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October 2014 ■ #213

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- Table tilt: 45° R, 15° L
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- Max. cutting height: 6"
- Blade size: 92½"–93½" L (⅛"–¾" W)
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- Motor: 2 HP, 110V/220V, single-phase, TEFC
- Precision-ground cast iron table size: 17" sq.
- Table tilt: 45° R, 10° L
- Cutting capacity/throat: 16¼"
- Max. cutting height: 12⅛"
- Blade size: 131½" L (⅛"–1" W)
- Blade speeds: 1700 & 3500 FPM
- Quick release blade tension lever
- Approx. shipping weight: 346 lbs.

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- Motor: 3 HP, 220V, single-phase, TEFC
- Precision-ground cast iron table size: 26¾" x 19"
- Table tilt: 45° R, 5° L
- Cutting capacity/throat: 18¼"
- Max. cutting height: 12"
- Blade size: 143" L (⅛"–1¼" W)
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- Capacity: 3⅛" @ 90°, 2¼" @ 45°
- Rip capacity: 30" R, 12" L
- Approx. shipping weight: 208 lbs.

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- Motor: 2 HP, 110V/220V, single-phase
- Precision ground cast iron table with wings measures: 27" x 40"
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- Capacity: 3⅛" @ 90°, 2³⁄₁₆" @ 45°
- Rip capacity: 30" R, 12" L
- Quick change riving knife
- Cast iron trunnions
- Approx. shipping weight: 404 lbs.

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- Max. depth of cut: 3" @ 90°, 2⅛" @ 45°
- Approx. shipping weight: 550 lbs.

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CSA C US 232857

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- Precision-ground cast iron table size: 9" x 72½"
- Max. depth of cut: ⅛"
- Max. rabbeting depth: ½"
- Cutterhead dia.: 3"
- Cutterhead speed: 5000 RPM
- Cuts per minute: 20,000 (G0656P), 21,400 (G0656PX)
- Approx. shipping weight: 500 lbs.

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- Motor: 5 HP, 220V, single-phase
- Jointer table size: 14" x 59½"
- Cutterhead dia.: 3⅛"
- Cutterhead speed: 5034 RPM
- Max. jointer depth of cut: ⅛"
- Max. width of cut: 12"
- Planer feed rate: 22 FPM
- Max. planer depth of cut: ⅛"
- Max. planer cutting height: 8"
- Planer table size: 12¼" x 23⅛"
- Approx. shipping weight: 704 lbs.

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15" PLANERS

- Motor: 3 HP, 220V, single-phase
- Precision-ground cast iron table size: 15" x 20"
- Min. stock thickness: 3⁄16"
- Min. stock length: 8"
- Max. cutting depth: ⅛"
- Feed rate: 16 & 30 FPM
- Cutterhead speed: 4800 RPM
- Approx. shipping weight: 660 lbs.

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BUILT-IN MOBILE BASE

G0453P ONLY $1125.00
WITH SPIRAL CUTTERHEAD **G0453PX ONLY $1750.00**

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20" PLANER

- Motor: 5 HP, 240V, single-phase
- Maximum cutting width: 20"
- Maximum cutting height: 8"
- Minimum stock thickness: 3⁄16"
- Minimum stock length: 8"
- Maximum cutting depth: ⅛"
- Feed rate: 16 FPM and 20 FPM
- Cutterhead diameter: 3⅛"
- Cutterhead speed: 4800 RPM
- Feed rolls: solid serrated steel
- Table size: 20" x 25¾" (20" x 55½" with extension)
- Overall dimensions: 55½"L x 39½"W x 45⅞"H
- Approximate shipping weight: 920 lbs.

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CSA C US 177335

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CYCLONE DUST COLLECTOR

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- Impeller: 13½"
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- Built-in remote control switch
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- Static pressure: 11"
- 6" inlet has removable "Y" fitting with two 4" openings
- Impeller: 12¾" balanced cast aluminum
- Bag capacity: 5.7 cubic feet
- Standard bag filtration: 2.5 micron
- Portable base size: 21¼" x 33½"
- Bag size (dia. x depth): 19½" x 33"
- Powder coated paint
- Height with bags inflated: 78"
- Approx. shipping weight: 122 lbs.

Polar Bear Series

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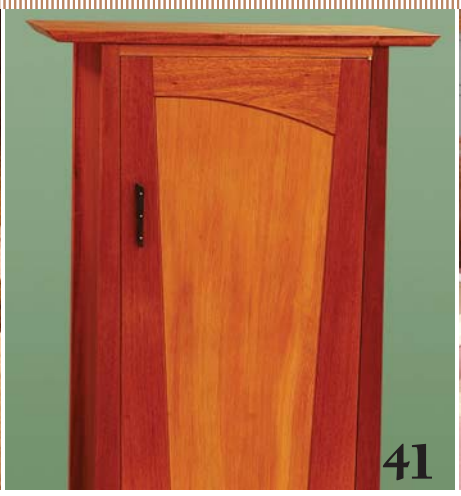

FEATURES

BREADBOARD ENDS PHOTO BY AL PARRISH; CABINET PHOTO BY GARY ROGOWSKI; VENEERING PHOTO BY JASON ZENTNER; BENCH PLANE PHOTO BY WILLARD ANDERSON

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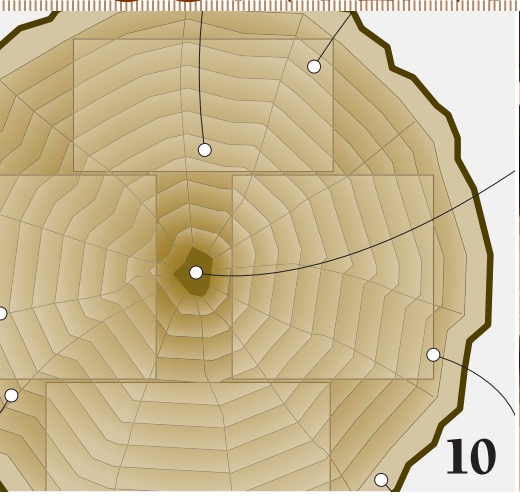

REGULARS

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POPULAR WOODWORKING MAGAZINE

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Welcome, Gentles All

With this issue of *Popular Woodworking Magazine* (PWM), we have some announcements – greetings, really.

PWM welcomes subscribers to *American Woodworker* (AW) – and in issues to come, we also welcome some of the best-known and best-loved authors from AW – to start, in this issue, you'll find Laurie McKichan's article on urea formaldehyde glue. And in future issues, you'll read articles from Alan Lacer, Spike Carlsen and of course, Glen D. Huey (who I am grateful to have back on the PWM staff as the executive managing editor).

I'm also excited to introduce you in coming issues to a couple of young and amazing craftsmen – you likely don't know their names or work yet, but they're well worth getting to know. Plus we'll be adding a few contemporary designs to go along with the evergreen Arts & Crafts, Shaker and period pieces. (And of course, we'll continue to bring you articles from the likes of Don Williams, Jeff Miller, Darrell Peart and more, as well as from all the editors.)

In other changes: As many of you have kindly noted, Bob Rozaieski has been doing a cracking job for the past year as our Arts & Mysteries columnist – a column founded in 2005 by Adam Cherubini to help revive the lost arts and practices of pre-Industrial woodworking. The title refers to the words used in contracts between masters and apprentices in the joiner's guild (and others). The word "mysteries" may be a period term for "vocation," or it may refer to the secrets of the craft, which were sworn to be guarded closely by its members.

Joseph Moxon's "Mechanick Exercises" (1678), the first English-language book on woodworking, gives us a glimpse and a look at tools – but not much more. We don't know, for example, what our forebears thoughts were on pins first vs. tails first (nor do I, for one, really care).

But we also have some historical evidence in engravings, carvings such as the Stent panel and, of course, in extant tools and furniture (overcuts on dovetails, anyone? Evidence points to "yea").

And, we have Adam Cherubini, Bob Rozaieski and Peter Follansbee – who I'm quite pleased to announce takes over with this issue the Arts & Mysteries column – delving into old ways of working, actually using the tools of the period to come up with their interpretations of the old ways, and making them new again. (And I dare say a lot of you do the same.) Given Peter's background in 17th-century woodworking, I think we can expect to see his topics go back a century farther than did Adam and Bob. Peter is a wholly inquisitive woodworker and researcher – I'm excited to see where his interests will take us.

So welcome to Peter, AW authors and AW subscribers; we're glad to have you with us. And as long-time PWM readers know, if you ever have a question, complaint or comment, we're just a phone call or e-mail away; you'll find contact information in the masthead (at right) of every issue. **PWM**

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Question of Pith

This morning I took a look at two beams of milled and dried white oak for the purpose of joining them in the manner Christopher Schwarz did in "The Workbench Design Book." There are issues with dimensions, and one beam includes the pith. I could really use your expertise before I lay down the cash.

On the latter, you recommended avoiding the pith. Does that include dried wood? This stock has air-dried for more than five years and there are very small cracks (maybe 1/16") radiating from the pith. My hope is that the cracking occurs in the drying, and because this stuff is dry I'm seeing all the cracking that will occur. Can normal movement even after assembly make it prone to cracking and splitting?

My desired final dimensions are same as yours: 3" x 20" x 8'. That would fit in my tiny shop. The shortest beam is a little over 7' long while the other is just over 12'. So I won't hit 8', but think I could live with 7'. Both beams are 4" x 13". You started with 5". Do you think it possible to true 4" stock and still end up with 3"?

Kurtis Jay Johnson
Lincoln, Nebraska

Kurtis,

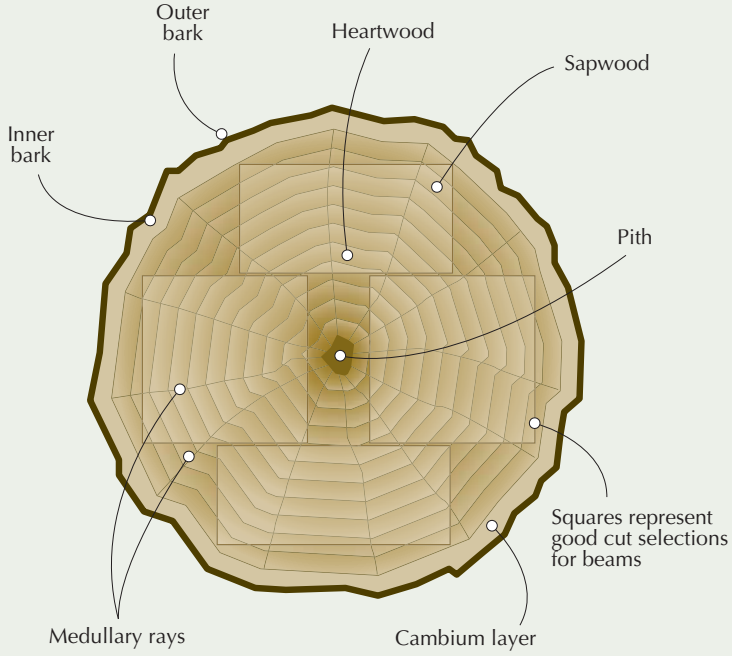
Pith is undesirable in all cases. Wood movement occurs along the annular rings. So having a circle of rings almost always results in splits.

When faced with pith in a benchtop, I usually rip out the pith section and rejoin the boards. Problem solved.

On getting a final thickness, every board is different. Cut your pieces to 1" overlong before surfacing them for the best results. You can also end up with thicker wood if you worry only about the flatness of the underside of the top in the joinery areas – instead of going for 100 percent flatness over the whole surface.

Typically with rough stock that is in good shape, 4" will finish out to 3½" for me.

Christopher Schwarz
contributing editor



Jacobean Dovetails

I enjoyed Chuck Bender's online article"Design in Practice: Arts & Crafts, Mission – It's All Jacobean to Me" (on the Editors' Blog). It got me wondering about the use of dovetails and Jacobean construction methods. Was Jacobean furniture typically constructed from green or seasoned lumber? Is there an historical precedent for using dovetails in green-lumber furniture construction? Did Jacobean furniture use drawers? If so, what joints were typically used?

Ian Jay
via e-mail

Ian,

Dovetails have been in use for thousands of years – they just were not the predominant method of case construction in this country until the late 1600s to early 1700s.

Much of the furniture prior to the William & Mary period was constructed using green wood, but a good bit of it also used dried material. It really depends on the piece. Most of the drawers I've seen from the mid- to late-1600s have usually had one big dovetail (or, at most, a couple). Lots, but not all, drawers were side-hung, which lends itself to one big tail so that there is a place to run the groove on which the drawer hangs. The backs of the drawers I've seen were constructed either with large, crude dovetails or a rabbet or butt joint.

I know that all sounds a little ambiguous, but there are no hard, fast rules for furniture construction details and design during any period. I've found that the minute someone says "This is absolutely the only way it was done," someone else comes up with a half-dozen variations that contradict the rule.

Chuck Bender, senior editor

Propane is Plenty Hot

In the June 2014 issue (#211), there is an excellent article, "Rehandling Mortise Chisels," that should do a lot to keep old mortise chisels in service (and the technique applies to any tanged chisel).

I do, however, take exception to two statements. First, the authors, Willard

CONTINUED ON PAGE 12

ILLUSTRATION BY MARY JANE FAVORITE

CONTINUED FROM PAGE 10

RENEWAL SCAM ALERT

It has recently been brought to our attention that a company called Publishers Payment has been mailing renewal notices for *Popular Woodworking Magazine* and for *American Woodworker*. This company, based in White City, Ore., is in no way associated with us and is grossly overcharging for any renewal or subscription services it may (or may not) provide. Our subscription fulfillment service is Palm Coast Data (PCD), based in Palm Coast, Fla. We are based in Cincinnati, Ohio. Protect your money; please do not respond to renewal notices from anyone other than us and/or PCD. And should you ever have questions or concerns about a renewal or subscription offer, send me an e-mail; I'll get you answers.

— Megan Fitzpatrick, editor

Anderson and Peter Ross, state that a propane torch will not produce enough heat to do this job, so an oxy-acetylene torch is needed. Second they state that if you use the actual chisel tang, the heat applied can draw the hardness out of the steel.

I know several people who have done both of the aforementioned for many years with great success. And I have also performed this handle-fitting operation with good success using a propane torch and a large iron vise with copper or aluminum soft jaws to wick the heat away.

My concern is that these inaccurate statements may discourage people from attempting this operation; I am sure that is just the opposite result the authors and the magazine wanted.

Bill Rittner
Manchester, Connecticut

Editor's note:
Bill Rittner, owner of Hardware City Tools, has written a blog post about his approach; you can read it at: newbritainboy.wordpress.com/2014/05/11/installing-a-handle-on-a-tanged-chisel.

Soap Finish Questions

I am intrigued by the finish that Bob Flexner describes in his article "Soap as a Wood Finish" (April 2014, issue #210), but I have a few questions.

The article states that the finish is high-maintenance, with high-use surfaces requiring frequent reapplication. Would a piece that gets no physical contact, such as a picture frame or sculpture, still need reapplication?

I would also like to know if I could achieve the same finish by shaving a bar of Ivory soap into flakes, then follow the process described in the article.

Jeff Ziegenhorn
Memphis, Tennessee

Jeff,
After a few applications, as I described in the article, I would think that the surfaces you're talking about wouldn't need any more for a very long time.

As for using Ivory bar soap, it's not the same thing. I really doubt it would work the same. A bag of soap flakes isn't expensive from the sources I listed. And it will go a very long way. You can also use it for washing clothes and other chores. **PWM**

Bob Flexner, 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.

PHOTO BY THE AUTHOR

Highly Recommended

I've been working with a lot of plywood lately to build kitchen cabinets, thus splinters and I are well acquainted. So with the exception of my drill/driver, no tool has been more used than my tweezers.

I have a few pair at home for brow maintenance, but those are pikers compared to those in my toolbox: Tweezerman's Splintertweeze ($15). The needle points make it easy to get under little slivers (and do a little jobsite surgery when required). Look for them online at tweezerman.com.

— Megan Fitzpatrick

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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.

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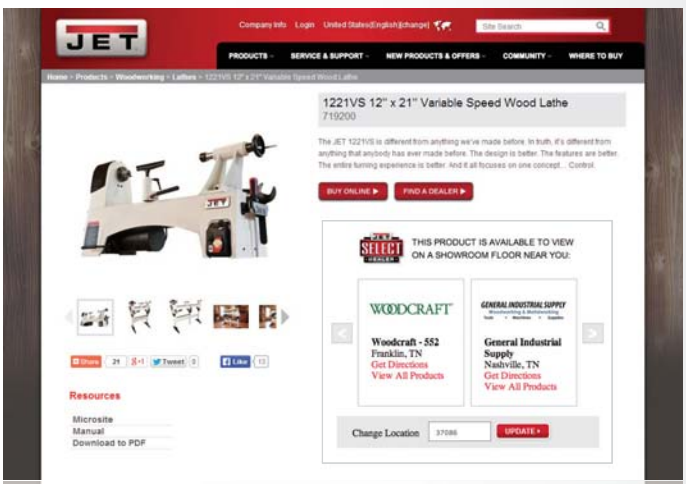

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THE WINNER:

Gas-powered Plane-till Lid

I have a meager collection of handplanes made up of mostly dog-meat users. I like using planes that have history because it's fun to think about what each might have made during the last 100 years. None of my planes are particularly nice, but I do want to keep them from getting destroyed.

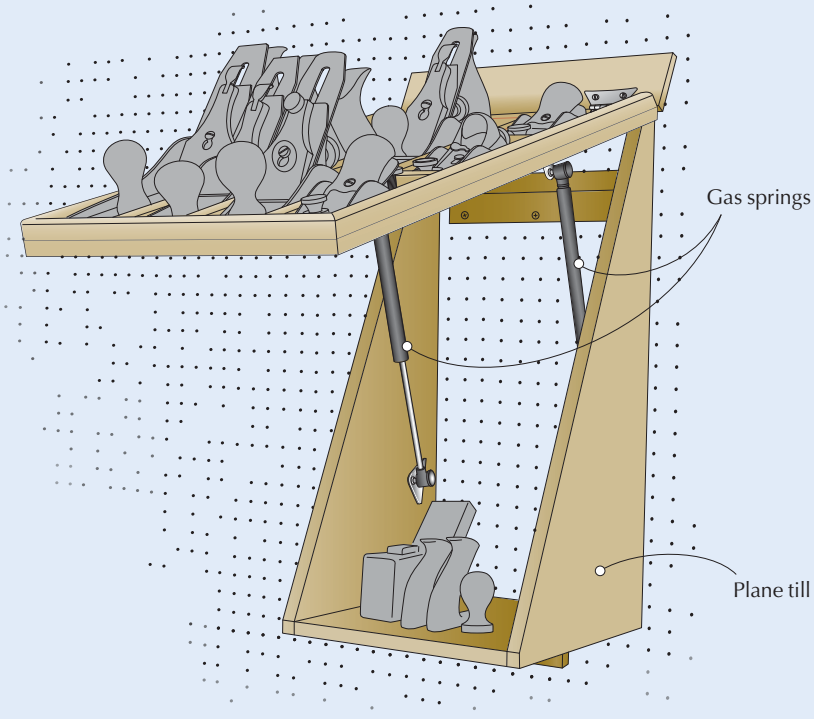
For a long time, my planes cluttered my workspace, got knocked around on my bench and were always in danger of crashing to the floor. In order to keep my tools in good shape, I decided to build a plane till.

The first thing I did was take inventory of the planes that I wanted to fit into the till. I then sketched out a plan of the appropriate size, gathered some lumber, bought butterfly hinges then started building. (The lid rests at a 65° angle, which is appropriate for my planes to rest safely.)

After all the planes were in place, the loaded lid was difficult to lift for access to the storage area behind. I considered safety lifts for toy chests, but couldn't find any that were strong enough to hold the fully loaded lid in an upright position – so I kept looking.

One day I opened the back of my wife's mini-van and the solution came to me – pneumatic gas springs. They would be perfect.

I found some gas springs through a woodworking mail-order supply, but the selection was minimal and the ones available also wouldn't support the 50 or so pounds of the loaded lid.

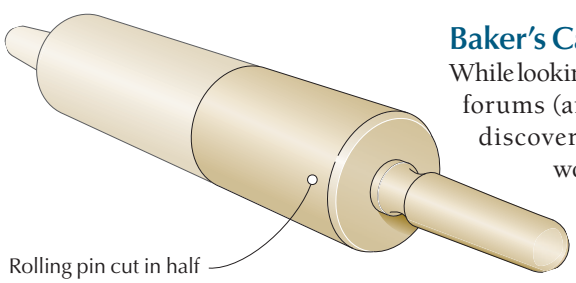


Springs are all over online auctions sites, but it's nearly impossible to identify load specs. Plus, most don't include the necessary mounting hardware, or the information needed to select it. I eventually came upon Guden, in New York. The company has a complete line of sizes with ratings. I calculated the load spec required, decided on hardware then placed my order at guden.com/Control/Gas-Springs.

The springs are easy to spec, easy to install and relatively inexpensive. For more information on calculating weight loads to choose the appropriate springs, see "Online Extras").

The springs work better than I'd hoped. The lid auto-lifts to almost full extension and requires only light pressure to return it to its resting position. One word of caution: You need to keep some weight on the panel at all times or it opens under its own power; a spring latch would easily resolve this problem. Adding gas springs makes using the plane till nothing short of fun.

Scott Perry
Douglasville, Pennsylvania



Baker's Carving Mallet

While looking through leather-working forums (another favorite hobby), I discovered something I thought would transfer to woodworking quite well.

Many leather-working tools are struck with a wooden mallet. Someone suggested purchasing a wooden rolling pin then cutting it in half to yield two mallets.

The handles are a little on the small side, but it's a good, cheap alternative to expensive carving mallets.

Kari Hultman
Lemoyne, Pennsylvania

ILLUSTRATIONS BY MARY JANE FAVORITE

Rabbet-plane Blade Setup

Here's a simple way to get the proper side protrusion of the blade on a rabbet or shoulder plane. (For a rabbet plane, remove the depth stop so the plane can rest flat on its side.)

Cut two pieces of regular-bond paper in half (giving you four pieces). With the plane on its side, place two pieces under the plane in front of the iron and two behind. The plane should now be held off the table, bench or other flat surface by the thickness of the two sheets of paper.

Loosen the blade (slightly) and press it sideways until the corner of the blade touches the table or bench. Tighten the blade and the corners of your plane blade will be sticking out by about .005" to .010".

You could instead use two business cards, but some cards are printed on heavy stock and this makes the protrusion too much.

Dan Miller
Lakewood, California

Trash Bag Rust Removal

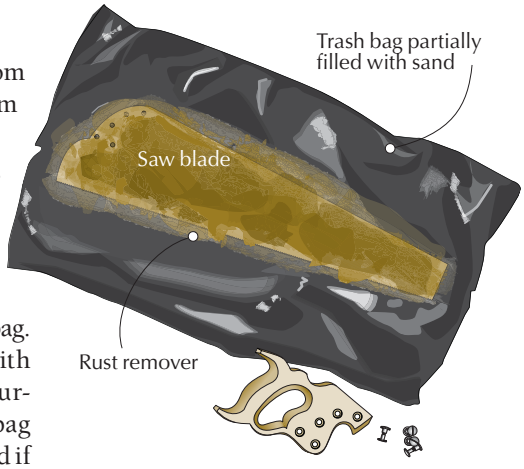
Try this method to remove rust from any hand tool using a minimum amount of rust remover.

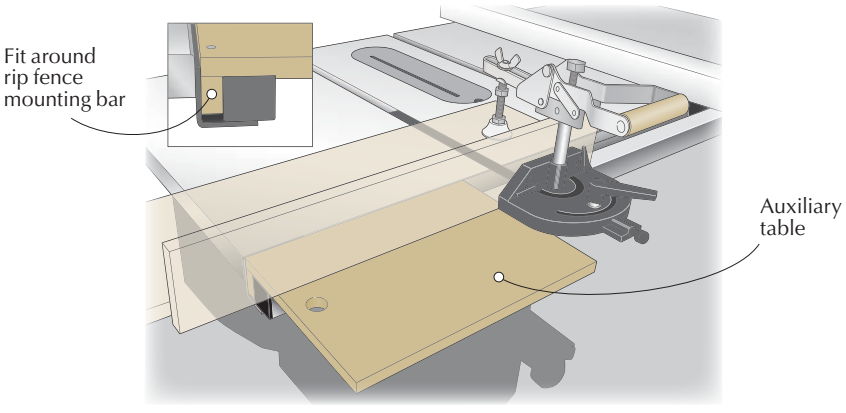
First, to a heavy-mil garbage bag, add a fair amount of sand (the larger the tool the more sand you'll need). If you're restoring something small, such as a spokeshave, you could use a one-gallon food-storage bag.

After you have the bag filled with sand, lay it on the floor or worksurface. Put your tool on top of the bag then press down the way you would if you were making a handprint in your neighbor's wet concrete.

If you're working with something sharp (such as a saw blade), put a piece of masking tape over the teeth before you press it into the sand. With the tool-shaped-depression created, dislodge the blade and remove the tape. Put the tool back into the depression then add the rust remover.

Jeff Vanek
Crown Point, Indiana





Crosscut Auxiliary Table

Rather than build a bulky crosscut sled for my table saw, I made a small jig that allows my miter gauge to work without getting stuck on the front edge of the saw. This helps when working on wider panels.

The jig fits tightly over the rectangular guide bar for the rip fence, is offset from the miter slot and brings the top surface level with the saw table. While in place, the long fence on my miter gauge doesn't sag when the protractor head hangs off the front of the table.

The auxiliary jig can be positioned to the right or left of the blade as appropriate, and stores on a hook when not in use. **PWM**

Larry Lapson
Brookline, Massachusetts

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‘Ready 2 Rout’ Automated Fence

Add computer power to your router table to make tasks quick and accurate.

Even if modern technology frightens you, it might be worthwhile to consider the Ready 2 Rout (R2R) for your router table. This automated router fence system is as easy to use as it is to set up – it’s literally touch and go.

With less than an hour invested in unpacking, setting up and testing the fence, I was amazed at how intuitive it is to use the tool. The touch-screen menus are easy to navigate, bright and easy to read.

With the standard metal touch plate, setup is five easy steps. Put your bit into the router table, punch the bit diameter into the R2R, clip the magnetic tether to the bit, put the plate against the fence and press the “OK” button. The fence moves automatically to make contact with the bit, then calibrates the readout to zero. From there, until you change bits, you can accurately adjust the fence position from the touch screen.

The $600 system shines when you’re doing repetitive operations such as making box joints or half-blind dovetails, but it’s not limited to those tasks. In fact, there are several other joint applications. It easily plans and executes complex conversions and operations.

The pre-programmed applications are even easier to use. If you want to make evenly spaced dovetails on your drawer fronts, tap the screen and plug in the width of your board, the diameter of your bit, the number of dovetails you want and, as my old teacher Werner Duerr used to say, “Bang – got it.”

Enter the digital age. *Once you use the touch plate to calibrate the Ready 2 Rout, you’ll find plenty of uses for this router table accessory.*

Box joints and sliding dovetails are handled the same. To make it easier, Next Wave Automation (the maker of R2R) offers an optional sled ($29.99) to make cutting those joints a snap. It works in any standard miter-gauge slot.

The machine also performs custom operations. Let’s say you’re building new shop cabinets using Baltic birch plywood, which is in metric sizes. If you need to run shelf dados but you have only Imperial-sized router bits, you can quickly tap in the bit diameter, the placement of the dado and its final width; the R2R does all the calculations necessary for a perfect fit.

When it’s time to update the applications and firmware, you’ll find the process to be quick and effortless, too. At the company’s web site, download the firmware file to a USB flash drive and head into the shop. With the power to the tool off, insert the drive into the USB port, turn on the machine and in less than minutes, the system is ready to rout using the latest operating system.

The construction of the tool is also top-notch. There’s a worm gear that moves the fence in and out – it has zero backlash. Once you have the fence zeroed in, it stays accurate. There’s no need to constantly re-calibrate. Plus, the extruded-aluminum fence has multiple grooves for T-nuts to make it nearly as versatile as the Ready 2 Rout.

A built-in dust port works reasonably well in conjunction with the optional wooden fence facings, but it’s not great. I found that when I used the fence facings pulled tight to the bit, dust collection was relatively decent. When making box joints – and other processes that use the fence as a stop – the port is fairly ineffective as the fence moves away from the bit.

If you’re looking to increase precision and bring your woodworking into the 21st century, this may be the tool for you.

— Chuck Bender

CONTINUED ON PAGE 18

Ready 2 Rout

Next Wave Automation ▪ nextwaveautomation.com or 419-318-4822

Street price ▪ from $600

▪ VIDEO *See how easy it is to calibrate the computer-guided router fence tool.*

Prices correct at time of publication.

READY 2 ROUT & DUST EXTRACTOR PHOTOS BY AL PARRISH; VISE SCREW PHOTO BY CHRISTOPHER SCHWARZ

CONTINUED FROM PAGE 16

Benchcrafted Classic Leg Vise

Until recently, workbench hardware on the market was so pitiful that you were better off looking for vintage vises and screws for your new bench. These days, however, woodworkers have an embarrassment of riches when it comes to workbench accessories.

Earlier this year, Benchcrafted released its latest vise design, the Benchcrafted Classic. It's an all-metal screw designed for use in a leg vise. While the Classic is based on 19th- and 20th-century European vises, it exceeds them on every point.

For starters, this vise is fast. Thanks to a double-lead, Acme-threaded screw, the vise travels 1/2" per revolution of the tommy bar and still manages a death grip on your work. Like all Benchcrafted equipment, the machining on the vise screws and nut looks ready for the International Space Station.

Instead of your typical gloppy paint job, the vise's hub, collar and tommy bar are "Parkerized" – a durable and rust-resistant surface finish typically used on firearms. The finish is matte, but if you rub it with some fine steel wool it will adopt a deep black glow.

But the sweetest thing about the vise is, surprisingly, the tommy bar itself. The bar has a detent in the center of its length. The hub has an adjustable spring-loaded plunger. This allows you to lock the tommy bar in the center of its length for rapid adjustments. A slight tug on the bar pulls it out of the detent and allows you to really crank the pressure if needed.

When paired with the Benchcrafted Crisscross parallel guide, the resulting leg vise is remarkably fast, smooth and has a tenacious grip. And when you add those features to the prime advantage of a leg vise (lots of clamping surface), you will have a vise that eclipses every quick-release vise on the market. The Benchcrafted Classic costs $195.

— Christopher Schwarz

Benchcrafted Classic

Benchcrafted ▪ benchcrafted.com

Street price ▪ $195

▪ VIDEO *See the Benchcrafted Classic Vise Screw in action.*

Prices correct at time of publication.

Bosch VAC140A Dust Extractor

There are lots of vacuums and dust extractors on the market, but what sets the Bosch VAC140A apart are the well-thought-out details. From the easily accessed drain hose to the hook for hanging the power cord, Bosch has taken into account how people actually use an extractor – the company made it both functional and convenient.

First and foremost, it's a vacuum with lots of suction – 150 cubic feet per minute to be exact (and that translates to 97.15 static inches of water). This means you can suck up dust, shavings and even liquids with ease. And with a tank capacity of 14 gallons, you can do that for quite a while before having to empty it. Plus, any 120-volt tool can be plugged directly into the vacuum for synchronized use.

I like the outrigger casters on the machine. They make it easy to move around the shop and still provide great stability. The unit doesn't get caught on tiny scraps; it just keeps rolling along.

Plus, for storing the hose and power cord, the hooks on the sides are great. They make it quick to tuck the vacuum away at the end of the day, and just as easy to set up whether you want to work in your shop or somewhere else.

The VAC140A has automatic filter cleaning. Every 15 seconds a shaker clears the filter, so it lasts longer and maintains constant suction. It's noisy, but sound beats having to clean the filter by hand. Plus, you can turn it off.

If I have a complaint, it's that the machine is a little noisy. At 70 decibels it's not horrible, but other vacuums in this class are slightly quieter.

The VAC140A is a powerful dust extractor that works well whether attached to a miter saw, sander or as a stand-alone vacuum to clean your bench or shop. **PWM**

— CB

VAC140A Dust Extractor

Bosch ▪ boschtools.com or 877-267-2499

Street price ▪ from $669

▪ BLOG *Learn more about the Bosch VAC140A on our Editors' Blog.*

Prices correct at time of publication.

Sketch a Volute Freehand

Use this classic, graceful curved form to punctuate your work.

Our craft is never far from the forest. Aside from harvesting timber, food and fuel from the woodlands, we harvest ideas and inspiration. The leaf duff covering the forest soil gives way to the green shoots of a fiddlehead fern announcing new life as it unfurls graceful curves.

This iconic inspiration is captured in a form called a volute and is repeated in countless designs from the termination of a crest rail on a Windsor chair to the massive capital of an Ionic column. Historic design guides often included detailed drawings for laying out a graceful volute with a compass and straightedge.

I'll be the first to admit that on the surface, a classical volute drawing can be intimidating with its swirling curves generated from multiple center points. Yet there is real value in the old drawings because they offer keys to guide a freehand sketch, especially for the furniture designer who often needs to draw a small volute over an irregular surface. In fact, even if you wanted to use a compass, on a smaller scale the tiny space won't permit it. With a bit of practice, anyone can draw a graceful volute freehand.

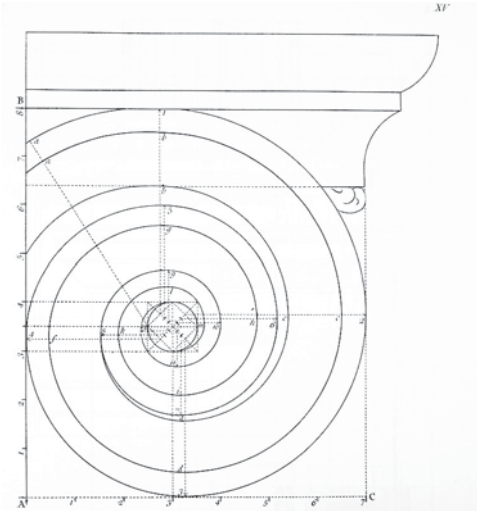
Fiddlehead figure. *When we see a volute in a built object, unconsciously our minds are transported back to the forest.*

Draw the eye. *A volute carving adds a pop of visual interest to this crest rail on a Windsor chair.*

Keys to Drawing a Volute

You might be tempted to just draw a spiral, like a coiled garden hose. But a spiral is a sure way to produce a mechanical-looking form that lacks life or spring. Actually, the first thing to note is that the curved line changes speed, then descends faster or steeper as it dives toward the center eye. This accelerating curve is more exaggerated than a spiral and gives it a sense of vigor.

One way to avoid the static look of a spiral is to consider the number of revolutions around the eye. The line rotating around the eye may revolve one-and-a-half times up to two-and-a-half times before it exits the form. Additional revolutions will tend to make the form look static.



Studied approach. *This formal drawing for a classical volute is from James Gibbs's book "Rules for Drawing," circa 1732.*

CONTINUED ON PAGE 22

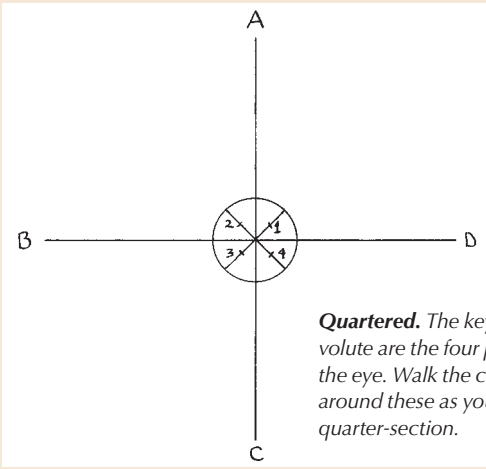
PHOTOS & ILLUSTRATIONS BY THE AUTHOR, EXCEPT AS NOTED

CONTINUED FROM PAGE 20

TRY IT WITH A COMPASS

Here's how to draw a simple classical volute with a compass. This uses vertical and horizontal layout lines that act as starting and ending points for each quarter-circle. Note that the eye is centered over these lines and also note the four additional diagonal lines at 45° inside the eye. Points 1, 2, 3 and 4 are pivot points for the sharp leg of the compass.

Place the compass point on 1 and adjust the compass pencil out to the outer edge of the volute at A. Then draw the first arc down to line B, move the compass point to 2 and adjust the compass pencil to blend with where the first arc just ended. Now start the next quarter-circle down to C. Repeat and walk the quarter-circles around the eye, moving and adjusting the compass point after each arc. — GRW



Quartered. *The keys to a graceful volute are the four points inside the eye. Walk the compass leg around these as you scribe each quarter-section.*

Note that the volute isn't simply a curve descending down to a center point; rather, it's a curved line that flows into a smaller circle or eye. It's as though it emerges from an egg. There are two more important things to note about the eye of a volute: Its diameter is approximately one-fourth to one-third the overall or widest span of the volute. And the eye is not centered; instead, it's pushed away from the widest portion where the volute transitions out into the larger furniture part.

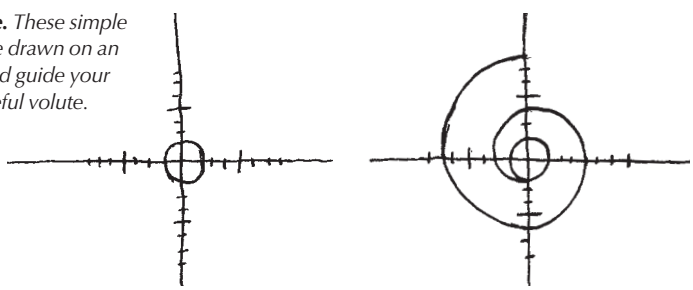
Finally, it's important to note that the essence of the formal compass drawing is to blend together a sequence of quarter-circles, each with a tighter radius. If you can establish starting and ending points for each quarter-circle, it's a helpful guide for a freehand sketch.

Execute a Freehand Volute

With this knowledge, draw a small freehand volute about the size of a soup can's lid. Start with a vertical centerline and a horizontal perpendicular, then draw a circle, or "eye," about the size of a dime centered over the intersection of those two lines. Next make a tick mark on the vertical line at 12 o'clock at the outermost boundary. In this example, the volute rotates one-and-a-half times around the eye. This will require six quarter-circles.

Starting at the top of the eye, divide the vertical space between the eye and the outer boundary into six equal spaces and mark it with small ticks. There is no need for a ruler; you can divide this fairly accurately by eye if you divide the line in half, then each half into thirds until you have six equal spaces. With this vertical marked as a guide, repeat identical tick marks on the other three lines that extend out from the eye.

Now you have reference points for the start and end of each quarter-circle.



Points of reference. *These simple guide marks can be drawn on an irregular surface and guide your eye to draw a graceful volute.*

Begin drawing from the outer boundary and draw a quarter-circle that descends toward the center eye; each arc slopes one tick mark closer to the eye than where it started. Start at the outer hash mark at 12 o'clock and end it at 9 o'clock, but one tick mark closer to the eye. Repeat until it blends into the eye.

I often pencil the quarter-circles in lightly then go back and adjust the curves afterward. I tend to draw the curves too flat, but can always go back and make them fuller once the form is roughed in. **PWM**

George is host of two videos on traditional design (from Lie-Nielsen Toolworks, available in our online store (ShopWoodworking.com).

ONLINE EXTRAS

For links to all these online extras, go to:

- **popularwoodworking.com/oct14**

VIDEO: *Watch the author draw a freehand volute in a free video on our web site.*

IN OUR STORE: *George R. Walker's DVDs.*

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About This Column

Design Matters

Design Matters dives into the basics of proportions, forms, contrast and composition to give you the skill to tackle furniture design challenges with confidence.

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Folding Bookcase

BY CHRISTOPHER SCHWARZ

Though not as lightweight as an eReader, this portable library is far more stylish.

Bookcases that fold up like a clamshell were common among British travelers of the 19th century. Soldiers, students, clerks and the clergy were all fond of this easy way to take a library with them anywhere in the world.

This version of a portable bookcase has been designed to simultaneously hold two different sizes of modern books, both 8½" x 11" and 6" x 9" editions. Or you can move the shelves around to accommodate odd sizes of books in your personal library.

On its face, this is a deceptively simple project. It is but two boxes hinged together. But once you immerse yourself in the details – how the drawers, doors and shelves all work together – you'll find the project is a bit of a puzzle. It's fun to unravel – if you can identify the obstacles ahead of you and sidestep them with grace.

Bookcases such as this were typically made from mahogany, walnut, oak or a local exotic species. I made this version using sapele (*Entandrophragma cylindricum*), an African relative to the three true mahoganies. Before you process a single stick of timber, however, I think it's best to first purchase the hardware for the bookcase. The hinges in particular will guide you as you position the brasses on the bookcase.

Joinery: Easy & Odd

For the most part, the joinery on this bookcase is straightforward. The sides, tops and bottoms of the cases are joined

PHOTOS BY THE AUTHOR; ILLUSTRATIONS BY ROBERT W. LANG FROM THE AUTHOR'S MODEL

They'll never show. *Full-blind dovetails are easy to cut – once you realize they only have to fit together. They aren't for showoffs.*

using full-blind dovetails (the easiest dovetail ever invented). The back is attached to the carcase with the only oddball joint in the project. The back is rabbeted and grooved to both float in the carcase and provide a clean-looking exterior. The doors are joined with typical mortise-and-tenon joints. The drawers are built like many pre-industrial drawers.

One last thing before we start: You probably think the shelf standards are difficult to make. They aren't.

Invisible Dovetails

Many campaign pieces are built using full-blind dovetails. From the outside, the joint looks like just a rabbet, but the pieces hold incredibly tight. On many campaign pieces, the tails would typically go on the top and bottom boards; the pins were on the sides. So that's how I laid out my joints.

Begin on the tailboard by cutting a 1/4"-wide x 1/2"-deep rabbet on the ends of the top and bottom boards. This rabbet creates the lip that covers the end grain of the pin board.

I also cut a second shallow rabbet (shown in the photo above) to help align the boards when I transfer my marks to my pinboard. This second rabbet is optional.

Lay out your tails – four per corner is enough. Cut the tails and remove the waste between them. I used a Forstner bit in a drill press to hog out most of the waste and finished things up with a chisel.

Sneaky dove. *A knife with a dropped point makes it easy to get into the joint and mark your pinboard. Another option: Use an awl with a bent tip.*

Transferring the marks to the pin board is easy. Position the tailboard on top of the pinboard just as they will be assembled. Place a heavy handplane on top of the tailboard to help the pieces stay put as you knife in the shape of the tails on the pinboard.

Wacky Back

The back of each bookcase floats in grooves in each carcase. The groove is straightforward: It is a 1/4" x 7/16" groove that is located 1/4" from the back edge of each side, top and bottom board. But the back itself looks odd. Its four edges are both rabbeted and grooved. This unusual joint allows the back to float and also allows the back to extend to the four edges of each carcase.

Here's how to make it: Cut a 1/4"-deep x 3/8"-wide rabbet on all four edges of your back pieces. Then plow a 1/4"-wide x 13/16"-deep groove in the middle of the four edges of each back. See the photo below (left) to view the result.

Before you glue up the carcases, remove all the machine marks from the interior surfaces. I've made a few of these bookcases; here is the best way I've found to glue these together.

Glue and clamp up one of the carcases. Adjust it until it is square. Then glue up the second carcase. Place it on top of the first carcase – just as they will be hinged together in the end. Use clamps to adjust the second carcase to match the shape of first one. Then clamp them together along their seams.

This procedure gives you two square carcases that mate up, without a lot of trimming one carcase to match the other.

Puzzling pieces. *The back, which is horizontal on the bench, has a rabbet and a groove to allow it to mate with the carcase, which is vertical in the photo.*

Come together. *Clamping the two carcases together during glue-up ensures they will be the same shape when the clamps come off.*

Birds' Mouth Shelf Supports

The notched shelf supports are surprisingly easy to cut with a table saw.

The best plan is to make the angled notches on a wide piece and rip the 2"-wide pieces free afterward. This saves time and allows you to rip away the torn long edges that result from cutting across the grain.

On the table saw, install a stack dado set on the arbor with enough chippers to make a 5/8"-wide dado. Tilt the arbor to 15° and lock it. Cut the birds' mouth notches using your slot miter gauge and the table saw's fence (use a stand-off block to prevent the work from binding between the blade and the fence).

Cut the first angled notch into the work. Then move the fence 5/8" and make a second cut. Move the fence 5/8" and make the third. Keep going until you have all the notches you want.

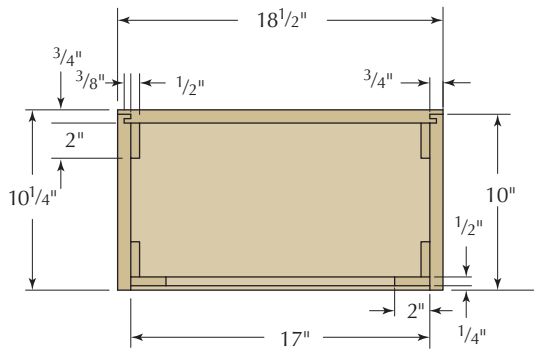
This technique works tremendously well. However, if you are worried about the case sides bowing out, square the bottom of the notches with a wide chisel. A historically correct option is to use a series of dados instead of the angled notches.

Installing the Guts

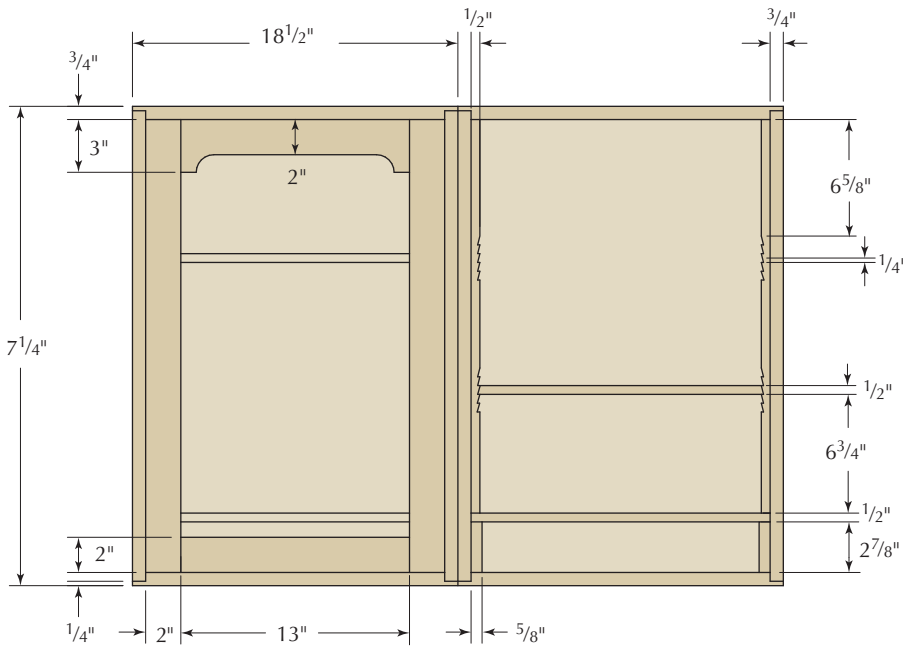
All the interior components of the carcases are glued and nailed. The boxes at the bottom of each carcase that surround the drawers are made of three pieces nailed together. Glue the bottom shelf supports to the interior walls of each carcase. Then glue and nail the fixed shelf on top of them. Done.

Once those drawer boxes are com-

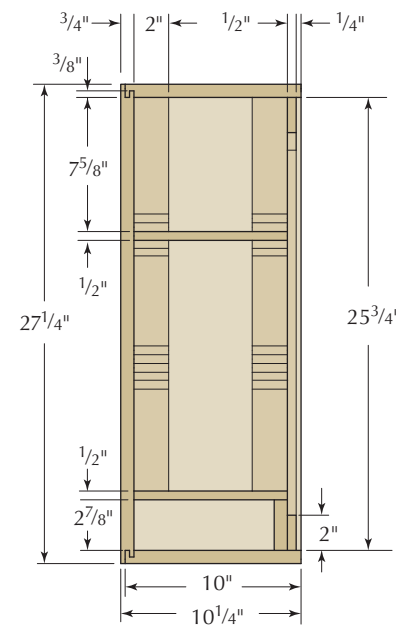
Easy birds. *The birds' mouth shelf supports are cut simply and directly using a dado stack and a table saw. Note the stand-off block clamped to the fence.*



PLAN



FRONT



SECTION

Nicer than metal pins. *The birds' mouth shelf supports are so easy to make, you'll wonder why anyone uses ugly metallic channels.*

Mind the gap. *This is going to sound like overkill, but it works. Measure the gap between the cases at the top and bottom using a dial indicator. Use clamps and shims as shown to adjust the gap. You will be surprised how dead-on you can get the gap.*

plete, you can glue the shelf standards to the interior walls of the carcases. Place one standard at each back corner. Place two more at the front of each carcase. When the glue is dry, cut the adjustable shelves to width and length.

The width of the shelves is easy – the adjustable shelves are the same width as the fixed shelves. The length, however, is trickier. Each end of each shelf is angled at 15° to fit into the shelf standards. With each shelf I cut one end at 15° and then sneaked up on the final length. I made sure that both shelves could fit in either carcase – in every slot and when turned 180°. Don't make them too sloppy, however, or they will rack too easily when you push them into place.

Attach the hinges that join the two cases. The only thing that is critical here is that the gap between the two carcases be dead-on identical. That ensures the pieces will line up like you intended.

Build the Doors

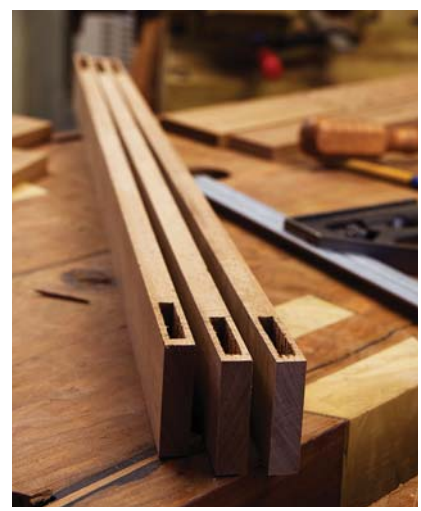
The doors are joined using straightforward mortise-and-tenon joints. I used a hollow-chisel mortiser to make the mortises, so I could get away with making 1/4"-wide mortises in 1/2"-thick material without splitting the material. If you cut these mortises by hand, use a 3/16" chisel instead.

The only wrinkle in these doors is the inside curve on the top rails. My recommendation is to tape the two

Folding Bookcase

NO.	ITEM	DIMENSIONS (INCHES) T	W	L	MATERIAL	COMMENTS
❑ 4	Case sides	3/4	10	26 3/4	Sapele	Full-blind dovetails
❑ 4	Case tops & bottoms	3/4	10	18 1/2	Sapele	1/4" lip for dovetails
❑ 2	Backs	3/4	18 1/2	27 1/4	Sapele	Rabbeted & grooved
❑ 8	Shelf standards	1/2	2	22 3/8	Sapele	
❑ 2	Adjustable shelves	1/2	8 3/4	16 1/4	Sapele	
❑ 2	Fixed shelves	1/2	8 3/4	17	Sapele	
❑ 4	Bottom shelf supports	5/8	8 3/4	2 7/8	Sapele	
❑ 2	Drawer fronts	3/4	2 7/8	15 3/4	Sapele	*
❑ 4	Door stiles	1/2	2	25 3/4	Sapele	
❑ 2	Top rails	1/2	3	15 1/2	Sapele	**TBE
❑ 2	Bottom rails	1/2	2	15 1/2	Sapele	

*Cut drawer sides, backs and bottoms in secondary wood; **TBE = Tenon both ends



Good joints. *Resist the urge to use stub tenons on this door. The glass is heavy and will place considerable strain on the joints. My tenons are 1 1/4" long.*

All together. *Small differences in the curves on the top rails are noticeable and jarring. Cut and refine the joints simultaneously to ensure they are identical.*

"The World is a book, and those who do not travel read only a page."

—Augustine of Hippo (354-430), Christian theologian & philosopher

pieces together and cut the curve on both simultaneously (as shown on the previous page). This ensures the curve will be identical, which is important because any difference will be noticeable.

Glue up the doors, then cut the 1/4" x 1/4" rabbet that will hold the glass on the backside of the doors. I used a router with a rabbeting bit. Then I squared the corners with a chisel. Now install the doors in both carcases.

Here's the only critical point of the operation: Make sure half of the hinge's pin extends out of the carcase. That will allow the door to fully open so the shelves and drawer easily clear the door as they as removed. Then install the locks and the exterior hardware (see "Installing Campaign Hardware" below).

INSTALLING CAMPAIGN HARDWARE

The brasses are the most distinctive feature of campaign furniture, and there are a lot of bits on a typical piece. Here are the strategies I use for the three most common parts: corner brackets (2" x 3/4"), corner guards (2" x 3/4") and pulls.

Corner brackets are simply L-shaped pieces of brass and are easy to install. Set your gauge to the length of each leg of the bracket, taking the reading from the outside of the piece of hardware. Use the gauge to mark the location of the bracket on the carcase. Chop out the waste with a chisel and clean the floor with a small router plane. To ensure the bracket fits tight, pare the sharp corner of the mortise away – or dent it with a hammer, which is my preference.

Corner guards are similar to brackets, but they also have a third surface that covers the entire corner of a piece. They are used on the tops of campaign chests, typically. With this bookcase, they are on the back corners.

You install them like they were simple brackets. Set your cutting gauge to the length of one of the legs and chop away the waste that will allow two legs of the guard to nest in place. That will allow you to then trace the shape of the third surface, which typically is a fancy curve or ogee, directly on the work. Chop that waste away and your corner guard is ready to screw down.

The third typical piece of campaign hardware is a pull with an integral backplate. First make a deep recess in the work that is the width and the length of the structure on the back of the pull. It doesn't have to be exact – it just has to allow the backplate to sit flat on the work.

You can hog out the waste with a drill, chisel or router. Whatever is handy. Then drop the pull into the recess and trace around the backplate. Chop and pare that second shallow recess so the pull sits flush. — CS

One leg. *With hardware for the corners, first make the mortises for the long and skinny legs.*

Now trace. *With the two legs mortised, you can drop the corner guard in place and trace its shape on the wood. Chop the waste away and your corner guard should fit.*

First recess. *The deep recess is the same basic shape as the structure shown on the back of the pull.*

And trace. *With the backplate flat against the work, trace around it with a mechanical pencil. Chop away the waste and fit the backplate until it is flush.*

Routed back. *Usually I cut a rabbet for the glass before assembly, and I use a rabbet plane. But because of the tricky curves and corners on the top rail, I opted for a router.*

Hide that groove. *If you plan your dovetails with care, you can bury the groove for the bottom in the bottommost tail, as shown here.*

SUPPLIES

Londonderry Brasses
londonderry-brasses.com or
610-593-6239

2 ▪ Brass pulls, #CP 6, $25.65 ea.

8 ▪ Brass corner brackets, #CP 35, $5 ea.

8 ▪ Brass corner guards
#CP 44, $12.80 ea.

Lee Valley Tools
leevalley.com or 800-871-8158

1 ▪ Brass safety hasp
#01H1504, $25.80

4 ▪ Brass butt hinges for carcase
#00D03.03, $24/pair

4 ▪ Brass butt hinges for doors
#00D02.01, $16.40/pair

2 ▪ Cast escutcheon plates
#01A19.11, $2.30 ea.

2 ▪ 25 mm surface locks
#00N29.25, $6.30 ea.

1 ▪ "Plain" key
#00N29.90, $5.90 ea.

Prices correct at time of publication.

Window glazing. *Applying window glazing is like working with Play-Doh (and it takes about as long to dry). Still, it gives the door a traditional look.*

Two Dovetailed Drawers

Many of these folding bookcases featured two or three drawers for holding writing materials. My drawers are typical for the early 19th century: The back corners are joined using through-dovetails. The front corners are joined using half-blind dovetails. The bottom slips into a groove plowed in the sides and drawer front.

I used white pine as the secondary wood for the drawer sides and bottom. However, if you are going for the 100-percent pure campaign look, consider using sapele for the drawer sides and bottoms as well for a case made entirely of a rot- and bug-resistant wood, through and through.

Bugs, heat and moisture are also the reason for the brass corner guards on campaign furniture. Not only do they protect casework from hard knocks, they keep it together if the glue fails.

Finishing Up

The finish for campaign pieces is fairly simple: shellac and wax. I applied two coats of garnet shellac then applied a black wax to fill the pores of the mahogany and supply some contrast.

The doors each have a piece of single-pane glass that is secured with traditional glazing points and glazing compound.

These folding bookcases were typically placed on top of a chest of drawers, meaning you could have a library with you wherever you traveled. It was a surprisingly modern idea for the 19th century. And while these bookcases weigh more than my current ebook reader, this bookcase will outlast the plastic contraption – a tradeoff I'm happy to make. **PWM**

Chris is the editor at Lost Art Press and the author of the book "Campaign Furniture." He can be reached at chris@lostartpress.com.

ONLINE EXTRAS

For links to all online extras, go to:
■ **popularwoodworking.com/oct14**

BLOG: *Read about other pieces of campaign furniture on the author's blog.*

IN OUR STORE: *"Handsaw Essentials," by Christopher Schwarz.*

TO BUY: *Plans for a Roorkhee chair, in our October 2012 issue (#199).*

Our products are available online at:
■ **ShopWoodworking.com**

Bench Plane Restoration

BY WILLARD ANDERSON

Learn five common fixes for vintage wooden tools.

There is a deep reverence in using a tool that has been used by generations of woodworkers, possibly traveled across the ocean, seen the Revolution and maybe been carried across the continent to help in building a new life. These tools define the term "vanishing resource" – once they are gone, they will never be seen again.

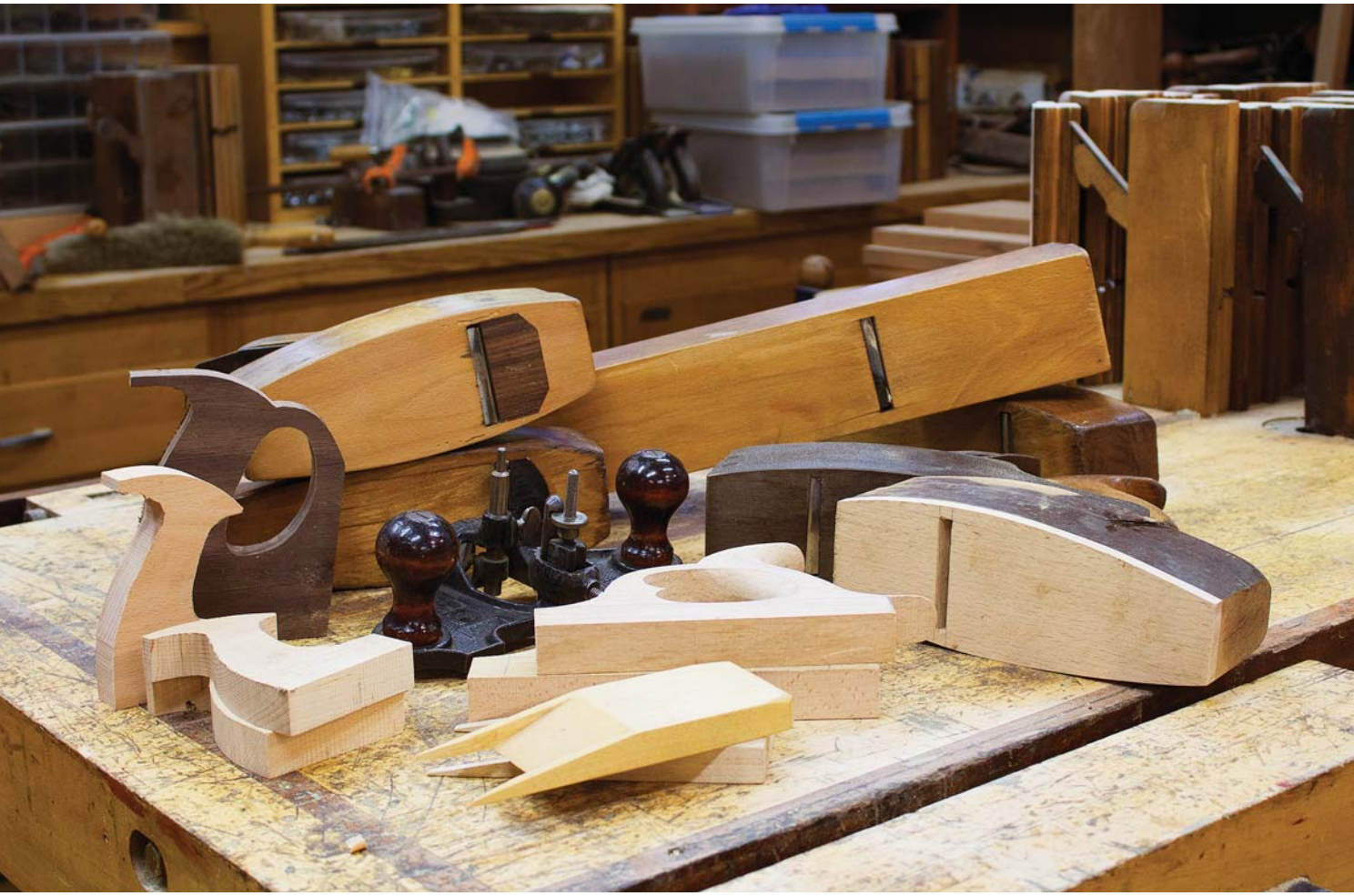
Every tool is a history unto itself, telling a story for those willing to look and listen. They have seen hard work and deserve to continue to be put to good use. You bring honor to the tool and to yourself when you preserve these implements.

This article focuses on "user tools" those – of modest historic or cultural interest – that can be restored to use in the shop. Maintaining tool marks, maker's and owner's marks, penciled-in vendor notations, as well as the patina from 100 or more years of use, is important to maintaining the character of the tool. I generally don't modify a plane or apply a finish (other than wax) – though sometimes I have to blend in a wooden repair so that it is not too glaring.

Make a Plan

Do your research first. Two great references on wooden planes are W.L. Goodman's "British Plane Makers from 1700" (Arnold and Walker) and Martyl Pollak and Emil Pollak's "A Guide to the Makers of American Wooden Planes" (Astragal Press).

Your plan of restoration should take into account the historical or cultural importance of the particular plane, the uniqueness of its design, the state



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

of its preservation and the purpose to which you'll put it.

Common Diagnoses

The most common problems with vintage bench planes are:

- The sole is not flat
- The mouth is too wide for its purpose
- The sole is damaged beyond repairing
- The wedge is broken, doesn't mate properly or is missing
- The handle is broken or missing.

Remember that the sole function of the plane body is to hold the iron at an appropriate cutting angle, and to limit the exposure of the iron to enhance the control and quality of the cut. Every variation on a bench plane is just a design to accomplish this task for a particular situation.

True a Sole

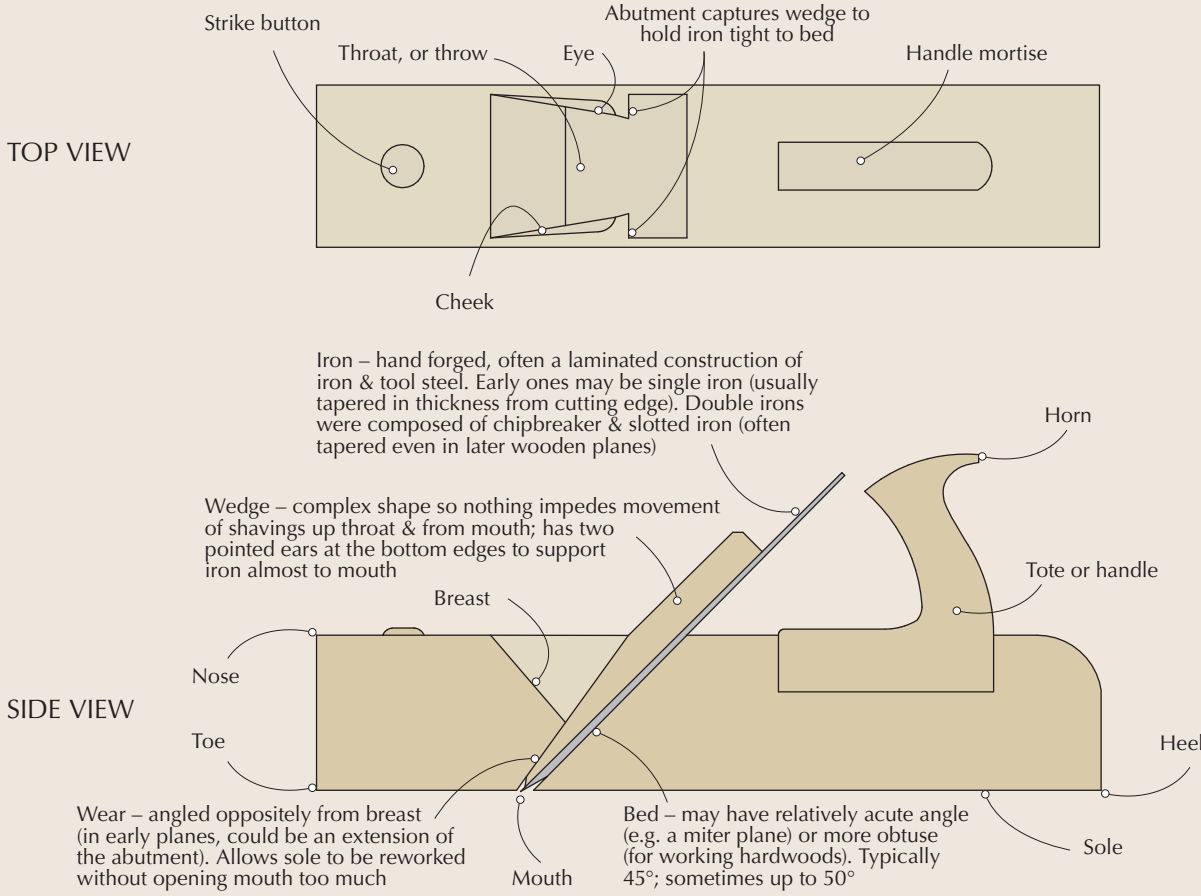
The sole can be damaged from misuse and have grooves or gouges cut into

LEAVE IT ALONE

Clever modification. *Sometimes a plane has been modified in an imaginative way to meet some specific purpose. The tool at left is the tongue plane from a pair for making tongue-and-groove flooring. The original iron is gone and the replacement was likely made by a blacksmith. The new iron allowed the user to tweak the size of the tongue, using a movable collar and metal wedge. In my mind, this plane is unique and should be preserved as is. The tool represents a clever solution to an immediate need.*

Function trumps beauty. *Some might consider this jack plane a restoration candidate due to its wide-open mouth, out-of-flat sole and curious handle. But it is completely functional and presents a charming user modification with a handle made from a crook of a dogwood tree branch. It still does exactly the job it was made to do.*

BENCH PLANE ANATOMY



the surface, or it can have a concave or convex surface. The sole may have been planed down so far that the "wear" has been used up.

It is also possible that the sole is no longer a parallel surface to the plane body. If the sole is too far out of square relative to the bed, the ability to adjust the iron right or left to get an even exposure of the cutting edge may be compromised.

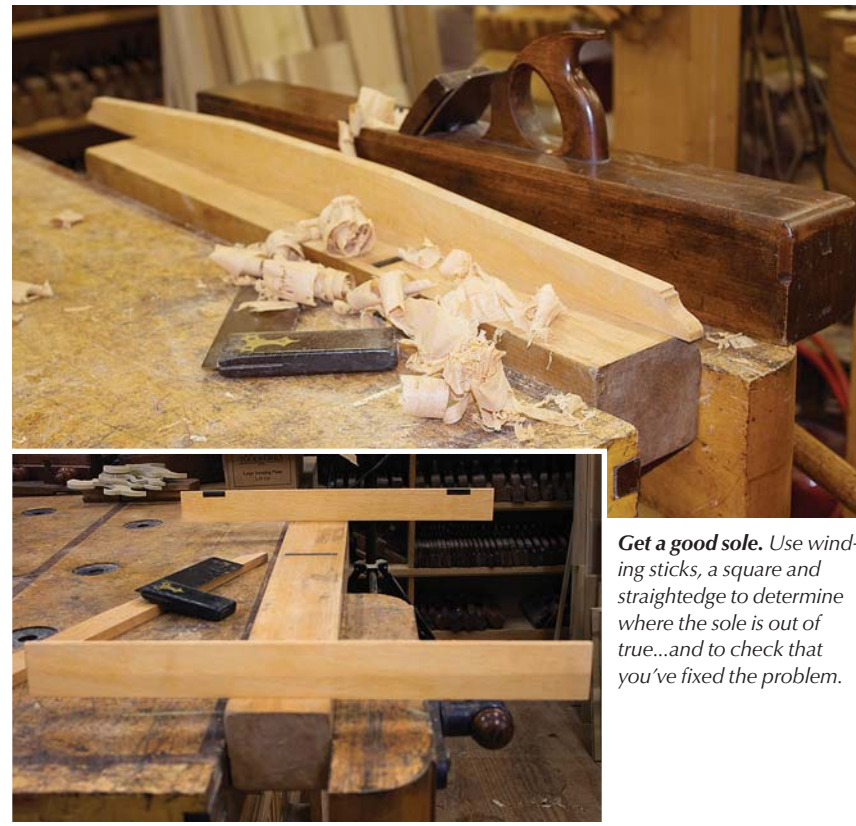
Check that the cutting edge of the iron is indeed square to the length of the iron – note that some plane irons (typically single irons from older planes) are tapered in width (as well as thickness) along their length, so this will have to be factored in. Recognize that the wedge and the iron, when firmly in place, will exert a cupping force along the length of the plane. Set the iron so the cutting edge is well shy of the mouth, and tap the wedge in firmly.

Check the length of the plane's sole with a straightedge. Check for wind with a pair of winding sticks. Lastly, check from either cheek with a square. If you have wind, identify the high corners (which will be diagonally opposite to each other). Pencil in the critical areas of the sole (at the toe, at the heel and everything just in front of the mouth), and high corners if they exist.

Now mount the plane upside down in a shoulder vise. Use a jointer or any smoothing plane as long as or longer than your workpiece, and take off as little as possible. Don't worry about planing down far enough so that the face of the sole is a perfect rectangle.

"Perhaps others, like this author, who has a complete collection of Stanley iron smooth planes – all 21 of them – never use them. I find them without soul, impersonal, cold, hard pushing, and almost always rusty. Enough said; let us go on with the wooden plane and its pleasurable use and construction."

—Cecil E. Pierce, from "Fifty Years a Planemaker and User" (Monmouth, 1992)



Get a good sole. *Use winding sticks, a square and straightedge to determine where the sole is out of true...and to check that you've fixed the problem.*

Close a Mouth

The size of the mouth opening will be dictated by the manner in which the plane is to be used. Scrub planes and jack planes typically take heavy shavings, with less regard to tear-out than smoothers or jointers. For a gossamer-thin shaving, you want a tight mouth and a smooth, flat sole.

Generally, I reserve my efforts for smoothers and for jointers. If the mouth is opened up from previous truing or from misuse, inserting a new throat plate immediately in front of the mouth is a good solution. Inserts are generally made of a hard, dense wood such as ebony, rosewood or maple). The grain direction of the insert is along the length of the plane, and the insert should be at least 1/4" thick, and as wide as the width of the mouth opening.

Shape the insert first. Common shapes are half of an octagon, a half-circle with a small base or a simple rectangle. The edges of the insert should be square or slightly undercut.

Clamp the insert to the sole of the plane, and advance the iron so that it touches the insert even with the sole. Carefully knife the profile of the insert onto the sole of the plane. Chop this shallow mortise with a series of chisel or wide gouge cuts, then chop out the waste.

Finally, take the mortise down to final depth (just shy of 1/4") with a router plane.

Glue in the insert (I prefer to use traditional hot hide glue)in with some hide glue, then clamp it and let it set overnight. When the glue is dry, plane the insert flush and true up the sole of the plane. Rasp the front edge of the mouth to open it up, at an angle that is suitable for the wear (around 70° relative to the sole) until the iron just begins to slip through the opening. Fine-tune this opening to meet the needs of the plane as you use it.

Replace a Sole

If the plane has been trued multiple times to the point where the wear is gone, or if the sole is much damaged, it might be necessary to replace the sole.

You should consider the grain direction of the plane in selecting stock to minimize any differential in seasonal

Plane. *First, plane the sole to remove any minor damage, then set the insert on the sole and knife in the shape.*

Chisels. *Use chisels to remove the waste at the edges of the knifed lines for the insert.*

Router. *A small router plane makes quick and accurate work of removing the remaining waste to bring the insert mortise to depth.*

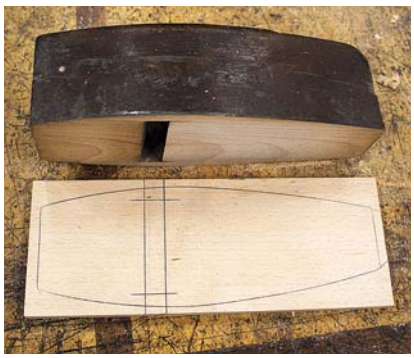
Glue. *Glue then clamp the insert in place.*

expansion and contraction. The plane has probably been drying for 150 years, and the new stock for considerably less time, so you might just have to go for it and see what happens.

First, to provide a good glue surface, plane the sole until it is smooth and flat. Select flat-sawn beech for the new sole if possible, although some repairs I've seen are of lignum vitae or rosewood.

Orient the grain of the stock so that the outside of the tree is to the bottom of the sole, and cut the stock long and wide. The thickness should likely be in the range of 1/2" to 3/4" – sufficient to bring the plane back to its original dimensions. Lay out the mouth mortise to the width and length desired. You may have to experiment with the mouth opening, but generally, 1/4" should do it.

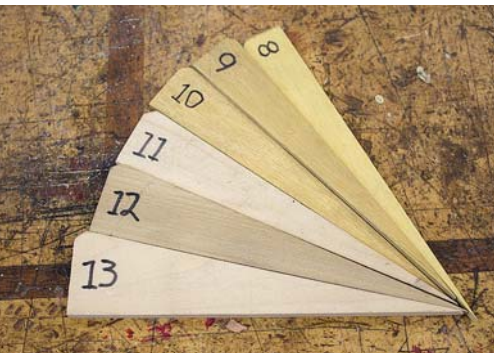
Now determine the bed angle of the plane. On the side of the stock, lay out this angle, and carry the line across the width of the stock. Chop the mortise opening square. Pare from the bed line to the rear of the mouth opening to replicate the bed angle. Lay the plane on this stock and align the bed with the mouth mortise so that the bed lines match.



Lay out. *Plane the material for the new sole flat, then lay out the plane's shape, mouth and bed line.*

Chop. *Use chisels to chop out the mouth and bedl ine.*

Adhere. *Confirm the two match, then glue and clamp the new sole to the plane body. Final shaping comes after the glue is dry.*



Wedges. *It's handy to have a selection of test wedges at various angles to quickly determine the correct abutment angle.*

Layout*. Use the test wedge and iron to lay out the wedge angle on the stock.*

One, two, three. *The initial tapered cut is made with a wide backsaw, just like cutting a tenon. The taper is then refined with a block plane and possibly a fine rasp. Finally, the wedge relief is cut with a coping saw, and the second taper and the ears are cut with chisels.*

Mark the outside of the plane onto the sole stock, then glue and clamp the sole to the plane. After the glue is dry, trim the stock carefully so as not to damage the existing plane cheeks. Bevel very slightly the edges of the sole all around. I stain the edges of the new sole to blend it into the old stock. Finish the new sole with a coat of oil, followed by wax.

Shape a New Wedge

Often, a vintage bench plane may be missing its wedge, or the wedge may be an inappropriate replacement. The role of the wedge is to hold the iron to the bed. The force the wedge exerts is between the iron and the abutments, not against the cheeks, and it should fit easily into the abutment slots. At the mouth, however, the ears of the wedge should fit closely so that shavings are directed up through the throat and not behind the wedge.

First, make an accurate measurement of the widths of the mouth opening and the top of the abutment. Ideally, the mouth opening will be the same or slightly smaller than the top. If this is reversed, consider working the cheeks with floats until the mouth opening is appropriate.

Determine the angle of the abutment slot. Generally, that angle is in the range of 10° more than the bed. A tapered iron, because it tapers in the opposite direction, will add about 1°. I have a set of test wedges (8° to 13°) and use these to match the geometry of the abutment. (Be sure to check that the angle is the same for both abutments).

I prefer quartersawn beech for wedge stock because it's traditional, though other stable hardwoods would work. The width of the stock should be just wider than the mouth opening, and the thickness should be just more than the abutment opening measured square to the bed, minus the thickness of the plane iron. Make the wedge stock plenty long so that you can affix it to your workbench with a holdfast for shaping.

To lay out the wedge angle, set the stock on the plane iron, bring the appropriate test wedge to the edge of this sandwich then trace the angle onto the edge of the stock so that the angle tapers to zero at the front end. Square a line across the top of the wedge stock at this taper line and carry the line back down along the opposite edge of the wedge.

Saw the taper proud of the line, then fix the wedge to the bench on top of a support block, with the wedge supported along its length. Plane the wedge to match the taper. Then plane the wedge to width by testing in the abutment (without the iron in place) until the wedge just reaches to the mouth opening. Insert the iron and the wedge into the plane abutment and fine-tune the taper and the width with a block plane.

When the wedge seats well, trace the profile of the throat onto the wedge and mark the point where the wedge exits the abutment. Divide the space between the end of the wedge and the abutment line in half. Cut away the mouth end with a coping saw to match the profile and shape the wedge ears. Taper the top end of the wedge from the abutment line to the midline to create a shavings ramp that is approximately double the wedge angle. The photos above show a progression of this process. Note that you may have to tweak the wedge taper and width for an optimal fit. After the shaping is complete, cut the wedge to length and bevel the top edges where they exit the plane body.

Replace a Handle

The most common problem with totes is that the horn has been broken off. I would not consider this a problem that needs fixing. On the other hand, a missing tote, or one that is split through the grip, needs to be dealt with. If the split is clean, and all parts are present,

then it may be possible to reglue the handle in place.

For this fix, make clamping cauls that follow the outside curve of the handle – and sometimes, it's useful to have a second set at right angles to the first. The cauls provide a square, parallel surface to clamp against. The second set will prevent the handle parts from sliding during the glue-up. (You may need to clamp across the thickness of the handle as well, depending on the nature of the break.)

If you need to entirely replace a handle, it is a straightforward procedure. Handle stock is often about 15/16" thick, and the handle is typically mortised into the plane body to a depth of 1". In older planes, you find the handle pinned through the plane body, or the leading edge of the handle is cut so that it can be nailed in place. The mortise is usually square into the body, with the toe endwall square across and the heel endwall rounded to a half-circle to match the curvature of the handle.

Razee ready. *This closed tote on a razee-style smooth plane still needs a little shaping, but it's almost ready to put back in action.*

Stock for handles is usually taken from boards at least 7" wide, that ideally are quartersawn without grain run-out on either face.

Make a template in the required handle shape, then align it with the stock so that the grain is long through the tip of the horn. I usually lay out the shape on the upper edge of the stock, leaving plenty of material for holding in the vise for shaping (once the handle is shaped, I cut if off at the level of the bottom of the tenon).

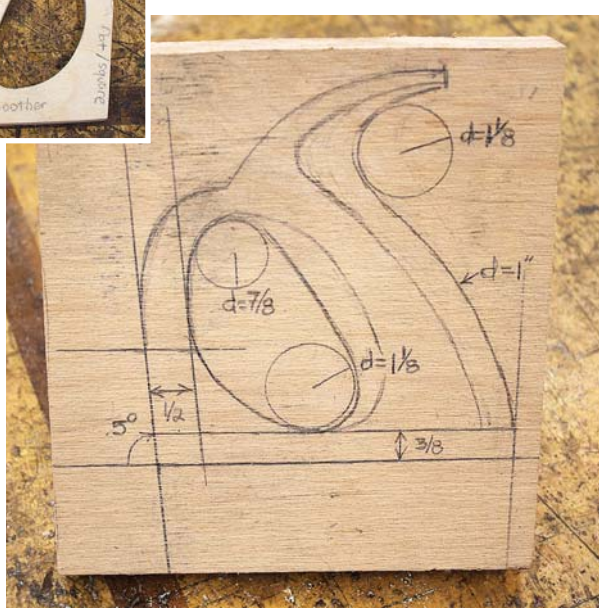
I rough out the shape with a coping saw or a bowsaw, then refine it with rasps, including a sawmaker's rasp (a curved rasp which is toothless on the outside face).

Handle shaping is nuanced. Where the palm meets the handle the cross section will show a half-circle. Where the web between your thumb and forefinger rests, the cross section will be a steep ellipse. The curves underneath the horn and in the inside of the handle transition into almost-flat surfaces at the top and the bottom. The leading edges of the closed totes are often squared off in cross section. The top edge of the handle is flat, with the sides squared down. The rear of the horn is shaped to a half circle. The transition from the edges of the horn to the underside is a parallel line leading to the ellipse for the web.

With your tote shaping complete, cut off any extra tenon material you left in place for clamping, then test-fit the tote in its mortise and make any adjustments needed. When satisfied, brush glue in the mortise and on the tenon, and set it in place. Once the glue dries, buff on some wax and your plane is ready to be put back in use.

Whatever fix you have made to your vintage plane, know that your work has helped rescue a piece of history; use that plane, and you'll add to its story. **PWM**

Tote types. *The patterns here are for several types of totes; each matches my grip. The open tote is typical for a jack plane, the top closed tote is for a jointer plane and the bottom closed tote is for a razzee-type smoother.*



Tote layout. *Here's the layout for a closed tote. Note that it fits my hand; the interior dimensions may change a bit for a comfortable fit to your hand.*

Willard is a retired research scientist who teaches woodworking at The Woodwright's School and other locations. His web site is edwardsmountainwoodworks.com.

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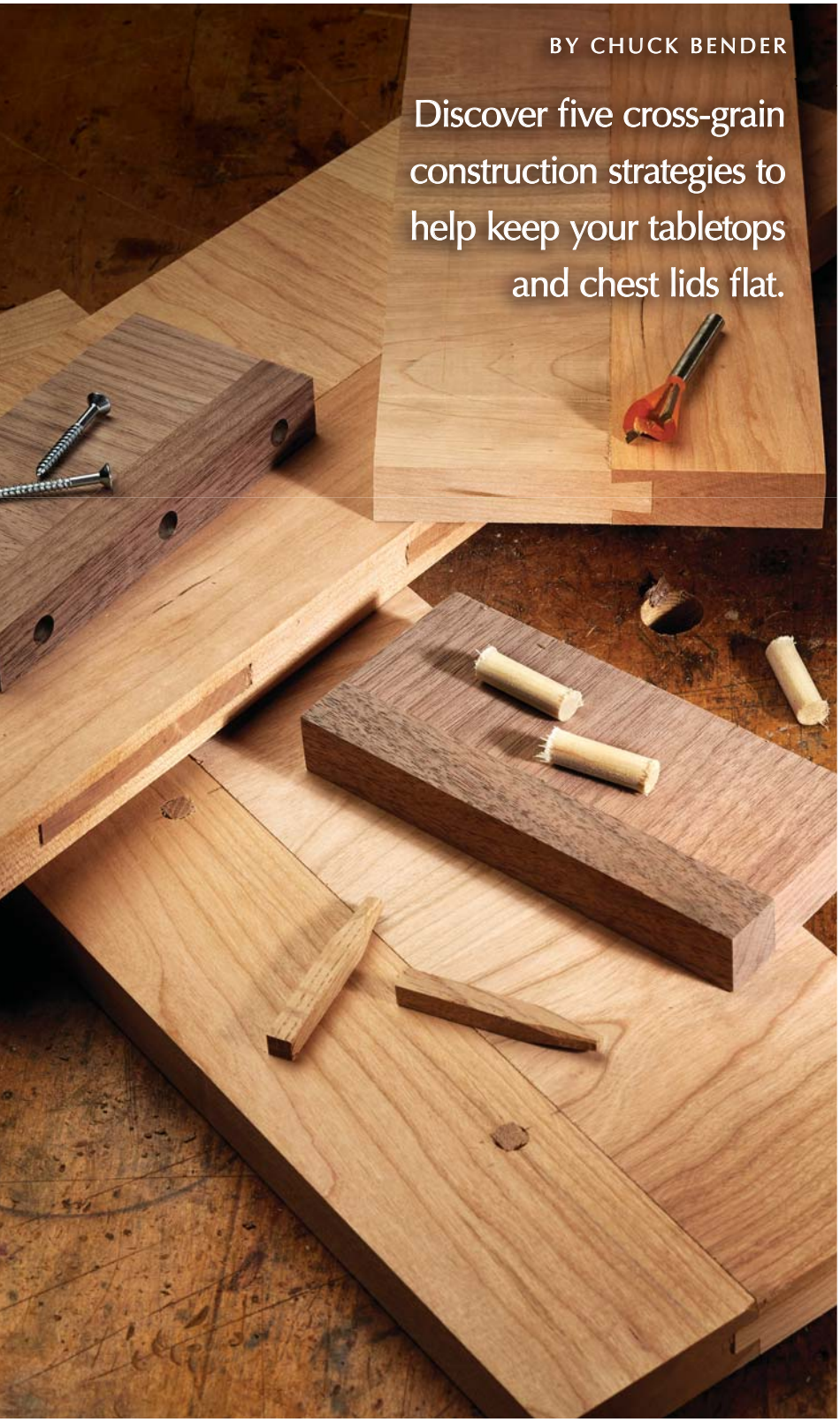
Breadboard Ends



BY CHUCK BENDER

Discover five cross-grain construction strategies to help keep your tabletops and chest lids flat.

Cross-grain construction tends to freak out most beginning woodworkers, but it's a viable construction method in many cases. Wide tables and chest lids often employ breadboard ends to keep things flat, as well as cover end grain. If it's done right, expansion and contraction problems can be nearly eliminated.

There are many methods to attach breadboard ends, but only a few actually accomplish the primary goal of keeping things flat. It takes a little understanding, sound joinery practices, proper planning and patience to avoid disaster.

Understanding

Before you jump into to making breadboard ends you need to understand what's happening and why; that begins with a basic knowledge of wood movement.

Boards expand and contract at a greater rate across their width than they do along the length. How much they expand and contract is more a matter of species and final resting place than anything else.

Also, wood tends to expand and contract more actively toward the bark side of the tree than toward the heart side. When you look at the growth rings on the ends of the board, the convex side of the rings is generally more active than the concave side. When one face moves more than the other, the board ends up bowed across its width – this is what we refer to as cupping.

Straight away you should know that, structurally, breadboard ends are strictly used to control cupping; they are not meant to stop shrinkage or expansion. There is no way to keep a board from changing dimensionally.

Breadboard ends are a mechanical means to overcome a board's natural

LEAD PHOTO BY AL PARRISH; STEP PHOTOS BY AUTHOR

Cupping. *Boards generally tend to cup, or bow, away from the center of the tree.*

tendency for one side to expand or contract at a greater rate than the other. Whenever you try to overcome the nature of wood, you run the risk of cracking, splitting or breaking something.

Acceptable Joinery Practices

Though there are many joinery methods to attach breadboard ends, some work well while others do not – and for the same reasons they aren't the best joinery choices for other projects.

Dowels are acceptable, but they provide limited hold and completely restrict wood movement. The vast majority of the surface-to-surface contact when using dowels is a butt joint; the long grain of the breadboard end mates to the end grain of the primary board. Dowels are the mechanical fasteners that keep the joint intact.

While the surfaces of the dowel and the holes in the primary board are mostly side grain, there is considerably less side-grain-to-side-grain contact between the dowel and the breadboard end. The main purpose of any joint is to increase that contact – that is how you achieve the strongest bond, no matter what adhesive you use.

Regardless of the diameter, dowels occupy only a small portion of the total space available as you join the two boards. This means there will be large spaces between the dowels, particularly if the primary board is extremely wide. Where there is space, the joined boards can move and not remain flush on the top surface, or the primary board could cup. This negates the reason for the breadboard end.

Another problem with dowels is that they don't allow for any seasonal expansion or contraction. If you drill a larger hole or elongate the proper size hole, you reduce the holding power of the dowel.

Does this mean there is no place in the universe for doweled breadboard ends? Certainly not. There are plenty of instances where doweling breadboard ends may be acceptable, such as in small tops. Just be aware that there are shortcomings with the joint.

Screws or nails are also an option when attaching breadboard ends, but they're only marginally better than dowels in most respects, and have the same drawback. Contact is concentrated in small areas, so that allow the primary board and the breadboard will not remain flush. Plus, these mechanical fasteners do not effectively control the cupping of the primary board.

Screws have the advantage of keeping the joint between the boards tight, while the use of slotted holes allow for expansion and contraction. Nails do not pull the joint closed, and they allow for some expansion and contraction because they are more flexible than screws.

Better Joinery Options

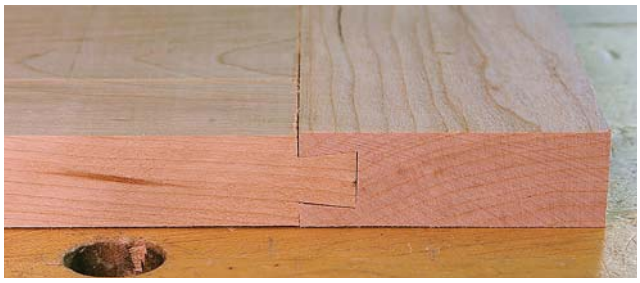
In the end, the best way to keep the primary board from cupping is to capture it in the breadboard end as much as possible. This narrows your joinery choices to sliding dovetails, tongue-and-groove joints, loose tenons or true mortise-and-tenons.

Sliding dovetails sound like they might be the ultimate breadboard end joint – until you examine the flaws of using them in this manner. There's a tremendous amount of the primary board captured in the breadboard, but grain direction is more problematic than with other options.

With the tail on the primary board

Fixed. *Dowels don't allow for any seasonal movement because the holes in which they are inserted have a tight fit in order for them to hold.*

Perfect alignment. *A trick to ensure your breadboard end is flush when driving screws is to use a handscrew clamp to line up the end and the main board. (The screw holes are plugged after the screws are in place.)*



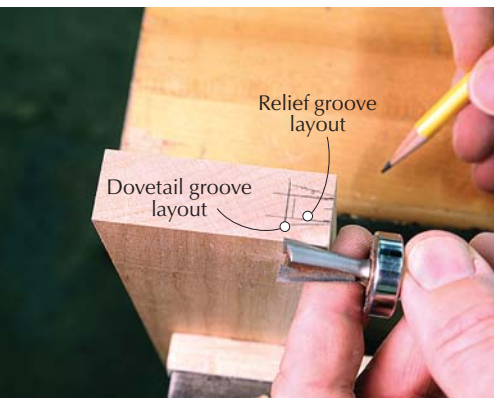
Built-in flexibility. *A sliding dovetail holds the breadboard end tight to the main board while allowing for expansion and contraction.*

and the socket in the breadboard, there just isn't enough meat left on the socket side to hold everything together when working with thicknesses of wood common in furniture work. The remaining material is so thin (so there is less strength) that you could find your breadboard separated from the primary board if it starts to cup. If, however, your top is thick enough to negate this problem, a sliding dovetail might be the right choice.

The tongue-and-groove work is really basic stub-tenon-type joinery. In other words, a groove is cut, usually in the breadboard end, that passes the entire length the piece. On the mating board there's a matching tongue (stub tenon) that runs its entire width.

This method works well on narrow boards made from extremely stable material because you'll most likely end up gluing a significant portion of the joint to get any hold out of it. The more you glue, however, the more likely you'll encounter cracks and twists with expansion and contraction.

Loose-tenon joinery has some of the same problems previously discussed, such as the spaces between the tenons. The upside is that you can make the tenons as wide as necessary to help keep the material between in check. You can also make the mortises a little wider to allow for expansion and contraction.



Stay centered. *When laying out a sliding dovetail for a breadboard end, I first mark the dovetail location, then mark a relief groove.*

Relief cut. *Install a straight bit in the router table and center it on the breadboard end. Make sure the diameter and the depth are set so that the cut happens inside the dovetail layout. Making this cut first relieves some stress on the dovetail bit.*

My Choice

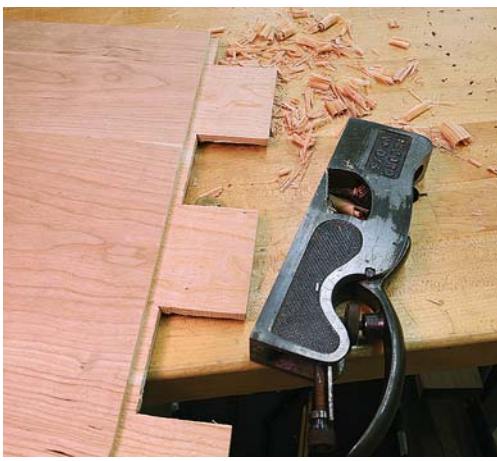
If you decide to go with true mortise-and-tenon joinery, you have several options available. You can use pocketed mortises and tenons that are haunched (combining tongue-and-groove with a mortise-and-tenon joint) – or not. There's also the possibility of using through-mortise-and-tenon joinery, also haunched – or not. The advantage to either version is that you get the hold you need to keep things aligned while having the flexibility to withstand expansion and contraction cycles.

Choosing to haunch the tenons or not directly affects whether your breadboard end and top remain flush. If you don't haunch the tenons, you have the same problem with spacing between your tenons. In the end, a mortise-and-tenon joint gives you the most options and control, which is what you're looking for in a breadboard end.

Proper Planning

In reality, if you're not using mortise-and-tenon joinery, you're merely attaching a material that covers the end grain of the primary board. If you plan properly, you can get the most out of whatever joinery method you choose.

Certain methods work better than others for specific situations. A slant-front desk lid, for example, that is 18" wide, certainly benefits more from mortise-and-tenon joinery than would a 7"-wide jewelry box lid. In the case of the box lid, nails might actually be the



Touch up. *No matter your method for making tenons, you'll likely find the need to tune them up for a perfect fit in the mortises. I find a shoulder plane makes short work of the job.*

Little wings. *Whenever possible, I like to overhang my breadboard ends so they can be easily removed during the fitting process.*

better choice because you don't have to remove material from a small board, thereby weakening it. In either case, some consideration for wood movement has to be taken into account. If the breadboarded piece is going to receive lots of hard use, I'd opt for a mortise-and-tenon joint.

How much do you plan for movement? And how do you actually make the joints so they hold while allowing for dimensional changes? The answers are dependent upon how large the joined pieces are and their intended use.

A jewelry box lid is typically going to have less shrinkage than the top of a 42"-wide trestle table. Less consideration for shrinkage needs to be given to the lid than the table's top.

Other things to consider are the type of wood (hard or soft) you're using, and how stable the material is. Softwoods tend to have a more dramatic dimensional shift from season to season than do hardwoods. So, if you are making a pine table, you might want to allow a little more room for expansion and contraction than you would with a cherry table.

Whether your material is dry and stable also affects how much room you need to allow. The more stable your material, whether that centers on species or proper drying techniques, the tighter you can make the joints. All that said, on some wide tables I've left 1/4" or more of room for seasonal change. I always err on the side of more movement, rather than less.

Another thing to consider when planning your joinery is whether you intend to glue or not. For some methods, such as screws or nails, gluing the joint is probably not a good choice because you end up with a cross-grain glue joint.

With dowels, glue is a necessity but you may decide only to glue the center or one side of the joint to allow for some movement. The choice is going to be driven primarily by how the piece will be used. Opt for more glue under more extreme use.

The same holds true for sliding dovetails and any type of mortise-and-tenon joint. Going back to the slant-front desk lid example: You would more likely glue the joint at the bottom of the lid to keep it from binding once it's hinged to the desk. If you glue the top of the lid and force movement toward the hinges, as the center board dries and shrinks, your breadboard ends will render the hinges useless because they will bind on the case before the lid is fully open.

If you go with mortise-and-tenon joinery, you can drawbore the breadboard ends to the center board. By offsetting the holes through which the pegs are driven, you can pull the joint between the two boards tight. If you elongate the hole in the tenon, you can easily allow for expansion and contraction. The offset might even allow you to attach the breadboard with minimal, or no use of glue. Consider the intended use and the stress that the joint will be under before deciding whether to use glue or not, as well as how much and where.

Pinpoint accuracy. *A finish nail is turned into an accurate dowel jig by simply driving it partially into the main board, cutting off the end and flipping it in the hole. Push the breadboard end into place and you'll have perfect transfer marks.*

Size matters. *On small boards, using dowels is an acceptable method of attaching breadboard ends. Once glued and driven home, they'll keep the main board from cupping.*

Patience

Once you've got all the details considered, it's time to jump into the joinery.

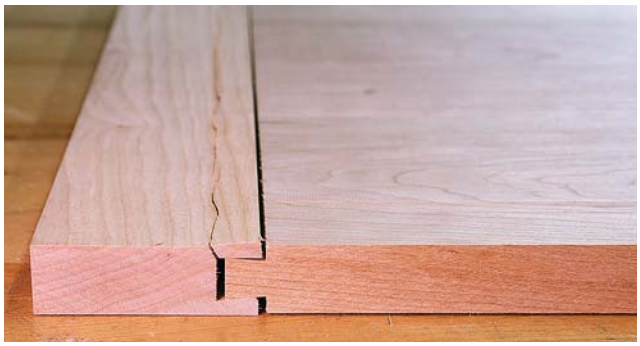
> "You cannot create experience. You must undergo it."
>
> *—Albert Camus (1913-1960), Nobel Prize-winning author*

Whether you're working strictly by hand, by machine or using a combination of the two, there are a few tricks to help improve your results. Regardless of the methods you choose, take your time and work as accurately as possible – that's where patience comes into play. You'll be rewarded with tight joints and breadboard ends that work.

In order to use dowels, you need an accurate method of aligning the holes in the breadboard end with the center board. The easiest method I know is to use small finish nails.

Locate the positions for the dowels on either piece. There is no need to lay out both sides of the joint – you'll see why shortly. Using small finish nails, drive them in about halfway at your layout points. Clip the heads off the nails then pull them out of the piece, taking care not to bend them. Reverse the nails then gently tap them back into their original holes leaving between 1/8" and 1/4" protruding. (Why reverse them? Clipping them blunts the tips a bit – you want the sharp point facing out). Then line up the two parts and tap them together. Separate the two parts and drill the holes for the dowels using your newly created center points. (Don't forget to remove the nails.)

Screws and nails are pretty straightforward. My only advice is to use them



Flawed slide. *Although the sliding dovetail appears to be the perfect breadboard-end joint, the primary flaw is the grain direction of the breadboard piece. Once it starts to split, it often runs its length.*

sparingly, and only on narrow pieces that receive light stress. When using screws, elongate the holes in the breadboard ends to allow for wood movement.

For the sliding dovetail and all mortise-and-tenon variants, you're looking for a slip fit. Too tight, particularly on the sliding dovetail, and you'll find yourself re-making breadboard ends. I've found that whether you make them by hand or machine, particularly on wide tops, you'll end up having to do a fair amount of fitting – again, patience is your friend.

Unless you are working with massive timbers, drawboring the mortise-and-tenon joints of a breadboard end should be done with a small offset, and always toward the shoulder. You want to provide enough pull to keep the joint tight, but not so much that you overcome your allowance for shrinkage. I usually offset my holes between 1/32" and 1/16" for hardwoods and a little more of softwoods.

Whether you are making a blanket chest, a slant-front desk or a new kitchen table, breadboard ends help you avoid cupping problems. To get the most benefit, you need to apply what you know about why and how wood moves before you decide on the best joinery method. Consider the type of wood you're using, how well it's seasoned and how it functions as part of the piece of furniture. If you plan properly, your breadboard ends will keep things on the level for years. **PWM**

Chuck is senior editor of this magazine and has been keeping furniture parts flat with breadboard ends for more than 30 years.

Scribe it. *I drill my peg holes in breadboard ends then dry fit them on the tenons. Once they're in place, I scribe the hole location directly onto the tenon.*

Slotted offset. *With the breadboard end removed, drill the hole in the tenon, making sure to offset it the appropriate amount. After it is drilled, use a rattail rasp to elongate the hole from left to right to allow for seasonal change without changing the drawbore offset.*

Offset in place. *After the holes are drilled and the tenons are fit, you should still clearly see the offset alignment of the holes in the ends and the main board.*

Pegged. *If everything looks good on the final dry-fit, make some pegs then drive them home. I've found longer pegs make them easier to drive – just don't get carried away.*

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For links to all online extras, go to:

- **popularwoodworking.com/oct14**

VIDEO: *Watch as Glen D. Huey makes breadboard ends.*

ARTICLE: *Don Weber includes breadboard ends in his Barnsley hay-rake table.*

IN OUR STORE: *Read "Powered-up Breadboard Ends," in the Autumn 2009 issue of* Woodworking Magazine *(No.15).*

VIDEO: *Chuck Bender explores several methods of joining breadboard ends.*

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Illusion Cabinet

BY GARY ROGOWSKI

Stylish legs and a dapper door dress up a simple case piece – and help to deceive the eye.

This design is inspired by a taper, but I needed to establish the right proportions to flesh the idea out. In much of my design work, I hover around the safe ground of a 3:5 or a 2:3 proportion in the neighborhood of Golden proportions.

For this cabinet, I thought if I were to make the eye search a bit, then a more distinct ratio was in order. Throughout the design, from the overall dimensions of the case to the size of the parts of the door, everything was held as close as possible to 1:2. This made for noticeable changes in shapes both in the overall form of the piece and in its members.

Simplified Construction

The cabinet appears to be frame-and-panel construction with the legs proud of the side panels. But the sides are solid with the legs simply glued on.

To yield 14" in width, I assembled the sides from two mahogany boards. I finished planing and sanding both panels then cut them to final length before gluing on the 1/16"-overlong legs, which are also mahogany. It's a bit easier to manage cleanup this way.

I milled my legs, cut the taper on the band saw and cleaned the faces on the jointer. A pass or two with my jack plane took out any milling marks and I was almost ready for gluing. I used my biscuit joiner to register the panel faces and legs.

Once the legs are glued on, you treat the sides like a flat panel. Plane or sand

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

Downhill. *After cutting the tapers on the legs with the band saw, remove any mill marks using a jack plane.*

Alignment. *Biscuits aren't needed to strengthen this joint, but they help keep the two legs and the panel aligned during assembly.*

them dead flat first, then mortise for the bottom panel.

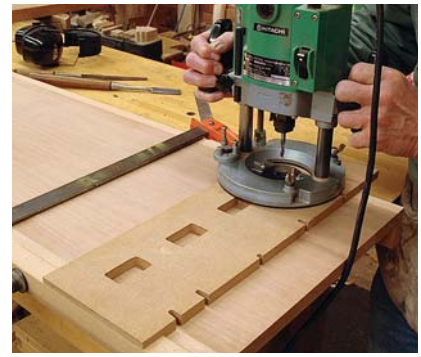
I made a mortising template to cut my mortises. Using a template guide and 1/4" straight bit in my plunge router, I routed the 1/2"-deep x 5/8"-wide mortises and chopped the corners square with my chisel.

I routed the shoulders of the tenons on the router table, making sure to have a backer piece in place to prevent blow-out on the back edge of the cut. These tenons are about 1/16" shorter in length than the mortise depth to allow for excess glue.

Cut the top rails to the same length as the bottom panel. Cut a 1/16" shoulder on the bottom face of each rail to match the bottom's tenon length. This guarantees identical shoulder-to-shoulder length for the top and bottom. The shoulder is used to register the parts for marking.

Stand the bottom panel in place on a side and make sure the front edges align. With a pencil, mark the mortise locations onto the bottom. With only a few tenons to cut, it's quicker to cut them by hand than on a machine. (I tried at the table saw – it was too fussy.)

After I marked out the tenon sides, I clamped the bottom panel low in the vise to eliminate vibration, then sawed down to define the tenons. I used my band saw to carefully remove the waste.



Time well spent. *It takes time and attention to detail to make the template, but the results are worth the effort.*

Square corners. *A sharp chisel squares the rounded corners left by the router.*

Fit the tenons starting at one edge and work your way across. Having a good shoulder plane makes a huge difference in your ability to finesse a fit. Chamfer the tenon ends as well to make sliding them home a bit easier.

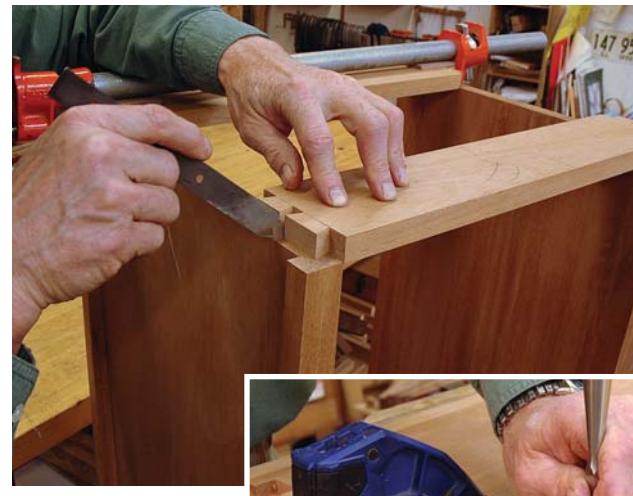
The top rails sit flat to the tops of the side panels. I used half-blind dovetails for this joinery because they're invisible and strong.

Three-step tenons. *Cut the tenon shoulders at the router table, then define each tenon cheek with straight cuts using a handsaw. The waste in between is removed at the band saw.*

Trim & fit. *Start at the front and work toward the back to fit the tenons in the bottom panel.*

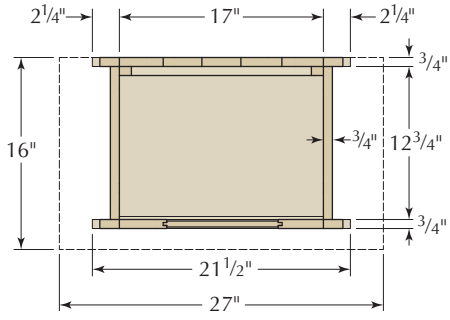
The top rails were first cut as long as the bottom panel. After I made the shoulders, I cut off 1/8" to keep the tails from being too close to the outer face of the panel. There's no point in risking a crack with too tight a fit. I used a 1:6 slope to lay out the dovetails and cut them at the bench before marking out the sockets on the panels.

To mark the pinboard, I put the bottom panel into the sides and clamped things tight. Before marking the pin position, I set the top rails in place and clamped those as well—the small shoulders make it easy to clamp across the

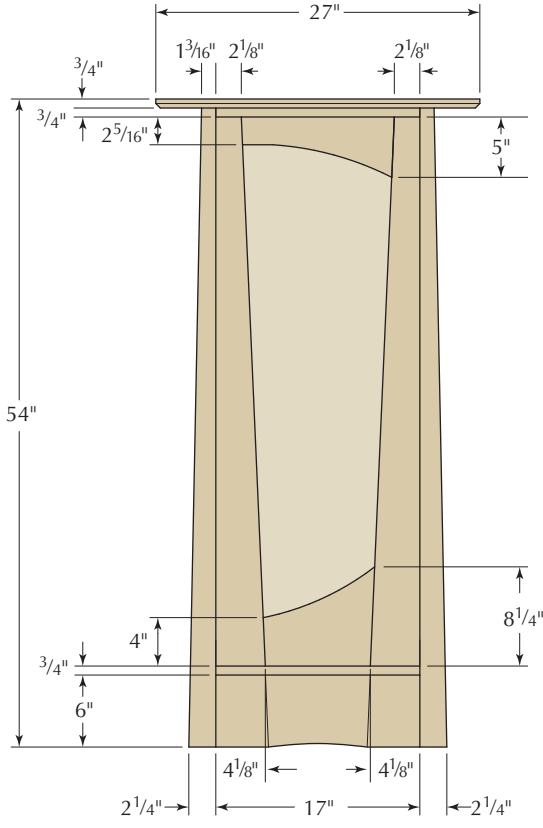


Tails on top. *After adjusting the length of the top rails, cut the dovetails. With the rail in place, mark the sockets.*

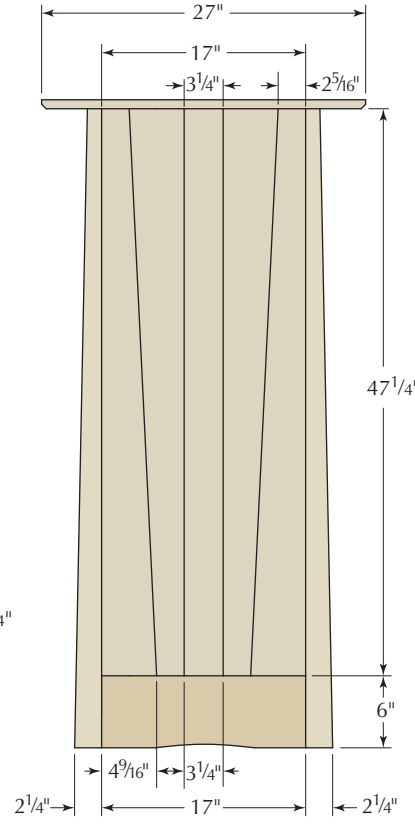
Saw then chop. *Define the edges of the tail sockets with two saw cuts. Then chisel out the waste.*



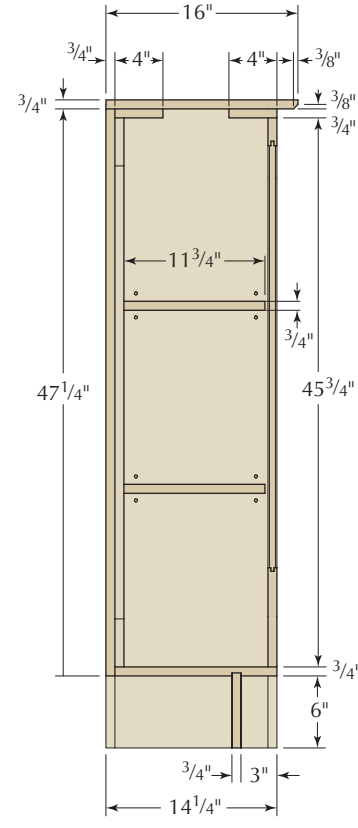
PLAN



FRONT



BACK



SECTION

case. I used a marking knife for this, but somewhere along the way I lost my ability to see tiny knife marks in end grain. To darken them, I used a drafting pencil sharpened to a fine point; it worked great. After sawing inside the lines, I used a chisel to complete the sockets for the tails.

Think Ahead About the Door

With the rail dovetails fit into the top of the case sides, it's time to lay out the knife hinges. First, make sure the front edges of the case are all trued up. I clamped the cabinet onto my bench and planed the edges flush.

Make the mortises for these hinges before assembly to keep your life simple. The Brusso knife hinges I used have a brass washer on the pin that separates the two leaves. This sets the reveals or gaps for all the door edges. I made shims out of plastic laminate and a piece of masking tape to match the thickness of the washer.

Put one shim against the case side to set the gap of the hinge stile then mark for the hinge leaf with a marking gauge and knife. I use a router to ensure a consistent depth on the leaf mortises, then chop the corners square. It's easier to drill for the screw holes now as well.

SUPPLIES

Brusso Hardware
brusso.com or 212-337-8510
1 pair ■ knife hinges
#ST-97, $65.10/pair

Price correct at time of publication.

I drilled and ran in steel pilot screws with some wax on the threads to lead the way. I can install my brass screws later on with no worries about breaking a screw.

This cabinet has only two shelves, and I like the ease that adjustable shelves give in building a piece. You just have to remember to get the holes drilled before gluing up. I made a template out of 1/4" MDF and marked hole centers for shelf pins exactly where I wanted each shelf to be.

To give me options for shelf placement, I made marks 1" higher and lower than my layout. Using a brad point bit, I drilled the template, then placed it inside the assembled case, marked the holes with the same bit, then deepened those marks with an awl.

These marks are easy to see and align at the drill press. Set up an auxiliary table to support the case side. Shim under the case sides to keep the tapered legs off the table (this also helps to ensure that the holes are drilled straight).

Before glue-up, I cut grooves for the kick piece that goes under the case bottom. I marked the stop point of each groove on the sides, then used my plunge router with a 3/8"-diameter bit and a fence to cut a 1/4"-deep groove. I used a chisel to chop the ends of the stopped cuts square.

Get it Together

As with any cabinet project, assembly is a calming and soothing balm after a long day's work. Right. How I wish that were true. Glue changes everything. Here is what I learned (again) from the experience: You have to plan your glue-up, get your clamps ready and have clamps and corner blocks ready to pull the cabinet square. Assume the worst and be happily disappointed if it doesn't occur. It's much better than assuming that everything will go right, then frantically trying to fix a problem with the glue drying.

I made clamping cauls out of some clear 2x4 scrap laying about. I put a slight convex curve on one edge using a band saw, then smoothed the curve with a handplane. The cauls fit between the legs of the side panels. Two deep extension F-style clamps hold things tight. The cauls pulled the tenons in fine, and the shoulders closed up great.

Detailed Door

The door frame is made of tapered stiles and shaped rails. The parts all taper from the wide to the narrow ends by a factor of two. This gives the door a distinct look, but makes for challenging construction because none of the frame joints are square.

I made a cardboard template of the taper for the stiles. That allowed me to visualize the slope and mark an identical angle on both pieces. I cut the tapers at the band saw, then removed the saw marks with a plane.

Pattern match. *The cardboard template ensures that the tapers on the door stiles are identical.*

Tapered rip. *The band saw is ideal for cutting the tapers on the door stiles.*

"Have no fear of perfection – you'll never reach it."

—Salvador Dali, (1904-1989)
Spanish surrealist painter

Joinery last. *After the door parts are adjusted to fit, use loose tenons to join the rails and stiles.*

Loose- or slip-tenon joints are the simplest way to build this door. Cut all your parts to size, taper the long door stiles then cut the angles and curves on the rails. (See "Center of the Universe" below.) I made corrections for both length and angle where needed using a low-angle jack plane to fine-tune the fit.

I then mortised all the parts for the loose tenons. It's much easier to make any adjustments when there are no tenons protruding from the rails.

Once I had the door frame put together dry, I planed all my parts flat then set up a router with a slot cutter to make the groove for the panel. I prefer to cut straight into the dry-assembled door rather than separately into its parts. The panel grooves will line up better this way.

The door frame is 3/4" thick, so I cut a 1/4"-wide x 3/8"-deep groove for the 1/2"-thick panel. I marked out the shape of the door onto a glued-up fir panel and added 5/16" all around for tongues that fit into the grooves. At the router table, I rabbeted both faces of the panel to make my 1/4"-thick tongue.

I cut the rabbet on the outside of the panel then planed, scraped and sanded it. To add texture to the panel's front face, I scrubbed it with a wire brush, then cut the second rabbet and fine-tuned the fit of the panel with my shoulder plane. A coat of shellac was applied to the panel before the door was glued up.

I fit the bottom door rail and hinge stile to the case then mortised in my lower knife hinge. I fit the top rail before putting in the top knife hinge. The handle stile is fitted next with a 5° back-

CENTER OF THE UNIVERSE

Open cabinets, with no fixed shelves and only a door across the front, can twist on an uneven floor. This is especially true when the cabinet is loaded with books or bottles or both. My strategy is to build them on a flat and true surface that becomes the Center of the Universe.

When the piece goes to its final home and the door doesn't close right or the reveals have changed, I can say: "When I built this piece, it was built at the Center of the Universe and built square – so it's the floor that's the problem." Then I can shim the case under the legs to make the door fit perfectly again.

After the case is glued, I set it on an assembly platform. This platform was double-checked to see that its not twisted because my shop floor is anything but flat. I placed winding sticks on top and adjusted with shims underneath the platform to pull it in true. Now I had a working area that I could trust.

I checked the bottom rail and the hinge stile of my door against my door opening. If the door is out of square, adjust it to fit. You want to have enough room to place shims under the door and against the hinge side of the case. I used a jack plane to fit the door to its opening. — GR

One at a time. *Fitting the pieces to each corner makes it easier to achieve a nice-fitting door. Loose joinery makes this possible.*

Rough & ready. *Use a wire brush to add texture to the front of the panel.*

Detail work. *With most of the door edges chamfered, a bit of work on the rail ends continues the detail as it highlights the joint.*

bevel on the edge of the door so it clears the case when opening.

Finishing Touches

The kick is the last piece to get glued in place. I fit it to the grooves in the sides and bottom of the case so it is a slide-in fit. Check for the high spots that show shiny on the tongue and plane those with a shoulder plane until the kick fits home.

The kick has a taper detail carved into it. With the door in place, I marked the taper line of the stiles onto the case then transferred this down to the kick. I pulled out the piece and with a V-chisel carved the lines before gluing the kick into the case, then cut a slight arch between the V-grooves on the bottom edge of the kick for visual interest.

The top is two pieces of mahogany glued up. A 45° bevel is added to the ends and front edge; leave the back edge square. I then planed a gentle bullnose to relieve the sharp edges. The top is screwed to the case through the top rails after finishing.

The back is made of five tapered redwood slats. The central slat is straight, but the outer slats are tapered and have overlapping rabbets. With the top rail and bottom panel set in the thickness of the attached legs, I screwed each of the back slats to them, top and bottom. I added cleats on the inside of the sides just to cover up any movement issues of the back slats.

The door handle is a piece of ebony with three brass escutcheon pins put in to brighten it up a bit. It's attached to the door with a pair of loose tenons. The catch is a brass three-way ball catch.

My cabinets have an inside finish of shellac. On the outside, to darken the wood, I used a coat of linseed oil and let that cure for several days. Six coats of shellac were applied and rubbed out, then I waxed the cabinet.

For the inside of a case, you can also scent the shellac. It's astonishing when you open the door to a pleasant smell if you choose the right scent. Avoid patchouli. Vanilla or lavender would be good. I mix 4 ounces of shellac and 20 drops of scented oil. That yields a delightful surprise when you open up the case. It's good to keep the oil around to brighten up the scent in time. **PWM**

Illusion Cabinet

NO.	ITEM	DIMENSIONS (INCHES) T	W	L	MATERIAL	COMMENTS
❑ 4	Legs	3/4	2 1/4	53 1/4	Mahogany	Tapered
❑ 2	Sides	3/4	12 3/4	53 1/4	Mahogany	
❑ 1	Bottom panel	3/4	12 3/4	18	Mahogany	
❑ 2	Shelves	3/4	11 3/4	16 7/8	Mahogany	
❑ 1	Top	3/4	16	27	Mahogany	
❑ 2	Top rails	3/4	4	18	Mahogany	
❑ 2	Back cleats	3/4	3/4	45 3/4	Mahogany	
❑ 1	Straight back plank	3/4	3 1/4	47 1/4	Redwood	*
❑ 4	Tapered back planks	3/4	4 9/16	47 1/4	Redwood	*
❑ 1	Kick	3/4	6 1/4	17 1/2	Mahogany	
❑ 2	Door stiles	3/4	4 1/8	45 3/4	Mahogany	Tapered
❑ 1	Top door rail	3/4	5	12 3/4	Mahogany	Curved
❑ 1	Bottom door rail	3/4	8 1/8	9 1/4	Mahogany	Curved
❑ 1	Door panel	1/2	13 3/8	39 7/16	Fir	Shaped to Opening**

*Back planks have shiplapped edges; **Door panel size determined by adding 5/8" to opening in dry-assembled door frame to account for the grooves.

Tapered, too. *To continue the overall design, the outer slats of the back are also tapered.*

In reverse. *The shape of the handle tapers in the opposite direction of the stile. Brass pins provide an accent to the darker wood.*

Gary runs the Northwest Woodworking Studio , A School for Woodworkers, in Portland, Ore. (northwestwoodworking.com) He continues to teach design and building techniques to interested students of all levels.

ONLINE EXTRAS

For links to all online extras, go to:

■ **popularwoodworking.com/oct14**

VIDEO: *See Gary Rogowski's technique for using the table saw to level chair legs.*

ARTICLE: *Read Gary's article on handle design from our February 2012 issue (#195).*

PLAN: *Download a free SketchUp model of this project from our collection.*

IN OUR STORE: *"Router Joinery Techniques," a video with Glen D. Huey.*

WEB SITE: *Visit the author's web site, view some of his work and sign up for a class.*

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■ **ShopWoodworking.com**

The Butterfly Horse

BY DON WILLIAMS

This flexible work support is a new solution to the age-old sawhorse problem.

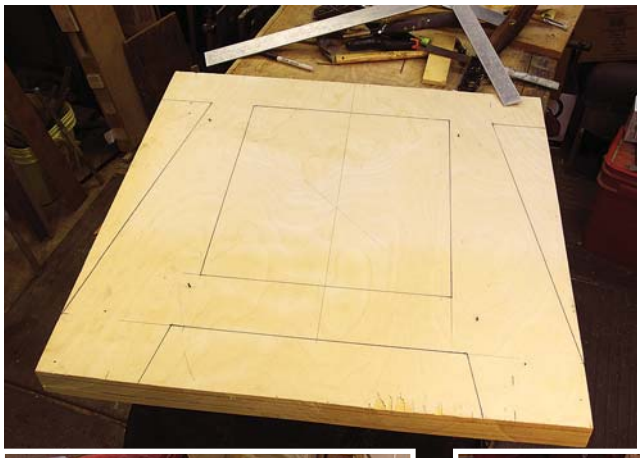
Whether I'm working in the shop, remodeling or performing routine maintenance around the house, I am in constant need of a sturdy, lightweight worktable. The most popular one for, oh, the past 2,000 years, has been a pair of sawhorses with a board on top. But the older I get, the shorter the fuse on my patience gets, and while I have sawhorses aplenty, my general dissatisfaction with them grows.

Fixed-leg horses are heavy and clumsy to move around. The plastic folding ones are easier to use, but far less stable and sturdy. Some of my small trestle horses are better, but the stinking feet get snagged on anything and everything as I move them about, so I just leave them in the shop.

And for a lot of tasks two sawhorses are too many, and one is too few. But what if we had a sawhorse-and-a-half? A Workmate suffices sometimes, but it still is not exactly what I want.

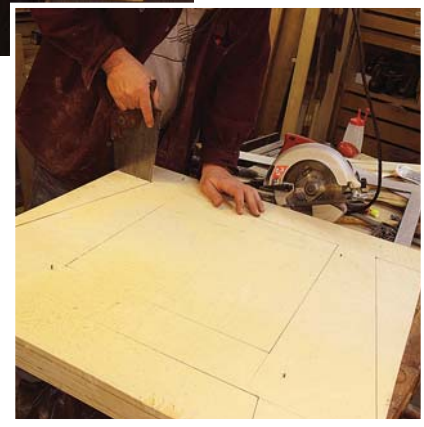
With those limitations roiling my creative juices, I embarked on a path that eventually found me designing and building the "Butterfly" – a sturdy, lightweight, flexible and folding workholding option that is almost exactly the dreamt-of one-and-a-half sawhorses. I created my first prototype several years ago, and have tinkered

PHOTOS BY AUTHOR, ILLUSTRATIONS BY ROBERT W. LANG



Identical quads. *It's critical that the four panels be identical. These four stacked pieces are each 30" x 30", minus the saw kerf. Each corner is simply tacked with a finishing nail to keep them together during the cuts.*

As a group. *Most of the cuts can be made with a circular saw and a straightedge. Large holes reduce the weight by a considerable amount, but keep in mind that removing material reduces the strength of the unit.*



In this corner. *Finish the cuts with a handsaw. (You could, of course, use a jigsaw or reciprocating saw instead.)*

with the concept and execution ever since to the point where I have it just where I want it.

Imagine a folding sawhorse, which is fine as far as it goes. But what if that single sawhorse had a pair of outriggers and could be transformed into two sawhorses on the same footprint? The Butterfly does exactly that.

As with most of my shop-accessory projects, this design is simple to construct with readily available materials and minimal tools. For the one built for this article, I used one sheet of ½"-thick Baltic birch plywood (my favorite sheet stock, and it should be yours too!), a circular saw, drill and a small handsaw to finish off the cuts, along with some ordinary hinges and metal stock from the local hardware store.

In the center. *A piano hinge inside the middle section allows the horse to open without any play.*

On the outs. *Surface-mounted butt hinges allow the outer leaves to swing open. Gravity keeps the leaves in place when the Butterfly is used as a standard horse.*

For the fabrication of the folding braces that hold the folding/expanding parts in place, I used metal bar stock, copper rivets (available at your local hardware store or online), a ball-peen hammer and a piece of railroad rail as my anvil when cold riveting the hinge pins on the folding braces.

As with most of these types of projects, you can tailor the dimensions and features to fit your own preferences. This Butterfly is simply one of several I have built to varying specifications.

Four Squares to Start

The starting point for this project was a full sheet of 60" x 60" plywood. Because the Butterfly requires four identical pieces of material, you could simply cut the sheet into quarters like I did here and proceed just fine, yielding a unit that is about 30" high, 30" wide and 30" deep.

Once the four identical pieces are cut, tack them together for the second phase of the project as you lay out and cut vertical and horizontal cross members, and the attendant center cutout. This is a bit of a fussy part, because the cutout for the center yields panels that I use on top as a working surface. I wanted panels the width of the horses, so I needed two 15"-wide pieces for each wing of my Butterfly.

Using a clamped-on straightedge to guide the circular saw, followed by a handsaw, I cut the perimeter of the center void for each of the leg units. If you wanted, you could skip this step and leave each 30" x 30" piece whole. That results in a much stronger but much heavier Butterfly.

With the center panels cut out, lift the unit to decide how much more material – if any – you want to remove to achieve a desired weight. I made tapered cutouts along the vertical edges and foot cutouts at the bottom of all four elements to get a weight that suited my desires. If you want to remove even more weight, you can do as I did on an early prototype and remove stock along the edges using a hole saw.

With each of the four elements cut out, they are ready for the initial assembly. The tops of the two center pieces

Stay put. *After opening, the center section is splayed 15" and a piece of scrap is tacked in place to maintain that distance.*

Tried & true. *The whole assembly is placed on a flat surface and the upper edges are aligned to a single plane. With the pieces tacked together, the sizes of the brace parts can be determined.*

COLD RIVETING

Cold riveting is a near-perfect and simple way to join two pieces of flat metal. Simply put, a rivet is a metal rod inserted into a same-sized hole that penetrates both pieces to be joined. The rod protrudes a little on each end (the protrusion should, ideally, be equal to half the diameter of the rivet), then the protruding rod ends are hammered into mushrooms, locking the assembly together.

If you do not have copper or brass rivets on hand, you can use either brass rod or brass machine screws from the hardware store. If you use machine screws, make sure to file the threads off or the rivet will bind the brace pieces too tightly for them to fold easily. Cut the braces to the proper length with a hacksaw.

Before hammering the rivets, you should anneal them. Simply put them on a hot plate, turn it as hot as it can get and wait for the pieces to completely discolor to blue-grey. Let them cool before you use them. Insert the rivet into the drilled hole and using a hammer on an anvil, pound each end into a mushroom and you are done. — DW

are joined with a piano hinge to make sure there is no racking in the finished unit. The two outside units are attached to the adjacent center sections at the feet with standard butt hinges.

Keep Your Distance

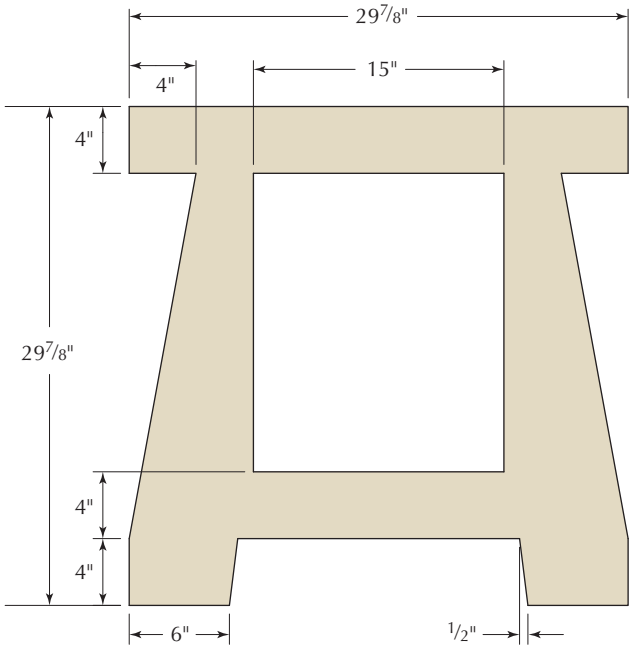
At this point you have a rough-assembled complete Butterfly. Fold it flat and on both front and rear edges, mark the halfway height; this is a critical measurement to fabricate and attach the folding braces.

Next, tack wooden strips to the center pair so the feet are splayed at your desired dimension. Flip the entire unit upside down on a flat surface, and splay the outside sections exactly the same as the feet. It is critical that you check the mock-up upside-down on a perfectly flat surface to make sure you have everything exactly configured.

Using the previously marked half-height dimension, measure and cut the necessary metal bar stock for making the folding braces. I prefer cold riveting for making the hinge pins of the folding braces (see "Cold Riveting" at left).

"There is a touch of divinity even in brutes, and a special halo about a horse, that should forever exempt him from indignities."

—Herman Melville (1819-1891), American novelist



ELEVATION

Repurposed. *Use the cut-outs from the wings as a quick work surface when the need arises.*

Keeping tabs. *The top panels are stored in the open area of the legs, retained by tabs that pivot on screws.*

Braces & Tops

I take precise measurements with dividers to get the construction of the braces exact, mark the hole locations with a punch, then drill them out. The two holes that will be joined with a rivet are left unmodified; the other two holes (the ends) can be countersunk for flathead screws or left unchanged if you use roundhead screws.

Riveted braces. *The braces are made of 1/8"-thick x 1/2"-wide aluminum bar stock (or similar material) held together with rivets.*

Once the braces are finished, you can simply screw them into the edges of the four folding units at the half-height mark. I like to screw the outermost brace ends first, then assemble the other end of the outer-unit braces and the end of the center-unit brace into the same hole, with the center brace on top of the outer brace.

You are now done building the basic Butterfly. The completed appliance is amazingly strong; this one holds several hundred pounds, as long as the weight is centered on the unit overall. I once loaded an early prototype with more than 1,000 pounds; it stood strong.

But for this iteration, I wanted to include a semi-integral "tabletop" to place on the unfolded unit for a more solid working surface. My center cutouts worked great for this purpose, and they are easy to store. Using wooden tabs, the top panels are held in the voids of the four sections and, with the turn of the tabs, are easily removed to be used as needed. **PWM**

Don recently retired as senior furniture conservator after almost three decades with the Smithsonian Institution. He is the project leader for the ongoing production of André Roubo in English; his work can be followed at donsbarn.com.

ONLINE EXTRAS

For links to all online extras, go to:

- **popularwoodworking.com/oct14**

VIDEO: *See Don Williams in action documenting the Studley tool chest.*

BLOG: *Read about Don's former life at the Smithsonian and see slides of his work.*

ARTICLE: *Read about Don's shop-made tail vise in the April 2014 issue (#210).*

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A Must-have Woodworking Glue

BY LAURIE MCKICHAN

Unibond 800 is perfect for veneer work and whenever you need extra open time.

Without a doubt, yellow woodworking glue has adhered its place in the Woodworker's Hall of Fame. But for complex joinery, veneer work and bent laminations, there is a better choice.

Urea resin adhesives are an industry standard for veneering. Many, however, require high temperatures for proper bonding, so they aren't suitable for small shops and individual woodworkers. That's why my choice is Unibond 800; it's formulated to provide the same bond quality at room temperature (70°) as those "hot" industrial glues. That makes it an excellent choice for just about any small-shop veneering job.

Why Unibond 800 rather than other cold-press urea resin adhesives for use at room temperature? The others I've researched have a higher water content. That could be a problem when veneering. Plus, other urea resins, when the powder is mixed with water, can leave a visible glue line in laminations, depending on your project wood. With Unibond 800, you have the ability to tint the adhesive to match your wood.

When fully cured, Unibond 800 forms rigid glue lines. This eliminates glue "creep," an unwanted characteristic commonly associated with yellow glue, which forms glue lines that remain flexible. Such flexible glue lines cause problems in a bent lamination, because they allow the lamination (which is under stress) to move after it's removed from the bending form.

PHOTO BY JASON ZENTNER

The long open time of this adhesive eliminates the chance of poor adhesion in glue-ups that take awhile to assemble and clamp – one with multiple parts and numerous joints, for example. In addition, this product contains much less water than yellow glue, so it doesn't cause swelling that can make a well-fitted joint bind up at the worst possible time. Instead, Unibond 800 actually makes such a joint slide together more easily. This glue also has more gap-filling capability than yellow glue, although not nearly as much as epoxy.

Working Properties

The shelf life, pot life, open time and clamping time of this adhesive are affected by the ambient temperature. In general, as the ambient temperature increases, the working time of these properties decreases (see the chart below). It's also important to note that Unibond 800 will not cure properly if the ambient temperature is too low.

Shelf life (which pertains only to the glue's liquid resin) indicates how long the adhesive remains usable when it's properly stored. The best way to store it is in a refrigerator that's not used for storing food. When the resin has thickened to the consistency of molasses and changed from an off-white color to yellow, throw it out – its shelf life has ended.

Pot life measures the amount of time the adhesive remains workable after its two parts are mixed together. Open time rates the length of time that glued parts can be left exposed to the air before they must be assembled. Clamping time marks how long the glued joints must remain clamped. The clamping times stated in the chart are for joints that are not unduly stressed.

Mix & Tint

Having to mix Unibond 800 is a small price to pay for it's utility and versatility. The manufacturer recommends mixing the adhesive's powdered hardener and liquid resin by weight for maximum accuracy, but also provides guidelines for mixing by volume. I prefer mixing by volume.

The powder blends easily into the liquid. Small batches can be mixed by hand. A mixer blade mounted in a hand drill works well for large batches. Make sure the powder mixes in completely. If a clump appears while spreading the adhesive, break it up with a finger and remix. When mixing large batches, let the mixture stand for a few minutes then mix it again.

And be sure to wear a respirator while doing this – you don't want to inhale any of the powder. The mixture emits a small amount of formaldehyde, so work in a well-ventilated area. After mixing, promptly clean any tools with soap and water.

Mixing instructions. *Blend the Unibond 800 powdered hardener into its liquid resin. You can mix by volume or by weight, and you can manipulate the working properties by adjusting the ratio.*

Match colors. *Choose or mix a color that matches the wood. Unibond 800 hardener comes in two standard colors that can be tinted to match almost any shade.*

Whether you mix by weight or volume, you can manipulate the adhesive's curing action by adjusting the ratio of hardener to resin. So doing affects the pot life, open assembly time and clamping time. One reason to adjust the ratio is to increase the open time for a complex glue-up, but such adjustments are just as useful when the temperature is less than ideal. In cooler temperatures, for example, a faster reaction time shortens the clamping time.

Unibond 800 comes in two standard colors and can be tinted to match almost any wood. This is important when working with veneers and laminations

Unibond 800 Working Properties

POT LIFE	OPEN ASSEMBLY TIME	CLAMPING TIME	SHELF LIFE
2 hours @ 65° F	45 minutes @ 70° F	3 hours @ 70° F	12 months @ 60° F
1 hour @ 75° F	30 minutes @ 80° F	2 hours @ 80° F	6 months @ 75° F
45 minutes @ 85° F	5 minutes @ 90° F	1 hour @ 90° F	3 months @ 90° F
30 minutes @ 95° F			

Best technique. *Use a foam roller to spread the adhesive quickly and evenly.*

One face, or two? *Apply the adhesive to only the substrate when gluing raw veneer. When gluing paper-backed veneer, which is less absorbent, apply adhesive to both surfaces.*

in which the adhesive might be visible. Bent laminations, for example, show a layer of glue at each lamination; exceptionally thin veneers may allow the adhesive's color to telegraph. Adjusting the color is easy and well worth the effort to avoid headaches later on.

The color is contained in the powdered hardener. Medium hardener is similar to oak or cherry (once darkened). Dark hardener resembles mahogany or walnut. Available white and dark tints allow adjusting the color of either hardener to create a perfect match for lighter woods such as maple or darker woods such as cocobolo. You can also match colors by adding aniline dye (water or alcohol based). Add just enough solvent to the powdered dye to make a paste. Then mix that paste into the mix of resin and hardener.

> "Sometimes if you want to see a change for the better, you have to take things into your own hands."
>
> *—Clint Eastwood (1930-, Actor, film director and producer*

Set a damn. *To avoid bleed-through when gluing raw veneer, add a powdered blocking agent that thickens the adhesive so it can't wick through the wood.*

The color darkens as the adhesive cures, so I keep hardened samples of both standard colors and all the colors I've custom mixed (as well as the recipes). They're great for color matching.

Application

It's most efficient to pour a zig-zag line of adhesive onto the surface and use an inexpensive foam roller to spread it. I cut a 9" roller to create two 4" rollers. When working a large area, I sometimes pour the glue into a paint tray.

When gluing raw veneer, apply the adhesive to the substrate only. It's good practice to glue a test piece to see if the adhesive's color telegraphs through the veneer, or if the adhesive itself wicks all the way through and ruins the surface. This occurrence, called "bleed-through," is common with many veneers, including oak, maple, cherry and walnut. One way to stop

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- Unibond blocker (1 1/2 pounds)
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Prices correct at time of publication.

GLUE COMPARISON

Urea formaldehyde glue has many uses and should become a part of your woodworking glue arsenal. But when should you choose it over other more traditional glues? Is your assembly complicated so you need extra open time? Are you working under a short deadline and need a quick set time?

To better select the glue or glues for your woodworking needs, a comparison is needed. Below is a listing of important glue characteristics of some other woodworking glues.

Open Time at 70° F:	
Polyvinyl acetate (PVA or white glue)	15 minutes
Aliphatic resin (yellow glue)	5 minutes
Liquid hide	10 minutes
Clamping Time	
Polyvinyl acetate	30-60 minutes
Aliphatic resin	30 minutes
Liquid hide	10 minutes
Fully Cured	
Polyvinyl acetate	18-24 hours
Aliphatic resin	12-18 hours
Liquid hide	12 hours

— Glen D. Huey

Lamination application. *Roll a thin coat of adhesive on both surfaces of each piece when working with bent laminations. Quickly rub the two parts together, then move on to the next piece.*

Better benefit. *Unlike yellow glue, Unibond 800 doesn't cause the wood to swell so you can apply the adhesive to both surfaces of each joint when gluing complex joinery.*

bleed-through is to add a blocker that thickens the adhesive.

When gluing bent laminations, coat both surfaces and press them together. When gluing complex joints or assemblies, apply the adhesive as you would apply yellow glue. If the adhesive gets on other surfaces during glue-up, resist the urge to remove it. Unlike yellow glue, Unibond 800 is easy to remove by sanding after it has dried.

Clamping Strategies

Clamping times are for flat work that is not unduly stressed. This includes flat veneer pressing and complex glue-ups where clamping pressure is not required to keep the parts in place. Bent laminations and curved veneer panels, on the other hand, require longer clamping times.

I leave all bent laminations and curved pieces clamped (or pressed, as in a vacuum bag) for at least 12 hours. To know for sure that the adhesive has cured, the manufacturer recommends pouring a small amount in a plastic bag and laying it flat near the glue-up. (Don't use adhesive poured into a cup, because a thick layer won't be an accurate indicator.) When the adhesive in the bag can be removed in one piece and is the consistency of firm rubber, a non-stressed glue-up can be removed from the clamps. Wait until the adhesive is completely hard and brittle before unclamping a "stressed" glue-up.

Sanding Properties

When this adhesive is fully cured, sanding will completely remove any residue left on the surface or in the wood's pores. Because the adhesive is tinted to match the wood, it's easy to miss a spot. I keep a chisel handy so I can easily remove any dried glue that appears when I'm applying finish. Sanding also creates a very fine dust that you don't want to breathe, so be sure to wear a dust mask. And be careful when working near exposed glue lines: my favorite urea resin adhesive dries glass-hard, so you can easily cut yourself. **PWM**

Laurie designs furniture that is, she says, "simple, honest and direct" – and she's been a professional woodworker for more than a decade. You can see more of her work at lauriemckichan.com.

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For links to all online extras, go to:

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Lighting Matters

Raking light through windows is the clear winner in a hand-tool shop.

In 2007, I was a speaker at Colonial Williamsburg's Furniture Forum, and there I met Adam Cherubini. He was in costume in the parking lot, talking period furniture and tools to anyone who'd listen. If you know Adam, or have seen him in a presentation, then you know he breathes this stuff. Deeply.

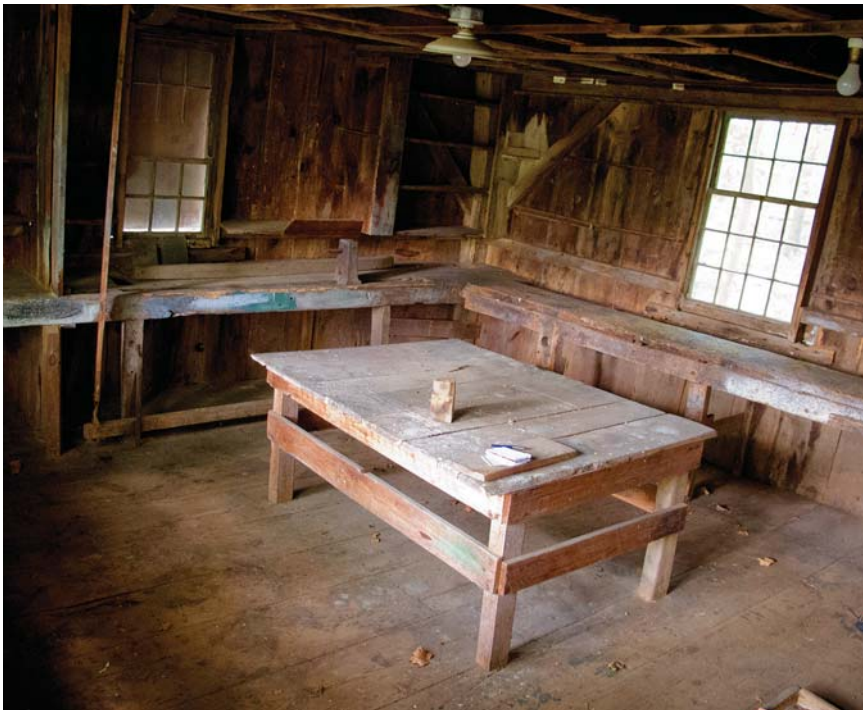
As I started to find out about him, one thing I learned was that he wrote a column called "Arts & Mysteries" for this magazine. We crossed paths several times after that, and he got me connected to the magazine, suggesting I contact some guy named Chris something-or-other. During one of Adam's sabbaticals, I even wrote a guest column. Then for a while Bob Rozaieski of the blog Logan Cabinet Shoppe filled in and wrote it. Now it's my turn to take it for a while.

As I write this first column, I am in between workshops. For the past two months, my hands-on woodworking has mostly been splitting wood and spoon carving. But my mind is all over the place as I think about what I want in the next incarnation of my workshop.

As a hand-tool woodworker, I don't need much in terms of space or equipment for a shop. I have a couple of benches and a pole lathe. Beyond that I need some room to store stock, patterns, tools, works-in-progress and not much else.

Readers of this magazine are quite familiar with some of the trends in woodworking today. "Roubo" benches, wooden-bodied planes, re-sawing by hand, carved decoration, inlay work, foot-powered lathes – all these things and more are being explored in tremendous detail by craftsmen and craftswomen both amateur and professional.

Period furniture continues to enthrall woodworkers and their customers even after all these years. They even have their own society: the Society of American Period Furniture Makers (members work with both hand and power tools).



Luther Sampson shop. *This 16' x 32' 18th-century joiners/carpenter's shop in Duxbury, Mass., had been used by the school on whose property it sits as a storage shed. In 2012, restoration carpenter Michael Burrey, of Plymouth, Mass., got a look inside and was stunned, recognizing it as the oldest known shop in the United States on its original site.*

But what one thing do we (I count myself among this "granfalloon") mostly overlook? Lighting. Many of us are in workshops that we did not get to design in full. My first one, like those of many, was in a basement. After that, I graduated to the second floor of a chicken coop. Not much in the line of windows there. The shop I had for the last 20 years had lots of windows, but it was part of a museum exhibit.

So for several reasons overhead lighting was the default. Once a hurricane left us without electricity for most of a week, and I had great raking light each day until about 3 p.m. During winter, when the museum was closed, I used to go in on weekends and work without the lights.

Historic Evidence

We know that period, or pre-industrial, shops had workbenches, lathes and other work areas positioned where they could make use of daylight from the windows. This results in raking light – light that shines across the work to leaves shadows that help the eye to see definition, shaping and depth.

Luther Sampson's 18th-century joiner/carpentry shop in Duxbury, Mass., has benches lining both long walls of the main room, with a third

CONTINUED ON PAGE 62

LEAD PHOTO BY CHRISTOPHER SCHWARZ; LIGHTING PHOTOS BY THE AUTHOR

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CONTINUED FROM PAGE 60

Dominy shop. *Now reconstructed at the Winterthur Museum, Garden and Library in Winterthur, Del., the Dominy woodworking shop was used by four generations of craftsment in East Hampton, N.Y., from the mid-18th through mid-19th centuries. This image, from the Historic American Buildings Survey collection at the Library of Congress, shows the shop before it was moved.*

bench converted to a lathe on the end wall between them. There are now windows over each of the long benches. We assume there were windows in similar positions originally; their size and placement is unknown.

I first visited this shop after the hurricane/daylight experience in my shop. While others were discussing how many workmen might have been in this shop at once, I was wondering if it was just one or two, and they moved from one bench to another as the light changed during the day.

The Dominy shop (originally in East Hampton, Long Island) is now installed at the Winterthur Museum in Wilmington, Del. The original shop was measured and partially photographed before being disassembled in 1946. Charles Hummel's book, "With Hammer in Hand" (University of Virginia), includes a couple of photos and a floor plan that were part of the Historic American Buildings Survey in 1940. There were two long benches in the Dominy shop; one nearly 17' with two windows over it. The smaller one, at a little more than 12', had one window.

Light matters. *Overhead light washes everything out and makes it look flat. With raking light, shadows and lines are highlighted, which makes it much easier to see the work.*

I'm disinclined to research the history of overhead lighting; but I know I don't like it. It might be good for an operating room, but for a workshop my preference is for windows near the bench. Overhead lighting is flat, with no shadows. I'm a carver among other things, and overhead lighting makes it hard to see the depth of your work. To really assess what's happening, you have to pick the workpiece off the bench and hold it so the light crosses it. And that slows you down.

Aside from the few extant workshops, historical paintings, photographs and other artwork help us to understand the relationship between the bench and the windows. Often the bench is 90° to the window; in other cases it runs parallel to and just under the windows, like in the Dominy and Sampson shops.

While I search for new shop space, I've been reviewing some of my earlier research. For me now, it's vicarious-woodworking as I peer over the shoulders of period workmen. I hope you'll read along with me; maybe we'll learn something. **PWM**

Peter is a teacher of 17th-century woodworking and host of several videos from Lie-Nielsen Toolworks. Read more from him at pfollansbee.wordpress.com.

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About this Column

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Tim Yoder, who starred in the Emmy Award-winning show *Woodturning Workshop* on PBS, has teamed up with *Popular Woodworking Magazine* to launch a new turning show.

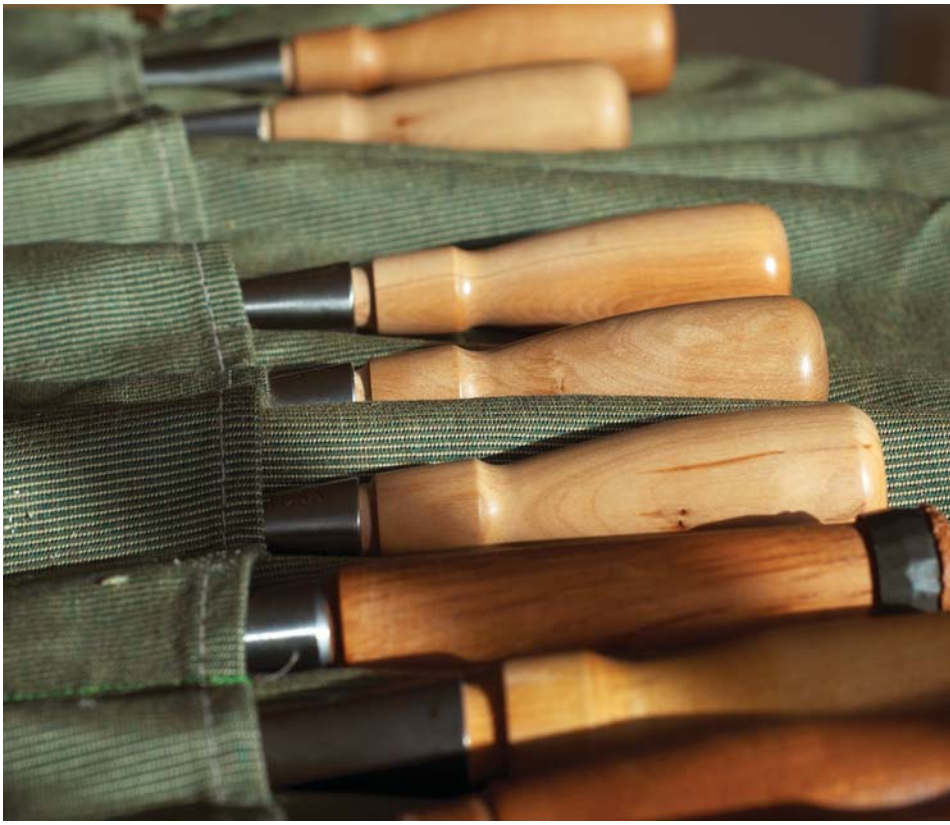
Inheritance

A sharp reminder and remembrance of a life cut short.

A chisel roll is an unlikely time capsule. Untouched in the three years since his death, the green canvas Ian salvaged from a discarded patio umbrella has protected his tools admirably. They are exactly as he left them: organized, razor sharp and without a spot of rust.

His mother and I sit at the dining room table he built for her with the tool roll open in front of us. We silently contemplate the tools she intends to give me. Ian was my closest friend and a gifted woodworker.

He was 24 when he was killed in a car accident and the tools tucked into the roll's many pockets speak of a life in progress. A life cut short. On the left are the tools that got him started – flea-market finds, ground down to the last inch, but lovingly restored. A nearly complete set of high-quality new tools, a mark of his newfound status as a successful professional, advances from the right. Only one pocket remains empty.



I remember when the first of the new chisels appeared. It was after college, we were living together in Seattle, and Ian had just started work with a renowned furniture studio. He thrived in the job and often stayed late to work on personal projects. In the quiet hours after the shop closed, I would join him to work on my first woodworking project, a small toolbox made from alder scraps.

Under his guidance, I cut my first dovetail joints. When it came time to pare the shoulders, he handed me a chisel. For a minute, he watched uncomfortably as I fumbled with the tool. When I cut my finger, he politely took it from my hands for fear I might inflict further harm.

Despite an inauspicious start, those evenings in the shop ignited a passion for woodworking that is among the most tangible gifts from a friend who I miss dearly. His gift has continued to evolve, even in his absence, and I am grateful for it.

With his mother's blessing, I roll up the chisels and carefully bring them home. I know the time will come to sharpen these tools and that to do so will replace one more physical sign of Ian's life. The edge he painstakingly established on each chisel, honing both faces until they cast a flawless reflection, will be replaced by an edge of my making.

Will I hesitate before putting steel to stone? Yes. In the privacy of my own shop, I'll probably even mutter a thanks and an apology to my friend, even though I know I don't believe he's anywhere to hear it. But, I will hold the blade just like he showed me and work it in slow circles across the stone, bringing a new edge, new possibilities, to the surface. **PWM**

Gus is a graduate student in natural resources at the University of Vermont. When he's not studying, you'll find him tapping out dovetails at the kitchen table.

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