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Fine WoodWorking

Low-cost lumber:
12 great choices, p. 67

Who makes the best vise?

Dust-proof any tablesaw

Tough topcoats for outdoor furniture

Build a classic Morris chair

Soup up your miter gauge

4 clever drawer stops

June 2009 No. 205

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Fine WoodWorking

MAY/JUNE 2009 ■ ISSUE 205

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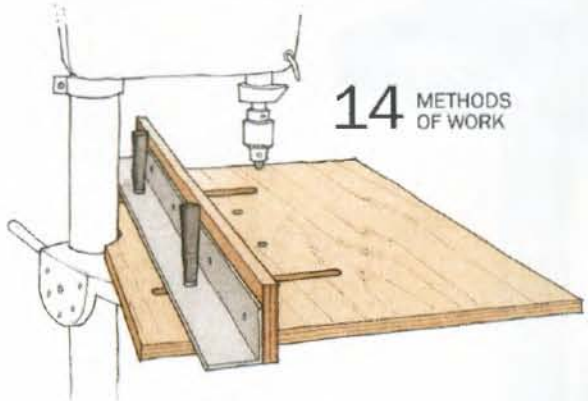
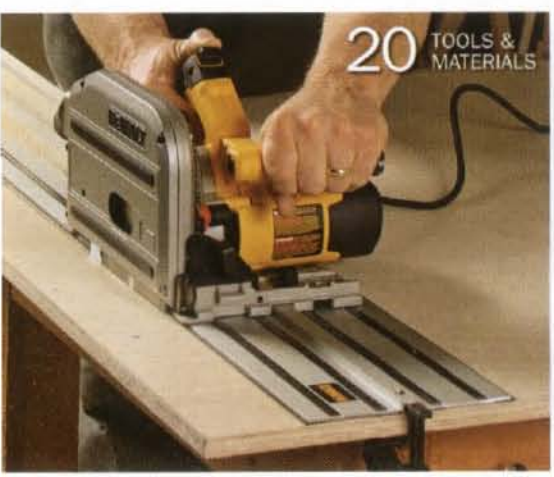


up front



features

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in the back

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on the web

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Visit our Web site to access free Web tie-ins, available April 16. While you're there, don't miss the collection of totally free content, including tool reviews, an extensive project gallery, and must-read blogs.

ARTICLE

Finish Recipe: Arts and Crafts Look Without Harsh Chemicals

Gregory Paolini ("Build a Bow-Arm Morris Chair") mimics the look of a traditional Stickley finish without fuming the piece using industrial ammonia.

VIDEO

Hot-Pipe Steam-Bending

Watch Michael Fortune (Master Class) demonstrate an easy way to bend wood using a shopmade device.

GALLERY

Share Your Work to Win a Prize

Join one of our monthly gallery challenges by posting photos of your work for a chance at great prizes. David Mathias of Dublin, Ohio, shared photos of his Gamble House entry table and won top honors during our recent exposed-joinery challenge.

PHOTO: DAVID MATHIAS

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VIDEOS

Build a Morris Chair

Read the article in this issue, and then watch the video workshop to see how Gregory Paolini builds this recliner, sharing expert tips and tricks along the way. It's our first ever woodworking project published simultaneously in print and on video.

Foolproof Brushing Techniques

Don't reach for a rag the next time you need to apply a finish. Grab a brush instead, and use Peter Gedrys' straightforward methods to avoid drips and sags.

Quick Tip: Edge-Jointing With a Router

Senior editor Thomas McKenna shows a jointer-free way to get an absolutely straight, square edge on a board. It's the perfect technique for panel glue-ups.

Fine WoodWorking

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contributors

It takes a shopful of woodworkers to test 14 vises. Associate editor Matt Kenney ("Bench Vises") is grateful to Dennis Fitzgerald of the School of Art + Design at Purchase College in New York for installing the vises on his benches, and for supervising the program's students (shown) as they subjected the vises to the rigors of a school shop. The students tested and used the vises for 16 weeks and then gave thorough evaluations of each. Fitzgerald (third from right, back row) also weighed in, of course.

While working as a stockbroker in California, **Richard Babbitt** *("Dust-Proof Any Tablesaw")* earned his private pilot's license with multi-engine, instrument, and commercial ratings. This in turn led to an exciting 27-year career selling private and corporate planes for Beech Aircraft. An avid woodworker, he used his knowledge of aerodynamics to solve the dust-collection problem on tablesaws.

Gregory Paolini *("Build a Bow-Arm Morris Chair")* spent the last year designing and building a new woodworking studio in the mountains of western North Carolina, with a lot of help from his wife, Ramona. He is a full-time furniture and cabinet maker, a frequent contributor to *FWW*, and occasionally teaches woodworking classes. His portfolio is online at www.paolinicrafters.com.

Mark Koons *("End Grain Up")* was introduced to the Japanese woodworking tradition in 1966, when staffing an Army evacuation hospital in Japan for casualties of the Vietnam War. Later, he spent time as an ironworker in Wyoming, where he would finally heed his call to woodworking. Koons, who also teaches the craft (www.markkoons.com), lives with his wife, Mary Ann, in Wheatland, Wyo.

When **Adrian Ferrazzutti** *("Tape: Unsung Hero of the Shop")* moved from a tiny basement shop in his house to a 4,000-sq.-ft. shared workspace, he found that he was losing too much time walking across the shop to make a single cut or pick up a tool. So he brought in his skateboard and now zips around. Ferrazzutti teaches woodworking at the Center for Furniture Craftsmanship in Maine and Rosewood Studio in Ottawa.

For more information on our contributors, go to FineWoodworking.com/authors.

We are a reader-written magazine. To learn how to propose an article, go to FineWoodworking.com/submissions.

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letters

Spotlight

ISSUE NO. 204
March/April 2009
p. 57

Rip to width. *The second edge can be cleaned and squared, and the apron cut to width, all at once at the tablesaw. Rip it concave side up, keeping the piece against the table at the leading edge of the blade. Use a splitter to keep the piece on track.*

TAKE THE GLOVES OFF

As a woodworker of many years' experience who still has both hands and all of his fingers, I winced at a recent picture showing a loosely gloved hand only inches from a spinning tablesaw blade.

I have heard many horror stories of mutilations of hands, fingers, and even forearms resulting from gloved hands being caught by spinning sawblades, drill bits, shaper spindles, and jointer blades. Our perception, and therefore our margin for safety, ends at the ends of our fingers and not at the end of a glove.

—WILLIAM SLOAN, cabinetmaker, Ann Arbor, Mich.

It is against the law in some states to wear gloves while operating rotating equipment. The glove is easily grabbed and pulled into the blade, including the fingers inside, creating a severe safety hazard risk to the operator. We had an experienced carpenter lose an index finger due to just such an exposure.

—JEFF GILSTRAP, contractor, Collinsville, Okla.

Thin-kerf blades continued

In the recent article "Thin-Kerf Blades Are for Everyone" (*FWW* #204), the author left out another significant benefit: Since the blade is 28% thinner, it should produce 28% less sawdust than a standard blade. This is reason enough for me to switch.

—CRAIG REICHERT, Moose Jaw, Sask., Canada

I have used thin-kerf blades for years with great success and no complaints about accuracy. But it is important to remind people that they will need to purchase a riving knife or splitter that is the same thickness as the blade. When I switched over to thinner blades, I had a narrow escape when a board stuck to the standard-kerf riving knife that came with my saw. Most manufacturers now offer riving knifes and splitters to match various blade kerfs.

—TIM POOR, Woodbury, Minn.

Threat to black walnut trees

I am a professor of entomology at Colorado State University, where we have discovered a new insect-carried fungus called Thousand Cankers, which poses an extreme threat to black walnut in North America. Currently we think the disease is restricted to the western United States, where it looks like it will kill all black walnuts within a decade or so; in some areas, most of the trees have already died.

It would be devastating if someone were to move a walnut log that contains walnut-twig beetles into areas where black walnut is native (much of the eastern half of the United States).

No walnut logs with bark intact should be moved eastward. Kiln-dried boards are thought to be safe, however. For more information, go to: www.ext.colostate.edu/pubs/insect/0812_alert.pdf.

—WHITNEY CRANSHAW, Colorado State University

Advice for would-be wood stackers

There is another benefit of harvesting and drying your own timber not listed in your article ("Dry Your Own Lumber," *FWW* #204), and that is access to specialty lumber such as very wide boards, thick slabs, crotchwood, book-matched boards, turning blanks, and more.

Over the past 10 years I have air-dried over 25,000 board feet, using the high-quality lumber to make the trim, floor, doors, and cabinetry for my house.

The article outlines exactly how I stack lumber except for one step. I sticker one additional layer of framing lumber on top of the pile, and then add rows of cinder blocks, centering them over the stickers. The extra weight keeps the boards on the top of the pile flat as they dry. On woods that are especially prone to movement while they dry, such as poplar, hickory, and sycamore, I tend to add a solid layer of cinder blocks.

I then cover the pile as described in the article. I have had tremendous success with this approach.

—TODD SMITH, Fairfield, Va.

YOUR TAKE

What got you started in woodworking?

28%	A relative
24%	Secondary-school shop classes
13%	TV show
10%	Economic necessity
7%	Magazines
5%	A friend
3%	Woodworking school
11%	Other

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Off to a fast start

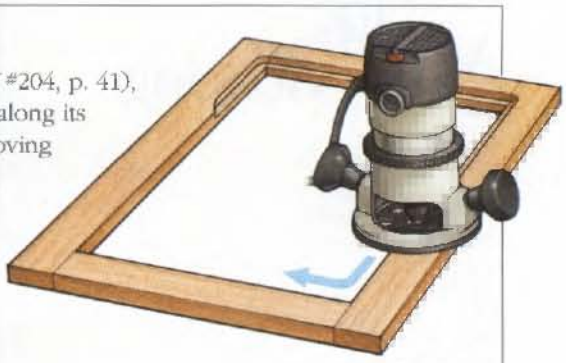
I recently retired from a 26-year career in go-kart racing, and started woodworking as a hobby. I accumulated some tools, but I really needed a workbench. A Google search led me to your free site (www.gettingstartedinwoodworking.com) with the three-part video on building a workbench. The videos were very straightforward and easy to understand.

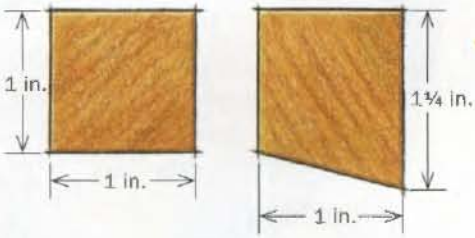
I printed out the plan and bought the vise, dogs, hold-downs, dowel-centering pins, and an assortment of clamps from our local woodworking store. I bought the lumber, MDF, threaded rod, and screws from a local home center. I built my bench over the weekend and it turned out great.

—ERIC ERICKSON, Rogers, Minn.

Correction

In "Illustrated Guide to Drawers" (*FWW* #204, p. 41), the drawing of a frame being rabbeted along its inside edge implies that the router is moving in a counter clockwise direction, which would be a climb cut. The safer way to make this cut would be in the other direction, as shown here.





Clarification

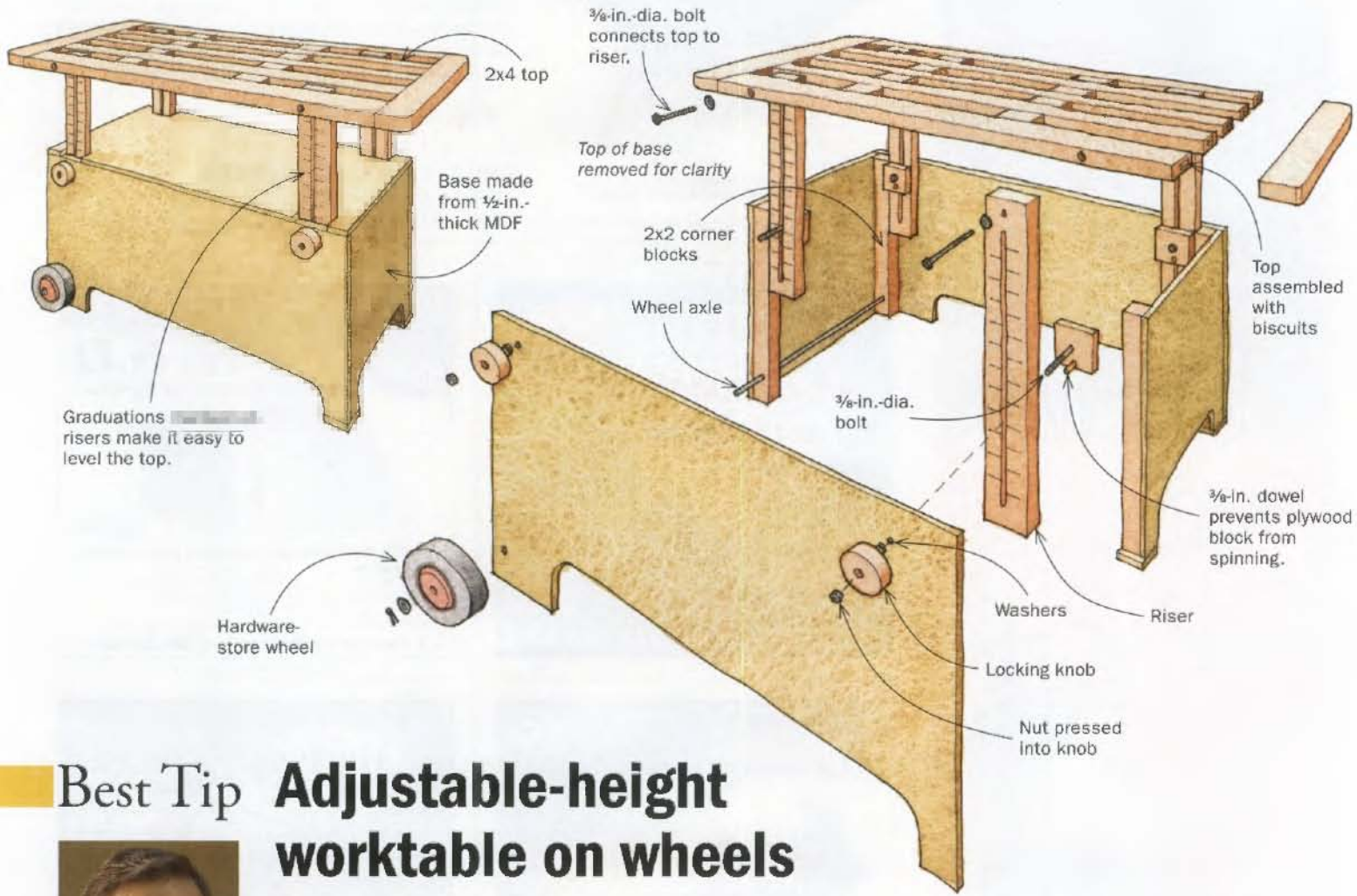
In "Build a Bow-Front Hall Table" (*FWW* #204), we failed to label the taper on the legs. See drawing at left for the footprints of the legs.

About your safety

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

methods of work

EDITED AND DRAWN BY JIM RICHEY



Best Tip

Adjustable-height worktable on wheels

Bob Belleville has been building furniture for more than 50 years. But boards from his lumber stack also have been turned into wooden cars, clocks, and even computers.

After several years and many projects, I'm still finding new uses for this worktable. The latticework top, made from 2x4s and assembled with biscuits, is a versatile aid for glue-ups and assembly work, and it can be raised or lowered as needed. I typically lower it for assembling cabinets and raise it to save my back for detail work, like cleaning up dovetails.

The top can be adjusted from 24 in. to 38 in. tall via four risers that fit through openings in the top of the base cabinet. Oversize knobs and plywood blocks lock and unlock the risers. Each knob has a captive ⅜-in. nut that connects to a ⅜-in. bolt threaded through the block and riser slot. A glued-in dowel prevents the block from pivoting in the slot. Each riser is marked in 1-in. increments to make it easy to level the top.

Clamps can be placed anywhere on the top, both vertically and horizontally, to glue up small and medium pieces or secure work for power sanding. I also clamp scrap lumber to the top to create impromptu stops and holders for speeding up repetitive work such as routing, pocket-screw joinery, or biscuit-slot cutting.

The top of the base cabinet helps prevent the cart from racking and provides a temporary resting place for tools and hardware. A pair of hardware-store wheels on a simple ½-in. axle makes it easy to move the table wheelbarrow style.

—BOB BELLEVILLE, Los Altos, Calif.

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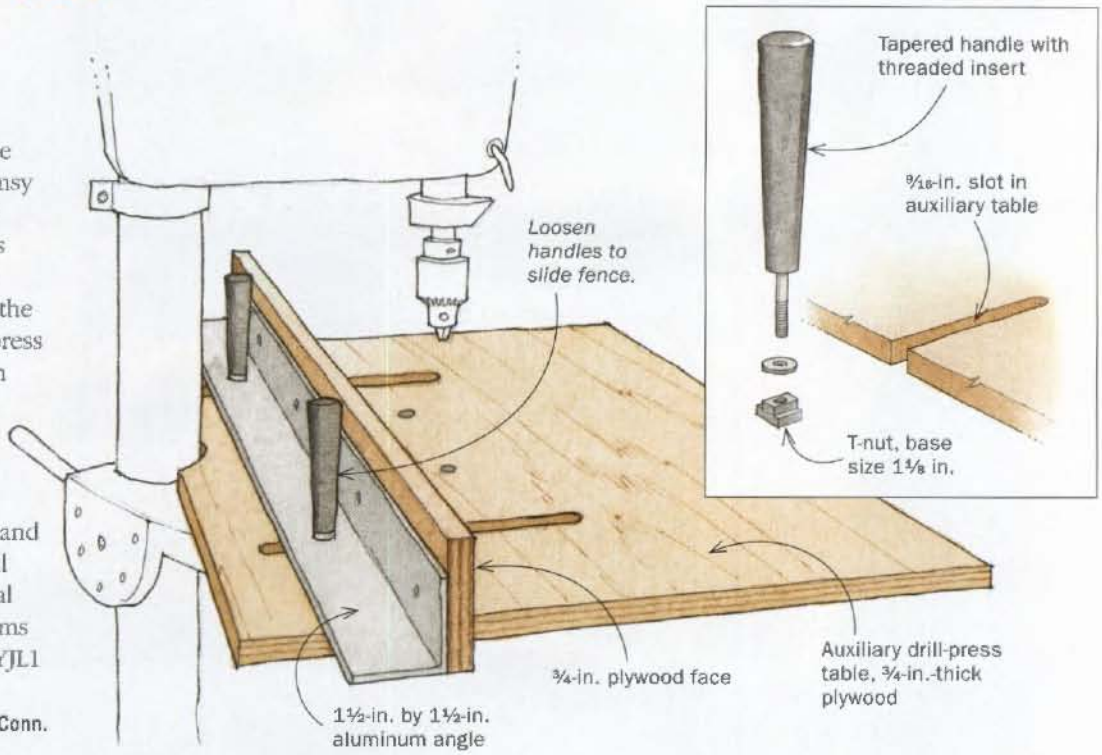
Easy drill-press fence

This quick-to-make drill-press fence is a big improvement over the clumsy strip of wood and two clamps that most of us use. The fixture consists of a ¾-in.-thick plywood auxiliary table and a movable fence. Attach the auxiliary table to the regular drill-press table—arrangements will vary from drill press to drill press. Make the fence from a length of 1½-in. by 1½-in. aluminum angle faced with plywood. The fence adjusts via two slots in the plywood table and locks in place by tightening vertical black handles that engage industrial T-nuts below. You can get both items at www.grainger.com: items No. 2YJL1 (T-nuts) and No. 4X501 (handle).

—DAVID M. GROSZ, Stamford, Conn.

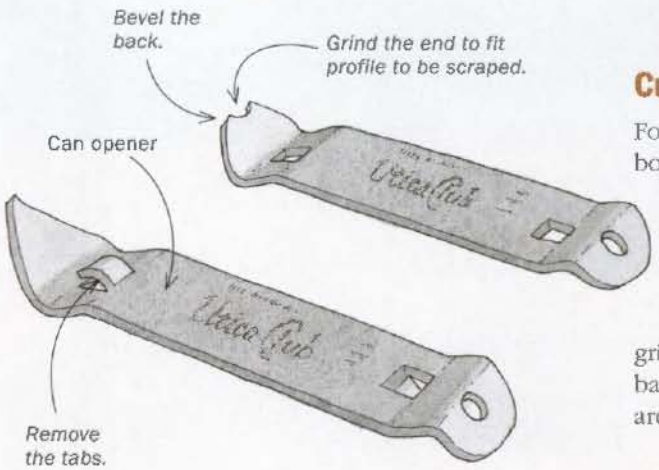


Custom scraper from a bottle opener

For many years I have been making scrapers from can and bottle openers (sometimes called church keys). I grind the ends of the openers to custom shapes for restoring antiques and scraping odd-shaped trim; they're also great for scraping glue out of tight corners. I have more than 50 different shapes that I use over and over again.

To make a scraper, I first snap off the little tabs. Then I grind the pointed end to fit the project at hand, beveling the back of the blade slightly. The curved ends of the openers are just the right angle for efficient scraping.

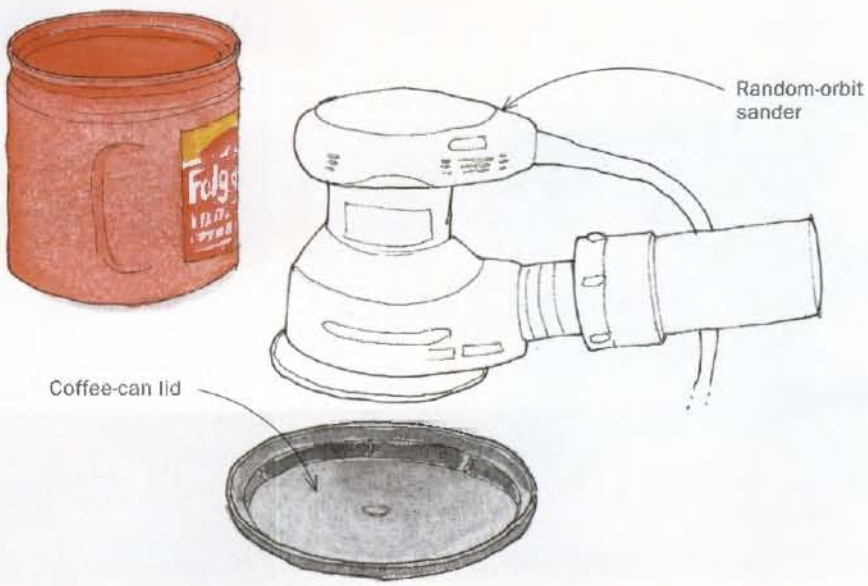
—JOHN H. MASON, Boise, Idaho



Cheap landing pad for sanders

Some time ago I purchased a fancy landing pad for my 5-in. random-orbit sander, but I wasn't very happy with it. I've since replaced that accessory with the plastic lid from a 39-oz. coffee can. I can set the sander down immediately after using it, and the lid will spin until the sander has come to a stop. You can't argue with the cost.

—JON MUNSTOCK, Chama, N.M.



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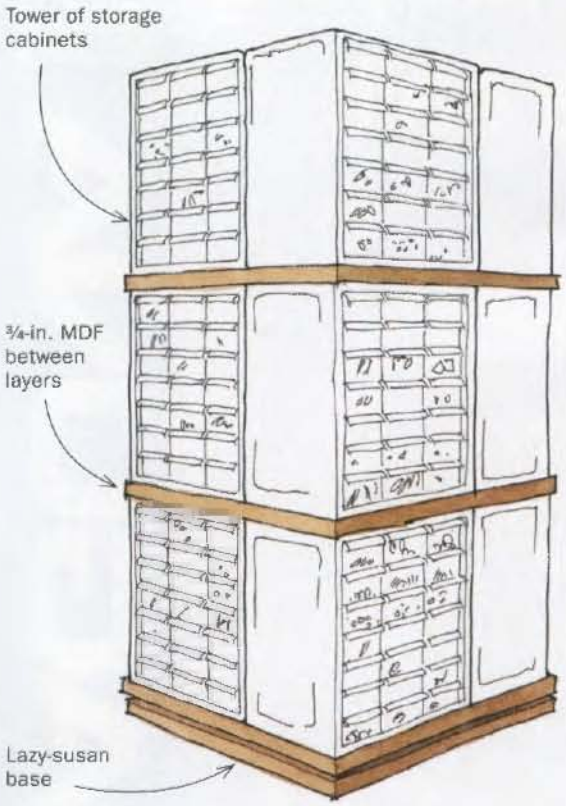
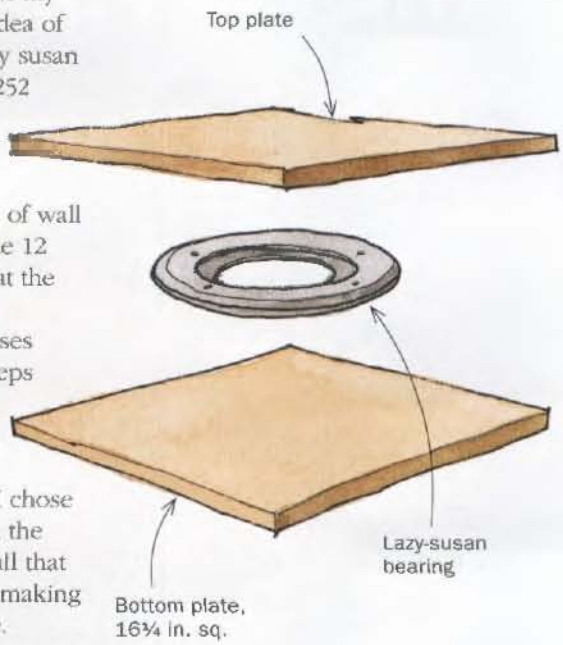


Rotating tower stores more hardware in less space

While rethinking the efficiency of my workshop, I came up with the idea of building a tower on top of a lazy susan to manage 12 cases containing 252 small drawers full of screws, nuts, bolts, and other hardware. Before I built the tower, the cases ate up 15 sq. ft. of wall space. With this arrangement, the 12 cases take up less than 2 sq. ft. at the end of the countertop.

I simply stack the layers of cases on ¾-in.-thick MDF. Gravity keeps them in place, but if you have doubts, you could hold them with a nonskid material or double-faced tape. I chose 12-in.-dia. lazy-susan hardware, the largest I could find to support all that weight. The tower spins easily, making every drawer instantly available.

—SERGE DUCLOS, Delson, Que., Canada



tools & materials

■ POWER TOOLS

Plunge-cut saw makes straight, clean cuts

DEWALT HAS ENTERED THE PLUNGE-CUT CIRCULAR-SAW ARENA with the introduction of its DWS520. Working in conjunction with a track, this saw makes straight, clean cuts with a minimum of fuss. Festool introduced this class of tool a few years ago and I soon wondered how I managed to get along without one.

Tracks for the DeWalt are sold separately and are available in three lengths: 46 in., 59 in., and 102 in. The saw also has a riving knife that retracts when you need to plunge the saw.

There are a few key differences between the DeWalt and the Festool. The plunge-action is fussier on the DeWalt: You have to place both hands on the back handle and apply pressure directly over the blade. On the other hand, the DeWalt can cut on both sides of its track, meaning you won't have to spin the long assembly around when working. Both saws make very clean cuts.

Forced to pick between the Festool and DeWalt, which are both excellent tools, I'd choose the Festool. It's lighter, easier to plunge, and has a better blade-changing mechanism.

The DWS520 sells for $500, the same price as the Festool T55EQ. Plan to pay extra for the track: $80 for a 46-in. length, $100 for a 59-in. length, and $230 for a 102-in. length. Go to www.dewalt.com for more information.

—Mark Edmundson builds furniture in Sandpoint, Idaho.

Accurate cuts with kickback insurance. *There are zero-clearance plastic inserts on both edges, for near-splinter-free cuts, and the riving knife (left) reduces the chance of kickback.*

■ WOOD TURNING

A better turning caliper

TYPICALLY, WHEN TURNING A SPINDLE with several diameters along its length, you need to constantly reset a caliper to check those critical dimensions, a tedious and time-consuming process. Or you need several calipers, each preset to a different diameter. Windsor chairmaker Peter Galbert has come up with a better way: a caliper that has a built-in, easy-to-read scale that measures any diameter from ½ in. to 2½ in. while the work is spinning. In fact, the caliper can be held in one hand and pressed against the back of the spinning wood while a parting tool is held in the other hand, cutting the wood until the desired diameter is reached. I found the caliper to be pretty much foolproof, as did a number of other turners who tried it. The Galbert Caliper sells for around $80. For more information, go to www.petergalbertchairmaker.com.

Measure as you turn. *With the caliper behind the workpiece, you can read the diameter as you turn.*

—Andy Barnum teaches wood turning at the State University of New York at Purchase.

Photos: staff

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READER SERVICE NO. 111

■ DUST COLLECTION

Compact dust collector is powerful and efficient

DELTA HAS ADDED A NEW PLAYER to its dust-collection roster. It gets you plenty of power in a lightweight, compact, easy-to-roll-around package. It also has a 1-micron bag, better than the 5-micron or 30-micron bags found on many other collectors.

Model 50-720 features a 1-hp, 10.8-amp induction motor that, according to Delta, moves air at the rate of 650 cubic feet per minute (cfm) at the collector port. This places the machine between a shop vacuum and the standard 1½ hp collectors reviewed in *FWW* #183. This model's capacity is enough to move dust and chips into the collector as long as you keep the hose length to under about 10 ft. (it comes with a 5-ft. hose) and connect the dust collector to only one dust-producing machine at a time. I hooked it up to a 13-in. planer, and it collected over 95% of the chips.

The Delta 50-720 sells for around $300. For more details, go to www.deltaportercable.com.

—Tom Begnal is an associate editor.

Roll-around convenience. *Delta's new 1-hp dust collector rolls from one machine to another with little fuss.*

■ BLADES

Sanding sawblade makes smooth cut

A TABLESAW BLADE THAT CUTS AND SANDS AT THE SAME TIME? That's a blade I had to try. The product, called Final Cut, is a 10-in., 40-tooth tablesaw blade with a 9-in.-dia., 100-grit self-adhesive sanding disk mounted to each side. To test the effectiveness of Final Cut, I crosscut and ripped some 5/4 cherry. The cuts were excellent. For comparison, I made the same cuts in cherry using a recently sharpened Forrest Woodworker II blade. The Final Cut blade produced smoother rip- and crosscuts than the Forrest. As a final test, I cut about 70 linear ft. of ¾-in. birch plywood to find out how long the disk would last. The quality of the final cut was almost as good as the first, and still better than the Forrest.

By the way, when using Final Cut, make sure the blade height is such that the perimeter of the sanding disk extends above the thickness of the stock. If it doesn't, the cut won't be fully sanded.

The 10-in. blade (with disks mounted) sells for $65; replacement sanding disks are available. For information, go to www.finalcutblade.com.

—Bob Nash is the shop manager at *Fine Woodworking*.

Cut and sand. *A Final Cut sanding disk on each side of this blade produced smooth cuts both ripping and crosscutting.*

■ ACCESSORIES

Ratchet action speeds up bandsaw tension adjustment

MOST EXPERTS AND MANUFACTURERS recommend releasing the blade tension when a bandsaw is out of use for more than a day. Blade changes also require releasing and re-tensioning the blade. The new Accuright Ratchet-Rod speeds up those adjustments considerably and makes them a lot easier on your hand and wrist. The kit fits most traditional-style 14-in. bandsaws with a cast-iron frame, replacing the factory tension screw, nut, and handle with an ACME-threaded rod and nut for easier rotation. Topping the assembly is a removable ratcheting knob. To change ratchet direction, you just flip a lever on the bottom of the knob.

Replacing the factory equipment takes less than five minutes. Major adjustments go very quickly, and the contoured knob fits the hand comfortably. The Ratchet-Rod has become a welcome addition to my bandsaw. It sells for $50 and is available from Carter Products (www.carterproducts.com).

—Roland Johnson is a contributing editor.

Better tension adjuster. *The knob on this aftermarket tension adjuster has a ratcheting action, so your hand doesn't have to work as hard.*

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READER SERVICE NO. 23

Miter-gauge basics

HOW TO GET THE MOST FROM THIS STANDARD TABLESAW ACCESSORY

BY STEVE LATTA

Not long after you set up your first tablesaw, you'll find yourself reaching for one of woodworking's most common and useful accessories—the miter gauge.

Standard equipment with every tablesaw, a miter gauge is the tool many beginners use to make their first crosscuts.

With a miter gauge, you can accurately cut workpieces to length with square ends and make a variety of angled cuts, including those for mitered corners. As you progress in your woodworking, you'll probably add a crosscut sled to your tool kit (see Fundamentals: "Build a simple crosscut sled for the tablesaw," *FWW* #188), but you won't outgrow the miter gauge.

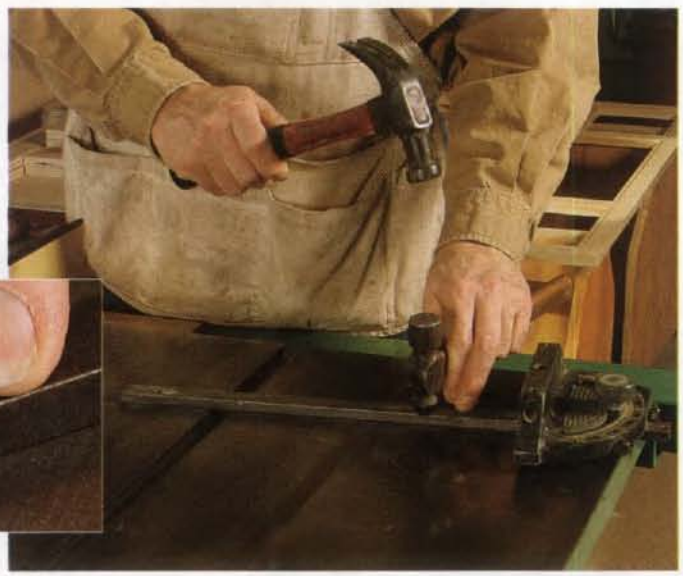
Setting up the gauge

The miter gauge consists of a bar and an adjustable head with a knob to lock the adjustment. The bar fits in the slots in the saw table that run parallel to the blade. Look for a sturdy aluminum headstock and an unobtrusive locking knob with a secure and comfortable grip.

Attaching an auxiliary fence will help brace the stock against the blade's tendency to push

Setup

Don't assume the stock miter gauge is ready to use as is. It needs some help.



Check the sliding action first. *If there's too much side-to-side play, peen the bar to dimple a corner and widen it slightly.*

Attach an auxiliary fence. *This is a must because it supports longer pieces and reduces tearout. Latta uses ¾-in. thick, 3-in.-wide MDF.*

Set the gauge for a square cut. *If the blade and slot are parallel, you can use a known 90° reference to orient the gauge to the blade.*

Check the results. *After setting the gauge to 90°, make a test cut. The cut surface should be square to the edge you held against the fence.*

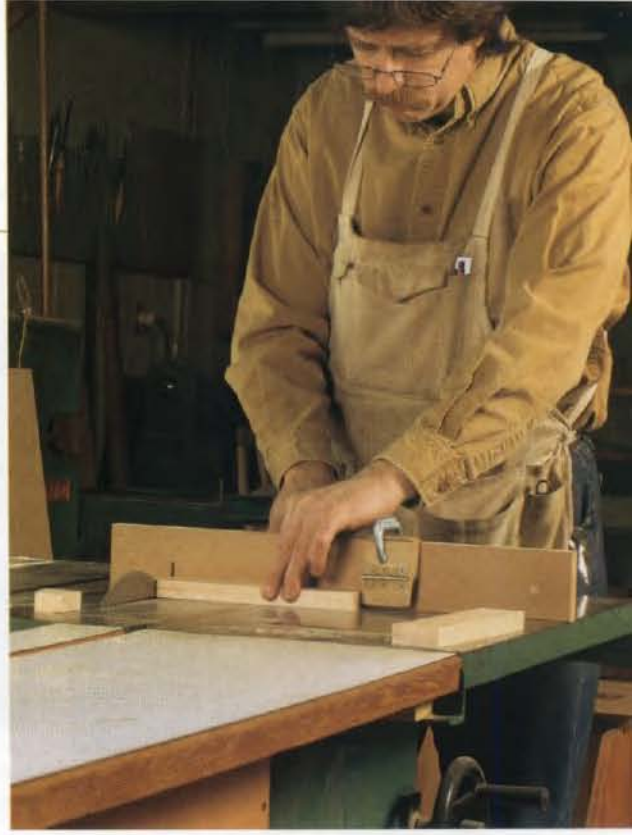
Photos: Steve Scott

Stop blocks

The stop block is an age-old way to cut multiple workpieces to the same length without measuring again and again.

A hinged block is nice. *It lets you trim both ends of a board without changing the setting.*

Using the hinge. *With the block flipped up, trim one end square (above). Then butt the square end against the block and cut to length (right). Cutting multiples will be quick and accurate.*



back toward the user and cause it to pivot on the corner of the gauge. The fence should be tall enough to retain its strength when the blade passes through it. Extending the fence 1½ in. or so past the blade will help you safely push short cutoffs beyond the blade.

The preset angle stops on most miter gauges are rarely accurate. To set for 90°, put the gauge in the slot upside down and, with the lock knob loosened, slide the head up flat against the rip fence rail and tighten the knob. If the saw is properly set up, that should do it. Check it once with a drafting triangle to make sure it is accurate.

Making a basic crosscut

To make a 90° crosscut, simply hold the stock against the miter-gauge fence and push the gauge through the cut. To avoid pinning the stock to the table and to keep your hands a safe distance from the blade, apply downward pressure only over the gauge's steel bar. After completing the cut, be sure to move the stock off the gauge and away from the blade before sliding the miter gauge back. This avoids the chance that the blade will catch, and throw, the workpiece during the return stroke.

You can work to a simple pencil mark, but a stop block makes it easy to crosscut multiple pieces to the same length. My block is hinged and designed to work with my 3-in.-tall auxiliary fence. A small piece of ¼-in. plywood fastened at the top of the block keeps it about ⅛ in. off

For longer work, a longer stop block. *A hooked block, held in place with a pair of clamps, works for even the longest workpieces.*

For short cutoffs, a standoff fence. *If you use the rip fence as a stop, short pieces can get trapped between the fence and blade. So butt the workpiece against a standoff stop, clamped to the rip fence well in front of the blade.*

Two gauges run side by side. *One sits in each slot; together they support a long fence.*

Two gauges can be better than one

Cut accurate dadoes. *The twin-gauge setup works well for making cuts across the middle of a long workpiece. Used miter gauges are inexpensive and easy to find at flea markets or online.*

the saw table. This gap prevents dust buildup, which can hinder accuracy. The plywood also keeps the stop perpendicular to the table. If a stop block is clamped at an angle, there will be discrepancies in length between pieces of different thickness. When crosscutting, hold the workpiece tight against the fence and stop block.

A second gauge adds versatility

I always have one or two extra miter gauges around the shop. They are handy for dedicating to a specific task or for using in tandem to support a long fence for crosscutting longer workpieces. A crosscut sled is better, but this arrangement is a good substitute. A twin-gauge setup also supports an L-shaped fence for making specialized cuts such as dentil molding, finger joints, and knuckle joints.

A tip for angled cuts

When setting up for an angled cut, it's important to set the gauge so that the leading end of its fence points toward the blade. If the trailing end of the fence is closest, the force of the cut tends to pull the stock into the body of the blade. This leads to burn and tearout when the blade exits.

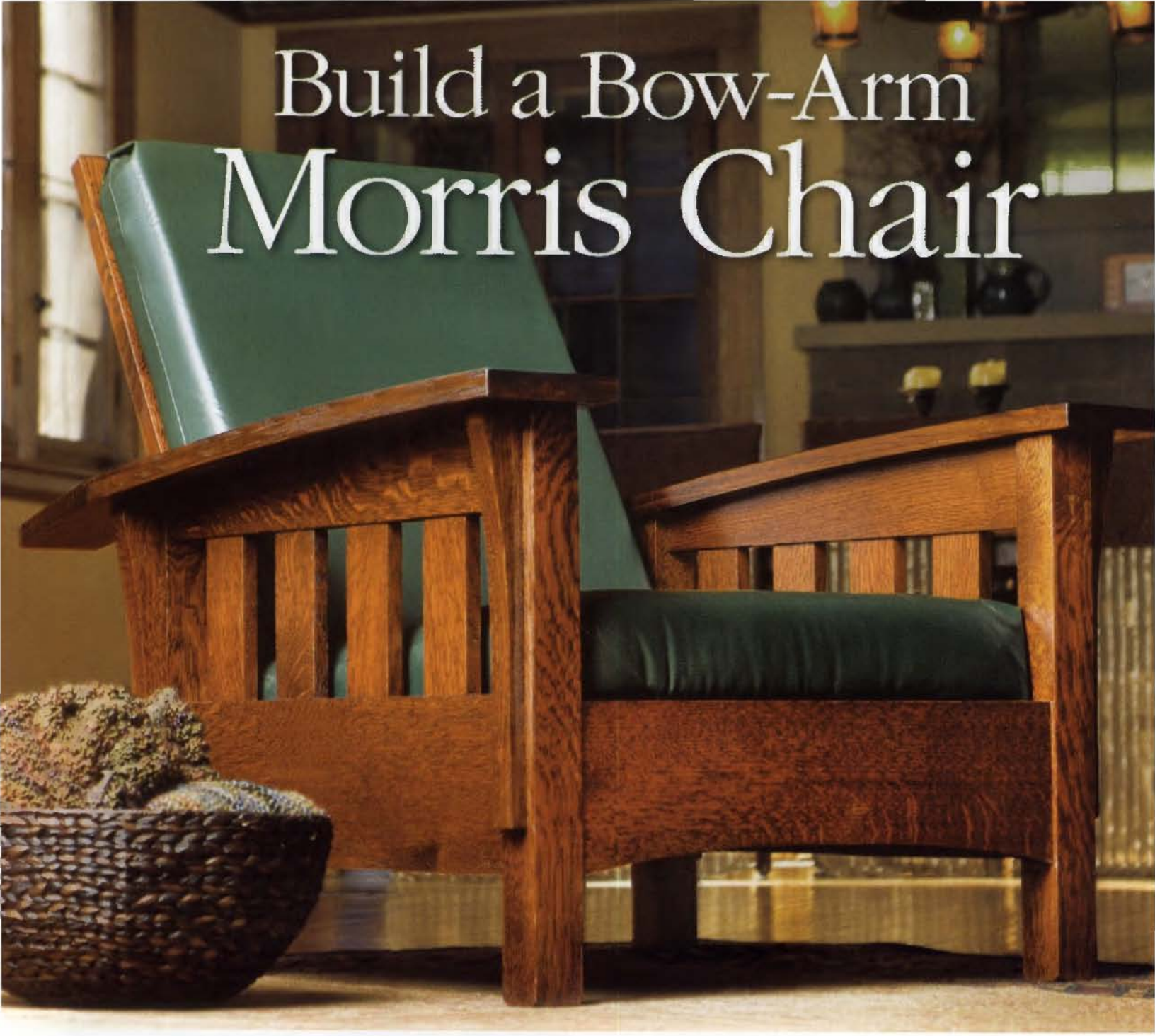
And if a stop block were used, the angle would tend to pull the stock away from the block. Also, the auxiliary fence should stop at the blade so the scrap from the cut does not get pushed onto the back of the blade. □

Add an L-shaped fence for small work. *The fence helps prevent tearout in small work like this dentil molding. The sawkerf in the fence also helps locate cuts in the workpiece. To make the fence, screw a 2-in.-wide strip of ½-in. MDF to the bottom edge of a ¾-in. piece.*

Make precise miters

Setting up an angled cut. *Use a pair of drafting triangles to set the gauge for a 45° cut. Also be sure the triangle is against the body of the blade and not a tooth, and set the gauge so the leading end of its fence points toward the blade.*

Build a Bow-Arm Morris Chair



Lamination puts beautiful grain and a graceful curve within arm's reach

BY GREGORY PAOLINI

Craftsman furniture is known for its straight lines, quartersawn oak, and sense of earthen mass and solidity. No piece displays those features better than a Morris chair, with its large, square legs and wide arms decked out in beautiful ray-fleck figure. The gracefully bowed arms of this version, based on a design by Gustav Stickley, lighten the mass just enough to give it the feel of irresistible comfort. Throw in a reclining back and firm, but giving, cushions, and you have a chair that you'll never want to leave.

For the most part, the construction is straightforward. But the most distinctive part of the chair—its arms—presents two big challenges: making bowed arms with attractive grain, and cutting a mortise-and-tenon joint on the curved arms and side frame. I'll show you how laminating the arms gets you around those challenges. And I'll show you how to

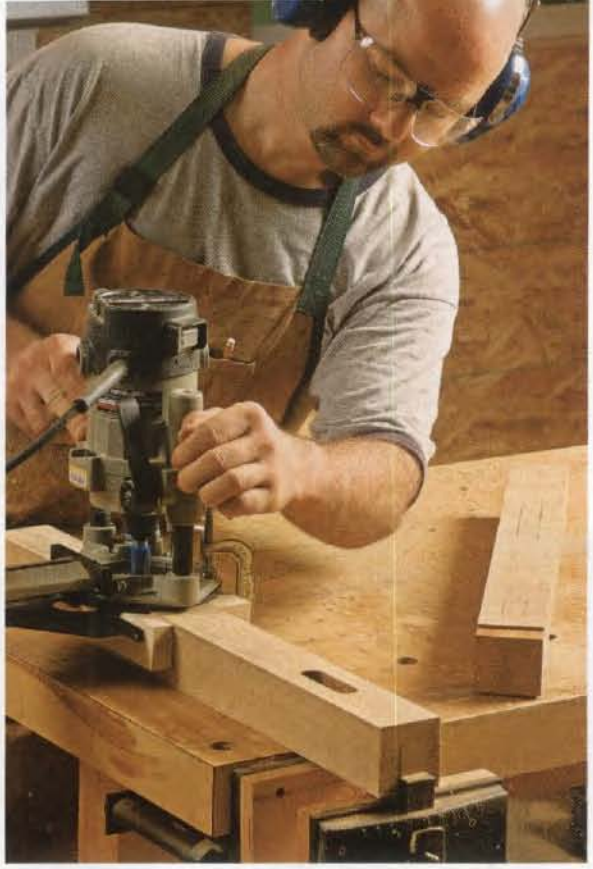
Photo, this page: Keith Wright; drawings: Bob La Pointe

ARTS & CRAFTS RECLINER

Bowed arms and beautiful quartersawn oak stand out on this Craftsman classic. All the joints are mortise and tenon, which makes this a chair that will last.

TIPS FOR ACCURATE JOINTS

Every joint in this chair is a mortise and tenon, the traditional Craftsman joint. They must fit well to get a square and strong chair. Here's how to cut the joints accurately with two common tools: a router and a tablesaw.



Start with the right bit. *When routing mortises, Paolini matches the straight bit's diameter to the mortise's width so he doesn't have to move the router side to side and risk tilting it out of square. Two fences (one the router's edge guide; the other clamped on) keep the router on track.*

get striking quartersawn grain everywhere it counts, including a simple and authentic method for making a leg with four quartersawn faces.

Legs that look good from every angle

The legs of a traditional Morris chair have four quartersawn faces. Lumber like that doesn't grow on trees, but it can be made in the shop. There are several different methods to achieve the look, but the one Stickley used, which is the easiest by far, is to glue up a core of quartersawn lumber and then laminate two quartersawn veneers over the flatsawn edges of the core.

After the glue is dry, trim the veneers flush to the core with a router and flush-trimming bit. Then crosscut the bottom of each leg to square it up. Don't worry about the tops right now.

Mortises, then tenons

When making a mortise-and-tenon joint, I usually start with the mortises. It's much easier to fit a tenon to a mortise than the other way around. You can cut all of the mortises now, except the four in the arms. They're laid out and cut after you make the tenons on the tops of the legs.

Remain consistent with your reference edges. When cutting the mortises on the legs, for example, reference the same fence against the outside face of each one. Otherwise, the position of the mortises will vary, resulting in sloppy joints and possibly a chair that's out of square.

Now cut all of the tenons, except those on top of the legs, at the tablesaw. Cut a full tenon on the back of the upper rail; you'll just saw away part of it later.

Router-cut mortises have round ends, so I round the tenons with the rasp portion of a Nicholson 4-in-hand file. Its smooth edges

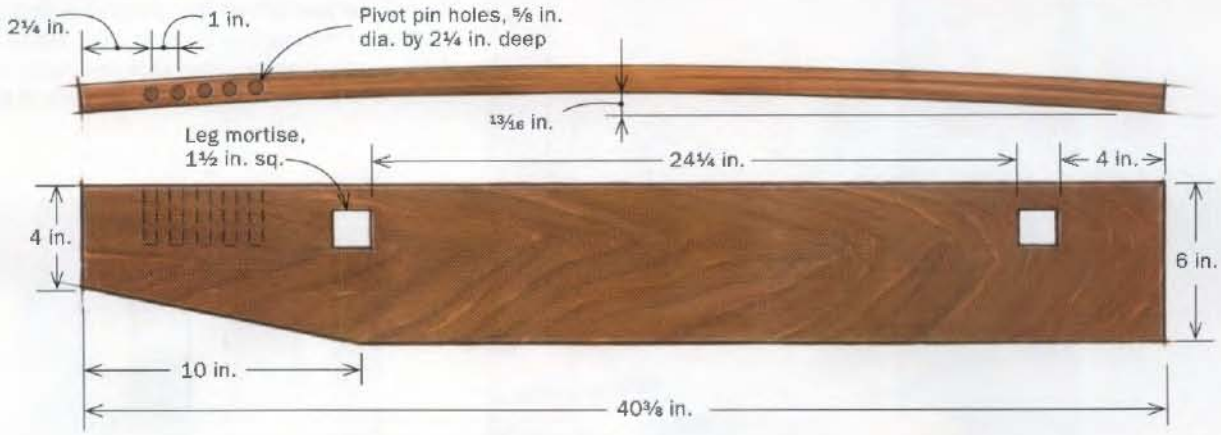
Double the parts for stable routing. *Thin pieces, like the side posts, don't provide a stable surface for a router. Clamp two or three of them together to get a wider bearing surface.*

Tenons at the tablesaw. *First, cut the shoulders a hair deeper than the cheeks using a combination blade. Then, use a dado set to cut the cheeks. Support the piece with the miter gauge.*

Photos, except where noted: Matt Kenney

HOW TO LAMINATE THE ARMS

The bow of the arms needs to match the curve cut onto the upper rails and legs. Use a full-scale drawing of the arm's profile to make the bending form and you'll get a great fit.



Resaw the plies. *Start the cuts on the tablesaw and use the kerfs to guide the bandsaw blade as you finish the cut freehand.*

Build the form layer by layer. *Make the first layer at the bandsaw, cleaning it up with sandpaper. Glue and screw on each successive layer and rout it flush.*

Finish the form. *Screw a melamine fence to the rear of the form and a stop to its front edge. Packing tape keeps the glue from sticking to the form and stop.*

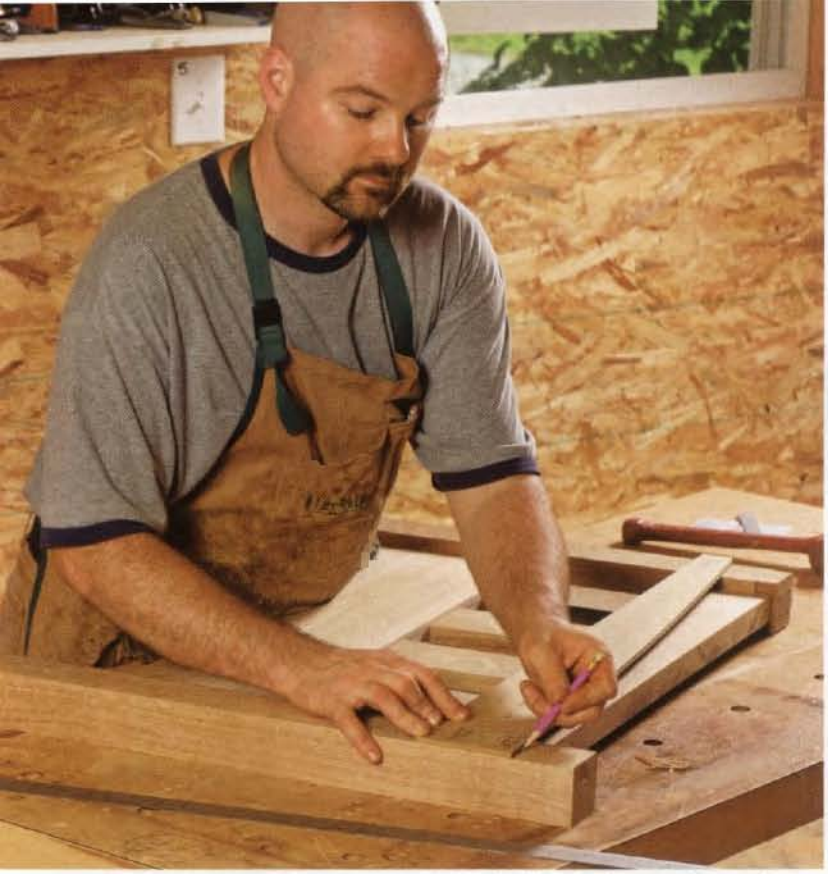
won't mar the tenon shoulders, and its aggressive teeth make quick work of the rounding.

The tenons on the lower side rails will interfere with those of the front and back stretchers where they meet inside the legs. The best way around this is to insert the side rails into their mortises and trace the front and back mortises onto them. You'll need to trim the tenons' thickness about ⅛ in. in those areas.

Drawing brings arms and legs together

The upper rail and the tops of the legs must be curved to match the bow of the arms. The easiest way to do this is to make a full-size drawing of the arm's profile. You'll use this drawing to make a pattern for marking the curve on the upper rails and legs and to make the bending form used to laminate the arms. Here's an easy

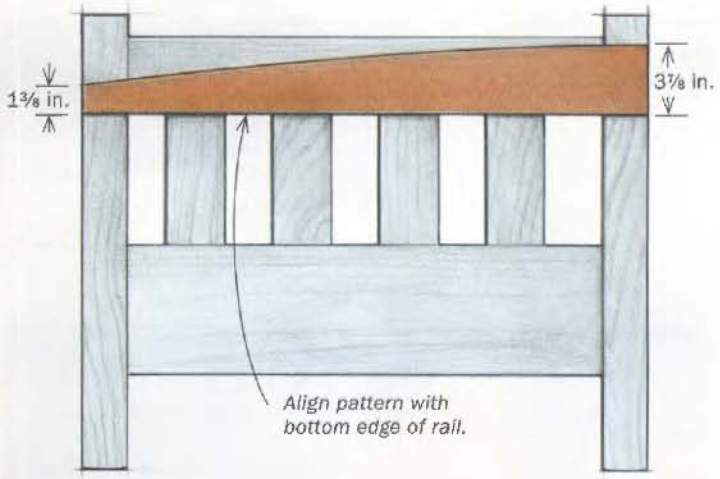
Clamps, clamps, clamps. *After coating the plies with glue, press them against the stop and fence. Add a flexible caul on top and start clamping next to the stop. Work progressively down along the form. Place a clamp every 2 in. You'll need two dozen.*



Mark the curve. *With the sides dry-fitted, align the bottom of the rail pattern with the bottom of the rail and mark the curve on the legs. This locates the tenon's shoulders on the legs. Then disassemble the sides, realign the pattern on the rail, and mark its curve.*

SAME PATTERN FOR THE SIDES

The hardest part of building this chair is fitting the arms to the sides. The tops of the upper rails are curved, and so are the tenon shoulders. Make a pattern of the upper rails and use it to mark the curve. It's easier to align and hold in place than one of the arms.



way to make the full-size drawing of the profile. Spring a batten between two nails located at both ends of the arc. Push the center of the batten up to the high point of the arc and trace the line.

To make the pattern for marking the curve on the legs and upper rail, use graphite paper to transfer the arm's profile (see drawing, p. 35) to a piece of MDF. Cut the curve on the bandsaw and use files and sandpaper to smooth it.

Laminated arms are a cut above

Because the bowed arms are so prominent in this design, the figure and grain that shows on the top of each arm must be just right. Arms sawn from solid lumber would have a wild, distracting grain pattern. But laminating the arms allows you to control their look, choosing your best stock for the top and orienting it for the best effect. A laminated arm is also more stable than one cut from solid lumber, and concerns about short grain weakness disappear.

Laminating form keeps plies in line—Bent laminations can be tricky, but they don't need to be. A fence and a stop on the form keep the plies aligned, and a simple caul applies even pressure over them. Using the right kind of glue will prevent the plies from creeping after you remove them from the form. Start by making a laminating form. First, transfer the arm's profile to a piece of ¾-in.-thick MDF. The pattern for marking the curve won't work here, because the arms are longer than it.

Cut close to the line of the curve on a bandsaw and sand or file down to the line. You need eight ¾-in. layers to get a form 6 in. wide. Use the first layer to make the remaining seven.

Screw a fence to the side of the form and a stop to its front end. They will keep the plies aligned as you glue up the arms. Cover all of the working surfaces with packing tape to prevent glue from sticking to them.

Cut the tenons. *Start by cutting the shoulders square. Cut the cheeks with a dado set. Then chop and pare away the waste with a chisel as shown to define the curved shoulders.*

VIDEO WORKSHOP

Watch Paolini build this project from start to finish in a members-only video at FineWoodworking.com/extras.

MORTISE THE ARMS

The most accurate way to locate the arm mortises is to mark directly from the leg tenons. That way, you're not guessing where they should be.

First, cut arms to size. *After scraping the glue from one edge and jointing it, rip the arm to width with the concave side up. Crosscut the arms to length, using a sled and small shim to get a square cut.*

Low-stress resawing—It takes a finely tuned bandsaw to resaw wide lumber. To make things easier, I begin resawing at the tablesaw and finish up at the bandsaw. The tablesaw removes most of the material and its kerfs help me guide the bandsaw blade through the arm. After resawing all of my laminates to 5/16 in. thick, I plane them to ¼ in.

The right glue for laminations—The best glue for laminating curved parts is urea formaldehyde. It has a long open time and doesn't creep once dry. Those benefits outweigh its longer drying time. It is, however, a known carcinogen, so wear gloves and use a respirator or work in a well-ventilated area.

I use a piece of whiteboard for a caul, because it bends well and is glue-resistant. Available at home centers, whiteboard is ⅛-in.-thick Masonite covered on one side with white thermofoil.

Once both arms are laminated, scrape the glue from one edge, joint it, and rip the arm to width on the tablesaw, concave side up. Then cut the arm to length using a crosscut sled and a shim to get a square cut on the end.

Curved arms mean curved sides

To mark the curve of the arm on the upper rails and legs, dry-fit the side assemblies together. Align the bottom of the pattern with the bottoms of the rails. The ends of the pattern will align with the outside edges of the front and rear legs. Mark the curve on the inside and outside faces of the legs. And mark the inside of the legs on the pattern so you can realign it to mark the rail. Disassemble the side, and mark the curve there, too.

Cut the curve on the upper rail on the bandsaw. When you do this, the back tenon will be cut down to its final width. To cut the tenons on the legs, first use a combination blade to cut all four shoulders square to the leg, in line with the highest shoulder (the one of the front of each leg). Then use a dado set to cut the

LOCATE AND CUT THE MORTISES

1. *Lay the side assembly on your bench and stand an arm on the tenons, flush against their shoulders. The front mortise is 2 in. from the front edge. Use that measurement to align the arm before transferring the tenon locations to the arm. Lay out the underside, too.*

2. *Now clamp the arm in a vise so the mortise area is level and use a Forstner bit to remove the waste. To avoid tearout, go halfway from one side, flip the arm, and complete the cut from the other side.*

3. *Use a chisel to chop away the remaining waste and square the corners. As you did when drilling, go halfway from one side and finish up from the other.*

ASSEMBLE THE BASE

Glue up the base before making the back, so you can take measurements for the back directly from it.

Work in stages. *Assemble the sides first (right). The slats don't need glue if they fit snugly. Glue the rails to the legs and leave the clamps on overnight. Next, glue up and clamp the stretchers. Attach the arms (below), brushing glue on them and on the leg tenons. Leave the clamps on for 24 hours.*

cheeks. To cut down to the curved shoulder lines on the sides and back of the leg, use a chisel and mallet. I back-bevel the shoulders to ensure a tight fit with the bottom of the armrests.

Through-tenons require careful layout—Dry-fit and clamp the side assemblies in preparation for cutting and fitting the arm mortises. Then clamp an assembly on the bench, inside face down with the tenons overhanging the edge. Set the arms on the tenons and press them snug against the shoulders. Mark the fronts and backs of the mortises directly from the tenons. Remove the arms and mark the mortise sides. Use a Forstner bit to remove most of the waste from the mortises, then pare down to the lines with a chisel. Next, chamfer the tenons that come through the arms. Cut them ⅜ in. proud of the arms and bevel them at 15°.

After the arms are fit and the tenons chamfered, lay out and drill the holes for the back support pins. A drill press will ensure that they're perpendicular. Be sure to bore the holes before cutting the outside back corner of the arm.

While you're at the drill press, drill the holes for the pivot pins in the legs.

Shape corbels to fit the arms

With the arms temporarily in place, you can fit and attach the corbels. I make a pattern for the corbels, mark out four, and cut them out at the bandsaw.

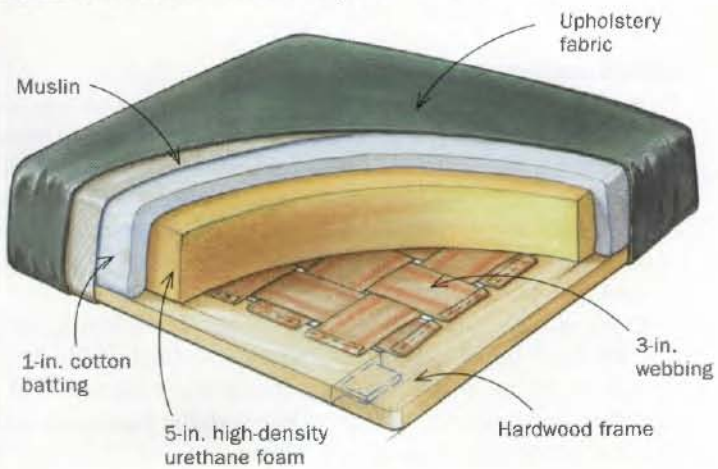
The front and back corbels are the same length, but they hang down lower on the rear legs because of the arm's curve. The corbels are centered on the legs, and their tops need some shaping for a snug fit against the bottom of the arm. After they're shaped, predrill them and the legs for screws, and use a Forstner bit to create a countersink for the screw head. Put a bit of glue on the corbels and screw them in place. Plug the countersinks with shopmade tapered plugs to get a good grain match.

Next, cut the arc on the front stretcher, and screw the seat-frame cleats to it and the back stretcher. Then glue up the base.

Over and under. *After stapling four courses of webbing across the frame's opening, weave webbing through them to create a strong but comfortable base for a cushion.*

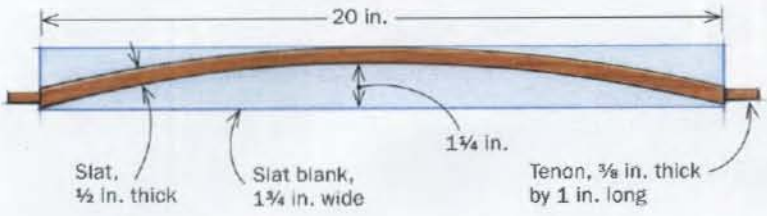
CUSHION ANATOMY

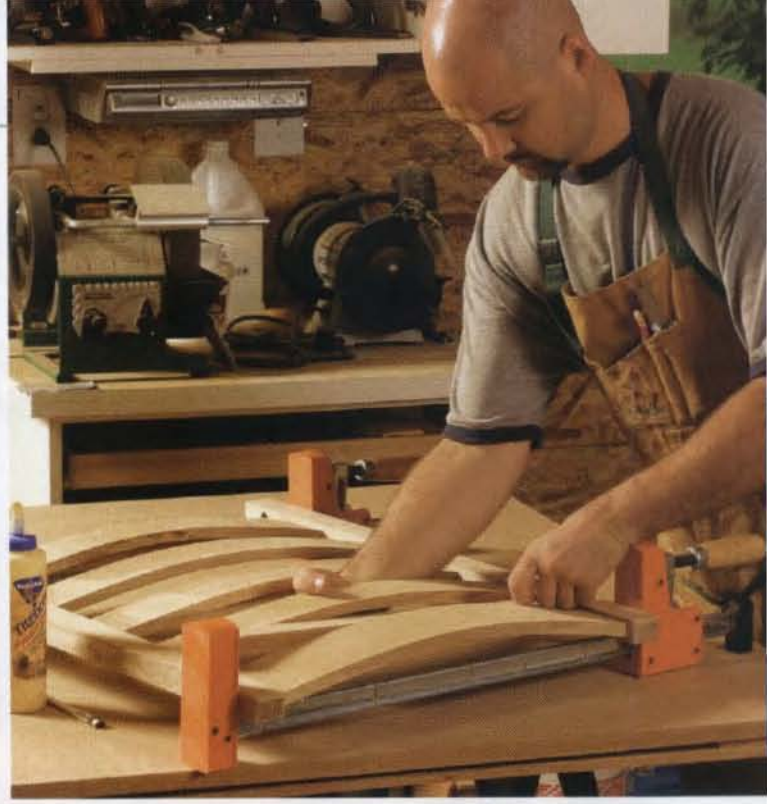
Ask your upholsterer to make a layered cushion like this one. It's firm and durable yet comfortable.



THEN MAKE THE BACK

Cut the tenons before shaping the slats. Using a half-pattern to mark the curve of the slats will ensure that they're symmetrical.





Cut the slats. *Bandsaw and smooth the curves after cutting the tenons. Because the slats are curved, they tend to flex a little under clamping pressure. Hardwood spacers limit the force of the clamps.*

After the glue dried, I made a hardwood frame with webbing for the seat cushion because I sent this chair to an upholsterer, and a hardwood frame is better than the plywood frame some upholsterers use. I used ash to make the frame, joining the parts with mortise-and-tenon joints. The length and depth of the frame should be ¼ in. undersize to allow room for upholstery to be wrapped around the sides and stapled to the bottom.

Back slats: Tenon the curve

I cut the tenons on the back slats at the same time as the other tenons because it is much easier to cut tenons on a square piece than on a thin, curved piece. Use a pattern to lay out the curve and then cut it at the bandsaw. I cleaned up the sawmarks with a stationary belt sander, but a spokeshave or sanding blocks also works.

Authentic look without the fumes

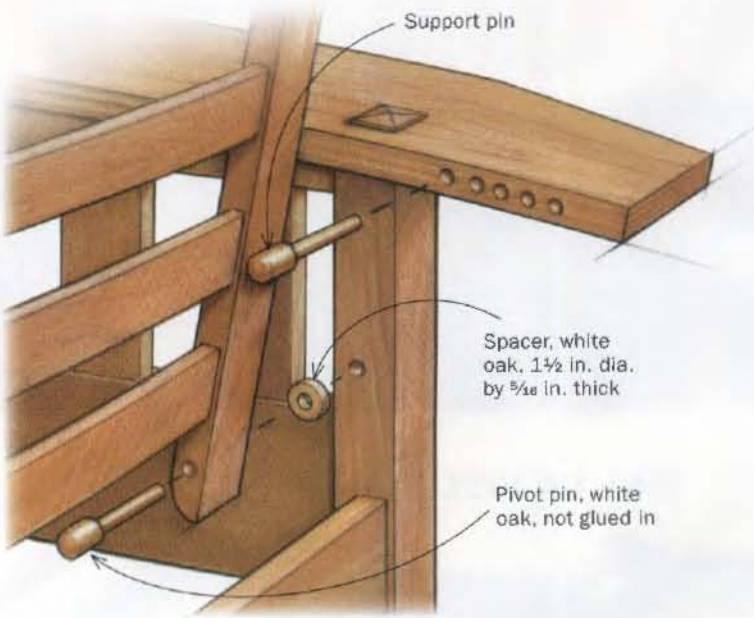
Stickley's furniture is well-known for its rich brown finish, which can be had by fuming with industrial ammonia. But you can forgo the ammonia and still get a great finish. After sanding this chair, I applied an antique cherry aniline dye. I let it dry overnight and then applied a dark walnut oil-based pigment stain. I finished it off with Minwax Polycrylic water-based polyurethane.

When the finish is dry and the upholstery done, bring your chair into the house, put it in a welcoming spot, and take a moment to enjoy its grace and beauty. Then take a seat—and maybe a nap—to enjoy its comfort. □

Online Extra

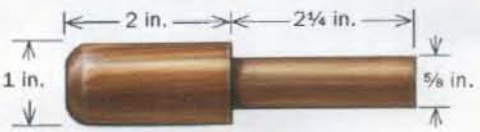
For the complete finishing recipe, go to **FineWoodworking.com/extras.**

Gregory Paolini makes Arts and Crafts style furniture in Waynesville, N.C.



PIVOT AND SUPPORT PINS

Even a novice can turn these pins. Check the diameter of the shaft with a ⅝-in. open-end wrench. Use a gouge until you're close, and finish up with sandpaper.



SUPPORT PIN

PIVOT PIN

TOOL TEST

14 Bench Vises

A head-to-head look at the tool everyone needs

BY MATT KENNEY

VISE OR VISE HARDWARE?

There are two basic choices. *Cast-iron vises (left) can be used right out of the box and give you the option of adding wooden jaws. With vise hardware (right), you'll need to make and install wooden jaws.*

My woodworking improved dramatically after I installed a vise on my bench. With a vise to hold my work, I could mark and cut accurate dovetails, plane square edges, and rout profiles without the board sliding all over.

That's why I'm convinced that a bench vise is as important as any tool in the shop. Whether you use power tools, hand tools, or both, a good bench vise will help you work more accurately, efficiently, and safely.

A bench vise is meant to hold your work securely. A good vise not only does that well, but also opens and closes easily, has jaws that clamp squarely to the stock and hold it tight, and is versatile enough to

Photos: Matt Kenney

handle a variety of woodworking tasks. A bad vise doesn't hold boards tight, or has a nut that pops off the threads when you tighten the jaws.

Narrowing the field

It wouldn't be practical to test every vise available, so I focused on front vises, because they are the first serious vise woodworkers buy and can be the only type they'll need. Front vises are not difficult to install and they can be used as end vises. All have a screw between two guide bars, but there are two types. You can buy a fully assembled cast-iron vise, which includes metal jaws, or simply the vise hardware, which supplies the screw and guide bars. You supply the wooden jaws.

Both types have their advantages. Vise hardware is less obtrusive, because there is less visible metal and the jaws can be made to match your benchtop. Cast-iron vises are easier to install and most have a built-in benchdog.

When I had the option, I chose quick-release models, because slowly winding a vise open to plane a drawer or use the built-in bench dogs isn't efficient or fun.

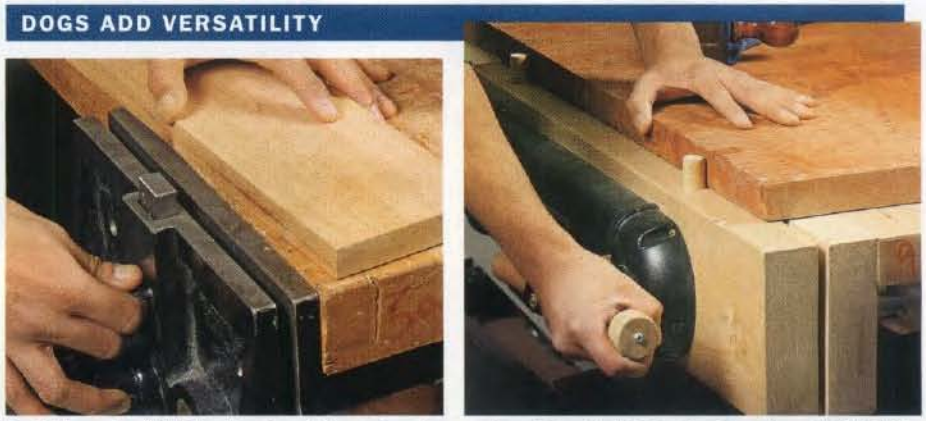
We also tested two twin-screw vises. One model was discontinued, so we're publishing only the results for the Veritas model. Like the other vises, it can be used as either a front vise or an end vise. Though it doesn't have the quick-release feature, it can clamp stock vertically in the center of

Features to consider

QUICK RELEASE IS FASTER

Trigger finger or twist of the wrist. *On trigger-release vises (left), a lever near the handle drops the nut so the outer jaw slides quickly to where you need it. This style is based on the iconic vises by Record. On some quick-release vises, a quarter turn releases the nut (right).*

DOGS ADD VERSATILITY



Built-in or build it in. *Most cast-iron vises have a benchdog built into the front jaw (left). With vise hardware (right), you add a dog hole (or two) to the wooden front jaw.*

CAN YOU LIVE WITH RACKING?

Easy fix. *Some vise jaws pivot and lose their grip when a piece must be clamped in only one side of the vise. The solution is to clamp a scrap of the same thickness at the other end.*

No fix needed. *Kenney was surprised to find that some vises racked very little. He could tighten the jaws enough to hold a board for dovetailing and not have the board shift at all (above left). On the Veritas vise, you can place a wide board between the two screws (below left), and the vise applies clamping pressure equally.*

Cast-iron vises

VISE NAME	SUPPLIER (PRODUCT NUMBER)	STREET PRICE
Anant 52½ ED	www.highlandwoodworking.com (199302)	$140
Groz 9-in. Quick Release	www.highlandwoodworking.com (199152)	$110
BEST VALUE Groz 9-in. Rapid Action	www.woodcraft.com (148437)	$100
Jet 9½-in. Quick Release	www.southern-tool.com (WMH708569)	$194
BEST OVERALL Jorgensen Rapid-Acting Bench Vise	www.woodcraft.com (16T52)	$155
Medium Quick-Release Steel Bench Vise	www.leevalley.com (10G04.12)	$145
Rockler Workbench Vise	www.rockler.com (33487)	$140
Shop Fox 9-in. Quick Release Wood Vise	www.japanwoodworker.com (66.252.5)	$72
Wilton 79A	www.southern-tool.com (WMH63218)	$250

ANANT 52½ ED

GROZ 9-IN. QUICK RELEASE

BEST VALUE GROZ 9-IN. RAPID ACTION

JET 9½-IN. QUICK RELEASE

BEST OVERALL JORGENSEN RAPID-ACTING BENCH VISE

its jaws, making it easier to dovetail wide boards. That's a compelling benefit.

To put these vises to the test, each one had to be used daily for a variety of tasks, and they had to be compared side by side. I needed help and found it in the School of Art + Design at Purchase College in New York. Dennis Fitzgerald, who oversees the woodshop there, installed the vises in the shop, and the students used and abused them for a semester on tasks such as dovetailing, planing, carving, and working on shaped parts. Fitzgerald and I also did our own testing, and weighed in on the results.

Note that the vises were used heavily for hand-tool work, which puts the most stress on a vise. Any vise that stands up to sawing and planing should be fine for machine work like routing and drilling. The students benefited, too. These vises were a big improvement over the old ones in their shop. And every vise was donated to the school by the manufacturer or supplier.

The makings of a good vise

We don't ask vises to do much, but there are features to look for other than the ability to clamp wood securely. There's an easy fix for vises that rack (see p. 41), but the less you have to deal with racking the better. We checked for racking by clamping a board vertically on one side of the vise and measuring how far out of parallel the jaws were on the other side.

Also, check the vertical alignment. The jaws should clamp squarely to the stock from top to bottom. Because the screw is at the bottom of the vise, the bottom tends to pull in as pressure is applied. To compensate, the moving jaw on cast-iron vises should be canted in slightly at the top. (With vise hardware, taper the front jaw so it's slightly thicker at the top.)

There are two types of quick release: trigger and twist. I recommend a twist-release

QUICK RELEASE	JAW WIDTH	OPENING CAPACITY	EASE OF USE	RACKING	VERTICAL ALIGNMENT	COMMENTS
Yes, lever	9 in.	12¾ in.	Poor	0.05	Good	Quick-release nut doesn't re-engage well.
Yes, lever	9 in.	9 in.	Good	0.05	Excellent	Low-quality plastic benchdog in front jaw.
Yes, twist	9 in.	13 in.	Excellent	0.09	Excellent	Must add wooden front jaw to get a benchdog.
Yes, lever	9½ in.	9½ in.	Good	0.06	Excellent	Release lever is not easy to operate.
Yes, twist	10 in.	12 in.	Excellent	0.04	Excellent	Steel benchdog moves easily and stays in place once set.
Yes, twist	9 in.	13 in.	Good	0.13	Good	Doesn't open and close smoothly.
Yes, twist	9 in.	13 in.	Good	0.08	Excellent	Doesn't open and close smoothly.
Yes, lever	9 in.	10¼ in.	Good	0.08	Excellent	Paint chipped easily.
Yes, twist	10 in.	13 in.	Good	0.06	Very good	Quick-release nut doesn't re-engage immediately.

MEDIUM QUICK-RELEASE STEEL BENCH VISE (LEE VALLEY)

ROCKLER WORKBENCH VISE

SHOP FOX QUICK RELEASE WOOD VISE

INSTALLING A CAST-IRON VISE

Just bolt and go. *If necessary, install a spacer under the benchtop to keep the top of the jaws just below the top of the bench.*

Get more with a long jaw. *Mortising a long wooden jaw over the rear jaw makes it easier to clamp wide and long boards.*

WILTON 79A

Vise hardware

ECONOMY QUICK-RELEASE FRONT VISE (WOODCRAFT)

LARGE QUICK-RELEASE FRONT VISE (LEE VALLEY)

VISE NAME	SUPPLIER (PRODUCT NUMBER)	STREET PRICE
Economy Quick-Release Front Vise	www.woodcraft.com (145444)	$87
Large Quick-Release Front Vise (AUTHOR'S BEST VALUE CHOICE)	www.leevalley.com (Large, 70G08.10)	$140
Quick-Release Front Vise	www.woodcraft.com (17A11)	$215
Rockler Quick-Release End Vise	www.rockler.com (37180)	$180
Veritas Twin-Screw Vise (AUTHOR'S BEST OVERALL CHOICE)	www.leevalley.com (05G12)	$230

QUICK-RELEASE FRONT VISE (WOODCRAFT)

ROCKLER QUICK-RELEASE END VISE

INSTALLING VISE HARDWARE

Start with the baseplate. *The first step is to screw the baseplate to the bottom of the benchtop. Then clamp the rear jaw in place and mark the holes for the screw and guide bars.*

Attach the rear jaw. *After you've drilled holes for the screw and guide bars, bolt the rear jaw to the benchtop. Barrel nuts mortised in from the bottom of the benchtop capture the bolts.*

Bolt the front jaw in place. *Clamp the wooden front jaw to the rear jaw, and then install the screw plate and guide bars.*

QUICK RELEASE	OPENING CAPACITY	EASE OF USE	RACKING	COMMENTS
Yes, twist	11½ in.	Fair	0.15	Too much play in screw and guide bars caused jaw to open and close poorly.
Yes, twist	13 in.	Good	0.09	Nut occasionally fails to disengage when you twist screw to pull jaw out.
Yes, twist	14¾ in.	Good	0.05	Required more force to open and close jaw than other vises.
Yes, twist	13 in.	Good	0.06	Can clamp up to 6-in.-wide boards between guide post and screw.
No	12 in.	Excellent	N/A	Can clamp up to 16-in.-wide boards between screws; two handles are a nuisance at times.

vise, because the nut disengages when the screw is turned. This makes it easy to hold a workpiece in one hand and use the other to turn the screw and adjust the front jaw. On a trigger-release vise, you must pull and hold a trigger to disengage the nut. It can be tricky to do this while moving the jaw with the same hand.

With a quick-release vise, an important feature is how well the nut engages. If the nut pops or jumps when you tighten the screw, the vise doesn't tighten and your workpiece can fall out. Finally, check the fit and finish. Rough castings can scratch or cut your fingers or workpiece, and screws that don't turn smoothly are frustrating.

And the winners are ...

Among the cast-iron vises, the Jorgensen is the best. Its twist-release mechanism works very well, and it has a big metal benchdog that moves smoothly and stays in place. The vertical alignment was always dead-on under pressure, and it racked the second least. The best value is the Groz rapid-action vise. It performed very well, and I like the action of the twist release.

Among vise hardware, the Veritas twin-screw is easily the best. It has the biggest clamping capacity and doesn't rack. The front jaw can be skewed for tapered parts or to overcome racking force if you clamp something outside the screws. The Veritas doesn't have quick release, but everything else about it is so nice we didn't miss it. We picked the large quick-release front vise sold by Lee Valley as the best value. It's a solid performer at a good price. □

Matt Kenney is an associate editor.

INSTALLING THE VERITAS TWIN-SCREW VISE

Attach the nuts. *The round nuts fit into holes drilled into the rear jaw, and the square bases are screwed in place. Then attach the jaw to the benchtop.*

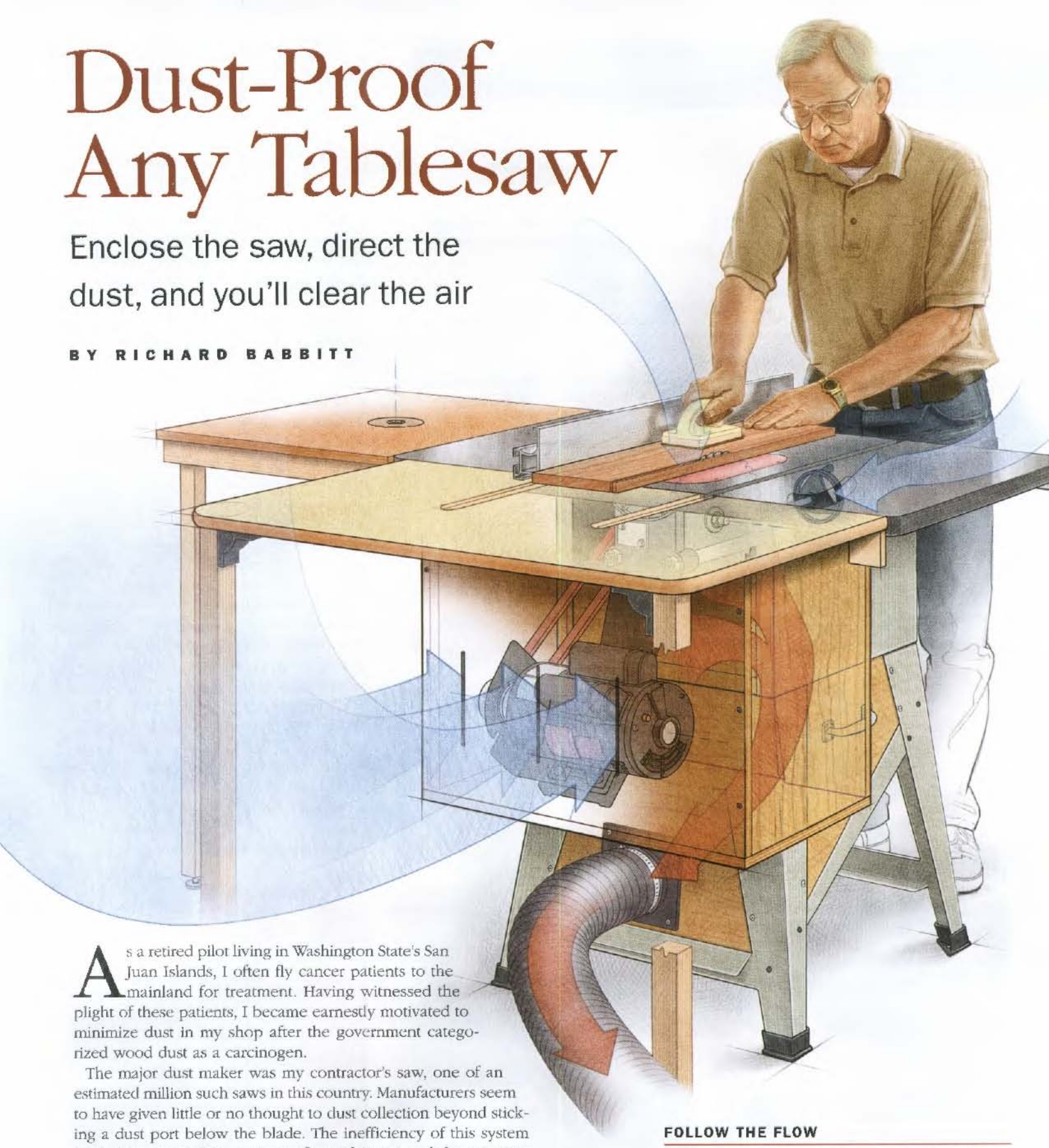
As the screws turn. *Clamp the front jaw in place and start cranking the screws. When tight, attach the screw plates.*

Clip the chain in. *A small spring clip holds the ends of the chain together. The chain turns a sprocket on each screw, and lets you open and close both screws with one hand.*

Dust-Proof Any Tablesaw

Enclose the saw, direct the dust, and you'll clear the air

BY RICHARD BABBITT



As a retired pilot living in Washington State's San Juan Islands, I often fly cancer patients to the mainland for treatment. Having witnessed the plight of these patients, I became earnestly motivated to minimize dust in my shop after the government categorized wood dust as a carcinogen.

The major dust maker was my contractor's saw, one of an estimated million such saws in this country. Manufacturers seem to have given little or no thought to dust collection beyond sticking a dust port below the blade. The inefficiency of this system is obvious every time a piece of wood is cut and the operator becomes surrounded by a cloud of dust. To come up with a better solution, I put on my pilot's cap and began to think about airflow. By applying aerodynamics to my tablesaw, I was able to

FOLLOW THE FLOW

No matter which type of saw you have, the principle is the same: Close off most of the saw, allow rapid airflow in a few key areas, and you'll send the dust toward the hose and not into the shop.

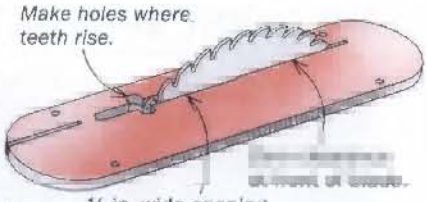
Photos: Mark Schofield; drawings: John Hartman

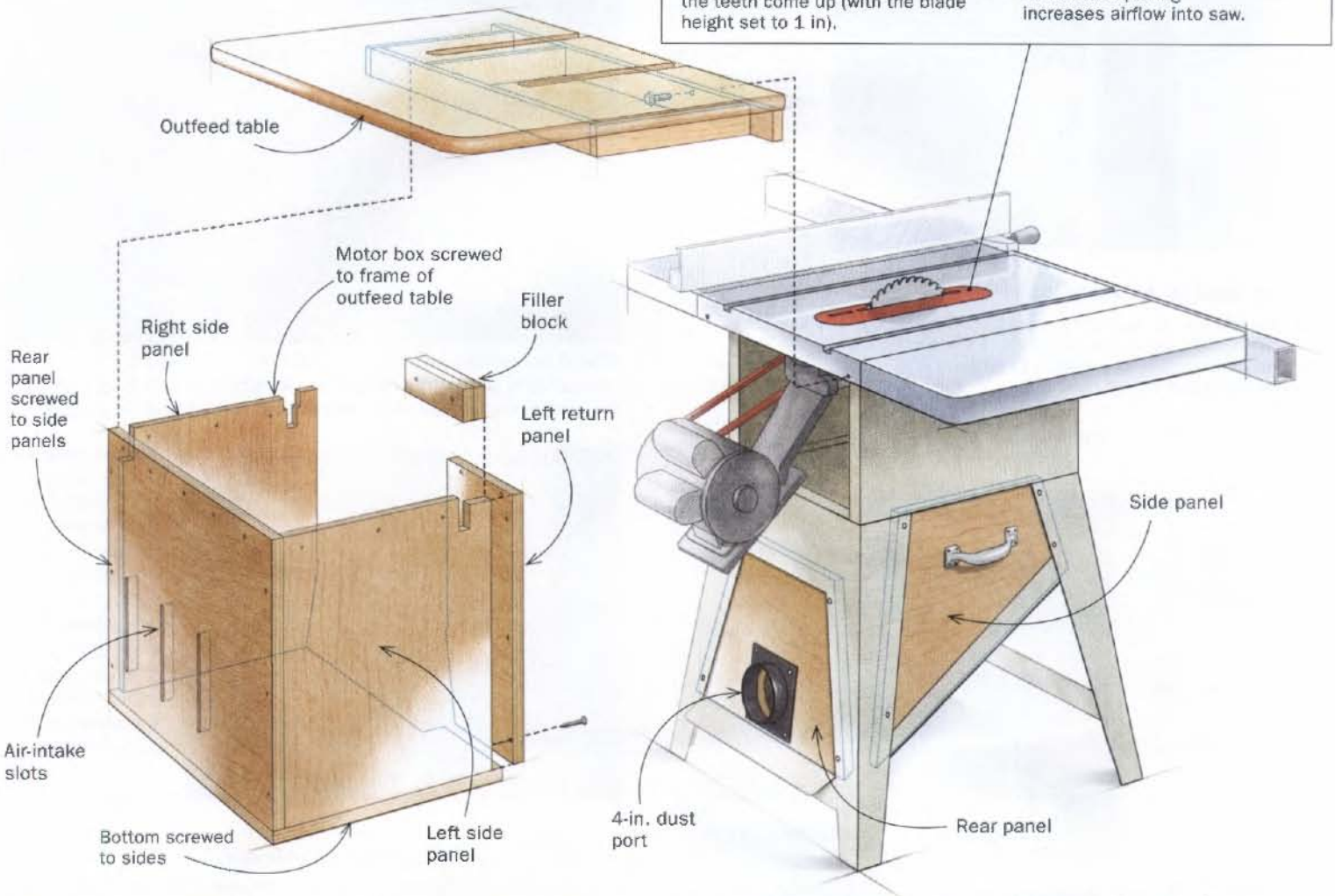
ENCLOSE A CONTRACTOR'S SAW

You need an outfeed table from which you can suspend a box to enclose the motor. The base of a typical contractor's saw already has a dust chute, so three small panels will close off the bottom; the rear one gets the dust port.

HOT-ROD THE INSERT PLATE

Widen the back of the slot in a zero-clearance insert plate to create suction where the dust usually shoots out. Increase the effect by adding a pair of holes at the point where the teeth come up (with the blade height set to 1 in).





vastly improve its dust collection, and keep the motor cooler in the process.

While I'll focus on the contractor's saw, the principles and techniques work on any saw. Two of *Fine Woodworking*'s editors will describe how they dust-proofed a hybrid saw and a cabinet saw.

Dust goes with the flow—if you direct it

The average contractor's saw, with its open design, is equivalent to sticking the dust hose in the middle of the room. Some dust-laden air will be drawn in, but the majority will be too far from the hose and will float off into the shop. You need to increase the velocity by restricting and directing the amount of air entering the base of the saw. My plan uses three pieces of plywood to enclose the lower part of the saw, and five more to build a small box around the rear-hanging motor. This enables me to direct the airflow to the dust port.

This system requires a dust collector rated at a minimum of 1,100 cubic feet per minute (cfm). Most 1½-hp mobile dust collectors fit the bill, but if yours doesn't have a 1- or 2-micron filter, you should invest in one. The smallest particles are the most dangerous.

Begin by enclosing the motor—The motor enclosure is suspended from an outfeed table. The bracing under my Rockler table is placed almost perfectly for this installation, but if you have another outfeed table, you can either adapt the bracing or attach a shopmade frame to the underside of the table.

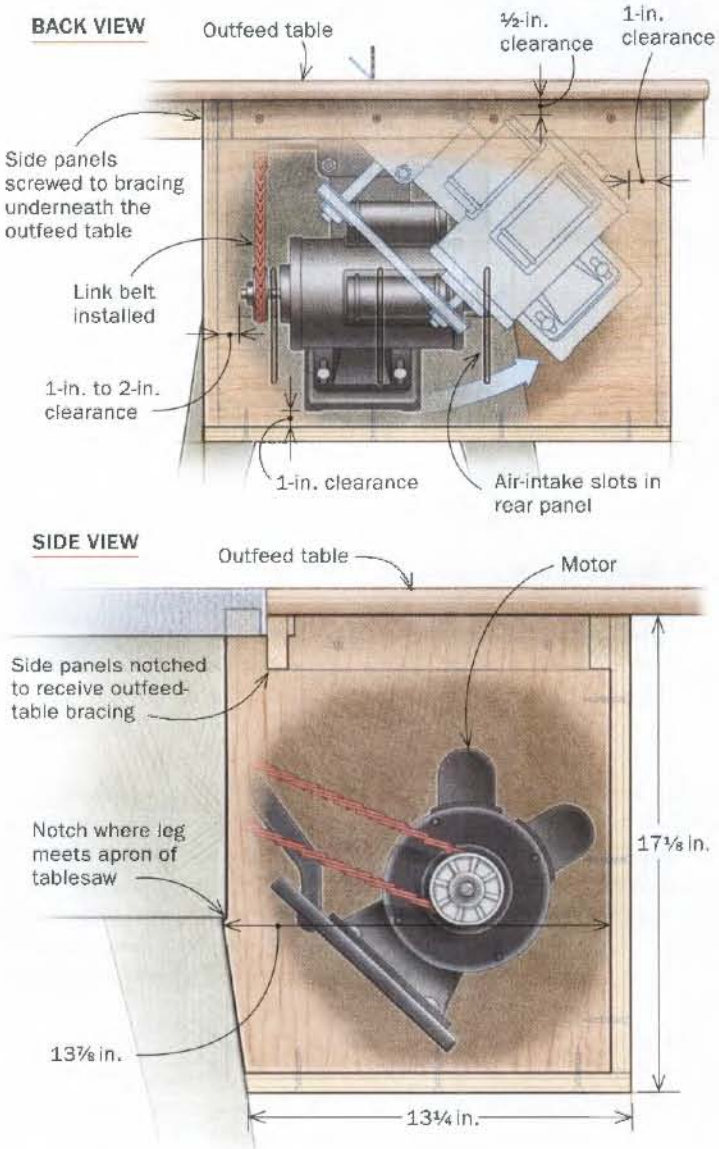
The first step is to calculate the size of the box required to enclose the motor at both the 0° and 45° blade settings. On most contractor's saws, the motor is mounted on a hinged plate and hangs down behind the saw, supported by the drive belt. To make the enclosure box as compact as possible, you'll need to pull the motor up slightly by shortening the belt. The easiest way to do this is to buy 4 ft. of link belt (www.in-lineindustries.com). Be sure to unplug your saw before working on it.

Because the motor will be completely sealed in, you can remove any belt guard. Now tilt the blade to the 45° position and adjust the belt length to give ½ in. of clearance from the motor's capacitor to the underside of the outfeed table. This in turn will

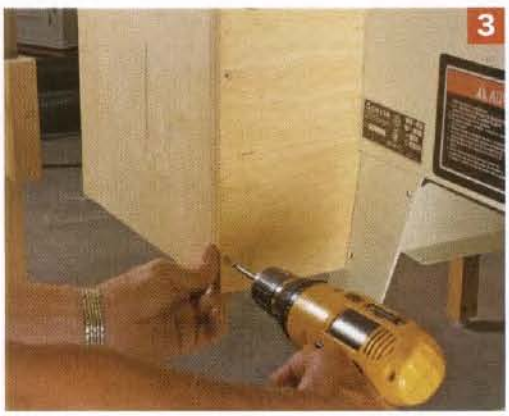
Measure the opening. *After installing a link belt to adjust the height of the motor, use a tape measure and level to find the height of the motor-enclosure box you need.*

AS SMALL AS POSSIBLE

To minimize the size of the box, the motor should be ½ in. from the outfeed table when the blade is tilted to 45°. The motor box dimensions refer to Babbitt's Delta contractor's saw. Your saw may need a different-size box.



Attach the motor-box sides. *The sides can be screwed to the bracing that supports your outfeed table. Cut the right-hand side of the box to fit the back of the tablesaw and notch the top to go around the bracing.*



Add the return. *On this right-tilt saw, the left-hand side of the motor box extends past the base of the saw to give the motor room to swing out when the blade is angled. To seal the box, a short return panel is attached.*

determine how far the motor hangs down at the 0° setting. To get the vertical dimensions of the box, reset the blade tilt to 0°, set a tape measure on the floor, run the tape up past the motor to the underside of the outfeed table, and lock it. Hold a level against the lowest part of the motor mount and across the tape, note the dimension, and add 1 in. for clearance. This will be the vertical dimension of the left, right, and rear panels (all references to right and left are from the operator's position). Hold the level vertically an inch away from the back of the motor and mark the underside of the outfeed table.

Begin with the right side panel—I have a right-tilt saw. For a left-tilt one, reverse the descriptions for the left and right side panels. The right panel must seal against the rear apron of the saw's base, plus a portion of the 7° splayed leg. I held a piece of cardboard tightly against the saw's side and scribed it. We know the height of the panel; for the width, measure from the top of the saw's base to the line you made on the underside of the outfeed table.

Depending on the design, your saw may have an indent where the vertical part of the saw meets the splayed leg. This is the widest part of the right panel. Cut the panel to height and width, then use the template to cut the profile to fit the tablesaw. Cut slots in

Look for gaps. *Use weather-stripping or duct tape to close off any gaps between the motor box and the tablesaw.*

Close the box. *Screw on the back. Slots in the back panel allow air to enter at high speed, cooling the motor and picking up the dust.*

the top edge to accommodate bracing under the outfeed table. Use drywall screws to attach the panel to the bracing.

Making the left side panels—When the blade is angled at 45°, the motor extends beyond the left side of the saw. To allow for this, the main left-side panel doesn't contact the back of the saw. It is the same height as the right panel but ½ in. wider and doesn't have to allow for the indent or the splayed leg. Locate the left panel an inch away from the tilted motor and attach it in the same way.

The gap between the front of the left panel and the left side of the saw is enclosed by a short return panel. This panel's top edge will butt up against the underside of the left table extension. Scribe a piece of cardboard to measure the side splay of the saw's left rear leg and use this to bandsaw the return panel to the correct shape. Now screw the return panel to the left side panel.

The bottom of the motor enclosure will be attached later, but cut it to size now. Add ¾ in. to the length for a shelf to receive the rear panel. Cut a hole in the front edge for the power cord.

Create the dust-collection area in the saw's base

The base enclosure on my saw consists of two side panels and a rear panel that houses the dust port. Place a piece of cardboard

SEAL THE REST OF THE SAW

Close off the base. *Screw panels to the existing framework. Attach a 4-in.-dia. dust port to the rear panel.*

Allow for access. *The base side panels have handles attached. This makes them easier to install and to remove for saw access.*

Seal the underside of the table. *Large gaps between the saw's base and table are best filled with a foam sealant.*

Add a simple adjuster. *A shop-made magnetic panel covers the curved slot for the height-adjustment crank. Adjust the opening to achieve optimum airflow.*

How to dust-proof a hybrid saw

After reading Richard Babbitt's article, I was curious whether I could achieve the same results on my DeWalt hybrid saw. I knew the base was open to the floor, but a closer inspection showed huge gaps between the base and the tabletop, and even the legs and side panels did not have a good seal. Not surprisingly, dust collection was never very efficient. Working with Babbitt, I came up with a design that adopted the principle of directing the air.

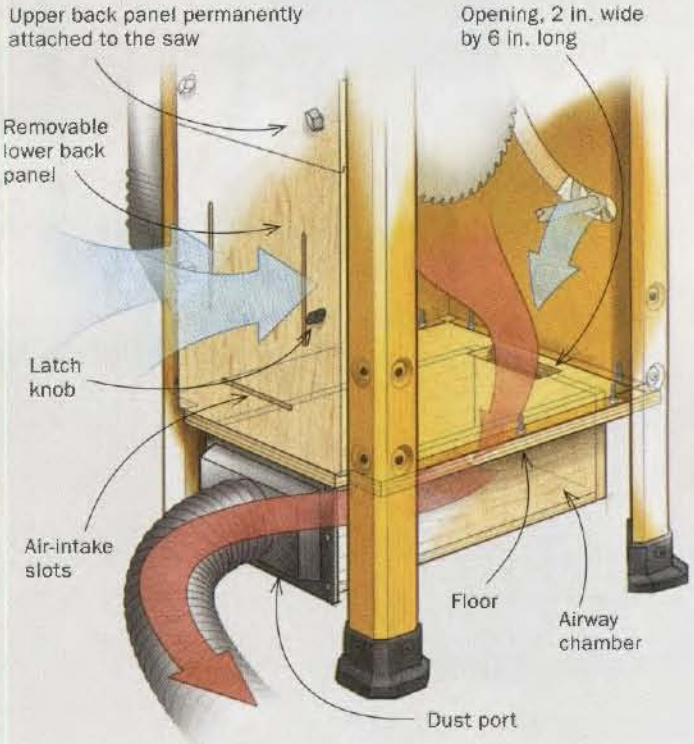
The first task was to remove the plastic combination blade-shroud and dust chute. Not having an easy way to create an angled dust chute, I installed a plywood floor in the base with a 2-in. by 6-in. opening at the front. From this floor I hung the airway dust chamber with the dust port at the rear. Not wanting to drill holes in the legs, I secured the back panel to the legs with latches that allow for easy access to the inside of the saw. The large gaps between the base and the table were filled with expanding foam sealant; weatherstripping filled the gaps between the sheet-metal legs and the side panels, and small pieces of magnetic sheet (refrigerator magnets) covered holes around crank handles, etc.

The improvement in dust collection has been dramatic. During several weeks of use that included cutting medium-density fiberboard and plywood, almost no dust escaped the saw. Inside, the motor and the mechanics remained remarkably clean.

—Mark Schofield is the managing editor.

CONSTRUCT AN AIRWAY DUST CHAMBER

Like Babbitt's contractor's saw, this design draws in clean air through the back slots and the tilt-control slot. But, instead of an angled dust chute, a floor opens into a lower dust chamber linked to the dust port.



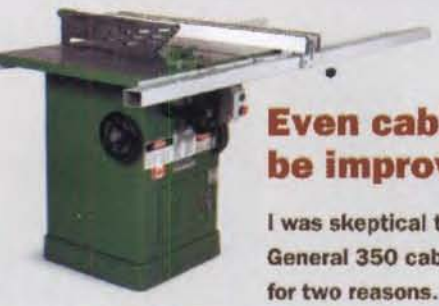
Air goes in, dust comes out. *Despite the semi-open base, this hybrid saw was successfully dust-proofed using the same principles employed on a contractor's saw. High-speed air enters slots in the rear panel, washes over the motor, picks up dust from the blade, and exits at the bottom via a 4-in.-dia. hose.*

over the rear opening in the saw's base and mark the opening on it. Add 1½ in. to the sides and transfer this outline to the plywood. The first cut should be on the bottom edge with the blade tilted to match the angle of the dust chute. After cutting the sides of the panel on the bandsaw, on center, draw a 4½-in.-dia. circle with its bottom 1¼ in. from the lower edge of the panel. Cut this out with a jigsaw. Now drill two clearance holes evenly spaced into each leg, staying ¾ in. from the inside edge. Screw the panel to the legs and seal the bottom of the interior with self-stick weatherstripping. Now that you are finished working on the back of the saw, you can install the bottom panel of the motor box.

Make the lower side panels in the same way, using a cardboard template. Stick weatherstripping on the top edge of the panels.

Use fridge magnets

Plastic magnetic sheet, often used for free advertisements, can be easily cut to close small gaps, like the one around the blade-angle crank.



Even cabinet saws can be improved dramatically

I was skeptical that dust collection on my old General 350 cabinet saw could be improved, for two reasons. First, it was already mostly enclosed. Second, I had already built a box to close off the one gaping hole in the cabinet—the square cutout that allows the motor to pivot when the blade is angled. But after seeing photos of my saw, Babbitt suggested a number of modifications.

The best upgrade was to cut three slots in the plywood box, located to send a stream of air across the motor, cooling it and helping to keep the gears and trunnions dust-free.

Then, starting at the bottom of the saw, I replaced a permanent pile of dust with a three-part plywood floor to funnel chips toward the port. The next task was to direct some air across this channel to push the dust to the port. A piece of plywood and a metal louver did the trick (below right). I then sealed other gaps with expanding foam and weatherstripping, used magnetic sheet to cover screw holes and gaps around handles, and fitted an adjustable cover to the tilt-control slot.

After several months of use, there is no buildup of dust around the base of the saw, I get almost no dust coming off the back of the blade, and when I remove the insert to look inside, the motor and trunnions are very clean.

—Asa Christiana is the editor.

Add intake. *Christiana had a plywood box covering the motor opening. So he just routed three slots, positioned to wash cool air over the motor.*

Install a floor. *To channel dust toward the dust port, install a floor in the base, with two plywood side panels angled downward.*

Front and back panels control the airflow

We've now closed off all the conflicting air inlets except for the back panel and the large tilt-crank slot. This is where we start to direct the airflow. Cut the back panel to fit the opening in the rear enclosure. Note where the motor is positioned with the blade vertical, and align the high-velocity air-intake slots so that the air flows over and around the motor.

There are a couple of ways to seal the tilt-crank slot: If you live near a sign company, see if you can acquire a piece of magnetic sign board large enough to cover the slot. Alternatively, cut a scrap of ½-in.-thick plywood 1 in. wider than the opening. Drill two holes diagonally opposite each other and epoxy in two magnets.

Open and close this panel to find the most efficient airflow. Too small an opening may starve the dust collector of air and reduce the flow; too large an opening may reduce air velocity entering the rear of the saw. I generally keep mine open 1½ in. to 2 in., and a little wider when running a dado blade. After several hours of use, check for sawdust buildup inside the saw by removing the back panel or the insert plate. Some dust sloped on the sides away from the main airflow is normal. You aren't attempting to get all the dust out of the saw, just to get the vast majority into the dust collector, not your nasal passages. □

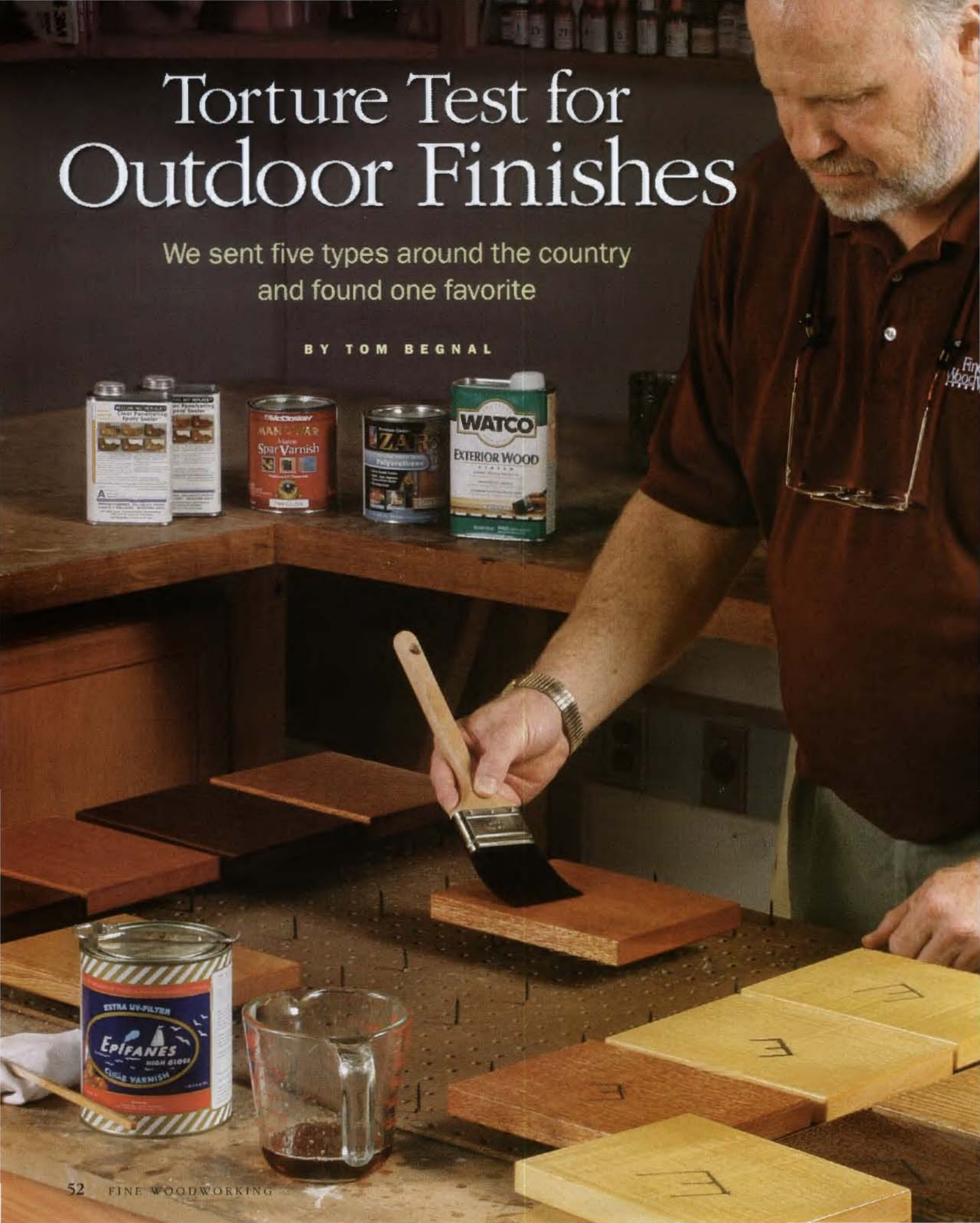
Woodworker Richard Babbitt attempts to keep the air clear in his shop on San Juan Island, Wash.

Let air sweep the floor. *A thin plywood panel blocks all of the louver slots in the access door, except the lowest. Because that slot is still several inches above the new floor, install a sheet-metal louver to direct incoming air down to the floor. Attach the panel with construction adhesive.*

Torture Test for Outdoor Finishes

We sent five types around the country and found one favorite

BY TOM BEGNAL



How we tested

We treated five wood species with five outdoor finishes. To find out how the samples would hold up over the course of the year to the weather in different regions of the country, we sent a rack of sample boards to Oregon, New Mexico, and Louisiana, while one stayed in Connecticut. Each region subjected the samples to a unique set of climate conditions. The data represent average numbers.

Salem, Ore.

Lots of cool temperatures and high humidity. On average, only one day in five is sunny.

Seasonal temperatures (°F) (high/low)
Winter: 48/34
Summer: 79/50

Relative humidity (AM/PM)
Winter: 74%/87%
Summer: 43%/85%

Sunny days: 77

Rainfall: 39 in.

Snowfall: 7 in.

Bridgeport, Conn.

In winter, freezing and thawing cycles aren't kind to wood.

Seasonal temperatures (°F) (high/low)
Winter: 38/24
Summer: 80/63

Relative humidity (AM/PM):
Winter: 58%/71%
Summer: 61%/78%

Sunny days: 99

Rainfall: 42 in.

Snowfall: 26 in.

Albuquerque, N.M.

Plenty of sunshine, not much rain, and low humidity make for a wood-friendly environment.

Seasonal temperatures (°F) (high/low)
Winter: 49/24
Summer: 91/62

Relative humidity (AM/PM)
Winter: 38%/67%
Summer: 25%/57%

Sunny days: 167

Rainfall: 9 in.

Snowfall: 10 in.

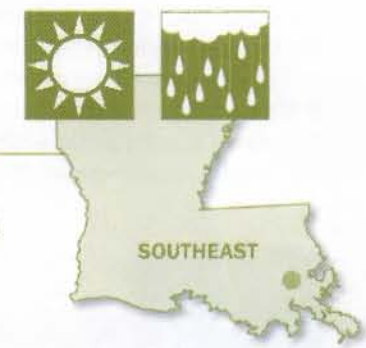
Seasonal temperatures (°F) (high/low)
Winter: 63/44
Summer: 90/72

Relative humidity (AM/PM)
Winter: 66%/85%
Summer: 65%/91%

Sunny days: 101

Rainfall: 62 in.

Snowfall: ¼ in.



New Orleans, La.

Hot and humid summers. Plenty of rain. Freezing and thawing cycles are as rare in Louisiana as snowy owls.

The great outdoors isn't great for wood. No matter if it's a fallen maple tree in the back woods or an Adirondack chair in the backyard, nature wants to convert all dead wood into compost.

Sunlight and moisture do a lot to start the process. Sunlight, particularly the ultraviolet (UV) wavelength, causes a chemical degradation in wood. Moisture absorbed by the wood fibers causes them to expand and contract, and that produces surface checks. Then, too, the freezing and thawing cycles common in northern climates can exacerbate the weathering process. Left unfinished, a new piece of furniture can start to look old in a few weeks. In a year, it can look ancient.

So to help outdoor furniture withstand the elements, a protective finish is a must. And if you want to see and enjoy the wood, you're going to want a clear finish rather than paint.

There are several types of clear finish made for outdoor use. But, as we discovered in a yearlong test, they don't all deliver. Some offered almost no long-term protection. Others did considerably

WATCO EXTERIOR WOOD FINISH

Source: www.rustoleum.com

Price: $14/qt.

Application: Two coats, each applied liberally

Results: The outdoor penetrating oil finish was the easiest to apply, but at the end of the yearlong test, all the samples, except for those in New Mexico, had weathered to various shades of gray. All the samples had rough surfaces. Shallow cracks and checks were common. Some pine samples had full-thickness checks on the end.

Rating: Unacceptable

better. But our test did more than help us find a couple of good outdoor finishes. It also showed us how several different wood species hold up to the weather. And, it gave us new insight into the effect of climate on both finish and wood.

Testing tells the tale

The test evaluated the four types of finish used most often outdoors: penetrating oil, water-based polyurethane, marine spar varnish, and marine extra-UV-filter varnish, plus a combo that one finisher touted in an earlier issue ("A Durable Exterior Finish," *FWW* #179), epoxy and marine extra-UV-filter varnish. Also, to see if the wood species made a difference, we applied each finish to five different woods: cedar, ipé, mahogany, pine, and white oak. All, except for pine, are known to hold up to the outdoors better than most. Finally, to see how geography factors in, we ran the test in four regions of the United States with distinctly different climates: the Northeast (Connecticut), Northwest (Oregon), Southwest (New Mexico), and Southeast (Louisiana).

Each wood sample was ¾ in. thick by 6 in. wide by 8 in. long. For consistency, all the samples of each wood came from the same board. And every coat of finish was applied equally to both sides and all edges. Each finish was applied according to the manufacturer's recommendations shown on the label.

We built four test racks, each designed to hold 25 samples. One rack went up on the flat roof of our Connecticut office building (a perfect out-of-the-way location, we thought, until summer arrived

ZAR EXTERIOR WATER-BASED POLYURETHANE

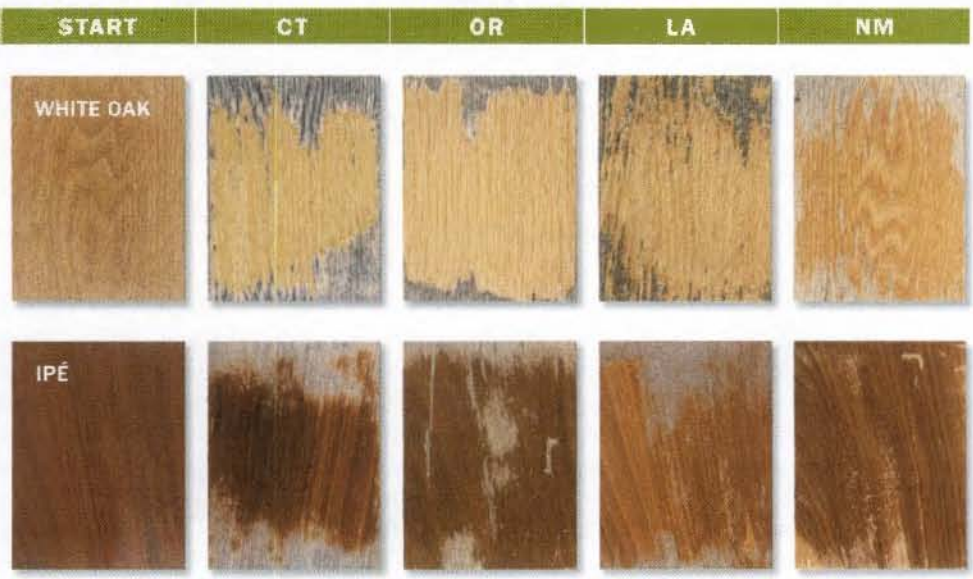
Source: www.ugl.com

Price: $22/qt.

Application: Three coats

Results: On average, about 20% of the finish had deteriorated, resulting in areas of weathered gray. Where the finish remained, much of it showed areas of flaking and chipping. The mix of grayed wood and remaining finish produced an unsightly mottled look.

Rating: Unacceptable



Photos: staff; drawings: John Tetreault

McCLOSKEY MAN O'WAR MARINE SPAR VARNISH

Source: www.mccloskey finishes.com

Price: $20/qt.

Application: Four coats

Results: The finish generally held up well on the mahogany, ipé, and pine. Same with the cedar samples, except for the one that visited New Mexico—that one showed some finish deterioration. The white oak samples had the toughest time, with about 40% of the finish deteriorating.

Rating: Fair to good

and a colony of hornets built a nest at the trapdoor leading to the roof); the other three went to our regional testers. All the racks were positioned to face south, ensuring maximum exposure to the sun, with the samples tilted at 45° to prevent standing water.

What we learned

After 12 months outdoors, all the samples came home to the *FWW* shop. The results are shown on these pages. For space reasons, we only included photos of the white oak (a light-colored, open-grained wood) and ipé (a dark-colored, close-grained wood).

One thing was immediately obvious: The samples finished with oil suffered the most. All five wood species in all four regions had roughened surfaces. With the exception of those from New Mexico, all the bright surface colors had been replaced by various shades of gray. Also, all the samples showed end-grain checks and surface cracks, most of them minor. The pine samples, however, showed several end-grain checks that extended the full thickness of the wood.

In fact, the oiled wood didn't look any better than unfinished wood exposed to the same conditions. So unless you want to reapply the oil every couple of months, don't bother with it.

Although faring better than penetrating oil, both the exterior water-based polyurethane and the spar varnish were disappointments. All the water-based poly samples showed deterioration, some minor but most closer to major. Spar varnish held up slightly better, with a 50/50 split between major and minor levels of

EPIFANES HIGH GLOSS MARINE VARNISH

Source: www.epifanes.com

Price: $45/qt.

Application: Seven coats, thinned per instructions

Results: No sign of finish deterioration, no sign of flaking or chipping. Samples showed only the slightest change in color. Mind you, it takes a while to apply the seven required coats.

Rating: Very good

Source:
www.smithandcompany.org

Price: $42/qt. plus $45/qt.

Application: Three coats epoxy plus five coats Epifanes (unthinned)

Results: No sign of finish deterioration, no sign of flaking or chipping. Only the slightest change in color.

Rating: Very good

SMITH & CO. PENETRATING EPOXY SEALER UNDER EPIFANES MARINE VARNISH

deterioration. The spar-varnish pine sample from New Mexico was an exception, as it held up pretty well.

Without question, the marine extra-UV-filter varnish and the epoxy plus marine varnish looked the best. The colors maintained much of their brightness. Surface cracks, checks, or defects were almost nonexistent. The only reason I rated them "very good" rather than "excellent" was because the colors changed slightly during the yearlong test: The ipé lightened. The white oak lightened, but only a bit. The cedar and pine darkened. The mahogany darkened, except in New Mexico, where it lightened slightly.

Interestingly, the samples from New Mexico suffered the least. Oregon samples did better than those from Connecticut and Louisiana. The Connecticut samples looked the worst for wear. So, according to our test, moisture causes more weathering than UV light. When moisture combines with freezing and thawing cycles, as is common in northern states, the wood weathers even more.

As far as wood species go, the cedar and ipé samples held up a bit better than the others. Mahogany and white oak showed slightly more weathering. The pine boards had the toughest time.

Choosing a favorite

The Epifanes finish and epoxy-plus-Epifanes held up equally and the work to apply them was about the same. Forced to pick a favorite, I'd take the Epifanes, because it is one product, not two. □

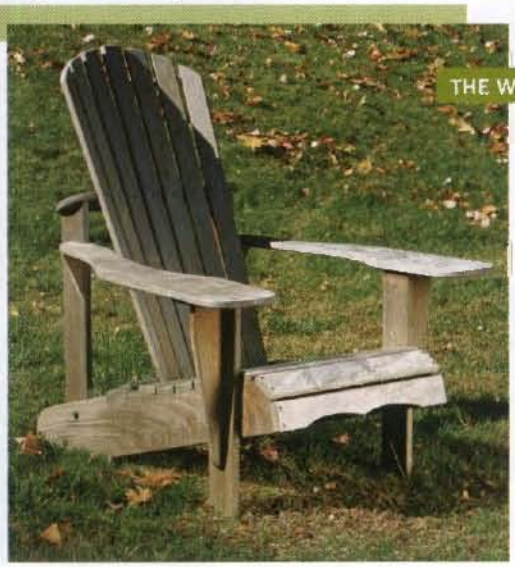
Tom Begnal is an associate editor.

Which finish is right for you?

A PROTECTIVE FILM FINISH

Keep wood looking new. *After about a year outdoors, this project finished with Epifanes looks almost as good as it did after its first day.*

THE WEATHERED LOOK



No finish at all. *If you like the rustic look of weathered wood, don't bother to add a finish. Oil finish (Watco) didn't have a visible effect after a year. But ipé, cedar, and mahogany weathered the best, in that order.*

The Ins and Outs of Drawer Stops

Four clever ways to keep a drawer in its place

BY PETER TURNER

A well-fitted, smooth-gliding inset drawer is a testament to fine furniture making. This type of drawer, often made with half-blind dovetails at the front and through-dovetails at the back, fits into a pocket built into a case or a table. In a case piece, the drawer usually is supported on a frame; in a table, it slides on a rail and runners, steered in and out of the pocket by guides.

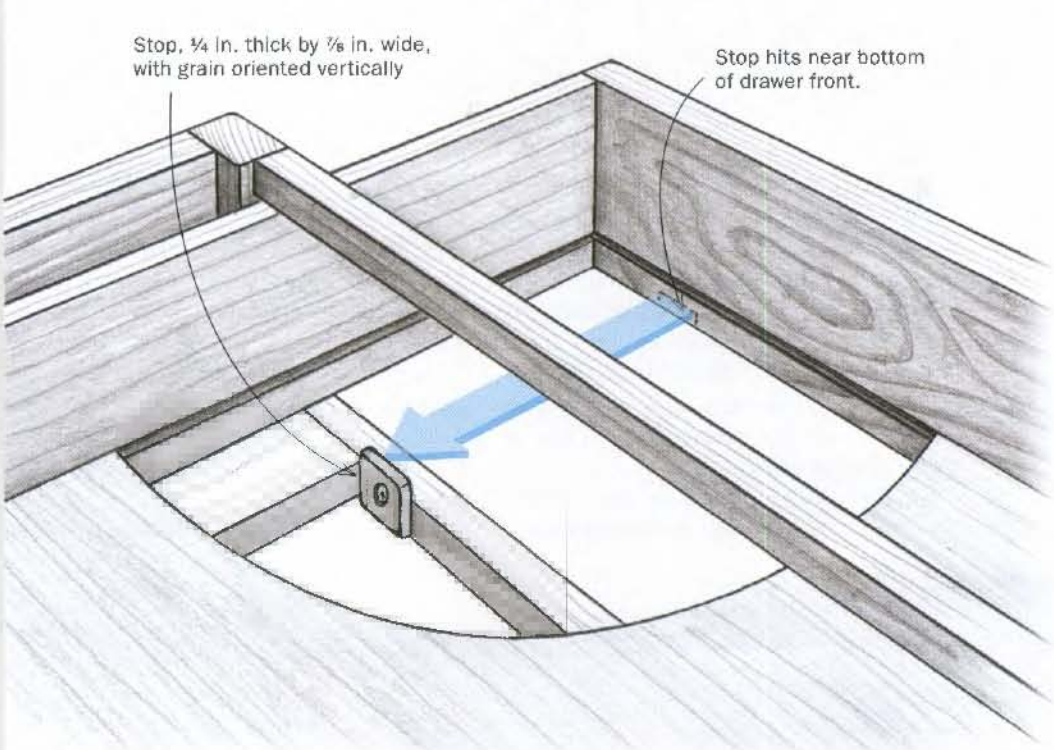
But the unseen grunts of the drawer pocket are the stops, which serve as the brakes to keep a drawer from being pushed in too far (in-stops) or unexpectedly pulled out too far (out-stops). Stops also help keep the drawer reveal consistent, whether you want a flush drawer front or one that's recessed a bit.

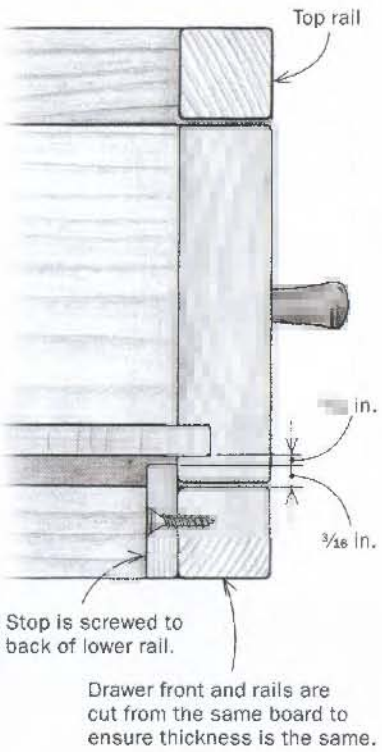
I've screwed in-stops behind the front rail, and I've mortised them into the rail (see pp. 58-59). For out-stops, I favor a couple of clever mechanisms (see pp. 60-61).

There are simpler methods to stop a drawer. But I stick to these few because they are positive and durable, making them worthy of fine furniture.

Peter Turner is a furniture maker in Portland, Maine. To see more of his work, visit www.petersturner.com.

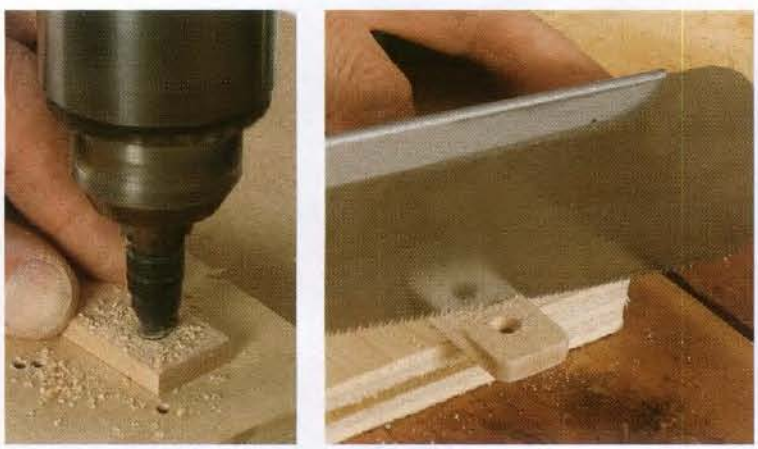
Thin rail? Put the stop behind it





In my furniture, grain typically plays an important role—whether I'm looking to play up contrast or work toward seamless transitions between parts. When building tables with drawers, I often cut the drawer face and its rails, above and below, from the same plank and then install them in the same order they were oriented in the plank.

This method has two advantages. First, it unifies the front of the piece, with a continuous grain match from the top rail to the bottom. Second, because I rip the parts after they've been jointed and planed, they are identical in thickness. This allows me to install two stops on the back of the bottom rail, making it easy to create flush drawers. The back of the drawer face, below the drawer bottom, rests against the face of the applied stop. If I want inset drawer fronts, I just dial in the setback by creating a small step in the stop. You'll need a full ¼ in. below the drawer bottom to accommodate the stop.

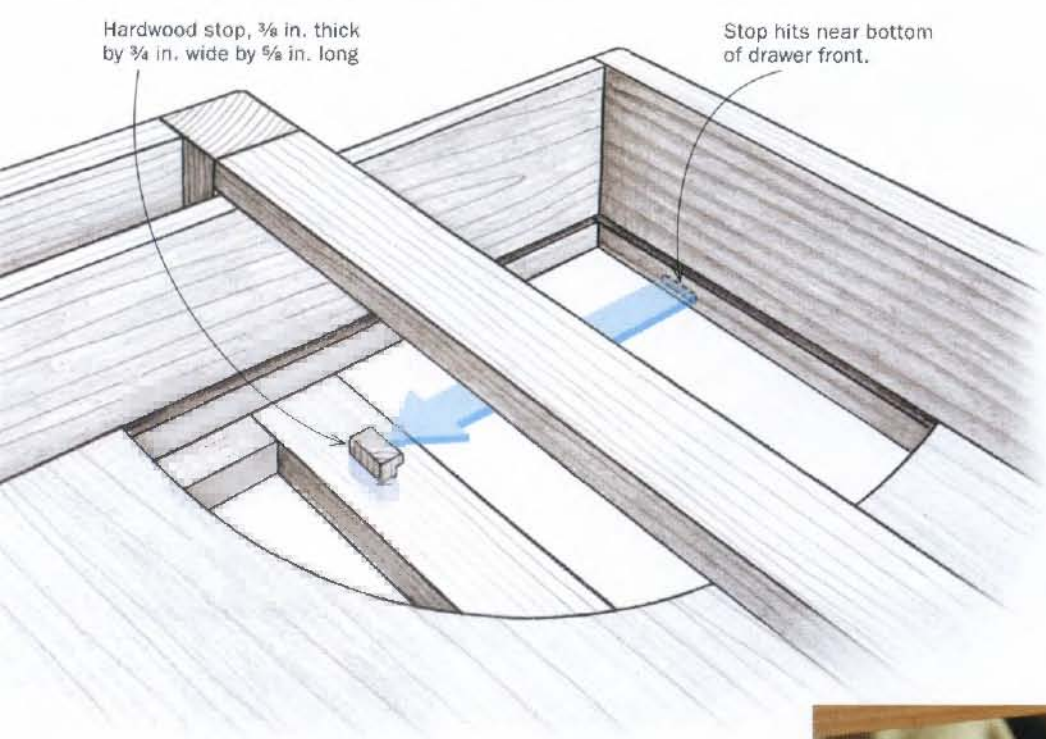


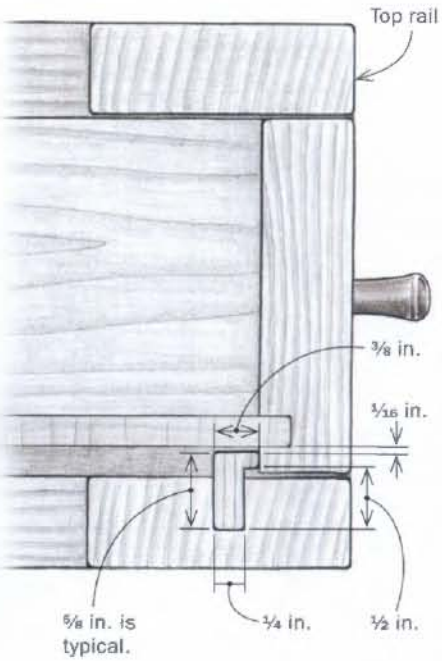
Two at a time. *Mill one piece of hardwood to thickness and width, then countersink a hole on each end. Round over the ends and cut off the two stops.*

Home on the rail. *Screw the stops behind the rail, one on each end, about 2 in. from the sides of the drawer pocket.*

Photos: Thomas McKenna; drawings: John Tetreault

On a wide rail, mortise it in





If the lower front rail is wide enough, I often mortise two L-shaped stops into it to keep a drawer flush with the front of the case or dial in the reveal of a recessed drawer. With this system, you need to cut the mortises for the stops before gluing up the piece. But a mortised stop is bulletproof and will keep a drawer in place forever.

Use a ¼-in. straight bit to rout the mortises for the two stops. The distance from the front of the rail will depend on the reveal of the drawer, but be sure the mortises are far enough away from the drawer pocket sides that you can use a shoulder plane to fine-tune the stops after installation. Square up the ends of the slots with a chisel.

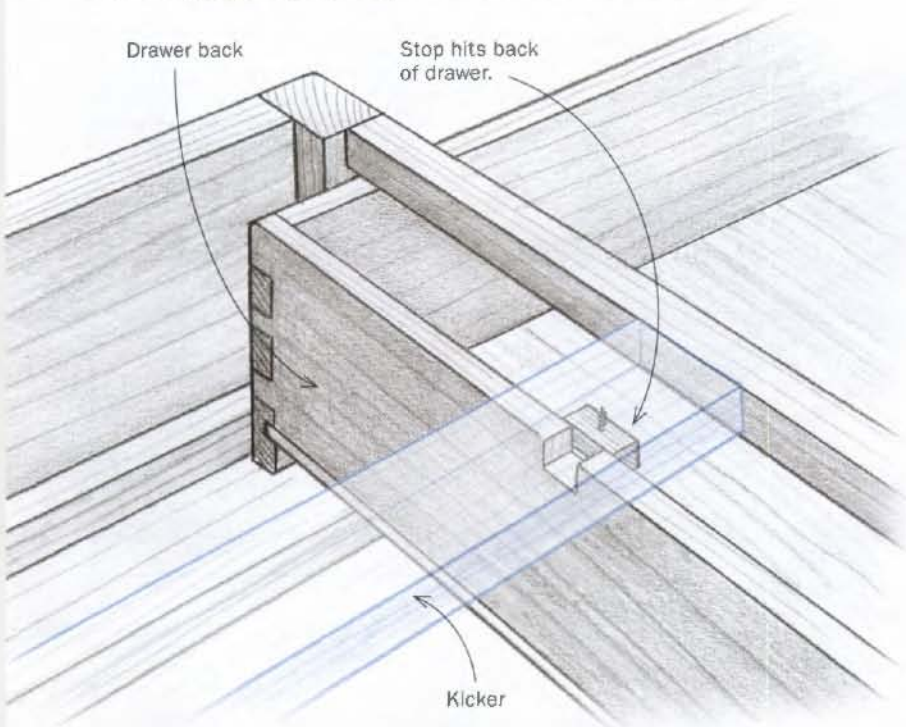
Make the stops out of a straight-grained hardwood stick that's about ⅜ in. thick by ¾ in. wide. I've used hickory and ash, but any dense hardwood will do. Cut a lip on each end of the stick before cutting the stops to length. The length of the stops depends on the clearance below the drawer bottom, usually ¼ in. I typically leave 1/16 in. of clearance above the stop, so it won't ever rub the drawer bottom.

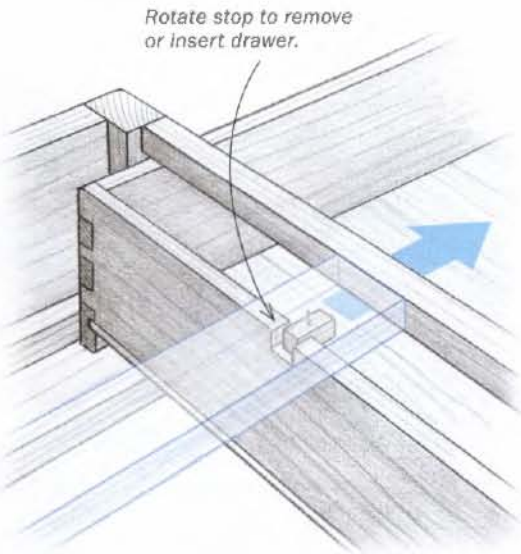
After installation, the front of the stop's lip can be planed to fit a drawer flush or to inset the drawer front. Take light passes and check the drawer alignment often.

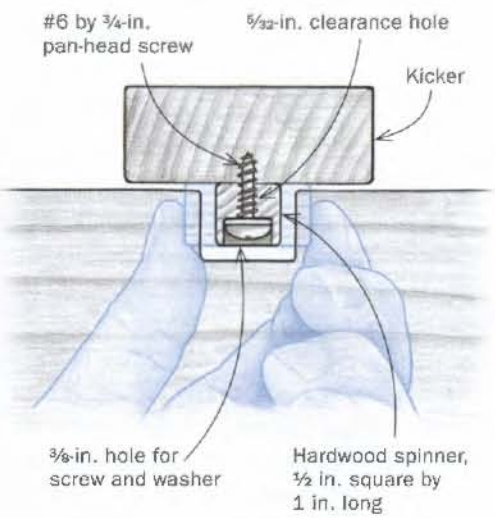
Drop in the stops. *After gluing up the case, install the stops in their mortises. Just remember to orient the lip outward.*

Dial in the reveal. *Insert the drawer to check its alignment. Then trim the stop as needed, using a shoulder plane set for an ultralight cut.*

Rotating stop spins on the kicker







A spinner stop is a clever way to keep a drawer from being pulled out of its pocket; the only downside is that you must cut a notch in the drawer back.

Make the spinner ½ in. square by 1 in. long out of a durable hardwood—I often use ash. Then cut a notch, centered in the top edge of the drawer back, that provides ⅛ in. of clearance around the stop. The stop is drilled to receive a round-head screw with washer.

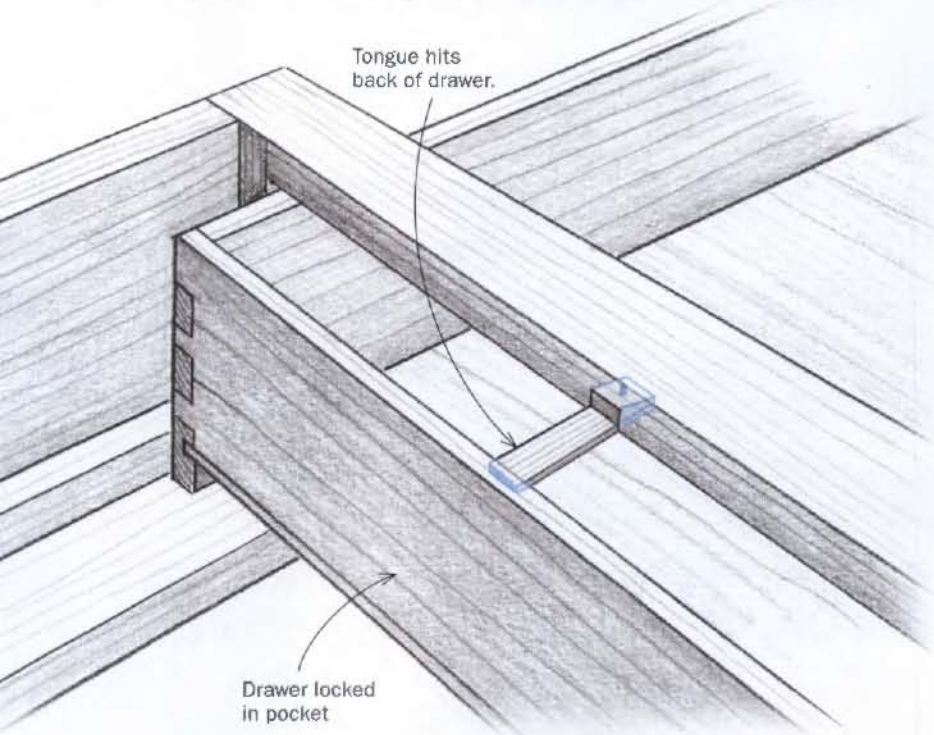
Position the stop below the tabletop or kicker so that one-quarter of the drawer's length will remain in the pocket. For example, if the drawer is 13 in. long from front to back, the spinner would be positioned so that its screw is 2½ in. into the drawer pocket. With a ½-in.-thick drawer back, this drawer will come to rest against the stop with about 10 in. of drawer exposed. Any more and there could be too much downward leverage on the drawer when fully extended.

The stop also aligns with the notch in the drawer back. You want the screw loose enough that the stop can be spun, but snug enough that there's no wobble in the connection. If the sound of wood hitting wood bugs you, glue a piece of leather to one face of the spinner to act as a cushion.

To install the drawer, spin the stop so that it clears the notch in the drawer back, and then spin it parallel to the drawer back to lock the drawer in the pocket.

Make a spinner. *With the spinner stock milled to width and thickness, drill the holes for the screw and washer (left). After cutting the spinner to length, screw it in place.*

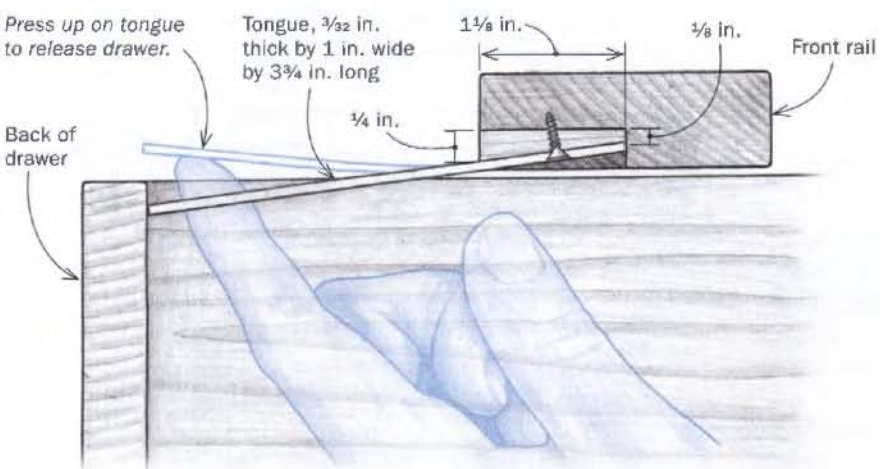
Spring-loaded stop is mortised into top rail



This springy ash stop angles down to hit the inside of the drawer back, but can be pressed up so that the drawer can be removed. Housed in a mortise in the upper rail, the stop has two parts: a flat tongue and a wedge-shaped base.

The angle of the base and the length of the tongue will depend on the depth of your drawer. Again, a good rule of thumb is to leave at least a quarter of the drawer's length in the pocket in the open, stopped position.

Cut the angled base on the bandsaw, then glue it onto the tongue so that the grain is aligned. Let the assembly dry, drill a hole and countersink for a screw, then mount the assembly into its mortise.



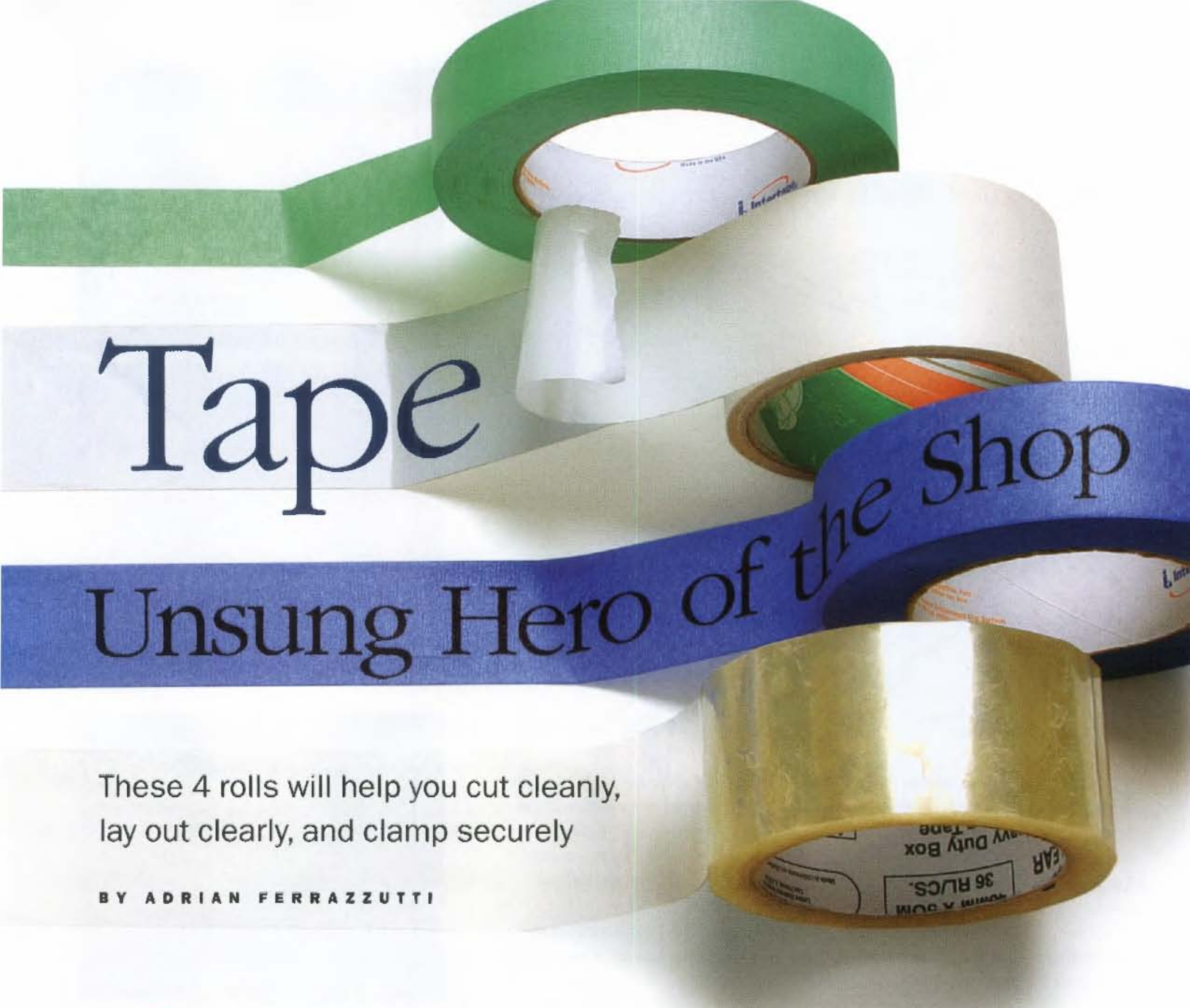
Find the right angle. *Lower the blade of a bevel gauge until it hits the back of the drawer (top). Transfer that angle to a small block and cut the angled base on the bandsaw.*

Make the flipper. *Glue the flat tongue to its angled base.*

Install it. *Screw the stop inside its mortise. Countersink the hole so the screw doesn't protrude.*

Tape

Unsung Hero of the Shop



These 4 rolls will help you cut cleanly, lay out clearly, and clamp securely

BY ADRIAN FERRAZZUTTI

Some of you will sneer at the thought that something as humble as sticky tape can possibly help your woodworking. But don't be stuck up about tape. I'll bet you will find in this article at least one use for tape that will make you a better woodworker.

But before you start peeling and sticking, it helps to become familiar with the different types of tape. Most useful for woodworking: green and blue painter's tape, packing tape, and double-faced tape.

Green painter's tape is a great all-purpose shop tape. Unlike regular white masking tape, it has a low tack, which means it will release from wood with less chance of pulling out the fibers. However, it's not that strong. It snaps if too much pressure is applied, so don't use it as a clamp when gluing.

The blue painter's tape I use is the 14-day-release type (3M, #2090) rather than the 60-day type, which has a lower tack. I prefer the crepe style over the smooth because it stretches better, pulling seams and joints together. Compared with green tape, blue tape takes a fair bit of force before it snaps, so it can handle light clamping tasks. It has greater tack but releases well. It also costs more.

Packing tape is a great choice for clamping where traditional clamps are cumbersome. It has great stretch before it snaps, which translates into lots of clamping force. Packing tape is also very handy as a glue-release surface. Tape the contact surfaces of bending forms and cauls to prevent them from being glued to your work.

Double-faced tape is a great helping hand for hardware installation. The many types vary in thickness and adhesion. I use a thin, less-aggressive type as well as turner's tape, which is thicker with a very aggressive adhesion.

Adrian Ferrazzutti is a furniture maker in Guelph, Ont., Canada.

Photos, except where noted: Mark Schofield; this page: John Tetreault

Green tape

Eliminate tearout

Even when combined with a zero-clearance insert, the best sawblades can cause cross-grain chipping, particularly on plywood. To prevent this, apply a strip of green tape straddling the cut line on the downward-facing side. Green tape is a better choice than blue, because it is less prone to pulling out wood fibers when removed.

Press down the tape firmly, really rubbing it on the wood surface. *To minimize edge blowout as the blade exits the cut, Ferrazzutti continues the tape around the edge (1). To prevent this end section of tape from acting like a shim and making the cut slightly off square, he wraps a small strip of tape on the other end of the piece that is in contact with the crosscut fence (2). Once the cut has been made, he gently peels away the tape to reveal a chip-free edge (3).*

Packing tape

Stretch it for extra clamping force

It's hard to attach edging to curves with conventional clamps, but packing tape works wonderfully. To get the thickness of the edge-banding that he wants without making it too stiff to bend, Ferrazzutti creates the banding from two thinner strips. He eases the outside corners of the outer strip with a block plane to prevent the tape from breaking as it is stretched.

Start clamping from the center outward. *Stretch the tape outward as if you're trying to break it, then wrap it down the faces of the panel (left). Check that the edging overhangs both sides of the panel. Ferrazzutti likes to leave the edging long so he can locate the last tape strip way out off the panel for good pressure at the corner (right).*

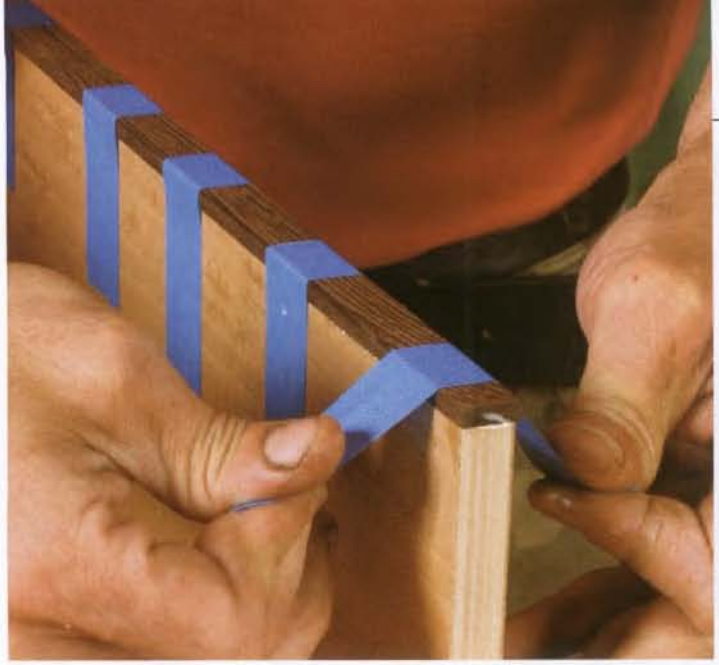
Blue tape

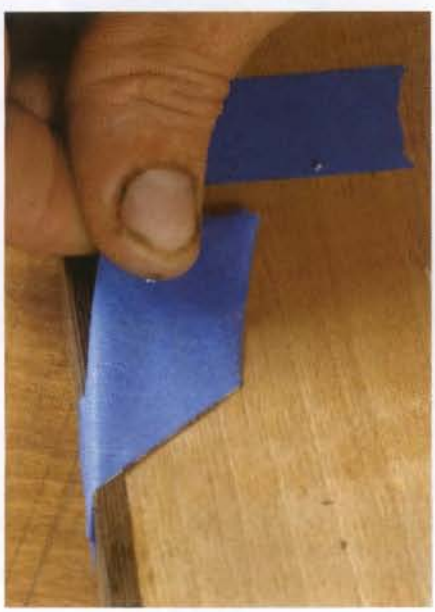
Apply straight edge-banding

When clamping edge-banding to plywood, tape is much easier to use than masses of regular clamps. Mill the edging about ⅛ in. wider than the thickness of the panel, and ease the outside corners of the edging so that the tape doesn't break when it is stretched. To make the glue-up go faster, tear off a number of pieces of tape and line them up on your bench.

Apply glue to the strip, but not the core. This helps prevent the plywood from swelling while you are clamping. Slide the banding back and forth until there is squeeze-out along the entire joint on both sides. Starting from the center, stick each tape strip to the banding, and then with equal pressure pull each end of the strip out and then down firmly onto both sides of the panel. After the glue is dry, remove the tape by pulling it as close as possible in line with the grain; this is less likely to pull out wood fibers than pulling the tape across the grain.

Bring the edging almost flush with the plywood veneer using a block plane or cabinet scraper. Then switch to a "safe" card scraper (below) until you start getting shavings from the veneer.





Clamp edge-banding with tape. *Stretch the tape outward, then wrap it down the faces of the panel (top). Check that the edging overhangs both sides of the panel. You can also use tape to clamp solid-wood corner banding to plywood boxes (above). Remove the tape in the direction of the grain to reduce the risk of pulling out wood fibers (right).*

SAFE EDGES PROTECT SURFACES

Control where you cut. *Create a card scraper with a "safe" edge by wrapping some tape around the end that is over the veneered panel (top). To make a "safe" file to flush the ends of edge-banding, wrap tape around the front of the file (bottom).*

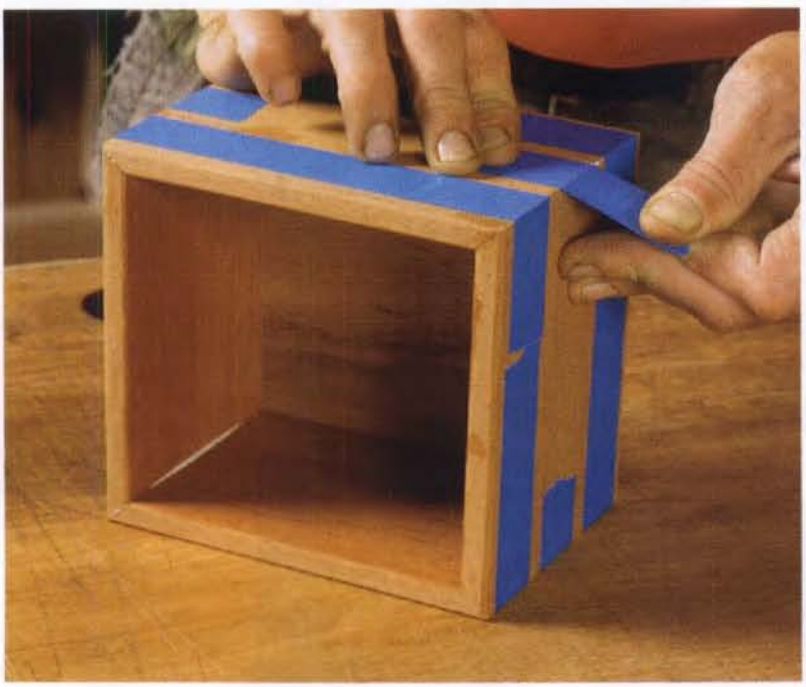
Assemble a mitered box

Miters are difficult to glue up with traditional clamps because the slightest imbalance in pressure can cause a side to squirm out of position. By applying uniform pressure to all four corners, tape overcomes this problem. Stretch strips of blue tape across the centers of the three adjoining joints, then stretch long pieces of tape along the entire length of the three joints. The number of strips will depend on the width of the miter joint. For this 5-in.-tall box, two strips are enough. By slightly stretching the tape, the joints are pulled tight and may even overlap very slightly.

Flip over the assembly and apply glue to the bevels of the miters. Insert the bottom of the box and begin rolling the assembly together. The tape provides clamping pressure and acts as a hinge, keeping the sides aligned. For the last corner, simply stretch short strips of tape across the joint. Check for square; you may need to lightly tap down a corner to maintain a flush edge.

It's a good idea to reinforce this type of joint using splines. Leave the tape on when cutting the slots on the tablesaw to avoid tearout, but remove it before gluing in the splines to avoid the risk of tape getting glued in with the spline.

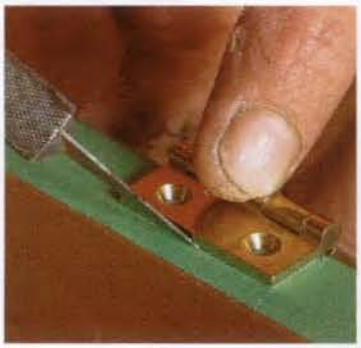
No-clamp glue-up. *Lay the four sides of the box on a bench, using a straightedge for alignment. Stretch short strips of tape across the center of the joints, then long pieces along the entire length (top). Flip the assembly, apply glue, insert the bottom of the box, and roll the assembly together (center). For the last corner, simply stretch short strips of tape across the joint (bottom).*

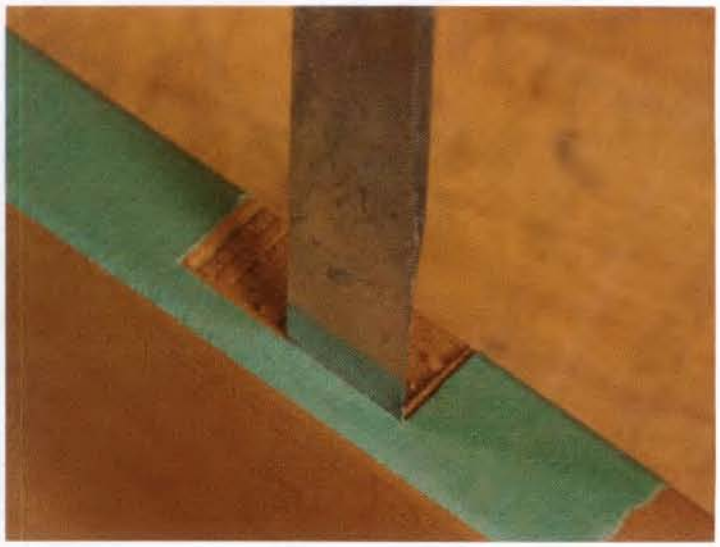


Perfect spline slots. *To avoid tearout, leave the tape in place when cutting the slots on the tablesaw.*

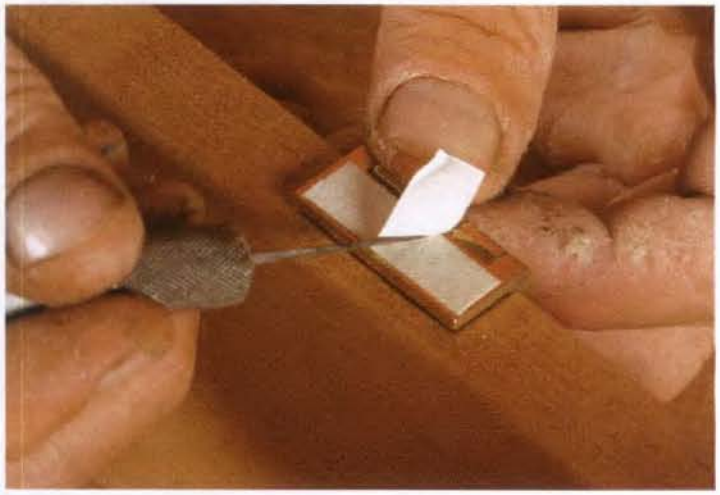
Green tape and double-faced tape

Combine them to simplify hinge installation





Locate the hinge mortise. *Apply green tape to the hinge area and attach a piece of double-faced tape to one leaf of the hinge (left). Then temporarily secure the hinge in its final location with double-faced tape and use a sharp X-Acto knife to scribe around the hinge (center). Peel away the cut-out section of tape, leaving a chiseling template. Chop away the bulk of the area while staying about 1/16 in. inside the tape perimeter, then make a paring cut along the line (right).*

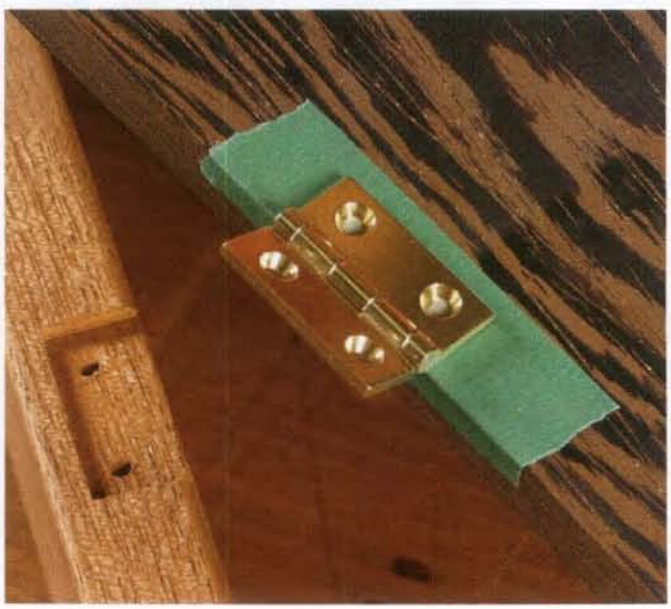


An ill-fitting door or lid is an eyesore, so you should install your hinges precisely. I originally developed this technique to achieve clean inlays in dark woods such as wenge, walnut, and ebony, where scribed pencil or knife lines are difficult to see even in the best of light. I now use it when inlaying on all woods, and when installing hinges and locks on doors and boxes.

Apply some green tape to the areas of the case where the hinges will be located. Then apply some thin double-faced tape to an outside leaf of each hinge.

After placing the hinge in the exact location desired, use a sharp X-Acto knife to scribe around the hinge, cutting through the tape. Peel away the tape from the field that needs to be chopped out, leaving the rest of the tape as a template surrounding the hinge area. Once the bulk of the wood is removed, place the back edge of a chisel against the edge of the tape and give the chisel a light tap with a mallet. The thin lip of the tape will act like a stop. Proceed around the outline until the final size of the recess has been defined.

Place the hinge in the recess and apply a piece of double-faced tape to the outside surface. Now place a piece of green tape on the door or lid where the hinge will be located, making sure the tape extends down the edge. Align the door to the cabinet or the lid to the box, press it down on the hinges, and then remove it with the hinge stuck to the green tape. Scribe around the hinge with a knife, and use a marking gauge set to the thickness of a hinge's leaf to mark the depth of the recess. Peel off the tape, remove the waste, install the hinge, and close a perfectly aligned door.



Determine the hinge location. *Set the hinge in the mortise and apply double-faced tape to the back of the other leaf (above). Apply green tape to the hinge area of the lid or door and carefully lower it into position. Lift off the lid or door and the hinge will stick to it (left). Scribe around the hinge and excavate the mortise in the same way as before.*

Low-Cost Lumber

With 12 great choices, you're bound to find a few near you

BY MATT KENNEY

Like most woodworkers, I love beautiful wood. And I want to use the best I can find in the furniture I make. Woods like cherry, walnut, and white oak, however, can cost $6 or $7 per board foot, and much more in some regions. Even in the best of times, that adds up quickly. In these hard times, with everyone's purse strings cinched tighter, it's not easy to drop several hundred dollars on wood.

It's possible to find cherry and walnut for less than retail if you buy green lumber from a small sawmill and dry it yourself, or if you're able to cut your own lumber. But those options are not open to everyone.

That's why I began to look around for some furniture woods that were high in quality but lower in cost. I asked editors and longtime authors, I queried lumber dealers around the country, and I scoured the Internet. I was given plenty of suggestions for low-cost woods, but not all of them panned out.

In the end, I whittled down the list to 12. True, most aren't suitable for high-style period furniture, but they work beautifully for almost everything else. Better yet, all cost less than $5 per board foot, some much less. Mind you, these prices are for rough lumber. You'll pay more if you need it surfaced.

Here's something else I learned. It makes sense to stay local. Being from the South, I've used white ash for furniture and never paid more than $2 per board foot. But I'd never heard of aspen or red alder, which are available out West, and at bargain prices.

So take a look at these low-cost but overlooked furniture woods, find one that grows in your area, and head out to the lumberyard. Don't let the economy keep you from making beautiful furniture.

Matt Kenney is an associate editor.

Behind the numbers

The best way to identify a wood's hardness, workability, and proclivity to warping and checking, without using subjective terms such as fair, good, hard, or soft, is with numbers. That's why we give the specific gravity and percent shrinkage for each species listed. More information about wood shrinkage can be found by visiting the Forest Products Laboratory Web site at www.fpl.fs.fed.us.

A wood's **specific gravity** speaks to how hard, dense, and heavy it is. The higher a wood's specific gravity, the tougher and stronger it is, basically. These numbers also mean that cherry and walnut are easier to work—by hand or machine—than white oak.

The **percent shrinkage** indicates a wood's stability. There are three numbers to consider: tangential and radial shrinkage, taken on their own, and the ratio of the two. As the ratio of tangential to radial shrinkage gets higher, wood is more prone to warping.

WOOD TYPE	SPECIFIC GRAVITY	PERCENT SHRINKAGE		
		Tangential	Radial	T/R ratio
Cherry	0.50	7.1	3.7	1.9
Walnut	0.55	7.8	5.5	1.4
White oak	0.68	10.5	5.6	1.8

Photos, except where noted: staff

Available throughout the United States

Beech

Average price: $2–$3 bd. ft.
Specific gravity: 0.064
Percent shrinkage:
Tangential 11.9, Radial 5.5
T/R ratio 2.2

Once favored for handplanes and other tools, beech is tough, even-grained, attractive, and fairly easy to work. It has the soft, fleshy tones of pear, with very fine, light flecks. Beech isn't known for its stability, so design accordingly.

"If oak is masculine, beech is feminine, and sexy too."
—Garrett Hack, contributing editor

Small scale, big effect. *Scott King (Barbados) used the soft tones and understated grain of beech to great effect in this tabletop treasure box, where garish grain would have upset the delicacy of the small parts.*

Hickory

Average price: $3–$4 bd. ft.
Specific gravity: 0.72
Percent shrinkage:
Tangential 10.5, Radial 7.0
T/R ratio 1.4

With a warmth and tone similar to raw cherry, hickory is a beautiful furniture wood, even if doesn't darken with age. It's extremely difficult to work with hand tools, but power tools can get the job done. Be wary of cracks: Once one starts, it tends to dive deeper. There are several types of hickory, shagbark being common, but there's little difference among them.

"Hickory often has wonderful, flame-like grain patterns like walnut or butternut. The more I use hickory, the more I like it."
—Peter Turner, frequent contributor

Strength and beauty. *Renowned woodworker James Krenov (Calif.) put the strength of hickory to good use. The hickory legs and frame are delicate but strong enough to support this pear cabinet.*

Poplar

Average price: $1–$2 bd. ft.
Specific gravity: 0.42
Percent shrinkage:
Tangential 8.2, Radial 4.6
T/R ratio 1.8

Poplar is often used as a secondary wood in furniture, and most woodworkers are hesitant to let it take center stage. One reason is its green streaking, which some try to hide under a coat of stain. But staining doesn't work well, because poplar is prone to blotching. Instead, finish with oil and let the poplar age gracefully.

"The creamy color of poplar ages to a mellow gold, while the green streaks turn dark brown. Arranged with care, these colors can be used to nice effect."
—Mike Pekovich, FWW art director

High-contrast wood. *In this bench by Pekovich (Conn.), the light and dark streaks of the poplar top add visual interest and blend well with the walnut base.*

Photos, this page: Ingeborg Suzanne (top right); Jonathan Binzen (center right)

Red oak

Smart design quiets loud grain. *This writing desk by Stephen Lamont (Alton, England) proves that red oak, despite its dark grain lines, can have a subdued beauty.*

Plainsawn red oak, with big cathedrals of grain swathed in stain and encased in polyurethane, is often associated with factory-made furniture that has little personality. But rift- or quartersawn red oak is a different story. The straight grain adds a clean, linear element to furniture, and its subtle ray fleck shimmers. It's often stacked, and priced, with the plainsawn stuff. You'll sometimes find curly boards in the same stack.

"Quartersawn red oak is sleek, handsome, hard wearing, and it works nicely."
—Mario Rodriguez, frequent contributor

Average price: $2–$3 bd. ft.
Specific gravity: 0.63
Percent shrinkage:
Tangential 8.6, Radial 4.0
T/R ratio 2.2

Soft maple

Spectacular figure, reasonable price. *Pekovich found the curly maple for this Shaker side table by digging through the soft-maple bin at a local hardwood dealer.*

It's hard to believe that soft maple isn't more popular as a primary wood. It has a uniform color and a nice grain pattern that is often indistinguishable from hard maple, and it's much easier to work. Soft maple is great for ebonizing. There's more than one species sold as soft maple, but they're all maples and are essentially the same.

"Often, figured soft maple isn't separated out from the regular boards. So to find it, you only need to dig through the stack."
—Roland Johnson, contributing editor

Average price: $3–$4 bd. ft.
Specific gravity: 0.54
Percent shrinkage:
Tangential 8.2, Radial 4.0
T/R ratio 2.0

White ash

Beautiful curves. *The wishbone curves of this chair and desk by Doug Chamblin (Ore.) display the beauty, strength, and bendability of white ash.*

Less dense than oak, white ash is a joy to work with hand tools. It's easy to work with machines and power tools, too. Given its weight, ash is tremendously strong, and it steam-bends very well, even when kiln-dried. So it's a great wood for chairs or any furniture parts, like legs and aprons, that might be curved. And the rich, creamy color of white ash makes it a great wood for fine furniture.

"Quartersawn boards, still available in wide widths, are especially stunning, and cost less than cherry and walnut."
—Matt Kenney, associate editor

Average price: $2–$3
Specific gravity: 0.60
Percent shrinkage:
Tangential 7.8, Radial 4.9
T/R ratio 1.6

Photos, this page: Mark Anderman (top left); Seth Tice-Lewis (bottom left)

Midwest/West

Aspen

Aspen is creamy white with a faint grain, and is slightly softer than cherry. Once dry, it's remarkably stable. The occasional tree can have as much flash and pop as the best curly maple. Aspen usually works well with hand tools or power tools, glues easily, and takes paint very well.

"Aspen is my favorite alternative to woods like cherry and walnut. It's an ideal secondary wood, but also is beautiful enough for an entire piece of furniture."

—Garrett Hack

Average price: $2–$3 bd. ft.
Specific gravity: 0.38
Percent shrinkage:
Tangential 6.7, Radial 3.5
T/R ratio 1.9

Plays well with others. *The light color and subtle grain of aspen blend well with other woods, such as the alder drawer fronts of this cabinet by Matt Kenney (Conn.).*

Red elm

The distinctive grain of red elm is a cross between ash and red oak, and when quartersawn it lacks the medullary rays (ray fleck) prominent in oaks. In color, red elm can vary from light tan to reddish brown, with hints of yellow and green. When roughsawn, it might appear a bit sickly, but once milled and given a hand-planed surface, it's very attractive.

"Easy to work and dimensionally stable, red elm makes a great furniture wood. It's one of my personal favorites."

—Roland Johnson

Average price: $2–$3 bd. ft.
Specific gravity: 0.53
Percent shrinkage:
Tangential 8.9, Radial 4.9
T/R ratio 1.8

Wood and design work together. *The straight grain of riftsawn red elm complements the lines of this side table by Kevin Kauffunger (Penn.), and its reddish color adds warmth.*

Red alder

Often referred to as poor-man's cherry, red alder has a grain pattern similar to cherry. It's dimensionally stable, relatively light, and works beautifully. Wide, clear, and long pieces are readily available. It takes a stain or dye well, and with the right color is a good cherry imposter.

"Red alder has a nicer grain pattern than cherry, and its sapwood is less of a headache when it's time to apply a finish."

—Mark Edmundson, frequent contributor

Average price: $4–$5 bd. ft.
Specific gravity: 0.41
Percent shrinkage:
Tangential 7.3, Radial 4.4
T/R ratio 1.1

Subtle grain, rich color. *Red alder has the warmth of cherry, with slightly more subtle grain, making it great for furniture with clean lines, like this table by Kenney.*

Photo, this page (center right): Kevin Kauffunger

East

Eastern white pine

Casual, but refined. *The relaxed feel of Eastern white pine is perfect for understated but elegant pieces like this Shaker lap desk by Christian Becksvoort (Maine).*

Plentiful, beautiful, and still available as wide planks, eastern white pine is a great furniture wood. It's easy to work, and a sharp handplane will leave a beautiful luster on the surface. Knots and pitch pockets can gum up your tools, but you can cut ruthlessly around them to get beautiful boards. You can do the same with a less-expensive grade, and save money.

"My favorite softwood, because it smells great, is a pleasure to work, and when quartersawn, it's more stable than any other native North American wood."

—Christian Becksvoort, contributing editor

Average price:
Select: $2–$3 bd. ft.;
1 common: $2 bd. ft.

Specific gravity: 0.35

Percent shrinkage:
Tangential 6.1, Radial 2.1
T/R ratio 2.9

Sassafras

An imposter with its own identity. *The color and grain of sassafras make it a great substitute for chestnut, but this step stool by Kelly Mehler (Ky.) shows that it can stand on its own as a furniture wood.*

A soft, open-pored wood with distinct grain patterns, sassafras gives off a unique but pleasant aroma when worked. Because of its light brown color, it can be substituted for chestnut. As a secondary wood, it has a stronger impact than poplar or maple, and it looks great as a primary wood, too.

"Sassafras is a pleasure to work. It's soft, cuts cleanly, and has a tangy aroma."

—Jon Arno, Fine Woodworking's late, great expert on wood

Average price: $3–$4 bd. ft.

Specific gravity: 0.45

Percent shrinkage:
Tangential 6.2, Radial 4.0
T/R ratio 1.6

Yellow birch

Furniture in flames. *Figured yellow birch is fairly common and can be used to add drama. Hank Gilpin (R.I.) chose a single splendid board for the drawer fronts of this sideboard in yellow birch.*

Because it's used heavily in kitchen cabinets, yellow birch is available at most lumberyards. Take your time going through the stack and you'll find some beautiful boards. It can be brittle and difficult to work, but patience gets around those problems. Curly yellow birch is also available, and is less expensive than curly maple or flame birch.

"Yellow birch isn't used enough as a primary wood, which is a shame, because it's beautiful."

—Christian Becksvoort

Average price: $4–$5 bd. ft.

Specific gravity: 0.62

Percent shrinkage:
Tangential 9.2, Radial 7.2
T/R ratio 1.3

Photos, this page: Dennis Griggs (top left); Hank Gilpin (bottom left)

End

NEW ANGLE ON GRAIN

End grain can bring a new perspective to working in wood. With a finish applied, the colors of domestic end grains are as vivid as the long grain of exotics, with striking textures and contrasts. Balance is important, though, when it comes to both looks and wood movement.

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

Grain Up

Bring butcher's block out of the kitchen with these design and construction tips

BY MARK KOONS

I started working with end grain because it packs an intense visual punch and gave me a use for scrap pieces that would otherwise have been discarded. End grain also allows me to use domestic woods with renewed interest because it brings out different grain features and colors than can be seen in the long grain. I also discovered that end-grain slabs allow unique furniture forms (see "Add an apron and legs," p. 78) that wouldn't be possible with long-grain construction.

End grain creates a very durable tabletop. Butcher-block countertops wear out knives before they need resurfacing, and finishes can wick deep beneath the surface of end grain, adding to its imperviousness. Of course, this quality isn't as important in a coffee table as it is in a countertop, but is it ever a problem to have a tabletop that's too durable?

Working with end grain up takes a good deal of planning, consideration of wood movement, and repetitive steps. But the results are worth the effort. I use end-grain construction in kitchenware, but this type of construction can be just as beautiful in high-end furniture as it is utilitarian in the kitchen. If you are intrigued by the possibilities of end grain, here's what you need to know.

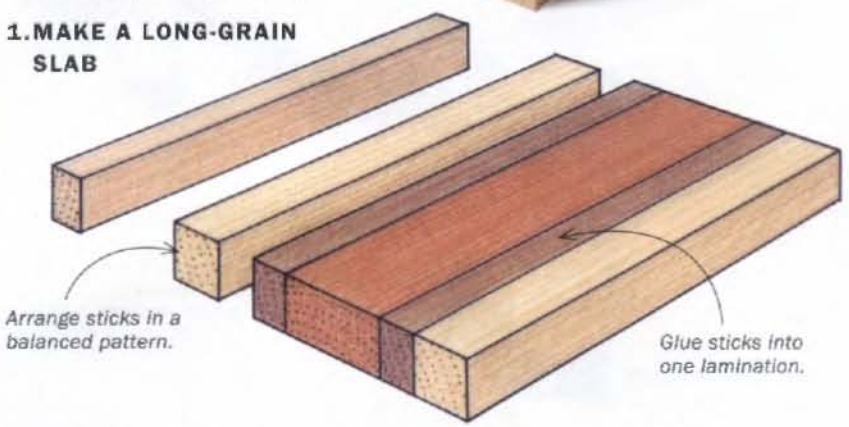
Arrangement of wood is key to success

The greatest challenge to this work is wood movement. Wood always expands or contracts with changes in humidity. The solution is balancing the construction—arranging the parts based on grain direction.

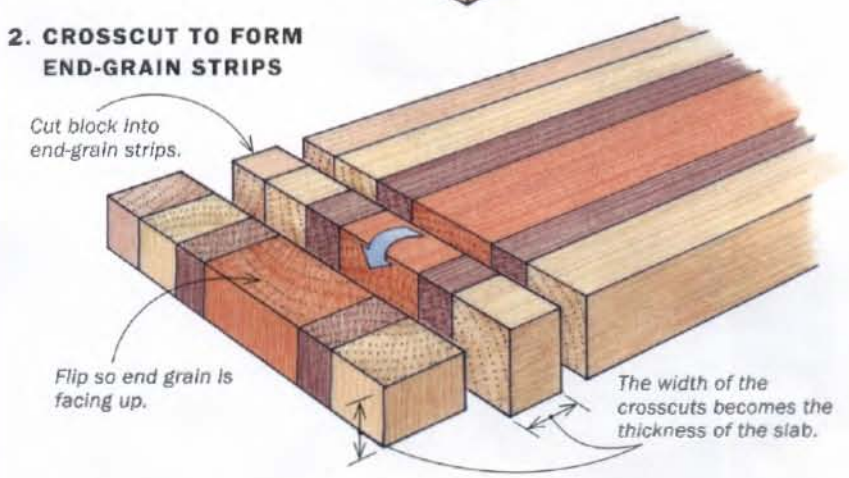
You could put the pieces together without considering their orientation, but that randomness would lead to an unstable slab. For example, instead of

THE BASIC STEPS

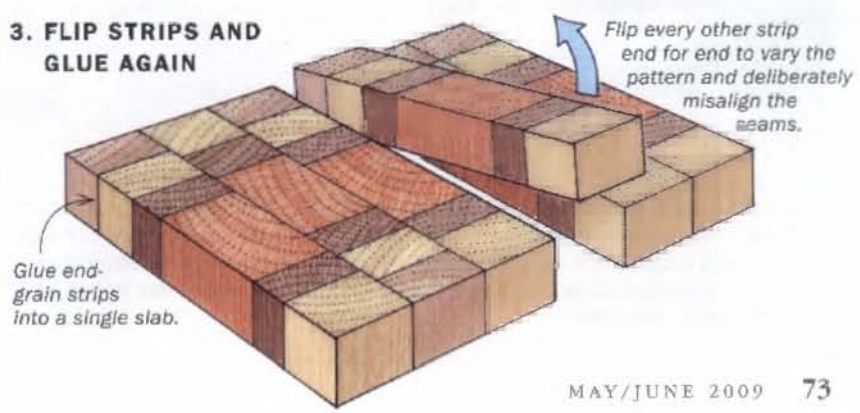
1. MAKE A LONG-GRAIN SLAB



2. CROSSCUT TO FORM END-GRAIN STRIPS



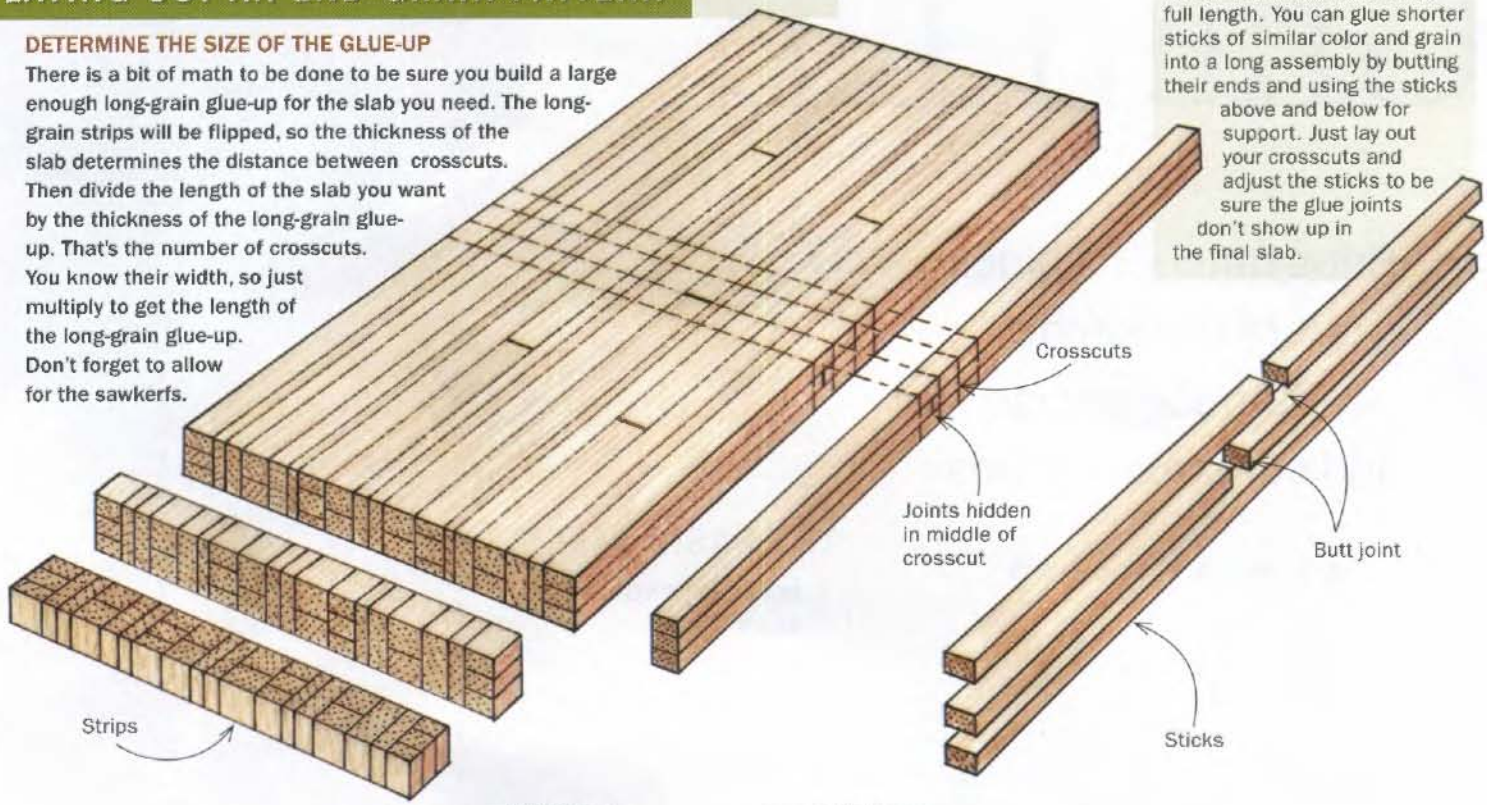
3. FLIP STRIPS AND GLUE AGAIN



LAYING OUT AN END-GRAIN PATTERN

DETERMINE THE SIZE OF THE GLUE-UP

There is a bit of math to be done to be sure you build a large enough long-grain glue-up for the slab you need. The long-grain strips will be flipped, so the thickness of the slab determines the distance between crosscuts. Then divide the length of the slab you want by the thickness of the long-grain glue-up. That's the number of crosscuts. You know their width, so just multiply to get the length of the long-grain glue-up. Don't forget to allow for the sawkerfs.

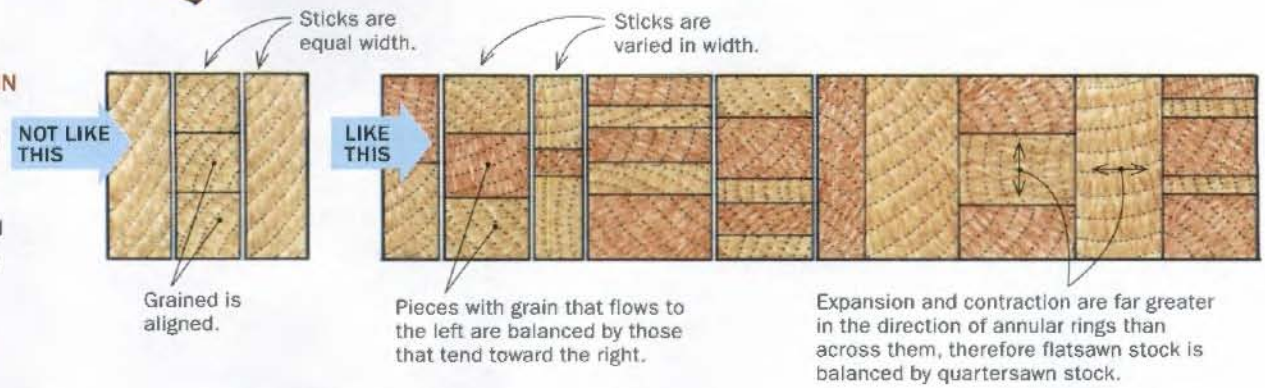


TIP

Not all the sticks need to be full length. You can glue shorter sticks of similar color and grain into a long assembly by butting their ends and using the sticks above and below for support. Just lay out your crosscuts and adjust the sticks to be sure the glue joints don't show up in the final slab.

BALANCE THE GRAIN

The force of all the grain in these pieces moving in the same direction could be strong enough to pull apart the glue joints.



Check the seams. *After crosscutting, alternate end-grain strips will be flipped end for end to create a repeating pattern. If any seams line up, they will be aligned all the way down the length of the end-grain pattern. To prevent this, Koons double-checks his array of long-grain strips with a ruler that starts at zero in the center and counts outward in both directions.*

deliberately arranging annular rings so that they alternate in direction and restrain each other's movement, you could end up with a row of end grain that all moves in the same direction. If you compound the problem in the adjoining row, the laminations will pull apart in about one year's time.

Keep in mind that smaller overall slabs accumulate less internal stress than large ones. Also, thinner assemblies generate less stress than thicker ones. So the thicker or larger an end-grain construction, the greater its tendency to move and surface check if the grain isn't arranged carefully.

Beginners also should consider that a single-species lamination, especially of some relatively stable wood like walnut, will be easier to lay out than one patterning a range of species with different expansion properties. Also, you can get plenty of contrast from the grain patterns and colors of a single species, while it's easier to create an eyesore when mixing woods.

Photos, except where noted: Anissa Kapsales; drawings: Vince Babak

1. GLUE UP THE STICKS

Be generous with glue. *Use a squeeze bottle and roller to spread glue on both faces. For a large surface that requires longer working time, glue half the lamination first and add the other half after it dries. Do a dry run to work out the arrangement and pre-adjust the clamps, then apply glue. Set the horizontal clamps in place, but don't tighten them. Loosely clamp the top cauls to the bottoms, and then loosely tighten the horizontal clamps. Now, snug the top and bottom clamps down tightly and go back to tighten the horizontals.*

CROSSCUT INTO END-GRAIN STRIPS

Begin crosscutting at the center. *To make the slab more manageable and reduce cumulative error across the top, crosscut the slab at the center (left). Then reference off the rip fence to cut the rest of the strips to the same width (right).*

Clean up the end-grain strips. *Take the end-grain crosscuts and skim about 1/16 in. off one side with a ripcut on the tablesaw. Then move the fence to take another skimming ripcut on the other side. If your gluing, clamping, and ripping were carefully done, you won't have much to clean up.*

Different wood species have different rates of tangential (parallel to the growth rings and perpendicular to the grain) and radial (perpendicular to growth rings) shrinkage. So if you do mix woods, species that are stable should be used to restrain those that are less stable. You can research the stability of different species in R. Bruce Hoadley's *Understanding Wood* (The Taunton Press, 2005) or at the Web site of the Forest Products Laboratory (www.fpl.fs.fed.us).

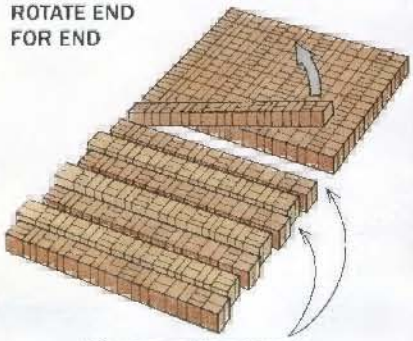
Butcher-block assembly made easy

Creating fields of end grain does not require fitting together hundreds of little cubes. Nor does it involve sawing off laminations like slices of salami, although some manufacturers do exactly that. My process involves two big glue-ups: a long grain glue-up and then an end-grain glue-up. Basically, I glue sticks together, surface and crosscut them, and then reglue them as end grain.

Arrange the sticks—First, I rip the sticks to width. Before any glue is spread, I arrange the components, balancing them the way I described earlier, to make good visual and structural sense in the final assembly. I pay attention to grain, widths of the sticks, species, and color. Once I settle on an arrangement, I mark the sticks with a soft pencil to keep track of the order. Throughout the process, I continually mark the pieces to keep them arranged in the

2. GLUE UP END-GRAIN STRIPS

Mark, flip, mark, glue. *Put the end-grain sticks back in their original order and mark them (right) so you can easily reorder the sticks after experimenting with different flips. You can flip and rotate, or just flip. Here, Koons flips every other stick upside down and end for end (below).*



Flip every other piece to orient the pattern and balance the stresses.

Glue them back together. *Use the same procedure as you did with the long-grain lamination to glue up the end-grain sticks. Taking the time to tape all the seams before the glue-up will keep the glue from seeping into the end grain and save you cleanup time later.*

correct order. In determining the length of your sticks and crosscuts, it's important to make note of the relationship between the thickness of the first lamination (the long-grain slab), the width of the subsequent crosscuts, and the overall thickness and length of the tabletop. The thickness of the long-grain slab will determine the width of the repeating end-grain pattern on your tabletop. The width of the crosscuts of the long-grain slab will determine the thickness of the top.

As an example, if I wanted to build a tabletop 1 in. thick by 24 in. wide by 36 in. long, I could begin by making a long-grain slab that was 2⅛ in. thick by about 24$^{3}/_{16}$ in. wide (leaving a little extra to trim the assembly square later). For the 1-in.-thick top, I would make my crosscuts 1$^{1}/_{32}$ in. But how long should I make the long-grain slab? If the crosscuts are a heavy 1 in. and they get turned end grain up so the 2⅛-in. pattern is facing the top and bottom, then I'll need at least 18 in. plus the amount of 15 sawkerfs for the length of the long-grain lamination. But why cut it close? Make the lamination longer than you need, even if that means a few extra crosscuts kicking around.

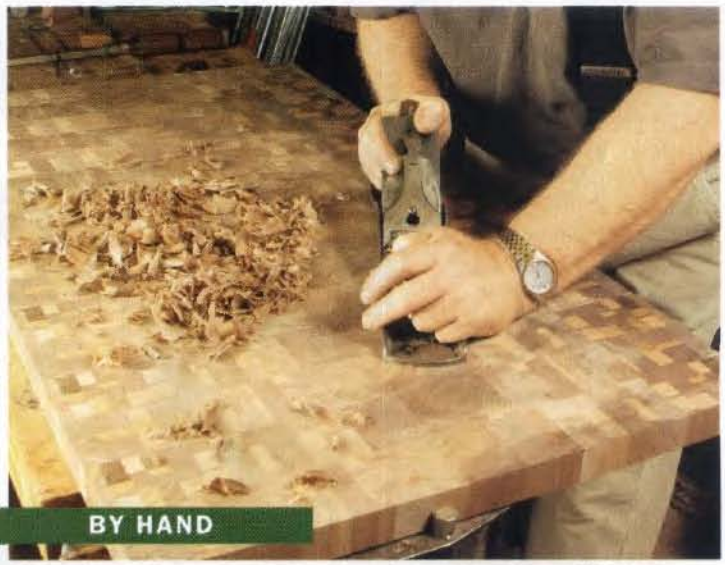
Glue and clamp the sticks—Once the assembly is arranged, it's time to glue the sticks into one wide, long board. Some of the sticks are made from multiple layers, and some of those are made of short sticks butt-jointed and held in place when glued to the adjoining layer. Those multilayered sticks must get jointed and planed before becoming part of the larger glue-up.

The cauls should be very straight and sturdy to prevent flexing, as they will determine how level the glue-up is. The lower cauls rest between pipe clamps and hold the work up off the bench and slightly above the clamps. The upper cauls have a layer of cork on the bottom side that helps press the work flat against the lower cauls. Make sure all the cauls are stick-free by taping or waxing.

You'll need a flexible adhesive. Yellow glue is notorious for cold-creep, the tendency for a glue to allow slow but inevitable movement over years. Here, that is an asset because it stretches when the wood expands and contracts as the wood does.

Surface then crosscut vs. crosscut then surface—Once the sticks are glued into a slab, you can make the crosscuts that establish the end-grain surface. This is a crucial place for quality machining. The more variation here, the more effort it will take to smooth the surface. You'll need a clean, sharp blade squared to the table, a zero-clearance throat plate, and a sacrificial backup fence on your crosscut sled or

3. SMOOTH THE SLAB



Or use handplanes. *The low angle and very sharp blade of this jack plane leave a smooth, refined surface. Put an arc, or camber, in the plane iron to keep the edges from digging in, and work from the outside in to avoid breakage on the edges.*

Sanders are one option. *Use different colors of chalk to mark the high spots and low spots. Using a belt sander, begin to remove the high spots only (above). Stop to reassess the surface with a straightedge and re-mark the high spots to sand again. Repeat until the surface is flat. The final surfacing is done with a random-orbit sander (right).*

miter gauge—elevated a little to keep dust from affecting the width of the crosscut. Ideally, you'll want no burn marks or saw flutter on your cuts. Every 0.001 in. error is 0.001 in. you'll have to work off across the entire slab later.

Remove the clamps and scrape off the excess glue while it is still rubbery. If you have a planer wider than the slab, use it to surface the board before making end-grain crosscuts.

If your planer isn't wide enough to accommodate the tabletop, you'll have to clean up the surface with a scraper, crosscut first, and then use my tablesaw trick (see bottom right photo, p. 75) to lightly skim the surfaces of the crosscuts before regluing them into the final end-grain lamination. Once you've cleaned up all the sides of the end-grain strips,

Two finishing options

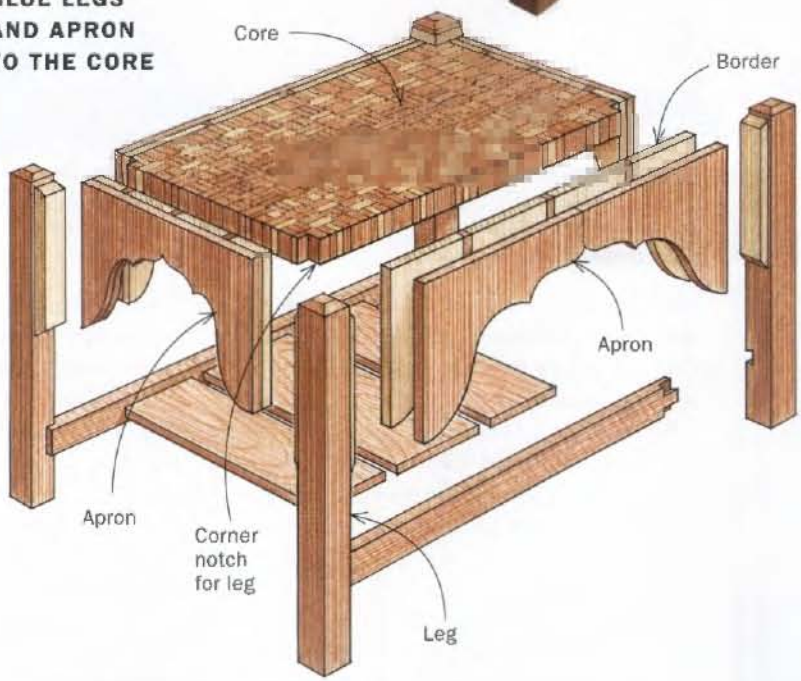
A finish fit for furniture. *Koons uses four to six coats (depending on how porous the wood is and how thin the finish) of a spar varnish/tung oil mixture to finish end grain in furniture. Before that, he seals the end grain with blond shellac to keep the colors vibrant and clear under the varnish.*

One suited for the kitchen. *A beeswax-walnut oil blend, about 1 oz. wax to 3 oz. oil, is ideal for kitchenware. This combo is fragrant, nontoxic, attractive, easily renewed, and cheap. Apply generously in a circular motion and wipe off the excess.*

ADD AN APRON AND LEGS

Because of the end-grain orientation, legs, a border, and an apron can be glued directly to the top. The legs could be notched directly into the top, but for a minimal investment of time, the border and apron dress up the core and add the appearance of depth to the entire top.

GLUE LEGS AND APRON TO THE CORE



arrange them back in order and witness-mark them. Now flip every other strip end for end and upside down, use a straightedge on the edges and a square on the end to square up the whole arrangement, and witness-mark them again. Align this mark in the final glue-up to keep the end-grain sticks square. Now you're ready to glue the crosscut strips into the final slab. Use the same procedure for the final gluing that you used when you glued the long-grain sticks together; but this time, the cauls and clamps run lengthwise.

Surfacing end grain

Because end grain is more durable than long grain and can be dangerous to run through jointers or planers, it takes a bit more work to surface. If you have your own wide-belt sander, then you are in luck. Renting time on a wide-belt sander is also an option, but short of that I've had success with a belt sander and random-orbit sander, as well as with handplanes.

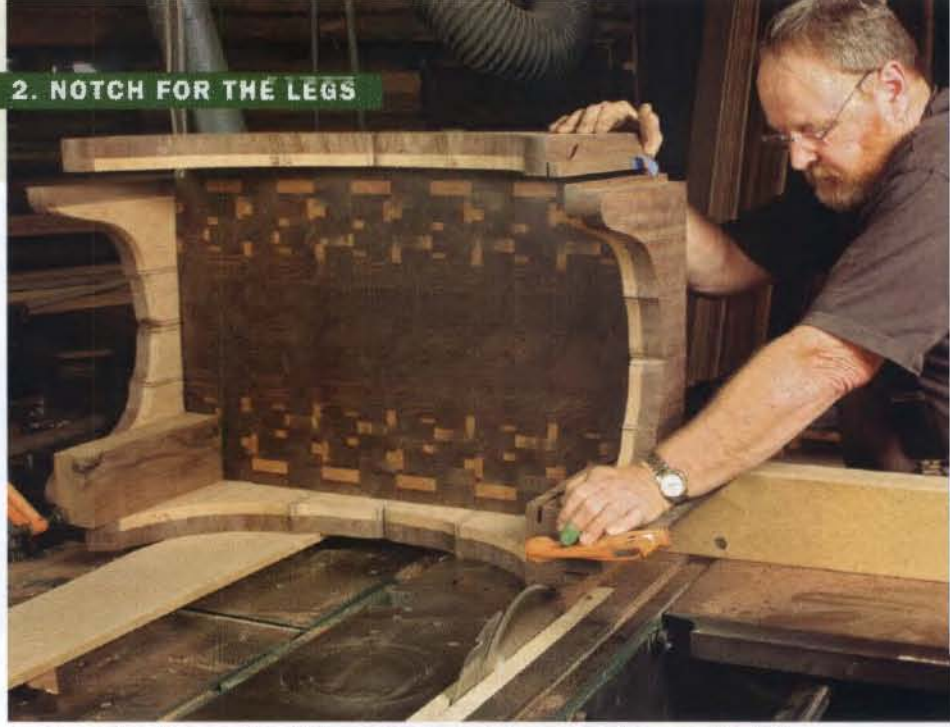
If you don't use a belt sander often, practice gliding the running sander squarely onto a test piece and backing off while slipping it sideways. On the actual workpiece, mark the high and low spots, grind away the high spots, and continually stop and check your progress with a straightedge, re-marking if necessary. Begin with 60- to 80-grit paper and move up to 220 grit on the belt sander. Clean and inspect the surface for uniform scratching before changing to a finer grit. When the defects are ground away and the surface is flat, move to the random-orbit sander, beginning with 80 or 100 grit and proceeding through 220 grit.

A well-planed surface is always the most beautiful. If you have a low-angle jack plane—even a low-angle

1. START WITH THE APRON

Create a border and apron. *After edge-gluing boards for one border and one apron per side of the table, laminate the border to the apron (left), and then use a scrollsaw or bandsaw to cut the shape of the apron (right). Sanding and filing will refine the shape.*

Apply the apron. *Working on one side at a time, clamp the apron in place and predrill and tap in a brad to locate the apron during the glue-up (left). Koons left the inside border slightly wider to accommodate the nail. Any excess material gets trimmed off when notching for the leg, which will cover the nail hole. Make sure the apron is square to the tabletop (right).*



Cut the notch. *Koons adds a higher, longer fence to the crosscut fence on his sliding tablesaw. It adds stability and extends the slider to the other side of the table, which is necessary because various cuts are made with the table extending to each side.*

No. 4 block plane will work—sharpen it well (expect to go back to your stones frequently), ease the corners of the blade, and work from the outside edges of the workpiece toward the center. In some ways it's easier to plane end grain because you don't have to worry about reversing grain. I've also had success with a standard-angle No. 7 plane equipped with a very sharp Hock iron.

A different approach to aprons and leg joinery

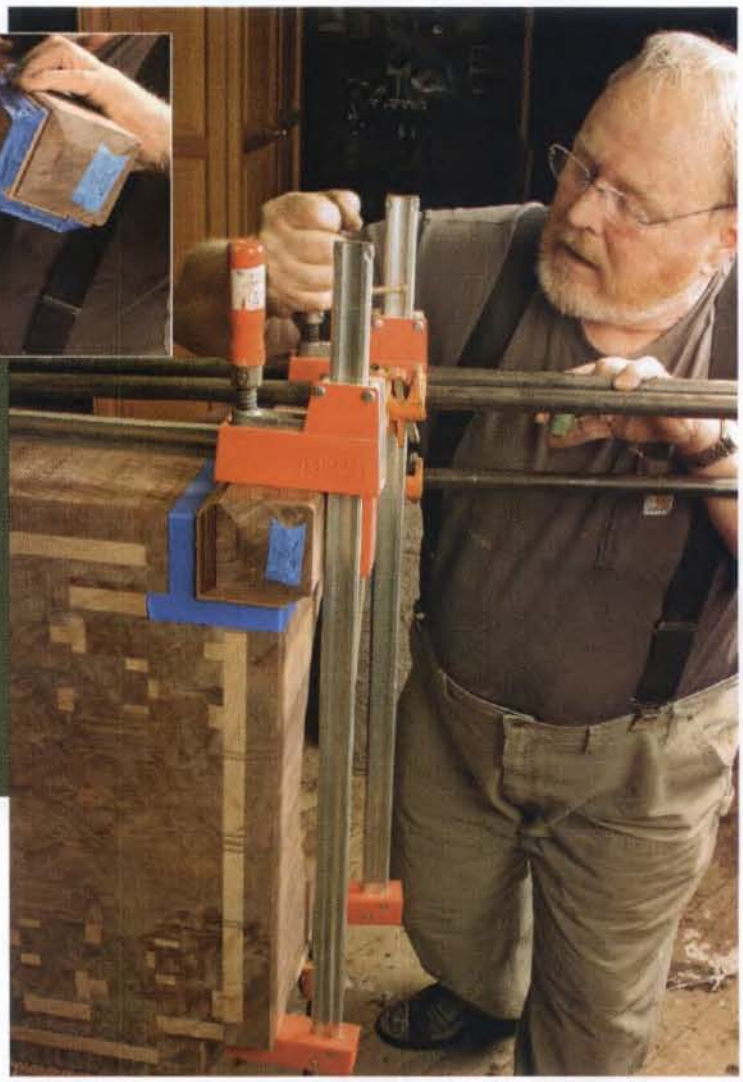
Long-grain tabletops are typically attached to a leg-and-apron system, and that type of assembly can be done with an end-grain tabletop as well. But end-grain work offers an alternative. Legs and aprons can be glued onto the edges of an end-grain slab. My method happens after the core tabletop is completely glued together.

At the same time as the apron, I add a border of the same width and length to my construction. It sits outside the table core but inside the apron and creates a transition between the tabletop pattern and the outside apron.

To create a border/apron combination, start by edge-gluing sticks into sections that fit the sides of the core. Keep in mind that you still have to balance the arrangement of the sticks in the border/apron construction. Once those sections are dry, laminate them to one another. Use a scrollsaw to cut the shape, and files and sanding drums to refine it. Then glue and clamp the apron assembly to the core.

Once the apron is secured on the core, I use my sliding tablesaw to cut corner notches for the legs. Don't worry if you don't have a slider on your tablesaw. Before I had one I used a shopmade crosscut sled to carry the tabletop assembly across the blade while notching out for the legs. Assuming a pair of miter-gauge slots and an extension to the right and behind the sawblade, make the sled out of two hardwood strips 20 in. long and two fences 2¼ in. by 5½ in., the front one about 16 in. long and the back one about 60 in. long.

You can assemble the sled right on the saw by gluing the fences square to the guide strips and the blade, then flipping the assembly and screwing the joints before the glue is fully cured. □



Glue the legs in place. *Taping anywhere squeeze-out will seep onto the end grain or surrounding area will save you cleanup time (above). Once the leg is glued in place, apply clamp pressure in both directions (right).*

Mark Koons is a self-employed woodworker in Wheatland, Wyo.

readers gallery

DAVID BENETELLO
Hartford, Vt.

Benetello based this cylinder-top desk (21 in. deep by 34 in. wide by 47 in. tall) on one in Thomas Sheraton's *The Cabinet Maker and Upholsterer's Drawing Book*. The mahogany case is joined with hidden mitered dovetails. The veneered lid and writing surface are connected with a ball bearing/strap mechanism so the lid opens as the writing surface is pulled out. Other woods are Brazilian rosewood, Macassar ebony, holly, black-dyed costello, and pine. The finish is shellac and wax. PHOTOS: LANCE PATTERSON

SAM NORRIS
Burlington, Vt.

Norris blended the influence of James Krenov with his own sense of scale to create this sideboard. The Swiss pear, big-leaf maple, and Deodar cedar sideboard is 14 in. deep by 44 in. wide by 42 in. tall. The finish is shellac. PHOTO: SETH JANOFSKY

Toolmakers wanted

Do you make your own woodworking tools? We want to showcase them in our annual *Tools & Shops* issue. We'd also like to include photos of restored vintage hand tools and machinery. Send entry forms (available at www.finewoodworking.com) and photos (unaltered digital images, prints with negatives, or slides) to Readers Gallery, *FWW*, 63 S. Main St., Newtown, CT 06470, or email fwgallery@taunton.com. The deadline is June 18.

JOHN OLENIK
Ballston Spa, N.Y.

Heavily influenced by the furniture of Greene and Greene, Olenik designed and built this sideboard (24 in. deep by 60 in. wide by 39 in. tall) as a gift for his daughter. The project took 600 hours over the course of a year. To ensure a precise color match, all of the mahogany came from two 28-in. by 16-ft. boards. Secondary woods are ebony, maple, and quartersawn oak. The finish is an oil/varnish mixture and wax.

RUSSELL F. GALE JR.
Fort Bragg, Calif.

When building this wall clock, Gale incorporated the techniques of veneering, bent-lamination, and steam-bending learned during his second semester at the College of the Redwoods. To keep the design as simple as possible, he veneered the face with 12 separate sections, eliminating the need for numbers or reference points. The biggest challenge of the project was the beadwork around the dial opening. The granadillo, hemlock, and snakewood clock is 5½ in. deep by 8 in. wide by 30 in. tall. The finish is shellac and wax, and the movement is a Hermle 14-day coil gong. PHOTOS: DAVID WELTER

FRANK DEJONG
Toronto, Ont., Canada

DeJong spent nearly 150 hours making this ash bar stool (21¾ in. deep by 17 in. wide by 38 in. tall). It was a lesson in sketching, refining a design, and angled joinery. The finish is linseed oil and oil-based polyurethane.

GREG PENNINGTON
Hendersonville, Tenn.

When building this white oak, maple, and basswood settee, Pennington shaped all 45 spindles by hand with a drawknife and spokeshave. The undercarriage was turned on the lathe, and the seat was carved with a scorp and travisher. Pennington says it was "an adventure in problem solving and geometry which resulted in many hours of fun." The chair, finished with milk paint, oil, and varnish, is 21 in. deep by 78 in. wide by 47 in. tall.
PHOTO: JOHN LUCAS

TODD PLUMMER
Morgan Hill, Calif.

This coffee table features a canvas-backed tambour that slides around the circumference of the piece. Sliding the tambour reveals compartments at the ends of the table and a central through-drawer. Plummer was inspired by tambours while studying Scandinavian design at Capellagården in Sweden. The top is big-leaf maple veneer over quartersawn poplar staves. The rest of the table (21 in. deep by 40 in. wide by 17 in. tall) is solid curly maple. The finish is shellac and wax. PHOTOS: ANDREW PATTERSON

RICK CANNON
Memphis, Tenn.

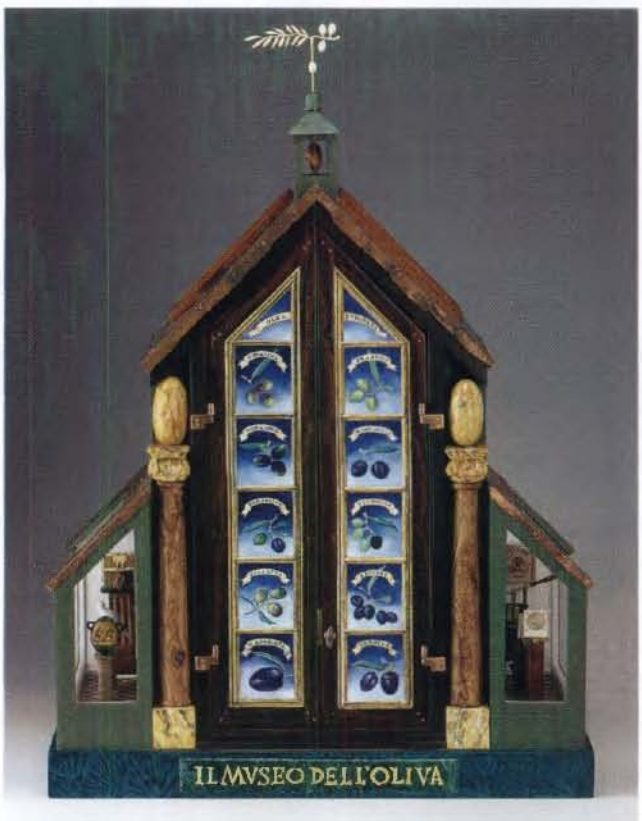
Cannon made this bowl in less than four hours from some rough boards rescued from a landfill. The darker wood is walnut, but the lighter wood is a mystery. His inspiration for the design and form came from the wood-turning books of Ray Key and Bert Marsh. The bowl, 6 in. dia. by 4½ in. tall, was finished with blond shellac.

TED SAXERUD
Arlington, Va.

Saxerud made a deal with his wife: If he could buy a tablesaw he'd build her a dining table. Once he built the table and she knew what beautiful things he was capable of making, she asked for a place to store her family china. This cherry corner cabinet (one of two) incorporates bubinga, sycamore, and ebony inlay. Saxerud used splined miter joints on the angled parts and mortise-and-tenon joints everywhere else. The cabinet, finished with shellac and lacquer, stands 22 in. deep by 42 in. wide by 87 in. tall.

CHUCK ZELLER
Bartley, Neb.

Inspired by old camel-back steamer trunks, Zeller decided to learn steam-bending and re-create the luggage as furniture. This white-oak chest is 20 in deep by 36 in. wide by 28 in. tall. The case is joined with a modified box joint, and the compound curve of the lid required a separate form for each piece. In keeping with the original trunks, the interior is lined in a heavy brocade fabric. Subtle distressing and a blend of waxes give the chest its antique look. PHOTO: OLSEN'S PHOTOGRAPHY



ROY SUPERIOR
Williamsburg, Mass.

Whenever possible, Superior likes to incorporate humor into his work. The Olive Museum, a wall-hung cabinet (9½ in. deep by 23 in. wide by 33 in. tall), is a parody of museum culture and includes such things as the world's largest olive, smallest olive, most bizarre olives, bearded olive, two-headed olive, mini olive press, and olive pits from around the world. In addition to a variety of exotic woods, Superior used bone, brass, copper, antique glass, Plexiglas, gold leaf, and egg tempera paints. The unpainted wood is finished with Watco Danish oil and wax. PHOTOS: JOHN POLAK

Q&A

Best brush for shellac

Q: I'd like to start using shellac to finish the furniture I build. What type of brush is best and how should I care for it?

—GRAHAM PARKER, Portland, Ore.

A: IF I HAD TO CHOOSE JUST ONE BRUSH, it would be a mop brush. The dome-shaped bristles make it great for small areas like legs and drawer fronts; and because mop brushes hold lots of finish, they also work great for larger surfaces. Less-expensive ones are fine for general work, but for laying down fine topcoats on small parts or molding, I'd use a mop brush with bristles made from squirrel or goat hair.

As versatile as mop brushes are, it is also very helpful to have a flat brush for laying down smooth, thin topcoats on large surfaces such as tabletops. I recommend a brush with synthetic bristles made from Taklon. However, they don't hold much finish.

SOURCES OF SUPPLY

Both types of brush can be found at art-supply stores, or online at www.dickblick.com

Buy these two. *Mop brushes (top) hold a lot of finish. So they're great for putting down a first coat over a large surface. Flat brushes don't hold much finish, but they put down very fine, smooth coats.*

As for cleaning brushes, there's not much to it. Just dip the brush in denatured alcohol, reshape the bristles, and set the brush aside to dry. Before you use it the next time, soak it in denatured alcohol for about 10 minutes to soften and dissolve any shellac on the bristles.

— Finishing expert Peter Gedrys is a frequent contributor.

Round dogs are more versatile than square ones

Q: I've just started planning my first real woodworking bench. I want to use benchdogs, but don't know if I should use round ones or square ones. Is one better than the other?

—ART GIBSON, Santa Fe, N.M.

A: IN MY EXPERIENCE, round and square benchdogs hold stock equally well. That being said, there are some important differences.

Round dogs are easier to install: Simply drill a hole in your benchtop and send the dog home. They also can rotate to accept oddly shaped workpieces, and their round holes work with holdfasts and hold-downs. The biggest drawback to round dogs is getting round stock that's the right diameter to press into place without falling through. Accurately sized hardwood dowels can be hard to find. You can turn them yourself if you have a lathe. You can buy round metal dogs, but be careful. They easily nick plane blades and router bits. An alternative is to make a dog with a square head on it (left), where the dowel doesn't need to fit perfectly.

Drop-in stop. *With round benchdogs, you can quickly make a planing stop, and easily match the stop's thickness to the workpiece.*

Square dogs are easier to make, but cutting square holes is difficult on a benchtop that's already glued up. They don't handle oddly shaped workpieces very well either. And you can't use their holes for holdfasts and hold-downs.

—Hand-tool expert Chris Gochnour is a frequent contributor.

Photos: staff

Working with warped panels

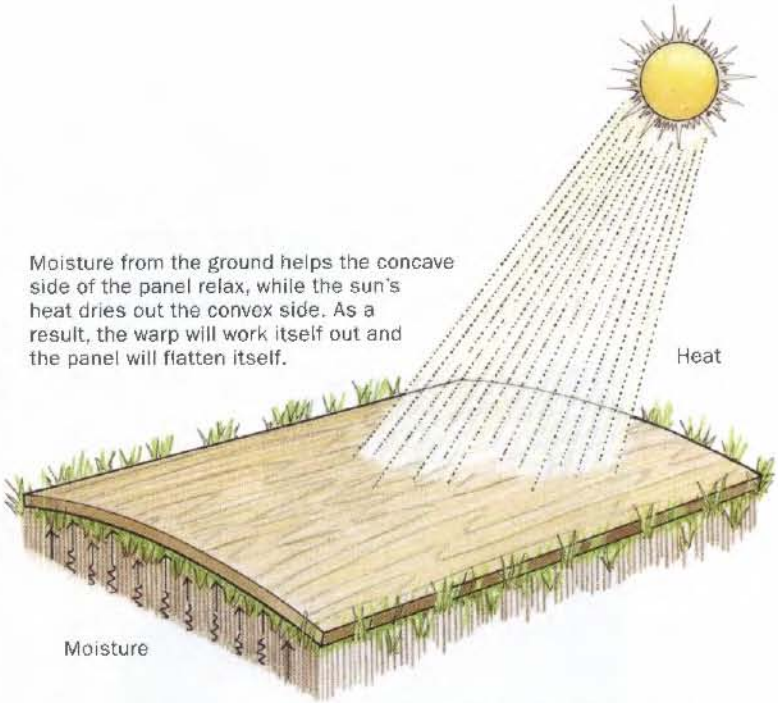
Q: I'm making a cabinet from cherry. After gluing up the panels and cutting the joinery, I stacked and stickered the panels. Unfortunately, they've warped. Why did this happen and is there anything I can do to correct it?

–JEFF HUNTINGTON, Loudon, N.H.

A: THE MOISTURE CONTENT and internal tension of properly dried lumber should be in equilibrium and the wood stable when you bring it home. However, there often is less moisture near the surfaces, and when you mill the board, you upset the balance and the wood can twist or warp.

To reduce this risk, wood should be milled equally on both sides, a little at a time, stickered, and then re-milled. This will slowly relieve the stresses and allow the moisture to equalize with the moisture in your shop.

Even with these precautions, wood still warps sometimes, but it's not the end of world. I work with warped wood frequently. If the ends are secured, like on a dovetailed carcase, the warping can be taken out by the joinery.



Moisture from the ground helps the concave side of the panel relax, while the sun's heat dries out the convex side. As a result, the warp will work itself out and the panel will flatten itself.

You also can remove the warp by placing the panel with the convex side toward a heat source and drying it back into shape. An old-timer I once worked with would toss a warped panel (concave side down) onto the lawn, and let the moisture from the earth and the heat of the sun take out the warp.

But your panels could warp again. After you get the warp out, assemble your cabinet quickly, before they get the chance.

—Christian Becksvoort is a contributing editor.

Don't use oil on waterstones

Q: The temperature in my shop regularly dips below freezing in the winter. If there's any water in my waterstones, it freezes, expands, and breaks them. Can I use oil to lubricate them instead?

–BENTON LANDERS, Minneapolis, Minn.

A: ACCORDING TO WATERSTONE MANUFACTURER NORTON, you shouldn't use oil on waterstones because the oil will clog the stone's pores. That would keep slurry from developing. Slurry is a soupy mixture of water and loose abrasive particles, and it's what does the honing.

Your best bet during the winter is to keep your waterstones in a heated area. Or you could just switch to another sharpening method.

—Matt Kenney is an associate editor.

Match lubricant to stone. *A waterstone needs water to sharpen effectively, and an oilstone needs oil.*

Slurry does the sharpening. *With sharpening stones, it's the muddy slurry that hones a tool's edge. You can't form a good slurry on a waterstone that's clogged with oil.*

Drawing: Vince Babak

The magic of hot-pipe bending

BY MICHAEL FORTUNE

Distinctive curves. *The five back slats on Fortune's signature chairs are bent on a hot pipe.*

This is a very easy technique for bending thin strips of wood to virtually any shape. Better yet, the simple apparatus is made from a few hardware-store parts.

You hold a strip of wood against a section of metal pipe heated by a propane torch. On the side in contact with the pipe, the lignin bond between the wood fibers is softened by the heat until it is pliable enough to bend partially around the pipe. Unlike steam-bending, there is no need to construct a large steambox or substantial bending forms.

The curved sides of musical instruments such as guitars and violins have traditionally been made this way, but I use the technique to bend door pulls, curved moldings, salad tongs (shown at right), back slats for chairs, and many other items.

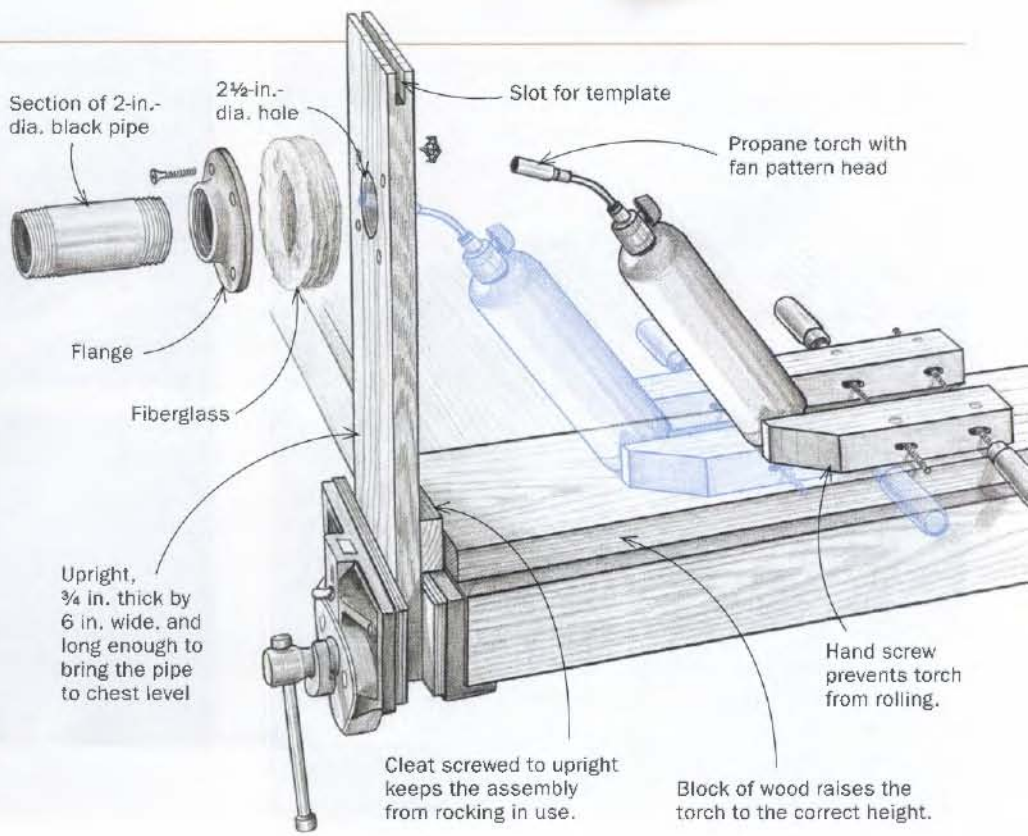
Most woods bend if the piece is thin

Unlike steam-bending, where only domestic hardwoods bend to any appreciable degree, you can use the hot-

Getting set up

All the metal parts can be bought at your local hardware store, and you can make the bending jig in less than an hour.

Insulate the wood. *A layer of thick fiberglass under the pipe flange keeps the board from burning. Cut away the fiberglass outside the flange (above). Sand off any protective coating (right) or heating the pipe will cause a lot of smoke.*



Photos: Mark Schofield; drawings: John Tetreault

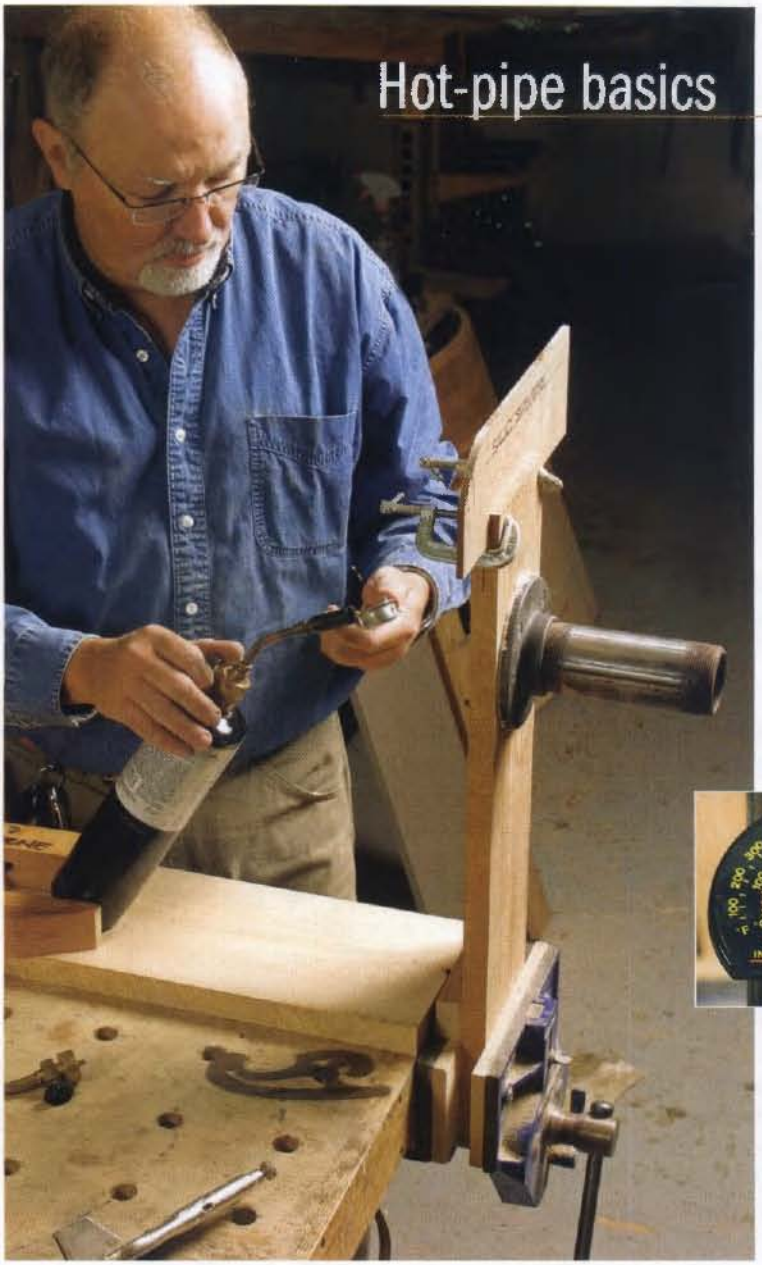
pipe method to bend a broad range of species. As with steam-bending, straight-grained wood that has been air dried will bend faster, to tighter radii, and with fewer breakages than kiln-dried wood. You can use kiln-dried wood, just expect to break a few pieces and to take longer.

Woods that bend well on a hot pipe include red and white oak, ash, walnut, elm, hickory, and beech. Woods that bend with less success, particularly to tight radii, include cherry, maple, Australian lacewood, Macassar ebony, imbuia, East Indian rosewood, mahogany, domestic softwoods, and softer domestic hardwoods such as basswood and poplar. Avoid bending curly or figured wood and burls; they break easily.

The thickest piece that can be bent is ⅜ in., and then only to a gentle curve. This is due to the limited depth that the heat from the pipe penetrates the wood. Heating both sides won't help; it will just encourage the outside fibers to stretch and fail.

It is important to have consistent grain across the width of the piece. You might get lucky and find a wide board with consistently flawless grain, but I've found that 3 in. is about the practical limit in width. You need to make the blank only about ⅛ in. wider and 1/32 in. thicker

Hot-pipe basics



Light it up. *Once the bending jig is complete, light the torch and slide the head into the pipe.*

The right temperature. *A stovepipe thermometer is a cheap and accurate way to tell when the pipe has reached 200°F, the right temperature to bend wood.*

Wet the wood. *To encourage air-dried wood to bend, soak it in water for about three hours. Fortune uses a section of roof gutter as a trough.*

Hot and pliable. *Once at the critical temperature, the wood is easy to bend around the pipe. For bends close to the end, grip it with Vise-Grip pliers designed for sheet metal.*

Check your progress. *Fortune attaches the bending templates to the top of the hot-pipe bending jig, making it easy to see when the workpiece has reached the desired radius.*

Create a double-bent door handle in two stages

Check the first bend. *Verify your accuracy by placing the first bend against the template.*

Create the next bend. *Being careful not to reheat the first bend, work on bending the second section.*

Right all around. *Check the second bend against the template. By the way, this handle works on doors and drawers.*

than the desired finished piece, but if the piece is to be bent at the ends, it should be about an inch longer at each end to give locking pliers a place to grip.

Build the bending jig

I find it best to have the surface of the pipe at about chest level. This way it is easy to see the wood bend without straining your back. So, the length of the upright, which clamps into a bench vise, is determined by the height of the workbench and your own height. A cleat screwed across the back of the upright rests on top of the vise and eliminates the tendency for the jig to rock as pressure is applied to the pipe.

I advise starting with a 2-in.-dia. pipe and working down to tighter radii as you gain experience. Do not use galvanized pipe because it will give off a toxic gas when heated. Use regular black pipe, scraping or sanding off any protective lacquer or shellac. Cut a hole in the upright ½ in. larger in diameter than the pipe. The heated flange must be separated from the wood with a gasket. I place a 2-in.- to 3-in.-thick wad of fiberglass insulation over the hole and then compress it as I screw the flange to the wood. After cutting around the outside of the flange to remove the surplus fiberglass, I turn the upright over and cut an X in the fiberglass in the middle of the flange. I fold the fiberglass back and staple it to the edges of the hole. This protects the wood from heat.

The heat source is a propane torch, fitted with a head that shapes the flame into a fan pattern. Very little propane is used. The valve on the head is never opened fully, even when the pipe is being heated, and a ¾-in.-long flame is sufficient to maintain the 200°F operating temperature of the pipe.

Have the tank sit at about 60° to the bench with the head about one-third of the way into the pipe. Secure the tank with a wooden hand clamp, if necessary using a block of wood to bring it to the right height. Make sure the tank cannot roll or slip out of place. An uncontrolled flame has no place in a workshop.

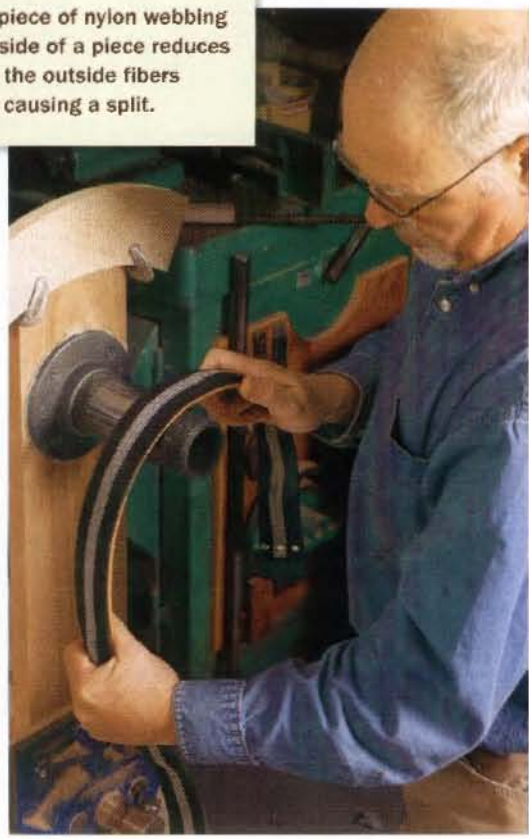
Coax the strips around the bend

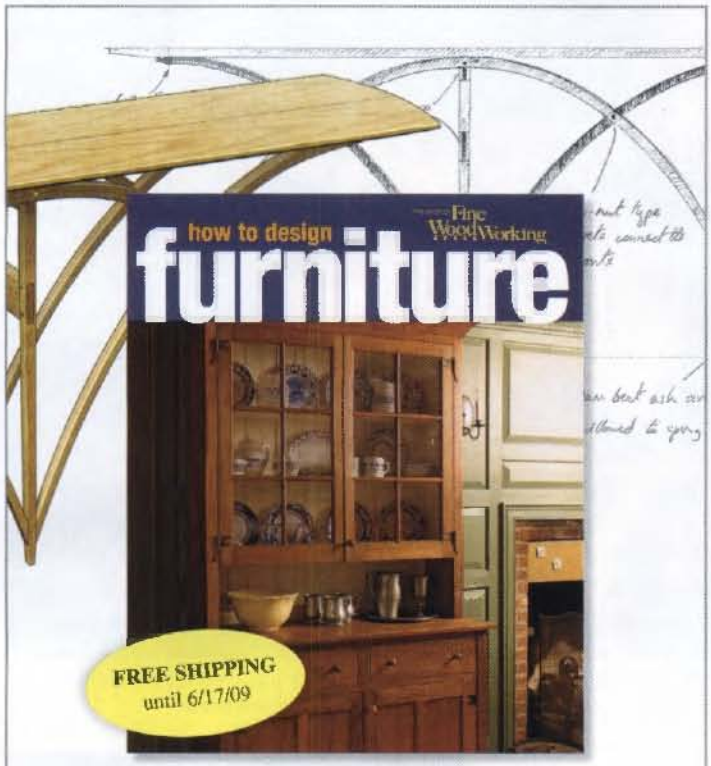
Before lighting the torch, I make a profile of the shape I need from ¼-in.-thick hardboard or plywood. It is then easy to overbend the wood strips and let them spring back to fit the pattern. With practice, it becomes easy to judge just how much and where to bend. If you are not using green wood, it helps to soak the strips thoroughly for about three hours before bending them.

Unlike laminating or steam-bending that relies on a form to provide the shape, this technique requires that you hand-form (coax, really) the part being bent to match the pattern. This can take from as little as a few minutes for ⅛-in.-thick strips to as long as 10 minutes

TIP

Holding a piece of nylon webbing on the outside of a piece reduces the risk of the outside fibers lifting and causing a split.





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READER SERVICE NO. 106

Lock down the pieces

A setting jig. *Often, the template for checking the curve also serves this role.*

Clamp lightly. *If the workpiece has not been bent sufficiently while being heated, firm clamping will not finish the job. A few clamps or even masking tape should be all you need.*

if you are bending ⅜-in.-thick material. Success means getting a feel for just how much surface area has to be heated and for how long, and how much overbending is required to achieve the correct result.

You can increase your success rate by holding a strap on the outside of the strip as it is being bent. This helps hold down wood fibers that want to lift and create a deeper split. The strap should be just wider than the piece being bent, and should not come in contact with the hot pipe. Nylon strap used for banding boxes is ideal and easy to find, while wider strips can be salvaged from old lawn chairs or a lawn-chair repair kit.

Online Extra

To watch Michael Fortune demonstrate his hot-pipe bending technique, go to **FineWoodworking.com/extras.**

Let the wood dry in its new curve

Once the strip has been bent to the desired shape, it needs to maintain that shape while the wood cools and dries. This setting time can be as short as three hours for thin pieces or 24 hours for the thickest stock.

Ideally you want the piece to have a moisture content of 7% to 8% before starting to sand it or apply a finish. You can speed the process by placing the pieces near, but not on, a radiator, or by having a fan blow air across them. Wood with pronounced medullary rays like red and white oak can develop checks on the plainsawn surface if it dries too quickly. I recommend putting a cloth or blanket over oak parts for the first 24 hours to retard surface drying.

You also need to maintain the curve while the piece dries. This can be as simple as a strip of tape across the bend, or you can build a wooden setting jig the same shape as the pattern. The bent part rests in the setting jig secured lightly with clamps or tape. One cautionary note: Because the bent wood is initially damp, metal clamps will leave a stain. This is particularly evident with woods high in tannin like oak and walnut.

Air needs to reach both surfaces of the drying workpiece to prevent warping or cupping. Therefore, the setting jig should be a frame rather than a solid surface. For simple "U" shapes, I just stick the piece in the open jaws of my wooden bench vise to hold the desired curve.

Once the parts have set to their new shape, they will have little memory of ever being straight. However, ends that are not restrained will have a tendency to move with changes in humidity. Parts bent this way also should not be immersed in water for any length of time, as they will straighten. □

Multiple parts. *If you are making several identical parts such as chair back slats, it can be quicker to build a single large setting jig.*

Held in a vise. *You may be able to dry small parts by clamping them lightly in a bench vise.*

WOODWORKERS MART

See ad index on page 97 for reader service number.

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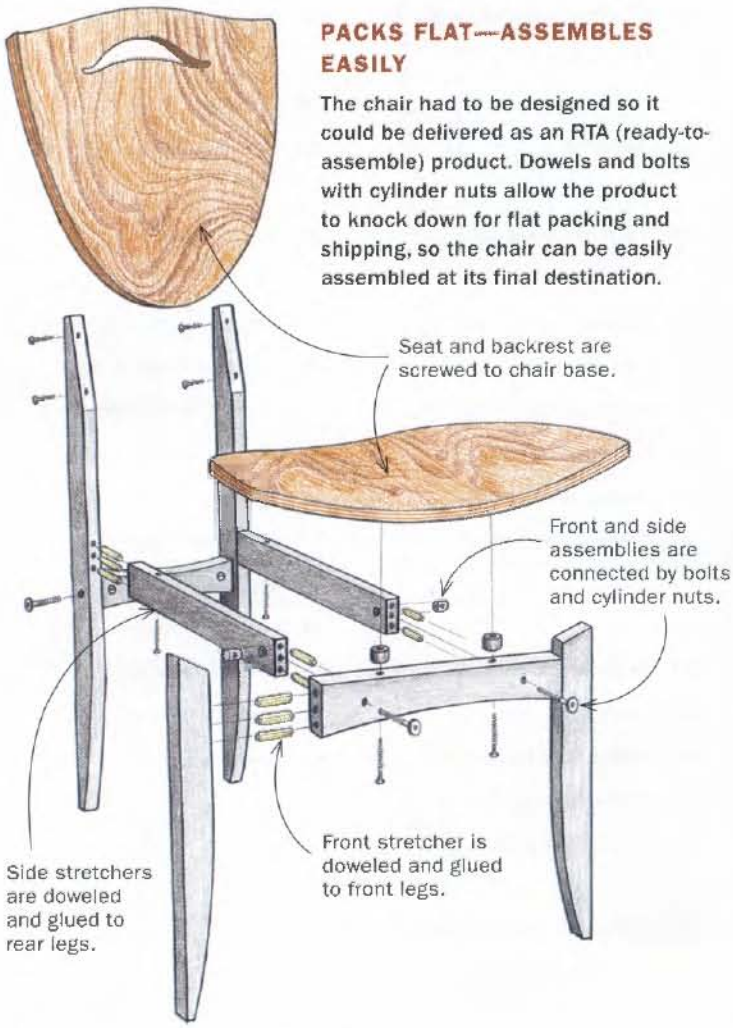
High design, low price

BY ANISSA KAPSALES

Michael Fortune's chairs (seen on the back cover) run the price gamut, but as the sticker price comes down the time and effort invested have to do the same. In this $34 made-for-production chair (right), he also had to accommodate the limitations of manufacturing in a developing country.

Traveling from his studio in Canada to a community in Belize, Fortune provided on-site training, researched the materials available locally (keeping prices down and further boosting the local economy), and worked with the available machinery, which was often low-tech. The design of the chair as well as the production methods got pared down to the basics, and organization was the key to success. Fortune said he appreciated the challenges as a designer and craftsman, and most of the lessons he learned can be carried back into the one-man custom shop.



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The chair had to be designed so it could be delivered as an RTA (ready-to-assemble) product. Dowels and bolts with cylinder nuts allow the product to knock down for flat packing and shipping, so the chair can be easily assembled at its final destination.

New life for an old machine. *At the site, Fortune found a defunct overhead router being used as a storage table. Luckily, he was able to procure missing parts and rehab the machine so it could be used, with shopmade jigs, to cut the curved backrest and seat after they were laminated on a form.*

Jigs make joinery foolproof. *The ready-to-assemble joinery was done with hand drills. A shopmade jig was clamped to a bench, and the workpieces set in place and drilled. To keep things fail-safe, all the jigs for this chair were color coded and precisely labeled. Then, multiple drills were set up with the bits at set depths.*

Photos: Michael Fortune; drawing: John Tetreault

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$34 vs. $3,400

Photo: Michael Fortune

One is a prototype for a knockdown chair produced by the hundreds in an open-air, 50-man shop with minimal tooling in Belize. It leaves the factory priced at $34. The other is built in a studio shop in Canada and sells for $3,400. Both were designed by Michael Fortune, who spends most of the year building custom pieces in his three-man shop outside Toronto. But he sometimes can be found in developing countries designing furniture, jigs, and assembly systems to suit local conditions.

With roots in industrial design as well as studio furniture, Fortune applies the efficiencies of factory production to his custom work and brings a craftsman's resourcefulness and feel for materials to his production pieces. When designing this production chair, Fortune's challenge was to create interesting, elegant shapes while employing right-angle joinery and surfaces straight off the machine. He made eight color-coded jigs that enable semiskilled workers to shape the parts and cut the joints accurately every time. In his custom chair, every part is curved and every surface hand-shaped. But most of the machine processes were guided by jigs—30 in all. Fortune knew that the first set of eight chairs, even at $3,400 apiece, would lose him money; the profits will come when he reuses the same jigs to build a second set or a closely related chair.

—Jonathan Binzen

How They Did It Turn to p. 98 to learn how Fortune worked out the details of production and made the $34 chair possible.

Pro Portfolio "The Clever Chair": Go to FineWoodworking.com to see an audio slide show and hear Fortune describe his design process.