes and components on-axis when you move them. Pressing the right arrow forces the object to move only along the red axis, for example. This is very helpful when you're trying to fit one component precisely against another.

Use SketchUp's tools for precision—I frequently use the tape-measure tool to place guidelines that help me position or connect components.

SketchUp's move tool helps connect components at precise locations. You place the tool at a corner of one component, then drag that component to connect with the corresponding corner of another component. SketchUp recognizes these points and snaps them together precisely. Last, you may want to turn on the X-ray view so you can see how, for example, a tenon fits in its mortise. □

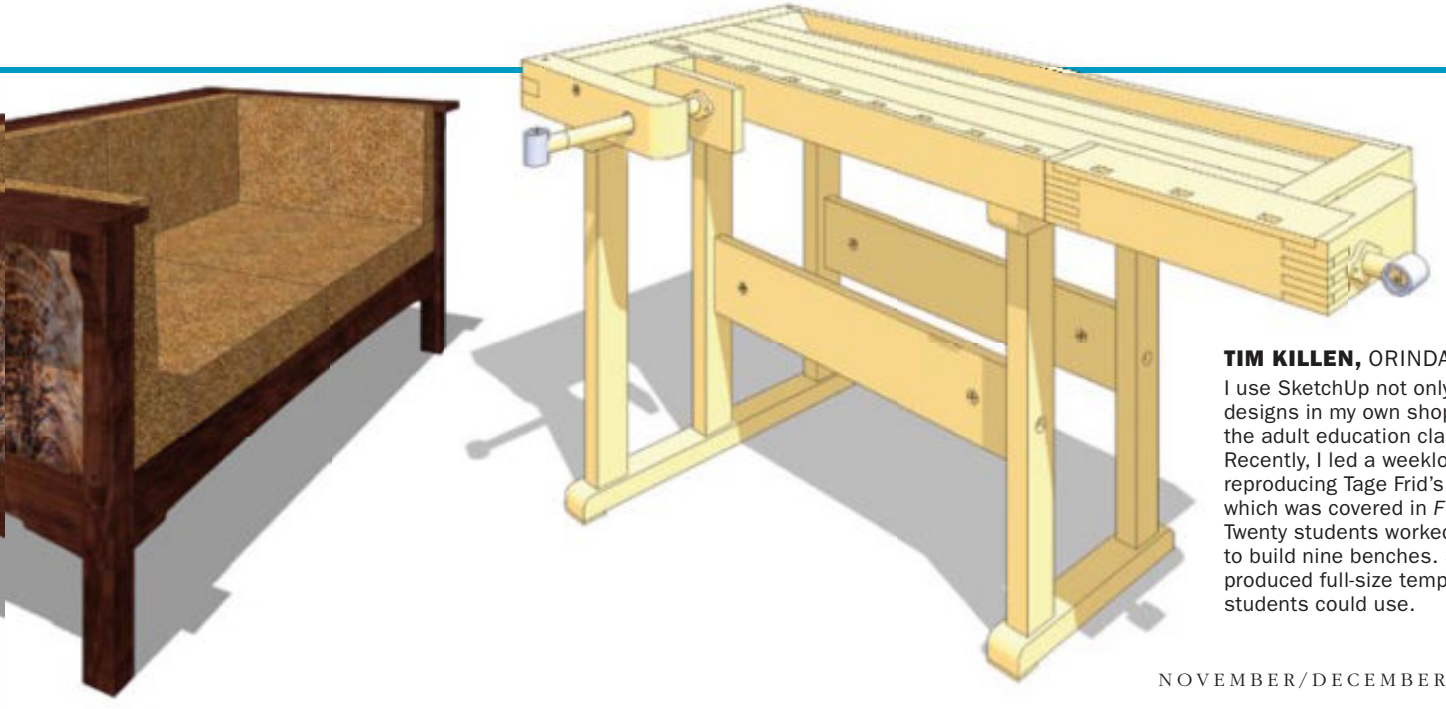
Tim Killen makes museum replicas of 18th-century and Shaker furniture in Orinda, Calif.

FINISHING TOUCHES

Despite its name, SketchUp lets you make precise, detailed drawings in full color. You can also add details to make drawings more realistic, such as shadows, textures, and patterns.

Add life. *SketchUp comes with a modest library of colors and textures, but you can import and apply images of real wood, too.*

Pick your style. *If you literally want to create a sketch in SketchUp, you can choose from more than a dozen pen and brush styles. If you don't like the way they look, you can always revert to the precise default style.*



TIM KILLEN, ORINDA, CALIF.

I use SketchUp not only to create designs in my own shop, but also in the adult education classes I teach. Recently, I led a weeklong course reproducing Tage Frid's workbench, which was covered in *FWW* #4. Twenty students worked together to build nine benches. SketchUp produced full-size templates that the students could use.

readers gallery

Student work

To recognize and support those starting a woodworking career or hobby, *Fine Woodworking* has devoted this Readers Gallery to their work. The photos on these pages are just a few examples of the exemplary pieces coming out of schools and colleges.

CHRIS HEDGES
Gallipolis, Ohio
Rio Grande Community College

This Philadelphia secretary swept the AWFS Fresh Wood student competition in July 2007, taking first place in the reproduction category, best in show, and the people's choice award. Hedges estimates it took 600 hours to complete this copy of a piece by Louis Irion. The secretary stands 21 in. deep by 40 in. wide by 100 in. tall, and the woods are quartersawn curly cherry, madrone burl, and poplar. Hedges finished the piece with aniline dye, tung oil, garnet shellac, oil glaze, and wax. PHOTO: CHRIS EATON

BRIANNA RHODES
Beaver Dam, Wis.
Lakeside Lutheran High School

Rhodes, just 15 years old, has been woodworking in the Leipsic 4-H club since she was 7. Her father, a cabinetmaker by trade, has been a big influence. This tiger maple Federal-style game table (a blue-ribbon winner at the 2007 Wisconsin State Fair) has rear legs that swing backward to support the hinged top when it is open. The table (18½ in. deep by 37 in. wide by 29⅜ in. tall) is finished with maple stain and lacquer. PHOTO: KEITH D. GLASGOW

CHRIS BARTELS
Springfield, Pa.
Springfield High School

Bartels reproduced this cherry-and-poplar sideboard for his mother, fine-tuning the design to her specifications. The sideboard is 19½ in. deep by 64 in. wide by 32½ in. tall. The finish is a 50/50 mix of cherry and red oak Minwax stain, and three coats of Deft lacquer. PHOTO: JEFF WHITLOCK

SCOTT M. KING
London, Ont., Canada
Inside Passage School

This chair (18 in. deep by 20 in. wide by 36 in. tall) is King's first attempt at chair making. He was inspired by two accomplished chair makers: Ejler Hjorth-Westh for the frame and Garrett Hack for the woven Danish-cord seat. The yellow narra wood is finished with varnish. PHOTO: INGEBORG SUZANNE

GREG KLASSEN
Fort Bragg, Calif.
College of the Redwoods

Inspired by the movement of the Pacific Ocean, Klassen wanted this bench (20 in. deep by 34 in. wide by 17 in. tall) to convey the eternal motion of a wave. The madrone seat is coopered and shaped with a round-bottom plane, and the claro walnut base is joined with double tenons. The bench, finished with wipe-on poly, won second place at the AWFS Fresh Wood student competition in July 2007. PHOTO: JOHN BIRCHARD

JEREMY AND JASON LYNCH
Springfield, Pa.
Springfield High School

The Lynch brothers (Jason, front seat; Jeremy, back) spent the summer of 2006 looking for a challenging project for the school year. They found inspiration in a 1924 Ford Model TT at the Gilmore Museum in Michigan. They scoured the Internet for a frame, towed it from Wisconsin with their father, and spent eight months restoring the now fully functional truck. The woodwork, finished with Epifanes spar varnish, is ash and African ribbon mahogany. PHOTO: JEFF WHITLOCK

IAN VINCENT GODFREY
Roberts Creek, B.C., Canada
Inside Passage School

Drawn to the clean lines of Danish modern design and traditional construction techniques and hand tools, Godfrey created this sideboard (15 in. deep by 45 in. wide by 35 in. tall) to combine those elements. The teak exterior has an oil finish and the beech interior is finished with shellac. The handmade pulls are bocote. PHOTO: INGEBORG SUZANNE

DANIEL H. PHILLIPS
Dallas, Texas
North Bennet Street School

Phillips adapted a drawing from Thomas Sheraton's *The Cabinet-Maker and Upholsterer's Drawing-Book* for the design of this chair. The original was drawn without arms and with turned legs. For this version, Phillips made the back splats as bent laminations with scratched beads. The arms are joined to the arm posts with a dowel, and the arm posts are joined to the seat rail with a sliding dovetail. Phillips caned the seat and then finished the mahogany, crotch mahogany, holly, and ash chair with super-blonde shellac, a 50/50 mix of boiled linseed oil and turpentine, and wax. The chair is 19 in. deep by 25 in. wide by 32 in. tall. PHOTO: LANCE PATTERSON

AMANDA BROEMEL
Orlando, Fla.
Springfield High School

Living in a home where nearly every piece of furniture was designed and built by her father, Broemel, formerly of Springfield, Pa., turned to him for design input. They pored over photographs, selecting elements to incorporate into this bed (88 in. deep by 64½ in. wide by 48 in. tall). The bed is primarily mahogany with lacewood panels. Broemel used walnut and tiger maple for the inlays and finished the piece with Danish oil. PHOTO: JEFF WHITLOCK

RIC WASHBURN

Appleton, Maine

The Center for Furniture Craftsmanship

Washburn reproduced this mahogany-and-oak portable writing desk from a photograph in Lon Schleining's book, *Treasure Chests: The Legacy of Extraordinary Boxes* (The Taunton Press, 2001). Not an exact reproduction, the desk is 15½ in. deep by 19 in. wide by 9½ in. tall. The tambour lid is attached to the drawer, so the lid retracts as the drawer is pulled out. The finish is Waterlox Original. PHOTO: CHRIS PINCHBECK

LAËL KI GORDON

Seward, Alaska

Inside Passage School

Gordon took advantage of the naturally prismatic quality of hemlock for this veneered whiskey cabinet (12 in. deep by 29½ in. wide by 45 in. tall). He created a subtle pattern that shifts from positive to negative as the viewing angle changes. The base, made of Pacific yew, is finished with oil, and the cabinet is finished with shellac.

PHOTO: INGEBORG SUZANNE

GERMAN F. PLESSL

Berlin, Germany

College of the Redwoods

The design for this bubinga and pear entry table (12 in. deep by 36 in. wide by 36 in. tall) came from Plessl's desire to create a natural "tree-branch form" that also incorporates classical and modern shapes. The legs and arms are attached to the tops with sliding dovetails, and the arms are attached to the legs with loose tenons. The finish is shellac.

PHOTO: JOHN BIRCHARD

Call for entries

MODERN DESIGNS SOUGHT

Fine Woodworking is planning a special issue on contemporary furniture design to be published in 2008. We're looking for functional pieces that reflect an imaginative approach to design and materials selection. Categories include tables, chairs, desks, cabinets, bookcases, bureaus, beds, and cabinetry for home entertainment and computers. The emphasis will be on contemporary forms, not period reproductions. Makers must provide professional-quality photography in digital or transparency formats and include a brief statement of design intent along with dimensions and material specifications, drawings, and brief construction notes that seem relevant. All entries must be postmarked by Nov. 16, 2007. For return of entry materials, include a prepaid mailing envelope. Send entries to DESIGN, *Fine Woodworking* Magazine, 63 S. Main St., Newtown, CT 06470. For more information, go to www.finewoodworking.com/design.

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Tage Frid (1915–2004)

This renowned woodworker taught at the School for American Craftsmen and the Rhode Island School of Design and was one of the first contributing editors to *Fine Woodworking* magazine. His work is in the permanent collections of many major museums.

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Handheld routing

THE SIMPLE FIXED-BASE ROUTER IS A REAL WORKHORSE

BY GARY ROGOWSKI

Learning to use your first router is a little like getting acquainted with your first computer, cell phone, or iPod. You've heard they can do so many things so well that you wonder if they can make a nice cup of cappuccino, too.

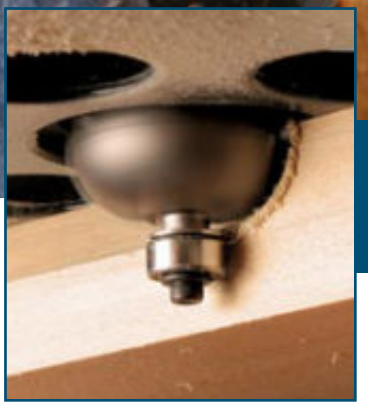
Well, not quite. However, a handheld router with a simple fixed base can cut edge profiles, joinery, and curves quickly and cleanly. In fact, it used to be that a fixed-base router was the easy choice for anyone making their first purchase.

The smarter move nowadays is the combination kit, which packages a single router motor with both a fixed base and a plunge base (for mortises and stopped cuts). For a few dollars more, this gives you plenty of room to grow and a great place to start learning. Even if you never take the plunge base out of the box (highly unlikely), the fixed base is versatile enough to take you a long way in woodworking. Let's see how far.

A few shopping tips

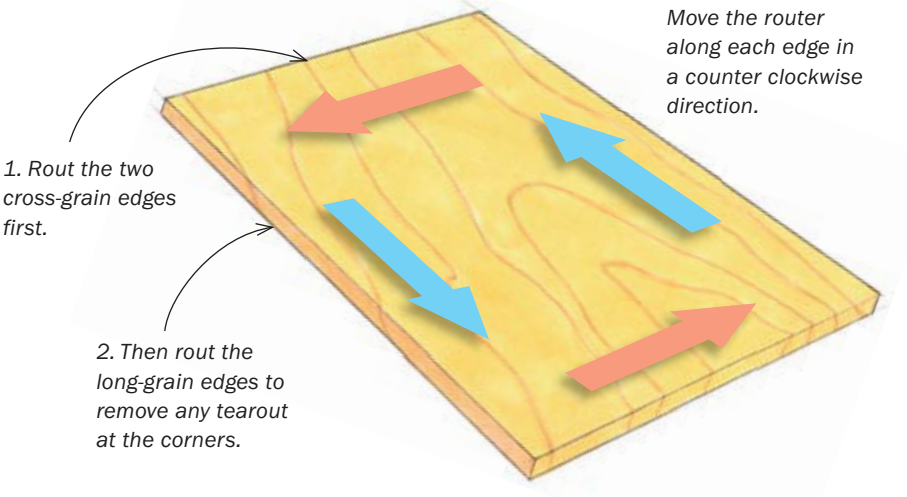
Routers come in different motor and collet sizes. Ignore the horsepower ratings and look for more amperage to get more power—12 amps should be plenty.

Most routers come with two interchangeable collets, ¼ in. and ½ in. Be sure to get a ½-in. collet so you can use bits with the beefier ½-in. shank. This gives you better strength in tough routing conditions and more bits from which to choose. Also,



Bearing-guided bits for edge profiles

The bearing serves two functions. It limits the cut and it rides the edge of the workpiece to follow its shape. To cut a deeper profile, increase the bit's depth.



Photos: Steve Scott; drawings: Hayes Shanesy

Add a fence for grooves

A fence attachment guarantees cuts parallel to an edge. A great way to modify this standard accessory is to add a straight piece of narrow stock for a longer, more stable fence (below).

Keep the fence tight against the workpiece. *This ensures that the cut is straight, smooth, and parallel to the edge.*

compare the ergonomics of the routers on your list before you buy. Feel how each fits your hands, where the on/off switch is, how well the locking handle works. These things will matter to you after you've spent hours making various types of cuts.

Cutting edge profiles

Bearing-guided bits cut molding profiles such as roundovers, coves, or ogees into edges using the bearing to limit the width of the cut. Some bits, like rabbeting bits, come with different-size bearings for making wider or narrower cuts.

Don't push the bearing all the way to the stock on the first pass. Make these profile cuts in a series of light passes to minimize tearout and reduce wear on the router. In fact, this advice applies to any of the cuts described here. Taking aggressively deep passes is hard on the router-bit edges. In addition, be sure to move at a decent feed rate in long grain to avoid burning. Across end grain you want to move even faster, as end grain burns more readily.

Jigs keep the router on a straight path

Put a straight bit in a router, start a freehand cut in a board, and it will rout a sinuous course through the softest wood it can find. The router won't cut straight unless you make it cut straight. Fortunately, there are many ways to accomplish this. Most routers, for instance, can be fitted with a fence that attaches to the base and rides along the edge of a workpiece.

This attachment is great for making straight cuts parallel to a nearby edge, such as grooves to accommodate supports for adjustable shelving. Attach a longer auxiliary fence made of plywood or straight stock to give it better stability.

For cutting dadoes, a shopmade edge guide with a right-angle fence gives you a way of making the cuts straight and at a perfect 90° angle to the edge of a workpiece. This is especially helpful if you're building a bookcase or cabinet

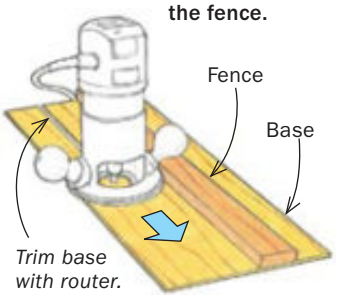
Make a jig for dadoes

Create a right-angle jig by attaching a piece of ½-in. stock at 90° to a 1-in.-thick crosspiece. Routing through the crosspiece marks the cut location, making it easier to align the jig with layout marks.

Making the cut. *The router's base rides the edge of the jig. To ensure a straight cut, avoid rotating the base.*

Make a guide for straight edges

Attach a piece of straight ½-in.-thick plywood or MDF to a piece of ¼-in. plywood. Use the router to trim the base parallel with the fence.



The guide keeps the router in line. *Setup is easy, because the edge of the jig marks the edge of the cut.*

with fixed shelves. The jig is a simple straightedge with a right-angle fence attached. Plowing through the right-angle crosspiece allows you to accurately align the fence with layout marks for each cut. Align the jig and clamp it to the work, with the fence snug against the edge of the workpiece.

One of the nicer tricks a handheld router can accomplish is jointing a straight, square edge on a board.

To do this, make a straightedge jig by screwing a straight piece of ½-in. plywood or MDF to a length of ¼-in. plywood. Use the router and a straight-cutting bit to trim the baseplate parallel with the jig's fence. This type of jig can be used to make any kind of straight cut, but it is especially useful for jointing an edge. Simply align the edge of the plywood platform along the edge you plan to joint, leaving a little rough stock showing along the board's entire length. Clamp the jig in place and rout the exposed surface with the same straight bit you used to make the jig.

When using this or any other straightedge jig, bear in mind that the router baseplate's outer rim might not be concentric with the bit. If not, then spinning the base during a cut will alter the distance between the bit and the fence, allowing the bit to go off line. To avoid this, take care to keep only one point on the base in contact with the fence as you move through the cut.

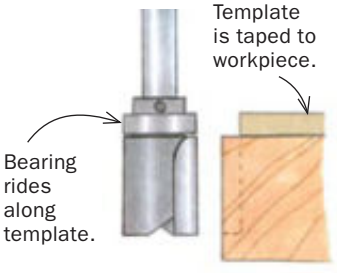
Cutting curves with a template

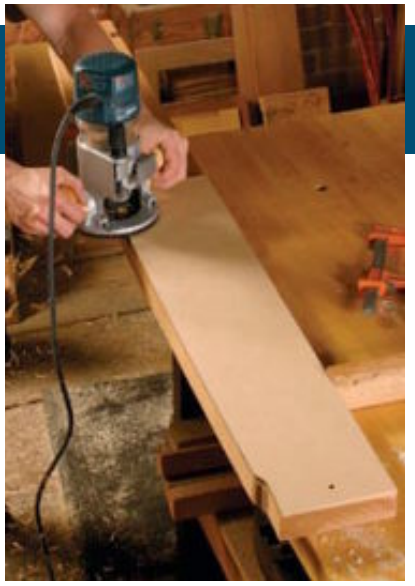
Pattern-routing or flush-trimming bits are straight bits with two or three flutes and a bearing mounted on them that is the same diameter as the bit. This allows the bit to trim a workpiece to exactly match the outline of an attached template, making it possible to cut multiple curved parts.

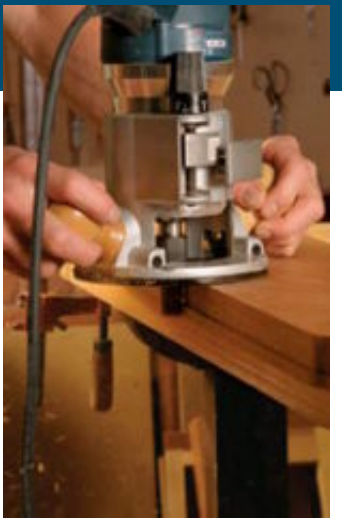
Carefully shape the template from hardboard or ¼-in. plywood, then trace the shape onto your workpiece. Cut out the shape on the bandsaw, staying about 1⁄16 in. from the lines. Next, use clamps, screws, or double-sided tape to hold the template to your workpiece. Move the router quickly through sharply curved areas to avoid burning the end grain. □

Use a template for curves

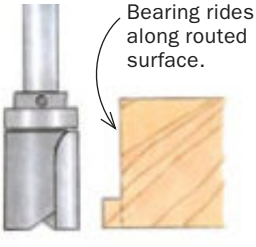
A bearing-guided straight bit rides the template's edge. The bit trims the workpiece flush with the edge of the template.







Thick stock requires a second pass. *Remove the template and increase the bit depth. The bearing will now reference against the already trimmed surface of the workpiece.*

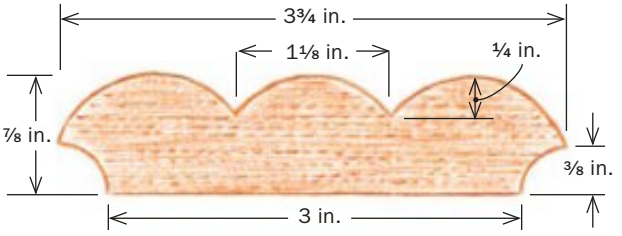


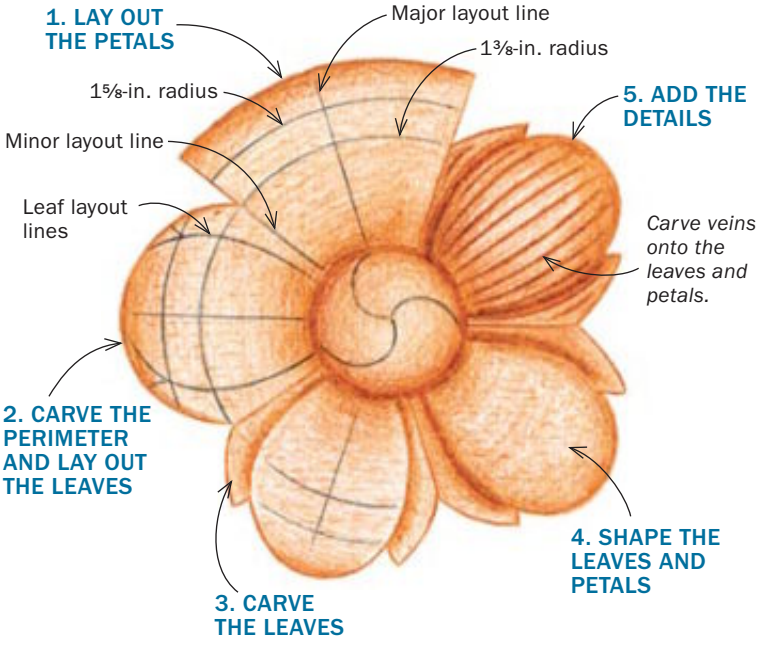
master class

Carve a rosette

LEARN ESSENTIAL CARVING SKILLS WITH THIS CLASSIC ORNAMENT

BY TONY KUBALAK





Too many furniture makers, carving is intimidating and frightening. A great way to overcome these fears is to carve an applied rosette: It requires only a small amount of wood; it's independent of the piece it eventually will reside on; and it has a small number of elements that are repeated multiple times. Rosettes come in many variations, and although small in size, they significantly refine a high chest or a clock case. I'll cover one style here and two more (see p. 100) on FineWoodworking.com.

When I became interested in building period furniture, I didn't think that I'd be able to tackle the carving. I assumed that you had to be an artist and I didn't consider myself one. I've since learned that carving is as much science as art, a process taken in logical, repeatable steps. That said, carving is a skill that you can continue to hone for a lifetime.

Turn a blank on the lathe and lay out the design

Start with a blank that's approximately ⅞ in. thick by 3⅞ in. square. After cutting out a rough circle on the bandsaw, screw the blank to a screw chuck that already has a ½-in.-thick disk of wood attached to it. You need to include this other piece of wood because you will undercut the back of the rosette and you don't want the turning tool hitting the

1. Lay out the turned blank

Lay out a backer board. *After turning the blank, lay out the 10 divisions on a plywood square. Score the lines with a knife and then darken them with a pencil.*

Lay out the blank. *Attach the blank to the backer board. Extend the lines onto the blank and use a compass to draw two circles.*

Draw the petals. *Starting where a line crosses the inner circle, draw two arcs out to where the next line meets the perimeter.*

Photos: Mark Schofield; drawings: John Tetreault

2. Carve the perimeter

Define the petals. *Use a V-tool to cut into the perimeter and then a #7 sweep gouge (shown) to profile the edge of the petals.*

Finish the perimeter. *Draw a pair of arcs either side of every other line to lay out the leaves. Then cut notches in each edge of the petals to define the tips of the leaves.*

3. Carve the leaves

Relieve the petals. *Make vertical "stop" cuts and then angled "relief" cuts (shown) to create V-shaped channels around the petals.*

chuck. Use a gouge or a scraper to turn the profile shown in the top drawing on p. 96. This rosette is one element repeated five times, so divide the disk into five equal sections.

You'll need a backer board to hold the rosette for carving. Lay out this board with lines radiating out from a center point at the desired spacing and extending about 3 in. beyond the blank. In this case there are five major divisions, so draw a major line every 72° marking the midpoint of the petals, with minor lines dividing the petals halfway between the major ones. Drill a hole through the center of the backer board and screw on the blank, penetrating the blank by no more than ½ in. Place a pencil dot at the center of the blank, and by eye, extend the backer-board lines onto the blank. Draw two circles and lay out the petals.

Carve the outside profile first

You carve this rosette working your way in from the perimeter. First, carve along the arcs that define the petals. Don't do this in one cut, but use a V-tool to cut away small increments beginning at the perimeter. Then round over the edges using a #7-20mm gouge. The exact gouge is not critical, but avoid one that's too narrow; a #7 sweep gives the petals a pleasing curve.

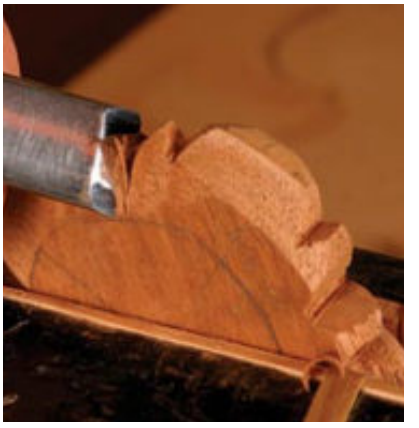
The next step is to refine each large petal into a smaller petal with a leaf on each side. Draw an arc ⅛ in. on both sides of a minor line out to where the adjacent major line meets the perimeter. Then draw a short curve from where this new arc crosses the outer circle out to the perimeter of the leaf (see drawing, p. 96). Carve to the lines using the same V-tool and rounding technique as the petals but using a #7-6mm gouge for the short sections and the #7-20mm for the longer sections.

Refine the petals and leaves

There are a couple of things to keep in mind while carving the petals and leaves. First, the leaves are lower than the petals;

4. Shape the leaves and petals

Round over and smooth the petals. *Use an inverted gouge to round over the sides of the petals and bring them down to the adjacent groove. Use a fine file to smooth the facets into a continuous surface.*



Undercut the back. *To give the edges of the rosette a crisper, lighter look, carve away some wood near the edge of the back and deepen the V between the leaves. Lay out a rough circle to guide your cuts.*

5. Add the details

Work on the dome. *Draw three lines that curve outward from the center of the dome, and then create grooves with stop cuts and relief cuts. Each third of the dome is further divided into two sections with another outward sweeping curve.*

Add the details. *With a small veining tool, add narrow channels to the petals, leaves, and central dome to represent the veins in the flower.*

second, the pairs of leaves are divided by a ridge. To define the petals, start by making perpendicular or stop cuts along each petal's perimeter with a #3-20mm gouge. From the leaf side of this cut, make a shallow angled cut known as a relief cut that terminates at the stop cut to remove a small wedge of wood. Repeat these two cuts until the depth matches the base of the central dome where they meet, and is slightly deeper at the perimeter. Work on the adjacent sides of two petals at a time, so that the angle into the stop cut does not get too steep. Repeat until all the petals are established.

From each centerline, round over the petals down to the cuts you just made using a shallow gouge, say a #3-20mm. Use a small file to smooth the facets into a continuous surface.

The ridge line between each pair of leaves begins at the base of the central dome, divides at the inner circle, and terminates at the outer circle. The ridge should be lower than the high point on the petal, but higher than the rest of the leaves. It is this variation in depth that gives life to the carving. Use a shallow gouge, say a #3-12mm, to define the ridge.

Now that the face of the perimeter is defined, you can give the rosette a crisper, more delicate look by extending the undercut area by about ⅜ in. toward the center using a shallow gouge. Strive for a nice crisp "V" between the leaf pairs around the perimeter and crisp, thin tips for the leaves.

Work on the central dome

The rosette's dome is carved to look like the central reproductive parts of a flower: the stamen and the stigma. I'm no botanist, so I'll just refer to the parts as leaves. With a pencil, sketch in three lines that curve out from the center and divide the dome into roughly equal thirds. Use a #7-10mm gouge to make a stop cut along each of the three curved lines, and with the same gouge make an angled relief cut. Repeat this process until the channel is about ⅛ in. deep.

You now need to round the tip of each leaf at the center of the dome. With a #7-6mm gouge near the center, connect one of the stop-cut edges with the adjacent edge formed by the angled cut. With the same gouge, step back from this line toward the center a bit and angle into it. This angle will be rather steep because there is not much room left without impacting another leaf. When completed there should be three well-defined leaves.

Use a relatively flat and narrow gouge, say a #3-8mm, to round each leaf from the high edge down to the bottom of the stop cut. Blend this cut smoothly into the outer baseline defined by the perimeter of the dome. The more refined the carving becomes, the more delicate the cuts, so a lighter hand will yield better results. Now create a small leaflet from each leaf, using a #7-4mm gouge to make a perpendicular cut followed by a relatively steep angle cut. Deepen this a bit and gently feather the line so that it disappears near the base of the dome.

Delicate details complete the rosette

What remains is to add some detail lines. Use a #11-0.5mm veiner to add shallow veins to the petals, the leaves, and the dome leaves. Take care to avoid tearout on cross-grain cuts.

Looking at your finished rosette, you'll understand how something that appeared complex and daunting became manageable with a few types of cut repeated several times. □

Online Extra

To learn more about Kubalak's basic steps for carving two other classic rosettes, go to **FineWoodworking.com/extras.**

a closer look

Water-based finishes

KNOW THE SCIENCE AND MAKE SMARTER CHOICES

BY JEFF WEISS

No finishing topic creates more controversy, head scratching, and general mayhem than water-based finishes. Much of the misunderstanding stems from the rather checkered history of these finishes. They've always promised fast drying time, low odor, easy cleanup, and nonflammability, but early versions were hard to apply and gave many woods a cold, dead look.

However, today's formulations match the clarity, hardness, and durability of most, if not all, of the solvent-based clear-coat cousins that they are increasingly replacing. As the founder of a company that makes water-based finishes, I'll shed some light on their history, describe the increasingly sophisticated science behind them, and give some tips on how to apply them. In this way, I hope to give you the confidence to make the switch.

Water-based finishes started life on the floor

The history of many of today's water-based wood-finish resins can be traced back more than a century to the floor-care industry. Early developments included water emulsion paste-wax blends for protecting wood and tile floors. These blends had the advantage of being lower in odor and less flammable than solvent versions. After the Second World War, we began to see the development of polymer acrylates for tile floor finishes and waterborne urethanes that featured the early polyester, and later polycarbonate, resins used to waterproof fabric and leather. In the early 1980s, these technologies became the first generation of water-based finishes for wood floors.

Water-based latex and acrylic paints were developed before water-based clear finishes for two reasons: First, the market volume for paint is much greater; second, paint was easier to develop because early water-based resins demonstrated poor clarity and were better suited to blending with pigments.

In many ways, water-based clear finishes are following the same track as water-based paints, but are about 20 years behind in terms of market share. In the early 1980s, solvent-based wood finishes occupied almost 100% of the industrial and DIY market. Today, their share is estimated at 70% and is rapidly declining, with most of the decline within the last seven years.

The link between solvent finishes and air pollution

The event that transformed water-based finishes from various niche products into increasingly widespread use was the Clean Air Act of 1970. One of the terms popularized by the act was

Complex formulations

Careful measurement, then into the tank. *Many different components, in precise increments, combine to make today's products perform better. Each one is measured by weight to the nearest tenth of a pound (top). After each component is weighed and a lid is attached to the top of the drum, it is lifted by forklift and placed over the top of a 550-gal. tank (right).*

Mixed together. *A spigot on the drum is opened and the contents are allowed to slowly enter the liquid already in the tank. Each batch of finish is mixed for at least six hours.*

Photos: Mark Schofield

Types of water-based finishes

RESIN TYPE	PHYSICAL CHARACTERISTICS (POOR/GOOD/EXCELLENT)		BRAND EXAMPLES	SPRAY/ BRUSH/WIPE
Acrylic Blends Commonly marketed as the water-based equivalent of solvent lacquer finishes, these finishes are designed only to be sprayed. They harden rapidly and give good gloss development. Those made with styrene acrylics have good corrosion resistance to household chemicals such as salt or vinegar, but yellow with age.	Hardness	G-E	M.L. Campbell UltraStar	S
	Chemical resistance	G	Target Coatings Ultima Spray Lacquer	S
	Clarity	G-E	Becker Acroma Akva Line 212 lacquer	S
	Burn-in	E	Van Technologies VanAqua-280	S,B
	UV resistance	P-G		
	Repairability	G-E		
Copolymers Due to rapidly changing technologies, these resins offer a unique range of performance values that are difficult to compare to old-world solvent-based finishes. They generally fall into the post-catalyzed lacquer and pre-catalyzed conversion varnish range of performance.	Hardness	G-E	Minwax Polycrylic	B
	Chemical resistance	G-E	Varathane Diamond Polyurethane	B
	Clarity	G-E	Benwood Stays Clear	B
	Burn-in	P-G		
	UV resistance	G		
	Repairability	P-G		
Urethanes These finishes develop a hard, chemical-resistant film, so they are used for wood floors, architectural trim, tabletops etc. This durability also means that successive coats tend to form layers rather than melting together like acrylic blends.	Hardness	E	General Finishes High Performance	B
	Chemical resistance	E	Target Coatings EM9300 Polycarbonate Urethane	S,B,W
	Clarity	G-E	Van Technologies VanAqua-480	S,B
	Burn-in	P		
	UV resistance	G-E		
	Repairability	P		
Urethane/ Acrylic Blends These are the most common type of water-based finish because the blend can be fine-tuned for specific uses.	Hardness	G-E	Hydrocote Resisthane Plus	S,B
	Chemical resistance	G-E	Enduro Clear Poly Topcoat	S
	Clarity	G-E	Aquazar Interior Water-Based Polyurethane	S,B
	Burn-in	P-G	Olympic Interior Polyurethane	B
	UV resistance	G		
	Repairability	P-G		
Hybrids The newest type of water-based finishes, they combine the warm tones, clarity, penetration, and in some cases exterior protection of solvent finishes with the low odor and quick-drying benefits of a water-based finish.	Hardness	E	Target Coatings Hybrivar WB Alkyd Varnish	S,B,W
	Chemical resistance	E	Hydrocote Danish Oil Finish	S,B,W
	Clarity	G-E	Target Coatings UltraSeal-WB shellac	S,B,W
	Burn-in	P-G		
	UV resistance	P-G		
	Repairability	E		

volatile organic compound (VOC). Aromatic solvents such as toluene, xylene, mineral spirits, and various ketones found in solvent-based finishes create low-level, or ground-standing, ozone—commonly known as smog. These VOCs also cause upper respiratory problems and can aggravate asthma.

Efforts to improve air quality placed limits on the amount of VOCs a finish can contain. These restrictions, in turn, gave a boost to water-based finishes. With a few exceptions, water-based coatings also contain VOCs. But because their components contain far fewer VOCs than those in solvent finishes, it is much easier to formulate a water-based finish to comply with clean-air regulations.

In recent years, state regulations on air quality have become more restrictive than federal ones. In particular, those of southern California and a coalition of northeastern states increasingly set the parameters used when formulating finishes. For example, the national limit for solvent lacquer is 680 grams of VOC per liter, whereas the northeast limit is 550 grams, and

The right brush. *Water-based finishes are best brushed with a fine-haired, artificial-bristle artist's brush. Larger, denser brushes tend to introduce too much air into the finish, leaving bubbles on the surface.*

in southern California the limit is 275 grams. The benefit for woodworkers is that these restrictions are causing a migration to water-based finishes. As that market grows, companies are devoting more time and money into developing better finishes.

So what is a water-based finish?

To better understand water-based finishes, it helps to know what goes into them. Water-based is a generic term for coatings in which the resin is suspended in a water medium. In basic terms, a primary glycol solvent dissolves the resin, allowing it to form a crude film, and water acts as the diluent (or secondary solvent) that evaporates with the glycol as the film dries.

Two families—Water-based coatings can be either waterborne or water-reducible. Waterborne coatings start with a resin, which can be a urethane, an acrylic, or a blend of the two in a solution of water and surfactants. This is known as the crude resin. Next, glycol ethers and performance additives based on the intended use of the finish are blended in. These include leveling agents to help it flow out during brush or spray applications, defoamers to minimize bubbles, anti-scuffing agents to stop marring, and ultraviolet additives to protect the wood from sunlight.

The second group of water-based finishes is known as water-reducible coatings. They consist of oil-based resins such as tung, linseed, and castor oils, blended with alcohols, glycol ethers, and neutralizers to allow the absorption of water and create a homogenous solution of oil and water. Like waterborne finishes, these coatings contain synthetic resins and performance additives. They are sometimes referred to as hybrids.

Application is now much easier

One legacy of the early water-based finishes designed for floors is that they developed a reputation as being hard to apply. They performed well with tools used for finishing floors, but due to their low viscosity, most could not be sprayed successfully. They were also a challenge to brush, as many dried too fast or developed runs and sags. Generally speaking, water-based finish manufacturers suggest dilution rates ranging from 5% to 20% by liquid volume to help thin the viscosity of the coating or to slightly retard the drying time. However, some can be reduced more than 50% with basic tap or distilled water and will still maintain their film-formation qualities, although thinner and less protective. Refer to the specific product's technical data sheet or contact the manufacturer for the best dilution rate.

The right brush makes all the difference—Instead of large, high-volume paintbrushes designed for thick house paints, I recommend the use of fine arts and special-purpose brushes that feature shorter bristles and a thin nap. Consider such brands as daVinci's Cosmotop and Top-Acryl Series, Winsor & Newton's Athena and Monarch Series, as well as Purdy's Syntox brushes. Appropriate sizes range from 1 in. to 3½ in. wide.

Many finishes can be sanded within an hour. On most finishes, if re-coated within the first 24 hours, the next series of coats will chemically bond, or burn in, with the previous coat. But check the specific instructions on the can.

New advances in finishes for spraying—As large industrial users are restricted in the amount of VOCs they can release, water-based finish manufacturers are creating finishes for them that more closely match solvent finishes in both application and performance. With proper guidance from the manufacturer, you can switch to water-based finishes in an afternoon with minor tip size and air pressure adjustments. (For more on spraying, see "Spray-Gun Choices," pp. 60-65.)

Like solvent finishes, water-based finishes have a shelf life, in most cases about a year. Signs of a finish past its prime include gelling in the can and either a pink or greenish/blue color.

Water-based finishes for all

Woodworkers have much to look forward to as they explore the range of water-based finishes now available. As research and development continues, more and more water-based finishes will successfully replace the solvent-based finishes of the past. □

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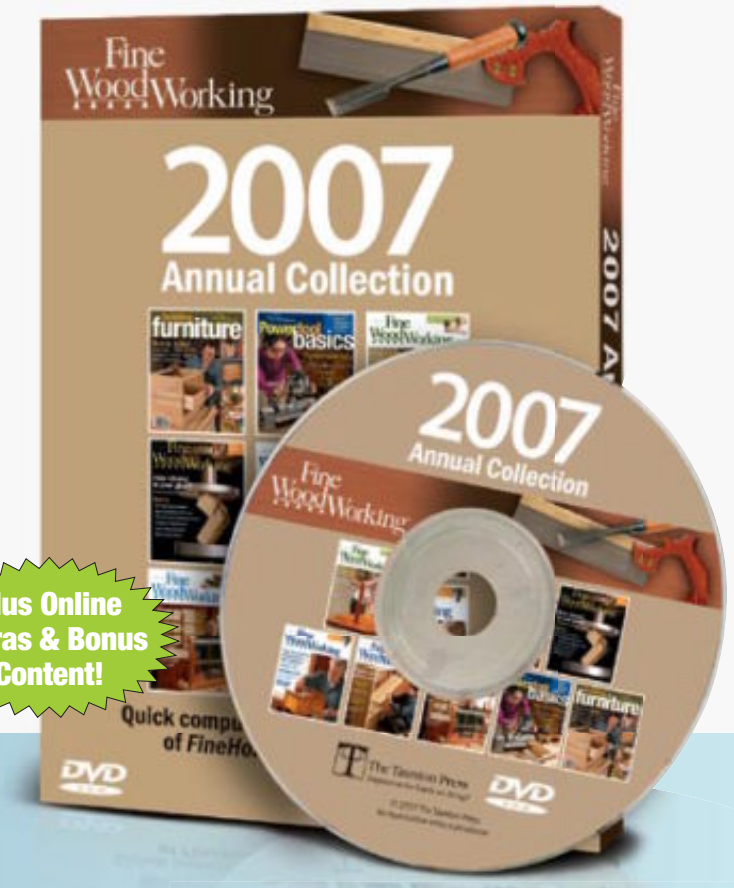

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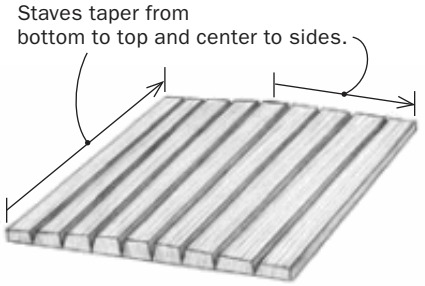
Sweeping curves

BY ANISSA KAPSALES

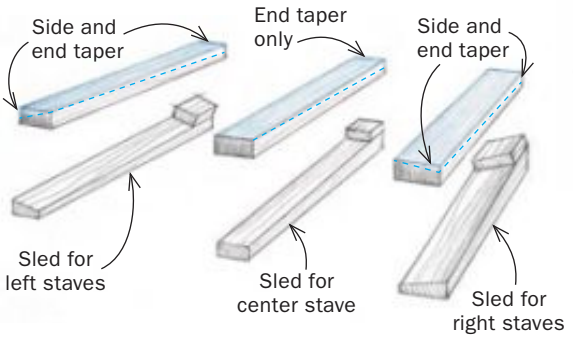
At first glance, Adrian Ferrazzutti's wenge-and-bloodwood chair (seen on the back cover) is sleek, elegant, and simple in design. Yet the chair's construction was anything but effortless. A deeper look reveals a coopered seat and backrest, compound angled joinery with wedged tenons, and twisted, tapered bent laminations. The coopering on the seat is straightforward, but Ferrazzutti felt that the backrest needed to be thinner at the edges and incorporate a taper—or two. If he were making one chair, it might have been quicker to just use hand tools. Ferrazzutti's set of 10 chairs meant power tools and a variety of associated jigs.

Coopering the backrest



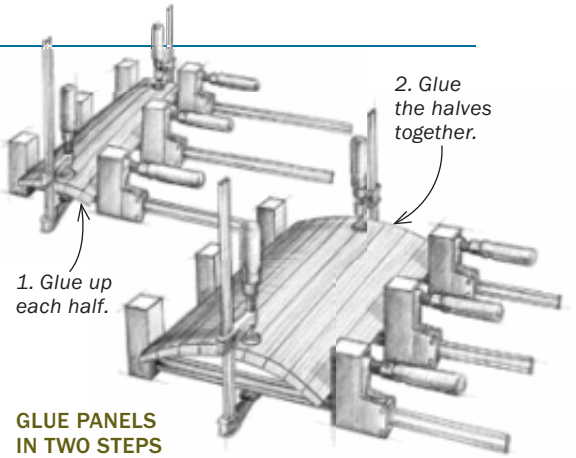
TWICE-TAPERED STAVES

The center stave tapers only along its length, but the staves to the left and right have varying degrees of taper across their width as well. The edges are beveled prior to tapering.



A TRIO OF SLEDS FOR TAPERING

Ferrazzutti uses three planer sleds to accomplish the double taper. One sled, with a taper along its length, is for the center stave. The other sleds are tapered side to side as well as along their lengths.



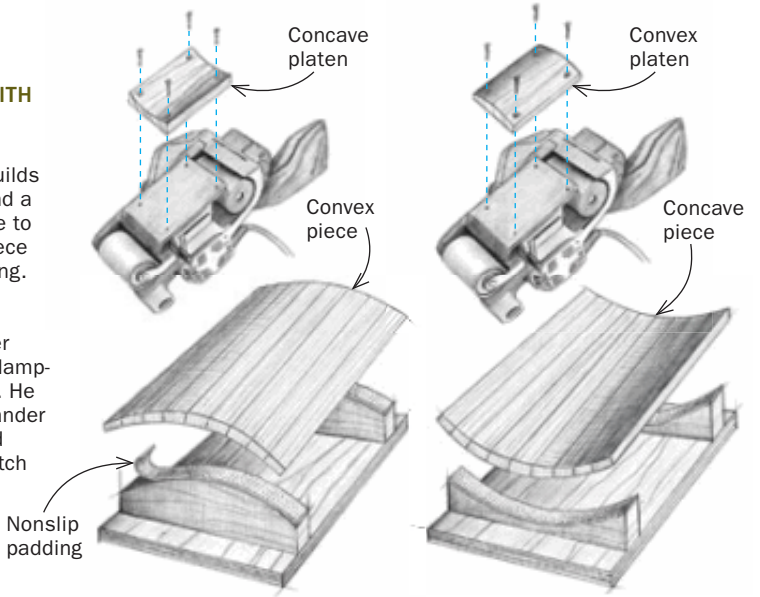
GLUE PANELS IN TWO STEPS

Working on half of the assembly at a time, Ferrazzutti uses bar clamps to secure the staves. Once dry, he glues the halves together.

Sanding curved panels

CURVED SANDING CRADLES WITH PLATENS TO MATCH

Ferrazzutti builds a concave and a convex cradle to hold each piece for beltsanding. He lines the cradles with nonslip router matting for clamp-free sanding. He outfits his sander with a curved platen to match each cradle.



MOVING THE BELT SANDER

Working with the curved-bottom belt sander, Ferrazzutti begins to sand side to side in a pendulum motion across the grain while slowly moving the sander up and down with the grain. He then sands lengthwise with the grain, removing any scratches, and does a final cleanup by hand with a curved sanding block.

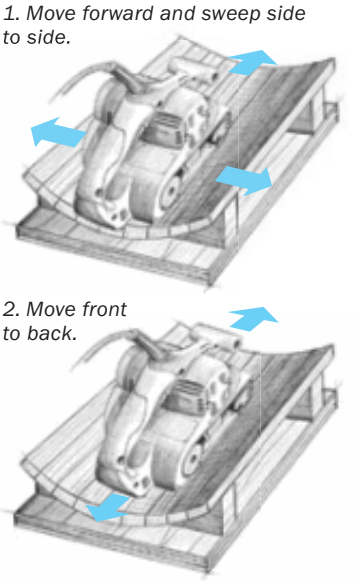


Photo: Ray Pilon; drawings: John Tetreault

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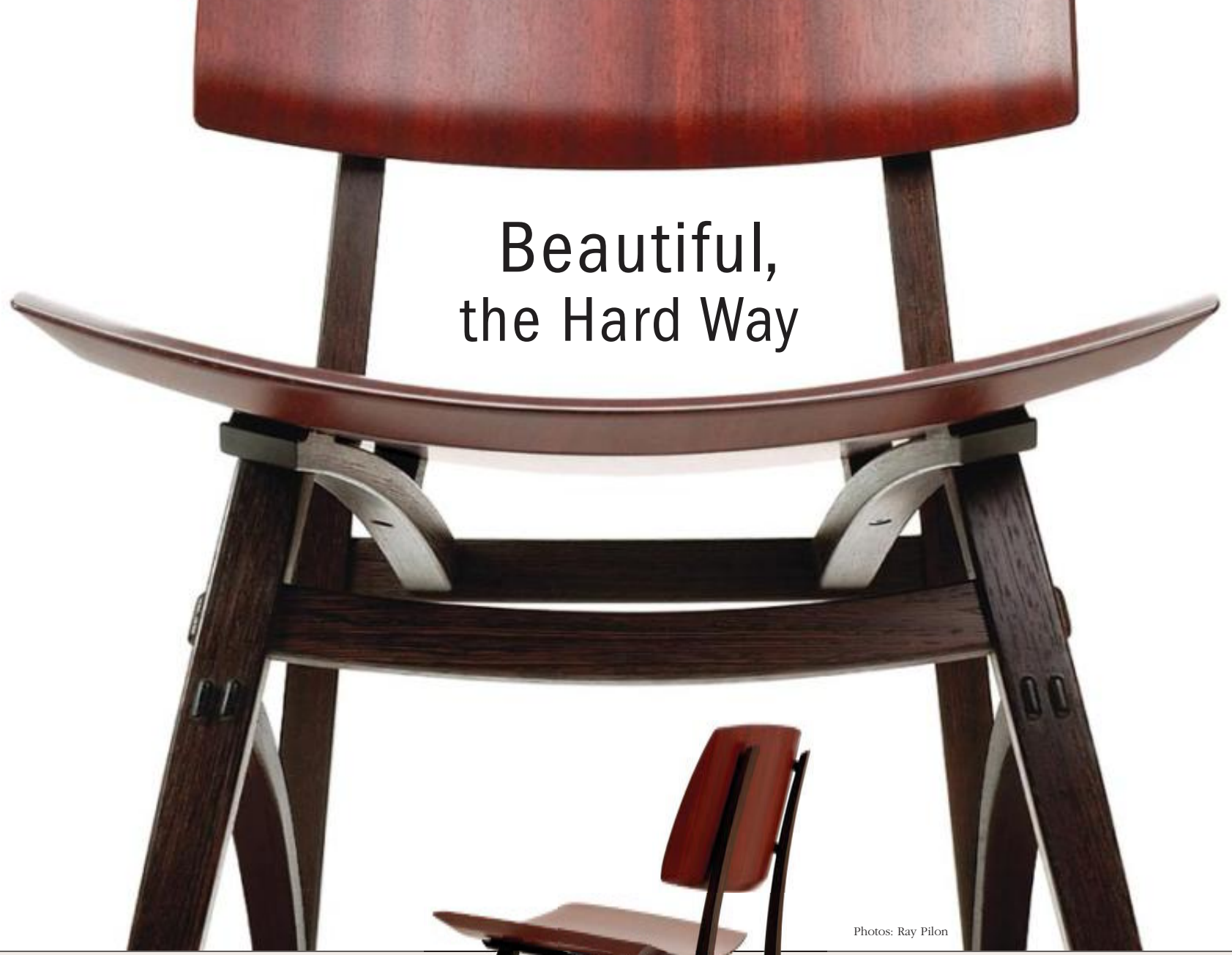

Photos: Ray Pilon

Ontario furniture maker Adrian Ferrazzutti is drawn to a clean, modernist style, so for the solid-wood seat and back of this chair, he borrowed from the mass-produced, bent-plywood chairs designed by Charles and Ray Eames in the 1940s. But he is equally attracted to small-shop craftsmen like Wharton Esherick, whose chair made of hickory hammer handles provided inspiration for the structure of this chair.

Ferrazzutti grew up watching his grandfather carve animal sculptures from limbs and antlers, and got his grounding in furniture making from an English shop teacher who was trained as a cooper. Ferrazzutti's education culminated with two years' study under James Krenov, who taught him to consider his designs from 360°.

To develop the design for this chair, commissioned as a set of 10, he dispensed with drawings and made a series of prototypes by bandsawing curved parts out of 2x4s and hot-gluing them together. In the finished chair, the seat and back are coopered from solid bloodwood, and the spare curves of the wenge structure are tapered bent laminations. To make all the curving members meet smartly, six of the parts—the back legs, the side rails, and the side stretchers—had to twist as well as curve and taper.

As Ferrazzutti says with a wry laugh, "I like very complicated work that looks simple when it's done."

—Jonathan Binzen

How They Did It Turn to p. 112 to see how Ferrazzutti constructed the tapered, coopered back and seat of this chair.

Pro Portfolio For a gallery of work by Adrian Ferrazzutti, go to FineWoodworking.com/extras.