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Popular Woodworking Magazine

August 2012 ■ #198

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- Cutterhead speed: 5350 RPM
- Cutterhead dia.: 3⅜"
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- Max. rabbeting depth: ½"
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- Max. cutting height: 8"
- Max. cutting depth: ⅛"
- Feed rate: 16 & 20 FPM
- Cutterhead dia.: 3⅛"
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153652	Nakiri, 6¼"	11½"
153653	Chef's Knife, $7\frac{9}{16}$"	12¾"
153654	Santoku, 4¾"	$9\frac{5}{16}$"
153655	Parer, $3\frac{5}{16}$"	$7\frac{1}{16}$"
153656	Bread Knife, 9½"	$14\frac{5}{8}$"

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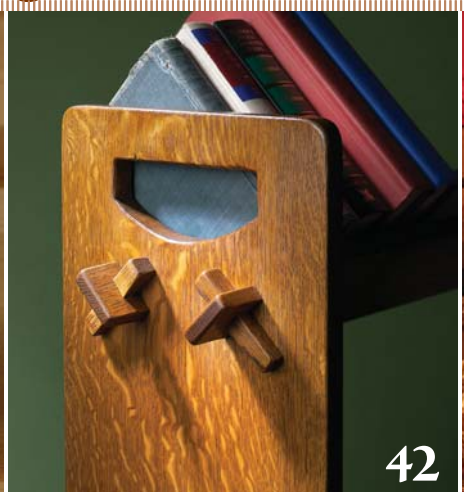

FEATURES

COVER , BOOK RACK & COMPASS PHOTOS BY AL PARRISH;
TRIFID PHOTO BY CHARLES BENDER; RULE-JOINT PHOTO BY ROY UNDERHILL

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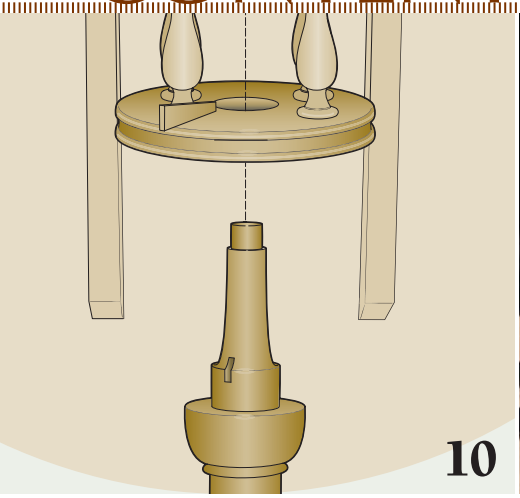

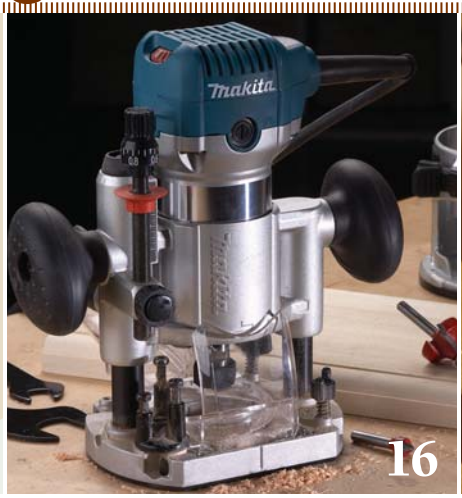

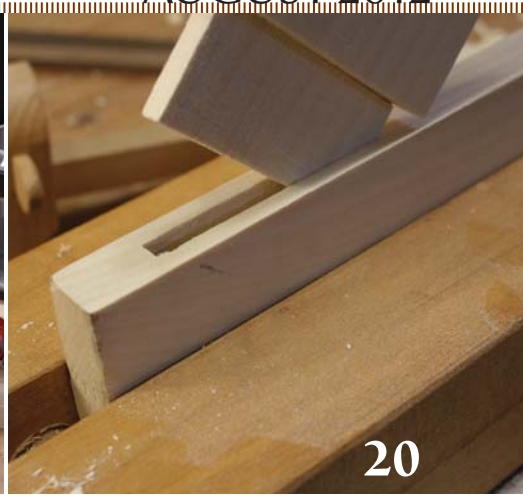

REGULARS

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ROUTER & TABLE PHOTOS BY AL PARRISH; MORTISE-AND-TENON PHOTO BY ADAM CHERUBINI

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The Very Best Editor's Letter Ever

Editors are given to hyperbole. At least twice a year a cooking magazine I subscribe to publishes a recipe billed as, "The Best Way to Roast a Chicken" or "The Last Roast Chicken Recipe You'll Ever Need." How many "best" ways to roast a chicken can there be? As editors who are passionate about the work we do every day, we get a little over-excited. And I'm as guilty as the next guy.

Off the top of my head I can think of at least a half-dozen ways to cut a mortise (and even more ways to cut a tenon). You can hog out the bulk of the waste with a brace and bit and then clean up the walls with a chisel, use a mortising machine that cranks them out in seconds or choose any number of methods that fall somewhere in between. Which is best? Well, are you cutting one of them or 200? Are you working in a well-equipped shop, or down in the basement while your 2-month-old finally naps upstairs? Are you trying to make a living as a woodworker or experimenting with a craft that's been your weekend obsession for years?

If you're cutting a single rabbet in a board but your table saw blade is set for a particular angle that you'll soon need again, why would you mess up the table saw settings when a rabbet plane could do the same job in a snap?

The same is true even of furniture design. I recently spoke to an award-winning period furniture maker who couldn't mention the name of a certain "art" or "studio" furniture maker (whose work, to my mind, is rightfully part of the permanent collection at the Smithsonian) without chuckling. But most of the studio furniture makers I know can't talk about reproduction period work without either throwing plates or falling asleep. Is one of these makers "better" than the others? Well, are you furnishing Monticello or a Brooklyn loft?

Don't get me wrong; not all woodworkers are equal. Some have exquisite technique, some have a brilliant eye, some are lucky enough to have both, and some are simply trying to enjoy a craft that is just beginning to open up to them. Leave us alone in our workshops and we're a pretty content bunch.

So if you haven't figured it out already, I'll tell you a deep, dark editorial secret: Where chicken roasting, woodworking or any other craft is involved, there is seldom a single-best method that fits every situation. It might be the latest power-tool technique or the way something was done 400 years ago, but only two things matter: Did you enjoy the process; and are you proud of the results?

So let me apologize here for any past or future hyperbole. I get carried away. We all do. It's the inescapable result of loving what you do. **PWM**

PHOTO © BARBARA DUDZIŃSKA - FOTOLIA.COM

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A Close Look at a Birdcage Swivel Joint

I am designing a high-end floor-model kaleidoscope. In the December 2011 issue (#194), Charles Bender's "Chester County Style" story shows a candlestand table with a hinge that both tilts and rotates. I have seen hinges that tilt but cannot discover how to make the rotating part. The legs and spindle are similar to what I use for the base of the kaleidoscope. Could I get some details on this rotating hinge?

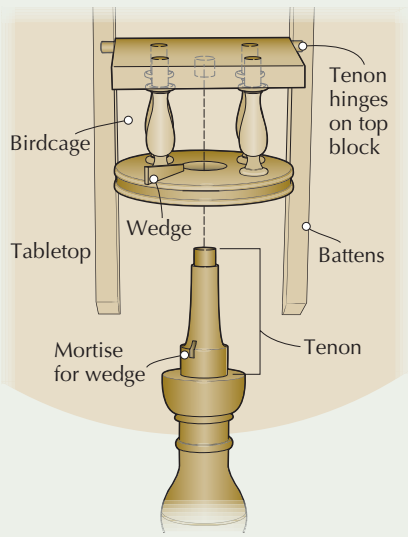
Jim Duxbury,
Graham, North Carolina

Jim,

Birdcage swivel-and-tilt mechanisms are simple. The hinge part is just a round tenon on each end of the top block that fits into battens under the top.

To make the birdcage swivel, turn a round tenon on the end of the column, then drill a hole large enough for the shaft of the column to pass through the bottom board of the birdcage. The round tenon on the shaft at the top of the column fits into a hole drilled into the top board of the birdcage. There's usually a mortise through the shaft into which a wedge is inserted; that keeps the birdcage attached to the base. On most, there's a washer between the birdcage bottom and the wedge, which stops the rotation from driving the wedge out of the mortise.

Charles Bender, contributor



'Erase' Red Wine Stains

I have splashed red wine on unfinished pine, and I tried using Murphy Oil Soap to remove it, but to no avail. What is the next best thing to do, with as little toxicity as possible?

Nicholas Michaels,
via Facebook

Nicholas,

This is my wife's department, and this is what she does (successfully with drips of red wine on our maple countertops).

Mix some OxiClean with water to make a paste and put it on the area. Check to see that it's doing something. If so, leave it for a short time until the wine stain is removed.

Or, scrub the wood with a scouring powder, such as Ajax, that contains a little chlorine.

The OxiClean doesn't leave a bleached area on maple – but if it does on pine, you should coat the entire surface for a short time to get an even coloring. Alternatively, sand or plane to even the coloring.

Bob Flexner, contributing editor

'Mystery Mallet' Success

The buzz you created over Roy Underhill's "Mystery Mallet" totally hooked me. When the April issue (#196) arrived in the mail, I wasted no time in heading to the shop to tackle this project.

Except for the wood and tools, you guys included everything I needed in the article. The step-by-step instructions, pictures and drawings walked me through this very challenging project, increased my confidence in woodworking and left me with a great result.

Glen Van Clise
Townville, Pennsylvania

No-smell Blanket Chest Finish

I have just completed a blanket chest lined with aromatic cedar. I plan to finish the outside with Tried & True linseed oil and beeswax, and I was planning to finish the inside with shellac for a finish that doesn't smell

However, I read a piece by James Krenov that recommends the following finish that will not interfere with the smell of the wood (kind of the point of having aromatic cedar lining). He suggests diluting shellac with two parts denatured alcohol, then filtering off the residue and diluting it again with one part alcohol. Krenov acknowledged that this is nearly pure alcohol and a very thin finish. I wondered what you thought about a middle course: simply diluting the shellac 1:1.

Bill Smith
via e-mail

Bill,

I have two thoughts.

First, I wouldn't put any finish on the inside of the blanket chest if it's aromatic red cedar. The point of the wood is to repel moths, and the aroma that does this softens and strips finishes. It's true that shellac is resistant to this softening, but what's the point? You're going to store blankets, sweaters, clothes etc., not wet things. Why do you need a finish at all?

If there are areas of exposed cedar, you could finish them with your thinned shellac just to give them a little shine. Don't use any oil or varnish product because the cedar oils will keep it from drying well. I have no opinion about how much to thin. If you get the finish too thin and it doesn't produce the shine you want, just apply another coat.

Second, be aware that Tried & True is raw linseed oil. It dries extremely slowly.

CONTINUED ON PAGE 12

ILLUSTRATION BY MARY JANE FAVORITE

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CONTINUED FROM PAGE 10

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We've recently received reports of suspicious phone calls and offers in the mail to renew subscriptions to Popular Woodworking Magazine.

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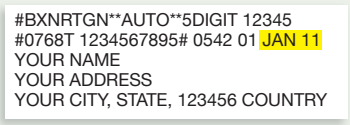
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Robert W. Lang, executive editor

Many people have problems because of this. But it does give a nice look (not much different, however, than other oil finishes that contain driers so they dry well). If you've used raw linseed oil before and are comfortable with it, no problem.

Bob Flexner, contributing editor

Miter Cuts Off the Saw

I am having trouble getting clean 45° angles in the context of thin strips of moulding, either with or without a miter box. I am fairly good at sawing to a line both at square angles and by dovetail standards. What else can I do to ensure I am following my cutline, front and back? How do most hand-tool moulding makers do it? I realize that planing is almost always a part of it, but cutting fat and planing down seems like a crutch … or is that standard procedure?

Rob Campbell
via e-mail

Rob,

I work from the saw – unless the miter doesn't fit because the miter is off or the corner isn't actually 90°.

1. Mark your cut with a knife.

2. Clamp the work when you cut.

3. Know the set of your saw so you can set the teeth right on the line.

4. The narrower the blade on the miter box, the less deflection of the blade. **PWM**

Christopher Schwarz, contributing editor

ONLINE EXTRAS

Letters & Comments

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Send your questions and comments via e-mail to popwood@fwmedia.com, or by mail to 8469 Blue Ash Road, Suite 100, Cincinnati, OH 45236.

Highly Recommended

One of my chair designs features 30-some holes (long story) that have to be marked out from a template, and seldom is doing so as easy as I'd like. I've used Forstner and brad-point drill bits to find centerpoints, but because of the shaft designs they're seldom accurate.

While visiting a luthier's shop one day, I noticed a set of transfer punches on the workbench and my problem was solved. After more searching than you would imagine, I recently found this set at Woodcraft for $19.99. They come in just as handy for finding the center of square holes, such as those used for pegging joints. *— Matthew Teague*

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Safety Note

Safety is your responsibility. Manufacturers place safety devices on their equipment for a reason. In many photos you see in *Popular Woodworking Magazine*, these have been removed to provide clarity. In some cases we'll use an awkward body position so you can better see what's being demonstrated. Don't copy us. Think about each procedure you're going to perform beforehand.

THE WINNER:

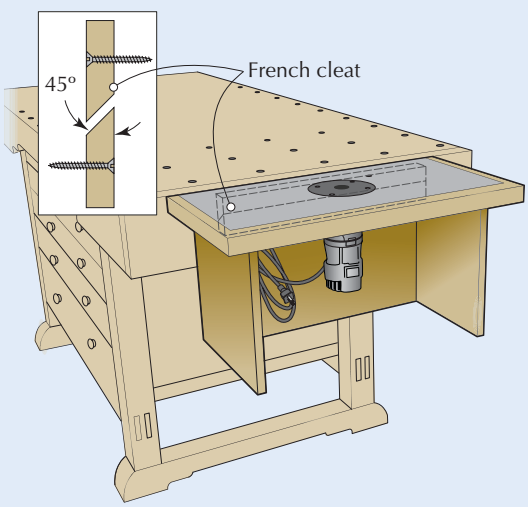
A Table for Your Trim Router

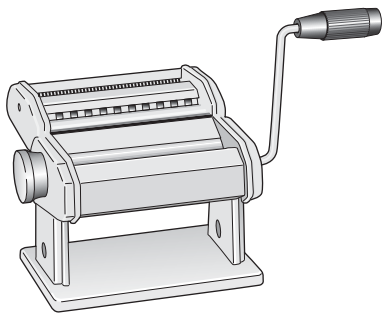
I was looking for a safer way to use my trim router for everyday chores around the shop. My solution was to build a router table that hangs off the end of my bench on a French cleat. When I'm not using the router table, I store it under the end of the bench on the floor. When I need to use the table, I simply hang it on the French cleat.

The router table is light enough that it is quite secure when mounted this way. This setup is great for doing small roundovers, chamfers, flush-trimming and the like. A standard router base plate is used in the table, so it's easy to pop the router out of the table for freehand work.

It's been a great addition to my shop, it doesn't take up much space and it is a good way to store the router when not in use.

Bruce Davis
Star, Idaho





Inlay Stringing the Easy Way

Here is a trick I learned a few years ago from a fellow member of the St. Louis Woodworkers Guild. It is an easy way to make stringing for inlay.

First, buy a hand-cranked pasta machine. Then run a sheet of veneer through it (not paper-backed veneer, obviously). Voilà! Instant string inlay! Now just shape a scratch stock blade to match the width and you can add a string inlay border to your woodworking piece in very little time.

Pro Tip: Don't use your wife's pasta machine. And don't spend a lot of money on a brand-new one. A friend of mine found one for me at a garage sale for $1. I store cut strips in a brown grocery sack on a shelf next to where I keep the pasta machine.

The only challenge is in finding thicker sheets of veneer, though you could use complementary strips of thinner veneers if you wanted to make banding.

Ethan Sincox
St. Peters, Missouri

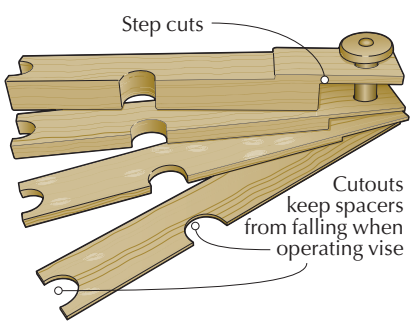
Spacers Prevent Vise Racking

Anyone who uses a racking vise has probably used scraps to counteract the racking. With some basic skills it is possible to make a stack of four spacers to produce any thickness from 1/8" to 1 7/8" in increments of 1/8". The spacer thicknesses are 1/8", 1/4", 1/2" and 1".

With two extra pieces, a 1/16" spacer and a 1x2 block, a full range of sizes can be attained up to just shy of 4".

Except for the 1/8" piece, all of the spacers have a step cut in them to allow them to swing out of the way when not in use. The overall length of my set is 11 1/4". The cutouts at the end and side are so the stack can sit on my vise's stabilizer bars without falling when the vise is operated.

The spacers are easier to make if the holes are drilled first. They are centered at 1" from the top. The step is 2 1/4" deep to allow the spacers to rotate freely. It is also easier to cut out the steps before cutting the spacers to their final dimensions. Check the steps before dimensioning to make sure the smaller spacer(s) fit and move freely.



The cap is made up of a 3/8" dowel inside a 5/8" dowel. Trim it flush on the backside of the 1/8" spacer.

My stack is made with a friction fit between the dowel and the cap to allow for future disassembly if necessary.

Jim Koepke
Longview, Washington

ILLUSTRATIONS BY MARY JANE FAVORITE

Blast Gate Modification

I have been happy with my central dust collection system for a few years, but I recently noticed the performance seemed to be a little off. Inspecting the system, I found some of the blast gates weren't fully closed though they were pushed in as far as they would go. I discovered that the blind corners at the back edge of the gates were packed with dust, preventing the gate from fully closing the air passage.

After trying several ways to clear the packed dust, I drilled a 5/16" hole in the two corners. Now when the gate closes, it forces any dust along the edges to the holes and out the gate. (I picked that hole size so I could use a screwdriver tip to "punch out" the really hard-packed stuff.) There is minimal air leakage with the gate open and none with the gate closed. I also suspect that the leakage when the gate is open will help evacuate the dust in the blind end, too. This "trick" should work for any type of gate that slides into blind corners.

Ed Winfrey
Sibley, Missouri

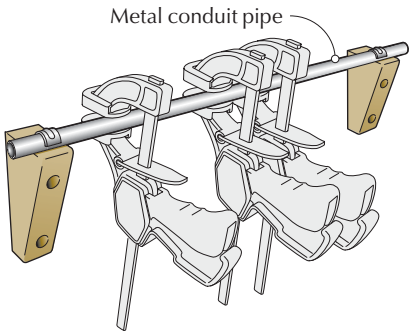
Simple Clamp Storage

I'm always amazed when I see another sophisticated clamp-storage system as a feature article in a woodworking magazine. Yes, such a system warranted if you really have a lot of long and beefy clamps or you're in a production shop that is big enough to require a portable rack to get them to the project.

But for most hobby woodworkers who work in relatively small spaces, a much simpler clamp-storage system will suffice.

The system I use is wall-mounted to save floor space and will accommodate a wide range of clamp styles. The main component is 1/2" electrical metal tubing (EMT) at a cost of $2 or less for a 10' length. Other supplies needed are some 1/2" EMT mounting clips, brackets made from scrap pieces of 2x4 lumber and a few wood or concrete screws for mounting the brackets to a wall.

All the required details of construction can be seen in the illustration. The spacing of the EMT from the wall is about 3" and the space between the wall brackets is approximately 5'.



A row of shorter clamps can be located above a row of longer clamps to conserve wall space. This system can accommodate a large variety of clamp types without modification.

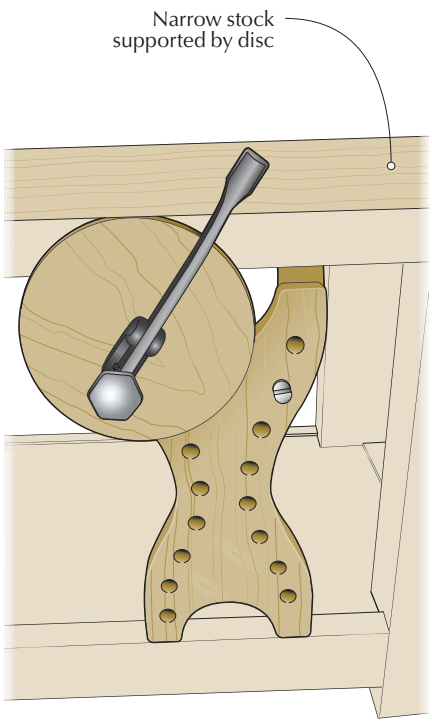
John Cusimano
Lansdale, Pennsylvania

Deadman Accessory Supports Long, Narrow Stock

I built a Roubo-style bench and chose to build the deadman following the design that Megan Fitzpatrick used for her bench (in the November 2009 issue, #179), which was termed the "sliding deadwoman." The uppermost hole for the deadman is about 6" below the benchtop. To support a long workpiece that is narrower than 6", I devised the following solution.

Cut a circle about 10" in diameter, bore a 3/4" hole through the center and insert a 3/4" dowel through it. This fixture can be inserted into holes in the deadman to provide support at the required height. Alternatively, insert a holdfast through the center hole and the work can be secured to the bench and supported from below. **PWM**

Adrian Mariano
Vienna, Virginia



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Makita Compact Router Kit

Bigger doesn't always mean better.

Small routers are easy to handle, and the addition of multiple bases makes them good all-purpose tools. The basic 1/4"-collet router that comes in the new Makita compact kit (RT0700CX3) has good power and variable speed. The motor slides in the base and clamps firmly, with rack-and-pinion fine depth adjustment. A plastic shield contains chips, and there's a fitting for hooking up a shop vacuum.

The kit we tested included the standard base, a tilting base, an offset base and a plunge base. Swapping bases is easy – no need for any tools. The plunge mechanism was a bit stiff out of the box, but a squirt of lube fixed that. The handles are comfortable, but due to the motor orientation, the switch and plunge lock are reached with the left hand.

Overall, this little router compares favorably with others of this size. My only complaint is with how this router is sold. The choices are the fixed base only, or the full kit with all the bases. I'd like to see the plunge base as an accessory, or perhaps Makita could offer a two-base kit for those who don't work with plastic laminate.

— Robert W. Lang

Compact combination. *Makita's new multi-base compact router kit packs many features in an easy-to-handle format.*

Compact Router Kit

Makita ▪ makita.com or 800-462-5482

Street price ▪ RT0700CX3 kit $260
RT0700C router $136

▪ **VIDEO:** *Watch the trim router in action: popularwoodworking.com/aug12.*

Prices correct at time of publication.

Lie-Nielsen No. 101 Block Plane

This wee bronze plane from Warren, Maine, is a reproduction (of sorts) of the Stanley No. 101 plane – a small block plane originally designed for household use and light work (and sold in toy tool chests, according to Patrick Leach's "Blood and Gore" web site).

But unlike its inspiration, this new version from Lie-Nielsen, which is also called a violin maker's plane, has all the same features as its slightly larger cousin, the No. 102, including a stainless steel adjuster to advance and retract the blade.

With a sole just less than 3" long and 1 1/4" wide, the plane fits comfortably in even the smallest hands, and its size allows you to work very locally indeed, and in tight spaces – and anywhere else you'd typically turn to a block plane.

Plus, it's the perfect size for slipping into an apron pocket or even your pants pocket.

The 7/8"-wide A2 steel iron is bedded at 20° for a typical 45° cutting angle.

— Megan Fitzpatrick

No. 101 Block Plane

Lie-Nielsen ▪ lie-nielsen.com or 800-327-2520

Street price ▪ $95

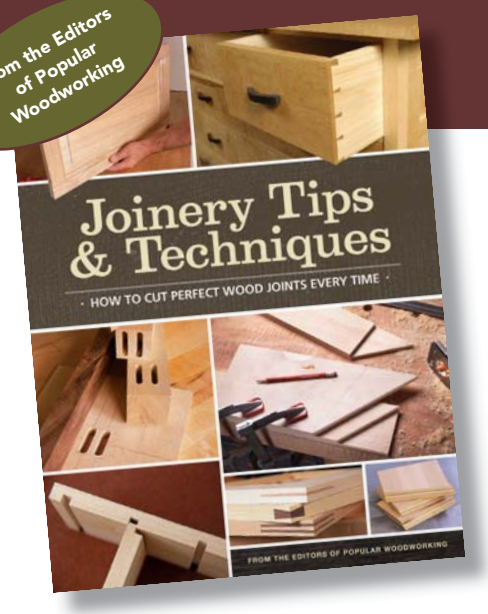
▪ **VIDEO:** *See the No. 101 plane in action: popularwoodworking.com/aug12.*

Price correct at time of publication.

CONTINUED ON PAGE 18

PHOTOS BY AL PARRISH

From the Editors of Popular Woodworking



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iVac Pro Automated Dust-control System

Laziness can reduce the efficiency of your dust-collection system, whether you use a shop vacuum or a centralized collector. Sometimes just walking around the machine to switch on your collector doesn't seem worth it.

Install an iVac Pro automated system and there's no excuse. You can opt for a remote control push-button system that clips to your belt, or use a stationary controller that connects to your machines and turns the collector on and off automatically.

iVac Pro

mBright Tools ▪ ivacswitch.com or 888-273-5742

Street price ▪ Units start at $45

▪ VIDEO *Watch a video about iVac: popularwoodworking.com/aug12.*

Price correct at time of publication.

With the remote control, your dust collector is plugged into an iVac Pro switch device. The remote control communicates via radio frequency (RF) with the switching unit to turn the collector on or off. And the device delays switching off the dust collector for a few seconds to clear the dust from the ductwork.

With the stationary unit, your machine is plugged into it. When the machine is switched this device senses current and communicates via RF to the dust collector to switch it on and off with your machine. And you can change it from auto to manual mode.

Up to eight machines can be hooked up to one switch unit. The tool units are available in either 15-amp or 20-amp versions for 115-volt (V) or 240V equipment. Similar systems are also available for use with higher-voltage machines and dust collectors, including 3-phase power. When the magazine recently moved and we built our new shop, we equipped the space with iVac Pro equipment. It not only satisfied us (and our lungs), but the local building, electrical and fire inspectors, too. **PWM**

— Steve Shanesy

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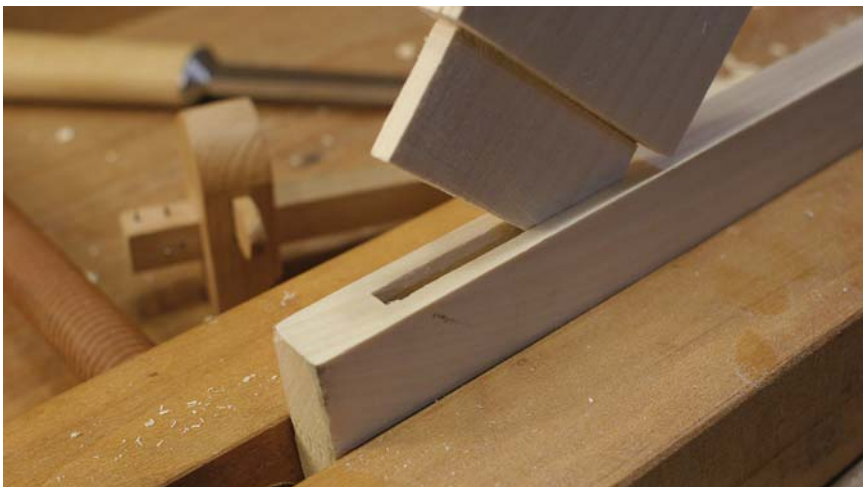
Mortising by Hand

The key to a lasting joint is a good fit – or good pegs.

Frankly, I can do without dovetails quite nicely. You can nail two boards together and be left with something strong and serviceable.

But mortises are trickier to live without; you need to know how to cut them. Mortises join boards edge to end. They are super strong. Because of their strength, they are often used in structural applications such as timber framing, chair and table joints. Unlike dovetails, they either fit well and function – or they don't and the finished product suffers in some way. And because they are essentially one-shot deals, it's pretty important that you get them right.



What's a mortise? *It's the pocket or slot that receives a tenon, and is typically oriented along the grain. On furniture, a tenon can be glued in place or retained by a peg. Some woodworkers advocate "warming up" with a few quick dovetail joints – why not do the same for mortises? They are equally challenging and in many ways more important.*

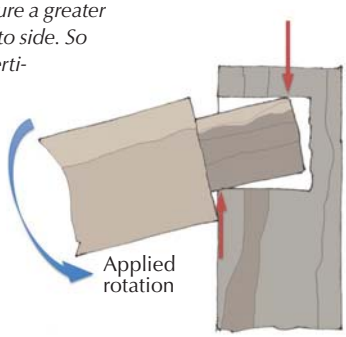
How do Mortises Work?

Mortises are complicated pieces of engineering. Rightly so, I've heard a fair number of questions about them. "Do I need to peg my tenons?" "How large should my mortises be?" Understanding how mortises work will help you deliver the fit and features you need to make your projects function.

As you can see from the examples below, retention of the tenon in the mortise is an important contributor to the strength and life of your project. You can retain tenons in two ways: with glue or with pegs.

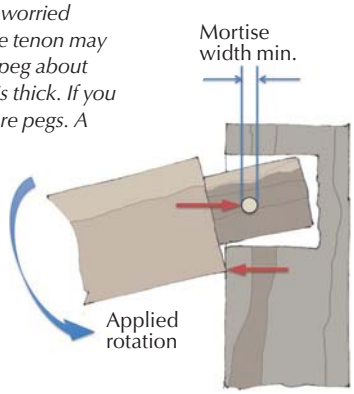
For glued joints, it's essential to spread glue on the broad surfaces of the tenons. The tenon's end grain is essentially worthless. And differential shrinkage may reduce the size of the tenon, causing the glue to fail. It's also a very small area. I'm going to skip recommendations about glues, but according to the literature I've seen, PVA (yellow and white glues) requires pressure to develop bond strength. Because mortises are essentially unclampable, the pressure you get inside your mortises will be based solely on the tenon's fit. So if you plan to use PVA, make your joint as tight as possible. I typically use hot hide glue, which I believe is a bit more forgiving of gappy joints – though you should strive to avoid them. A properly fitted sawn

Mortises resist pressure. *Ensure a tight fit to resist the force the joint will encounter in use. The mortises on a chair endure a greater load vertically than they do side to side. So concentrate your effort on the vertical fit. Deeper mortises and longer tenons will generally be stronger. As the red arrows spread farther apart, the force they represent goes down proportionally.*



Red arrows balance the rotation

Pegs allow looser fits. *If you are worried that your glue may not last, or the tenon may shrink, pegs can help. Make the peg about the same diameter as the tenon is thick. If you can't practically do that, add more pegs. A decent fit at the shoulder is also important for pegged joints (the rotation is exaggerated here), but with a sufficient shoulder, the peg will hold the joint together.*



Red arrows balance the rotation

PHOTOS & ILLUSTRATIONS BY THE AUTHOR

tenon mating to a cut mortise gives the glue enough surface to bond.

The other method of retaining joint integrity is to use pegs. The key to using pegs is producing contact at the shoulder. This is why I prefer to drawbore my pegs. I drill slightly offset holes and force them to align by inserting a peg with a tapered end. Some say clamping the parts together does the same thing.

Use Dictates Technique

Creating a good mortise requires an understanding of how the finished project will be used. A kitchen cabinet door may not need superior mortise quality. The load on the door is low. A chair or the stretchers joining your workbench legs require your best efforts. If you are planning to hold your project together with PVA glue, you'll want nice straight, parallel mortise walls and ends. If you plan to use pegs – which I certainly recommend for a workbench – you may not need perfect mortises. But by all means make sure your tenon's shoulder is tight against its mating surface before inserting the pegs or you'll be left with a wobbly bench.

Chopping Mortises

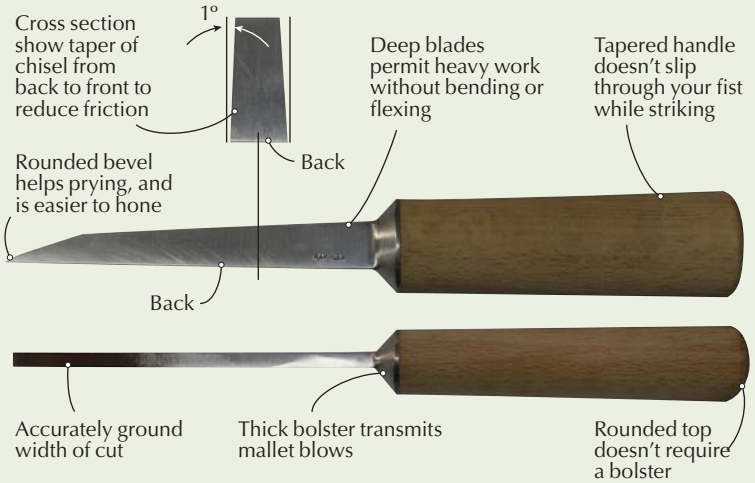
Historically, mortises were chopped out. This technique involves holding the chisel more or less vertically, and pounding it into the work in a series of cuts. The waste is levered out and the process is repeated to deepen the mortise.

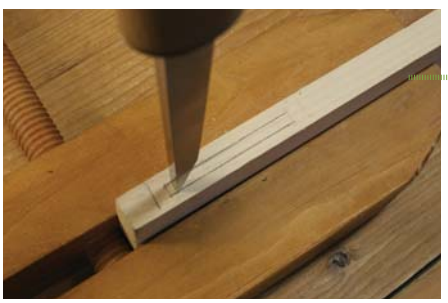
This seems a simple enough approach, and it is. But I've encountered several challenges that have made me gravitate to another technique. It can be difficult to control a chisel under mallet blows; there's nothing to guide the chisel.

Paring the walls may not be quite as simple a solution as one would think. Used carefully, the mortise chisel alone will produce parallel walls. Paring often destroys that. Then there's the matter of the size. Chopping also compresses wood, making it difficult to lever out waste. Last, the process of chopping and levering destroys the edge of your

ANATOMY OF A MORTISE CHISEL

Mortising chisels have specialized features. While you can try using a regular chisel to cut mortises, you'll get better results with a proper mortise chisel. The one below is a modern reproduction of a 19th-century tool (by Ray Iles, available from toolsforworkingwood.com), and it represents hundreds of years of development informed by trained professionals who spent their lifetimes working with such tools. — AC





A CHOPPED MORTISE

1 ***First blow.*** *Begin your mortise by defining the ends. But as you begin to lever out the chips, leave about 3/16" on each end to serve as a fulcrum. (Chop the end material away after your mortise is to full depth.)*

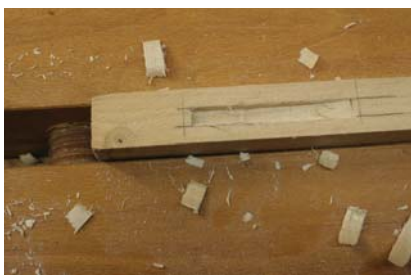
2 ***Down the line(s).*** *Continue cutting down the entire length of the mortise. Don't worry about trying to reach full depth. You can only hit a chisel three or four times before it ceases to cut and is just compressing wood against the bevel. One pass may deepen the mortise 3/8" to 1/2" or so, depending on the species of wood.*

3 ***Now lever.*** *Finish the first pass by levering out the waste. Notice how the chisel pries against the end of the mortise? That's why you need to reserve material there.*

A PARED MORTISE

1 ***Use your weight.*** *This technique is described by Joseph Moxon in "Mechanick Exercises." Hold the chisel like a pencil. Your hand is fully supported on the work so precise control is achievable. Place the helve in the hollow of your shoulder so your full weight can be brought to bear behind the edge.*

2 ***Shallow cuts.*** *Make a series of shallow cuts, aligning the chisel to the scribe line each time. While it's a little tedious, it doesn't take long.*



3 ***Waste removal****. Remove the waste carefully with light cuts in the opposite direction. Once you've created a shallow trench to guide the chisel, you can push harder. A downward chop at the end of the mortise will allow the chips to break free.*

4 ***Sloping bottom****. With the chisel held bevel down, pare the bottom of the mortise as aggressively as you dare (a sharp chisel helps). Work into one end of the mortise to create a sloping bottom, then finish by working in the opposite direction.*

tool. Either you sharpen constantly, or you learn to work with a dull tool, which makes chopping all the more unpredictable. Still, this is a technique you must master.

Paring Mortises

Over the years, I've developed a paring technique for mortising. Using my shoulder, and the weight of my upper body, I push the chisel into the wood. Paring mortises can help in several ways: It's significantly easier on the tool and chopping is kept to a minimum.

Because paring doesn't compress the wood, the edge-blighting caused by levering out the waste is reduced, which aids in edge retention. The resulting mortise is often cleaner and more uniform than a chopped mortise because the mortise guides the tool. I've used this technique to great effect when cutting angled mortises in irregular stock.

Conclusion

Mortising by hand is a basic skill that I think all woodworkers should master. Need an angled mortise? Or a mortise in a piece of wood you can't squeeze under the hollow chisel mortiser? You can do it by hand pretty quickly.

I don't think the basic technique is difficult. You can try my two methods or try other ways. The place to start is with an understanding of the mortise-and-tenon joint's engineering – and a good chisel. **PWM**

Visit Adam's Popular Woodworking Magazine *blog at artsandmysteries.com for more discussion of traditional tools and techniques.*

PERIOD CHISELS

Period makers often had a large set of mortise chisels. I do, too, but I find I use only two or three sizes for furniture. Mortises are typically one-third of the thickness of the stock in which they are cut. Our modern 4/4 stock planes down to about 3/4". So a 1/4" mortise chisel is appropriate for this. For furniture made from 5/4 stock you should use 5/16" chisels. I'm looking forward to a project using 1/2" mahogany I have laying around. I'll use my 3/16" mortiser for that.

Lay out your mortises carefully. Use a mortising gauge to scribe the sides of the mortise. Define the ends however you wish. I typically cut the mortises first, then fit the tenons to them, so I'll use my chisel to quickly mark the ends. If you've already cut the tenon, then of course you need to mark the mortise from the tenons. Just remember that this dimension is important to the fit and function and needs to be done appropriately.

I typically leave some extra length in the workpiece that the mortise isn't so close to the end of the board. The force of chopping and prying can break out the short grain at the end of the board. After the mortise is complete, and often after the tenon is fit, the excess can be trimmed away. — AC

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Campaign Furniture

BY CHRISTOPHER SCHWARZ

Simple, rugged, masculine and awesome – this sometimes-forgotten style of furniture is great for beginning and advanced woodworkers.

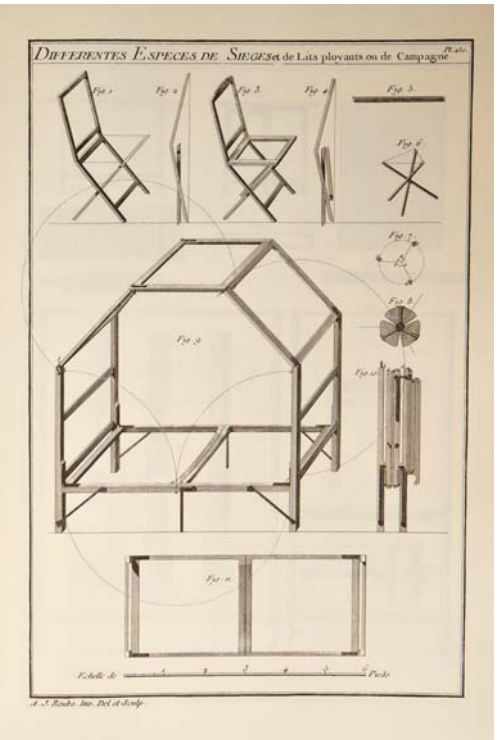
Contrast. *Many galleries in campaign secretaries would have contrasting woods or be finished in a different color than the exterior.*

Campaign-style furniture is as sturdy and simple as Shaker. It is as masculine as Arts & Crafts. And it is free of adornment, like Bauhaus pieces. Yet many woodworkers are unaware of this furniture style, which was popular for more than 150 years in Great Britain, its colonies and North America.

Perhaps the problem is that campaign furniture goes by many names: military furniture, "patent" furniture or traveling furniture. Perhaps enough original examples of the style haven't survived or been featured at major museums. Or maybe there just aren't enough books written about it. For whatever reason, campaign furniture is rarely discussed or built by modern woodworkers, and I would like to change that.

I grew up surrounded by the style, which has roots in both Great Britain and Asia. My grandparents collected the stuff, and my grandfather built several pieces in the style, including some campaign chests and at least two coaching tables. Coaching tables, by the way, are folding tables with a graceful X-shaped base that were used to serve refreshments at carriage stops in the pre-Industrial world.

OPENING PHOTO BY AL PARRISH; STEP PHOTOS BY THE AUTHOR; ILLUSTRATIONS BY ROBERT W. LANG FROM THE AUTHOR'S MODELS.



For a mobile military. *André Roubo's 18th-century book on woodworking featured designs for several pieces of campaign furniture, including a folding bed, chair and stool (left). The drawing below, attributed to a Lieutenant Wilmot, depicts a Bengal Regiment of Infantry in Scinde, India, on the move circa 1843. Note the furniture packed onto the camels.*

After my grandfather died, I inherited a box of his leftover pieces of cast brass campaign hardware. And after stumbling upon this box in 2011 in my basement, I decided to embark on building a number of campaign pieces, including a chest of drawers with a secretary in the top drawer.

A campaign chest is a great project – a classic campaign-style piece. But instead of focusing this article entirely on its straightforward joinery and simple construction, I'd like to introduce you to the campaign style, its history and its important details. Though many joints are similar to those in Shaker pieces, there are many construction points that are unique to campaign furniture. So let's get started in medieval Europe.

Furniture of War – at First

Invading armies have to travel, so it makes sense that they would own furniture that was lightweight, portable and rugged. And indeed there is documentary evidence of special field beds for officers during the Renaissance and even earlier, according to published research by William Rieder, a curator in the Department of European Sculpture and Decorative Arts at the Metropolitan Museum of Art.

But it wasn't until the European wars of the 18th century and early 19th century that we encounter a fully formed and separate style of military furniture. British officers purchased their own furniture, and so an entire industry developed to supply them with beds, fold-up tables, collapsible chairs, campaign chests, writing slopes and commodes.

With such strong demand, many leading furniture designers published their own versions of furniture for the military, including Thomas Chippendale, Thomas Sheraton, André-Jacob Roubo and George Hepplewhite.

And many British firms patented their collapsible mechanisms – there were quite a number of these patents issued between 1790 and 1830. Hence, sometimes this style is called "patent" furniture. Many of these mechanisms are ingenious: The seat of a chair folds up and the chair's front apron folds flat against the chair's back – like an accordion. The Morgan and Sanders "patent metamorphic library chair" is one famous example of patent furniture – it changes from a chair to library steps in an instant. Plus there are all manner of dining tables that fold down into the size of a suitcase.

These pieces of furniture became popular with civilians. Students pur-

Drawers & feet. *On this period example you can see that the smaller drawers are on the bottom and the bigger ones are at the top. Also note the turned feet added below a traditional plinth.*

chased folding bookcases for school. And the limited space in urban centers in England made folding, stow-away furniture quite handy, according to Nicholas A. Brawer's "British Campaign Furniture: Elegance Under Canvas 1740-1914," one of the few books on the style.

But one of the most popular and enduring pieces of campaign furniture was the chest of drawers – usually called a campaign chest. These chests were typically made in two pieces that stacked on top of one another. Why two pieces? Well, there were several reasons. The British Army General Order 131 (d) from 1871 states that the maximum size for a chest of drawers was 40" wide x 26" x 24". So two pieces would create a typical chest of 40" to 42" high. Also, according to Brawer, the two halves of a single chest could be strapped over a mule's back to create a balanced load on the animal.

> "The purpose of the cavalry is to give panache to what would otherwise be a vulgar brawl."
>
> *— Early 20th-century British military cartoon*

As a result of this rough treatment, the chests needed to be rugged. Dovetails alone would not be enough.

Design of Campaign Chests

I've inspected a fair number of these original chests, plus I've collected photos and measurements from auction catalogs of many more. When designing your own campaign chest, here are some guidelines to follow.

When stacked and in use, most of the full-size chests are 40" wide, sometimes a little less. Their height is usually about 40", though sometimes they are as tall as 43", especially the

DOVETAILS FOR CASEWORK

When dovetailing drawers, most people tend to prefer skinny pins. But when you are dovetailing casework and the dovetails will be hidden, the rules change. For a typical 18"-deep carcase, I'll lay out five or six tails, which will result in considerably bigger pins. That's OK – six dovetails offer plenty of strength.

With this project, there are three kinds of dovetails: through-dovetails for the backs of the drawers; half-blinds for the drawer fronts and the hidden parts of the carcase; and full-blinds for attaching the top of the top carcase.

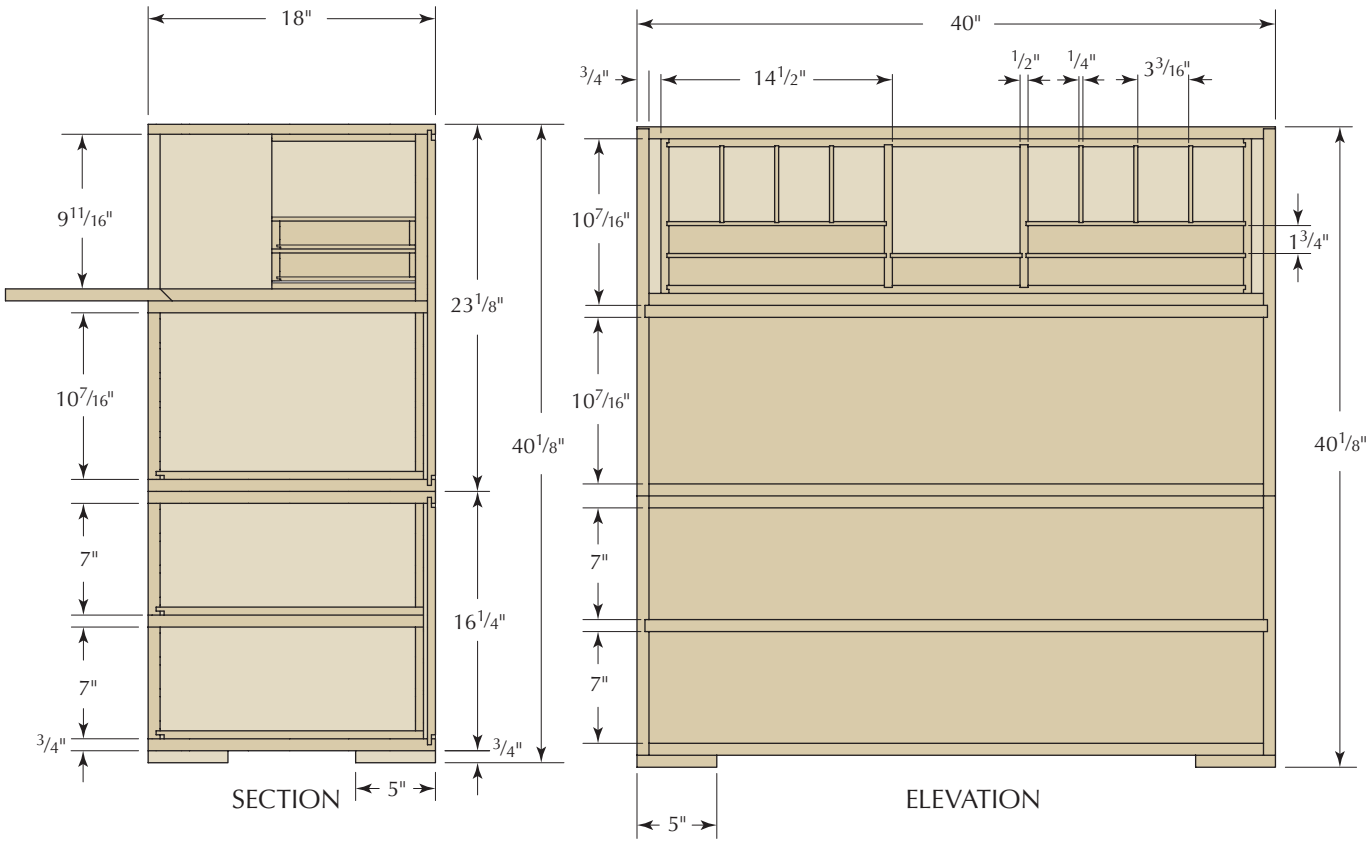
Most woodworkers will scratch their heads about cutting the full-blinds. Stop scratching. They are easy and forgiving. Here's how to do it. — CS

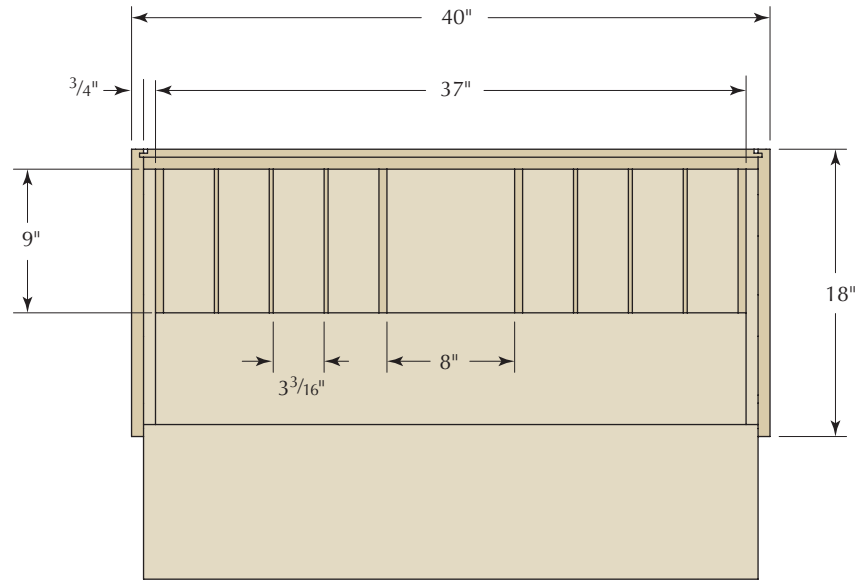
1 ***Rabbets.*** *There are two rabbets for this joint: a narrow one that lips over the sides of the carcase, and a wide one that helps register the top onto the sides while cutting the joint.*

2 ***Avoid & overcut.*** *To cut the blind tails in the top, overcut your baseline. But don't nick the narrow rabbet, because that would show when the joint is assembled.*

3 ***Clear out.*** *Remove the waste between the tails with a Forstner bit and a chisel. Don't worry about the overcuts on the tails. Those will be hidden inside the carcase. Only a conservator will see them.*

4 ***Transfer the weight.*** *A jointer plane is used to hold the tail board securely on the pin board while marking out the pins with a knife. Then you saw the pin waste and remove it just like you would when you build a drawer.*





PLAN

ones with turned feet. The depth of a campaign chest tends to vary – 17" to 18" is typical, though some are as deep as 23".

There are a few different kinds of bases, or plinths, on these chests. The one shown in this article is the simplest – it's just four square feet screwed to the underside of the bottom case. While that base was fairly typical, I've encountered many campaign chests with four turned feet. These turnings are removable and have a wooden screw at the top that threads into the base. You'll also find campaign chests with bracket feet, like a traditional chest of drawers, though many of these have been added to the chests later on in their lives. And finally, I've seen a few weird chests that combine two of these kinds of bases. You'll have square feet or a bracket base plus turned feet below.

The other curious design feature of campaign chests is the way the drawer sizes are graduated. While some campaign chests have a typical drawer-graduation scheme – the taller drawers are at the bottom and the shorter ones are at the top – many chests do not.

Instead, the two drawers in the lower section are short and the drawers in the top section are tall – it basically reverses the design scheme to which we are accustomed.

After many years of looking at these campaign chests, I actually like this reverse-graduation scheme. Some people do not. In the chest I built for this article, the two lower drawers are each 7" tall; the two upper drawers are each about 10" tall.

HOW TO KEEP THE CASES ALIGNED

With campaign chests you need to keep the top unit from sliding off the bottom unit when you open and close the drawers. Some chests were screwed together. Others used gravity and four wooden dowels to keep the top unit in place. And that's what I opted to do.

The top surface of the bottom unit has four $1\frac{1}{2}$"-diameter holes that are about $\frac{1}{2}$" deep. Then I glued and screwed in a 1"-long section of $1\frac{1}{2}$" dowel into each hole. The underside of the top case has four matching $1\frac{1}{2}$" holes. So the top case just drops in place on the bottom one and stays put unless lifted off. — CS

Holes & pegs. *The $1\frac{1}{2}$" holes were bored using a modern Forstner bit and a brace (yup, that works). Before inserting the dowels into each hole, the ends were chamfered a bit to make the units' docking procedure easier.*

Full blinds. *Here are the dovetails for the secretary's top. Note the small rabbet at the end. When the joint is assembled the rabbet is the only part of the joint that shows.*

Why are the drawers sized like this? Usually it's because the chest also functions as a secretary, or desk, for its owner. One of the drawers in the chest opens up to offer a writing surface and that needs to be 30" off the ground. That dictates all the other drawer sizes. A typical arrangement is for the front of the drawer to fall forward and lock flat – revealing a host of internal drawers and cubby holes.

A less-common arrangement is for the second drawer to pull out and reveal a writing surface that is actually a lid on the drawer. Lift the writing surface and you can get to your writing supplies below. Close the lid and you can begin your correspondence.

The other prominent feature of campaign chests is the flush hardware. And there is a lot of it. Some of the hardware protects the corners; some of it is in the form of brackets that reinforce the joints. The hardware is flush-mounted so that chests could be stacked closely together on ships, according to an article by Jerome Phillips in the June 1984 issue of *Antique Collecting* magazine.

The furniture also had to be tied down, and so the ends sometimes have handles that accommodate ropes. And some antique chests have indentations from ropes. Other chests were packed inside wooden crates to protect them from abuse while traveling.

Wood Selection & Joinery

Campaign chests were built using a wide variety of domestic and tropical woods, from oak and beech to mahogany, teak and camphorwood. Most examples I've seen use solid wood as opposed to veneers. What is particularly interesting about the wood selection is that in many campaign chests there is no secondary wood. Every scrap – even the drawer bottoms – are solid mahogany or teak.

Why would they use such expensive wood inside a case? Simple. To defend against bugs and rot, according to Brawer's book on the style. In fact, their owners would occasionally set the feet of their furniture in ceramic bowls of water or oil to prevent bugs from eating their furniture. Of course, soaking the wood in water led to rot, which is why you will find many pieces with missing or shortened feet, according to Brawer.

When it comes to joinery, most campaign chests were assembled using dovetails, though the joints aren't obvious. While some campaign chests have through-dovetails or half-blinds that show at the corners, most chests do not. It's only when you unstack the chests that you can see that the tops and bottoms are dovetailed to the sides.

The biggest question for most woodworkers is how the top of the top chest is connected to the sides. From the outside, it looks like the top is rabbeted to receive the sides. Some chests have nails through the top and into the sides, which has led some people to think the chests were just nailed together.

When you look inside the top chest, you can usually find the answer: The top can be connected to the sides using full-blind rabbeted dovetails. You can see evidence of the maker overcutting the tails on the inside of the top. Or you can see small gaps where the pins go.

This joint gives the exterior a clean appearance and offers a lot of strength.

No surprises. *The lower drawers have half-blind dovetails at the front and through-dovetails at the back. The drawer bottom sits in a groove.*

SUPPLIES

Horton Brasses
horton-brasses.com or 800-754-9127

1 ■ Campaign secretary hardware package; call to order and for pricing.

Tools for Working Wood
toolsforworkingwood.com or 800-426-4613

1 ■ BT&C Tiger Flakes Shellac, garnet #MS.TF.XX, $32.95

Woodcraft
woodcraft.com or 800-426-4613

1 ■ General Finishes Gel Stain, java #826979, $19.99

Prices correct at time of publication.

Plus, it's a forgiving joint to execute. You cut the tails, transfer the shape onto the sides and cut the pins in the sides. When you assemble the chest the only gap you have to worry much about is where the rabbet on the top board meets the side board.

The rest of the joinery in these cases is fairly standard stuff. The drawer dividers, which are typically solid panels, are dadoed into the sides. The back is nailed on (in cheaper versions) or secured in a groove in the top and sides of the chest – then nailed to the bottom.

The drawers have typical joinery – dovetails at the corners with the bottom secured in a groove in the front and sides. Some of the drawers use slips to secure the drawer sides.

About the Gallery

Campaign chests that have a gallery are a little trickier to construct. But once you understand the mechanism, it's pretty standard stuff. The gallery is a separate assembly that is inserted into the top drawer of the chest. The top drawer's sides are dovetailed to the back piece. The front of the drawer is attached to the rest of the assembly with desktop hinges.

What makes everything work smoothly is that the bottom edge of the drawer front is beveled, as is the front edge of the drawer's bottom. When the drawer front is folded down, these two bevels touch, which stops the drawer front. For extra security, many secretaries also had brass quadrant stays – the quarter-circle pieces of hardware in the photographs.

The fussy part is getting the bottom edge of the drawer front sized so that it folds down easily yet looks like a plain drawer front when closed.

Other than that, the gallery is typical of what you will find in old work. The dividers are either dadoed into each other or connected with a V-groove. Some chests have secret drawers in the gallery; others do not.

Finishes

Extant campaign chests have a wide range of coloring. I've seen plain pine with a clear finish, all the way to a stain that looks like ebony. Because of the age of these pieces, it's difficult to know

Critical bevel. *A bevel on the desktop and the drawer's bottom allows everything to fold down flat and fold up neatly.*

Router work. *Many campaign chests have a desktop reinforced with quadrant stays. Lay out the channels for the stays with care and cut them with a router guided by templates.*

what was original. But because they exhibit a full range of hues, we have a lot of choices that will look correct on a modern campaign chest.

The Decline of Campaign Furniture

Most furniture historians place the time period for campaign furniture as beginning in 1790 and lasting until the Boer War (1899 to 1902) against the Transvaal and Orange Free State in South Africa. It was "the last of the gentlemen's wars," according to Brawer. The British were outmaneuvered and humiliated by the quick-moving Boers. Soon after that, the British Army and Navy began producing their own forms of simple traveling furniture, and the firms that built the high-style stuff went out of business.

But that's not the end of the story of campaign-style furniture. British military men still had a sense of style, and that led to the development of the Roorkhee chair, which in turn influenced a generation of contemporary furniture designs. And it is the direct ancestor of the chair you probably take with you when you go camping or on a picnic. So the campaign furniture style lives on, even if we don't realize it. **PWM**

Christopher Schwarz is the editor of Lost Art Press (lostartpress.com) and is currently building a series of Roorkhee chairs for a future issue of this magazine.

INSTALL FLUSH HARDWARE

A typical campaign chest can have about 20 L-shaped brackets, four corner brackets and eight flush pulls. And all of these pieces are recessed flush to the case. Though I would normally install hardware like this with hand tools, the number of pieces of hardware pushed me into using the router and some custom templates. Each piece of hardware had its own special challenge, as you can see in the photos. — CS

In two dimensions. *For the L-brackets, an L-shaped template is clamped to the carcase to guide the router.*

Gouges are better. *You could make a template for the corner brackets, but if they have a cyma shape as this one does, you are better off doing the work with a firmer gouge.*

Two templates. *The flush pulls required two recesses. The first template made room for the pull's back plate. The second template made room for the part that shows. The shape was roughed out with a router and the work was finished with chisels.*

For use or show. *Campaign furniture is simple enough that it fits in with almost any home's decor, from Colonial to contemporary.*

ONLINE EXTRAS

For links to all online extras, go to:

- **popularwoodworking.com/aug12**

BLOG: *See an array of historical campaign chests with unusual drawer arrangements.*

VIDEO: *Watch a video of the author installing the L-brackets on this chest.*

BLOG: *The author reviews several brands of campaign hardware.*

HARDWARE: *The hardware used on this chest is from Horton Brasses. You'll also find a full range of excellent hardware for campaign-style pieces at Londonderry Brasses.*

TO READ: *"British Campaign Furniture" by Nicholas A. Brawer (check at your library).*

IN OUR STORE: *"The Joiner & Cabinet Maker," a British book that will introduce you to traditional casework techniques.*

Our products are available online at:

- **ShopWoodworking.com**


Keyed Miters


Turned


Finger Joints


Dovetails

4 Boxes, 4 Ways

The editors present some of their favorite designs.

Whether we spend most of our time building 18th-century highboys, production cabinetry or toys for our kids and grandchildren, we all build small boxes from time to time. Because we produce so many small offcuts of beautifully grained and highly figured woods, to do otherwise would be a shame. Building small boxes can be the mainstay of our shops – or simply a nice diversion from our usual work.

Often, a simple box can be made in just a few hours, either to break up the work on a more involved project, or simply to test our skills with a miniature masterpiece. Boxes can be customized for display, built to house jewelry, cigars or various keepsakes and collections. Plus, small boxes are lightweight, which makes them a nice respite if we've logged hours muscling larger timbers around the shop.

Most every woodworker has at least one go-to box design that he or she builds from time to time. And we could all use a few more to throw into the mix. What follows are four of our favorite small box designs – one from each of the *Popular Woodworking Magazine* editors. You'll find links to SketchUp models of each of these boxes on our web site, but feel free to mix and match our methods, and adapt the designs to suit. Building boxes of any shape, style and size presents a great opportunity for skill-building and experimentation.

BY MATTHEW TEAGUE, ROBERT W. LANG, MEGAN FITZPATRICK & STEVE SHANESY

LEAD PHOTOS BY AL PARRISH; STEP PHOTOS BY THE AUTHORS

Strong Miters

BY MATTHEW TEAGUE

Simple but handmade. *Curly maple sides are highlighted with contrasting walnut splines and a textured birdseye top panel.*

Almost every woodworker builds some variation of this simple mitered box. My version features corner joints reinforced with keys cut from a contrasting wood, and a raised-panel top that is textured along the edges – it's just enough handwork to give the box a tactile, personal touch.

Building the box is pretty straightforward. Start with a nice board and base the length and depth of the box off the width of your stock – I usually rely on golden rectangles or simple proportioning ratios: 1:2:3 or 3:6:12. This box is 3¼" x 5" x 8".

Take the time to make test cuts to ensure that you start with miters that are spot-on so the project will go together easily. So that the grain continues around the corners and wraps all around the box, keep track of the order of the sides by using tape or marking the pieces in order before you make the first cut. Cut the miters and then groove the top and bottom edges of the sides to capture the top and bottom of the box. I texture the edges of the top and finish both the top and bottom before assembly.

I assemble the box by simply taping the outside faces of the corners then spreading glue on the joints. Then I set the top and bottom in place, and roll the box up around them; the tape provides the clamping pressure. After the glue dries I use a keyed miter jig to cut slots in the corners to accept the keys. For more on making and using the splining jig, see Jig Journal on page 60.

Once the keys are installed, I cut the box apart at the table saw. I set the blade so that it's about 1/16" shy of the depth of the sides. After running all four sides through the saw I finish up the cuts with a backsaw.

The finish is one that I picked up from Jeff Jewitt years ago when I was looking at a dozen unfinished boxes that had to be delivered the next day. Jewitt refers to it as his "30-Minute Finish" – wipe on a light coat of linseed oil and rub it until it is dry. Immediately apply a coat of thinned shellac and finish up with a topcoat of wax. It's quick, easy and it looks good every time.

TEXTURED EDGES ON A RAISED PANEL

My favorite details are easy to create but have a big effect. The texturing on the edges of this raised-panel top falls into that category – at least to my eye.

I start by taking two passes on the table saw. The first is made with the blade angled 45° and the stock flat on the table. The second establishes the tongue and is made with the blade set to 90° and the panel held upright against a tall auxiliary fence.

The texturing is done with a gouge. Align the edges of the gouge with the top edge of the field and simply press down. Take the cut slow.When you approach the bottom of the angled field resist the urge to lever the gouge and transition to cut the flat tongue; leaving the tongue flat creates a cleaner look where the panel fits into grooves at the top of the box. If you want, you can even leave the tongue 1/32" or so fat until after the carving is done. Then give it one more pass at the table saw to trim away the U-shapes the gouge can create on the tongue.

It takes only a few minutes to get the hang of the process, but it's worth practicing on scrap. You can also experiment with gouges of different widths and sweeps to achieve different looks. Wider gouges or deeper sweeps often require two lighter passes for each hollow. — MT

Smooth motion. *Start at the field edge; take a light cut down the slope and ease up as you reach the bottom.*

Add depth. *Once the finish is applied, color variation creates interesting shadow lines and highlights a texture that begs to be touched.*

Fit to a Tea

BY ROBERT W. LANG

Small boxes can make everyday events special occasions, and they are an excellent way to explore design ideas. I had a purpose in mind when I designed this box: a container for tea bags. But I didn't want an ordinary box. I was curious about variations of shape and decided to apply a new shape to a familiar joint.

As I started to sketch, I decided to taper the sides in two directions. Finger joints that varied in size seemed a good fit, and leaving the ends of the joints proud of the adjoining surfaces added interest. The top-most finger became a place to locate a sliding lid, and I thought it would be clever to make the thing so that it wasn't obvious how it opened.

I set the dimensions from the inside out, starting with the envelope for our favorite tea and adding 1/4" to the width and the height. At the top I added 1/2" for the sliding top and some space above it. To keep the piece from looking top-heavy, I set the 1/4"-thick bottom in a rabbet (routed after assembly), flush with the bottom.

Nine inches seemed right for the length. To avoid clunkiness, I chose 5/8" as the thickness of the sides and ends, tapering to 1/2" at the top and bottom. The tapers begin at the top of the lowest finger.

I milled the parts from a walnut board, keeping the sides and ends in order and resawing the top and bottom. The joints look trickier than they are. They are made while the pieces are square.

After laying out the joints, I attached an L-shaped fixture to the sliding table on the table saw and installed a 1/4"-wide blade. I adjusted the height of the blade to the thickness of the pieces plus 1/8" from the horizontal part of the fixture. Then I passed that over the blade to leave a slot lined up exactly with the blade's location.

That slot allowed me to line up my layout lines and clamp the small parts to the fixture for cutting. I stuck the two short ends together with double-sided tape and after milling the joints, I used the ends to mark the joints on the longer side pieces. I then milled the sides and made a test assembly.

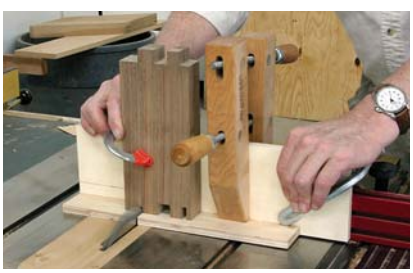
I marked the finger location on the end that opens, and I cut off the top with a dovetail saw to make a clean cut with a narrow kerf. I ran the groove for the top on the router table. The grooves run the length of the sides, but stop within the last finger on the short end. The top panel is glued to a stopped rabbet in the bottom of the pull.

With all the parts cut and fit, I laid out the taper on one of the side pieces. I tilted the table on the band saw to match the angle and removed most of the waste, then planed the surface smooth.

After tapering the sides, I reassembled the box and marked the angles on the end pieces. I placed a straightedge about 1/16" thick across the outside of the joints to mark the ends. I made the angled crosscuts on the band saw and cleaned up with a disc sander.

I eased the edges of the exposed joints and glued the box together, then planed a bevel on the bottom of the top panel to allow it to slide, and on the bottom of the pull until it would slide over the top finger with enough resistance to hold the lid in the closed position. The finish is sprayed lacquer.

Purpose-built. *This box was designed around its contents, and it takes a moment to discover how it opens.*



Careful aim. *The blade cuts a slot in the bottom of the fixture; use that to line up the cuts before clamping the parts.*

Lean on me. *Beveling the sides turns the square and mundane into a lively shape.*

Visual aid. *The line of the joint helps to reduce the visibility of the junction of the top and bottom.*

Period Pretty

BY MEGAN FITZPATRICK

I'm typically drawn to period work, from the Renaissance up to the early years of the Victorian era. So when I have to make something – anything – the first place I look is to auction catalogs to see if there's a period piece that inspires me.

I found a poplar grain-painted chest-on-feet online at Antique Associates at West Townsend (aaawt.com), and adjusted the dimensions a wee bit to better suit my eye and available stock. The sides are 5/8" x 6 5/8" x 9 1/2"; the front and back are 5/8" x 6 5/8" x 16"; the bottom is 1/2" x 9 1/2" x 16"; the lid is 3/4" x 9 3/4" x 15 5/8"; and the feet started out as 2"-square, 4 1/2"-long blocks.

Construction Details

The box is simply dovetailed together. I followed period joiners in leaving my layout lines (if that offends your sensibilities, plane or sand them off after the glue on the dovetails dries). While I don't typically obsess about perfect spacing of my pins and tails, in this case they're a major part of the design. So I marked a half-pin 3/8" up from the top and bottom on each end, then spaced the full pins at 1 1/2" intervals, and marked 1:8 slopes.

The bottom is then nailed on flush with the box edges using rosehead nails; these have relatively broad, flat heads to securely attach the bottom to the sides.

The lid is simply one piece of mahogany, with the two ends and front edge moulded by hand using a No. 10 hollow. (You can achieve the same look with a router and roundover bit, but I prefer to use moulding planes because there is little cleanup.) I added sliding-dovetail battens to the underside of the top to combat the almost-inevitable cupping.

To cover the seam between the box and the bottom, I used quarter-round moulding cut with a No. 12 hollow. I then wrapped and mitered the corners, added glue to the front piece and front 2" of the side pieces, and nailed the moulding in place flush with the bottom using standard "fine finish" cut nails.

The Feet

I turned a tenon on the top of each foot, then left a 3/4"-long square to form the foot block. The top of the block was undercut starting about 1/4" in from the edges, to allow it to easily sit flush with the box bottom. I turned the remainder round, then cut two beads under the block, a vase shape below, and what's basically a wee bun foot at the bottom.

In a larger piece, the feet would typically be attached to the bottom with wedged through-tenons, but in this case, the tenons interfered with the box walls, so I trimmed the tenons to about 1/4" in length, drilled corresponding holes in the bottom of the box bottom, then simply glued the tenons in place.

Hardware

The hinges are 6" iron strap hinges, set in 1/4"-deep mortises in the box back to accommodate the knuckle swing. They're screwed in place with black rosehead screws. I also installed a half-mortise lock and keyhole escutcheon.

After applying a coat of oil/varnish blend, I put the piece in the sun for a touch of tan, then I applied a second coat of oil-varnish blend and buffed on a topcoat of paste wax.

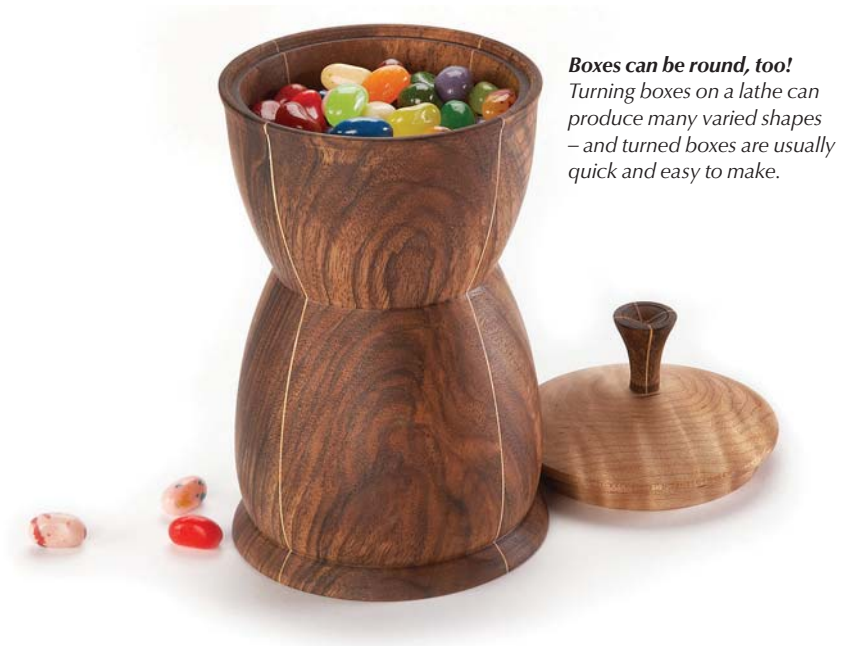
Hand-cut moulding. *Cut a chamfer to remove the bulk of the waste and create a flat at the apex of the hollow moulder's iron, then run the moulding plane along the stock until you've created the desired ovolo.*

Stub tenons. *The feet are installed flush to the box edges with glued-in stub tenons fit into corresponding holes in the box bottom.*

Traditional approach. *Period details pop without 300 years of patina to mask them.*

Turned & Delicate

BY STEVE SHANESY



Boxes can be round, too! *Turning boxes on a lathe can produce many varied shapes – and turned boxes are usually quick and easy to make.*

A box is a popular item in the world of turning. And as for our woodworking brethren in the "square and parallel" universe, the inspiration for a box may often begin with a small piece of special wood.

And so it was with my box project. I'd been hoarding a small chunk of walnut for several years. It was just thick enough at 4" square and about 8" long.

And like so many works that come off my lathe, the wood dimensions suggest the overall shape and size of the piece. I decided to add the delicate and contrasting maple detail for ornamentation. The vertical lines were added by sawing the block in half, gluing it back together with a piece of maple veneer between, letting it dry, then repeating the process so the veneer formed four quarters within the block.

To turn the walnut portion, including the knob on the figured maple lid, I formed the outside shape with the blank mounted between a spur drive center and live tail center. Then I added a dovetailed tenon at the base so I could change workholding to a four-jaw scroll chuck. That allowed me to hollow the inside.

With the base in the chuck, I finished up the knob and included a small tenon for gluing it into the maple lid later. Then I parted the knob off.

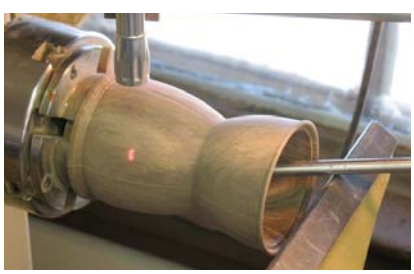
Turn the outside. *The first step is turning the outside shape with the blank mounted between a spur center and a live center in the tailstock.*

Hollowing the upper portion of the base was easy because the mouth is wide and the outside shape is easy to follow; below the waist it's tricker. That's why I switched to a setup that feels a bit like cheating – a rig that has the hollowing tool set up with a small laser attached above it. You simply set the laser to project a light just off the tip of the cutting edge. When the laser beam starts to trail off the outside edge of the work, you know you've hollowed to the wall thickness you want. For this box, that's about $^{3}/_{16}$".

I sanded the piece on the lathe from #120 up to #320 grit.

The lid is made in much the same way, starting with the work between centers. In this case, I formed the inside shape, a center dome area with a lip cut at the outside perimeter. But instead of changing to the four-jaw chuck, I made what's called a jam chuck. A jam chuck is a piece of waste wood slightly hollowed to the exact size of the step in the lid's lip. The lid is held in the jam chuck by virtue a tight friction fit.

The outer domed shape of the lid was quickly turned and sanded, then I drilled a hole in the center for the knob's tenon. After gluing the knob in place, I finished the box with a couple applications of boiled linseed oil. **PWM**



Hollow the inside. *A laser (note the red spot on the side) tracks the location of the tool deep inside the box and makes it simple to hollow.*

All jammed up*. Once the lid's inside is done, the lid is mounted in a jam chuck to turn the outside.*

ONLINE EXTRAS

For links to all online extras, go to:

- **popularwoodworking.com/aug12**

BLOG: *View a series of step photos that show how to assemble a solid box then cut the top off using the table saw.*

IN OUR STORE: *"Box Builder's Handbook," by A.J. Hamler.*

Our products are available online at:

- **ShopWoodworking.com**

A Trio of Trifids

BY CHARLES BENDER

Three variations on a carved foot offer high style.

Access to information provides the modern woodworker with greater variety, and it challenges their skills more than their 18th-century counterparts. When we consider how fashion-conscious both producers and consumers were in the 1700s, it's truly amazing to think how quickly the word spread of stylistic changes such as cyma-curved backsplats in chairs, cabriole legs and ball-and-claw feet.

Over the course of a few decades, furniture construction methods and aesthetics shifted between simple, unadorned pieces to richly carved and decorated pieces – then back again. Even with all this tumult in the furniture fashion world, period cabinetmakers were limited by regional taste and tradition.

While they may have known about ball-and-claw feet, per se, they may not have understood the regional variations that took place between areas such as Boston, New York and Philadelphia. Fashion changed from the rigid Jacobean to the more curvilinear William & Mary style and, eventually, to the dainty, feminine style of Queen Anne. Throughout the Colonies, cabriole legs were all the rage. Pad feet ran rampant – everywhere except in Philadelphia and its surrounding environs.

A great influx of Irish cabinetmakers and carvers brought with them a foot design that would dominate the Philadelphia Queen Anne style: the trifid foot. Pad feet were made in the region but no other foot design caught

PHOTOS BY THE AUTHOR

the ever fashion-conscious consumer's eye like the trifid foot. An outgrowth of the pad foot, a trifid foot is elegant yet simple – which played well with local Quaker sensibilities.

Carvers divided a pad foot into three distinct toes creating a more "naturalistic" looking foot – so much so that trifid feet are also called "drake" feet (after the male duck). The style sense was shifting from the rigid toward the rococo. Having furniture with more "realistic" carving adorning it was quickly becoming the height of fashion. Trifid feet filled that need in the greater Philadelphia area unlike any other. The simple fact is that even though trifid feet were extremely popular in Philadelphia and England, they just never really caught on much elsewhere else in the Colonies.

Trifid feet are as varied as the consumers who coveted them. They can be clubbish or delicate and elegantly carved. They can have well-defined toes or be far more abstract. They can be cuffed, stockinged or plain. I'm sure that if cabinetmakers throughout the Colonies had the same access to the variety of trifid feet we have today, the feet would have been far more popular in many areas of the country.

From One, Many

In the 1720s and '30s the cabriole leg was rapidly becoming the height of fashion. Furniture to this point had been primarily the playground of the joiner and turner. As the cabriole leg came into vogue, the turners kept their hand in furniture making by creating pad feet. And while there are a few variations on that theme, for the most part, one pad foot looks much like any other.

Looking for ways to set their work apart from one another, craftsmen of the 18th century added their own flair to cabriole legs. Some of the simplest versions were really no more than the cabriole leg cut out and shaped smooth. And while that simple look may have been appealing to certain clients, it certainly wasn't the look that everyone coveted. Also, it didn't give the rising class of carvers a chance to show off their skills.

Once carvers took over the block feet of a cabriole leg, it wasn't long until there were a multitude of trifid foot variations. The first trifid feet were little more than the block foot with three defined toes – and even with just three toes there can be variations. The toes round over into one another creating line divisions between them, or hollow valleys can be carved between the toes to give them a more separated look. The edges of the toes can be sharp or rounded off, or even a combination of the two.

In an effort to further distinguish the toes of the trifid foot, carvers began defining them through the ankle and up the leg, essentially creating webbing between the toes. Sometimes this webbing was squarish in nature and other times it was a hollow. Either way, this extra definition gave the feet greater visual punch by creating more areas of reflection and shadow.

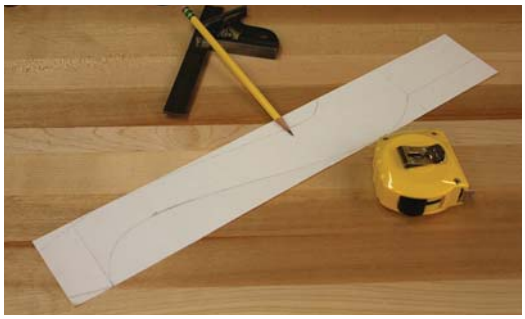
Although the majority of 18th-century carving on American furniture isn't very deep, it creates surfaces that capture and reflect light to impart depth and interest. The appearance of unwebbed trifid feet is much flatter. By adding webbing, the carver adds interest and depth to the entire foot.

In yet another example of the carver's efforts to create more light and shadow lines, some trifid feet had a cuff line added. These cuff lines defined the end point of the webbing just above the ankle. They are also sometimes referred to as "stockinged feet." The cuff not only adds another shadow, but gives the leg a visual transition between the ankle and the calf of the leg, thus accentuating the foot even more.

The Beginning

The making of a trifid foot is fairly simple. The bulk of the work happens when shaping the cabriole leg. Proper planning of your pattern prevents improperly proportioned trifid feet from plaguing your furniture designs. If we begin with the simplest version of a trifid foot, I'm sure you'll see how minor changes in the sweep of the leg can dramatically affect the look of the foot. This foot truly leans toward the simple Philadelphia Quaker taste.

SHAPE A CABRIOLE LEG

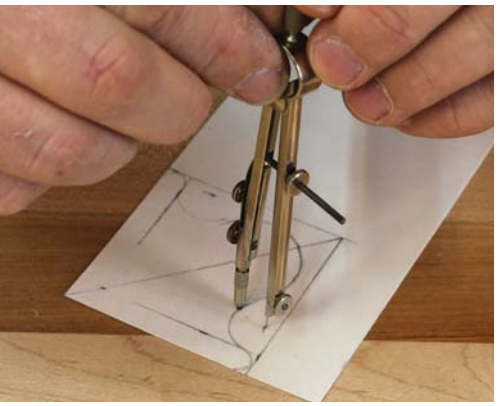


Draw the pattern. *The cabriole-leg pattern doesn't vary much from a pad-foot pattern.*

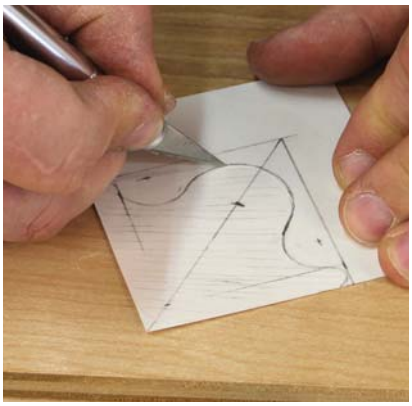
Cut the leg. *Cut out the cabriole leg using the method you like (my "Cabriole Legs Simplified" DVD offers good instruction).*

Refine the shape. *Smooth, shape up and refine the curves on the leg using a spokeshave.*

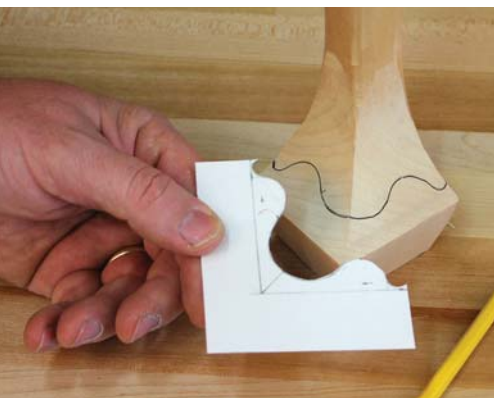
LAY OUT THE FOOT



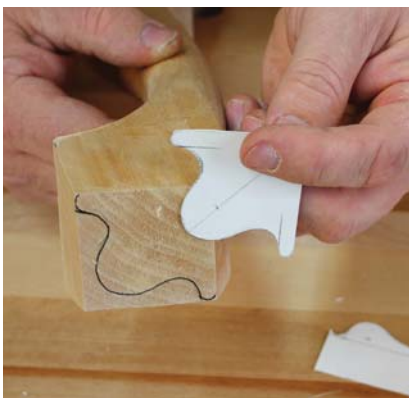
Draw a pattern. *Draw a diagonal line from the back of the foot pattern to the toe, then strike the arcs for the toes.*



Cut it out. *Cut out the patterns carefully. An X-Acto knife is ideal for the task.*



Now the negative. *Use the larger negative pattern to mark the top of the foot.*



Foot bottom. *Draw, cut out then mark the smaller pattern on the bottom of the foot.*

It all begins with the pattern for the cabriole leg. For most chairs and tables, I begin with 2¾" stock. The pattern should not vary too much from that of a cabriole leg with a pad foot. The main difference comes in how far down the toe of the pattern is swept. While there is variation amongst feet, the most delicate looking have the toe of the pattern swept down a good bit thinner than your standard pad foot. I usually start somewhere around 1¼" in height. The best trifid feet are smaller at the point where they touch the floor than they are at the top of the toes.

Cut out the cabriole leg blank the same way you would for a pad foot leg. The point where the pattern exits at the top of the toe should be about 2⅜" square. The foot should angle back so that the bottom of the foot is about 2" square. When you're finished you should have a leg with a square block foot. For this first foot you need to decide if you want the toes separated by division lines or hollows. Either way, we're going to need two patterns in order to lay out our feet: one for the top of the foot and a smaller one for the bottom. I'm going to show you how to lay out the foot where the toes are separated by hollows; the other two trifid feet in this article will be based on that same basic design.

To draw the patterns I usually begin with cardboard or poster board. Draw two squares: the first should be 2⅜", and the second about 2" square. At the top of our foot the outer two toes will be about 5/16" in width. The center toe will be about 1¼" in width where the convex portion ends. On the bottom of the foot, the outer two toes will be about ¼" in width and the center toe will be about 1" in width where the convex portion ends. In order to make sure both patterns are symmetrical, start by drawing a diagonal from one corner of the pattern to the other.

On Your Toes

It's time to begin laying out the toes. I usually start with the larger pattern. Lay out two lines parallel to two adjacent sides that are 5/16" from the outside of the pattern. These lines represent the width of the outside toes. In fact, two half-circles can be drawn at the outside of the patterns within the 5/16" space for the toes. From the back corner of the foot, along the diagonal line, mark a point at 2½". This will become the centerpoint of the central toe. With a compass set at ⅝", strike a half-circle from that centerpoint on the diagonal line.

Mark two centerpoints ⅛" from the front edges of the pattern that are 11/16" from the back edge of the foot. With the compass set at 7/16", strike the two concave lines that will separate the three toes. The toes should flow smoothly from the outside toes through the middle toe. Because the arcs do not meet, you'll need to sketch them in so the lines flow together.

The next step is to cut out the pattern. With this upper pattern, we'll be saving and using the outside of the poster board. The inner portion will be discarded because there is no way to transfer the pattern to the actual foot. In essence, we've created a negative pattern.

The lower pattern is created in much the same way. We begin by striking two lines on adjacent edges of the pattern that are ¼" from the outside of the pattern. Draw in the diagonal line from the back corner of the foot to the front corner. Along that line, plot a point that is 1 11/16" from the back corner. At that point, with the compass set at 9/16", draw a half-circle. These arcs should meet but you still may have to modify the area where they come together to get a good flow. Cut out this pattern the same way as the upper – but we're going to use the positive pattern this time.

Begin by placing the bottom pattern

on the bottom of the leg blank and trace it off. This becomes the line to which you will carve the bottom of the foot. Along the back edge of the foot, mark points 2 3/8" from the heel of the leg. These become the alignment points for our pattern. Taking the negative pattern for the top of the foot, line it up with the marks you just made and trace off the pattern.

This will be the general shape for all three feet we'll be carving. The tools necessary for carving most trifid feet are: a 5/16" bench chisel; a 1 1/2"-wide (or as wide as you have) bench chisel; a 20mm No. 5 gouge; a 10mm No. 8 gouge; a 15mm No. 7 gouge; a 12mm No. 9 gouge; and a 6mm No. 15 V parting tool (a No. 12 would work as well).

Begin by knocking off the toe with your wide bench chisel. I follow this by inverting a 20mm No. 5 gouge to shape the front toe. It's as easy as connecting the upper and lower lines on your foot. With the 12mm No. 9 gouge, begin to hog out the waste between the toes. Once you get close to the lines, you'll switch to one of the other gouges to smooth out the surface of the curve. Round over the vertical ends of the outside toes and we've nearly finished the first trifid foot.

> "I can't be funny if my feet don't feel right."
>
> — *Billy Crystal (1948-)*
> *American comedian*

Mark from the bottom of the foot up between 1" and 1 1/8" to establish the thickness, or height, of the foot. I used a spindle sander to knock off the bulk of the material above my line then moved right to my wide bench chisel to finesse the surface to the line. I finish using a spokeshave to smooth out the chisel marks. A little sanding and the basic trifid foot is complete.

Hollows: a Lasting Impression

While the basic foot adds interest compared to a pad foot, it still lacks the facets to create light and shadow. To give the basic foot a bit more punch, let's define the toes a bit by adding some simple webbing.

Begin by carving the basic foot then measure and mark a centerline from the front toe through the ankle of the leg. This will be the base of our center toe. Using my finger I extend the line of the outer toes up the ankle of the leg. This line is about 5/16" from the back edge of the foot. Using my centerline as a reference, I draw the outer lines of the center toe webbing so that the center toe flows in a smooth taper from the front of the foot to the ankle. The webbing area between the toes may need to be adjusted slightly to keep a pleasing flow. I usually do this by cheating the outer and center toe lines in or out just a bit to give the foot a pleasing appearance.

In between the toes, I usually sketch in an approximate depth of the webbing by bringing it down to the line that established the thickness of the foot. Taking the 12mm No. 9 gouge, hollow out the webbing area to the lines. You'll want to fade out the carving as you

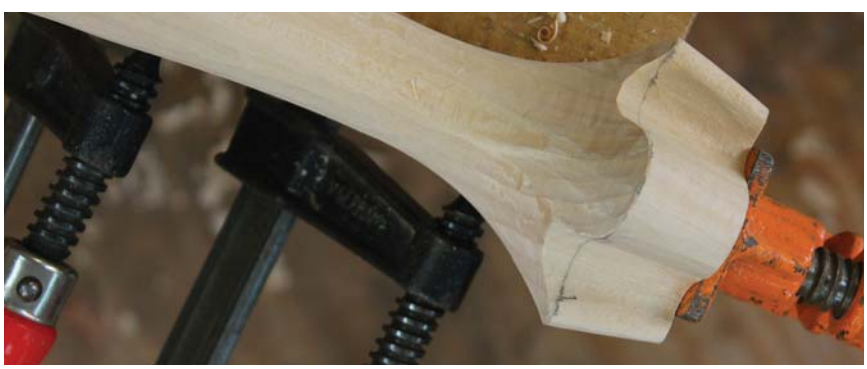
VARIATION ONE: SIMPLE TRIFID FOOT

Middle toe. *Invert the 20mm No. 5 gouge to shape the front toe.*

Toe jam removal. *Use your 12mm No. 9 gouge to remove the bulk of the waste between the toes.*

Curve. *Round over the hard edges of the outside toes.*

Height. *After marking off the height of the foot at about 1 1/8", use a bench chisel to bring the foot to final height.*



Foot one. *The simple trifid foot – the basis for variations two and three – is now ready for sanding.*

VARIATION TWO: WEBBED TRIFID FOOT

Finger guide. *Use your finger to extend the toe line up through the ankle of the leg.*

Upper marks. *Using poster board as aflexible straightedge, mark the upper portions of the center toe.*

Cove. *Mark out the cove for the webbing between the toes.*

Carve. *Using a 12mm No. 9 gouge, carve to the lines.*

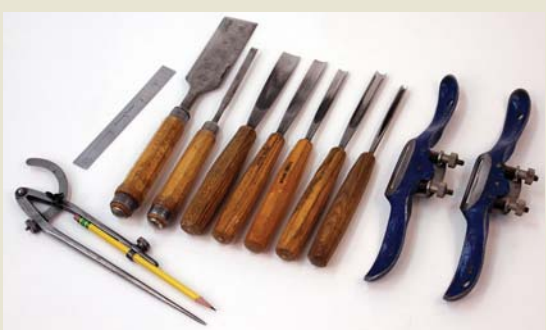
Foot two. *The webbed trifid foot variation is now ready for sanding.*

THE NECESSARY TOOLS

From left to right:

- compass for drawing the arcs
- ruler for measuring the various centers of the radii necessary to lay out a trifid foot
- wide bench chisel for rough and fine shaping of the calf ankle and foot of a cabriole leg
- narrow bench chisel for carving and defining the webbing between the toes of a trifid foot
- 20mm No. 5 gouge for shaping the center toe
- 15mm No. 7 gouge for smoothing the concave areas between the toes
- 10mm No. 8 gouge for defining and shaping the area between the toes and the webbing
- 12mm No. 9 gouge for roughing out the concave areas between the toes
- 6mm No. 15 V parting tool for defining the cuffs and the webbing
- flat-face spokeshave for shaping the cabriole leg
- round-face spokeshave for refining and shaping the ankle and the transition between the calf and stocking

— CB



move from the foot to the ankle. The transition between the ankle and the webbing should be defined but fairly shallow.

Round over the top of the center toe a bit with a wide bench chisel. You might also need to refine the shape of the outer toes a bit to give the ankle a good flow. A little more sanding and you've completed another variation of a trifid foot.

Stockings add Style

For the final variation, we again begin with the basic foot. Establish the centerline as in the last example then draw in all three toes up to the ankle. Coming up off the bottom of the foot $4\frac{3}{4}$", draw in a cuff, or division, that will accentuate the transition from leg to foot. This is usually done by flowing convex lines where the toes are into concave lines at the top of the webbing. I usually give my cuffs about $\frac{3}{16}$" of rise or fall.

VARIATION THREE: CUFFED TRIFID FOOT

Establish the cuffs. *Draw in the cuff and put convex lobes over the toes and concave lobes over the webbing. Then use a V parting tool to carve in the cuff.*

Transition. *Use a bench chisel to flow the leg into the cuff.*

Define lines. *With a V parting tool, carve in the toe and webbing dividing lines.*

Refine lines. *Use a small bench chisel to shape and define the webbing.*

Even it out. *Use a wide bench chisel to round over the center toe and even out the depth of the webbing.*

Foot three. *Here's the third, cuffed, variation on a trifid foot, now ready for sanding.*

Using a 6mm No. 15 V parting tool, carve along the cuff line about 1/16" deep. You'll need to fade this cut out at the beginning and end of the cuff for an elegant look. Then, using a wide bench chisel and a spokeshave, flow the calf of the leg into the cuff.

Using the V parting tool, carve along the toe lines to separate the toes from the webbing. This cut should be about 1/16" deep along the entire length of the line. With the 5/16" bench chisel, carve out the webbing. Between the toes, the webbing should have a slight convex arch.

As the webbing moves up the leg, it eventually flows out through the cuff and blends with the calf of the leg. I primarily work with the chisel held bevel down to help control the depth of cut. Round off the central toe and trim the outer toes to give the leg a nice flow.

A little sanding, and the third variation of a trifid foot is complete.

No Limits

Trifid feet were my primary diet of carving early in my career. At the time, I dreamed of carving ball-and-claw and hairy-paw feet. Trifid feet were rather plain to my eye because the shop in which I worked sold only one or two styles. As my study of period furniture progressed, and I saw so many variations, I came to truly appreciate the grace and beauty of the nearly infinitely variable trifid foot. Let your imagination take your trifid feet in different directions. Who knows, maybe you'll start the latest furniture fashion frenzy. PWM

Charles is a renowned period furniture maker and the lead instructor at Acanthus Workshop in Pottstown, Penn. (acanthus.com).

ONLINE EXTRAS

For links to all online extras, go to:

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Stickley Book Rack

BY ROBERT W. LANG

Expose your joinery skills with this Arts & Crafts classic.

In the early 1900s, furniture maker Gustav Stickley began producing a unique style of furniture that he called "Craftsman." At the time, the world was coming into the modern industrial age, and Stickley, among others, began to question the value of mass-produced furniture and its effect on those who made or owned it.

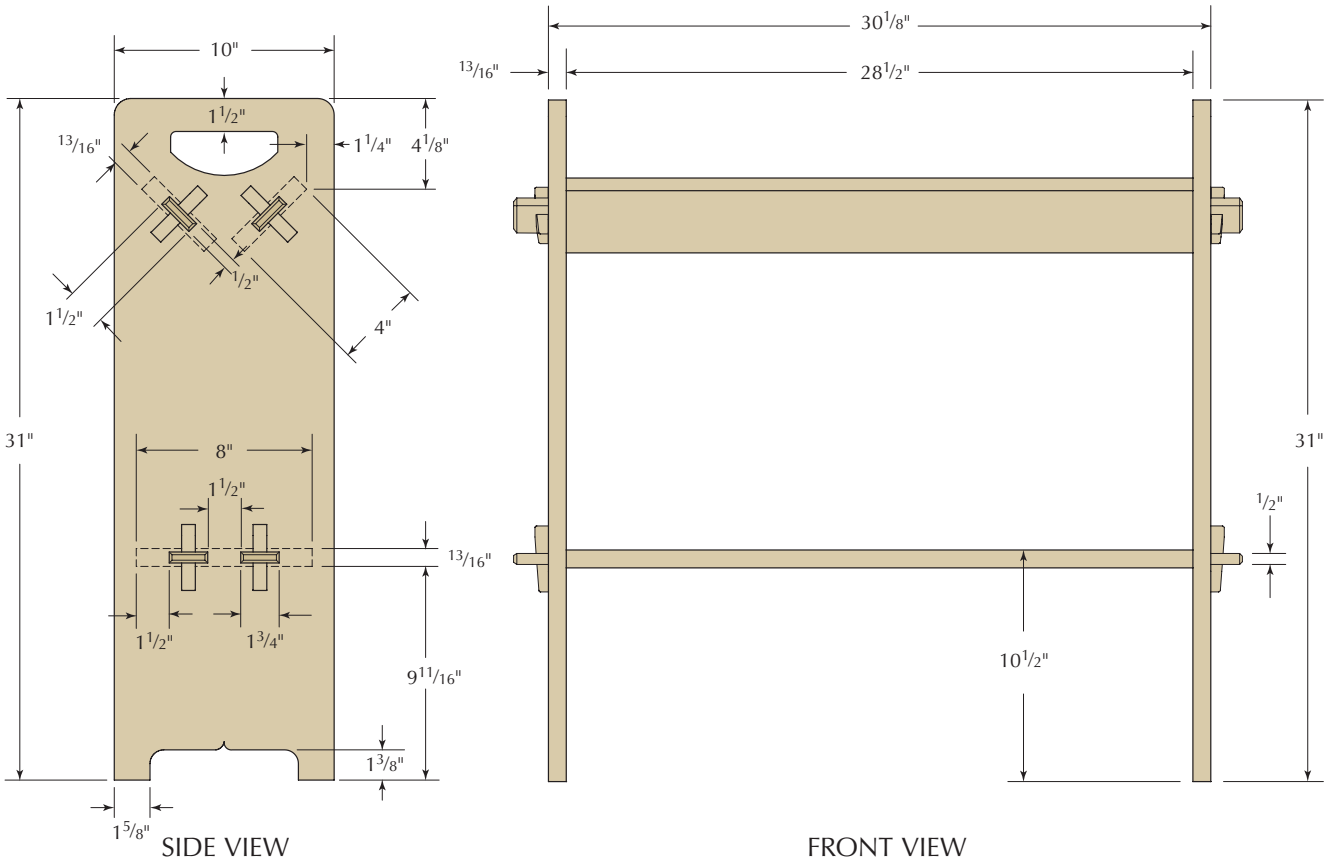
Victorian furniture featured many machine-made elements that sought to mimic the handwork of earlier times. In most cases these adornments detracted rather than added. Just because machines could produce intricate imitation carvings and mouldings didn't mean that they should. Stickley decided to get back to basics.

This simple book rack is a good example of the style. The joinery, along with the character of the quartersawn white oak, becomes the decoration. Function comes first, and the form is a combination of nice wood, good proportions and honest joinery.

Making this piece is like going to Craftsman boot camp. You'll get to know the nature of the wood and how to make exposed joints. It's not a big piece, but there are enough joints and details to provide plenty of practice.

Craftsman furniture was factory made, but Stickley's aim was to use machines to save the workers from drudgery while providing room to display skilled workmanship. At the time, most of the machines we know today were in common use, but the subtle details that make this piece special have to be completed by hand.

LEAD PHOTO BY AL PARRISH; STEP PHOTOS & ILLUSTRATIONS BY THE AUTHOR



We have the choice to work by hand, work by power or work with both. If we understand where each method excels – as well as where each falls short – we can master both sides and produce furniture we're proud of, without taking forever to make it.

Precision & Productivity

The heart of this piece is the keyed through-mortise-and-tenon joinery. There are eight of these joints to make, each with two through-mortises. One of the givens in this type of work is consistency, and the electric router, combined with the precision of a template, provides that.

I print a full-size pattern of the side profiles and joint locations, and attach the prints to a piece of 1/2"-thick Baltic birch plywood with spray adhesive. These patterns are available online in PDF format. You could do all of the layout by hand, but using the pattern is faster and more accurate.

I use a straightedge and an X-Acto knife to mark the lines of the mortises from the pattern. Then I remove the pattern, drill a 7/16"-diameter hole at each mortise location and place double-sided tape over the lines. That allows me to place small pieces of plywood along the lines. The adhesive is pressure-sensitive, so I smack the pieces with a mallet to fix them in position.

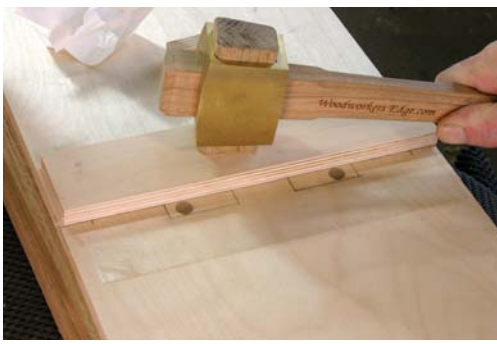
With the pattern pieces in place, I use a 3/8" bearing-guided flush-trim bit to cut the openings exactly on the layout lines. After routing, I peel off the pattern pieces and remove the residue left by the tape with lacquer thinner.

The router makes straight and parallel edges, but leaves round corners that must be squared with a chisel. To make the D-shaped handle opening at the top of the pattern I drill a hole at both ends of the top edge, and cut the curve with a jigsaw. The edges of this opening are then cleaned up with a rasp.

Why bother cleaning up the corners of the template when the router will also leave round corners on the workpiece? The router does a good job of making straight edges, but can tear out the solid wood. I score the grain on the work with a knife and a chisel to prevent that.

I cut the sides to finished size and

MAKE THE TEMPLATE



Don't cut, assemble. *Small pieces of plywood, attached with double-sided tape, will be added to surround the opening.*

Cut above. *Routing around the pieces cuts the template exactly like the drawing.*

then make a rough cut with the jigsaw at the top opening to lessen the load on the router and bit. Then I clamp the template to the side, and clamp both to an open-ended box on my bench. This holds the work at a comfortable height and I run the router around the inside perimeter of each opening.

Chisel Time

After the noise and flying chips of routing, cleaning up the corners with a chisel and float is a nice change of pace. I hone a fresh edge on a wide chisel, and place the flat back face on the long routed edge. Then I rotate the chisel down and into the corner to begin the squaring process. This keeps the chisel from drifting past the layout lines as I make the cuts.

> "…One element does not strike a note of luxury discordant with a neighboring element of extreme simplicity."
>
> *— Harvey Ellis (1852-1904)*
> *American architect and artist*

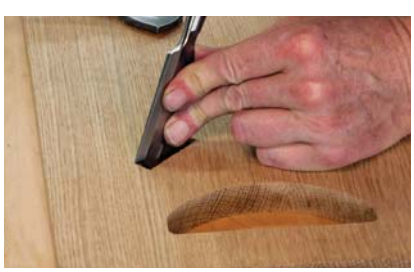
I alternate cuts with a chisel that matches the width of the mortise and the wide chisel until the corners are complete. All of this takes place with the outside face of the side facing up. Any tear-out or chips will be hidden by the shoulder of the tenoned shelf.

CUT THE MORTISES

Score first. *Prevent tear-out by scoring around the openings before cutting with the router.*

Saw first, then trim. *Cut close to the lines with a jigsaw and use the router to trim the opening at the top.*

On top. *Positioning your shoulder over the chisel allows you to use your body weight to pare the end of the mortise.*



Swing it. *Press the back of the chisel against the mortise wall, then rotate the edge down to the corner to maintain a straight edge.*

A flat float is used to put the finishing touches on the mortises.

All in a Row

After cutting the three shelves to finished size, I place them beside each other on the bench and mark all of the shoulders at once using a large square. This ensures that the distance between the shoulders is consistent. Then I take a smaller square with a metal rule and knife in the shoulder lines all around each piece.

In theory, the mortises are all exactly 1/2" wide, but in reality there will be some variation. I place the end of one of the narrow shelves next to a mortise to gauge the width directly from one part to the other. I set the shelf end on one long edge and mark where the other edge of the mortise hits.

I set my marking gauge by eye to the middle of the distance from the pencil mark to the edge of the shelf. I then mark with the gauge from opposite faces of the shelf, and make any needed adjustments until the tenon layout matches the mortise. When I have the setting right, I mark around the ends of the tenons with the gauge.

This seems like extra work, but the cut layout lines won't rub off, and they help to prevent tear-out as the tenons are cut and fitted. The layout marks will be the visible edges when the joint is finished. Tenons look simple, but there are several cuts to be made.

I cut the shoulders with a backsaw. The shoulders are only about 1/8" deep, and a fine-toothed saw leaves a nice, clean edge. There are a several ways to make the cheek cuts, and on the narrow shelves the cheeks could be cut on the band saw.

Stickley No. 74 Book Rack

NO.	ITEM	DIMENSIONS (INCHES) T	W	L	MATERIAL	COMMENTS
❑ 2	Ends	13/16	10	31	QSWO*	
❑ 1	Lower shelf	13/16	8	33 5/8	QSWO	1 3/4" TBE*
❑ 2	Upper shelves	13/16	4	33 5/8	QSWO	1 3/4" TBE
❑ 8	Keys	5/8	5/8	5	QSWO	Trim after fitting

* QSWO=Quartersawn White Oak, TBE=Tenon Both Ends

MARK OUT THE TENON

On your mark. *Use the mortise to determine the exact thickness of the tenon.*

Get set. *Set the gauge to half the distance between the pencil line and the edge.*

Check & go. *Mark from both sides to center the tenon and adjust until the parts match.*

The cheeks on the lower shelf are too wide for a small band saw, so I remove the material with a straight bit on the router table. This leaves a consistent flat surface across the wide board. These tenons need to fit neatly, but one of the challenges is that the last cut is the visible surface in the finished piece. I rout close, but fine-tune the fit by hand.

A Different Rout

I begin the setup by raising the top of the bit to the bottom of the layout lines on the ends of the shelves. There is some trial and error here, so it is best to begin with a fat tenon, then make minor adjustments until the machined corner of the tenon will just fit in a mortise. Adjustments to the cut are tiny, because the cuts are made on both sides of the piece. The difference is twice the amount of the height adjustment.

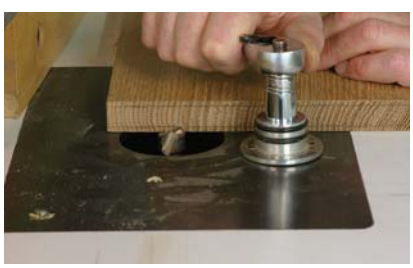
I set my combination square to the distance from the end of the tenon to the shoulder, then use the square to set the router table fence. I've already made the finished shoulder cut, so I set the router bit to just meet the saw kerf. The first pass is made with the end of the board against the fence. I use a wide backing board to push the material across the bit and move the board out with each pass.

When the cheeks are the proper thickness, I place the end of each shelf on end next to its mortise. I mark all the joints with a lumber crayon so that I keep the arrangement of the parts the same as I fit each joint. I mark the end cuts with a pencil, then use the combination square to carry those lines back to the shoulder.

I make the tenon end cuts for the narrow shelves with a band saw, and stop just before the blade reaches the edge of the shoulder.

On the wide shelf, material between the two tenons must be removed. I

CUT THE TENON



Rise to the challenge. *Set the cutter to the bottom of the layout line.*

Got your back. *Use a wide block to move the narrow shelves across the router bit.*

Stop in time. *Cut the end of the tenon, but stop just short of your shoulder line.*

Now you know. *Aim for a snug fit by testing a corner of the tenon in the mortise after routing the cheeks.*

From the source. *Mark the ends of the tenons directly from the mortises.*

Ease in. *Bevel both the ends of the tenons and the edges of the mortises for fitting.*

Off the top. *The pencil marks indicate the high spots. Remove them with a float, then test the fit again.*

make a rough cut at the band saw, and aim wide on these cuts so that when I remove the band-saw marks I don't end up beyond the layout lines. I set a guide bearing on a flush-trim bit in the router to ride on the pre-cut edge of the shoulder and use the router to clean up the junk between the tenons back to the shoulder line.

Fit to be Fit

In a perfect world, the tenons would slide neatly into the mortises at this point, and I would move on to the next step. In real life, however, it isn't that easy. There needs to be a slight amount of clearance to assemble the joint, but not so much as to leave a visible gap on the outside. The prudent course is to make the tenon just a bit big, then reduce its size in controlled, small amounts.

Before fitting the joints, I take a chisel and bevel both the ends of the tenons, and the inside edges of the mortises. This makes it easier to slide the tenons in, and it prevents the hard edges of the tenons from breaking the edges of the mortises as they exit.

I start with the narrow top shelves with the single tenons, and I push the piece in as far as I can. I remove the tenon and look for dents or shiny spots that indicate where material needs to be removed. It's easier to remove material from the tenon, and depending on how much needs to be removed I will use a chisel, shoulder plane or a float.

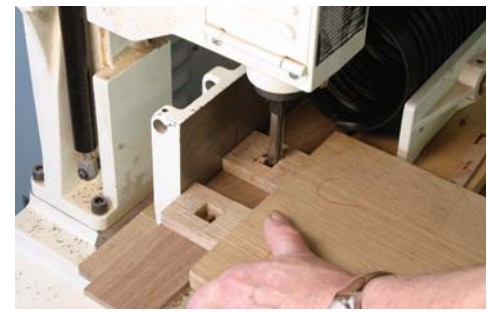
Before the second attempt at fitting, I take a soft pencil and make hatch marks on the tenon. Then I shove the pieces back together. The pencil marks smear on the high spots, and I'll work on those with the float. The mortises shouldn't need any work, but sometimes there will be a bump on the inside walls that has to be removed, so I always take a good look at both parts of the joint.

It's tempting to break out the mallet and start pounding away, but it is safer to work on the joints with hand pressure only. Banging can split the side piece, especially if it has been glued up from narrower pieces and is weak near the opening at the top.

The lower shelf is worked the same way, but it is trickier to fit both tenons at the same time. Each round of fitting and trimming requires some detective work to find out exactly what is keeping the joint from going home. When all the tenons have been fit, the shelves should fit snug and square.

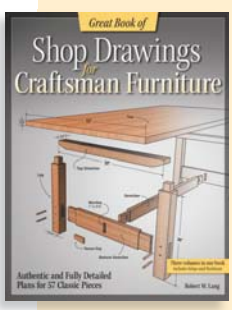
Mortises, Take Two

I lay out the secondary mortises by marking the outside of the upright on the tenon. Then I set my combination square to leave a $\frac{5}{8}$" opening when marked from each side. Then I make a mark $\frac{9}{16}$" away from the upright, parallel to the first mark.



Back it up. *A thin piece of scrap under the tenon provides support when making the second mortise.*

SHOP DRAWINGS FOR CRAFTSMAN FURNITURE



In 2001, my first book, "Shop Drawings for Craftsman Furniture," was published by Cambium Press (now Fox Chapel). I had been a fan of Gustav Stickley designs since the start of my woodworking career, and I was tired of seeing misguided interpretations and watered-down imitations of this wonderful furniture presented as authentic.

My idea was to show detailed drawings of original pieces, along with text pertinent to making good reproductions, and a brief history of those who made the originals. That book was a success, and it was followed by "More Shop Drawings for Craftsman Furniture" and "Shop Drawings for Craftsman Inlays and Hardware" (both from Fox Chapel).

Those three books are now combined in a new, single edition titled "Great Book of Shop Drawings for Craftsman Furniture" (Fox Chapel). The new book contains all of the drawings for 57 different pieces of furniture from the original books, drawings for authentic hardware and the inlay designs produced for Gustav Stickley by Harvey Ellis. The introductory text has been combined and updated and there are many new photos of both vintage pieces and the steps for making reproductions.

If you're among the many woodworkers who enjoy this style of American furniture, this is a comprehensive resource for understanding these designs, and building pieces of your own. — RWL

Angle by eye. *Use a chisel to taper the end of the mortise for the wedge.*

Just behind. *The square end of the mortise lies behind the face of the side to allow the wedge to seat tightly.*

Fit first. *Leave the wedges long until they fit nicely in the mortises, then mark and cut them to length.*

The mortise is initially cut at 5/8" square, with the inner edge set 1/16" behind the outer face of the upright. This ensures that the wedge holds the joint tight, no matter what kind of swelling or shrinking may take place over time. The mortise can be cut with one pass of a 5/8" hollow-mortise chisel, or four passes with a 3/8" chisel.

Cut a piece of scrap to match the height of the shoulder so that the tenon isn't hanging in space at the mortise machine. Set the fence of the machine to the exposed outer end of the mortise and make the cuts. Reset the fence to cut the back edges. The outer edge of the mortise is angled by hand to match the angle of the wedge.

I don't worry about the angle; I make a sloping cut that starts 1/16" away from the layout line. I mark the line, then press my chisel against the wall of the mortise and swing the edge down to the corner. Then I stand facing the tenon, put the edge of the chisel on the line and angle it back by sighting down the back of the chisel to the edge of the mortise below.

After tidying up the edges of the small mortises, I cut 5/8"-square pieces a few inches longer than needed for the wedges. I carry the layout lines from the mortise to an edge of the tenons, and mark the slope on each wedge from the marks on the tenon. I make the angled cuts on the band saw, then remove the saw marks with a few swipes of a block plane.

The wedges are seated by tapping them gently with a mallet. The sound changes when they are tight. If you hit the wedges too hard, it's easy to break out the end of the tenon. Should that happen, the broken piece can be glued back in place.

When the wedges fit nicely, I mark an equal distance above and below the tenon, and cut them to length. I make a discrete mark on both the wedge and the inside of the mortise so the wedges will go back in the same holes to which they were fit.

Hard & soft*. Edges on the tenons and keys are beveled, but they fade away to leave clean lines at the joints.*

After Everything Fits

After completing the joinery, the book rack is taken apart for finishing. All the parts are exposed, and need to have the edges eased and surfaces smoothed. The curved portions of the cutout at the top and the scroll at the bottom of the sides are smoothed with rasps.

I put a slight bevel on the edges of the shelves and sides using a block plane for the long edges and a fine rasp for the curved parts. I remove any mill marks from the faces of the boards with a smooth plane. The ends of the tenons and the wedges are also eased, starting where these pieces exit their mortises. The chamfers on these edges gradually increase the farther away they get from adjacent surfaces.

Original pieces were ammonia-fumed, then shellacked. I used a combination of oil stain, walnut Danish Oil and shellac for a similar look. **PWM**

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Rule Joints: by Hand & by Power

BY WILLARD ANDERSON

No matter how you cut them, understand their subtleties to make a smooth-moving joint.

The rule joint is elegant in its apparent simplicity and is a classic element of fine furniture. Much of what has been written on rule joints – or table joints as they're often called – is from the power-tool perspective. While there's nothing wrong with cutting this joint using power tools – a process I'll discuss later – the way to truly learn about this joint is to cut it by hand using layout techniques and tools that craftsmen of the 18th and 19th century used. Once you understand the subtleties of this joint, you'll be able to achieve better results no matter how you cut them.

What is a Rule Joint?

The rule joint gets its name from its similarity to the brass joint in folding rules. With a rule joint, the round portion of the joint provides support for the drop leaf and, when the drop leaf is lowered, eliminates the unsightly gap between the drop leaf and the tabletop. The joint is composed of a fillet at the top, a quarter-round profile on the tabletop side of the joint, a mating cove and a land on the drop-leaf side (see the illustration at right on the next page).

The hinge for this joint is unique in that it is mounted upside down (so that the barrel is buried in the workpiece) and set flush in a mortise on the underside of the tabletop. In its down position, the drop leaf rests evenly with the height of the land. The observer sees only the fillets and the barrel of the joint, but no evidence of the hinge or the hinge mortise. For the joint to operate smoothly, the hinge has to be located precisely.

Table Joint Planes

Joinery planes usually cut grooved joints (tongue-and-groove, dado, rabbet etc.), and moulding planes are generally used for decorative profiles. While table joint planes could be classed as joinery planes, they look like moulding planes. One member of a table joint pair is used to cut the profile on the tabletop (the round) and the other cuts the mating profile on the drop leaf (the hollow or cove). Table joint planes were manufactured in matched pairs but sets have often been separated over the years and they are not easy to find.

The most obvious characteristic of table joint planes is that they cut a 90°, or quarter-round, profile. In contrast, hollow and round planes cut a 60° profile (equivalent to the segment of the circle on which the profile is based). Almost every table joint plane I have seen cuts a 3/8" arc or round. Any pair of these will cut rule joints on stock ranging from about 1/2" to 1" thick – the difference in thickness is made up by the height of the fillet. With any of these planes, the fence of the plane references off the underside of the stock.

The advantage of using table joint planes is that you can knock out a serviceable joint in just a few minutes, and essentially no layout is required. You get only one choice for the profile, a 3/8" radius arc, but you can use the same plane

PHOTOS BY ROY UNDERHILL; ILLUSTRATIONS BY ROBERT W. LANG FROM THE AUTHOR'S DRAWINGS

To truly understand how rule joints were laid out and cut, go back to the source – the tables of the 18th and 19th centuries. Existing tool marks and layout lines tell us a lot. I was fortunate to be able to spend a day at the Museum of Early Southern Decorative Arts (MESDA) at Old Salem in Winston-Salem, N.C., looking at drop-leaf tables in the collection.

A few things stood out. The fillet height accounted for one third to one-half of the tabletop thickness (**A**, below left). The round part of the table leaves was correspondingly smaller, often with a radius of only 5/16" or 3/8". Tabletops were generally undercut on the bottom edge and sometimes the curve on the drop leaf was overcut to match. The hinge spacing was also wider than expected, with outside hinges placed close to the edges, often one part in 20.

In every case where I could make a determination, the hinge leaves were tapered in thickness and the hinges were mounted flush to the underside. In most tables, rather than a simple chiseled and excavated hinge mortise, the shoulders of the hinge mortise were sawn with shallow kerfs then chiseled out across the grain. These kerfs were about twice as long as the hinge leaves, providing a pragmatic method of laying out a tapered mortise to fit the leaves (**B**, below center).

In a majority of the tables, the hinge mortise was visible along the joint when the drop leaf was down, although this could easily have been due to wear on the tables (**C**, below right). In fact, in all of the tables that I looked at (nine at MESDA and another nine at Whitehall Antiques of Chapel Hill, N.C.), a surprising number had significant repairs done at the joint barrel around the hinge mortise. This makes sense when you realize that when the drop leaf is in the down position, the whole weight of the drop leaf essentially hangs on the few short screws holding the hinge to the leaves.

The most surprising feature of every joint I studied was that the lands were thin (1/16" or less), even though the hinge barrels were in the range of 1/4" to 5/16" in diameter. Everything I've read and every picture I've seen about the joint layout states that the land is laid out to the height of the midpoint of the hinge barrel. Clearly these craftsmen did not read the same texts. The joints should rub, but they do not because in most of these tables, the table leaf was undercut to allow the joint to clear as the drop leaf rotates. In some tables, the maker solved this problem by setting a significant gap between the two leaves to allow clearance. This undercutting has another advantage, which I will discuss a little later on. The drawing on page 51 compares a textbook rule joint and my observations of 18th-century rule joints. — WA


A


B


C

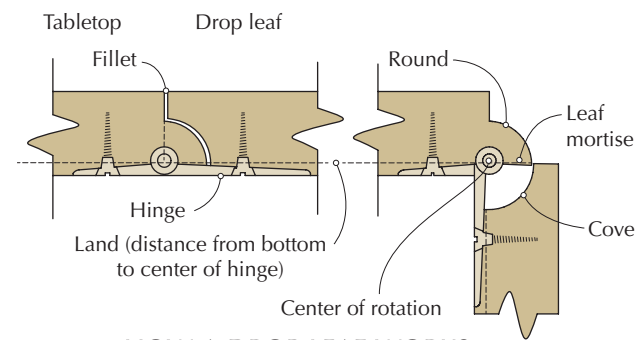
to make a rule joint for a thin-topped card table or a heavy dining table. To vary the proportions of your rule joint, however, you need to use hollows and rounds.

Cutting the Drop-leaf Joint

If you use a matched pair of table joint planes, most of the parameters of the joint are decided for you by the plane design. Because they cut a 3/8" radius round on top of a thin land, fillet height varies with the stock thickness.

These planes are straightforward to use, with a possible exception: The round member of each pair has no depth stop, so to get a straight joint you must cut precisely to a scribed line. Makers of table joint planes sometimes provided a two-sided gauge to lay out this line – one side to strike this line on the top and bottom of the stock, and the other side to lay out the width of the hinge barrel on the bottom. Even without the original gauge, these markings are easy to replicate.

If instead you use a pair of hollows and rounds, every aspect of the joint must be laid out precisely. The other disadvantage of using hollows and rounds is that they require practice to control, in part because they cut only a 60° arc rather than a full quarter-circle.



HOW A DROP LEAF WORKS

The advantage of using paired hollow and round planes is that you can vary the proportions of the fillet and the curvature of the joint. You can also work in either direction along the workpiece, based on grain direction. Because table joint planes only make the process easier, we'll focus on cutting the joint using a set of hollows and rounds.

1. Define the Land. Set a marking gauge to the thickness of the hinge barrel at the center of the hinge pin. Referencing off the bottom of the workpiece, mark the ends of the tabletop and drop leaf to a length equivalent to the thickness of the stock. With this same setting, scribe the long edge of the drop leaf, too, referencing from the bottom edge. On the edge of the tabletop, connect the two land marks with a pencil line.

2. Define the Round & Cove. The curvature of the joint is built on top of the land. As a rule of thumb, the quarter-round profile should be about half as thick as the stock. Set a marking gauge to this height (the circle radius) and reference off the edge to mark the tabletop along both its top and bottom edges. Then scribe down the ends through the line defining the land. This will be the centerline for the hinges when they are installed.

Use this same setting to mark the drop leaf; reference off the bottom edge of the workpiece, and scribe up on the ends through the line defining the land.

Set a pair of dividers to the radius of the circle, and use the intersection of the land line and the vertical line as your centerpoint for scribing an arc on both ends of the tabletop. To scribe the drop-leaf arc, clamp a board to the edge to provide a seat for the compass point.

3. Define the Fillet. The height of the fillet equals whatever is left over from the two layouts you just finished. Referencing off the top face of the workpiece, set a marking gauge to the top of the curve. On the tabletop, scribe this line around both ends and along the long edge. This defines a rabbet that needs to be removed. On the drop leaf, again referencing from the top face, mark the two ends. Connect these two scribe lines with a pencil line.

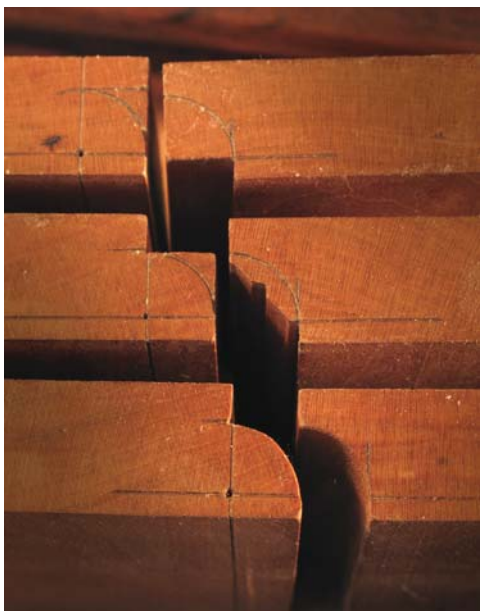
4. Cut the Rabbets. You're left with two rabbets to cut: The one on the tabletop defines the fillet, and the one on the drop leaf defines the land. To rough out the rabbets, use a moving fillister set shy of both layout lines. Then use a small shoulder plane to first bring the rabbet to depth and then to move the shoulder back to the proper width. As you plane, look for the shavings to "feather" – that tells you you're one shaving shy of cutting through the middle of the scribe line.

5. Cut the Round. The round profile on the tabletop curves from the base of the fillet to the pencil line at the top of the land. Choose a pair of hollows and rounds that cut to this radius. Hollows and rounds are often numbered to increase in 1/16" increments (up to a 3/4" radius; after that, they increase by 1/8"). Thus a pair of No. 6 planes will likely cut a curve corresponding to a radius of 6/16", or 3/8". In practice, I tend to use a hollow that is a bit wider than necessary.

I sharpen my hollows and rounds so that the outside edges of the irons disappear into the profile of the plane body. This means that the round will have a slightly more pronounced curvature and the hollow will have a slightly flatter curvature, but the two profiles will still match. Setting your planes this way eliminates the groove marks, or shoulders, these planes generate when the corners protrude. With the hollow set for a light cut, work the profile down to the arc scribed on the ends of the tabletop.

A WELL-PLANNED JOINT

Mark out for hollows & rounds. *Scribe layout lines on the ends and faces of the stock to guide the planes*



Work down with hollow & round. *Use a rabbet plane to establish the fillet and land. Then finish shaping the joint using hollows and rounds.*

Or use dedicated planes. *Matched sets of table joint planes cut perfectly matched profiles – simply work to a scribed line.*

Take your pick. *Rule joints can be cut using either a set of hollows and rounds, like the set at left, or with a matched set of table joint planes, like the four other sets shown.*

6. Cut the Cove. The cove on the drop leaf curves up from the top corner of the land rabbet to the pencil line along the front edge, defining the depth of the fillet. Use a rabbet plane to bevel off the waste and then an out-cannel gouge to make a track for the round plane. Stay well shy of the two layout lines but try to generate a relatively straight and even groove.

The round plane makes short work of any inequalities. Because the hollow and round only cut a portion of the arc, work these planes out to the edges, using the fingers of your off hand to guide the plane. Hold the round plane vertical at the bottom of a curve, and work through the rising arc so that the plane is essentially horizontal at the top of the curve. It is very easy to run off the edge here, so a take a light, controlled cut.

7. Fit the Joint. Set the tabletop and drop leaves on a flat surface and bring the joint together. Ideally, the two edges will be flush without any gap between them and the two curves will match on the ends. If this is not the case, look for high spots. Profile gauges allow you to identify ill-formed curves. It is also useful to put a straightedge along these joints to make sure that the edges are straight. You may have to go back with the hollows and rounds to clean up the profiles. On the drop leaf, where the cove moves in to the vertical shoulder of the land, you may want to use a slightly larger round to ease the transition. Scratch stocks can help fair the curve as well.

18th-century Style

So how do I think an 18th-century craftsman varied from this procedure? Let's assume he used a hollow and round pair and freehanded the joint. The land would have been set just high enough to get the divider points on the edge of the workpiece and maybe to provide a small flat on the edge of the table leaf for reference purposes. The fillet and the hinge centerline on the underside still needed to be laid out in the same manner. The rabbet would still need to be cut on the table leaf. Once the joint was cut and the hinges set in, however, the joint would have rubbed along the bottom portion of the arc. As you can see in the drawing at right, the center of rotation for the hinge would have been higher than the center of the arc (the land). Because the land is reduced in height during layout (below the center of the hinge pin), the tabletop must be undercut to allow the joint to rotate.

If the craftsman used a dedicated pair of table joint planes (I have seen several such pairs that were made in the mid-1700s), most of these decisions would already have been made for him. Of the dozens of planes that I have examined, all cut a profile with a very small land. Also, many of them were designed to undercut the bottom edge of the round part of the joint as part of the profile.

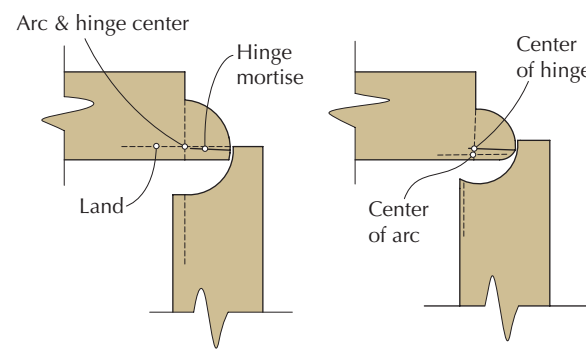
The only layout job left to the craftsman would be to first scribe lines on the top and bottom edges of the tabletop to define the face of the fillet and the centerline of the hinge. He would have planed to that fillet line, cut the cove on the drop leaf and then hinged the two together. If the joint still rubbed a bit, he'd have rounded over the bottom edge of the tabletop until the joint moved freely.

Undercutting this joint has another benefit: It allows the drop leaf to be hinged a bit closer to the tabletop. Because this moves the drop leaf in a bit, the leaf sits higher when in the down position. The higher the drop leaf rests, the more completely it covers the mortise in the tabletop.

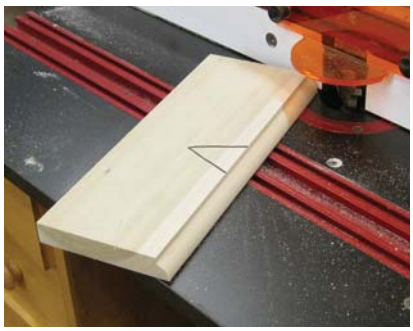
Cut Rule Joints With a Router

Though not my first choice, you can also cut rule joints using a router. For lengths under about 36" you can use a router table, but longer lengths may be easier to cut with a handheld router. There are two main kinds of table-joint router bits available – those with guide bearings or rub collars and those without. Those with bearings or collars work best in a handheld router. However, most of these bits have a 1/2"-radius curve, which means they work better on 1"-thick stock. On 3/4" stock, the fillet and the land could be no more than 1/8" each – not enough to accommodate and conceal the hinge mortise. A matched pair of 3/8" cove and roundover bits could work better.

Other rule joint bits, like a set of Corob bits I have, are more carefully designed. Their profile radius of 3/8" makes them suitable for use in 3/4" stock. They come as two separate bits that bolt to a 1/2" shaft (provided). The bits can be used in a shaper or on a large table-mounted router. Because they do not have rub collars, the bits must be used with a fence. However, I view this as an advantage. A router table provides a lot of surface area for stability and the stock bears with its



Rout better rule joints. *For period-looking machined rule joints, choose a set of bits that cuts a rule joint with a 3/8" radius.*



Rout it out. *Riding against the length of the fence rather than off a bearing does a better job of routing a straight profile on the leaves.*

A perfect fit. *When set up correctly, a matched set of table-joint bits gurarantees profiles that will mate and work smoothly.*

full thickness against the fence, rather than just on the narrow surface of a collar or bearing. The fence also helps keep the developing edge straight and true. Another advantage of using these bits is that after you cut the hollow, you slip the bit off the shaft and easily replace it with the mating round.

Start by milling your stock and marking the mating tabletop and drop-leaf parts with a cabinetmaker's triangle to aid in alignment. Install the hollow bit in the router table to cut the round part of the joint. Set the height of the bit so that the land is about 5/32". This makes the fillet 7/32", leaving 3/8" for the barrel of the joint.

Once cut, unbolt the bit and replace it with the mating cutter. In theory, you should be able to get the second profile without any additional fettling. That said, you should still rout a test piece. Most often, you'll have to lower the round bit by a few thousandths to get a good final fit.

Installing Drop-leaf Hinges

With traditional tapered leaf hinges, you could set a router up to cut the mortises, but you'd spend more time making jigs to taper the mortise than it would take to cut the mortise by hand. Since my visit to MESDA, I have changed my thinking about how to mortise in tabletop hinges. I like the pragmatic approach of making long saw cuts to define the mortise shoulders, and then chiseling the tapered mortise cross grain. This is quick and can be very precise.

Almost every antique piece I've seen has a full-length scribe line on the underside of the tabletop. The scribe line mirrors the shoulder of the fillet above and is the line along which the barrel of the hinge is aligned during installation. Regardless of the method of cutting the joint, this line should always be laid out because you'll need it for mortising.

Start the hinge installation on the tabletop. The photos

RULE-JOINT HINGES

A good table joint requires good hinges. And they must be installed precisely. The leaf of the hinge is mortised into the underside of the tabletop, but this mortise is hidden by the way that the drop leaf hangs. How the drop leaf hangs depends on the difference in thickness between the hinge barrel and hinge leaf, how it is set into the stock and how the profiles of the joint line up.

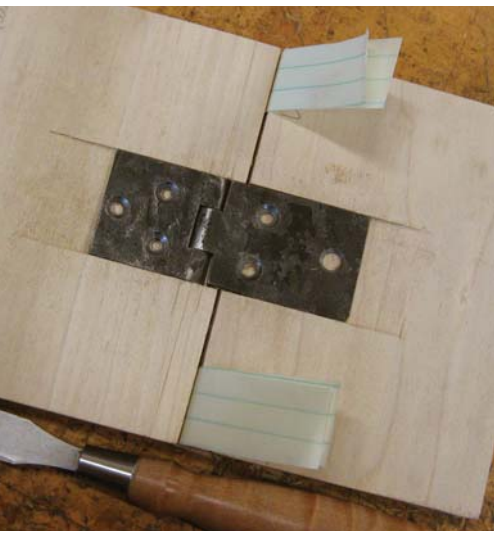
With most hinges, the drop-leaf side is longer than the tabletop side (to bridge the cove). All are flush-mounted upside down (barrel-up) on the table's underside. Unlike many modern and reproduction hinges, antique ones are often tapered in length. No matter what style you use, look for a hinge barrel that is thicker than the leaf.

Actual antique hinges. When compared to modern hinges, the diameter of the barrel tends to be larger and the leaves thinner. The leaves are flush with the barrel so one face of the open hinge is flat. The combination of a large barrel and thin leaf makes it easy to hide the hinge-leaf mortise behind the drop leaf.

Modern high-end (brass) hinges. Like antique versions, quality hinges like those from Horton Brasses, Ball & Ball or Whitechapel have one face of the open hinge flat, the leaves are thick and the barrels are close to 1/4". The leaf action is tight, which means the hinge operates smoothly and hangs firmly. The difference between the center of rotation and the top of the leaf hinge is small, so you must cut precise mortises to hide it behind the leaf.

Low-end modern hinges. These have thin leaves, wide barrels and a lot of play. On most, leaves are almost centered on the barrel. The center of rotation for the hinge is therefore closer to the bottom of the workpiece. The difference between the center of rotation and the top of the tabletop mortise is usually less than calculated. The leaf play also tends to expose the tabletop mortise. — WA

INSTALLING DROP LEAF HINGES



Make it easy. *In most cases, paper shims create just enough space between mating parts so that the rule joint works smoothly.*

Mortise for the hinge. *Saw guidelines for the mortise sides and then cut to two different depths – one for the leaf and one for the barrel.*

above show the progression for laying out and cutting the mortise on both halves of the joint. Note that the mortise for the hinge is actually two mortises: one for the hinge barrel (cut first) and one for the hinge leaves (cut second). Locate the hinge along the table edge by whatever proportioning method you choose. Lay the hinge flat on the workpiece with the barrel up. Center the barrel on the center scribe line. With a marking gauge, scribe lines on either side of the centerline to define the width of the barrel. Carry these lines past the mortise shoulder a bit to preserve this layout during the cutting of the barrel mortise. Set the marking gauge to the thickness of the hinge leaf where it will cross the edge of the workpiece, then scribe this line along the front edge of the tabletop. This will be the depth of the mortise at that point. You can see these layout lines on the top piece in the photo above right. Turn your attention to the mortise for the hinge barrel. A square mortise would remove enough material to weaken the joint, so I use a gouge (6mm No. 10 or No. 11 sweep) to excavate this part.

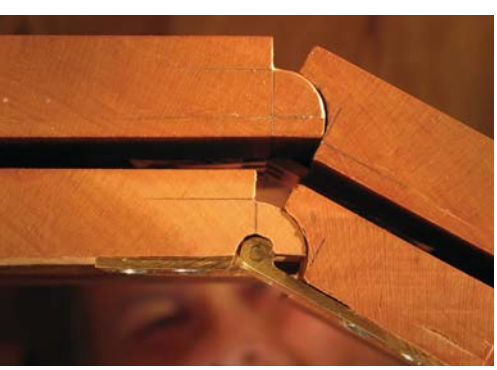
Once the mortises are cut, lay the hinge in the barrel mortise. Make sure the hinge is square across the edge of the workpiece, then knife in the two edges of the hinge-leaf mortise. Saw out the mortise shoulders with shallow cuts about twice as long as the length of the hinge leaf. Be sure not to cut through the scribe line on the front edge of the workpiece. With a bench chisel or paring chisel, begin cutting from the end of the saw cuts toward the barrel mortise. This will give you a tapered cut. Fit the hinge again. You may find that the barrel bottoms out and you need to deepen that part of the mortise. If the leaves are only very slightly tapered (when using high-quality brass hinges for example) you can scoop down with the chisel along the sides of the mortise to deepen the cut.

Once the leaf mortise is cut, verify that the hinge sits square to the edge of the table leaf and that the barrel is aligned with the center scribe line.

Align the drop leaf with the tabletop and transfer the locations of the mortise shoulders using a knife. Scribe the shoulders with a square and with deep knife cuts. As above, saw the mortise shoulders and chop out the waste with cross-grain chisel cuts.

Anchor the hinge to the tabletop with one screw. Align the drop leaf with the tabletop. Use pieces of paper as shims between the two. Set the hinge in the drop leaf with one screw and test the action of the joint. If any rubbing occurs you may need to tweak the alignment of the drop leaf, or slightly round over the underside edge of the tabletop. Once the action is even and in the down position the drop leaf hides the tabletop mortises, install the other screws. Use wax or mutton tallow to ease them in. **PWM**

Willard is a retired research scientist who now walks to "work" in his shop. He teaches woodworking at the John C. Campbell Folk School and at The Woodwright's School. His web site is edwardsmountainwoodworks.com.



Correct setup. *When set up correctly, a matched set of table-joint bits gurarantees profiles that will mate and work smoothly.*

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BLOG: *Discover more good resources for drop-leaf hinges in many finishes and price ranges.*

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Elliptical inlay. *This Federal card table reproduction made by Phillip Houck (original by William Whitehead) makes liberal use of elliptical shapes for both stringing and other dramatic inlays.*

The Elusive Ellipse

BY FREDDY ROMAN

Plot an ellipse using simple geometry in 4 minutes or less – really!

As a furniture maker with a fondness for the Federal period, I'm interested in the ellipse-shaped decorative details that regularly appear in furniture from the era. When I study these details, I think of master craftsmen of the day and wonder how they drew and cut elliptical shapes.

So I turned to one of today's masters, Will Neptune, to learn more about drawing and cutting this intriguing shape. Here, I'll share with you several of the tricks and techniques he taught me.

Like the old masters, you need to have a basic working knowledge of geometry that can be used to lay out the cavities for ellipse-shaped inlays and stringing, and to generate pleasing elliptical shapes for tabletops, door panels and more.

Ellipse – True or False?

When working with ellipses, the first thing to understand is the difference between a true ellipse and a false ellipse. A false ellipse is two different-sized radii blending together at four intervals around an oval shape. A true ellipse, on the other hand, is an ever-changing series of radii. But if you lay out a false ellipse on top of a true ellipse, you'll see they are very close to being exactly alike.

Why is this important to furniture craftsmen? The difference comes when laying out an ellipse. If you first lay out the false ellipse on paper, you know the four key center or swing points. Knowing these locations, you can connect a hand tool to a trammel-beam or a router to a circle-cutting jig and swing the arcs of the ellipse. Using the false ellipse provides accuracy and repeatability, and it saves time. In many cases, using a false ellipse is the smarter choice.

While it is easy to draw a true ellipse using the old "string and nail" method, it isn't always easy to apply that method to a tool in the shop. But it helps to understand the true ellipse and how it's drawn. Nails are driven into two points known as the foci (the plural of "focus"). The size of an ellipse is determined by the total distance between these two points and the length of the string that moves around them. To set the string length, a third nail is placed on the minor axis at the widest point of the ellipse and the string is then tied as it loops around all three nails. The third nail is then removed.

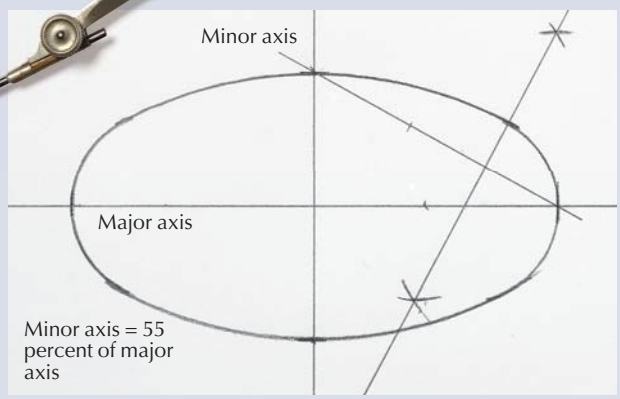
Once the nails are set and the string is taut, you are ready to scribe an el-

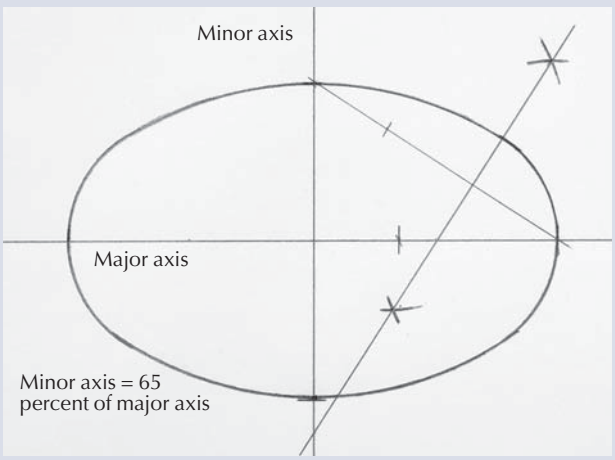
OPENING PHOTOS BY LANCE PATTERSON; DRAWINGS BY STEVE SHANESY

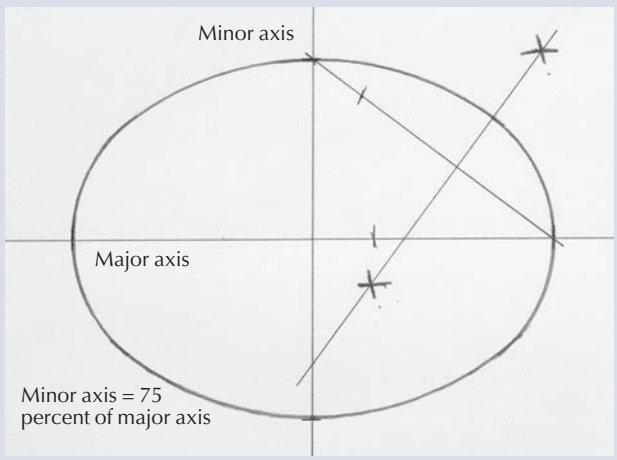
GOOD-LOOKING FALSE ELLIPSES

It's often the case that when you first draw an ellipse it looks too squashed or too round. If you are making an ellipse to inlay stringing, an ellipse that is too squat may cause the stringing to break when making the sharp bends at the ends of the major axis. An elliptical table that's more round than oval looks more like an out-of-round circle than a graceful elliptical shape.

While beauty is in the eye of the beholder, good-looking ellipses have a range of proportional ratios between the major and minor axes. A rule of thumb is to stay between 55 percent and 75 percent as a ratio of the length of the minor axis to the major axis. — Steve Shanesy







lipse. When you draw it, notice that the length of the string on either side of the pencil tip changes as it moves along. This variance occurs throughout the scribing of the ellipse, but the total length to the foci is continuous at every point throughout the ellipse.

Endless arrays of ellipses are formed by the location of the foci. The farther away from one another the points are, the more squashed the ellipse. The closer together the points, the more the ellipse resembles a circle. In fact, if the foci are at the same point, it forms a circle.

Draw a False Ellipse

Like most things in woodworking, there's more than one way to get things done. On the following pages are three different methods to generate an elliptical shape. In "Method 2" and "Method 3," you start with the length of the major axis, and use a pleasing proportion to develop the minor axis. The results are two visually different ellipses; one is more round and the other is more squashed. "Method 1," which is the most involved, is used when you want to design your ellipse to a width and length of any dimension you choose. While the procedure requires a few more steps, you have more control over the resulting shape because you are choosing both the width and length dimensions.

> "Everything is hard before it is easy."
> *— Johann Wolfgang von Geothe (1749-1832) German writer, author of Faust*

These methods are great for a variety of uses in furniture making. I have used them many times to make elliptical tabletops, mirrors, carving blanks and inlayed fans. All three of these methods can be used with a trammel beam, a knife blade, a router or Dremel tool to cut out elliptical patterns, housings for inlay or grooves for stringing. You simply swing a tool from the radius points instead of swinging a compass. There is an endless array of uses for these methods in the shop.

You may think these methods are a lot of work, but once you draw a few ellipses and get the hang of it, you will quickly knock them out in a matter of minutes.

Freddy is a graduate of The Furniture Institute of Massachusetts, a member of the Society of American Period Furniture Makers and the New Hampshire Furniture Makers Assoc. See his work and contact him through his web site: periodcraftsmen.com.

How to Draw a False Ellipse

Study the drawings and get familiar with the terminology before you get started. Then as you read the steps for drawing a false ellipse, refer back to the drawings to understand the specific locations of points being referenced, as well as their relationship to other points. It is also helpful, but not necessary, to have a compass or set of dividers on hand to use while studying the illustrations.

METHOD 1: DRAW AN ELLIPSE – ANY DIMENSION BOTH AXES

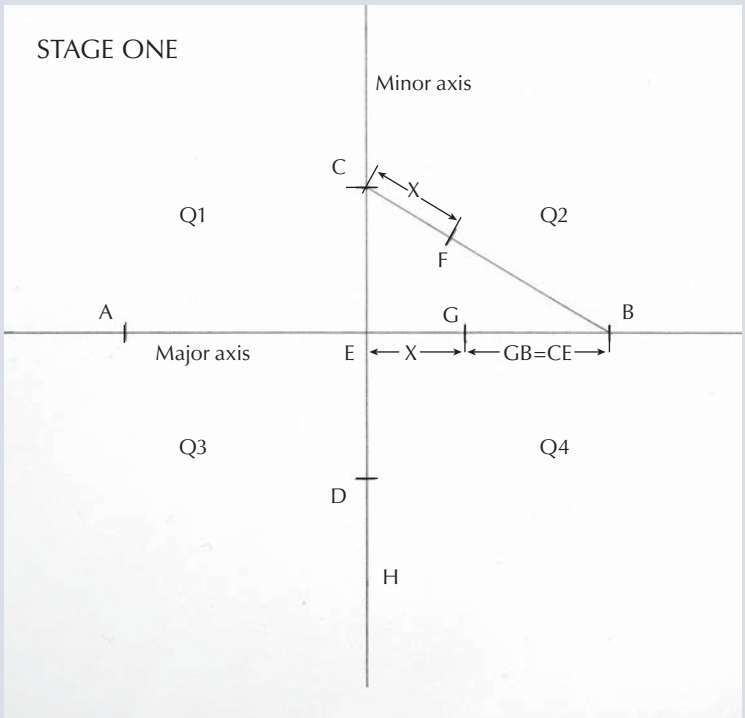
There are really two stages to drawing a false ellipse using the method described here. In **Stage One,** establish the lengths of the major and minor axes and transfer fixed lengths to other lines:

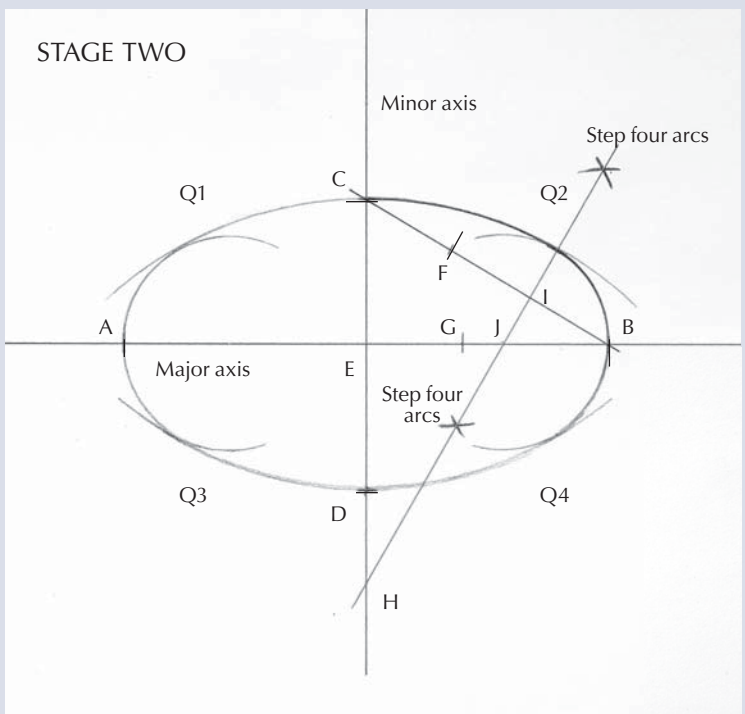
1. Draw the major and minor axes (I am using 2½" x 1½") and label the extremities A, B, C, and D and the intersection (centerline) of the lines E.
2. Set your compass to distance CE and transfer the length starting from point B (¾" in this case) heading toward point E, strike an arc and label it G. Label the distance that remains on BE as X.
3. Next, draw a line from point B to point C. On this line measure from C the length of X, strike a line and label it F.

In **Stage Two** you swing the arcs using the compass points established in Stage One.

4. Set at a convenient length a compass point on F and scribe an arc into quadrants (Q) 4 and Q2. Using the same compass setting, scribe an arc from point B in Q4 and Q2 that intersects the arcs.
5. Strike a line through the two arc intersections and continue the line until it meets the minor axis. At the minor axis label this point H, label it J at the major axis, and label it I where it crosses line CFB.
6. Now scribe the arcs and draw the ellipse. Set a compass the length of HC, use H as the centerpoint and draw an arc from point C to line IJH.
7. Reset the compass to the distance of JB. Use J as the centerpoint and draw the arc from line IJH to B on the major axis. Q4 is done.
8. Complete the remaining quadrants by transferring the locations of the arc centers to the opposite ends of the major and minor axes.

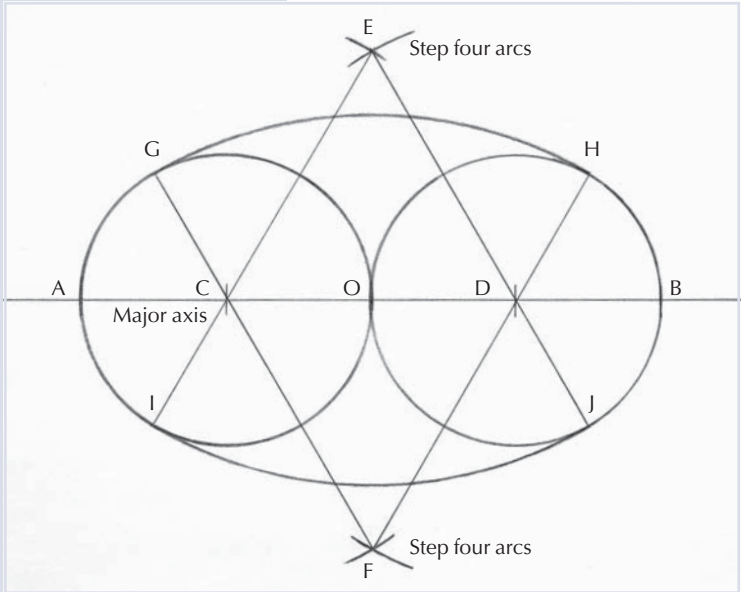
Once you're familiar with the process, you can complete the other quadrants by simply using the same compass settings for the other quadrants. — FR





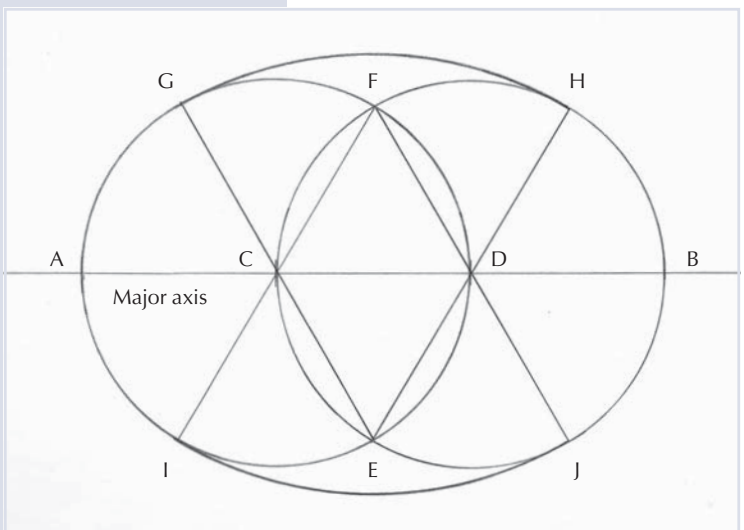
DRAW A FALSE ELLIPSE – SQUASHED SHAPE

1. Draw a horizontal line and name it AB. In this example, it is 3" long.
2. Divide line AB into four equal parts (3/4") to form points C, O and D.
3. Set a compass the distance from AC and with C as the centerpoint draw a circle. Repeat for DB with D as center.
4. Set your compass the distance from point C to D, and scribe arcs from these points. Where the arcs intersect label them E and F.
5. From points E and F draw lines through C and D to form points G, H, I and J.
6. With points E or F as center, set your compass to the distance of either line ECI or FDH and draw an arc from I and J. Move the compass point to F and draw an arc from G to H.
7. All the arcs are now swung and an ellipse has been established. — FR



DRAW A FALSE ELLIPSE – ROUNDER SHAPE

1. Draw a horizontal line; for this exercise let's draw the line to a length of 3" and name it AB. This is the major axis.
2. Divide line AB into three equal parts of 1", and introduce points C and D.
3. With points C and D as centers, set your compass to the radius of AC.
4. Draw circles from points C and D, with the compass setting from step 3. Please note that the ends of the ellipse are now complete.
5. The two circles scribed intersect at two points. At these intersections points E and F are formed.
6. From point E draw a line through point C and continue to cut the circle to establish point G. Line ECG is complete and this step must occur three more times to form lines EDH, FCI and FDJ.
7. With all the points established, set your compass to the distance of line EG, then draw an arc from the centers of E and F to form arcs GH and IJ. All the arcs are now complete and your ellipse has been formed. **PWM** — FR



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VIDEO: *See an ellipse plotted in less than four minutes using "Method 1" as described in this article.*

MORE VIDEO: *See a true ellipse drawn using two sticks that slide in perpendicular grooves.*

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Keyed Miter Jig

This shop-made table saw jig makes quick work of reinforcing miter joints.

I love the clean look of a mitered box that has continuous grain wrapping around the corners. It's an easy detail to create, but a sure sign that the maker is paying close attention to the details. The downside of a mitered box? Miter joints are notoriously weak because they have no real mechanical strength; glue is all that holds them together.

You can reinforce miter joints in a few different ways, but my favorite method is to use exposed keys. These hardwood keys are nothing more than thin lengths of wood glued into slots that span both sides of the joint to help hold everything together. To cut the slots for these keys at the table saw you need only a small jig that runs against the saw's fence. The jig cradles the assembled box at a 45° angle and allows you to guide it through the cut.

Keys not only add great strength to miter joints, they also provide a decorative effect. Once the jig is made, you can arrange the keys in any number of ways, using either a matching or contrasting wood. For a slightly different look, you can cut wider key slots by simply adjusting the table saw fence to take two or more passes for each slot. For angled keys, which create joints that arguably are even stronger, simply angle the blade. You can even use this same jig at the router table to create dovetailed key slots – just be sure to hog out the bulk of the waste in the jig itself before you cut the actual box.

Making the Jig

This jig can be made from plywood, MDF or whatever scrap you have on hand. If you choose sheet goods or thinner stock, you'll need to face-laminate a few thicknesses so that the cradle of the jig is wide enough to hold the full height of the box. I simply glue and screw through all the thicknesses to create one large chunk of material. It's a good idea to glue up a longer length of stock than necessary, just so that it is easier to hold during the next step.

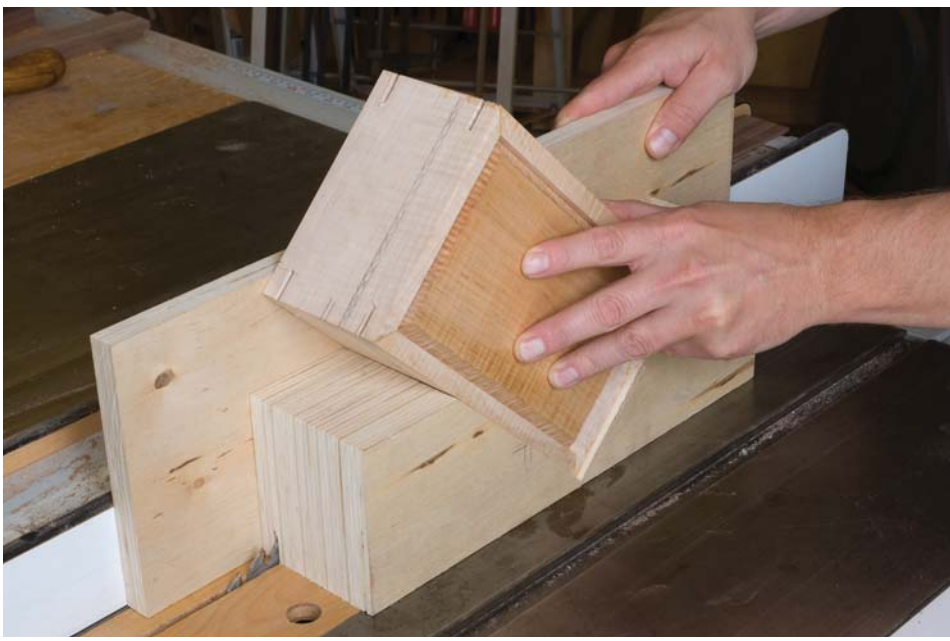
Once the glue dries I remove the screws so that there's no risk of the saw blade catching a screw when the jig is in use. You can then cut both ends of the stock at 45° angles on the miter saw or use your miter gauge at the table saw. Instead of cutting the miters to a sharp point where they meet, I like to leave about 1/8" or so flat on each piece; once the jig is assembled and in use, this raises the box off the saw table and allows the jig to move more smoothly across the table.

Once the end cuts are made, crosscut the stock into two separate pieces. Attach them point-to-point centered on a backer board. You should size the backer board so that it will stand a few inches above your table saw fence. Use the extra height as a handle to keep your hands out of harm's way when the jig is in use. This extra height also provides enough room for you to secure your box with clamps when necessary.

You can glue the angled blocks to the backer board, but I simply secure them with a few screws driven in close to the top of the angled blocks (where there is no risk of a blade catching them as you pass the jig across the saw). When the jig gets chewed up from use, this allows you to replace fouled parts easily.

Using the Jig

Once the jig is ready to go, start by setting the height of the table saw blade. Position the box in the jig and hold it alongside the blade. For both strength and aesthetics, make sure your blade is low enough so that it won't cut into the



Clean cuts. *Registered against the fence, this cradle jig safely holds the work 45° to the saw table as you cut the slots for miter keys.*

PHOTOS BY THE AUTHOR

INSTALLING MITER KEYS

Installing keys is a simple process. Mill a long length of hardwood to fit snug in your key slot. Use a backsaw or band saw to trim it down to make triangular keys of a more manageable size. Glue the keys into place and trim them flush to the box sides with a backsaw or flush-cut saw. — MT

Square the slot. *If you cut slots using an alternate top bevel (ATB) blade, you'll need to square the bottom of the key slots with a chisel.*

Glue the keys in place. *After a dry-fit to make sure the splines are snug but not tight in the slots, add glue and slide them in place.*

Saw away the waste. *A backsaw or flush-cut saw is used to cut away the bulk of the waste.*

Clean it up. *A sharp chisel trims the key flush. Work from the corner of the box toward the center to prevent tear-out.*

interior of the box. I usually raise the blade so that it cuts only about three-quarters of the way through the miter joints.

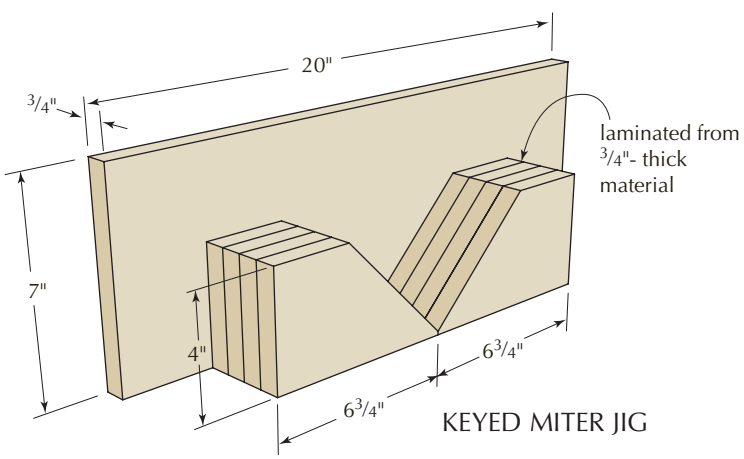
Once the blade height is set, mark out the position of the keys on the box. (If you're working with a solid box that will have the top cut loose later, remember to locate keys with the future cutline in mind.) Hold the jig against the fence and position the box against the upright face of the jig. Then adjust the fence so that the blade aligns with your desired key location.

To cut the slots for the miter keys, I usually just hold the box in place against the upright face of the jig and then run the entire assembly against the fence. If the box is particularly large, small or otherwise awkward, you can clamp the box to the backer board of the jig before you cut the slots; just make sure to position the clamps so that they won't interfere with the cutting procedure. You should be able to make each cut in a single pass.

Make the same cut on all four corners of the box. Relocate the fence to align with the next key location and repeat the process until all your key slots are cut. Once the slots are cut, the keys are easy to install, as you can see above. (You can see the finished box on page 32.)

I've come to love the look – and the strength – that hardwood keys add to a miter joint. **PWM**

Matthew is the editor of this magazine. He can be reached at matthew.teague@fwmedia.com.



KEYED MITER JIG

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BLOG: *See more on building mitered boxes and a slide show on installing the keys.*

MODEL: *Download a 3D SketchUp model of the box seen here.*

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Contemporary Coffee Table

Take the easy way out: Find sizes without measuring.

This small coffee table is a great introduction to building furniture. It doesn't require much material and it's an opportunity to develop your skills. This project is sturdy, attractive and easy to build. All of the parts come from standard widths of lumber. I used poplar from my local home center, and I made the table from one 6'-long piece of 1x8, one 8' length of 1x6 and two 8' lengths of 1x4.

Start by gluing the top from two pieces of 1x8 and one piece of 1x6. If you are cutting the parts from 6'- or 8'-long boards, leave them a couple of inches long, then trim them to the final length after the glue has dried.

The goal during glue-up is to keep the faces of the boards aligned. Use a couple straight strips of wood below for a level work surface and, if you need to, clamp straight pieces across the top and bottom to hold the edges in alignment while the glue dries.

Let the glue dry overnight, then trim the top to length. Clamp a straightedge across the top to guide your jigsaw or circular saw to make the cut. When the top is at its finished size, set the blade of your combination square at 2" and draw lines in from each corner on the underside of the top.

Start From the Bottom

Use the angled side of the combination square to draw a line at a 45° angle from the corner of the top to the intersection of your layout lines. Cut the legs to length. Then mark the center of one edge of each leg.

Stand the legs in the corners and line up the center marks with the angled lines on the top. Use your combination square to set each leg at a 45° angle to the edge, then trace around the ends of the legs.

When the leg locations are marked, use the lines to determine the exact lengths of the rails. Cut the rails a few inches longer than the dimensions in the cutlist, with a 45° angle on one end of each piece. Place the angled end against the line, with the back of the rail even with the back of the leg.

Draw a line up the edge of the rail from the layout marks drawn at the other end, then draw an angled line across the face. Cut the second end of each rail to the line.

After cutting the rails to length, draw a line 1" in from the outer edges of the rails. This is the location for the outer face of the aprons, and you can put them in position to mark the lengths exactly without measuring. Cut the aprons to size at the miter saw with a 45° cut on each end, then mark and cut the angle at the bottom of each leg.

Check, Layout, Drill

Place the rails and the legs in position on the tabletop. The rails and legs join with two types of screw connections: countersunk screws through the legs into the long rails, and pocket screws through the short rails into the legs.

Mark the rough positions of the screws with the countersunk screws

On your mark. *Lay out all the pieces on the underside of the top. You won't have to measure, and all the pieces will be the exact size you need.*

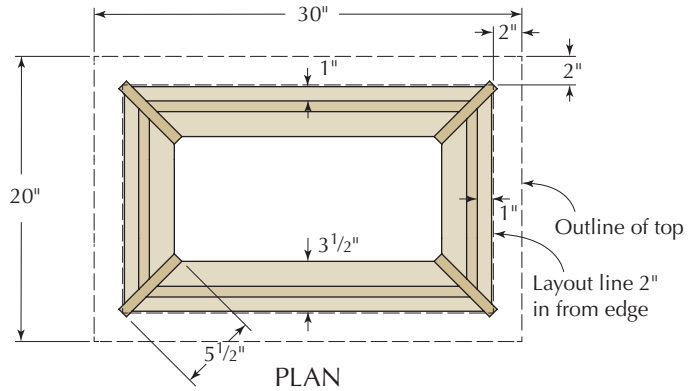
Double-check. *After cutting, put the parts in place and mark the locations for the screws.*

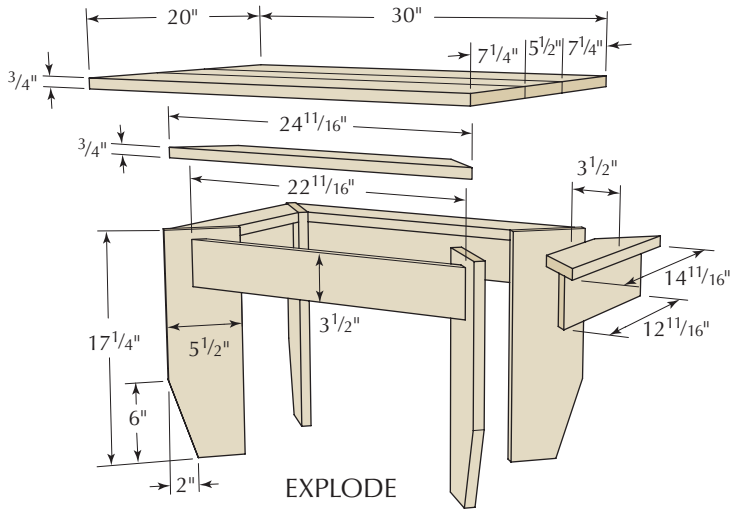
LEAD PHOTO BY AL PARRISH; STEP PHOTOS & ILLUSTRATIONS BY THE AUTHOR

Contemporary Coffee Table

NO.	ITEM	DIMENSIONS (INCHES) T	W	L	MATERIAL
❑ 1	Top*	3/4	20	30	Poplar
❑ 4	Legs	3/4	5 1/2	17 1/4	Poplar
❑ 2	Long rails	3/4	3 1/2	24 11/16	Poplar
❑ 2	Short rails	3/4	3 1/2	14 11/16	Poplar
❑ 2	Long aprons	3/4	3 1/2	22 11/16	Poplar
❑ 2	Short aprons	3/4	3 1/2	12 11/16	Poplar

*Glue up top from two 1x8 and one 1x6 pieces





near the edges, and the pocket holes toward the center of the rails. Be sure to locate the screws so they won't run into each other during assembly.

Drill through each leg into the ends of the long rails. A bit with an integral countersink makes this a one-step process. Use a pocket-hole jig to drill through the ends of the short rails. Sand all the parts before assembly.

Connect the legs to the long rails first. Apply some glue to the end grain of the rails and wait a few minutes (a.k.a. "sizing"). Apply a fresh bead of glue and screw the legs to the rails with #8 x 1 3/4" screws.

When all four legs are attached to the long rails, connect the two subassemblies with the short rails. For stronger joints, size the end grain with glue. To keep the boards from shifting, clamp the subassembly down to your worksurface before driving the pocket screws.

Size the mitered ends of the aprons with glue before assembly and run a narrow bead of glue on the long edge of each apron to hold it to the rail. Drill pilot holes in the apron ends then fasten them to the legs with 4*d* finish nails. Set the nails below the surface and fill the holes.

Top it Off & Finish

The top is screwed to the base through the rails. The pan head screws used for the pocket holes work well. The solid-wood top will expand and contract as seasons change, so take that into account when drilling the screw holes.

At the center of the short rail, drill a clearance hole slightly larger than the diameter of the screw's shank.

In the long rails, the holes should be larger to allow the top to move. Drill a 1/4" hole and use a washer under the screw head, or drill two smaller holes and tilt the drill back and forth to connect the holes and make a slot.

Place the assembled base on the upside-down top and drill pilot holes for the screws. Use a bit the size of the unthreaded part of the screws, and be careful not to drill through the top.

When the top and base are assembled, give the entire table a finish sanding with #180- or #220-grit sandpaper. Round or bevel the sharp edges at the corners of the boards with coarser sandpaper, then go over it again with the finer grit.

I used a water-based stain, and after letting the stain dry overnight, I brushed on two coats of a water-based polyurethane finish. This is a durable coating, but it can show brush marks after the finish dries. I rubbed the dry surface with a non-woven abrasive pad to remove the brush marks and leave the surface with a satin sheen. PWM

Bob is executive editor of this magazine. You can reach him at robert.lang@fwmedia.com.

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Finishes: They are A-changin'

Reformulations may compel you to adjust your finishing process.

Many years ago a friend explained to me the difference between woodworking tools and finishes. Woodworking tools, he said, are physics. You can see them. You can see that a band saw isn't a table saw even though it has a table.

But finishes are chemistry. You can't see chemistry. Varnish and lacquer, for example, look the same, both in the can and on the wood.

So there is much more opportunity for finishes to be confusing, especially when manufacturers misrepresent them and magazines publish contradictory information about them.

I think this description goes a long way toward explaining why the health problems associated with finish solvents are feared more than those that are obvious with woodworking tools (cutting off your fingers, for example). This, even though the infrequent, low-level exposure to solvents experienced by most amateurs is quite unlikely to cause any problems at all.

Can you spot the difference? *If the solvents aren't listed on a can of finish, you can always find them online on an MSDS from the manufacturer, usually on the first page. Search for the name of the finish plus MSDS, or go to the manufacturer's web site and search from there.*

Finish Regulations

With this said, the particular solvents currently used in coatings (paints, finishes and stains) are changing, but you won't "see" any differences. You will "feel" them, however, because they make the products dry faster, smell worse and may make them more viscous (thicker) – and more expensive.

So it will help your adjustment if you are aware of these changes so you recognize what is happening if a new can of the finish you're used to behaves differently.

The impetus for the changes is to lower the volatile organic compounds (VOCs) and hazardous air pollutants (HAPs) that are exhausted into the atmosphere.

All solvents are VOCs, which react in sunlight with nitrogen oxides to form ground-level ozone (smog). Nitrogen oxides are produced in high-temperature-combustion power plants and car and truck engines.

Some solvents, however, are so low in reactivity that they have been made "exempt" from VOC regulations. For coatings, these include primarily acetone, but also a few that are unfamiliar, including methyl acetate, parachlorobenzotrifluoride (PCBTF) and tert-butyl acetate (TBAc). You may see these listed on finishing products promoted as environmentally friendly.

Solvents that are considered health problems are called HAPs. Actually, it could be argued that all solvents are hazardous at some level of exposure, but some are more so than others.

Most solvents are restricted both as VOCs and HAPs, but there are some exceptions. The most notable is methylene chloride, the fast-acting stripping solvent. It is a HAP when used in large amounts, but it is exempt as a VOC. Therefore, high-volume refinish shops with employees come under OSHA restrictions, but everyone has access to high-percentage methylene-chloride strippers in small quart and gallon containers.

Location

Location is everything when it comes to restrictions on exhaust and availability of products. Some areas are much more restrictive than others, and the trend everywhere is to become increasingly more restrictive.

The counties around Los Angeles (which united to form the South Coast Air Quality Management District, or SCAQMD) are leading the way with the strictest regulations. The entire West

CONTINUED ON PAGE 66

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CONTINUED FROM PAGE 64

coast and states in the Northeast and Midwest are not far behind. Various large-population localities in between also have restrictions.

One of the big problems is that the definition of exempt solvents keeps changing. There are many ways to measure VOCs – for example:

- by percentage, counting each non-exempt VOC as having the same environmentally damaging effect
- by relative reactivity, with the most reactive (with nitrogen oxides) being restricted the most
- by evaporation rate, with the slowest evaporating being the least reactive.

Various regulatory bodies use different methods and standards for measuring and setting limits.

Moreover, standards differ for different products. For example, oil stain is usually allowed a higher non-exempt VOC content than polyurethane, and gloss paint is allowed more than flat paint.

It all becomes so complicated that many finish manufacturers hire trained environmental specialists (with college degrees in the field) just to keep abreast of everything that is happening so they can advise their formulators and their large-user customers.

The restrictions are aimed primarily at these large users, so you aren't affected directly if you are an amateur or small-shop professional doing finishing on an irregular basis. But the restrictions are increasingly being applied to what can be sold, so you are affected if the varnish or lacquer you've been using changes in viscosity, dry time or odor, or it increases in price.

Even if you don't live in one of the more restrictive areas, you may still be affected because manufacturers often reduce costs by complying only with the most restrictive regulations and selling these products everywhere. It's much less expensive to have just one formulation and one label.

Fast-drying problems. *Reformulated finishes, made to comply with new VOC regulations, tend to dry faster than the finishes you may be used to. Faster drying causes problems such as more pronounced brush marks (top), dry spray when spraying (center) and lacquer blushing on humid days (bottom).*

Other VOC & HAP Solutions

Reformulating finishing products isn't the only way to reduce VOC and HAP emissions. There are several others, two of which you're probably familiar with: high-volume, low-pressure (HVLP) spray guns and water-based finishes.

HVLP is a spray-gun technology introduced in the 1980s that produces a soft spray with much less bounce-back and waste than traditional high-pressure spray guns. HVLP spray guns work with both compressors and turbines and are now so efficient that they have almost entirely replaced high-pressure guns. In fact, it's difficult to even find new high-pressure guns anymore.

Water-based stains and finishes used at the mass-consumer level continue to contain non-exempt VOCs and HAPs but in so little quantity that they rarely exceed even the most restrictive regulations.

Formulation using exempt solvents, however, can actually produce a solvent-based finish that contains fewer VOCs and HAPs than a water-based finish. So don't think that solvent-based finishes as a category are going to disappear everywhere anytime soon. They're just going to change.

On the industrial level, there are three types of coatings in wide use besides water-based finishes that make compliance possible: high-solids, such as polyester and two-part polyurethane; UV-cured; and powder. All require specialized equipment.

Bottom Line

Unless you are a large user of finishing products, you don't fall under any environmental restrictions regarding the products you use. But you will increasingly find that the products you're accustomed to using change in their application characteristics, or disappear entirely from your local stores and mail-order suppliers. **PWM**

Bob wrote about specific examples of environmentally friendly solvents in the February and April 2012 issues (#196 and #196) of Popular Woodworking Magazine.

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A Teacher's Seat

Imperfect woodworking often imparts the best lessons.

A good friend asked me if I could help his son put together a chair he wanted to make and like a good neighbor, I said, "Sure, I will be happy to look at it and offer a little advice." That was two years ago and we are still happily learning a few things each week about woodworking.

You may have noticed I said "we" – and it is true. We began with six cedar trees that my young friend had chopped down and stripped of bark. He had no real tools and even less knowledge about how to construct a chair. He did come with lots of ideas and opinions. I am surprised when I look back that the two of us not only survived but managed to construct Justin's chair.

The chair was a journey of 10 months, four hours and one week. My learning consisted of listening to an 11-year-old with lots of ideas, more energy than I could remember having and no woodworking knowledge, focus, concern for quality or a clue about tools.

Along the way Justin learned how to cut tenons by hand. I learned that it was OK if they did not fit perfectly. He learned how to make half-lap joints. I learned it was OK to shim them. He learned how to make rails with wedged-tenon joints. I learned a small split was OK. He learned to sharpen my chisels. I learned it was OK to touch them up when he went home. He learned to vacuum the shop. I learned it was OK to not get it all. He learned to put the tools away. I learned it was OK to let some sit out for a while. He learned to weave a rush seat. I learned it was OK to have a few spaces.

We took a break from the chair as he became tired, frustrated and a little disappointed that it was taking so long. Justin carved crosses for Christmas gifts. He made a sturdy box. He took a tree limb from an oak that had fallen in a storm and he hand-carved a bowl. He took offcuts of pine and built a box for his tools. He carved a spoon for camping which began a whole new journey of working with green wood.

I must have moved that chair and all of its parts a hundred times, wondering if it would become firewood. Finally the day arrived, and as Justin finished weaving the seat he said to me, "Mr. Scot, I now know why chairs cost so much."

Justin's chair sees daily use and no one notices all the small issues; they see only the beauty of a rustic chair.

After two years we still meet. I never know what Justin will bring or what we will do. What I do know is that he now has good tools and maintains them. He is building his own home shop. He is teaching his younger brother to carve. He now begins by drawing designs and works to finish his projects.

Justin keeps me on my toes because he always has a new project along with ideas about how it should work. He is still learning and he's still teaching me. The important thing is that Justin brings freedom and joy to the craft of woodworking not only for himself, but for me. **PWM**

Scot worked in furniture and home restoration for a number of years in the historic districts of San Antonio, Texas, before building a career in ortho-bionomy. He now works wood for pleasure and relaxation – much of the time alongside Justin.

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PHOTO BY PATRICK MCGRATH

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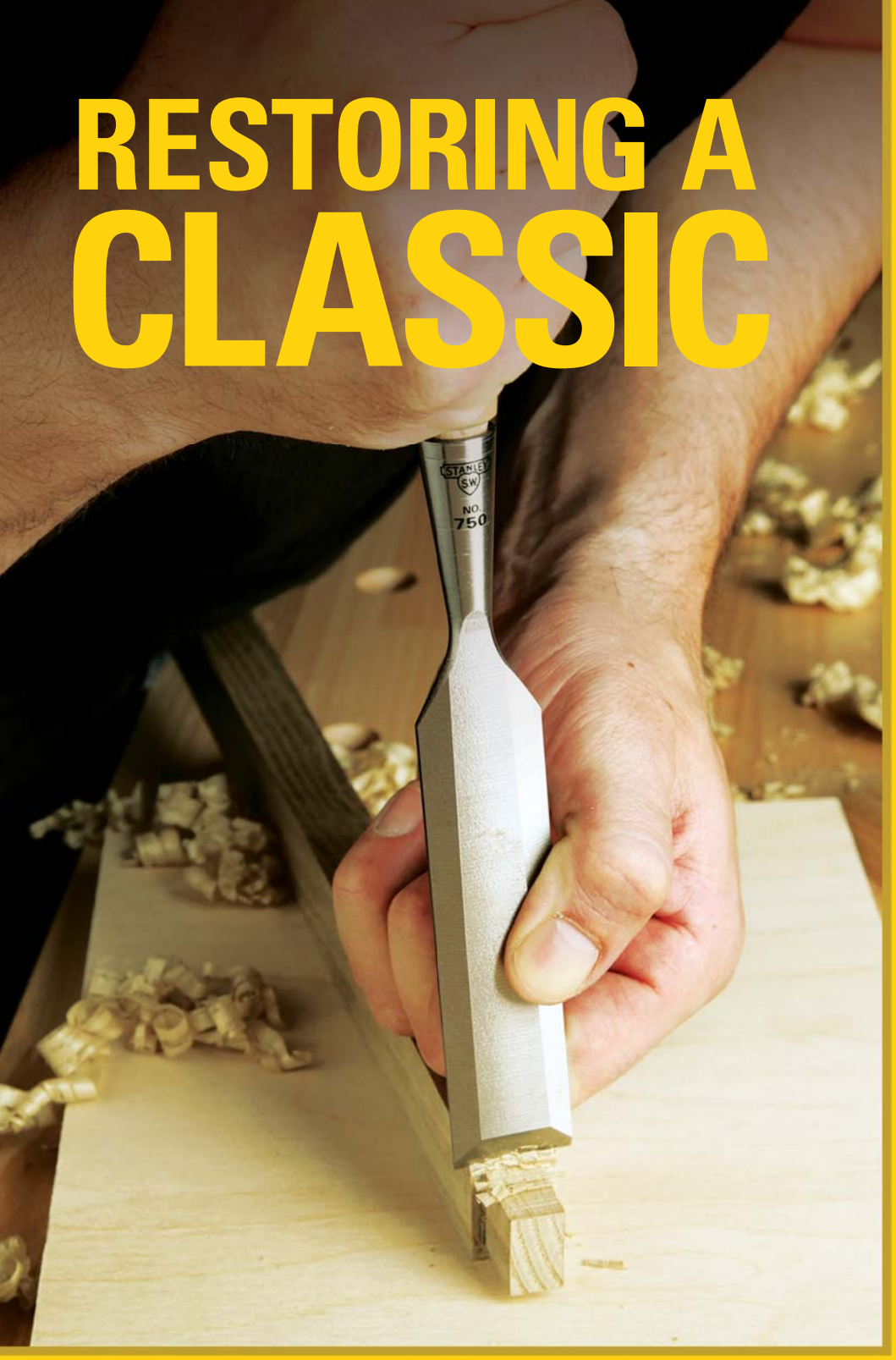

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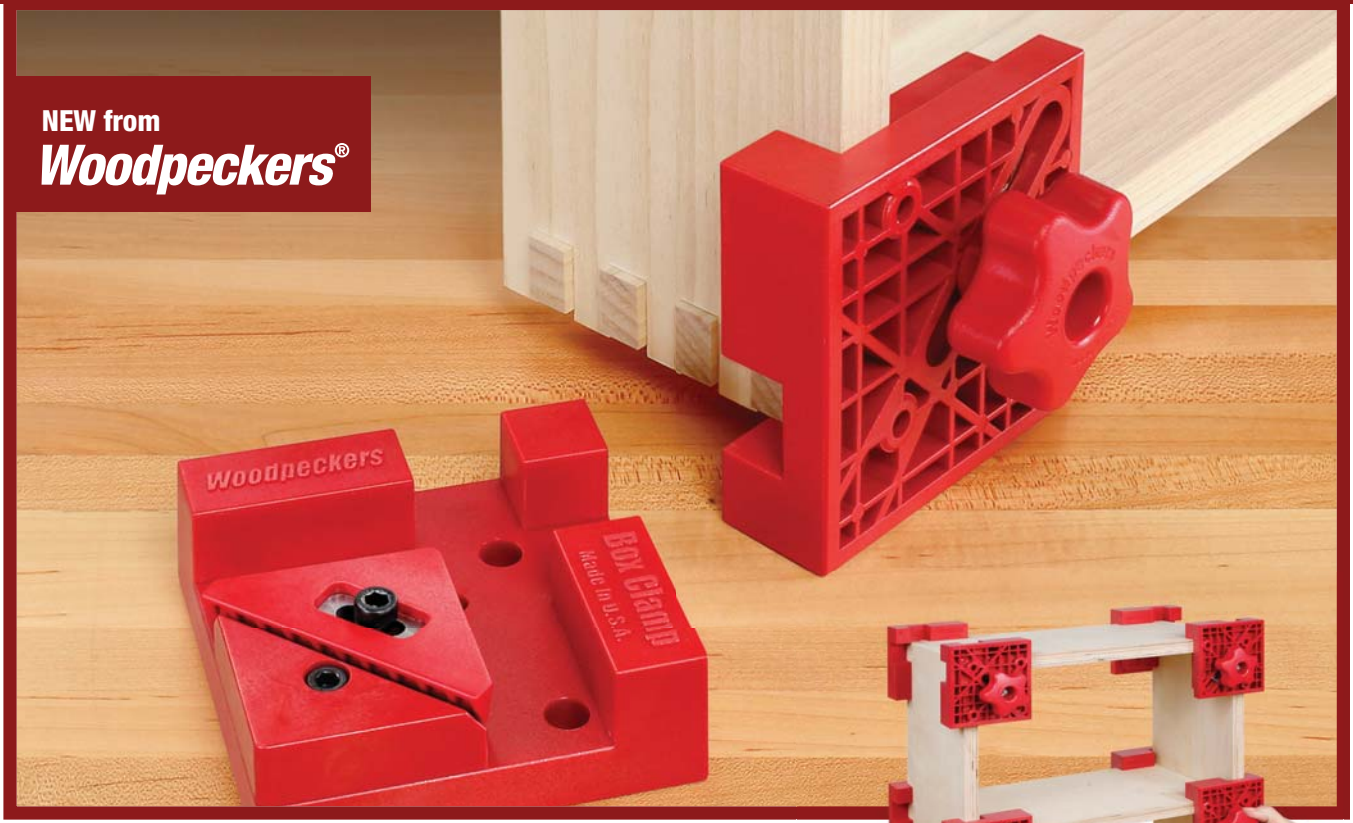

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Imagine being able to dry-fit all parts at the same time without any clamps to interfere with the assembly process. You'll know right from the start if your project is square and be able to confirm part placement and dimensions.

Even better, you can to do all that without a second set of hands. Once your project is glued and clamped, you can easily install pocket screws from the inside or any other fasteners from the outside. Both parts will be square and secure from unwanted movement.

Woodpeckers Box Clamps are designed for most 90 degree joints including pocket hole joints, lap joints, dado as well as T-joints. Virtually any joint found in common cabinetry.

The new Box Clamp™ is also perfect for box joints, half-blind and through dovetail joints. Whether the corner is flush or has material extending from the surface, the clearance is there to ensure a square corner.

When you need square corners, you can't beat the Woodpeckers Box Clamp™.

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