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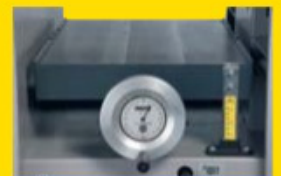


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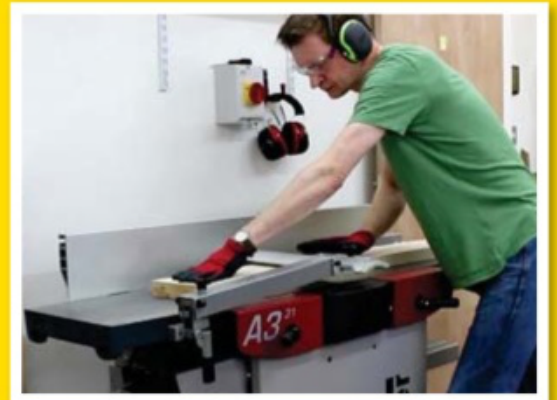
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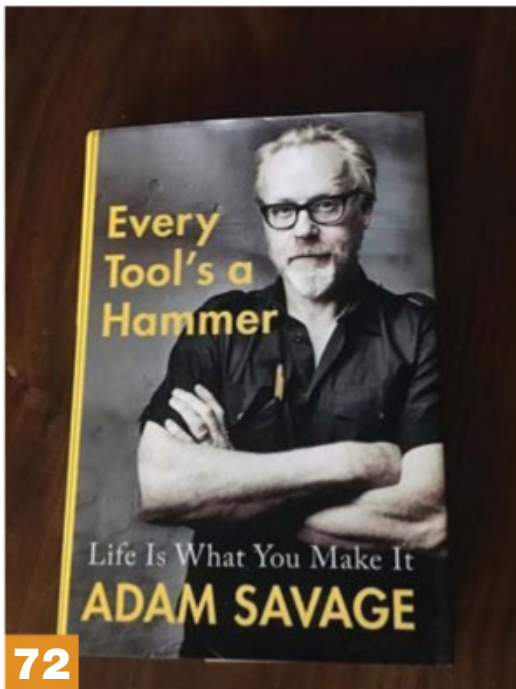
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December to Remember Holiday Sweepstakes!

To celebrate the holiday season, *Popular Woodworking Magazine* and its sponsors are giving away a prize a day throughout December. To earn your chance, you must enter separately for each day's prize. All entrants will qualify for the **Grand Prize: JET JPS-10 ProShop II Table Saw, 1.75 HP, 115V, 30" rip capacity, cast-iron wings (725000K).**

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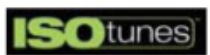
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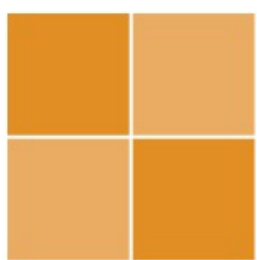


Popular Woodworking Magazine and its sponsors will award one prize each day from December 1 through December 31. The prize pictured on each day in the calendar above is the prize offered for that day. To register for a chance to win each prize, you must enter on the day the prize is offered. You may enter as many of the daily contests as you like, but are limited to one entry per day. All entries from the first 30 days will be eligible for the **Grand Prize: JET JPS-10 ProShop II Table Saw, 1.75 HP, 115V, 30" rip capacity, cast-iron wings (725000K).**

Registration starts midnight EST, December 1, 2019 and ends 11:59 PM EST, December 31, 2019

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■ FROM THE EDITOR

The Importance of Community

By Andrew Zoellner

As the editor of a woodworking publication, I spend my days reading and writing about woodworking, and talking to other woodworkers about projects they're doing. Part of my job is to research new techniques, new makers, interesting designs and woodworking history. (I also spend my fair share of time in meetings and talking about initiatives and business goals and all that jazz, trying to hurry it up so I can get back to the woodworking.)

And then, I get to put it all into a magazine and send it to you. Hopefully, you'll find it inspiring, and maybe you'll even make some of the projects. That's the goal at least. It is work, but it's some of the most worthwhile, fulfilling work a person can do, and I'm very grateful to be able to do this.

Most of my workshop time is spent alone. My shop is really only big enough for one person to work efficiently. I'll spend hours out there listening to music, milling and fitting parts, experimenting with ideas, building shop projects and generally just thinking about making things. If my girlfriend asks, I've been hard at work on the next project for our house. But sometimes, it seems like even putting on my shoes to head out to the shop seems like a chore—usually when I have hours of sanding and finishing work ahead of me. And it's times like that when it hits me how important community is.



A gathering of the woodworking community at Woodsmith Workshop in October. This event (and the others like it) remind me how much knowledge and enthusiasm there is in our small part of the world.

Being part of the woodworking community takes work. It's up to you to get out of the shop and take more classes, meet new people and learn new skills and techniques. Is there something you want to learn, but can't find someone to teach it locally? Get some friends together and bring someone in to teach! You don't need to be a store or a magazine to do this. You just need a few folks and enough space to build some things for a few days. Yes, you might get out of your comfort zone. You might have to send some emails. You might have to call in some favors. But I can tell you: It's worth it. You know just how much woodworking means to a person; it's up to you to share that with others.

Making in person connections, sharing skills and helping each other get better at woodworking is a good start in creating community.

Volunteering your time to get your neighbor acquainted with the table saw, or help repair some furniture, or do some work on their house is just as worthwhile. All someone needs is a little bit of encouragement and a friendly person to share their tools, and they start down this same path. And you know what? Seeing that excitement, that growth in another person will inspire you to get back into your own shop.

Yes, this all takes work, and takes away from precious shop time. But, in the end, it's likely those people you've met and worked with, that you've helped and who have helped you that you'll continue to carry with you. And really, in the grand scheme, maybe that's what we're all after in the first place.

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WORKSHOP TIPS



Magnetic Clamping Pads

C-clamps can make nasty dents that are tough to sand out. Pads or block will prevent this, but they're often awkward to hold in place while you tighten the clamps. I make pads that don't require extra hands.

I bought a roll of 1-inch wide adhesive backed magazine strips from a craft store and cut off a number of long lengths. I adhered these

strips to 1 1/4" wide pieces of 1/4" plywood. Using a miter saw, I cut these pieces into shorter lengths as needed to fit the C-clamp jaws. I store my magnetic pads on a steel strip that I screwed to the end of the bench. The pads are ready to go whenever I need them. —*Peter Smith*



Duct-Taped Sanding Block

Sometimes I prefer to sand by hand using a rubber block. This method gives me a better feel for the work than using a random-orbit sander does. Blocks like mine have been around for many years, but believe I've made an improvement.

I had noticed that most of the work was done by the paper's leading edges. The paper's center didn't seem to have any wear at all. To compensate, I stick a piece of duct tape to the bottom of the sanding block, not quite reaching the ends, before I attach the sandpaper. The tape allows me to apply even pressure across the block's entire surface, but it isn't thick enough to spoil the block's flatness. —*John Vasi*

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GENERAL MANAGER ■ Peter Miller

PUBLISHER ■ Steven Nordmeyer

EDITOR IN CHIEF ■ Andrew Zoellner

SENIOR DESIGNER ■ Danielle Lowery

DIGITAL EDITOR ■ Collin Knoff

CONTRIBUTING EDITOR ■ Bob Flexner

EDITORIAL CONTACT

pweditors@aimmedia.com



ACTIVE INTEREST MEDIA

PRESIDENT & CEO ■ Andrew W. Clurman

SENIOR VP, CFO, COO & TREASURER ■ Michael Henry

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ADVERTISING

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ADVERTISING DIRECTOR ■ Don Schroder

331 N. Arch St., Allentown, PA 18104

tel. 610-821-4425; fax. 610-821-7884

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ADVERTISING SALES COORDINATOR ■

Julie Dillon; jdillon@aimmedia.com

NEWSSTAND SALES

Scott T. Hill; scott.hill@pubworx.com

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No-Slip Miter Gauge Face

Trimming miters used to drive me crazy, because I couldn't hold the piece I was trimming securely enough against the miter gauge. The piece would always slide away from the blade during the cut. I solved the problem by covering the miter gauge face with a 120-grit PSA (pressure sensitive adhesive back) sandpaper. One 5" disc will cover most gauges. I clean the face with denatured alcohol, to assure good adhesion. Then I simply cut the disc to fit the face and press on the pieces.—*Rich Petrushka*

Save the Straw!

A can of lubricant is very useful around the shop, and so is the little red straw... if you can find it after the first use! I figured out that the straw fits in the groove in the top of the can, and you can still put the lid on. No more lost straws!—*Brian Roesch*



Groovy Handscrews

After years of use, the handles on my handscrews became slick, smooth, and hard to grip. My solution is easy and costs nothing. I carve grooves lengthwise on the handles using a medium-size gouge. Problem solved.—*Clovis Davis*



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—John Economaki

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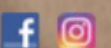
With the new GearKlamp, BESSEY® moved the handle to make clamping easier. The rail-mounted handle is now offset from the point of contact and allows a wider variety of assembly applications in comparison to more traditional clamps.

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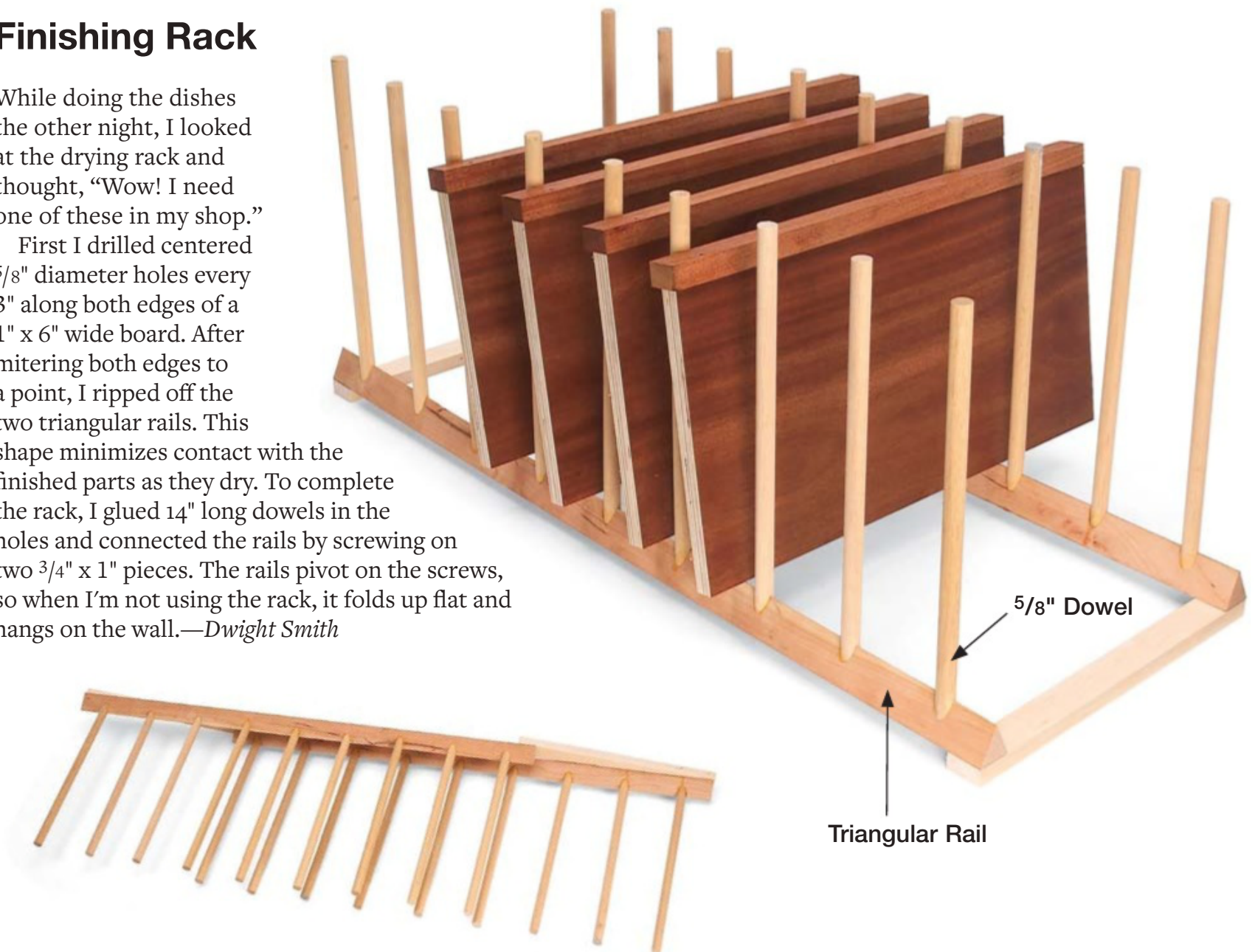
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Finishing Rack

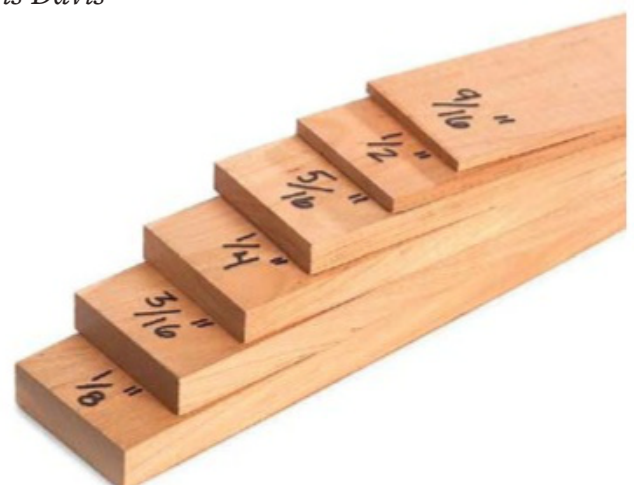
While doing the dishes the other night, I looked at the drying rack and thought, “Wow! I need one of these in my shop.”

First I drilled centered $\frac{5}{8}$ " diameter holes every 3" along both edges of a 1" x 6" wide board. After mitering both edges to a point, I ripped off the two triangular rails. This shape minimizes contact with the finished parts as they dry. To complete the rack, I glued 14" long dowels in the holes and connected the rails by screwing on two $\frac{3}{4}$ " x 1" pieces. The rails pivot on the screws, so when I'm not using the rack, it folds up flat and hangs on the wall.—*Dwight Smith*



Router Depth Setter

This jig makes it easy to set up the bit for routing flutes and dadoes. I simply drop the appropriate depth gauge into the channel, set my router on top and lower the bit until it touches the gauge. The base is an 8" square piece of $\frac{3}{4}$ " MDF. Two strips of $\frac{3}{4}$ " MDF on top create a channel for the gauges. To make the gauges, subtract the depth of the dado you want to rout from $\frac{3}{4}$ ". For example, a $\frac{1}{4}$ " deep dado requires a $\frac{1}{2}$ " thick gauge. —*Clovis Davis*



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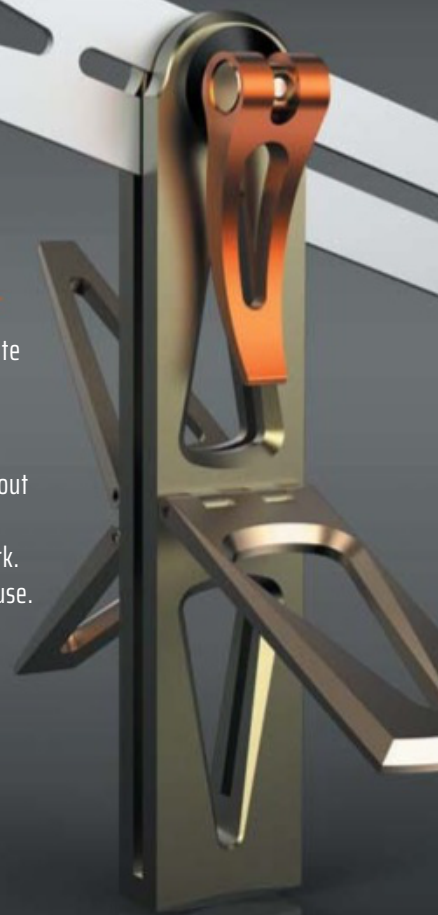
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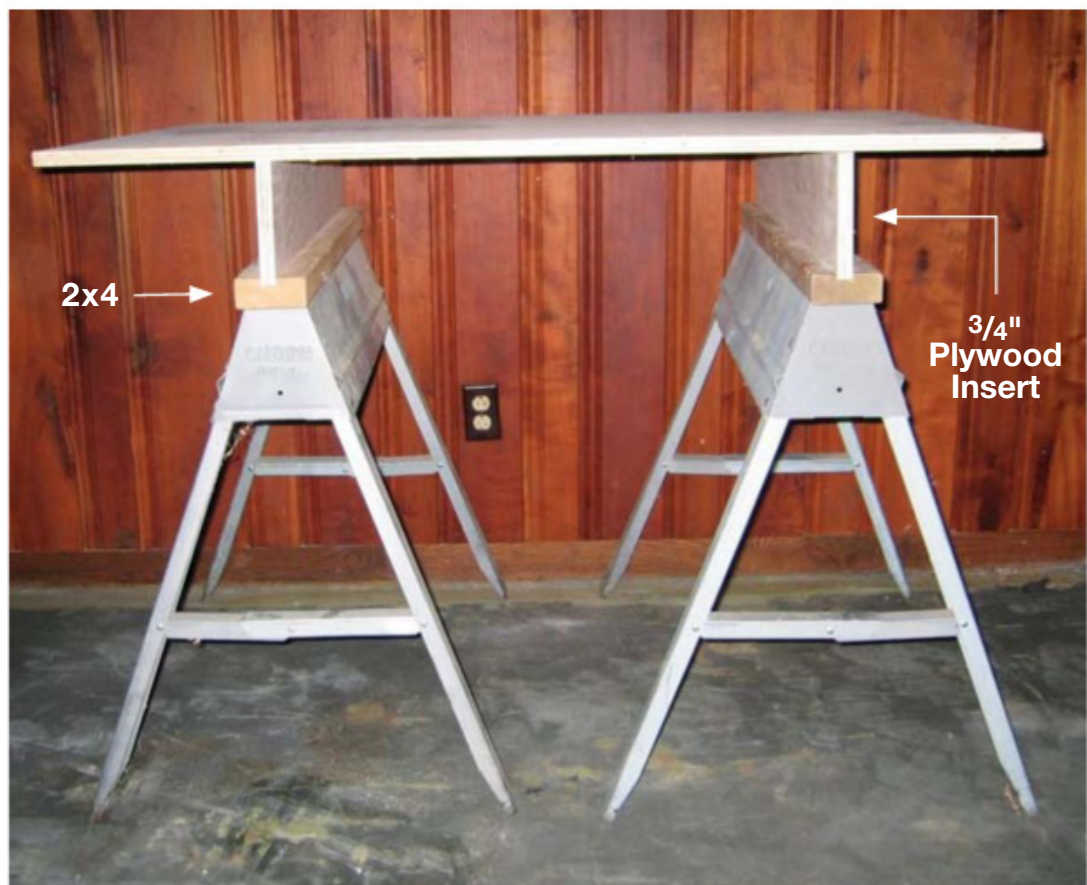
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There's no single surface in my shop that's the ideal height for every job. With my adjustable-height sawhorses, I can quickly set up an outfeed table, drawing table, or assembly table at different heights as need arises.

My sawhorses are the folding, galvanized-metal kind, but any type will do. Cut 2x4's to fit on the sawhorse's top surfaces. Make a $\frac{3}{4}$ " wide x $\frac{3}{4}$ " deep groove down the center of each 2x4. Fine-tune the groove's width so that a $\frac{3}{4}$ " thick piece of plywood will fit snug. Then, screw the 2x4s to the sawhorses. Cut $\frac{3}{4}$ " plywood inserts to raise or lower the tabletop to whatever height you need.—*Craig Kortz*



Quick Circles on the Router Table



One afternoon my wife called out to the shop with an urgent request. She needed me to make a round cake plate from $\frac{1}{4}$ " plywood for a charity auction. I assured her it would be no problem. I was in the middle of a project and didn't want to spend all afternoon on this. Then it hit me: I could use my router table.

I ripped a $\frac{3}{4}$ " strip of $\frac{3}{8}$ " hardwood to fit the miter slot and drilled a pilot hole near one end for a box nail, which I inserted from the bottom. Then I clamped the hardwood strip into my router table's miter slot so the distance from the nail to the bit equaled the circle's radius.

I drilled a center hole in the soon-to-be-cake plate, and positioned it on the anvil. I held the edge of the plywood up while switching on the router, then lowered it onto the bit bored through. I rotated the plywood counterclockwise, opposite the bit's rotation, to cut a perfect circle.—*Doug Bittinger*

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Making a Seat At the Table

Make no mistake: This is must-see exhibition. Curated by Laura Mays and Deirdre Visser, *Making a Seat at the Table: Women Transform Woodworking* showcases a collection of works by 43 artists. From well-crafted functional forms to experimental materials and idea-driven designs, the exhibition encompasses the wide range of work that women are contributing to the field of woodworking. It's truly a treat for woodworkers of all kinds.

The exhibition is on view at the Center for Art in Wood in Philadelphia through January 18, with a comprehensive book to follow in 2021. Learn more at centerforartinwood.org and womenwoodworking.org.

— Andrew Zoellner



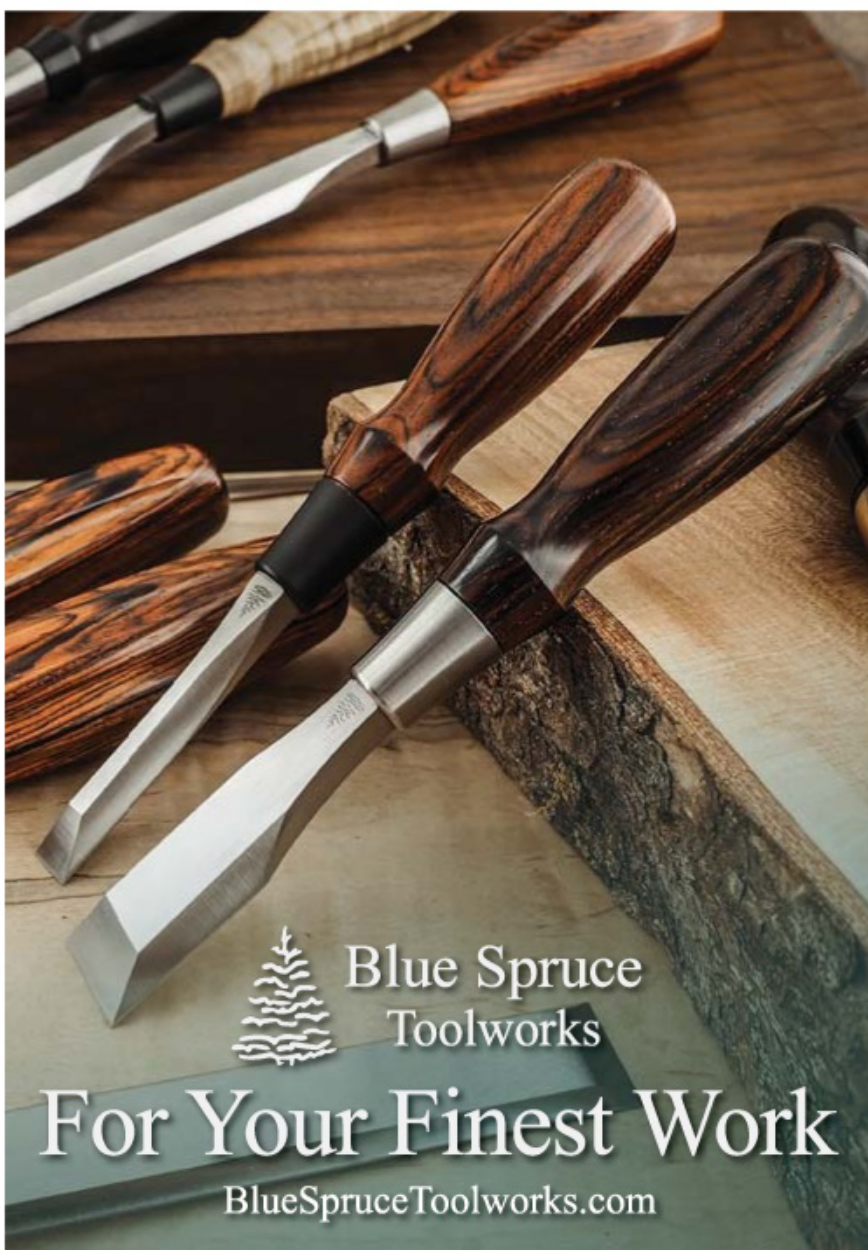
1 Katie Hudnall, *Spirits Cabinet*, 2012, reclaimed wood, 65" x 12½" x 36".
Photo by Michelle Given

2 Annie Evelyn, *Windsor Flower Chair*, 2018, ash, flowers, glass test tubes, 28" x 26" x 40". Photo by L. Gnadinger

3 Leslie Webb, *Linda Lou Rocker*, 2018, ash, caning, 39" x 38" x 22½".
Photo by the artist

4 SIOSI, *Lowdown Coffee Table*, 2019, walnut, 17" x 48" x 48".
Photo by the artist





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5 Christy Oates, *Facet Chair*, 2014, sapele and maple veneered plywood, 16" x 16" x 32½". Photo by the artist

6 Jennifer Anderson, *Cadwalader Chair*, 2016, mud and steel, 37" x 22" x 26". Photo by Heather McCalla

7 Gail Fredell, *Tansu Blue*, 2014, dyed red oak, pickled white oak with a blue wash, satinwood, steel hardware, 34" x 34" x 14". Photo by Mark Johnston

8 Wendy Maruyama, *Sonje* (from the #wildLIFE series), 2015, polychromed wood, 98" x 42" x 26". Photo by Scott Cartwright

9 Laura Kishimoto, *Yumi Chair II*, 2016, ash and mild steel, 46" x 43" x 52". Photo by Matthew Staver

10 Yuri Kobayashi, *Believing*, 2009, ash and sterling silver, 74" x 20" x 74". Photo by Craig Smith

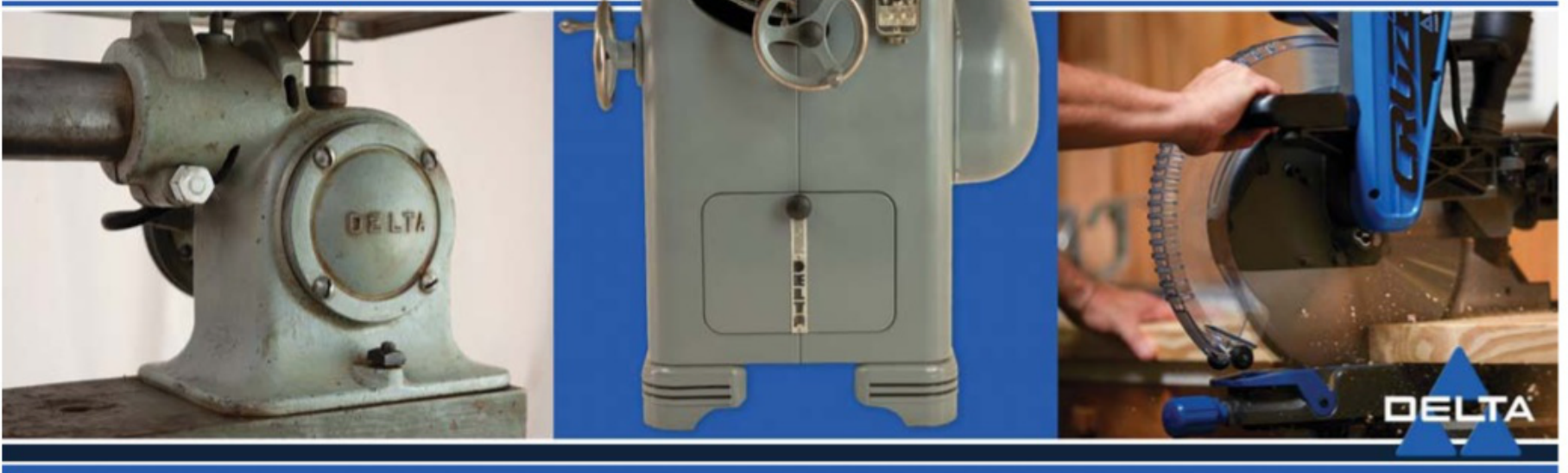


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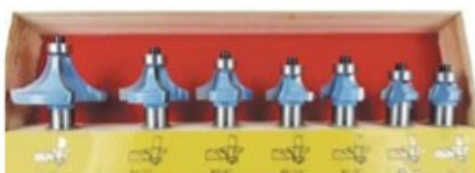
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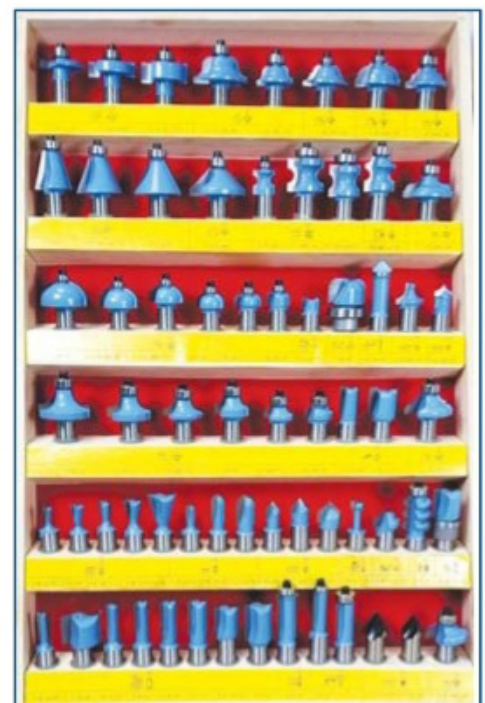
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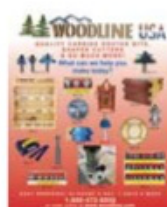
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Mix and Match

Sometimes mixing it up yields a perfect pairing.

By George Walker

I usually try to wiggle my way out of it. Repairing furniture that is. Seems everyone has a wobbly chair or a drawer that sticks on a dresser, and most of it isn't worth fixing, especially if it's some modern particle board disaster. That was my thought when the neighbor lady asked me to look at a child's chair in need of some work. To my surprise it was nice example of an early Ohio country chair that had been handed down for many generations. In spite of hard use it was in remarkably good shape except the arm rests on each side were loose and one would pull right off without effort.

Back in my shop I placed it up on my bench for closer inspection. It was covered with several coats of old darkened finish and more than its share of grime. A few gentle taps with a mallet separated both pieces



Black and Tan. The dark apron and legs on this table highlights the figured top.

and I took a look at the raw wood on the interior surfaces. To my utter surprise the right armrest was good old American Black Walnut while the left armrest was a replacement and actually made of Cherry. Shazaam! Oddly enough when you held both parts right next to each other you could see that they were significantly different. Yet when they were separated on either side of the chair they somehow managed to escape notice. There were several factors that allowed it to keep this secret for so long.

Foremost is that given enough age, both walnut and cherry take on a warm chocolate tone. Secondly they were spaced two hand spans apart. Our eye is quick to notice differences in things right next to another but not as keen when spread apart. Finally they were both sculpted parts with some contours. The eye naturally focuses more on the shape than on minor differences in color tone.

There's a lesson there about mixing and matching when designing and building a piece of furniture. We often desire and look for symmetry or a good match in a design. Sometimes it's critical that we achieve a perfect pairing. Other times we can mix polar opposites and achieve good results, and sometimes like in the case of those armrests, we can wear different colored socks and no one will notice. All three of these mix and match scenarios can guide our designs.

The Perfect Match

Gluing up boards to create a wide panel begs for a perfect match. That's one of the reasons mass produced furniture often relies on the generous use of stains to even out colors and mask boards with different wood tones. As furniture builders we have the luxury of matching boards to achieve a seamless marriage. Whenever I can glue



1 Oops! A two tone glue up in spite of using pieces from the same board. One half is dead due to the way the light reflects differently on each piece.

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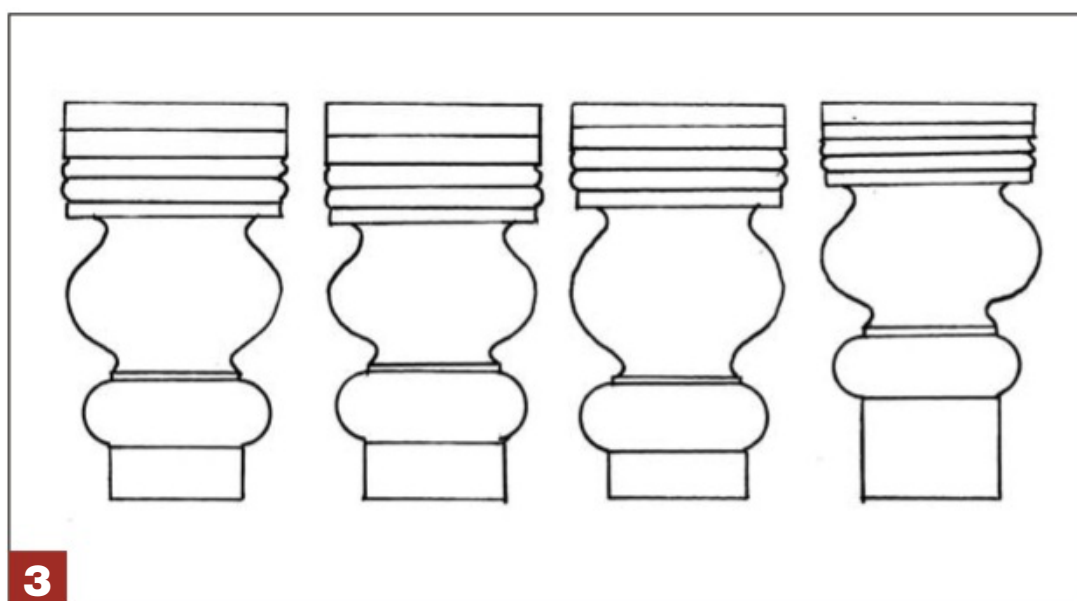


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2 These turned feet were ebonized on the original piece I was using as a pattern.

3 After discovering the differences in the originals, I made drawings of all four feet just to document how differences can still work.

up panels, the ideal option is to use pieces cut from the same board to achieve the best match. I'm careful not to mix sapwood and heartwood and pay attention to the grain to make sure it flows the same way.

I even take it a step further and finish plane the show surfaces and wet them with mineral spirits to get a good sense for how light will reflect off the surface. I orient them so the light reflects the same on both boards. On many hardwoods and especially figured maple, the light will pop the grain shining from one direction and go dead from the other. I make sure both planks reflect with the same intensity. Ignore this and you can end up with a two tone panel.

The Perfect Mix

Sometimes the perfect pairing is not to match at all, but to mix. If you want to highlight the texture and contours in a carving, place it next to a plain smooth surface. If you want to draw attention to some stunning figured grain, frame it with straight grained stock. Traditional artisans selected straight grained material for the rails and stiles

on frame and panel construction for multiple reasons. It's true that straight grain is less prone to tear out when using moulding planes to shape profiles. Yet I'm convinced they understood that the plain frame enhanced the beauty of the panel, just as a picture frame enhances a painting. You might also think about using a contrasting painted apron and legs on a table to show off the beauty in the tabletop.

The key to make this work is we aren't just utilizing contrast. By that I mean we aren't pairing up contrasting parts that both shout and compete for attention. Our contrasting element always plays a quieter more subdued supporting role of drawing attention to the part we want to emphasize. Done right and we don't even realize the door frame has straight grain or the table undercarriage has black legs. Our eyes are drawn to the focus of attention. This is a classic example of how less can be more.

The Perfect Mismatch

This is a practical lesson I've learned from working on vintage furniture and reproducing period pieces. Like

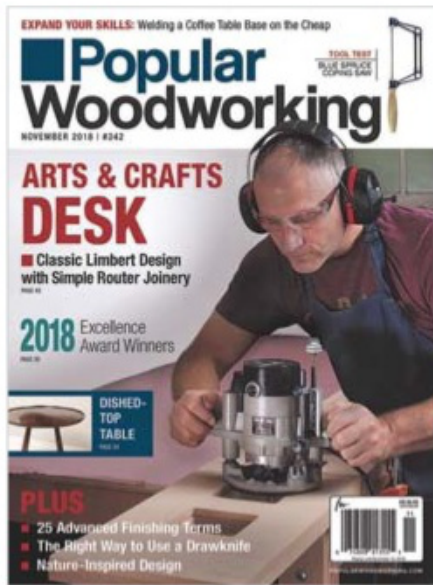
our child's chair example, parts that are supposed to match, can be different and still work. I once reproduced a small chest of drawers that had turned feet. (Figure two) I documented a foot from the original and made a drawing of it. Days later I went to double check my drawing and was surprised that it was off. Then it dawned on me that all four turned feet were a bit different, one quite dramatically (Figure Three). Yet, no walking by would pick up on it without someone pointing it out. Why is this important?

We don't always have perfectly matched boards from the same tree to build our project. Understanding that a bit of space can make a pair out of distant cousins can make your design work. In reality, one of the charms of handmade work is that everything need not match perfectly. The contours and quirks left by the artisan's hands and nature's whims are the best match-maker of all. **PW**

.....
George Walker is the co-author of two design books and writer of the By Hand & Eye blog with Jim Tolpin. Read more at www.byhandandeye.com.

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Oak (Red)	4/4	Select	2.80		\$105.00
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Authentic Sloyd Tool Cabinet



This reproduction is a fun build and a great gift for a budding woodworker. **By Bill Rainford**

PROJECT #1922

Skill Level:
Intermediate
Time: 3 days
Cost: \$200

“Hand and heart lead to life.” was an early motto of the North Bennet Street Industrial School (NBIS), now called the North Bennet Street School (NBSS). Founded in 1885 by Pauline Agassiz Shaw, a progressive Boston philanthropist, the school was established to “train students for careers in tradition-

al trades that use hand skills in concert with evolving technology, to preserve and advance craft traditions and promote greater appreciation of craftsmanship.” The school started off as a social and educational experiment designed to help residents in the North End of Boston, many of whom were immi-

grants, acclimate to America, learn a trade, socialize and become better citizens. In pursuit of this goal Shaw learned of Otto Salomon’s work at the Sloyd School in Naas Sweden and was instrumental in bringing Swedish Educational Sloyd to America. Under the direction of Gustaf Larsson, a graduate of

PHOTOS BY THE AUTHOR

Naas, he helped adapt Educational Sloyd to American needs at NBIS as a training lab and also went on to direct the Sloyd Training School in Boston for training teachers in manual arts instruction. Moving beyond traditional apprenticeships Educational Sloyd was a structured program wherein hand skills are taught by building a series of model projects, deliberately chosen to result in useful household objects prescribed in a specific sequence that helped bolster hand skills, mental skills, confidence and prepare for the next exercise. The goal was to train the “whole person”—the body and the mind working in concert to produce better work, an appreciation for hand work and improve overall well-being.

As a graduate of NBSS I can say that the core principles of Sloyd are still alive and well at the school even if the term ‘Sloyd’ is not often explicitly used. We started with the fundamentals, taught in a hands on manner and built upon those skills until we reached our culminating projects which involved demonstrating the hand and design skills learned. It served me well as a student and continues to be a part of my own teaching efforts. In the years since I graduated I’ve done some research on Sloyd in general and specifically in relation to NBSS and have found it to be a fascinating rabbit hole of discovery.

In teaching students and teachers alike Larsson designed a novel workbench which went on to be called the “Larsson Improved Sloyd Bench” which was manufactured en masse by Chandler & Barber which was a large tool supplier in Boston that specialized in manual training supplies that were shipped around the world.

As a companion to that workbench Chandler & Barber also offered ‘Good Quality’ tool sets of varying sizes and combinations including a handsome set that came in a hand tool cabinet. The cabinet was even

advertised in the NBIS Alumni newsletter as a ‘practical holiday gift’ for the Sloyder in your life. After learning of the existence of this cabinet when researching Larsson’s workbench I serendipitously stumbled on the only extant example of one of these cabinets I’ve found to date. We’ll walk through how I built my replica of the cabinet and its hardware in this article.

Building the Cabinet

Start off by milling your cabinet stock. I used clear Eastern White Pine, but Oak would also be appropriate if you want to build the more upscale option. Mill the stock for the cabinet sides, back and top to be $\frac{1}{2}$ " thick. The fixed shelf in the cabinet, and the drawer sides are $\frac{3}{8}$ " thick. The drawer bottom is $\frac{1}{4}$ " thick. The drawer runners and corner reinforcements are $\frac{7}{16}$ " square. From some scrap wood mill a small amount of $\frac{1}{4}$ " square stock we’ll use as part of our jig below. (You’ll want two $2\frac{1}{2}$ " long pieces).

Finger Joints

Cut your cabinet sides, top and bottom to size. Label your parts and explicitly label the inside and outside as it’s important when cutting the finger joints to know the orientation. Hold onto any sizeable off-cuts as you can use them to fine tune your finger jointing jig. I used a Freud Box Joint Cutter set which is similar to a dado set but specifically ground to cut clean shoulders on the box joint fingers. Configure the two blades

to cut $\frac{1}{4}$ " wide fingers and set the height of the blade to $\frac{1}{2}$ ".

Set your rip fence to be 12" to the right of your blade. With some scrap $\frac{3}{4}$ " thick plywood cut a 24" x 6" piece we’ll use as a sacrificial fence. Place the two $\frac{1}{4}$ " square $2\frac{1}{2}$ " long pieces against the rip fence—they should be equal to twice your pin width. Slide the plywood piece up against those two pieces and clamp the plywood to your miter gauge (see images 1 and 2).

Remove the small $\frac{1}{4}$ " pieces. Using this clamped setup and minding your fingers push the jig through the saw. Turn off the saw. Now put one of the $\frac{1}{4}$ " pieces back up against the rip fence, remove the clamp and carefully slide the fence up against this piece and the fence. Secure the plywood to your miter gauge with screws. Remove the $\frac{1}{4}$ " piece from the fence. Run the jig through the saw again. Turn the saw off. This should produce a nice evenly spaced set of slots. Glue one of the $\frac{1}{4}$ " pieces in the first slot you made (this is the slot now closer to the fence) and gently chamfer the ends of that alignment pin with some sandpaper. The jig is now complete.

Using the scrap you saved before let’s make some test cuts and fine tune the jig as needed.

1-2 Build the box joint jig. Slide the plywood piece up against the two $\frac{1}{4}$ " pin pieces and clamp the plywood to your miter gauge.



Using the Jig

Place your stock on the jig vertically and slide it right until it's firmly against the 1/4" piece you glued into the jig. Use a quick clamp to secure the piece as you slide the jig through the blade-keeping your fingers well clear of the blade (see image 4). Return the jig to your starting position well clear of the blade.

On the next pass you'll move the workpiece to the right by placing the slot in the workpiece over the 1/4" alignment pin. Clamp the board and carefully slide the jig through the blade.

Then repeat the process of making a slot and moving the board over one notch until you finish cutting all the fingers.

Important Note #1: The piece that makes of the other half of this joint will need to start with a pin width

offset so the board line up correctly when assembled. You can do this by putting a 1/4" wood spacer between your workpiece and the alignment pin for the first cut on this second board, then clamp the piece to the fence, remove the spacer and make that first cut. The rest of the procedure is the same as before.

Important Note #2: The left side of the cabinet is narrower to accommodate the door and thus the fingers do not run all the way across the left side top and bottom pieces. Please layout and plan accordingly.

Fixed Shelf

Test fit your sides. Once you are happy with the fit it's time to layout a stopped dado for the fixed shelf in the cabinet. Use a marking knife to sever the cross grain fibers.

Use a chisel and router plane to

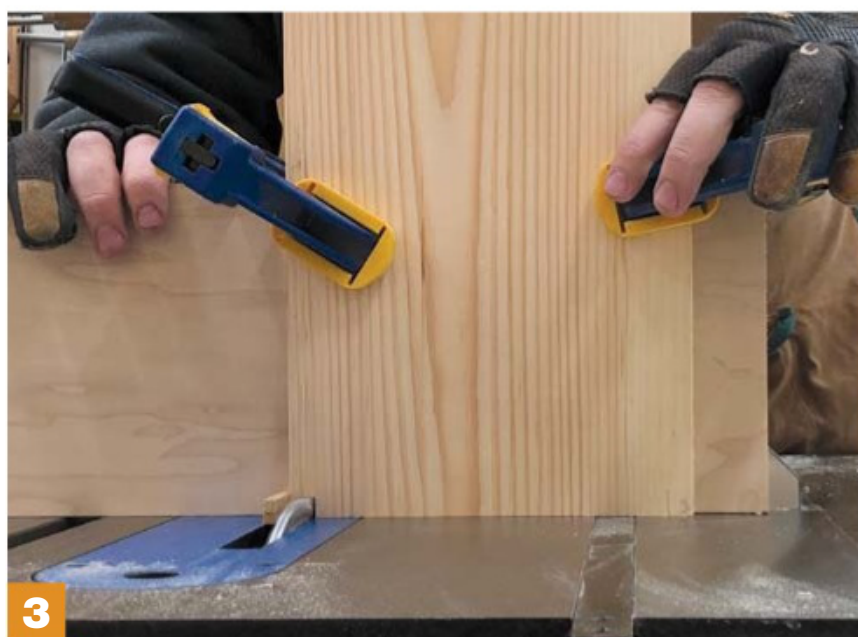
remove the waste from the stopped dado.

Note: The dado should be about 1/2" narrower than the width of the shelf (see images 7-9). You'll cut a notch into the end of the shelf so that you won't see any exposed dado slot when the wood moves seasonally.

3-4 Cut your first joint with the board next to the pin. Then, use the cut slot to index over the pin and repeat.

5 The joinery cut for the sides. Repeat the process for the top and bottom, using a 1/4" spacer for the first cut.

6 From left to right: blade is too high, blade is too low, blade is the correct height. **NOTE:** If you have to err on one side, go with longer fingers as you can always sand them off as needed.



Cabinet Back

Now layout a dado to capture the back panel of the cabinet. This dado should align with one of the fingers. I used a single box joint cutter blade to accomplish this. Dry fit the sides and shelf and leave that in the clamps (see images 10-13).

Edge glue up the panels that will form the door and the back of the cabinet. If using flat sawn wood alternate the orientation of the growth rings. Cut the dried panel to size. Cut it slightly narrow to allow for seasonal movement and in sizing the panel make sure you take into account how it will be captured in the side dados.

Using a sacrificial wood fence attached to your rip fence and your stacked dado blade cut a rabbet into the back panel on all 4 sides. **Tip:** Use some scrap from the panel blank to test your setup and make sure it fits nicely into the dado before cutting into your panel.

Test fit your panel on the dry fit carcass that is still in the clamps. Use a shoulder plane to fine tune the fit and allow room for seasonal expansion of the panel.

Glue and clamp up the carcass taking care to make sure everything is nice and square and all the joints pull up nice and tight. I used hot hide glue so any squeeze out would not affect the finish and to have a longer open time.

Once dried, plane and/or sand the fingers flush and roundover or radius the corners.

Door

Cut the glued up door panel size. Cut the breadboard ends slightly long. Mill a dado down the center of the breadboard end stock using a feather board to help keep things centered (see image 18). Use the same general setup (a dado and sacrificial fence) to mill a tenon onto the top and bottom of the door panel to fit snugly into the breadboard dado. Apply glue to the center 1/3 of the breadboard dado and clamp up the door. (This will allow for panel sea-



7 Lay out the stopped dado to capture the fixed shelf. I mark the waste to be cut.



8 After removing the bulk of the waste with a chisel, I flatten the bottom of the dado with a router plane.

9 Because of the stopped dado, the shelf needs notches on both sides of the front edge. I cut these with a handsaw.





sonal movement. See images 14-17.)

Once dry flush up the breadboard ends with the rest of the panel and test fit it into the carcass. Use cards or similar spacers to allow for an even spacing around the door top, bottom and right side and adjust as necessary. (Left side with hinges is flush with the outside of the cabinet.)

Build the Drawer

Follow same steps as used to make the carcass to make the draw and its divider (see images 19-21).

Once you have the sides glued up, shoot a pin nail or similar in through the fingers from the bottom to keep the joint together even if the glue fails in the future. (Do the same for the rear of the finger joints on the main cabinet as well.) Glue and pin nail the bottom onto the drawer and test fit and sand as needed. Use two credit cards as spacers between the top of the drawer and the fixed shelf.

Pin nail in a $7/16$ " square profiled runner on each side to support the drawer. From that same size stock also nail in spacers on the right side of the cabinet to function as a door stop. The drawer divider partitions the space into a 60/40 split.

Once the drawer is complete you'll want to use a wide stacked dado to cut in a finger grip that functions as a drawer pull. Securely clamp a stop block on the outfeed of your table saw. Place the far end of the drawer up against that stop block and slowly but firmly hinge the drawer down onto the blade. Be very careful when attempting this operation and make sure to do some test cuts first to ensure you are centered and not cutting too deep. Once you make the cut, turn off the saw and wait for it to stop before removing the drawer.

Hardware

In the late 19th and early 20th cen-

10 Cut a $1/4$ " dado for the back panel. Take care to line it up with a finger.

11 The back panel is $1/2$ " thick, with a $1/4$ "-deep rabbet cut around the edges.

12 Cut the rabbet on your table saw and fine tune the fit with a shoulder plane.

13 Dry-fit the back and cabinet carcass and make sure the pieces are ending up tight and square.

tury there was a much wider variety of hardware available in the marketplace. This Sloyd Tool Cabinet has a lot of interesting hardware, much of which you can fashion in your own workshop to provide some interesting tool storage solutions. I also took the time to 'clock' (align) all of the screw heads to be oriented the same way which adds a nice touch to this handsome cabinet.



14-15 The back panel floats in the dado to accommodate season expansion/contraction. Size the rabbet to leave a small ($\frac{1}{16}$ ") gap on each side.

16 With the panel and shelf fitted, glue up the cabinet. Use hide glue or similar with a long open time to let you get all the pieces in place and clamped properly.

17 Sand the fingers flush, and add a small roundover on the edges.

18 Mill a dado down the center of the breadboard end stock using a feather board to help keep things centered.



overlay hinges that don't require any mortising (see images 22-27). The centerline of each hinge is located 4" from the top and bottom of the cabinet respectively. Be careful not to drill through the cabinet sides or door. Once the hinges are installed apply some chalk or pencil graphite to the moving portion of the lock bolt, or use some carbon paper and turn the key in the lock to gently press the lock into the side of the cabinet. Using this mark excavate a small mortise to catch the lock.

Handle and Lock

Center the brass handle on the top of the cabinet. Transfer the layout of the holes. Pre-drill through the top and into some scrap wood to prevent blow out. Use 1" brass screws and a washer and doubled up nuts to secure the handle. Trace the lock onto the door and carefully remove

wood and test fit as you go. Use a router plane to help excavate the wood. Use a file to remove the mill marks from the brass. Make sure to relieve the wood around the keyhole for a nice clean look.

Hinges

The hinges used on this cabinet are

Cast Brass Hooks

A pair of cast brass hooks are installed on the back wall of the cabinet to hold your bit brace and a pair are installed on the door to hold your panel saws. Layout where you want the hardware to be, use a center punch to start the hole and drill using a depth stop. Install the screws by hand as brass is a soft metal.



Square Hooks

Square hooks are used to secure your folding rule and try square to the door. These simple little hooks do a surprisingly good job of keeping those tools in place. When laying them out make sure to use the actual tool(s) for reference and make sure they don't interfere with the saws, the drawer or the ability to close the door.

Fabric Straps

To keep the panel saws in place you'll want to cut two 6" pieces of fabric backed velcro or nylon webbing. Use a lighter to melt the ends. Screw each strap to the cabinet door with some pan head screws and washers for a clean look. When installing the fabric, the center should not be flush with the door, rather place the screws a little closer together so there is room to easily remove the saw. (I liked the velcro strap as I had it on hand from an old bag, its stiff and it gives some air to the saw blade so its less likely to rust.)

Wire Tool Holders

Some of the most interesting hardware in the cabinet are the bent brass wire tool holders. With some fairly simple tools and jigs you can make custom hardware to hold just about any tool you can imagine (see images 29-33).

Cut a 12" length of the brass wire. Bend the middle of the brass around a metal bending form or socket. Form a sort of 'M' shape to make the arms. A wire jewelry bending jig or screws set into a piece of wood can be used. Using pliers twist each arm 90° and then bend the straight section of the wire on the same

19 Use cards to space the drawer under the shelf, then add two square drawer supports under the drawer.

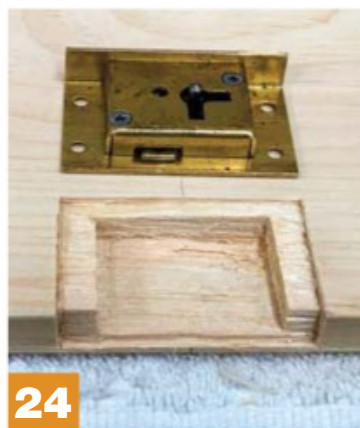
20-21 I used a wide dado stack in my table saw to cut the hand hold in the bottom of the drawer. Just a shallow recess is enough.



22



23



24



25



26



27

form you used in the first step of this procedure. Use the tip of your needle nose pliers form a tight circle and trim off any excess wire. Using pliers grab each arm about $\frac{1}{4}$ " from the end and bend/flare them out just a bit so it's easier to push a tool into the holder. You can further refine the fit once installed. Lay out where you want the hardware to be in the cabinet. Then mark where the screws will go (They are all going to be a little different) and use a center punch to mark the location.

You can set a countersink backwards on your drill bit to form a nice consistent depth stop and not drill through the wood. For narrow pieces you may consider filing down the points of some of the brass screws to make them a bit shorter.

Heavy Tool Holders

This simple but sturdy tool holder is great for holding heavier items like hammers and larger items like your cutting gauge (see images 34-36). Start with some 0.063"-thick sheet brass. Trace your template onto the brass plate with a sharpie. Mark the center of the small mounting holes using a center punch. Use some scrap plywood to support the plate

22-25 The mortised lock is cut in stages. First, I cut the recess for the lock mechanism. Then I cut the shallower portions to get the lock to be inset on the piece.

26-27 The hinges on this cabinet are just simple overlay hinges that don't require mortising (just careful layout).



28

as you cut it with a jigsaw fitted with a metal cutting blade.

Place the rough cut holder in a vise with wood jaws and use a single cut file to refine the shape of your holder, remove any burrs and round over the edges. Remember that a file only cuts on the push stroke—don't drag the file back and forth like a saw as that will only shorten the service life of the file.

Place the cutout holder in your wood faced vise jaws and bend it. Warm or hot brass will be more pliable. If you work quickly through the prior steps you may have enough residual heat left in the metal to help or you can heat it up a bit with an iron or a torch. If your bend has some spring back that leaves the arms tilted up just a bit that is ideal.

Flip the piece over and place about an inch of the arms in the vice to bend the tips of the arms up a bit more to help keep tools on the

28 I used cast brass hooks to hold my saws, secured with simple straps. Square hooks hold the ruler and square.

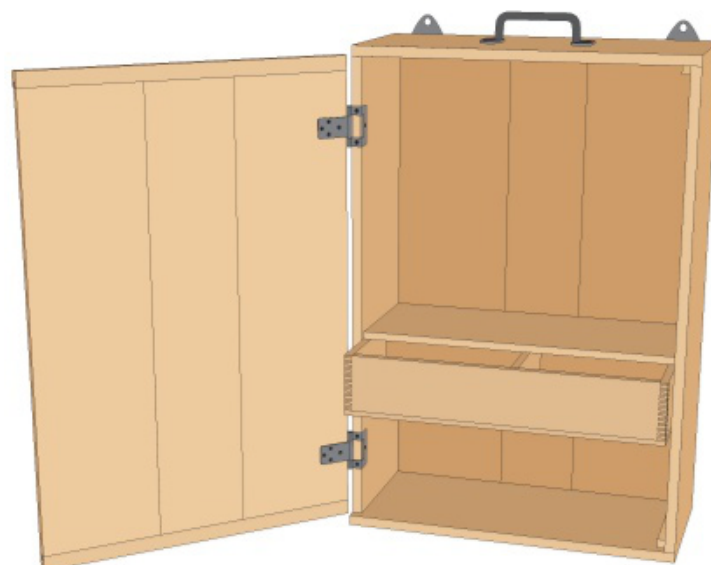
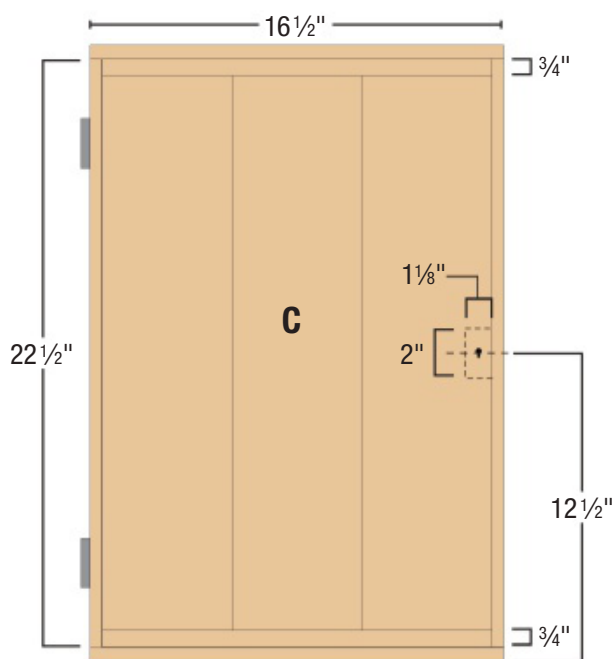
A New Tool Cabinet

“The cabinet would be an ornament to any manual training school. The corners of the cabinet are reinforced with steel, and the arrangement of tools convenient. The cabinet contains two saws, steel hammer, Bailey Jack and block and rabbit planes, rule, two chisels, two gouges, screw-driver, bit brace and auger bits, two gimlet bits, screw driver bit, countersink, marking gauge, spoke shave, brad awl, nail set, try square, bevel, half round file, oil stone, oil can, combination pliers, glue, and boxes of assorted brads and screws. It is so constructed that the cover is light, and the cabinet will not fall if resting in a very small space. The heavy lifting handle on top is bolted on the under side so that the cabinet can easily be carried from one place to another. It locks with a level lock and flat key. Chandler and Barber, 15 and 17 Eliot Street, Boston Mass.”

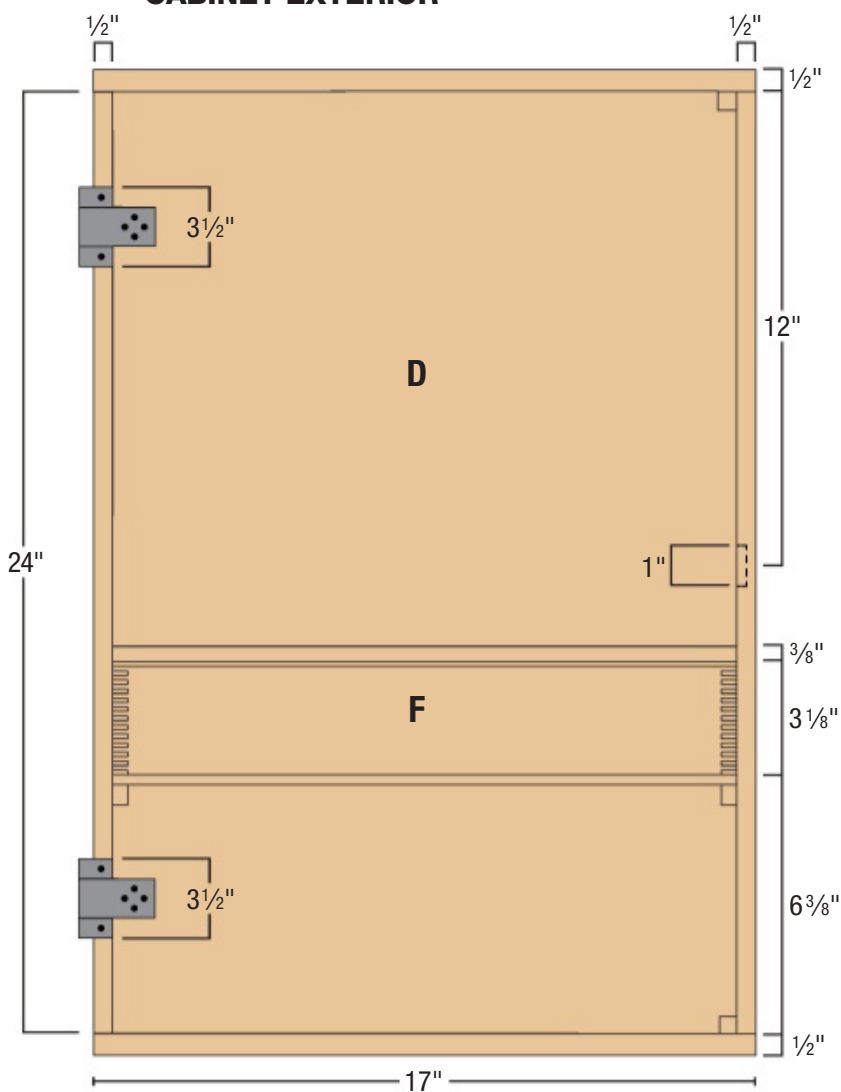


TOOL CABINET.
Size 25 1-2 x 17 1-2 x 7 1-2.
Other Sets or Combinations at Various Prices.

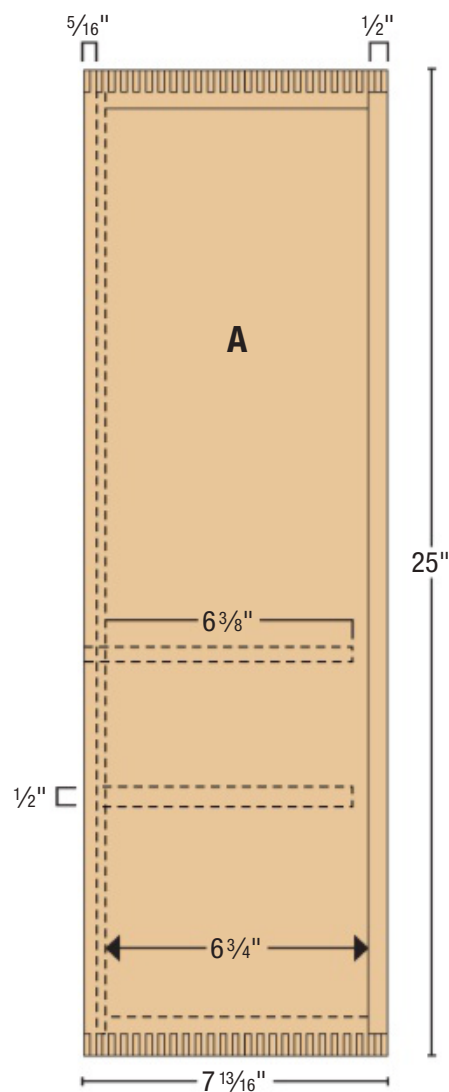
Sloyd Tool Cabinet



CABINET EXTERIOR



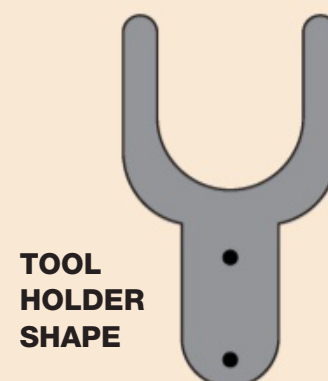
CABINET INTERIOR (Door Removed)



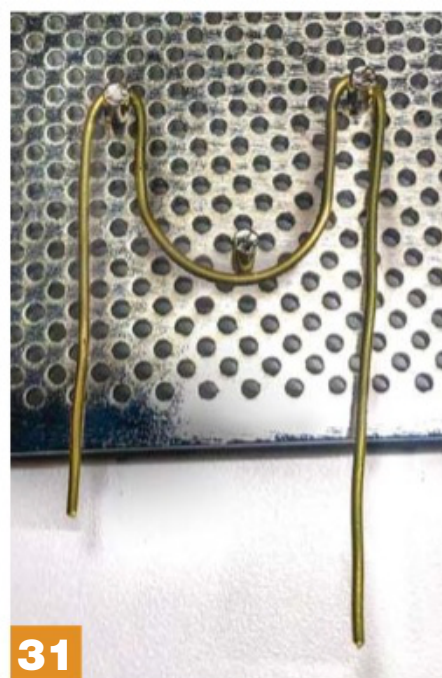
LEFT SIDE

Cut List

No.	Item	Dimensions (inches)			Notes
		T	W	L	
2	A Sides	1/2	7	25	Trim to fit Floating panel Trim to fit
2	B Top/Bottom	1/2	7	24	
1	C Door	1/2	17	13 1/2	
1	D Back	1/2	16 1/2	24 1/2	
1	E Shelf	3/8	6 3/8	17	
2	F Drawer Front/Back	1/2	3 1/8	16	
2	G Drawer Sides	1/2	3 1/8	6 3/8	



**TOOL
HOLDER
SHAPE**



29 A few simple tools are all you need to precisely bend wire for tool holders.

30-33 Start the U shape with corresponding groove in the wire bending jig. Then use the artistic wire jig to add a couple more bends. Back to the wire bending jig for a second U, finished off with two small loops in the back, made with pliers.

34-36 The hammer holder is also fashioned out of brass. Make a template and trace onto a piece of brass sheet. I used a jigsaw with a metal cutting blade to cut it out, then filed the edges to finish the shape.

37 The original bit holder is cast iron, but I 3D-modeled it and printed it in black ABS plastic. It's printed in two pieces to fit the bed of a small 3D printer.

Materials List

Lee Valley (leevalley.com)

No.	Item No.	Description
1	91Z0407X	#4, 1" Flat Brass Screws (10ct)
1	91Z0402X	#4, 3/8" Flat Brass Screws (10ct)
2	91Y0605X	#6, 3/8" Round Brass Screws (10ct)
1	91Y0602X	#6, 3/4" Round Brass Screws (10ct)
2	91Z0805X	#8, 3/4" Round Brass Screws (10ct)
4	00H2810	2 3/4" Utility Hook
1	00S5601	1/2" Brass-Plated Square Hooks (100ct)
1	00S5603	1" Brass-Plated Square Hooks (100ct)
1	00H5812	1/2" Brass-Plated Overlay Door Hinges (1 pair)
1	00P2920	2" Standard Cut Cupboard Right Lock
1	56K6012	Old Brown Glue, 20 fl. oz.

McMaster Carr (mcmaster.com)

No.	Item No.	Description
1	92451A199	Brass Slotted Flat Head Screw, 8-32 Thread Size, 1" long (50ct)
1	92561A009	Brass Hex Nut, 8-32 Thread Size, Width 1 1/32", Height 1/8" (100ct)
1	92916A335	Brass Flat Washer, No. 8 Screw Size, 3/8" OD, 0.025–0.039" T (100ct)
1	8956K132	Ultra-Formable 260 Brass Sheet, 4" width; 36" length; 1/16" thick
1	8864K76	Ultra-Formable 260 Brass Wire, 1 lb. Spool; 0.064" Diameter, 83 feet

Amazon (amazon.com)

No.	Description
1	Wire Bending Jig (made by Micro-Mark)
1	Artistic Wire Deluxe Jig Kit (made by Beadalon)
1	Nylon Webbing Strap*

*If you have an old backpack laying around, you can repurpose the strips. Simply cut to size and cut a lighter to seal/melt the ends.

hook during travel. Drill through the marks you made earlier with the punch and use a counter sink bit to fit your brass screws. Install these hooks in the same manner you installed the wire tool holders.

3D Printed Hardware

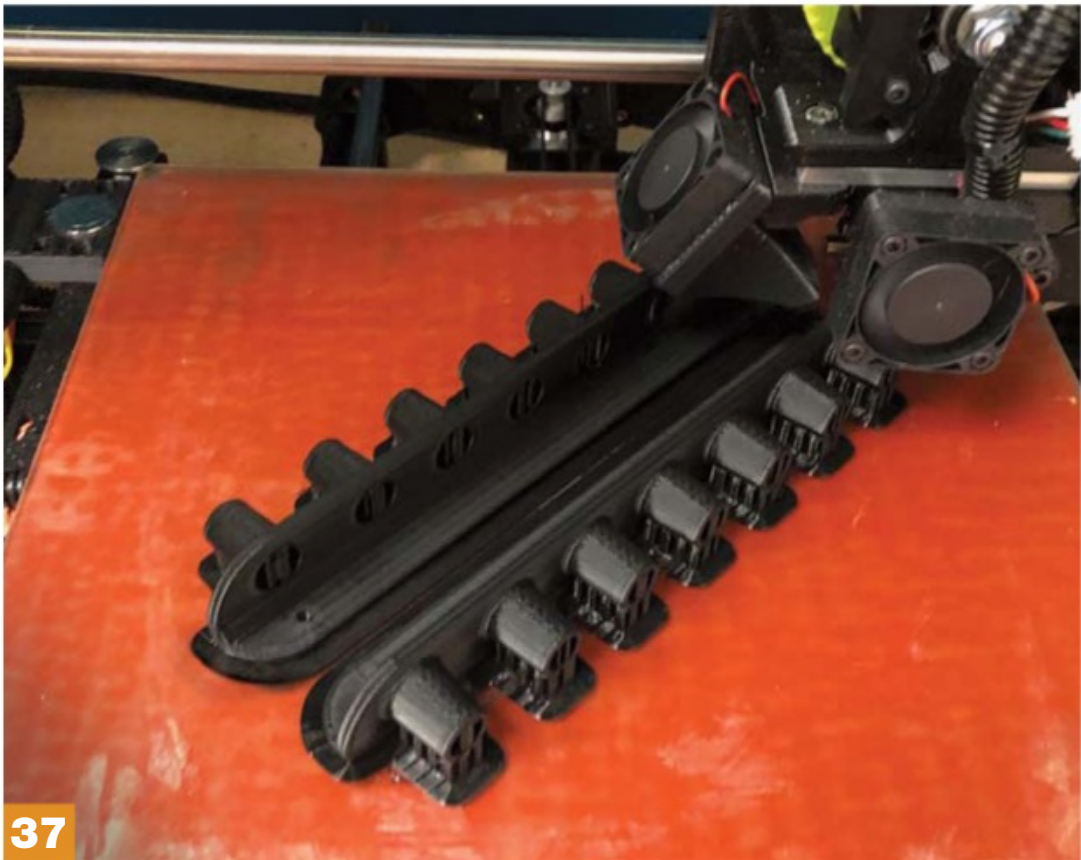
One of the more interesting pieces of hardware in the back of this cabinet was a cast iron bit holder designed to hold tapered bits for use with a brace. This piece of hardware has not been made in almost a century so I needed to come up with an alternate way to produce this piece. Using the original as a sample I made a 3D model of this piece and printed it in black ABS on my 3D printer. Don't worry, if you don't have a 3D printer there are lots of online services that will print a part for you for a reasonable price or ask around as you may have a friend with one. Print the part with 100% infill, a brim and full support material.

For the 3D printed model, it's made in two interlocking pieces to fit a wider range of print beds. Any support material can be removed with nippers, files and/or an X-acto knife. Once installed it does a great job of holding bits and from any reasonable distance it's hard to tell its not also a cast metal piece. Use 3 slotted brass pan head screws.

Conclusion

The Sloyd Tool Cabinet is a nice skill builder that results in a useful object-much in the spirit of Sloyd training-and is great for taking some core tools to a workshop or jobsite around the house. You may also want to consider making one with or for someone eager to learn woodworking. As we learned from an 1898 ad for the cabinet (see "A New Tool Cabinet," page 32), a cabinet filled with good tools that are useful makes a practical holiday gift. **PW**

Bill Rainford is a woodworker, instructor and software developer in Massachusetts. See more at rainfordrestorations.com.





PROJECT #1923

Skill Level:

Advanced

Time: 1 Week

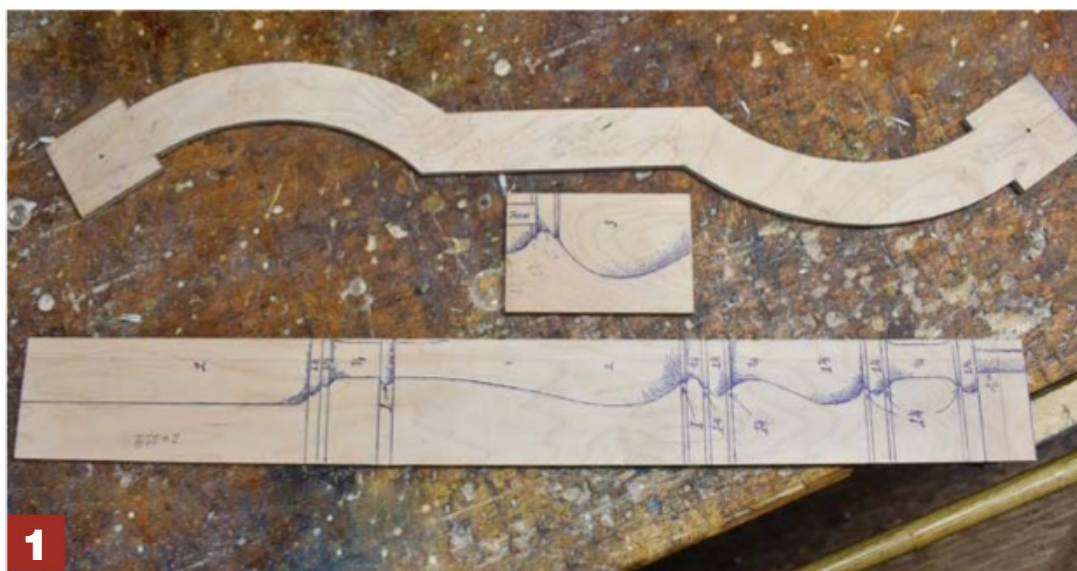
Cost: \$250

William & Mary Table with Drawer

Unique details make this build a masterclass in the style.

By Kerry Pierce

I'm not a fan of period furniture from England. The English emphasis on the horizontal conflicts with the American emphasis on the aspiring vertical that I find so appealing in period furniture built in this country. But, of course, there are exceptions, like this petite William-and-Mary one-drawer table which I found represented by a tiny black-and-white photo in a 30-year-old issue of *The Magazine Antiques*. Like nearly all William-and-Mary tables from both sides of the Atlantic,



1

Carve Your Legs on a Lathe

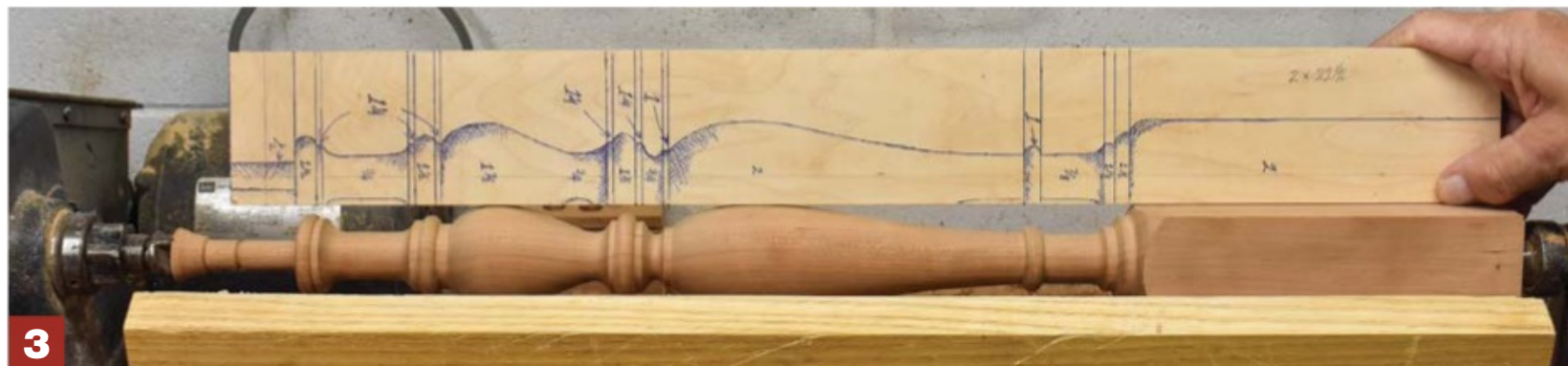
1 This particular table required the use of two story sticks—one for the feet and a second for the legs—as well as one pattern for the components of the X-stretcher.

2 On the wall above my lathe, you can see the black-and-white photo on which I based my table. On the English original, the radiussed trim appears only below the drawer. On my version, that trim runs all around the piece. Also, I increased the overhang at each end of the table top. Please note the array of calipers. Each is set and labeled with a different diameter. Together, this array reflects every significant diameter on the leg.

3 Notice the relationship between demarcations on the story stick and the various turned elements of the leg. Without this story stick, it would be necessary to measure the length of each segment by hand, a pretty cumbersome process that could lead to errors.



2



3

William & Mary Table

this example is distinguished by well-conceived turnings, oversized onion feet, a wide lip around the top, and a variation of the William-and-Mary X-stretcher.

Prepping

After I had generated scaled front and side drawings, I used this information to create the necessary pair of story sticks and the stretcher pattern. The stretcher pattern was a bit of a puzzle until I figured out the geometry the original maker had used. In the case of this table, that geometry is based on two compass-drawn circles centered on a point half between the two stretcher blocks on one end of the table on a line connecting the inside edges of two of those two blocks. (**NOTE:**

Cut Flawless Stretchers

4 A furniture-making friend Rick Davis volunteered to make the stretcher. He began by bandsawing the two halves from 1/2" stock.

5 He then drilled a 1/2" mortise in the exact center of the squares at each end of each stretcher half.

6 Rick then created this clever fixture to facilitate the accurate layout of the half-lap joint which connects the two stretcher halves. The 1/2" dowels are press-fit into 1/2" mortises drilled 12" apart, front-to-back and 19" apart, side-to-side (measurements are given center to center). When the stretcher components are placed over these stub dowels as shown here, they are in the exact alignment they will have in the finished table. This allowed Rick to accurately establish the angles and limits of the half-lap joints which you see him marking here.

7 Then with a fence set up an appropriate distance from the lap joint on the bottom stretcher component, he used a router to establish both the limits and angles of the lap joint.



■ Creating the 60° Lap Joint

By Rick Davis

The X stretcher assembly must be cut with precision. The tenons at the bottom of the legs must align with holes at the ends the stretchers. Cutting the lap joint presents a problem, but by using a simple jig, the necessary precision can easily be achieved.

Draw the stretcher layout on a piece of 21 1/4" by 14 1/4" poster board, marking a 2 1/4" square at each corner for the ends of the stretchers. Locate and mark the center of those 4 squares, and then finish drawing the stretchers per the plans.

Place the completed drawing on top of a piece of 3/4" plywood or MDF, and with an awl press through the center point of the four 2 1/4" squares to mark their location on the plywood. With a

1/2" forstner bit, drill a hole at those 4 locations and place a short dowel in each hole.

Cut out one of the stretchers drawn on the poster board to use it as a template to draw the two stretchers on the boards that will be the final stretchers, using an awl to mark the center points for the holes. Cut out the stretchers on a band saw, drill the holes, and create the rounded edges on the squares with a block plane.

Place the stretchers onto the plywood jig to form their final X shape. With a sharp marking knife pressed tight against the top stretcher, mark a line onto the bottom stretcher to set the location for the first half of the lap joint. Use a palm router to cut out the waste

on the bottom stretcher. In order to assure that there will be no blow out at the exit of the router cuts, you may also want to first use a dovetail saw to saw just off the line to the desired 1/4" depth.

Put the two stretchers back onto the jig. They should make a perfect fit. Remove the two stretchers as a unit, flip it upside down, and place it back onto the jig. Again, using the upper stretcher as a guide, mark onto the second stretcher the location for the cuts, and rout out the waste on the second board. Return the two boards onto the jig for the final fit. Glue the top stretcher onto the bottom one and secure it in place with three #6 3/8" screws. Let the assembly dry on the jig.

The stretcher blocks are the four squares on the ends of the stretcher arms through which the table's four legs penetrate.) One of the circles represents the inside edge of a stretcher arc; the other, the outside edge. The two story sticks allowed me to quickly and easily establish locations long the turned feet and legs.

We won't focus on the turning for these legs. Instead I'll direct you to the August 2018 issue of this magazine for a more thorough approach to turning these legs. Instead, we'll focus on the rest of the details in the pages to follow.

Fabricating the 69° Stretcher

When I described, to my friend (Rick Davis), the half-lap stretcher problem posed by this table, he volunteered to tackle the problem. My first thought was to measure the angle where the stretcher com-

ponents crossed, then transfer that measurements to the tablesaw's miter gauge in much the same way I used to create the half-lap joint in the X-stretcher of a William-and-Mary table I made for the April 2017 issue of this magazine. But the 69° I read from my plastic \$3.00 protractor turned out to be not quite accurate enough to give us the proper distance between the centers of the four leg tenons.

So Rick gave the problem some thought and came up with an ingenious method of accurately marking those angles which led to a method for cutting the half-lap joints (see sidebar, above).

Measurements

Accurate measurements are critical to the fabrication of any piece of hand-made furniture; nevertheless, it's a mistake to assume that corresponding parts on any piece

will have exactly the same measurements. In the case of the turned elements on these table legs, I produced lengths and diameters of reasonable accuracy, but a few minutes with a ruler and a pair of calipers would reveal discrepancies; however, this isn't a problem because the human eye can't read small errors across the surface of a piece of furniture. Plus—and even more important—these small discrepancies offer proof that this table was built by human hands.

What I mean is this: When you're turning the legs or the feet of this table, and you realize that the vase on one legs is a 1/16" greater than the same vase on another leg, don't panic. That isn't a problem; that's a virtue. **PW**

.....
Kerry Pierce is a longtime woodworking author and furniture maker based in Ohio.

Mortise & Tenons for the Table Base

8 When you're laying out mortises on a set of table legs, it's very easy to mark a mortise on the wrong face of one or more of the legs. To avoid that problem, after I've pencil-marked the mortises but before I knife-mark them, I bring the pencil-marked legs together in the alignment they will have in the finished table, and check to see that everything is the way it should be.

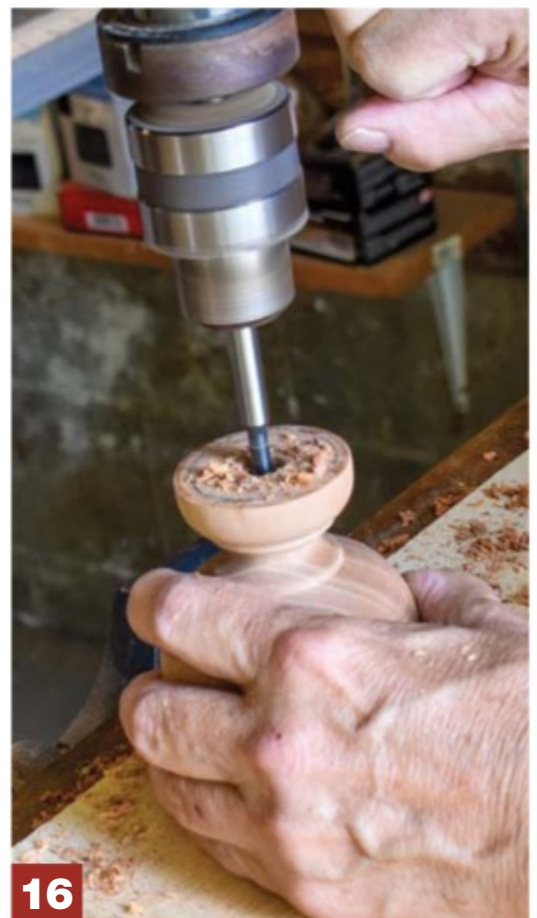
9 After struggling for many years to hold a metal rule in exactly the right position for knife-marking mortises, something kicked my brain into gear. I purchased a supply of 6" metal rulers and attached wood fences to them that represented the inside and outside edges of each mortise. This makes mortise layout nearly idiot proof. You simply press the fence against the work and move your marking knife along the edge of the ruler.

10 Mark the outside edge of the apron mortises. Notice the wider fenced ruler on the bench beside me. That will be used to mark the inside edges of those mortises.

11 I completed the knife marking using a tri-square to align the knife for cross-grain marks.

12 Here you can see how clean and accurate the knife marks are.





13 For forty years, I've thought about buying a hollow-chisel mortiser, but somehow I always end up chopping my mortises by hand—which I believe is a pleasant way to pass a few hours in the shop. I find a comfortable working position, turn on the radio, put my hands on full auto, and before long I have a set of mortises.

14 The finished hand-chopped mortises are pleasant to contemplate. I'm not sure I'd feel the same about mortises ground out by a machine. Plus who can hear a radio when the hollow-chisel mortise is chugging and clattering along.

15 Perhaps oddly given the fact that I create mortises with chisels, I take the easy way out when cutting the tenons by thickening them on a stack of dado cutters. I then finish by bandsawing away the sections that are not part of the tenons.

16 I cut the mortise into the top of each foot by holding the foot in my hand while I bring a 1/2" Forstner bit into the end grain. This would be difficult or impossible with a twist bit which imparts a powerful rotation.



Finishing the Table Top

17 Almost fifty years ago when I began making stuff from wood, I bought a belt sander and a vibrating sander, and those two tools destroyed every surface they touched. No matter how light my touch, the edges of the belt sander's belt cut grooves in the surfaces, and the vibrating sander left small circular scratches. So I pitched these tools, and ever since, I've finished surfaces as you see here. Working in the illumination of strong side light, I first cleaned up the surface with a really good finishing plane set to take a shaving far thinner than a facial tissue, then went back in with a very sharp chisel used as a scraper to clean up tiny areas of tearout. I finished the surfaces through hours of work with a hand-sanding block and a variety of sanding grits. Noble efforts maybe but more drudgery than I really want to invest in getting a clean surface.

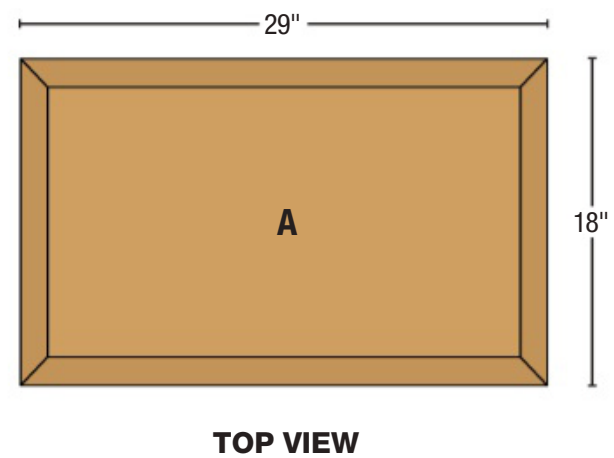
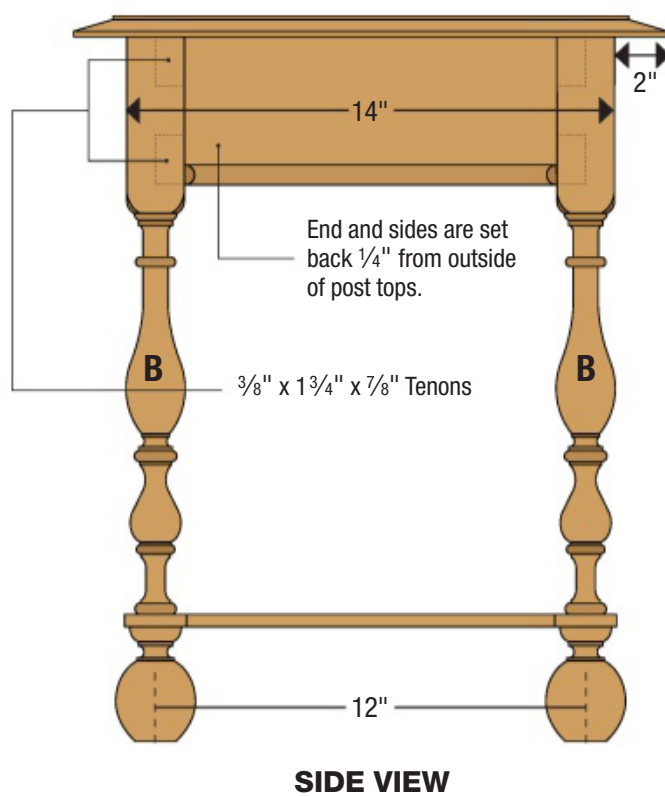
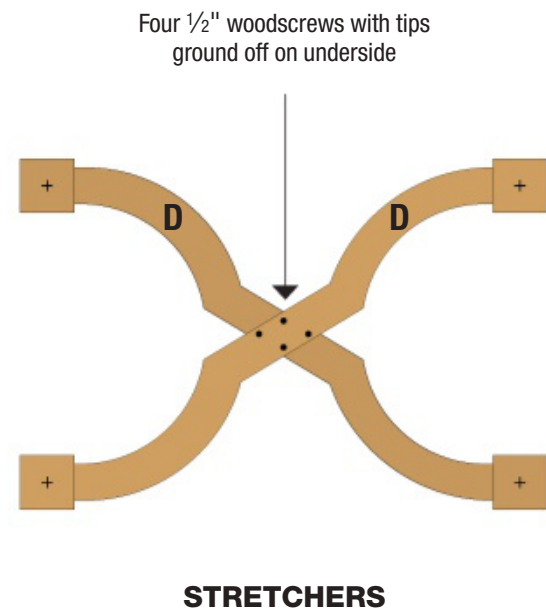
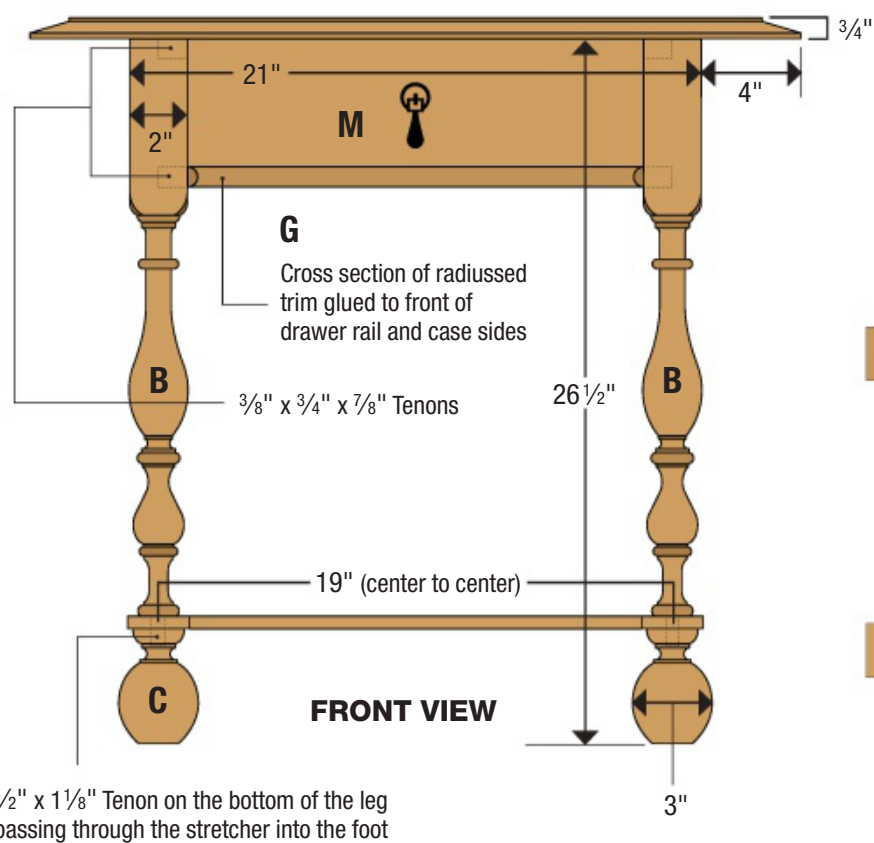
18 Then one day during my work on this table, I walked through the local Lowe's store and saw this sander. I decided to give it a chance, and it was a revelation. In 20 minutes, I could produce a clean, flat, scratch and groove-free surface. Progress.

19 The wide lip around the top could be roughed in using hand planes, but the table-saw makes such quick work of this task: once around with the top stood on its edge as shown here, then once around again with the top laid flat on the saw table.

20 But good hand planes are essential to fine tune the lip. I used this wide shoulder plane up close to the fillet (and on the fillet itself with the shoulder plane on its side) and the little block plane on the left for the rest of the lip.



William & Mary Table with Drawer

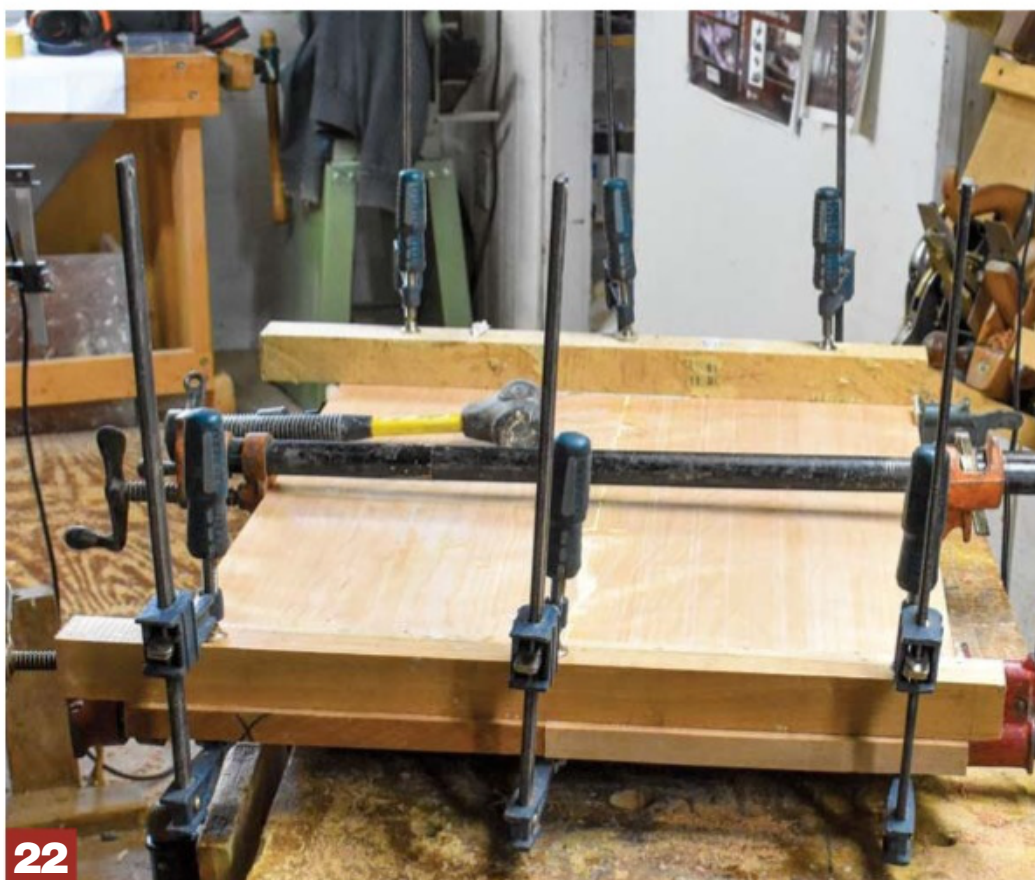


Cut List

No.	Item	Dimensions (inches)			No.	Item	Dimensions (inches)		
		T	W	L			T	W	L
1	A Top	3/4	18	29	2	J Front/Back Top Hold-Down Cleats	3/4	1	16 3/4
4	B Legs	2	2	29	2	K Drawer Runners	3/4	1 3/4	11 3/4
4	C Feet	3	3	4 15/16	2	L Kicker Strips	3/4	1 7/8	9 3/4
2	D Stretchers	1/2	4 1/2	26	1	M Drawer Front	1	4 3/4	17
2	E Side Panels*	3/4	5 1/2	11 3/4	2	N Drawer Sides	5/8	4	12 3/8
1	F Back Panel*	3/4	5 1/2	18 3/4	1	O Drawer Back	5/8	2 1/2	16
2	G Front/Back Radiussed Trim	5/8	3/4	17	2	P Fitting Strips	3/8	3/4	10 1/2
2	H Side Radiussed Trim	5/8	3/4	10	1	Q Drawer Bottom	5/8	11 3/4	15 1/8
2	I Top/Bottom Drawer Rails	3/4	3/4	16 3/4					

*Includes 7/8" long tenons on each end.

Full-size plans are available at popularwoodworking.com.



Glue Up & Assembly

21 Sometimes when I'm gluing up a table base, I'll glue the end panels first, then join them with the front and back members. This table, however, was small enough that I could do the whole base at once. The heavy motor on top ensures that the bottoms of all four feet are in the same plane.

22 I used nine clamps to create the two-board table top: three pipe clamps across, staggered bottom and top and three vertical bar clamps on each end pressing a straight-edged caul tight against the surface. This multitude of clamps ensures both a tight glue joint and a flat surface

23 The top is held in place primarily by a pair of $\frac{3}{4}$ " x 1 cleats, one in front, the other at the rear, but the screws in the kicker strips add additional hold-down strength for the top. The trick to using screws to hold a top down is to make sure that the hole through the cleat is slightly larger than the diameter of the screw. That way the top can expand and contract across its width without cracking.

Radiussed Trim

24 I began the creation of the radiussed trim at the bottom of the apron by milling some 5/8 x 3/4 stock. I then cut the material to length and marked the flush point on either end. After establishing some guidelines, I roughed in the trim radius using a block plane.

25 Here you can see the flush line of the end grain, as well as the guidelines and the rough plane work. Each trim piece is then finished with a rasp and sandpaper.

26 The taper on each end of each trim piece was cut with a chisel.

27 The glued trim pieces were then installed by holding them in place for a slow 60 count, giving the glue time to grab. (This can't be done if the back of the trim piece is bowed or twisted.)



Lastly, the Drawer

28 I cut the half-blind drawer dovetails by hand.

29 Notice the fitting strip on the side of this drawer. These strips make it much easier to fit a drawer to its opening because you need to plane only the strip—not the entire drawer side. (I think these strips are my invention, but it could be that I stole the idea from someone else years ago.)



■ A Modern Parametric Bench

PROJECT #1924

Skill Level:
Intermediate
Time: 4 Days
Cost: \$200

Spine and rib construction is key to this design.

By Tim Celeski

Thanks to advanced design tools, an entirely new category of modern architectural details, furniture design and art has emerged. Named after the specialty software tools used to create it, it's called parametric design.

Parametric furniture consists of evenly spaced rows or stacks of shapes that create the illusion of large three-dimensional forms. Usually, these exacting shapes are cut on a CNC and assembled in several ways. Stacks of parts are glued together to form large laminations, evenly spaced shapes are held together with complex internal structures or drawn together with threaded rod and spacers.

As a furniture maker and artist, I've been exploring parametric sculpture and have developed some new techniques that woodworkers can use to quickly build and create their own parametric furniture with or without a CNC. I call this technique spine and rib construction.

As the name implies, the main components are a spine and a lot of ribs. The ribs slide into position so that they form around whatever shape the spine happens to be. Spines can be straight, bowed or curved in many ways. This feature allows the builder to experiment with the overall look by tweaking the spine shape. And, because the plywood parts have large, glued,

connecting surfaces there is no traditional joinery. The bench in this article is based on the shape of classic Cabriolet furniture legs.

Rib Design

The bench consists of 48 ribs plus a spine for an overall length of about 36" was made from two sheets of 3/4" Baltic Birch plywood. A shorter version, with say 24 ribs makes a terrific side table. Certainly, make a longer version or change the rib shape as you prefer, but keep in mind the weight and the details used to produce 24 Cabriolet leg-shaped ribs per sheet.

During the project development, I explored various rib shapes and built a number of scaled and full-size models. Besides shape and efficiency, I've discovered that it's important to consider the shape or symmetry of the top corners and the size and position of the slot in the middle. If you create a new rib design, these factors will affect the overall look.

Spine Design

Because of the slot, the ribs are pushed against the spine to collectively form the overall bench shape. This makes the spine design important. To explore the effect, I created spines with sweeping curves, S-curves, bulges, short curves, bumps and the design for this article that bows out the middle for a neo-classic

look that fits well with Cabriolet legs.

Spine designs carry both limitations and possibilities. If the spine curves are too short, the ribs protrude oddly rather than progressively moving in and out. I suggest gradual changes over at least 18" or so. Bonus: if the sides of the spine are



1 The ribs stack around the spine. As you pull the ribs outward against the spine, the bench follows the spine's shape.

2-3 The overall shape of the bench is determined by the shape of the spine.





4

4 Using the same ribs with different spine shapes, you can create several different benches or side table designs.

parallel, either curved or straight, you can have a curved seating area rather than flat one.

Construction Technique

There are several ways to build this project. You can make your parts on a CNC, use a small CNC to make the sample and pattern, create a full-size drawing from this article, or use the PDF drawings available online to print out paper templates to make your patterns from.

If you have a CNC large enough to machine from large pieces of plywood, it's certainly the fastest way to make a lot of parts quickly. If you don't have one, I've come up with a couple of new techniques for imitating the accuracy and repeatability of a CNC using a router.

Start with Your Patterns

For this project, I made the $\frac{1}{2}$ " plywood patterns with the Shaper Origin, a simple to use, hand-held

CNC. Beginning with the original Rhino3D CAD drawing of the rib and offset pattern, I exported SVG files that can be read by the Origin. After laying out ShaperTools' marker tape, I cut the pattern and sample out. Yes, you can make all your parts using the Origin but the process is slower.

The full-size sample is used to lay out the parts you'll cut from $\frac{3}{4}$ " plywood. The second is a special offset pattern. It's $\frac{1}{8}$ " smaller all

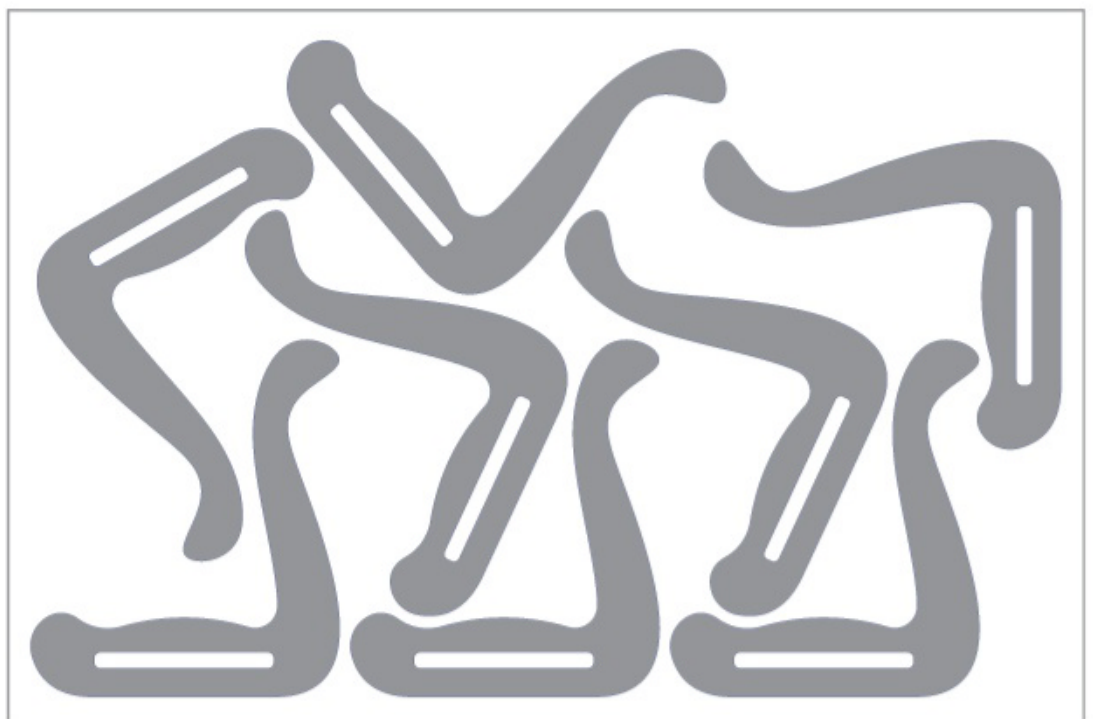
around to allow for shaping parts with a router, $\frac{3}{8}$ " router bit and $\frac{5}{8}$ " bushing. Once you've drilled the two $\frac{1}{8}$ " holes near the ends of the ribs as shown on the drawing and completed the two patterns, use a marker to identify the smaller, offset shaping pattern so you don't confuse it with the sample part.

Materials

Most parametric designs feature visible and touchable plywood edges. Being furniture, this is not the kind of project for the lesser quality plywood found at typical home centers with paper thin top layers, few layers and a core full of voids. Just like carefully selecting hardwood for fine furniture, your material choice is important. Baltic birch plywood is the default material for parametric furniture with its many solid core layers and 0.005" thick top layers. Various grades are available all the way up to perfect and expensive Eurocore plywood. For this project, I used standard Baltic birch plywood.

Lay Out the Parts

Handling heavy, 4' x 8' sheets of plywood is a challenge, so unless you're using a large CNC, consider cutting sheets into thirds. (I've included a layout drawing for efficiently yielding eight parts out



of 32" x 48" pieces.) Next, position your ribs on the plywood. Use the full-size sample rib for layout, not the smaller offset shaping pattern. Start at the lower left-hand corner of the plywood and trace around the pattern. Following the layout, continue tracing using a small 1/2" piece of wood or short dowel for the gaps between rib locations.

Cutting Blank Parts

When rough cutting the blanks leave an extra 1/8" or so outside the line. Use a bandsaw if you wish but I've found that a jig saw also works well for this job as it gets into that tight inside corner and you aren't wrestling a sheet of plywood.

Think Like a CNC

On most projects that require shaping, I turn to a shaper or a router table and my adjustable shaping jig for holding parts. But, the parts in this project are small, narrow and shaped on all sides which makes holding the pattern and blank safely particularly challenging. It's time for a little CNC thinking.

When cutting plywood parts on a CNC, operators often use what's referred to as a spoil or waste board. Typically, it's a piece of MDF that sits underneath the plywood to be cut. Its purpose in life is sacrificial.



5

5 The Shaper Origin is a handheld CNC router. It registers itself using marker tape and auto-adjusts to the programmed cut.

6 Spoil boards are an essential tool for machining plywood with a CNC. If you use one with your handheld router, you can do your shaping upside down.



6

No CNC? No Problem!

Start by making the shaping pattern and sample from full size paper drawings spray glued onto 1/2" plywood, rough cut with a jig saw or a bandsaw. For the large slot in the middle, drill 3/8" holes in the corners and use a jig saw to remove the rest of the slot area. Precision matters in this project. Spend time making your patterns and slots exactly right using rasps and files to smooth, right to the line in the drawings.

The full-size sample is used to lay out the parts you'll cut from 3/4" plywood. The second is a special offset pattern. It's 1/8" smaller all around to allow for shaping parts with a router, 3/8" router bit and 5/8" bushing. Once you've drilled the two 1/8" holes near the ends of the ribs as shown on the drawing and completed the two patterns, use a marker to identify the smaller, offset shaping pattern so you don't confuse it with the sample part.





7 A plunge router, a $\frac{3}{8}$ " bit and a $\frac{5}{8}$ " pattern bushing are used to make the bench ribs.

8 Start with the special parts first. Use double sided tape to hold the blank to the spoil board and the pattern to the blank.

9-10 With your pattern, rough cut parts and routing station all set, it's time to mill your pieces.

A spoil board allows the cutter to cut completely through plywood into its surface rather than damage the CNC bed.

For this project, we're going to do our shaping in a different way. Upside down, using a router and a spoil board. With 48 parts or more

to cut, the spoil board will get a lot of use. For your sacrifice, I suggest a piece or $\frac{3}{4}$ " MDF that's at least 2' x 3' to 4' in size. Plywood works, too, but the layers chip off easily. Before you begin, secure the corners of the spoil board onto your workbench with a couple of clamps.

Cut Special Parts First

With a few exceptions, all the ribs in the bench are the same. The standard ribs have two holes near the ends for alignment and holding during shaping that ultimately will be hidden. The exceptions are the visible outside ribs and second ribs where we don't want to see holes. Cut and shape two of each of these parts first. Rather than screws for holding, use two-sided carpet tape

to secure the blank part to the spoil board and the smaller offset pattern to the blank.

Use a plunge router with a $\frac{3}{8}$ " spiral upcut or compression bit and a low profile $\frac{5}{8}$ " pattern bushing. Because the parts are small and narrow, it's all too easy to tip a heavy router slightly as you go and spoil the visible edges of your plywood parts. To help stabilize your router, I suggest gluing up several small support blocks out of scrap the height of the combined $\frac{3}{4}$ " plus $\frac{1}{2}$ " pattern materials and set them near your cutting path.

Shaping the Ribs

For a clean plywood cut, set your router's final depth to slightly penetrate the spoil board. Once your



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part, pattern, router and support blocks are ready to go, I suggest you start by cutting down an $\frac{1}{8}$ " down at a time, working your way around the rib shape, counter clockwise. Step down in increments until you've cut all the way through and just into the spoil board. For the two special outside ribs, rather than cut a through slot, cut the slot just $\frac{5}{8}$ " deep. For the second ribs cut the slot all the way through. Repeat until you have two of each of these special ribs.

The big production run is easier. We're going to screw the parts and pattern together right onto the spoil board. Start by placing your blank part on the spoil board and the center the pattern on the blank. Holding the two pieces together, drill $\frac{1}{8}$ " holes through the pattern

holes, through the blank part and deep enough to just tap into the spoil board. Using a $1\frac{5}{8}$ " deck screws, screw the pattern and $\frac{3}{4}$ " blank stack onto the spoil board. With your plunge router and support blocks in place, follow the earlier shaping process for the special ribs. Each time you complete a rib, move your setup to a new location around the spoil board so you're not using the same holes. After a couple of dozen parts the spoil board will be pretty beat up. Just flip it over and use the other side.

Make the Spine

Once your impressive stack of parts is ready, it's time to make the spine that defines the shape of your bench. I use the bowed design, but whatever

11-13 With the ribs cut out, I carefully sand to 220 grit with random orbit and pad sanders. Then add a small chamfer with a trim router, before softening the edges with 320 grit by hand.

14 Set aside the end and second-from-end ribs and the ribs modified to accept furniture glides.

er shape you use, make the maximum width of the spine at least $\frac{1}{4}$ " narrower than the slot. For length, measure your stack of all your parts and add an extra couple of inches to make assembly easier. As suggested, keep the spine shape simple and curves gradual and consistent. With no reason to use fancy plywood, my spines are made from scraps from other projects.

Test fit your spine to see if it moves easily into the slot. I sized the slot drawings to just match the default thickness of $\frac{3}{4}$ " plywood so chances are it will be too snug. To adjust the fit, use a belt sander to gently and evenly sand down one side of the plywood spine a little at a time until it fits smoothly into the rib slots. To make dry fitting and glue up easier, soften the edges your spine with an $\frac{1}{8}$ " round over bit.

Time for a Dry Fit

Dry fitting is one of the most important steps in this project—it



15

15 Dry fitting is one of the best parts of the projects. You get to try out different shapes of the spine and change the look of your bench.

also happens to be the most fun. Putting it all together allows you to see and adjust what the overall bench shape will be. If you don't like the shape or width of the bench you've created, you can quickly create a new spine and try out a new one.

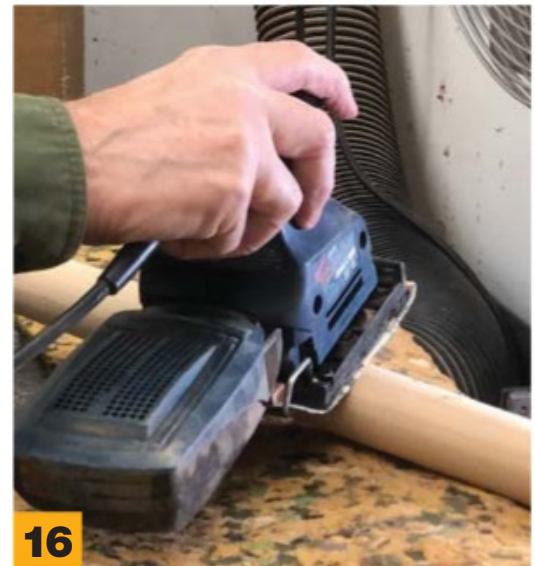
To dry assemble, work upside down with the heavy seating part of the bench on the bottom. Alternate ribs back and forth until your bench is assembled. For now, you can leave off the special end and second ribs. Carefully rotate the now heavy bench right side up. Now, pull each leg outward until it the inside bumps into the spine to define the bench shape.

Leg Spacers Stiffen Bench

Once you have a shape you like, carefully clamp the set together. You'll notice that the heavy top is rigid but the legs wiggle a bit at the bottom. What's needed are spacers between each leg. There are a variety of ways to do this, but for the cabriolet shape of the legs I chose to compliment the rounded shape

with round spacers. I made mine from commonly available 1 1/2" pine closet rod. After sanding the rod smooth, use a bandsaw and fence to make test cuts. Measure spacers with a digital caliper until you matched the thickness of the plywood ribs. Once you produced enough spacers for the bench (it never hurts to make a few extras), drill an 1/8" hole through the center of discs you're created. These holes will help you align the legs and spacers during final assembly.

To avoid confusion with the dozens of parts you'll deal with during assembly, set aside the two sets of special outside and second rib parts. To that collection, we're going to modify four of the main ribs to better accommodate furniture glides. Set up a table saw and fence to make a small flat spot by trimming off just 1/16" off the feet of the four ribs. Slide the flat part of the rib along the fence. Set these four ribs aside and add four more regular ribs to your collection of special ribs. You should have a total of two end ribs with no through slots or holes, two second



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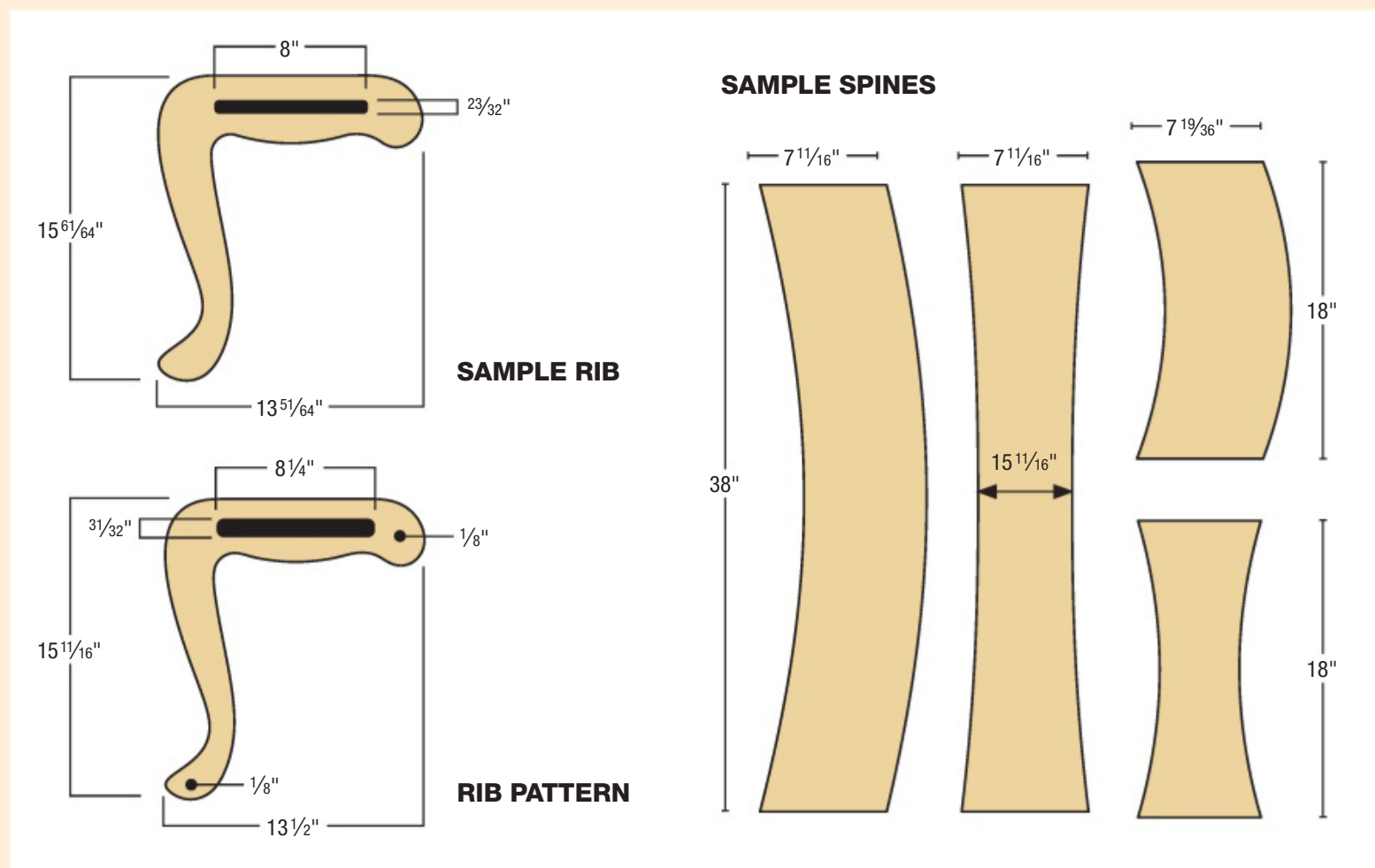
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19

16-19 I used closet rod for spacers. After sanding the rod smooth, I make test cuts to match the thickness of my plywood, then batch out a bunch with 1/8" alignment holes.

Parametric Bench



ribs with no holes, four regular ribs and four ribs flattened for attaching furniture glides.

Final Preparation

With a random orbital sander, sand the ribs with 220 grit sandpaper. Remember, the top layer is only 0.005" thick so use a light touch. Smoothing the edges, which are seen and touched, is more challenging. Being a furniture maker I have both edge and spindle sanders to help in the task but if you have neither, a carefully controlled pad sander or using a block sander making use of the curved and flat side, should help. Once sanding is done, I like to put a $\frac{1}{16}$ " chamfer on all edges and then soften slightly by hand sanding with 320 grit.

Assembly in Two Stages

It's very difficult to clean up excessive glue on this project, so apply

carefully. During the dry fit, note the areas that touch each other are near the end of the ribs, not the shoulder end of the leg. As the spine shape is applied and the parts move into position, the glue area varies. It's the area near the end and above and below the slot that always touches the part next to it where you want to apply your glue. To keep it from seeping out, I only apply glue to the area around the spine (see image 20). Also, I keep glue about $\frac{3}{8}$ " from all outside edges. Unlike regular furniture joinery, there's a massive amount of glue surface area to hold the bench together.

Build a Backstop First

With a lot of parts to handle, to make final assembly easier, I've found that it helps to first vertically build a backstop. With your collection of special parts and spacers, start with an end rib with the slot up. Like any mortise



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20 Apply glue to the two areas show in white, keeping it away from the edges to minimize squeeze out.



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21-26 Assemble the backstop vertically first. Be mindful of alignment and glue squeeze out—it's very hard to clean up afterward.

27 For the main assembly, push the legs outward as you go and use a clamp to hold the stack of parts together.

and tenon, apply glue to the slot and end of the spine.

Next, carefully add glue to the top of one of your prepared spacers. Position the second rib as it will be once added to the stack. Using a nail just big enough to pass through the $\frac{1}{8}$ " hole in the special second rib, align the spacer underneath. Hold the two parts onto your bench using a piece of $\frac{3}{4}$ " scrap to support the rib and tack together with a brad nailer loaded with $1\frac{1}{4}$ " brads. Now, apply glue to the other side of the second rib and the spacer, slide the assembly down the



28

Finishing Plywood

When choosing a plywood finish be aware that plywood can raise its grain severely with a water based finish and blotches easily with certain stains. Ideally, the bench with all its nooks and crannies is an good candidate for lacquer if you have a spray setup. A hand applied finish like Watco oil is another possibility. With any hand finish remember that getting into those little gaps will be challenging.

Wanting to add a little warmth, I chose a long time personal favorite: Osmo Polyx Oil. This German floor finish is made from various vegetable oils and waxes. You can hand apply the very thick Osmo in the manner of a rub-on oil/varnish finish. Wipe on. Wipe off. Build up three or four thin layers, and it's a rich and very durable finish.

Don't forget to add furniture glides to the four flattened legs. Being a heavy bench, use small HDPE glides so it can easily be pushed or pulled around.



29

28-29 Trim off the excess spine with a hand saw. Apply glue to the mortise on the final outside rib and the spine and clamp the bench assembly together.

spine, and align the part. Remember your dry assembly. Always push the ribs in all the way into the spine until they touch. Use the same process of adding spacers and glue for the next two regular ribs. Finally,

add the two flattened ribs. With a square, align the short stack of six ribs and spine and clamp or hold down the backstop to your bench and let dry before proceeding to main assembly.

Once the backstop is cured, rotate the bench so that it sits upside down, resting on its back. Assembling the bench this way uses gravity to your benefit and is the only way to align the parts and keep the bench flat. With the backstop in place, it's time to complete the bench.

Continue adding ribs, spacers and glue, pushing them against the spine. As I go, I use ratcheting bar clamps to pull and hold the horizontal stack together. Once you run out of regular ribs, add the final pair of flattened ribs, followed by the last two regular ribs and finally the second rib.

Your last step is to trim off the excess spine that's left over. To do that, use piece of 1/2" plywood scrap plywood resting against the rib as a spacer and trim with a handsaw. Glue and align the spine and end rib and clamp the completed bench

together to dry.

Don't forget to add furniture glides to the four flattened legs. Being a heavy bench, use small HDPE glides so it can easily be pushed or pulled around.

Just the Beginning

Parametric plywood furniture is great area for woodworking hobbyists to explore. And, using Spine and Rib construction and upside down shaping you don't even have to have a CNC to do it. I look forward to seeing what you come up with.

Head to popularwoodworking.com for more on parametric furniture. You can downloadable PDF project files to help you make your patterns and get into the details on how to CNC the parts or use a Shaper Origin to make the project bench. Plus, I'll show how the design was created, explore alternative designs and finishes, tricks to make the best of less expensive plywood, and more. **PW**

Tim Celeski is a furniture maker, artist and CNC enthusiast based in Washington. See more at woodworking.digital.

THE BEST NEW WOODWORKING TOOLS OF 2019

From the Editors and Contributors

In an effort to inform our readers about the latest and greatest, *Popular Woodworking* has surveyed the rich landscape of tools and equipment available and made our picks of woodworking tools of note for 2019. Here's our top ten, plus one tool storage accessory thrown in for good measure.



Auto-Jig Pocket Hole System

Armor Tools
armor-tool.com
Price: \$140

Pocket hole joinery using screws is, many times, easier and faster than traditional joinery methods, and Armor Tool's Auto-Jig has features to make the process easier yet. The "Auto" in the name means that the jig self-adjusts to the thickness of your material as it is clamped in, and the action of clamping down your workpiece also sets the drill guide to the correct height as well as setting the position of the stop collar on the drill bit. It takes all the guesswork out of using a pocket hole jig.

If you use Armor Tool's screws, they are painted to correspond with color-coded dots on the drill guide so you can confirm the correct length at a glance, too.



Stratus Portable Ambient Air Cleaner

Axiom Tool Group
axiomstratus.com
Price: \$499

Ceiling-mounted ambient air cleaners are stuck in one spot in your workshop, and have to fight gravity to collect airborne dust.

The Stratus air cleaner can be moved to wherever you're working, so it's closer to the source of dust. It's designed to catch dust on the way down before it has a chance to circulate throughout the room.

At its top setting, the Stratus inhales air at a rate of 848 cfm through its washable outer filter and 1 micron inner filter. Available upgrades include a stainless steel body and an odor and smoke neutralizing charcoal filter. The Stratus packs a lot of air-cleaning power into a small footprint.



AUTHOR: MICHAEL SPRINGER / EDITOR: ANDREW ZOELLNER / PHOTOS COURTESY OF THE MANUFACTURERS

■ HP-9v2 Dual Angle Block Plane

Bridge City Tool Works

bridgecitytools.com

Price: \$769

When John Economaki sold Bridge City Tools to Harvey Industries, some people were worried about a drop in quality (we were, too). But having gotten our hands on the products coming out of the factory, we were very impressed (John was, too). Case in point is this high-tech, high-concept block plane with both the adaptability and precision to justify its price tag.

Unlike other block planes, (with the exception of previous Bridge City models), you can switch the HP-9v2 from a 42-degree low-angle plane to a general purpose 47-degree model by flipping its dual-sided iron end for end. With its unmatched fit, finish and precision—not to mention its knockout good looks—this Bridge City plane is awesome. It comes with depth-guide skids and a side-mounted combo square and bevel fence. And, because they're being made at scale, you don't have to wait six months or more to get yours.



■ Kapex KS 120 REB Sliding Compound Miter Saw

Festool

festoolusa.com

Price: \$1,475

No other miter saw has the cachet to be known by a singular appellation like the Kapex, and now the next generation of this venerable saw has arrived. But beyond any snob appeal, the Kapex has a well-deserved reputation as an accurate and easy-to-use saw with great dust collection.

Legacy features include the up-front, micro-adjustable bevel angle adjustment knob and dual lasers that define both sides of the blade's kerf. New features on this latest model add extendable material supports, an improved motor and optional crown molding supports and stops.





Grex Power Tools

grexusa.com

Price: \$288 / \$305

■ **G0857/G0858 8" x 76" Parallelogram Jointer**

Grizzly Industrial

grizzly.com

Price: \$1,295 / \$1,725

Every woodworker wishes they had a wider and longer jointer, and these new models from Grizzly more than fill the bill for most workshops.

The G0857 has a cutterhead with four straight knives while the G0858 employs 36 indexable carbide inserts on a helical head, but both models share the same specs in other regards, such as 3hp motors, integrated mobile bases and parallelogram bed adjustment with four points of contact and arched table travel for alignment. These jointers are priced right, function well and are made to last.



Jet Tools

jetttools.com

Price:
\$1,700 (JWP-15B)
\$2,600 (JWP-15HH)

■ **H859LX 21-Gauge, 2" Nailer**

A 21-ga. nailer is a crossover tool that leaves a smaller countersink hole than an 18-ga. brad nailer, and provides more holding power than a 23-ga. pin nailer. The H850LX from Grex shoots slight-head brads from $\frac{3}{8}$ " to up to 2". An ingenious edge guide keeps the nailer in the correct position where accuracy really counts such as fastening along the edges of casework or applying edging to sheetgoods. Like other Grex nailers, this tool features an all-metal design for durability, as well as other premium features like rear exhaust and dry-fire lockout with a manual override to allow you to use the last several nails if you're not at a convenient stopping point to reload.



■ **JWP-15B/BHH 15" Planer**

Jet's new 15-inch straight-knife and helical-head planers aren't just their latest mid-size models, with the addition of Jet's PASS system, they're also quite possibly their greatest. PASS stands for Precision Air Strut System, which is a mechanism that actively pushes the cutterhead upward to alleviate snipe.

Both planers share the same 3 hp motor, two-speed gearbox with 16 fpm and 20 fpm feed speed, and 5,200 rpm cutterhead speed. But the 15B has folding steel infeed and outfeed support wings, while the pricier 15BHH has fixed, cast iron supports. As for cutterheads, the 15B uses three straight steel knives, and the 15BHH features a helical head outfitted with 48 carbide-tipped inserts.

■ Adaptive Cutting System

Kreg Tool Company

kregtool.com

Price: \$900

Track saws are an easy, portable solution to using a table saw for making precise cuts in materials, especially when working alone. It's much easier to guide a saw over your workpiece rather than struggling to feed heavy, unwieldy sheetgoods along the fence of a table saw. And for long diagonal cuts, a track saw is really the only way to achieve accurate results.

Kreg has introduced a plunge-cutting track saw and track system, along with a work table and other accessories designed for woodworking, and they've done it at a significant bargain compared to major competitors in the market. For a woodworker looking to save space or have a portable, fully-featured cutting solution, the Kreg ACS is definitely worth a look.



■ 10-326 Deluxe Bandsaw with Smart Motor DVR Control

Rikon Tools

rikontools.com

Price: \$2,000

Rikon took their model 10-326 14-inch bandsaw and made it one of the most versatile upright bandsaws for the shop with the addition of a DVR motor. That's digital variable reluctance in case you're wondering, and it lets you slow the speed of the motor way down (to an amazing 100 rpm) without losing torque. Common induction motors found on most shop equipment run at one speed and require you to rearrange belts and pulleys to shift gears.

With its "smart" 1 3/4 HP DVR motor, Rikon's new saw features 15 preset speeds ranging from 45 sfpm (with a pulley change) to 4,400 sfpm so you can choose the correct blade speed to avoid scorching certain woods, melting plastics, and overheating blades when cutting metals. Other welcome benefits from the DVR motor include very low vibration and an electronic brake eliminates a long coast-down period after cutting.





■ TSPSP650 Handheld Oscillating Spindle Sander

Triton Tools
tritontools.com
Price: \$119

Oscillating spindle sanders add an up-and-down motion to their rotating spindles to avoid wearing out their sanding sleeves in one place along the thickness of your material.

Most spindle sanders are benchtop models, but Triton is offering a portable handheld version to allow you to smooth and profile the edges on larger workpieces.

This sander is just the thing for squaring up the edges of curved materials or thick slabs, but it can also be used freehand for breaking sharp edges with more maneuverability than a belt sander. The included adjustable edge guide adds a measure of control to keep you from gouging divots into edge surfaces, and the tool also comes with a bench-mounting kit that lets you use the tool inverted in stationary benchtop mode for use with small pieces. For maximum versatility, the tool comes with four rubber sanding drums in $1/2"$, $3/4"$, $1\ 1/32"$, and $1\ 1/2"$ diameters.

■ 16" Clamp Rack-It System

Woodpeckers
woodpeck.com
Price: \$125

Pipe clamps, f-clamps, and parallel-jaw clamps are a chore to store efficiently, and the weight of all that steel adds up quickly, so you need a heavy-duty storage solution to load them on.

Rack-It brackets from Woodpeckers provide high-density and secure hanging storage in a small amount of wall space.

Mounting plates of different widths are sized to span common wall stud spacing, and you can attach the two sizes of arm brackets to the plates in different positions to customize the rack for your specific clamp storage needs. Optimally packed, the 16" model can hold 43 clamps in the space of a single stud bay (as shown).





■ Straight Talk on Jointer/Planer Combo Machines

These modern machines are for more than just the space-challenged woodworker. **By Charlie Kocourek**

I've got a nice woodshop, but it wasn't always that way. I started with a contractor saw in the garage. A while later I moved to a bigger house where I could have a dedicated shop. One of the first things I bought for the new shop was a vintage 16" planer. That planer produced a lot of snipe and the dust chute clogged when I ran wide boards through it. Then I bought a nice 13" lunchbox planer, but kept the larger one "just in case." Later, I added a 6" jointer. I finally had everything I needed to work with rough sawn lumber effectively, but that jointer left a lot to be desired, and I started looking for something better.

A few years ago, a friend got a 16" jointer/planer combination machine, and he raved about it. He talked on about perfect cuts from the helical

cutter head and how nice it was to have a wide jointer. Then another friend of mine told me about his 12" combination machine and how much he liked it. With limited space in my basement, it seemed like the route to go for me.

A jointer/planer combination machine is just that. It's a machine that converts from a jointer to a planer, and it uses a single cutter head for both operations. Combination machines have been the norm in Europe for decades, but they're becoming more popular stateside. And for good reason, beyond just saving space.

Upgrade Needs

I wanted at least 10" of jointing capacity and 16" of planing capacity. I also wanted a helical cutter head. I considered keeping my two planers

and buying a 12" jointer, but I ultimately decided on a 16" combination machine. The benefits of a combination machine in my space are:

- Smaller footprint. I could replace my three machines with just one.
- Requires less clearance than separate machines. For example, surfacing a 9' board requires nine 9' of clearance on both the infeed side and the outfeed side. With separate machines you need this clearance for each machine, but with a combination machine you only need it once.
- Extra jointing capacity. I would have been thrilled with a 12" jointer, but 16" was like going to heaven!
- With a new combination machine I could have a carbide helical cutter head for both jointing and

PHOTOS BY THE AUTHOR



1 The combo machine set up for jointing. The footprint is about 6' x 3'.

2 I bought an extra European-style blade guard and cut it into two pieces, so I have three different sizes that I use depending on the operation.

3 With the jointer table up, you can see the helical head used for both jointing and planing

planning and not have to worry about sharpening multiple sets of straight blades.

Several companies offer 12" machines, but there are fewer options for 16" machines. After much research and agonizing over the decision I chose the Hammer A3-41 with a helical cutter head. For me, this met my needs on price, features, and quality. It was far and away the most expensive machine that I had ever purchased, but it was worth it. I found an end of the year special, and it's a lifetime machine. I won't need to buy either a jointer or planer ever again.

I did add a few accessories. The planer doesn't have an outfeed table, so I bought a 16" extension table for the outfeed that's almost always

attached. The jointer table is 70" long, which is fine for most furniture projects, but I wanted to be prepared for anything so I bought another table extension for that. I don't use the extensions on the jointer very often and when I need them I also "borrow" the one from the planer (they're interchangeable), which extends the jointer table to 102". Hammer also offers a mechanical height indicator for the planer that mounts in the hand wheel, and I added a mobility kit, too. The planer height indicator allows repeatable cuts that are accurate within a few thousands of an inch.

Set Up

My machine arrived about two months after I ordered it. It weighs

Pros

- Smaller footprint than separate jointer and planer.
- Need to allow space in shop for only one infeed area and one outfeed area
- Much less expensive than a comparable set of jointer and planer machines.
- Most of these machines are available with helical, carbide cutter heads.

Cons

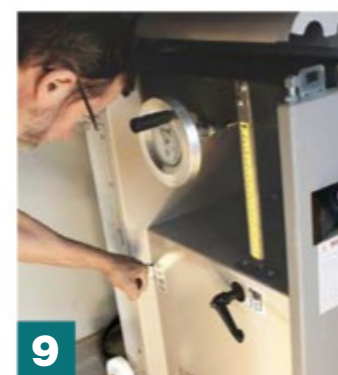
- Expensive. Even though they're less expensive than comparable separate machines, they usually require a large upfront cost.
- Time is required to switch between jointing and planing.
- Heavy and difficult to move into basement shops.

Things to Consider

- Jointer tables on 16" machines require more effort to raise up than 12" machines.
- Will require 220 volt wiring.
- European jointer guard takes getting used to, but some people love them.
- Ask vendor if there are any upcoming sales or discounts.
- Table extensions are not available from all manufacturers, so be sure to check if this is important to you.
- Changing over from jointer to planer is similar on most combination machines, but they're not all exactly the same. Again, try them out before placing your order.

650 pounds and my shop is in the basement of my house, so I hired piano movers to carry it in and down the stairs for me. Set up was pretty easy. A little clean up, add a plug on the end of the cord, mount the fence and I was ready to go.

I was disappointed initially because there was some snipe from the planer, and I was unable to adjust the jointer outfeed table. I called Hammer and they sent a factory technician from Delaware to my house in Minnesota to fix it. Their customer service is outstanding! Everything



was perfect when he finished the adjustments, and things are still dialed in after a year of use and moving it around my shop. I couldn't be happier with how well everything works.

Jointing

The jointer has an aluminum fence. It looks a bit wimpy compared to a cast iron fence on a traditional jointer, but there have been no problems and it works great. The blade guard is also different than what I'm used to. It has a European blade guard rather than a "pork chop" guard like the one that was on my 6" jointer.

The guard is a narrow piece of aluminum that stretches over the entire cutter head. Instead of swinging out of the way as a board passes over the cutter head, a European blade guard remains stationary and the board passes under it. Some people love the European blade guards, but I've had trouble getting used to it. One of the issues is that the guard sticks out past the side of the machine when I adjust the fence for narrow boards or for edge jointing. My work around for that was to buy an additional blade guard and cut it into two shorter pieces. I now have guards in three

different lengths. The shorter blade guards don't get in my way when I'm jointing narrow boards.

Planing

The planing function feels familiar, like both my old 16" and lunchbox versions, and it's easy to use. It doesn't have an infeed table, but surprisingly, that doesn't affect how well it works.

Switching from Jointer to Planer

It only takes about 40 seconds, but I still try to minimize how often I change between the jointer and planer. That means I try to face and joint all of my pieces for a build before I thickness them. There are still times where I need to go back and forth, but it's forced me to be more efficient, which isn't a bad thing.

Changeover is a Four-Step Operation:

1. Unlock and raise the jointer table.
2. Reposition the dust hood for planing.
3. Raise planer table to desired thickness.
4. Engage planer drive rollers.

4 A European guard does take practice if you're used to Western, porkchop-style guards.

5 The combo machine in planer mode with the table flipped up.

6-9 Changeover is a four-step process. Flip up the table, reposition the dust hood, raise the planer table and engage the drive rollers.

The jointer table on my 16" machine is kind of heavy and it takes some effort to raise it up. A few of my friends have 12" machines and theirs aren't as heavy. The extra effort to lift the 16" jointer table isn't a deal breaker by any means, but it is something to consider.

I am very happy with my decision to buy a combination machine. I was surprised how much space it freed up in my shop (despite it being a big machine to start with). Having a wide jointer has improved my work process greatly, and I love the finish off the helical cutter head! **PW**

Charlie Kocourek is a woodworker and inventor of the Jack Bench Adjustable Height Workbench. You can see more of his work at jack-bench.com.

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The Times, They are a-Changin'

Even in wood finishing.

By Bob Flexner

One of my favorite songs back in the 1960s was Bob Dylan's, *The Times, They are A-Changin'*. This theme applies today to what's happening in wood finishing.

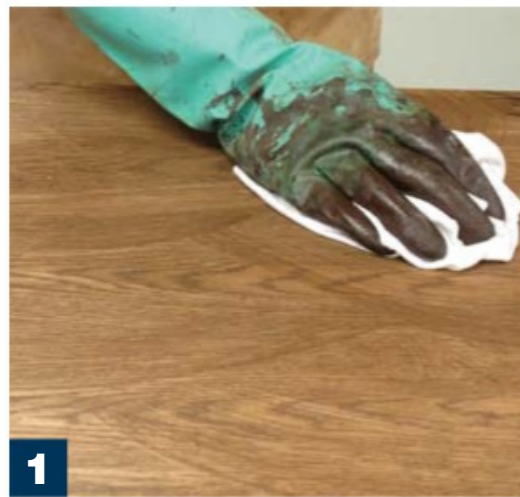
It's natural for us to believe that the way things ought to be are the way they were in our youth or young adulthood. Change always brings with it the necessity for adjusting. I've had to make lots of adjustments in my wood finishing. The main areas are finishes, solvents, spray guns, paint strippers and adjusting to the widespread consolidation that has been occurring.

Finishes

The biggest change is the introduction of water-based finishes and the slow disappearance of nitrocellulose lacquer and varnish. Actually, just using the term "varnish" is becoming out of date. There aren't many varnishes left. They have been replaced by "polyurethane," which is a type of varnish and which was widely disparaged in the woodworking community in its early days as a "plastic," as in "I don't allow plastics into my shop." (Actually, all varnishes and lacquers are plastics.)

Back to water-based finishes. Despite manufacturer labeling trying to make you think they are just like lacquer or varnish, they are an entirely new and different type of finish. The big reason, of course, is the inclusion of lots of water. Water raises wood grain, is more weather sensitive than organic solvent, increases the difficulty of applying decoration (stains, glazes, pore fillers and toners), and causes rust on metal cans.

Industry has converted significantly to water-based finishes in order to comply with VOC regulations, especially local regulations where



1 Decorative products using water-based technology such as stain, glaze and pore fillers are more difficult to use because they dry so fast. Here the stain dried before I could get all the excess wiped off.



2 In order to make "paint thinner" compliant with strict VOC rules, manufacturers add a lot of acetone, which is an "exempt" solvent. The problem is that acetone attacks many common finishes, as it's doing here on this lacquer finish.

their factories are located. But these finishes haven't caught on nearly as much in the amateur and small-shop woodworking community because they are more difficult to use than solvent-based finishes and don't look as nice on quality woods.

Solvents

The change in the availability of solvents hasn't happened everywhere yet, but it's coming. The driving force behind the change is air pollution, which is contributed to by VOCs. So some areas of the country, especially California and parts of the Northeast and Midwest, are restricting the sale of certain solvents.

The finishing solvents most affected are lacquer thinner and mineral spirits (paint thinner), though denatured alcohol has just joined the list in California. To make these solvents compliant with VOC laws, manufacturers have added a lot of acetone because this solvent is much less

polluting than the M.E.K., toluene, xylene and petroleum distillate traditionally used. Acetone can be used because it's classified as an "exempt" VOC.

Acetone has two characteristics, however, that you need to be aware of because it changes how lacquer thinner and paint thinner work. First, acetone evaporates very rapidly, so you may not have as much time as you were used to. Second, acetone is a very strong solvent that dissolves or blisters a lot of dried coatings (finishes and paints). So wiping over a coating, for example, to remove wax, with reformulated paint thinner may attack that coating. Read the ingredients on the can to check that acetone isn't included.

Spray Guns

Spray guns have almost totally changed since the early 1990s in response to the desire to put less finish into the air. Traditional spray

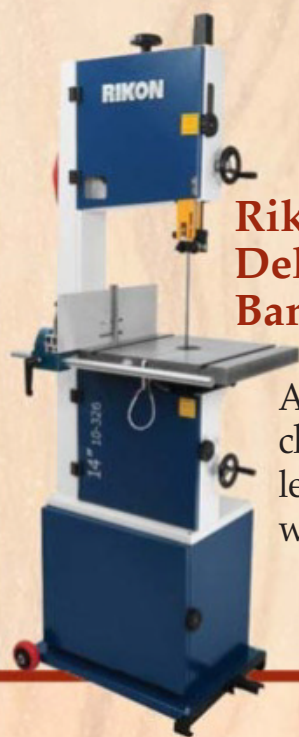
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3 There are two sources of air for HVLP spray guns: a compressor and a turbine. HVLP spray guns are available that can be operated off of either. Some brands can be operated off of both.

4 Early HVLP. Kirby vacuum cleaners came with an HVLP-gun attachment as far back as the 1930s. It was used to spray soapy water on carpets. The technology has been improved a lot since then.

5 The paint or finish being stripped makes all the difference. Here I'm stripping lacquer with just lacquer thinner. It would have had little success on oil paint, polyurethane or a catalyzed finish. Manufacturers of stripping alternatives to methylene-chloride strippers, which have been removed from the consumer market, don't tell you the coating being stripped in their marketing demonstrations.

guns operate off of air under high pressure, which causes a lot of the coating to bounce back off the target and be exhausted into the atmosphere.

To reduce the bounce back, spray guns were developed to deliver a soft spray. At first, these guns operated just off of a turbine, which is like a reverse vacuum cleaner. In fact, old Kirby vacuum cleaners as far back as the 1930s came with a spray-gun attachment. Slowly, spray-gun manufacturers figured out how to design their spray guns to produce a soft spray with compressed air. Both the turbine and compressed air spray guns are called "high-volume, low-pressure," or HVLP. Not counting airless and air-assisted-airless spray guns, almost all spray guns sold today are HVLP because they lower costs by reducing waste and produce just as good results.

Unlike the difficulties adjusting to water-based finishes and the disappearance of some very useful solvents, adjusting to HVLP spray guns is fairly easy.

Paint Strippers

I've written a number of times recently, both in this magazine and at popularwoodworking.com opposing the forced removal of methylene chloride from paint strippers. Unfortunately, this has happened. First, under pressure from consumer groups, big-box stores have stopped selling strippers containing methylene chloride, then the EPA issued a ruling prohibiting the sale of methylene-chloride strippers in the consumer market. Methylene chloride is by far the most effective solvent for removing paints and finishes.

So as manufacturers continue to supply more and more durable paints and finishes, their removal will be more and more difficult. This will result in increased damage to the wood, which may not be an issue with most modern trim and furniture, but it will reduce the value of old surfaces, especially antique furniture.

Consolidation

You may not have noticed, but there are many fewer companies supplying

finishing products now than there used to be. This has happened partly because of larger companies buying smaller ones and partly because of companies simply going out of business. It appears that all paint and finish companies are being consolidated into just three: Sherwin-Williams, PPG and Akzo Nobel. The result is that we have much less choice than we used to have.

The most obvious example is the current dominance of Minwax, owned by Sherwin-Williams. This company was tiny back in the days when I was making and restoring furniture. At that time I used two brands of stain that don't exist any more. One was an oil-based wiping stain that closely imitated the colors on antique furniture and the other was a "lacquer" stain that I added to lacquer to tweak the color to get a closer match.

It's been hard to find replacements. Adjusting to change is difficult. **PW**

Bob Flexner is the author of *Flexner on Finishing*, *Wood Finishing 101*, and *Understanding Wood Finishing*.

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Lessons from a Lifetime Maker

Thoughts on Adam Savage's *Every Tool's a Hammer*

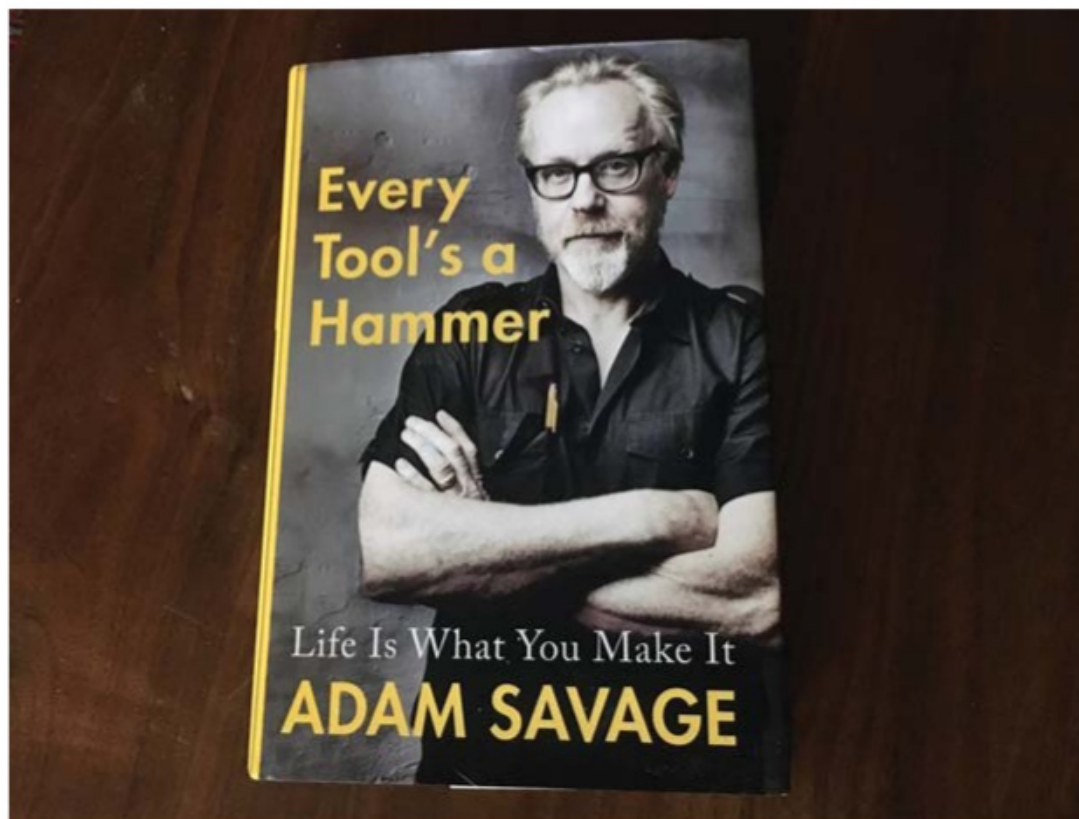
By Andrew Zoellner

*Every Tool's a Hammer:
Life Is What You Make It*
Simon & Schuster, \$27
simonandschuster.com

You may recognize the man on the cover of this book, Adam Savage, as one half of the duo from TV's "Mythbusters." The show ran for more than a decade in its original incarnation, spawned multiple spinoffs and showed the world that making and destroying stuff in the name of science was pretty darn cool. And reading the book confirms my suspicions that Adam is more than just a bearded face on TV.

Part memoir, part how-to with lots of advice on living a maker's life, it's almost like he's telling the story of his life through the different workshops he's inhabited. (His current shop, a cavernous underground space he calls "the cave" in San Francisco can be toured via Google Street View as well as seen in regular Youtube videos on the Tested channel.)

One of the central themes throughout the book is embracing curiosity. Taking things apart, putting them back together. Finding out what happens when you take a chance. Taking on a project without knowing exactly how to do it. Savage is a big proponent of going deep – following your curiosity to the next level, digging into whatever it is that you're passionate about, and adding purpose and meaning to your making. For Savage, that means crafting picture perfect props and costumes from and for the big screen. For me, that means learning to weld, cut and shape metals and exploring different ways to incorporate leather and textiles into furniture. And, of course,



going down all sorts of woodworking rabbit holes.

Savage's advice on workshops is golden: have a spot for everything, and make sure you don't have to do more than you need to to grab a tool. In Savage's shop, you'll see carts and cabinets organized by medium and need, all ready to be wheeled into action at a moment's notice. I've recently started to implement the same practice, though not on the same scale. With my track saw on a shelf (and not in its case), it's maybe less protected, but I reach for it more often. The same goes for my jigsaw and even my hand tools. They're only in the chest when I'm moving them.

For a guy that seems to want to learn how to do everything and buys the tools to do it, Savage also preaches patience. Recounting some bad decisions with his first cordless drill (a present for his 16th birth-

day), he tells the tale of trying to hurry and just get something done with bad results. I've been there more times than I care to admit. But I've gotten better.

More than anything, though, Savage is proof that a creative life filled with making stuff out of whatever you can is a very rewarding one, indeed. Yes, he's a TV star that's at the helm of a very successful digital media company, but his journey wasn't a straight line to the top. Detours into art, set-building and prop shops all led to where he is today. It wasn't easy, but the right tools make it easier.

In between the often comedic tales of projects gone wrong and right, there are lots of little nuggets of wisdom. If you're looking for a good read to relax with during your downtime, this might not be it. It'll only make you want to get right back out in the shop. **PW**

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CABINETS & DRAWERS

From the editors of *Popular Woodworking*
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- 1 Shaker Cupboard: Rejuvenated**
- 8 Drawer Slips**
- 12 Roy Underhill's Nail Cabinet**



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 **Lee Valley**





Shaker Cupboard: Rejuvenated

A White Water Shaker stepback is sprinkled with water from the fountain of youth.

BY GLEN D. HUEY

Shaker stepback cupboards aren't abundant. In fact, there are only a few examples in the many published books on Shaker furniture. Unless you have a sharp eye for Shaker furniture, or are excited about painted furniture with a heavily worn surface, I doubt you would give a second look to the original cupboard on which this project is based. However, the fact that the original is part of the White Water Shaker Village collection propels this piece, in my opinion, toward the top of Shaker cupboards. A reproduction of this cupboard is a must. And in the process, we can turn the clock back to see the cupboard in its earlier days.

INSPIRATION FROM THE ORIGINAL

The original Shaker stepback, with its missing crown moulding and other absent features, required detective work before construction began. As we move through the project, we'll examine some missing features and try to reach conclusions that bring this piece back to an earlier day.

The first question is: What about feet? The cupboard at White Water has a three-sided frame that rests on the floor. Was that the original design? Or were the feet worn away or removed?

Also, what happened to the crown moulding? It's obvious there was a moulding, but it is long since gone. What was the profile?

Other features to look at are the unique drawer construction and the use of a half-dovetail sliding joint to secure the shelves to the case sides—even with this complex but strong joint, the builder nailed in the shelves.

FACE (FRAME) FACTS

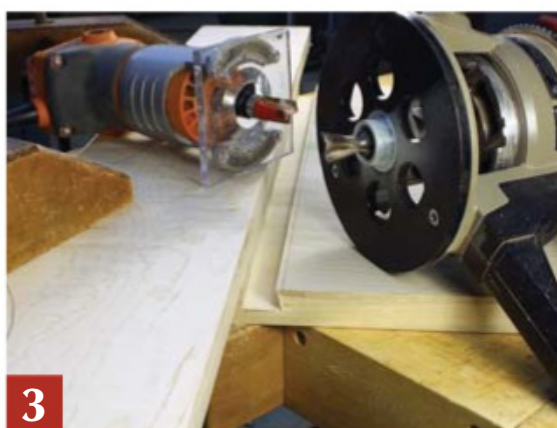
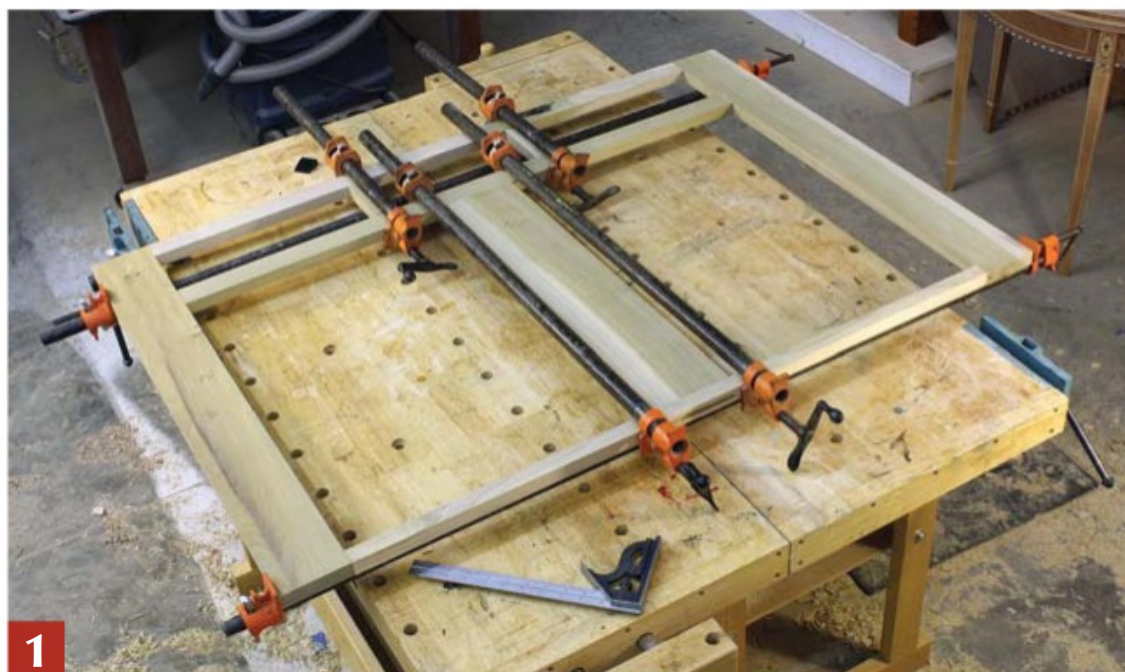
Before we get to the detective work, we need to build the cases and face frames. The frames for both sections use mortise-and-tenon joints. Mill your parts to size according to the materials schedule, but leave an extra $\frac{1}{8}$ " in width on the stiles. After the frames are fit to the cases you'll use a router and flush-trim bit for a perfect fit.

Locate and mark the mortise locations for $\frac{1}{4}$ "-thick tenons. Wherever possible, each joint should have a $1\frac{1}{4}$ "-long tenon. With the face-frame material at $\frac{7}{8}$ " in thickness, a $\frac{5}{16}$ " face shoulder produces



(Top) Inspired by an original cupboard at the White Water Shaker community, our revitalized Shaker stepback blends nicely into the surroundings of the North Family dwelling.

(Left) The original cupboard, on which our piece is based, has lost its crown moulding. And no one is sure there were ever any feet to lift the cupboard base off the floor.



a centered tenon. An edge shoulder of a matching size ensures a stout joint.

There are two frame joints where the matching edge shoulder is not used: on the bottom rail of the lower section where the tenon would end up $\frac{3}{8}$ " wide, and on the bottom rail of the upper section where the tenon would be $\frac{5}{8}$ " in width.

As always, cut your mortises first then cut your tenons to fit the mortises. Set up and cut all the mortises on your face-frame parts. It's best to cut the mortise then reverse the position of the workpiece and make a second pass at each mortise. Yes, the resulting mortise may be wider than $\frac{1}{4}$ ", but the joint will be centered on the stock, and that's most important.

Cut your tenons using your favorite method, then test-fit all your joints. When your tenons fit snug and can be slid together with a little muscle, it's time to assemble the face frames. Work methodically through the assembly. Apply glue to both the mortises and the tenons to achieve the most strength. Clamp the frames and allow the glue to dry.

FREAKY DOVETAIL JOINTS

Dovetails abound in the carcasses. Both

sections have half-blind dovetailed corners and shelves attached with half-dovetailed sliding joints.

On the upper section the case top is dovetailed to the sides; on the lower section, the case bottom has the dovetails. The pins of the half-blind dovetails are positioned in the sides with the tails in the mating pieces. Also, there is a $\frac{3}{4}$ " difference in widths between the upper case sides and the top, and the lower case sides and the bottom. Those offsets capture the backboards.

The half-dovetail sliding joint is easy with two router setups. You can work with a single router, but you'll need to change the bits multiple times or position the fence in the exact same location each time.

The setups are this: One router has a $\frac{3}{4}$ "-diameter, 14°-dovetail bit coupled with a $\frac{5}{16}$ " outside-diameter template guide bushing. The second router has a $\frac{5}{8}$ "-diameter pattern bit with a top-mount bearing.

Begin by marking lines across the sides at both the top and bottom edges of the dados. Position and clamp a $\frac{3}{4}$ " fence at the top edge of a shelf location. Always work with the fence set to the left of the area to be routed. If these guidelines aren't followed, you can form the half-dovetail

1. To assemble the face frames correctly, you'll need to work in a specific order. Plan the steps and have plenty of clamps handy.

2. The bottom of the lower section is joined to the sides with half-blind dovetails, as is the top of the upper section.

3. Two routers, two bits and a guide bushing take the guesswork out of creating the half-dovetailed sliding joints.

on the wrong edge.

Begin with the dovetail router bit set-up. Set the bit to cut $\frac{1}{2}$ " deep into the case side, then hold the guide bushing tight to your fence as you make a pass. The cut should be close to, but not beyond, the lower shelf layout line.

Grab your second router, set up with the bit tweaked to cut at the same depth, then make a second pass making sure to hold the bearing tight to your fence. This cut completes the socket. Move to the next shelf location and repeat the process.

Before moving on, cut the grooves in the side pieces for the backboards. The grooves are $\frac{3}{8}$ " in from the back edge of the case sides; each is $\frac{3}{8}$ " wide and $\frac{1}{2}$ " deep. A dado stack makes this quick work.

JIG UP THE SLIDE

Now it's time to cut the mating shape on the horizontal shelves. To hoist these large panels onto your router table is quite a task. But with a simple shop-made jig, you won't need to. Instead of taking the panel to the router, you'll take the router to the work.

Build a jig to create the sliding half-dove-tail with two straight pieces of $2\frac{1}{2}$ " wide and $\frac{3}{4}$ "-thick scrap that are 24" long. Screw the pieces together to form a "T" with one leg of the top piece set at $\frac{7}{8}$ ".

For the jig to work, you'll have to size that top leg according to your router set-up. This time use a $\frac{3}{4}$ " outside-diameter template guide bushing with the same dovetail router bit. (The matching diameters allow the router bit to cut where the bushing rubs.) Clamp the jig on a test piece, then make a pass to create the half-dovetail profile as shown below.

Check the test piece in a socket. If the test piece is too wide, take a light table saw cut off the working edge of the jig, make another test cut and check the fit. Continue to take light passes off the jig to sneak up on the correct fit.

If your test piece is too narrow to fill the half-dovetailed slot, you'll have to



remove thickness from the bottom piece of the jig, or remove and replace the top piece at a new location. Once the fit is correct—the workpiece slides into the slot without slop—the jig is ready to go.

Clamp the jig in position, then run the router bit to shape the profile on both ends of each shelf. (Use the jig and clamps to pull out any warp in your shelves.)

Each shelf in the upper case receives two plate grooves on the top face (the lower section's shelf is not grooved).

The grooves are 2" and 4¼" from the back edge of the shelf and extend from end to end. Use a router and a core box router bit.

BUILD THE BOXES AND PEG THE FRAMES

Assemble the boxes by swabbing glue in the sockets (and a small amount on the shelf ends), then slide the pieces together.

After the shelves are installed, butter the dovetail pins with glue, then tap those joints together.

When the glue is dry, fit the face frames to their boxes. It's important to align the middle rail of the lower section with the drawer support. A thin bead of glue secures the frame to the boxes. Position the frames, add clamps then allow the glue to dry.

Drive square pegs into the face frames. Doing this after the glue sets provides additional strength so there is less of a chance to split the frame pieces. To match the original cupboard, evenly space four pegs in each rail and outside stile.

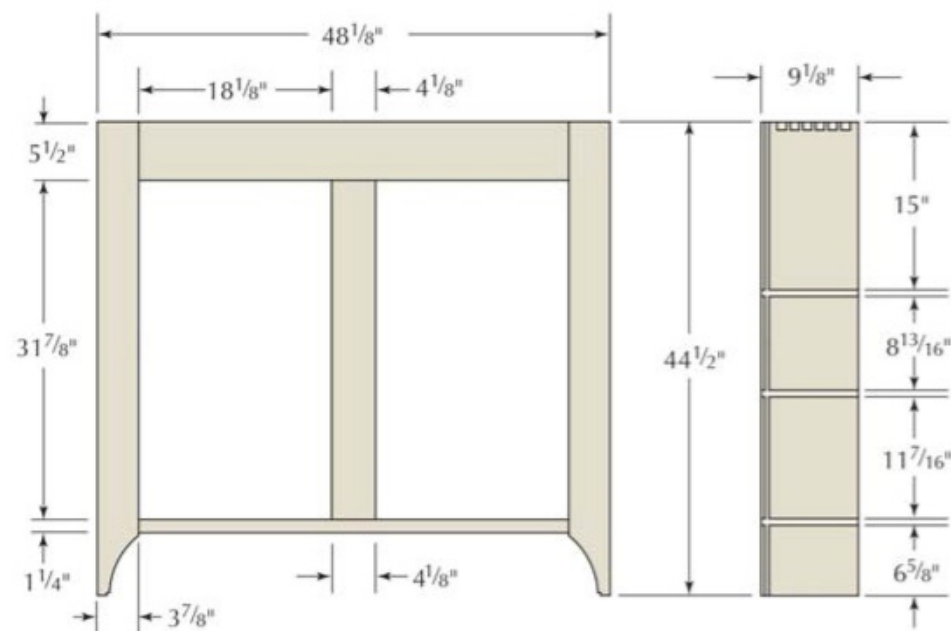
Before adding the pegs, trim the stiles to the case with a flush-trim router bit with a bottom-mount bearing. The uppermost stile's peg is located behind the cove moulding. As is done on the original cupboard, don't forget to drive a couple nails into the shelves.

The detail work on the upper section face-frame stiles is router work. To cre-

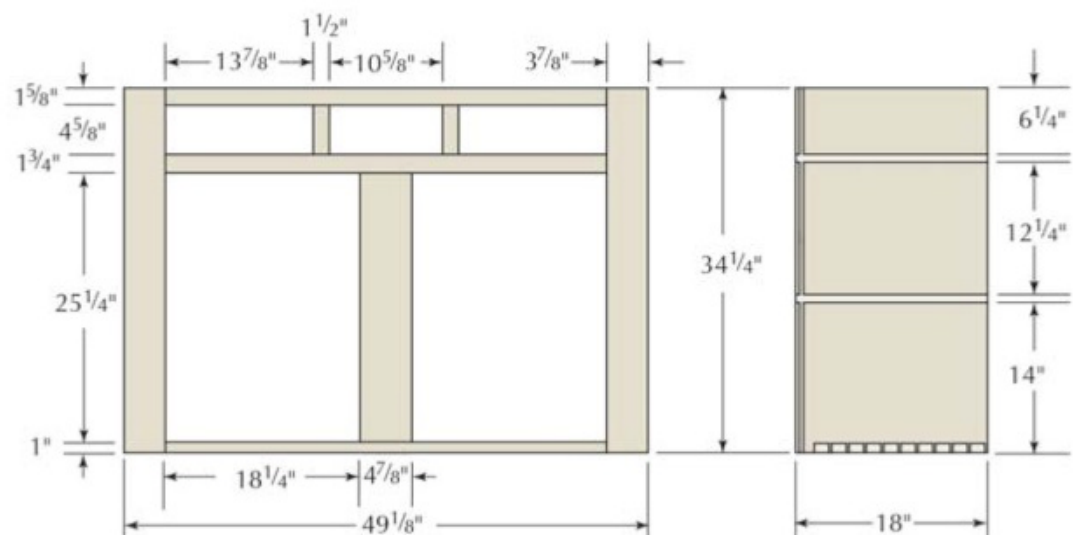
4. This shop-made jig not only dials-in a perfect sliding dovetail, it allows you to pull any warp out of your shelves.

5. It's not often you find plate grooves behind blind doors. It's a bigger wonder as to why two different grooves were plowed. Maybe it's for plates and bowls?

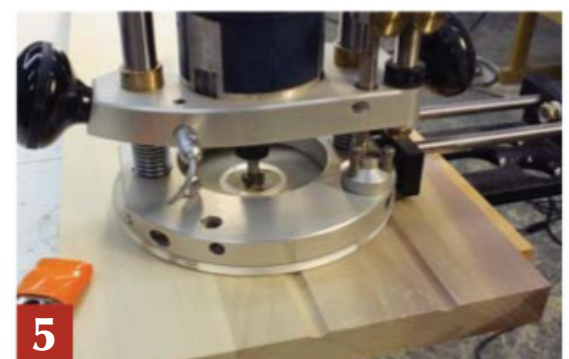
6. The glue swells the wood and makes the joint fit more tightly than before, so light taps with your mallet might be needed.



UPPER FRAME & CABINET DETAIL



LOWER FACE FRAME & CABINET DETAIL



ate the design, make a plywood pattern of the curve—the pattern keeps the look consistent from side to side—then make the cut using a router with a pattern bit. Square the inside corner with a chisel.

THROUGH-TENON DOORS

Construction of the four doors is identical, so after you mill the parts to size, gather your stiles and mark them for ¼"-thick tenons with ½" edge shoulders.

With through-mortises, work from both edges of your stile as you mortise so you don't blow out the exit edge. Transfer your layout lines to both edges of the stiles and make sure you work within those confines.

Work past the halfway point of each mortise, then flip the stile edge for edge to clear the mortise.

Most 10" table saws have a maximum 3⅝" depth of cut. The door stiles on this piece are 3¼" in width. Because the through-mortise joinery on the doors exceeds the maximum cut, it's best to install your dado stack and sharpen your shoulder plane or bullnose plane.

Set a dado stack to its widest cut, raise the blade to just less than ⅝", position your fence to create a 3¼"-long tenon, then make the passes needed to clean away the waste.

The door's flat panels fit into a ⅜" deep x ¼" wide groove in the rails and stiles. Plow the grooves through the entire length of the stiles. (Doing so requires haunched tenons to fill in the small lengths of groove beyond the edge of the mortise. The haunches are formed with the dado stack as well.)

Fit each joint so the tenon fit is snug, but doesn't require a mallet to assemble.

Dry-assemble the frames, then measure the openings for the panels. Measure across the opening, then add ⅝" (this builds in ⅛" of space for panel movement). Mill the four panels to size. Finish-sand the panels and knock off the sharp inside edges around the panel area before assembling the doors.

When ready, add a thin layer of glue to the tenons and in the mortises, then slip the joints together. Add clamps (keep clear of the through-tenons) and let the glue dry.

Chances are you'll have small top-to-bottom gaps in the tenon fit. If so, cut thin wedges milled to the same width as your mortise to fill them. This cleans up the look. Fit and hang your doors.

A DRAWER BUILD – D'OH!

I can't count the number of antique drawers I've studied, or the number of drawers I've built. I don't think I have ever seen drawers built as they are on the original

White Water cupboard. The drawers use typical 18th-century construction methods, but the drawer backs are different—the backs are square at the top and bottom and are held a ¼" below the top edge of the drawer sides. At first glance, this looks odd, but there is a nice benefit to it.

The cupboard drawers are flush fitting with minimal gaps between the drawer fronts and the case. If you build with tight

7. You could complete the face frame stile detail before the frame is attached to the box, but there's added stability afterward. Here, a plywood pattern ensures a perfect match.

8. The door mortises are best accomplished by working down from both edges of the stiles. And be sure to keep the slot centered for the best results.

9. Because this dado cut is not a through cut, it's OK to use your fence as a stop when using the miter gauge, too.

10. I usually grab my Shinto rasp to fine-tune my tenon fit, but with the amount of work left to do, I found a bullnose plane did the work that much more quickly.

11. With #120-grit sandpaper, knock off the sharp edges around the panel area. This area is difficult to sand after the panels are in place, and the softened edges help age the cupboard's appearance.





Shaker Cupboard

NO. ITEM		DIMENSIONS (INCHES)			COMMENTS	
		T	W	L		
BASE						
❑	2	Sides	7⁄8	18	34 1⁄4	
❑	1	Bottom	7⁄8	17 1⁄4	48 3⁄8	Dovetailed to sides
❑	2	Shelves	7⁄8	17 1⁄4	48 3⁄4	Sliding dovetail ends
❑	1	Top	7⁄8	20	50 3⁄4	
❑	1	Base frame front	5⁄8	3 7⁄8	49 5⁄8	Miter both ends
❑	2	Base frame ends	5⁄8	3 7⁄8	19 1⁄8	Miter one end
❑	6	Drawer guides	5⁄8	1 1⁄2	17	
❑	1	Back	1⁄2	48 3⁄8	34 1⁄4	Tongue-and-groove
❑	6	Profiled feet	3⁄4	5 1⁄2	7 1⁄4	
❑	2	Rear feet*	3⁄4	5	5	

BASE FACE FRAME				
❑ 2 Stiles	7/8	3 7/8	34 1/4	
❑ 1 Top rail	7/8	1 5/8	43 7/8	1 1/4" TBE**
❑ 1 Middle rail	7/8	1 3/4	43 7/8	1 1/4" TBE
❑ 1 Bottom rail	7/8	1	43 7/8	1 1/4" TBE
❑ 1 Vertical divider	7/8	4 7/8	27 3/8	1" TBE
❑ 2 Drawer dividers	7/8	1 1/2	7 1/8	1 1/4" TBE

BASE DOOR PARTS				
❑ 4 Stiles	7/8	3 1/4	25 1/4	
❑ 2 Top rails	7/8	3 1/4	18 1/4	Through-tenons
❑ 2 Bottom rails	7/8	3 1/2	18 1/4	Through-tenons
❑ 2 Panels	1/4	12 3/8	19 1/8	

BASE DRAWER BOXES				
❑ 2 Outside fronts	7/8	13 3/4	17	
❑ 1 Center front	7/8	10 5/8	17	

TOP				
❑ 2 Sides	7/8	9 1/8	44 1/2	
❑ 1 Top	7/8	8 3/8	47 3/8	Dovetailed to sides
❑ 3 Shelves	7/8	8 3/8	47 3/8	Sliding dovetail ends
❑ 1 Back	1/2	47 3/8	44 1/2	Tongue-and-groove
❑ 1 Crown front	3/4	3	55	
❑ 1 Crown end	3/4	3	24	

TOP FACE FRAME				
❑ 2 Stiles	7/8	3 7/8	44 1/2	
❑ 1 Top rail	7/8	5 1/2	42 7/8	1 1/4" TBE
❑ 1 Bottom rail	7/8	1 1/4	42 7/8	1 1/4" TBE
❑ 1 Vertical divider	7/8	4 1/8	33 7/8	1" TBE

TOP DOOR PARTS				
❑ 4 Stiles	7/8	3 1/4	31 7/8	
❑ 4 Rails	7/8	3 1/4	18 1/8	Through-tenons
❑ 2 Panels	1/4	12 1/4	26	

*All pieces are poplar with the exception of the back rear feet which are oak.
**TBE = tenon both ends

12. Achieving a tight top-to-bottom fit of your tenons takes time and wastes time. The holding power of the joint is the flat-grain connection — and that’s not found on the edge shoulders. A small wedge can tighten up the appearance.
13. Drawer construction for the cupboard is in typical 18th-century fashion, but the drawer backs are below the sides by a 1/4". Is this a boon or bust?
14. Small profiled pieces of wood hold the drawer guides from side-to-side movement while glue at the guide fronts and a few brads keep things tight to the dust board.
15. If you flip the position of your miter gauge in the slot, you can guide one half of the foot pairing for its 45°-bevel cut. It’s similar to using a panel-cutting sled.
16. Make two passes with your blade set at 45° to form the slots for the splines. Add a fence extension and use a push stick to guide your foot through the blade.



17



19



18

17. One of the easiest ways to join feet to furniture is with a plate added to the top edge of your foot pairs. Screw the plates down then add a single block at the miter for extra support.

18. The treatment of the backboards on the Shaker cupboard is unusual. The thin boards have tongue-and-groove joinery and the end boards are beveled into dados in the case sides. To be true to the original, not one of the top section's backboards is rectangular.

19. It's best to attach the top after dye and shellac, but just before adding the paint to the cupboard.

stepback. But the piece doesn't look right without something to stand on.

If you're a purist, skip the feet. If you look at the cupboard and think there's something missing, make the feet. Undecided? Make the feet separate and attach them with screws. If you change your mind, remove the feet.

Trace the foot pattern onto your stock, cut the profiles and sand the edges with a spindle sander. Arrange the feet into pairs. At the table saw, cut a 45° miter onto two sets of the pairs. Your miter gauge, with a short wooden fence attached, is the tool to use. Place the top of the foot (the long side) against the fence, then push the foot through the blade to bevel one half of your pair. To cut the opposing foot, reverse your miter gauge in the slot. Again, keep the top edge of the foot tight to the auxiliary fence, then push the piece through the blade while using a push stick to hold the stock tight to the tabletop and fence as shown below.

A 45° cut into a 45° angle forms a per-

fect slot for a spline to hold the pairs as one. Leave your table saw blade set at 45°, add an extension to your saw's fence and slide the fence into position. Make a cut into the bevel of each foot. Reposition the fence to make a second pass to increase the slot width to match a piece of 1/4" plywood. Plywood is a great choice for splines because of its strength and stability.

Slip the front feet and splines together with glue. While the glue dries, dovetail the other profiled feet to the rear feet. Place the pins in the shaped feet with the tails in the rear feet.

Each foot unit receives a plate that's set in a 3/8" deep rabbet at the top edge. Make that cut at a router table using a rabbet bit. The operation leaves a rounded corner. Square the corners or round the plates to fit. Afterward, glue and nail the plates to the feet.

The base frame's top edge is profiled with a 3/8" roundover bit set to a 1/4" depth of cut. The corners are mitered. I recommend a mitered half-lap. When complete, nail the frame to the case. The feet are

then attached to the frame using screws through the top plates.

TOPS, MOULDINGS & BACKS

The lower section top is a simple plank of 3/4"-thick stock. Cut a stop-rabbet on the under-side of the back edge where the backboards attach. Align the top's rabbet with the grooves in both case sides.

The crown moulding is designed from examples found on other Ohio Shaker pieces. The moulding is made using a table saw. Cut the cove while pushing the stock at an angle over the blade. (Raise the blade incrementally with each pass and make multiple passes.) The remaining cuts are made with the blade angled at 45° and the fence maneuvered to appropriate positions.

Miter the moulding at the corners and fit it in position. Use brads to attach the pieces and make sure to add glue to the short grain of the miters for a better hold.

The backboards on the original cupboard are unusual. Not only is the thickness 1/2" (rather than the usual 5/8"), the pieces are tongue-and-grooved together. The joint is thin and fragile until installed.

Additionally, the upper section's back is comprised of non-rectangular pieces. It is an interesting assembly, but one that is difficult to copy without increasing the workload.

AN UPDATED FINISH

The finish schedule for the cupboard is involved, but easy to replicate. Sand the piece to #180-grit. Dye the piece with a water-based cherry aniline dye. A couple coats of 1 1/2-pound shellac, sanded between coats with #400-grit sandpaper, allow the top coat of acrylic latex paint to be manipulated. Apply the paint, then rub through the paint at appropriate areas to simulate age. My mantra for aging paint is "less is best." Overdoing it is easy.

It's obvious that we've pulled our Shaker Cupboard back to an earlier day in its history. But the big question is: Did the detective work pay dividends? The feet are of a Shaker design and accurately scaled for this size cupboard. The moulding is in balance with the new base and the overall design is proportionally pleasing. Job done. There's no way you could walk past this cupboard without giving it a look-see. **PW**

Drawer Slips

An historical detail adds refinement to projects both period and modern.

BY JEREMY COY



The 18th century—a time when human hands were set to work in order to create the objects of material culture; when men and women by their sweat and ingenuity wrought wares in the latest fashions; when the cabinetmaker, toiling away in dusty corners of the world, rode at the vanguard of improvement and progress.

Over the course of that century, anonymous workers of wood trained their planes and chisels on many problems, perhaps none so unassumingly complex as that of making drawers. Their search for elegant and durable methods of affixing bottoms, in particular, led them to one of the final developments in the art of crafting fine drawers by hand: slips.

Drawer slips—slender pieces of wood glued to the sides of a drawer and grooved to accept the bottom—have remained largely mysterious, especially to those of us on American shores. But the time has come for the light of history to shine once again on these milestones of human thought and hallmarks of careful craftsmanship.

IN THE BEGINNING

The earliest drawer bottoms were little more than boards nailed to the underside of boxes. This arrangement was perfectly satisfactory, as drawers did not ride upon their bottoms. Instead, grooves plowed into their thick sides engaged with guides attached to the surrounding case.

As time passed, new types of lumber were made available, novel forms of furniture emerged, and fashion began to dictate slimmer drawer components.

English cabinetmakers abandoned the exterior groove, instead designing cases in which drawers rode directly on their bottoms. But the bottoms wore and nails loosened, compromising the integrity of both drawer and case. Something needed to be done.

In particular, the drawer bottom needed to be raised. The most straightforward solution was to affix slender pieces of wood underneath the bottom and sides. These runners, sometimes referred to as “slips” (though of a different sort than the subject of this article), were usually applied with glue

and could be easily replaced. The whole arrangement appeared awkward, however, and was sufficiently unsound that further experiments were warranted.

A breakthrough came in the 1720s. Rabbits were cut into the lower, interior edges of the sides and front, allowing both the drawer bottom and runner to be tucked neatly within the confines of the drawer. It was a remarkable achievement in construction. The bottom and runners were stabilized within the rabbits, the runners were still easily replaceable, and, with a nod to appearance, the entire assembly was now hidden from view.

One weakness remained, however: the bottom was fixed in place, unable to shrink and swell with the seasons. Though rabbits-and-runners remained the dominant form of attaching drawer bottoms through decades worth of cyclical expansion and contraction, the inevitable splitting of bottom boards called for more ingenious ways forward.

SLIPS ONTO THE SCENE

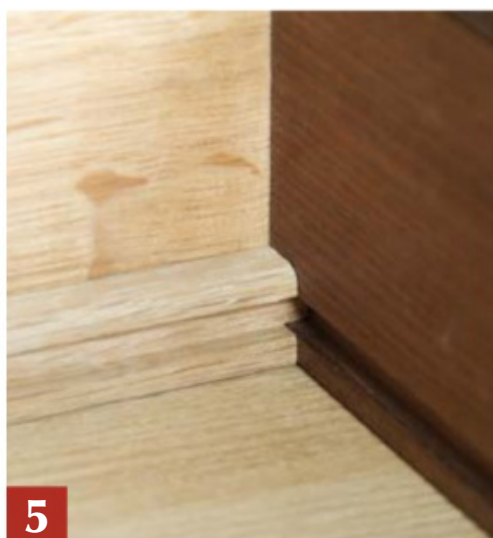
References to slips began to appear in print by 1788, when the first edition of the “Cabinet-makers London Book of Prices” included a succinct entry for “slipping drawers.” Later editions of the same work (1793 and 1803) offered more detail in proposing prices for “slipping drawer sides and plowing in bottoms.”

A definitive description of drawer slips was not published until 1803, when the following appeared in Thomas Sheraton’s “The Cabinet Dictionary:”

“Slips are sometimes glued on the inside of drawers, and plained [sic] to receive the bottom, which is the best method for preventing drawer bottoms from splitting, as is too often the case when they are confined by a rabbet, and the slip is glued down at the under side.”

Ten years later, Thomas Martin cribbed Sheraton’s definition for his “Circle of the Mechanical Arts,” an appropriation repeated by Peter Nicholson in his “Practical Carpentry, Joinery, and Cabinet-making” of 1826. Nicholson, at least, elaborated on the reasoning behind the use of slips:

“Drawers made of unseasoned wood, break at the joints: to prevent this, slips are sometimes glued on the inside of drawer-sides or ends, and these are



grooved to receive the bottom, and the upper edge rounded; this is esteemed the best method for preventing drawer-bottoms from splitting...”

It is notable that these early chroniclers mention only that slips were employed to avoid split bottoms. This may have been the real problem that spurred period makers to action. Sensing that drawer bottoms would be able to more freely expand and contract in a groove than in a rabbet, they discovered a clever way to retain the best features of earlier systems—an elevated bottom and wide bearing surfaces—while leaving the bottom free to move, even in the thinnest of drawer sides.

This discovery almost assuredly took place in England, where a preference for slipped drawers in bespoke work persists to this day. The English taste for thin drawers never made its way across the Atlantic, where thick sides in softer woods have long been more common. Because slips were likely developed at a time when England’s influence in this country was waning, using rabbets-and-runners and plowing grooves directly into thick sides remained the standard methods of attaching bottoms for American cabinetmakers.

MAKE YOUR OWN

In examining how slips are made, it’s natural to begin with the rounded version, generally regarded as the earliest form.

First, prepare the front, back and sides of a drawer in the usual manner. Lay out the dovetails in front, keeping in mind that despite using slips along the sides, the drawer front must still receive a $\frac{1}{4}$ " x $\frac{1}{4}$ " groove to support the bottom. Therefore, plan to cover the groove with a full or half tail.

With the drawer box assembled, prepare a board from which to cut the slips. It should be longer than the drawer sides and wide enough to produce several slips (which also makes it easy to hold in a vise). Its thickness should be equal to the height of the slips, plus an extra $\frac{1}{64}$ " or so for trimming. In practice, the position of the groove in the drawer front determines the finished height of the slips, because each slip must bear a corresponding groove in its inner face. Also, enough wood must re-

1. Grooves to accept a drawer bottom are plowed into the edge of a wide board, which will then be cut into narrow slips.

2. After its groove is plowed and top edge shaped, each slip is marked for width and sawed free.

3. The back of each slip is planed to remove saw marks and to square up its gluing surface.

4. Small tenons are formed on the front ends of a round slip (left) and a flush slip (right).

5. The round slip’s small tenon fits into a groove in the drawer front, making alignment during glue up a cinch.

main to support the bottom; $\frac{3}{16}$ " above and below the groove is a good compromise between strength and appearance.

Secure the board, square the upper edge and plow a $\frac{3}{16}$ "-deep groove a hair more than $\frac{3}{16}$ " from the reference face. This slight addition will allow the slip to project from the drawer side so that it may be planed perfectly flush after gluing.

Plane the upper, interior edge of the future slip into a series of long facets, blending them with light passes to arrive at a final rounded shape. Referencing from the grooved edge, scribe the width

6. Round slips are notched to pass under the drawer back and align their grooves with the back's bottom edge.

7. Affixing a slip to protrude slightly below the drawer side allows you to plane it perfectly flush after gluing.

8. The groove in the drawer front accepts a flush slip's tenon and eventually, the rabbeted front edge of the drawer bottom. The bottom's rabbeted sides slide into grooves in the slip.

9. With the slip firmly seated against the drawer front, mark its finished length directly from the back of the drawer.

10. Flush slips require a specially shaped bottom; it is first rabbeted along the top of one side, flipped over, then rabbeted again along the front edge.

of the slip on both faces of the board. Saw just outside the line, and plane the resulting slip down to its finished width.

Prepare the slip to meet the drawer front and back. First, cut a small tenon at the front end. Mark a shoulder line $\frac{1}{4}$ " from the end, and saw away the material above and below the groove. The resulting tenon is a positive version of the groove's negative space and should register neatly with the drawer front. Next, form a notch at the top rear of the slip. Its depth is equal to the amount of material above the groove, which allows the top of the groove and the bottom of the drawer back to align.

Butt the shoulder of the slip's tenon against the back of the drawer front and scribe where the rear of the slip meets the inside and outside of the drawer back. Transfer the latter mark around the entire slip, and cut and plane it to length. Use the inside mark to square across the top of the slip, then transfer it down both vertical faces to the top of the groove. Saw and pare away the waste above the groove.

All that remains is to glue the slips in place, clamping to ensure solid contact along their entire length.

MODERN STYLING

Flush slips are so named because the top surface of the drawer bottom sits

flush with the top surface of the slips—a look that appeals to more modern sensibilities. In order to achieve this, the sides of the drawer bottom must be rabbeted along their top edges, and the lower, front edge of the bottom rabbeted to fit a groove plowed higher up the drawer front.

After plowing a $\frac{3}{16}$ "-wide x $\frac{1}{4}$ "-deep groove in each slip, cut a tenon on one end. This time, square across the bottom face of the slip $\frac{1}{4}$ " from the front end, and transfer the mark up the vertical faces to the top of the groove. Saw out this lower portion, then repeat for the other slip.

Because flush slips simply butt against the underside of the drawer back, they don't require a notch at rear.

Seat the tenons into the groove in the drawer front, mark and cut the slips to length, and glue them to the drawer sides.

Now make the rabbeted drawer bottom. First, cut a rabbet into the top of one side. The rabbet's depth should be the distance from the top of the slip to the top of the slip's groove and its width identical to the depth of the grooves. Next, cut a rabbet into the lower front edge of the drawer bottom. Its width is again equal to the depth of the grooves, but this time its depth should be the





11. To ensure a clean fit, the shoulder of the first side rabbet is pressed against a slip while the second rabbet's shoulder is scribed directly from the other slip.

12. Flush slips support a drawer bottom along its sides, while a groove in the drawer front receives the bottom's rabbeted front edge.

13. A view of the back of a drawer reveals the profile of a flush slip and a rabbeted bottom.

14. To simplify the fitting of the mitered slips, glue the front slip in place before mitering and notching the side ones.

15. A small scrap of wood planed to perfectly fit the grooves of mitered slips guarantees that they'll be aligned after glue up.

16. A drawer front, drawer side and two mitered slips combine to form a seemingly complex joint.

distance from the bottom of the slips' grooves to the bottom of the groove in the drawer front.

Set the drawer box on top of the partially rabbeted bottom, pressing the shoulder of the side rabbet against its corresponding slip. Scribe a line where the bottom meets the other slip; this establishes the

edge of the second side's rabbet. Cut the rabbet into the top edge of the second side to the appropriate depth.

The bottom should now slide in from the rear, its top surface butting against the bottom edge of the drawer back, its sides engaging with the grooved slips and its leading edge ultimately entering the groove in the drawer front.

ANOTHER ANGLE

Mitered slips are perhaps the easiest version to make. Because they do not require a groove in the drawer front, they involve much less initial planning and make laying out symmetrical dovetails a straightforward affair.

Start by preparing a grooved slip for the front of the drawer. Miter both ends to fit snugly between the drawer sides, profile the top edge to your liking, and glue the slip in place. Next, miter one end of each side slip, press it against the corresponding miter at the front, and mark for length and notching. As in their rounded brethren, the top of the groove in mitered slips should align

with the bottom of the drawer back. Cut the notches accordingly, profile the top edges to match the front slip, and glue the side slips to the drawer.

WORTH THE EFFORT

Slips do require a bit of extra effort, but as symbols of attentive and thoughtful work, they imbue meaning even to parts normally hidden from view. They evoke, too, the spirit of cabinet-makers past who, through decades of experimentation, wrestled with the intangible forces of weight and wear and the seasonal expansion of wood to produce a tradition of small boxes capable of great endurance and subtle beauty.

Given the vast scale of industry and manufacture governing our era, it is now rare for those devoted to the intimacy of craft to effect such widely influential change. But for those of us engaged in making fine things out of wood, quiet moments of pride at having done the simple things well and beautifully—slipping drawer bottoms, for instance—often prove satisfaction enough. **PW**

Roy Underhill's Nail Cabinet

It's a crate. It's a cabinet.
It's useful shop furniture.

BY CHRISTOPHER SCHWARZ



Roy Underhill's nail cabinet is a converted crate. The cabinet has seen a lot of use and has held up pretty well.



One of the enduring features of Roy Underhill's "The Woodwright's Shop" PBS television show is the familiar and rambling back-drop of former projects, parts, tools and wood that frames most episodes. My favorite item in his shop is his nail cabinet—a pine wall-hung cabinet tucked in the far back corner.

On the inside of the door of the cabinet, Roy has hung a print of a lovely lady holding a bock beer alongside an admiring goat. And while that's some nice lens candy for the television cameras, I'm more attracted to the 21 drawers on the right side of the cabinet. These drawers are more useful to the married woodworker.

Nail cabinets show up frequently in traditional workshops of many trades, and they are illustrated and discussed in books about traditional shops. These cabinets stored the screws, nails and bolts that a workshop might need. And because these fasteners were valuable, many of the cabinets would have a lock.

The last time I visited Roy, I asked permission to measure and reproduce his nail cabinet, which he purchased during a yard

sale in Washington, D.C. As I measured the piece, I was bemused by its unusual construction—it was a finger-jointed carcass covered in nailed-on battens.

Then Roy showed me the reason for the odd construction: The cabinet was built from an old crate for Ohio Blue Tip Matches made by the Ohio Match Co. of Wadsworth, Ohio (1895-1987). For me, this made the project even more fun: I had to first build a crate and then turn it into a wall cabinet.

As a result, some of the construction techniques might seem a bit odd. If you don't like them, feel free to change them. My goal was to make a respectable reproduction of this charming cabinet because I've always liked the one on Roy's show.

CONSTRUCTION OVERVIEW

The original is made entirely of pine—probably Eastern white pine—though any dry softwood will do. The carcass of the original crate is joined at the corners with finger joints (though I opted for dovetails on my version). The back of the carcass is nailed-on $\frac{3}{8}$ "-thick boards that

are shiplapped.

The assembled carcass is covered with narrow 1x battens to make the "crate" easy to grab and lift. These battens conceal the joinery on the corners of the carcass.

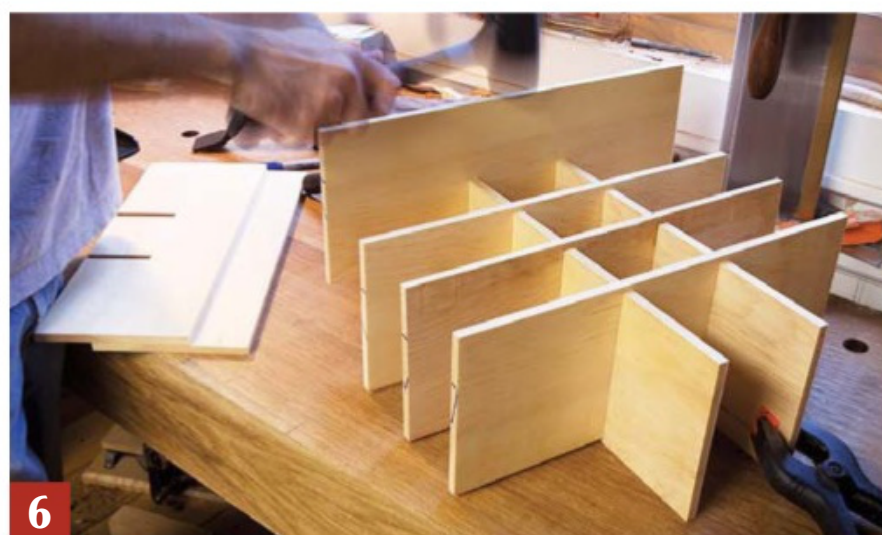
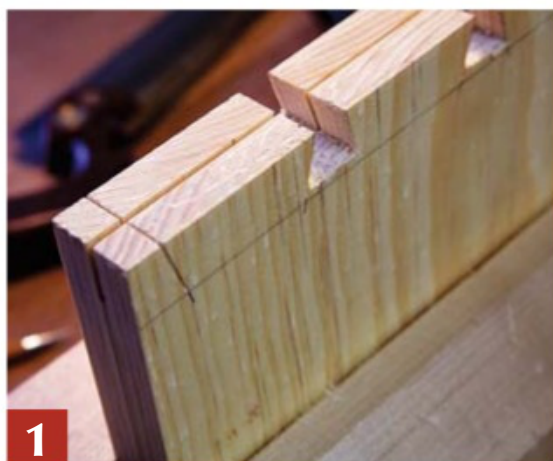
Once you have your "crate" built, you can turn it into a cabinet. The interior is divided into 21 spaces using thin pieces of pine that are joined with an egg-crate joint. The drawers are simply glued and nailed together; the only thing difficult about the drawers is that you have to build 21 of them.

Finally, the entire cabinet is fronted by a door with mitered corners. The panel of the original door was simply nailed to the inside of the mitered door frame. The panel had cracked over time, so I chose to make my panel float in grooves plowed into the rails and stiles.

The whole thing is finished with shellac and hung on the wall with a French cleat.

THE WALLS OF THE CRATE

As mentioned above, the walls of the original crate were joined at the corners by narrow finger joints (you can see the joints



1. Whenever possible, I gang-cut my tail boards, which saves time and (in my opinion) makes it easier to keep the saw 90° to the face of the board. A shallow rabbet on each tail board makes it easy to keep things square during transfer.

2. Take extra pains to get the carcass square at glue-up. It will save you frustration later when you fit the door and the 21 drawers.

3. The shiplapped joints on the long edges of the backboards hide any gap that would open up when the boards shrink in the dry season.

4. Nails will bend, allowing the back to expand and contract without splitting the backboards. Be sure to use nails with a pronounced head to hold the backboards in place.

5. Lay out the slots on one board, clamp all the dividers together and make the cut in one go. Here on the table saw, I'm using the saw's miter gauge and a high fence to push the dividers through the blade.

6. You should have to knock the joints together with a mallet. Then pin all the intersections with 1"-long headless brads. You'll have to nail them in diagonally to secure them.

from the inside where they have separated a bit). I don't have the jigs or desire to make narrow finger joints here, and cutting this machine joint by hand is just silly.

So I joined the case sides, top and bottom using through-dovetails. The joinery is all covered by battens in the end, so the end result looks the same as the original. For strength, I put the tails on the case sides; the pins are on the top and bottom bits.

Glue up the carcass, paying close attention to keeping the corners square at both the front and rear of the case. I use hide glue for joints like this because it's reversible.

If you can't get the case perfectly square at glue-up, you have one more chance to pull it square with the backboards. The backboards are $\frac{3}{8}$ "-thick boards of pine that are shiplapped on their long edges and nailed to the back of the case.

I used 3d cut fine finish standard nails to affix the back, though 4d will do.

If your case is out of square, pull the case square with a clamp diagonally across two corners, then nail the backboards in place. This usually helps if the case isn't too racked.

THE INTERIOR DIVIDERS

The interior drawer dividers of the origi-

nal nail cabinet were obviously built up using miscellaneous scraps that were nailed and glued on to get the job done. Some parts were rough-sawn; some were different species.

Instead of replicating every odd scrap in the cabinet, I simplified the construction while still maintaining its look and function. On the original, the horizontal and vertical dividers are joined with eggcrate joints, and so I used that same joint for my dividers.

The dividers are all $\frac{3}{8}$ " thick and 6" wide. Every divider has $\frac{3}{8}$ "-wide slots cut into it. The slots on the horizontal dividers are 2 $\frac{7}{8}$ " long. The slots on the vertical

dividers are 3" long. When the dividers are knocked together, they will be offset by $\frac{1}{8}$ " at the front, just like the original.

Lay out the locations of all the slots using the drawings as a guide. I used dividers to step off the drawer sizes, and I used an actual piece of the drawer divider to lay out the width of the slots. Note that the three bottom drawers are taller than the others.

I cut the slots on a table saw, though they are easy to cut by hand or on a band saw. After cutting the slots, knock the dividers together and pin the joints by toenailing them with headless brads.

With the dividers together, knock the assembly into the carcass. The front edge of the horizontal dividers should be located $1\frac{1}{2}$ " from the front edge of the carcass. That spacing allows room for the bin pulls and knobs on the drawers.

The next step is to nail the horizontal dividers to the carcass. This is done easily with a simple jig that makes it (almost) impossible to miss with your nails. (See the photo above for details on the jig.)

Use 4d headless brads to secure the horizontal dividers to the carcass. There's no need to nail the vertical dividers to the carcass; gravity and friction are sufficient.

MAKING IT A CRATE

The fun part of this project is taking this nice carcass and turning it into a packing crate. You do this by nailing on 1x battens so they look a bit like rails and stiles. There is no other joinery between the battens—just glue and nails.

Cut the battens to the sizes shown in the cutlist. The easy way to install these is to first attach them to the carcass sides, trim the pieces flush to the top and bottom of the case then finish up the work on the top and bottom.

The important thing to remember is that the battens should extend out $\frac{1}{2}$ " (or a tad more) from the front lip of the carcass. This $\frac{1}{2}$ " lip creates the opening for the door. Before you attach the battens, make sure their position works with the hinges you have purchased for

the door. If the hinge leaf is wider than $\frac{1}{2}$ " you have to shift the battens forward a little on the case so the hinge can open and close.

All the battens are attached with brads and glue.

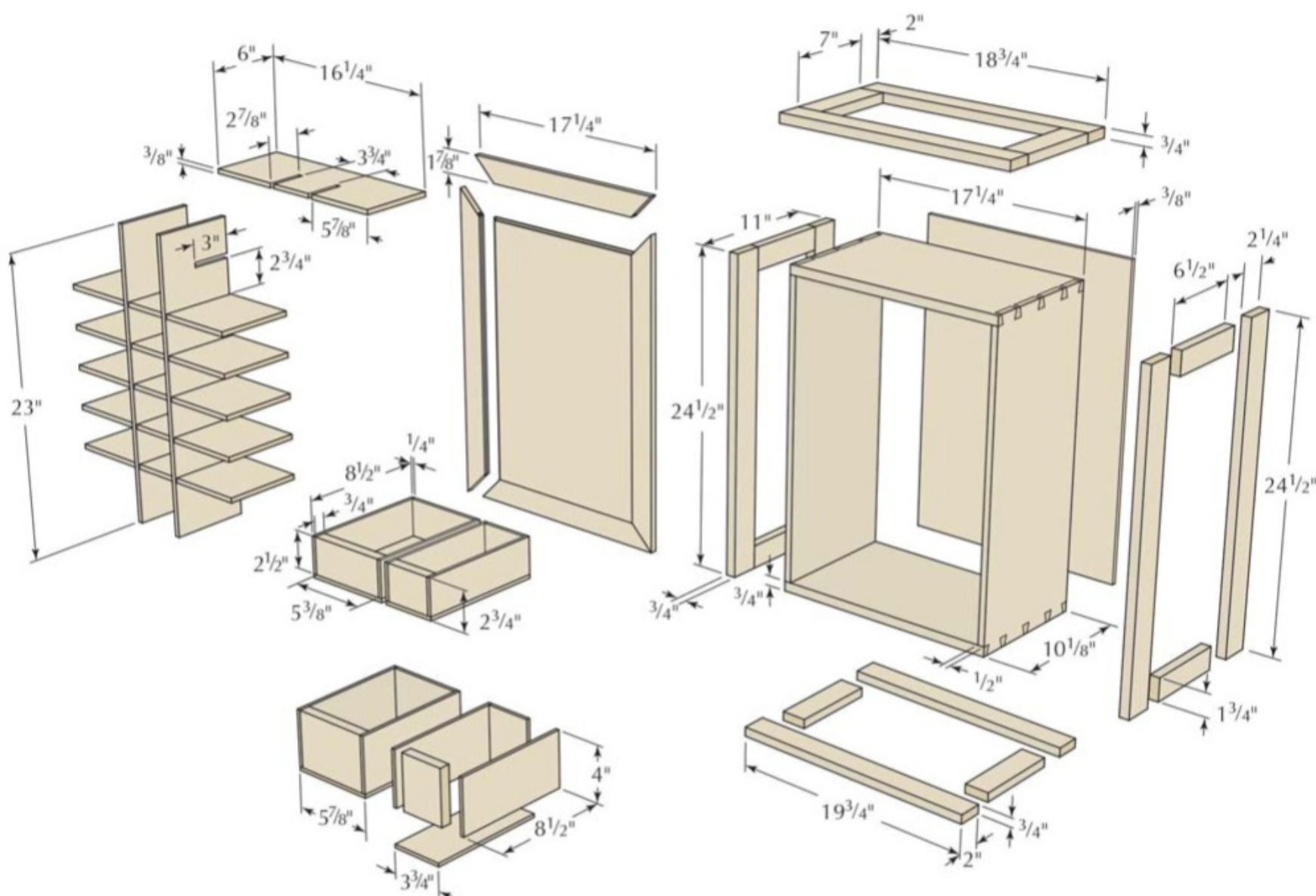
MITERED DOOR

With all the battens attached, you can determine the final sizes of your rails and stiles for the frame-and-panel door. The corners of this light-duty door are joined by miters that are glued and nailed, just like the original.

When I cut miters, I saw them first then trim them to a perfect length and a perfect 45° with a miter shooting board and a handplane.

Even if you love your chop saw, I encourage you to give this a try some-time. I've found no easier way to cut perfect miters. By shooting the miters with a handplane you can control the length of your rails and stiles in .001" increments. And you can hit dead-on 45° with ease.

Once the miters are cut, plow a $\frac{3}{16}$ "-



EXPLODED VIEW



Nail Cabinet

NO.	ITEM	DIMENSIONS (INCHES)		
		T	W	L
❑ 2	Sides	½	10 ⅞	24 ½
❑ 2	Top/bottom	¾	10 ⅞	17 ¼
❑ 1	Back	¾	17 ¼	24 ½
❑ 2	Door rails	½	1 ⅞	17 ¼
❑ 2	Door stiles	½	1 ⅞	24 ½
❑ 1	Door panel	¾	13 ¾	21 ⅞

TOP FRAME

❑ 2	Stiles	¾	2	18 ¾
❑ 2	Rails	¾	2	7

SIDE FRAMES

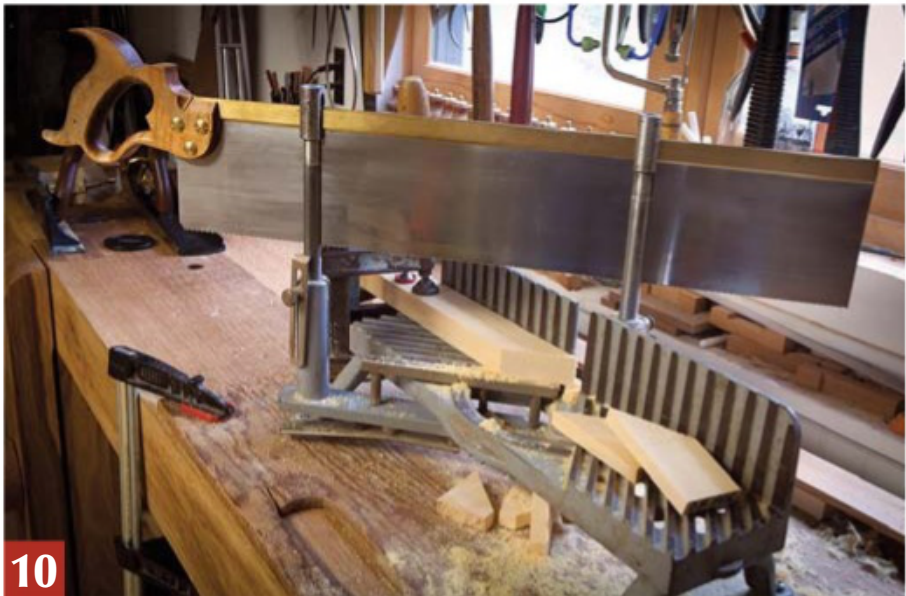
❑ 4	Stiles	¾	2 ¼	24 ½
❑ 4	Rails	¾	1 ¾	6 ½

BASE DRAWER BOXES

❑ 1	Front stile	¾	2	19 ¾
❑ 1	Rear stile	¾	2	18 ¾
❑ 2	Rails	¾	2	7

INTERIOR

❑ 2	Vertical dividers	¾	6	23
❑ 6	Horizontal dividers	¾	6	16 ¼
❑ 12	Wide drawer fronts	¾	2 ½	5 ⅜
❑ 6	Narrow drawer fronts	¾	2 ½	3 ¼
❑ 2	Wide lower drawer fronts	¾	4	5 ⅜
❑ 1	Narrow lower drawer front	¾	4	3 ¼



7. This scrap-wood jig helps you locate exactly where the horizontal dividers are located. It is made using two thin pieces of scrap that are nailed to a scrap of ½"-thick pine. Slip the jig onto the carcass and press one of the thin slips against the dividers inside the case. Trace its location on the exterior. Repeat.
8. With the lines drawn on the carcass sides, drive in the cut headless brads and set them 1/16" below the surface.
9. The battens form the rails and stiles that frame the exterior walls of the crate. As on the original, they are simply nailed and glued to the carcass — there's no joinery between the rails and stiles. So this is fast work.
10. The 45° setting on my iron miter box is off by about half a degree. But I don't mind. That's because I shoot my miters, which allows me to sneak up on the perfect length and angle.

wide x 3/16"-deep groove on the inside edge of the rails and stiles. The 3/8"-thick panel fits into the groove thanks to a rabbet cut on all four edges of the panel. Be sure to size the panel so it has a little room for expansion and contraction in its width.

I don't own any fancy clamps for gluing mitered corners — most band clamps are fairly frustrating to use — so I glue up miters, corner by corner.

First I spread a little glue on the two mating surfaces of the miter and let them dry for a minute. Then I add more glue to the joint. I press the two pieces together

and drive a single nail through the stile and into the rail.

I repeat this process for each corner (don't forget to slide the panel into the frame before adding the last piece).

Then I clamp up the joints using four ordinary bar clamps. The nails prevent the miters from sliding as you apply pressure at the corners.

21 DRAWERS

Because this is a cabinet for nails, it's appropriate that the drawers are nailed together. All the drawers are constructed in a simple manner: The front and back

are captured by the sides. The bottom is then nailed on.

The drawers look a little odd — the end grain of the sides and bottom is visible on the drawer front. But they are acceptable for a piece of shop furniture — and the drawers in the original have survived many years of use.

Begin by fitting all the drawer parts for each opening. I try to do as much fitting as I can before assembly. This usually means the drawer will require little or no tweaking after assembly. First I fit each bottom to its opening. Then I fit the sides, front and bottom. Then I begin as-



11



12



13



14



15



16

11. A single nail through the stile and into the rail prevents things from sliding around as you clamp up this mitered joint. This was, by the way, how the original door was assembled.

12. Get each bottom board to slide in and out of its opening before sizing the other drawer parts. If the bottom binds, the assembled drawer will bind.

13. Dry-assemble the drawer to feel if the drawer front is too long.

14. Because the parts are all softwood, which doesn't move much once it's dry, you can get away with both gluing and nailing this cross-grain joint.

15. If the drawer front is too long, shoot it to perfect length with a plane on a shooting board. Count your strokes. Then reduce the length of the drawer back by the same number of strokes, provided your original lengths were the same.

16. When I have to do something 14 times, you can bet I'm going to make a jig to ensure my mind doesn't wander and cause me to make a fatal error at this stage of the project. This simple jig locates the holes for the bin pulls in the correct place. For the taller drawers on the bottom, I set the jig $\frac{3}{8}$ " lower on the drawer front.

sembling the drawer.

To do so, place the front and sides in position on the bottom. Feel if the drawer front needs to be reduced in length so the sides are flush to the bottom. If you need to trim the drawer front, trim the back by the same amount.

Glue and nail the sides to the front. Then glue and nail the back to the sides. Finally, glue and nail the bottom to the drawer. Fit each drawer to its opening, numbering the drawer and its opening as you go.

HARDWARE & FINISH

As on the original, I used bin pulls for the larger drawers and knobs for the smaller drawers in the center. To ensure I got the bin pulls located correctly, I made a quick drilling jig that I clamped to each drawer front. The jig ensured I didn't make a layout error.

The knobs are located dead center in the fronts of the smaller drawers.

Were I to make changes to this cabinet, it would be with the hardware. While I like the bin pulls, it would be more helpful to have pulls like an old library card

catalog; the card could tell you what type of fastener is inside the drawer.

To solve the problem, Roy simply wrote what is in each drawer on the bin pull. I think he did it with pencil—it's almost impossible to see on camera.

Another thought: Add 2" of depth to the cabinet and you can hang hammers, screwdrivers and other accoutrements of fastening and unfastening on the inside of the door.

Install the hinges and knob on the door. I used a magnetic catch to hold the door shut. Because I'm the only person who works in my shop, there's no need for a lock.

I finished the nail cabinet with two coats of garnet shellac, sanding between the coats. The cabinet hangs on my shop wall with a French cleat made from $\frac{1}{2}$ "-thick material.

And now comes the fun part: Emptying my tackle boxes of nails and screws and putting them into their new drawers, which are located conveniently above my workbench. Oh, and I guess I'll have to look for a picture of a lady and a goat. **PW**



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 **Lee Valley**

1. Veritas® Router Plane 05P38.01
2. Veritas® DX60 Block Plane, A2 Blade 05P70.01
3. Veritas® PM-V11® Mortise Chisels, set of 5 05S31.40
4. Veritas® PM-V11® Bench Chisels, set of 7 05S21.70
5. Veritas® Small Shoulder Plane, A2 Blade 05P47.01
6. Veritas® Medium Shoulder Plane, A2 Blade 05P41.01
7. Veritas® Large Shoulder Plane, A2 Blade 05P43.01
8. Veritas® Standard Block Plane, A2 Blade 05P22.30
9. Veritas® Low-Angle Block Plane, A2 Blade 05P22.01