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- Chisel travel: 4¼"
- Max. distance column-to-chisel center: 6¼"
- Table size: 6" x 16"
- Heavy-duty cast-iron construction
- Includes ½" mortising chisel
- Approx. shipping weight: 92 lbs.



W1671 ~~\$325⁰⁰~~ SALE **\$312⁰⁰**



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- Motor: ¾ HP, 110V, single-phase, 1725 RPM, 9A
- Swing: 13¼"
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- Arbor: JT33
- Spindle travel: 3½"
- Oscillating spindle: ¾"
- Number of speeds: 12 (250, 330, 380, 500, 590, 640, 980, 1530, 1600, 1870, 2580, 3050 RPM)



W1848 ~~\$415⁰⁰~~ SALE **\$395⁰⁰**



15" HEAVY-DUTY PLANER

- Motor: 3 HP, 240V, single-phase, 14A
- Max. cutting width: 15", depth: ¾"
- Max. stock thickness: 6½", min.: ¼"
- Min. stock length: 6½"
- Feed rate: 16 and 30 FPM
- Cutterhead diameter: 3"
- Number of knives: 3 HSS
- Knife size: 15" x 1" x ½"
- Cutterhead speed: 5000 RPM
- Table size: 20½" x 15" x 3½"
- Overall size: 32" W x 28" D x 23½" H
- Approx. shipping weight: 382 lbs.

OPTIONAL STAND AVAILABLE



G0815 ~~\$995⁰⁰~~ SALE **\$950⁰⁰**



1 HP SHAPER

- Motor: 1 HP, 120V, single-phase, 13A
- Table size: 15½" x 17¾"
- Table counterbore: 3" dia. x ¾" deep
- Spindle travel: ½"
- Spindle size: ½"
- Spindle length: 3"
- Spindle speed: 13,200 RPM
- Floor to table height: 34¼"
- Overall size: 27" W x 23" D x 40¼" H
- Approx. shipping weight: 172 lbs.

INCLUDES ¼" & ½"
ROUTER BIT ADAPTER



G0510Z ~~\$465⁰⁰~~ SALE **\$409⁹⁵**

12 SPEED HEAVY-DUTY BENCHTOP DRILL PRESS

- Motor: ¾ HP, 110V, single-phase
- Swing: 14"
- Drill chuck: ¼"-5/8"
- Drilling capacity: ¾" steel
- Spindle taper: MT#2
- Spindle travel: 3¼"
- Speeds: (12) 140, 260, 320, 380, 480, 540, 980, 1160, 1510, 1650, 2180, 3050 RPM
- Collar size: 2.040"
- Precision-ground cast-iron table
- Table swing: 360°
- Table tilts: 90° left & right
- Overall height: 38"
- Approximate shipping weight: 148 lbs.



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INCLUDED)



G7943 ~~\$385⁰⁰~~ SALE **\$365⁰⁰**



13" BENCHTOP PLANER WITH BUILT-IN DUST COLLECTION

INCLUDES DUST
COLLECTION
BAG!

- Motor: 2 HP, 120V, single-phase, 15A
- Max. cutting width: 13", height: 6"
- Max. cutting depth: ⅛"
- Feed rate: 26 FPM
- Number of knives: 3 reversible HSS
- Knife size: 13" x ½" x ⅛"
- Cutterhead speed: 9000 RPM
- Number of cuts per inch: 87
- 2½" dust port
- Footprint: 22½" L x 13" W
- Approx. shipping weight: 71 lbs.



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G0832 ~~\$389⁰⁰~~ SALE **\$369⁹⁵**



10" JOINTER/PLANER

- Motor: 2½ HP, 220V, single-phase, TEFC, 3400 RPM, 9.9A
- Max. depth of cut: ⅛" (jointer), ⅜" (planer)
- Max. width of cut: 10¼" (jointer), 9¾" (planer)
- Max. planer cutting height: 8¼"
- Jointer table size: 12½" x 40½"
- Planer table size: 9¾" x 23½"
- Cutterhead speed: 6500 RPM
- Cutterhead knives: 2 HSS
- Knife size: 10¼" x 1½" x ⅛"
- Cuts per minute: 13,000
- Planer feed rate: 16 FPM
- Approx. shipping weight: 378 lbs.

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BLOCKS



G0675 ~~\$1425⁰⁰~~ SALE **\$1375⁰⁰**



2 HP SHAPER

- Motor: 2 HP, 120V/240V, single-phase, prewired 240V, 18A/9A
- Table size: 24" x 21"
- Spindle travel: 3"
- Spindle sizes: ½" and ¾" (included)
- Spindle speeds: 7000 and 10,000 RPM
- Miter gauge slot: T-slot
- Stand: cabinet-style, powder-coated finish
- Power cord length: 10' x 14 AWG
- Max. cutter diameter: 5"
- Approx. shipping weight: 293 lbs.



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W1674 ~~\$1025⁰⁰~~ SALE **\$965⁰⁰**



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3 HP DUST COLLECTOR



- Motor: 3 HP, 240V, single-phase, 3450 RPM, 12A
- Air suction capacity: 2300 CFM
- Static pressure: 16.7"
- 7" inlet has removable "Y" fitting with (3) 4" openings
- Impeller: 12 $\frac{1}{2}$ " cast aluminum
- Bag capacity: 11.4 cubic feet
- Standard bag filtration: 2.5 micron
- Footprint: 58" x 33"
- Height with bags inflated: 78"
- Approx. shipping weight: 170 lbs.

MADE IN AN ISO 9001 FACTORY



G1030Z2P ~~\$495.00~~ SALE \$455.00



2 HP DUST COLLECTOR



- Motor: 2 HP, 240V, single-phase, 9A
- Impeller: 12 $\frac{1}{2}$ " aluminum
- Air suction capacity: 1700 CFM
- Max. static pressure: 10"
- Sound rating: 83-85 dB
- 6" inlet has removable "Y" fitting with (3) 4" inlets
- Canister filter size (dia. x depth): 19 $\frac{1}{2}$ " x 23 $\frac{1}{2}$ "
- Bag capacity: 4.5 cubic feet
- Overall size: 37 $\frac{1}{2}$ " W x 31 $\frac{1}{2}$ " D x 71" H
- Approx. shipping weight: 150 lbs.



MADE IN AN ISO 9001 FACTORY



G0548ZP ~~\$515.00~~ SALE \$495.00



14" DELUXE BANDSAW 35TH ANNIVERSARY EDITION



- Motor: 1 HP, 110V/220V, single-phase
- Amps: 11A at 110V, 5.5A at 220V
- Precision-ground cast-iron table size: 14" x 14"
- Table tilt: 10° left, 45° right
- Floor-to-table height: 43"
- Cutting capacity/throat: 13 $\frac{1}{2}$ "
- Max. cutting height: 6"
- Blade size: 93 $\frac{1}{2}$ " (1 $\frac{1}{2}$ " to 3 $\frac{1}{4}$ " wide)
- Blade speeds: 1800 and 3100 FPM
- Overall size: 27" W x 67 $\frac{1}{2}$ " H x 30" D
- Footprint: 23 $\frac{1}{2}$ " L x 16 $\frac{1}{2}$ " W
- Approx. shipping weight: 247 lbs.



G0555LA35 ~~ONLY \$625.00~~



10" HYBRID TABLE SAW WITH RIVING KNIFE & IMPROVED FENCE

FREE 10" X 40" CARBIDE-TIPPED BLADE

- Motor: 2 HP, 120V/240V, prewired 120V, single-phase
- Amps: 15A at 120V, 7.5A at 240V
- Precision-ground cast iron table with wings measures: 40 $\frac{1}{2}$ " W x 27" D
- Floor-to-table height: 35 $\frac{1}{2}$ "
- Arbor: 5"
- Arbor speed: 3450 RPM
- Max. depth of cut: 3 $\frac{1}{4}$ " @ 90°, 2 $\frac{1}{4}$ " @ 45°
- Rip capacity: 31" R, 16 $\frac{1}{4}$ " L
- Overall size: 64" W x 40 $\frac{1}{4}$ " D x 35 $\frac{1}{2}$ " H
- Footprint: 21" L x 19 $\frac{1}{2}$ " W
- Approx. shipping weight: 371 lbs.



G0771Z ~~\$845.00~~ SALE \$819.95



MADE IN AN ISO 9001 FACTORY

17" HEAVY-DUTY BANDSAW 35TH ANNIVERSARY EDITION



- Motor: 2 HP, 110V/220V, prewired 220V, single-phase, TEFC capacitor 110V start induction, 60 Hz, 1725 RPM
- Amps: 20A at 110V, 10A at 220V
- Precision-ground cast-iron table size: 17" x 17" x 1 $\frac{1}{2}$ "
- Table tilt: 10° left, 45° right • Floor-to-table height: 37 $\frac{1}{2}$ "
- Cutting capacity/throat: 16 $\frac{1}{4}$ " L of blade
- Max. cutting height: 12 $\frac{1}{2}$ "
- Blade size: 131 $\frac{1}{2}$ " long
- Blade sizes available: 1 $\frac{1}{2}$ "-1" wide
- Blade speeds: 1700 and 3500 FPM
- Overall size: 32" W x 73" H x 32" D
- Footprint: 27" W x 17 $\frac{1}{2}$ " D
- Approx. shipping weight: 342 lbs.

MADE IN AN ISO 9001 FACTORY



G0513ANV ~~\$995.00~~ SALE \$950.00



10" LEFT-TILTING TABLE SAW WITH RIVING KNIFE AND CAST-IRON TABLE

- Motor: 3 HP, 240V, single-phase, 14A
- Max rip: 8" left, 26" right of blade
- Max. depth of cut @ 90°: 3"
- Max. depth of cut @ 45°: 2 $\frac{1}{2}$ "
- Table size w/ extension wings: 48" W x 27" D
- Footprint: 20 $\frac{1}{2}$ " x 20 $\frac{1}{2}$ "
- Approx. shipping weight: 550 lbs.



G1023RLW ~~\$1525.00~~ SALE \$1475.95



16" X 46" SWIVEL-HEAD WOOD LATHE WITH CAST IRON LEGS & DIGITAL READOUT



- Motor: 2 HP, 110V, single-phase, 14A
- Swing over bed: 16"
- Swing over tool rest: 13 $\frac{1}{2}$ "
- Distance between centers: 46"
- 1" x 8 TPI RH headstock spindle
- MT#2 spindle & tailstock tapers
- Spindle bore: 3 $\frac{1}{2}$ "
- Spindle speed range: 600-2400 RPM
- Overall dimensions: 72 $\frac{1}{2}$ " L x 19" W x 48" H
- Approx. shipping weight: 354 lbs.

DIGITAL SPEED READOUT!

MADE IN AN ISO 9001 FACTORY



G0462 ~~\$665.00~~ SALE \$625.00



OSCILLATING SPINDLE SANDER

- Motor: 1 HP, 120V/240V, single-phase, TEFC
- Cast iron 25" x 25" table tilts to 45° forwards, 15° backwards
- Spindle sizes: (10) 1 $\frac{1}{4}$ " x 5", 3 $\frac{1}{2}$ " x 6", 1 $\frac{1}{2}$ " x 6", 5 $\frac{1}{8}$ " x 6", 3 $\frac{1}{4}$ " x 9", 1" x 9", 1 $\frac{1}{2}$ " x 9", 2" x 9", 3" x 9", 4" x 9", tapered and threaded
- Floor-to-table height: 35 $\frac{1}{2}$ "
- 1725 RPM spindle speed
- Includes formed and welded steel stand
- Spindle oscillates at 72 strokes-per-minute
- Stroke length: 1 $\frac{1}{2}$ "
- Built-in 4" dust collection port
- Shielded and permanently lubricated ball bearings
- Approximate shipping weight: 296 lbs.



G1071 ~~\$875.00~~ SALE \$845.00



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POPULAR Woodworking

Number 239, June 2018. *Popular Woodworking Magazine* (ISSN 0884-8823, USPS 752-250) is published 7 times a year, February, April, June, August, October, November and December, which may include an occasional special, combined or expanded issue that may count as two issues, by F+W Media. Editorial and advertising offices are located at 10151 Carver Road, Suite #300, Cincinnati, OH 45242. Unsolicited manuscripts, photographs and artwork should include ample postage on a self-addressed, stamped envelope (SASE); otherwise they will not be returned. Subscription rates: A year's subscription (7 issues) is \$24.95; outside of the U.S. add \$7/year • Canada Publications Mail Agreement No. 40025316. Canadian return address: 2835 Kew Drive, Windsor, ON N8T 3B7 • Copyright 2018 by F+W Media, Inc. Periodicals postage paid at Cincinnati, Ohio, and additional mailing offices. Postmaster: Send all address changes to *Popular Woodworking Magazine*, P.O. Box 420235, Palm Coast, FL 32142-0235 Canada GST Reg. # R132594716 • Produced and printed in the U.S.A.



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It's time to give every Dad his due with more than a month full of top-flight woodworking prizes. From May 15 through June 17 (Father's Day), *Popular Woodworking Magazine* and its sponsors are giving away a prize a day to celebrate dads. To earn your chance, you must enter separately for each day's prize. All entrants will qualify for the **Grand Prize: JET ProShop II Table Saw (Model 725000K).**

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Popular Woodworking Magazine and its sponsors will award one prize each day from May 15 through June 17. The prize pictured on each day in the calendar above is the prize offered for that day. To register for a chance to win each prize, you must enter on the day the prize is offered, you may enter as many of the daily contests as you like but you are limited to one entry per day. All entries from the first 33 days will be eligible for the **Grand Prize: a JET ProShop II Table Saw (725000K).**

Registration starts midnight, EDT on May 15, 2018 and ends 11:59 EDT, June 17, 2018.

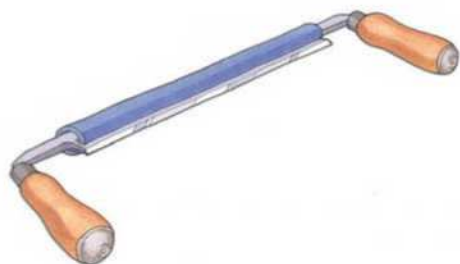
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The Joy of Woodworking

Earlier this year, I took the reigns of *Popular Woodworking*. To be perfectly honest, it's been a little nuts. How did I get here?

The short story is that I've been a writer and editor in the DIY/woodworking/craft magazine world for the last decade. When the opportunity arose to help shape the future of a publication I've long admired, I jumped at it.

I caught the woodworking bug in college and got my first post-journalism school job at *American Woodworker*. It was there that it really struck me: Making stuff is how I want to spend my time. I've built furniture, made speaker cabinets, tried my hand at welding, hacked together stuff out of leather and geeked out over more handmade work than I care to admit. And I've loved every minute of it.

I believe, quite frankly, that making things with your hands is incredibly important. It's part of a truly fulfilled human experience. I've made some really ugly yet functional things; I've made some beautiful things. My life is better because I've made both.

Wood is such an approachable material – it surrounds us. And yet, for some reason, woodworking seems out of reach for many people. We need to change that.

To the non-woodworker, power tools can be dangerous and expensive. Chisels and planes take knowledge, skill and time to use effectively (not to mention keeping them sharp). The lumber at the home center can be a nightmare to use if you're not careful. There's a lot of discouragement for would-be woodworkers.

Thankfully, this also presents a lot of opportunity. We're here to inspire people to make more of the stuff they



have in their lives and to learn the virtues of craft.

So what do we do? For starters, if you're reading this, you're already part of the solution. Keep making what you're making and sharing it with those around you. Support your local lumberyards, makerspaces and craft fairs. Don't be shy about sharing *why* you do woodwork, alongside the how-to.

Even better, help others build the things they want to include in their lives. Be generous with your tools and expertise. It really can be as simple as a tree branch and a pocket knife – before you know it, you have a spoon!

Don't trick yourself into thinking your tools and materials are more precious than they really are. It's what you do with them that counts. And remember, who you share your tools with counts just as much, too.

Andrew Zoellner

P.S. Want to tell me what you think of this issue or anything else? Send a note to andrew.zoellner@fwmedia.com.

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Refinishing a Weathered door



After I read the letter in the October issue, "Weather Protection for Doors", I would like to ask you about refinishing our front door in our summer home in Maine. I believe it is constructed of maple and has over the years (50+) accumulated black spots in the wood. The door was sanded and a coat of polyurethane added several years ago but it seems that not enough was done to take care of the black areas. What do you suggest for refinishing this door to bring it back to its original condition? Attached is a photo that illustrates what I am talking about.

John Neiman,
Savannah, Georgia

John,
To get rid of the black stains you'll need to strip the finish off the door. Most strippers available in Maine should work OK but they may be slow. The fastest acting will include methylene chloride. Slower acting will include n-methyl pyrrolidone (NMP). Everything I'm suggesting here will be easier if you can take the door off its hinges and lay it horizontal on saw horses or

something similar. You could also sand off the remaining finish.

When you're down to wood, you need to bleach out the black stains. A deck brightener might work, but I always use oxalic acid crystals which I dissolve in hot water, the hotter the better. I keep adding crystals until no more dissolve. The crystals sink to the bottom. Oxalic acid can be difficult to find anymore, but you can get it from Amazon. The brand I use is Savogran. I'm not familiar with any of the other brands, but they may work just fine.

So with the finish removed, brush on the dissolved oxalic acid. Brush it on very hot for the greatest effectiveness. Let the liquid dry on the wood so that the crystals reappear. Then hose or wash them off. Don't brush them off because they will choke you up if you breathe any.

You can apply the solution again once the wood has dried if all the stains aren't removed. There is sometimes a little brown stain remaining but it is superficial and easy to sand off.

If the door gets direct sunlight, you should use a marine varnish from a marina, not from a home center. There are lots of marinas up and down the Maine coast. Typical brands are Pettit, Z-Spar, Interlux, etc. They have UV inhibitors that block the UV light. Brands like Minwax Helmsman are worthless for blocking UV.

If the door isn't exposed to sunlight, you can use any finish. But the idea is to block the water penetration that has caused the black stains. So I would apply at least three coats.

I hope this helps. I've written a lot about exterior finishing. If you have one of my books, there might be more detail.

Bob Flexner, contributor

Cutting Board Finish

I have a follow-up question to Bob Flexner's article, "Oils in Finishing" (issue #236). Recently I saw a cutting board made out of walnut, maple and padouk with a tag that stated it had been hand-rubbed with "oil and wax."

What kind of oil/wax combination could be used that would be safe with foods on a cutting board and how would they be maintained?

John Lelak,
via email

John,

You can use any oil and any wax. Food safety is not an issue. I've written about this many times. There are no problems. The issue got started in the late 1970s in Fine Woodworking and keeps popping up.

But neither oil or wax really protect the wood from liquids. My approach to cutting boards is to not finish them at all unless I'm selling them and want them to look nice so people are more likely to buy them. For the cutting boards in my kitchen, I don't apply any finish. It's just not worth it because the finish disappears really quickly.

Bob Flexner, contributor

Newspaper-Backed Veneer

My father was a professional woodworker his whole life, and while he taught me many things, he didn't teach me everything he knew.

He passed recently and in going through his shop I found a large amount of burl veneer. Looks like Carpathian elm.

I've seen and worked with backed veneer, but this veneer (slightly thicker than the average thickness of veneer found today) is backed with newspaper (1960 and 1961!)

I want to build my sister a table with this veneer but I have a few questions.

1. The fact that it's backed with regular newspaper, do you think it will be a problem when gluing?

2. Since it's almost 60 years old, it's dry and very wavy. I wet it with hot water and placed in clamps which

CONTINUED ON PAGE 12



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worked to flatten it, but it was still hard to work with and became wavy again within hours. Would you recommend veneer softener?

3. Regarding glue. The piece I'm making is curved. I don't have a vacuum press and have used contact cement with veneer with good results. However, I read that burl is porous and I'm afraid that when I finish it, the lacquer may affect the bond. The fact that it has backing makes me think it should be OK to use contact cement. Without a vacuum press or adequate clamps, the only other option is to use brown glue with an iron, but I've never done that before and am unsure of the strength of the bond. What do you think?

Dante Brunetti,
via email

Dante,
The veneer sounds like a great find and should be beautiful!

I don't know of issues with newspaper as a backer. Certainly a '60s paper would have a higher "rag" content, so it should serve as a good backer. You mentioned you wet the veneer. If you don't see any separation issues, you should be safe.

Yes, I would recommend a veneer softener, especially because of the thickness and of the burl.

I don't believe you should have any concern with lacquer releasing the adhesive, but there are a couple of untried variables here. As with most "first times" in woodworking, it might make sense to try a small sample piece, and I'd recommend recreating the curve on your sample. Better safe than sorry!

David Thiel,
Online Content Developer

New Radial Arm Saws?

I had a Craftsman radial arm saw for years and I could do almost anything with it, but I decided to upgrade. I gave it to my son and now I can't seem to find any saw of any size. I have looked all over and I can't seem to find any radial arm saws of any size.

What happened? Does anyone make them anymore?

Gordon Burki,
Janesville, Wisconsin

Gordon,
It looks like the majority of new radial arm saws are manufactured with more industrial processes in mind than those of a home woodworker. Craftsman still sells a new 10" model, and the Original Saw Company sells a 12" model (though considerably more expensive).

For the cost of a new radial arm saw, you could purchase a 10" sliding miter saw and a portable 10" table saw and be able to do nearly all of the same cuts you'd have done on your radial arm saw. I think it's this market fact (very affordable miter and table saws), along with the big recall Craftsman did on their radial arm saws in 2000 (involving 3.7 million units), that led most manufacturers away from selling new radial arm saws.

There are still a large number of radial arm saws on the used market, including industrial-quality machines that can be had for pennies on the dollar. If you keep your eyes on Craigslist, you'll see all kinds of different models and sizes. You'll have to take a chance on something without a warranty and might have to do a little restoration work, but if you're selective about what you're looking for and willing to wait, you can find some great deals.

Andrew Zoellner, Editor

ONLINE EXTRAS

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When we're not in the shop or planning projects, we're still talking about wood. In January, the Popular Woodworking team launched a new podcast, called The Afterlife of Trees. Each month, we delve into topics beyond the shop including woodworking mysteries, skateboards, urban lumber, boats and more.

Have an idea you'd like us to cover or want to tell us what you think? Send a note to afterlifeoftrees@fwmedia.com and don't forget to subscribe on your favorite podcast service.

— Andrew Zoellner



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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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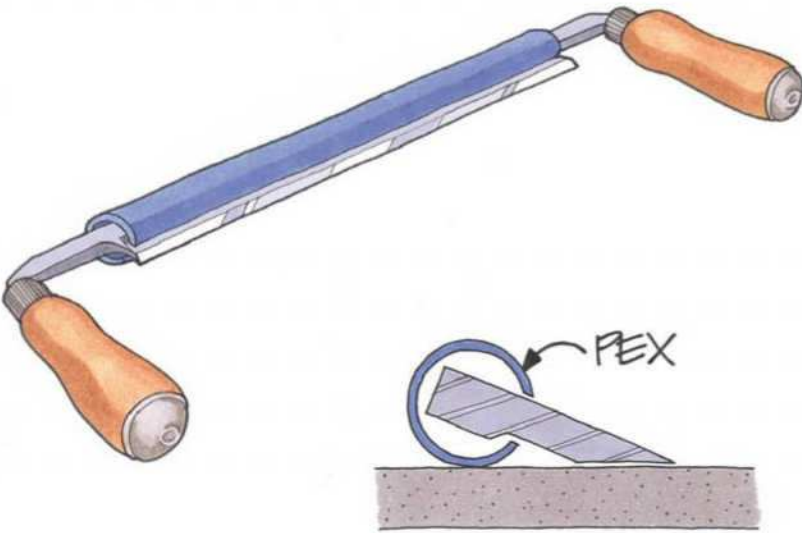
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The key to making this system work is getting a straight cut along the length of the PEX. The best method I've found is to clamp a utility blade in my bench vise and slide the PEX through the knife, using the groove of the jaws to keep it straight.

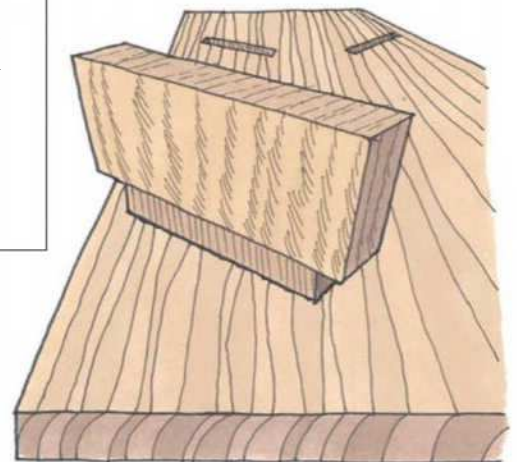
Chuck Nuesmeyer,
Bluffdale, Utah

Pre-Finishing Test Tenon

I often prefer to complete some or all of my project finishing before glue-up. It's easier to get stain and topcoat into awkward corners that way, and it's a nice way to prevent glue squeeze out from fouling the finish. It's always a bit of a challenge, however, to keep the finish from seeping into the mortises, which interferes with glue adhesion. I've never been completely satisfied with the method of stuffing rags or shop towels into the mortise when applying the finish.

So now, when I cut my furniture part to length as the final step of dimensioning my lumber, I save the cutoff to use as a "test tenon" to dial in my table saw settings before I cut into my actual parts. As I'm fine-tuning the tenon on the final part, I also fine-tune the test scrap, which then becomes the plug for its mortise when I go to apply finish. I mark the dimensions on each plug and toss it in a box along with the others I've made, for the next time I cut the same size mortise and tenon.

Tim Buckley
Bellingham, Washington



CONTINUED ON PAGE 16

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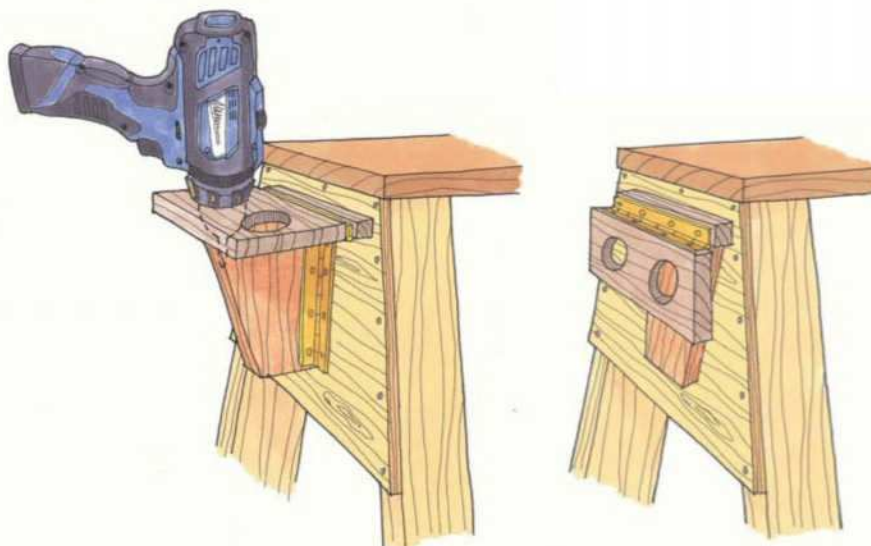
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Flip-Up Drill Holster

Since I usually need to drill a couple different size holes and use different types of driver bits on projects, I often have two or three drills sitting on my work surface. I needed to get them out of the way, so I designed these drill holders that I mount permanently to the ends of my sawhorses. This allows me to keep my drills close by when needed, but the holders flip out of the way when I'm done with assembly.

These are made from scrap with a few pieces of piano hinge. I've also incorporated a few magnets (3" round magnets with predrilled center holes are the easiest to use) attached on the top to keep spare bits nearby.

Leroy Stumme,
Sherwood, Oregon



PVC Tool Organizer

My toolpouch in my shop was full and cluttered when inspiration struck. I took some 1½" PVC (in this case I had some electrical conduit leftover) and got to work. I used PVC glue and glued a few pieces together in bunches. As you can see, it helps me see the tools easier and keeps the tools upright and accessible.

I find this system saves time when searching for the tool that I need. I'm actually going to use 2" as well to hold the hammer and other larger items.

In addition, I use a Harbor Freight small roll-around to set the tool pouch on. It helps move the items around the shop and saves my back.

Harry Woodard
Decatur, Alabama

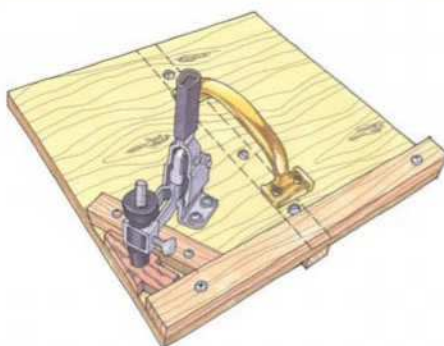


Table Saw Sled for Small Parts

When small parts are needed to be cut at odd angles, the band saw first comes to mind. But it leaves edges that require a fair amount of sanding. So, I made a shop-made fixture that makes those small parts' cuts safe, repeatable and easy on the table saw.

I made the base plate about 10" square, and I cut a groove in the bottom for a miter bar to ride in the miter slot. The bottom is waxed for an easy ride and the miter bar is made from plastic. Place the bar so that a first cut with the saw blade will cut away the edge of the base. That way you will know where to position the part to be cut. I screw strips of wood on the base for repeatable part placement and add a handle for easy use. I use a hold-down clamp to secure the piece to be cut.

Dan Martin,
Galena, Ohio

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- Height with belt arm horizontal: 11 1/2"
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New



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This attachment makes power carving hollows fast and fun.

The Arbortech ball gouge is one of the most fun tools I've used in recent memory. It turns an angle grinder—a relatively crude wood-working tool—into a more precise instrument that can still hog away lots of material quickly.

The first thing I did was thread this somewhat odd-looking attachment on to my angle grinder, don some safety apparel and see what kind of damage I could do to a piece of firewood. I was expecting to have to deal with some kind of kickback or employ a good bit of muscle to make it do what I wanted. But that wasn't the case at all. It simply cut nice, rounded divots with a good deal of precision.

The attachment itself consists of a 1³/₁₆" diameter ball-shaped head with an integrated, replaceable cutter affixed to a steel shaft. It attaches via threads to an angle grinder. The gouge is designed to fit most 4" or 4¹/₂" grinders and work with speeds between 9,000 and 12,000 RPM.

The ring-shaped cutter is designed to self-sharpen in use. As the cutting edge of the cutter cuts, the back edge is burnished. That means you can rotate the cutter to expose a new sharp edge a few times before needing to replace the blade (a replacement cutter costs about \$30).

My immediate thought with this gouge was to hollow out a stack of spoon blanks. And it sure did make quick work! Compared to using a handheld gouge or spoon knife and working by



BYO grinder. Arbortech's ball gouge is compatible with most 4" and 4¹/₂" grinders with speeds between 9,000 and 12,000 RPM.

hand, it was (unsurprisingly) much quicker. The spoons still needed some finishing work by hand, but I got to that point quicker than I would have otherwise.

Then I set about hollowing out a larger piece of firewood to make a serving dish. This took a bit more time than the bowl of a spoon—in hindsight, I probably should have used a hatchet to get closer to the form I was going for before I used the ball gouge. But it was still surprising how quickly I could make a useable form.

The last thing I tried was making a patterned surface on a piece of flat stock. This was trickier than simple hollowing—especially achieving an even, repeated pattern—but still much

easier than I thought it was going to be.

You'll want to make sure you're using adequate protection—safety glasses, hearing protection—and have your piece securely clamped to a stable work surface. You'll notice that the ball gouge doesn't create much dust—it's mostly small shavings. You'll also want to make sure you're using your grinder's auxiliary handle to keep two hands on the tool at all times. It makes controlling the tool much easier, and it keeps your hands out of the way of the spinning gouge. It's not an insignificant investment at about \$110 for the tool, but once you start using it, the creative juices start to flow and you really start having some fun.

—Andrew Zoellner

Ball Gouge

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Street price ■ \$110

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Bosch 1250DEVS Random Orbital Sander

My wife and I purchased our first home just over a year ago—a spectacular farmhouse that has been cared for by generations of responsible owners. We were not particularly excited, however, about 30-year-old carpet, and the moment we got the keys to the house we started to tear it out.

Enter the Bosch 1250DEVS. I buried the cost of this sander in the many bills that came in the first month (a fact that I have not revealed until this very moment....sorry, hon!) Ahead of me was touching up 1,500 square feet of painted pine flooring (before we painted them again), stair treads

that needed attention, decking that needed taming, plaster walls that had developed cracks, and I even used it for some drywall work. I put this sander through many torture tests and could not be happier about the investment.

The banner feature of this sander is its dual-mode capability. The random orbit function is what you'd expect, though the added real estate of the 6" disk is significantly faster than a 5" ROS. Now my favorite part—the eccentric orbit (a feature often found on more expensive tools). With the right touch, this powerful mode can waste away the hardest of lumber very quickly. I have since used this sander to treat a massive red oak slab and various pine shop projects since the home improvement sprint of last year. And I've found that the eccentric mode saves loads of time. There is a second handle that can screw into either side of the grinder that you



absolutely need for the eccentric mode.

The Bosch features soft start at variable speed settings. The dust collection is incredible—Bosch claims 96 percent dust capture through the channels in the pad. I heartily recommend this sander if your random orbit just isn't cutting it.

—David Lyell

1250DEVS Random Orbital Sander

Bosch ■ boschtools.com

Street price ■ \$270

Ryobi Cordless Pin Nailer

In my shop, my most used pneumatic tool by a wide margin is a 23-gauge pin nailer. So when I tripped over my compressor's hose and the nailer hit the ground for the umpteenth time and finally gave up the ghost, I headed off to find a replacement.

I thought I'd just get the new version of the model I'd used previously, but then I started thinking about how I actually use my nailer.

I use it to drive a dozen nails at a go, to hold parts in place while glue dries or to knock together a quick jig. It turns out, a cordless pin nailer made a lot of sense, and this Ryobi cordless pin nailer was added to my cart.

The nailer drives 1/2" to 1 3/8" pin nails, includes an LED light and the manufacturer claims it will drive up to 3,500 nails per charge (with a 4ah battery).

In use, the nailer performs very much like my pneumatic pin nailer. It sinks 1 3/8" pin nails into oak with ease. Try as I might, I couldn't get it to jam, either. The only frustrating thing about the nailer is that it's sold as tool only, so if you aren't on this battery platform, you'll need to grab a battery and charger to use it.

With a battery, it's definitely heavier than my old pneumatic pin nailer, but that's about the only drawback. A little extra weight is an excellent trade-off to losing the compressor's hose. The LED light is also really appreciated when I'm working in my dimly lit garage workshop.

—Andrew Zoellner



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Addition by Subtraction

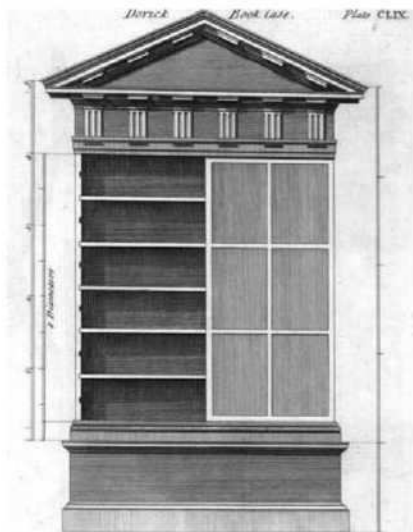
When adding design elements, less is often more.

One useful way to think about furniture design is to think about it as a language. It's a set of ideas and structures furniture makers and builders passed down through the centuries to express their ideas in wood. Much like a spoken language, the words or ideas you use are thoughts and words that our ancestors used long before us. As our language needs evolved beyond simple words, we invented verbs and adjectives. And somewhere far back in time, artisans realized they could tell stories in wood with borders, edges and space. Language works exceedingly well for us precisely because it's a shared set of ideas that we understand and can use with precision.

If furniture design is a language, architecture is the mother tongue of much of what we know about it. For much of our history, architecture and furniture design were one and the same. Architecture lies at the root of the string



Design details. These two thin lines of beading transform this bookcase design.



Roman influence. Is this a bookcase or a temple? 18th-century designs romanticized the architecture of Rome.

of material knowledge passed down through our ancestors that furniture makers have used to carry out their ideas in wood.

Design DNA

Nowhere is this link to architecture stronger than in 18th-century Western furniture. Designers (and the trend-setting elite) were in love with classical motifs from ancient Rome and Greece, building homes and public buildings that mimicked Roman temples. Furniture designers took their cues from those structures and designed furniture and cabinets that reflected that same idea.

Architecture shifted over time into iconic styles like Arts & Crafts, or Mission, and furniture designs went right

along on for the ride. There's a really good reason for this. Architecture defines the neighborhood (interior space) most furniture will reside in, so furniture designs naturally tended to try to harmonize with that space. Most of our iconic furniture designs reflect a period of iconic architecture. This chain was broken when architects embraced Modernism and Post-Modernism, but it's largely because those movements intentionally strove to break with all things from the past.

Whether you are a traditionalist or a modernist or somewhere in between, there are still lessons to be learned from this ancient design language. One of those lessons is that we can make our designs more appealing if they feel like they grew organically out of their sur-

CONTINUED ON PAGE 24

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roundings. It's OK, even encouraged, to grab something from the interior space and weave it into the design. This helps our design feel like it's local to the neighborhood and not some pesky tourist.

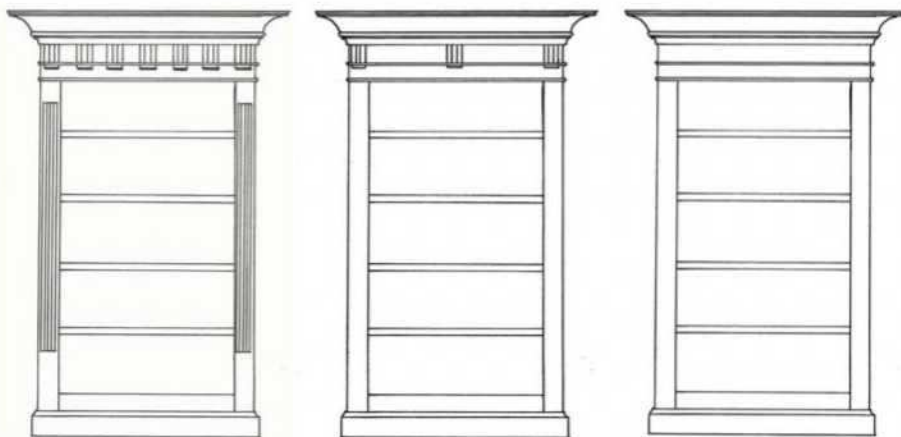
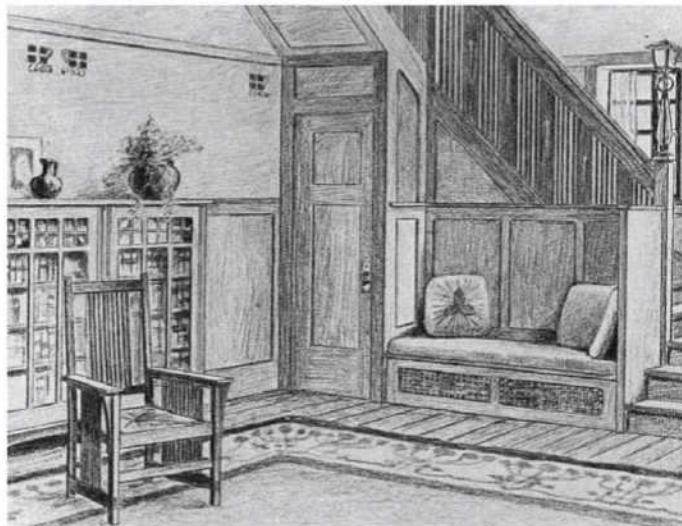
Designers understood that there was a range of how much they could reflect the surrounding architecture. They could do a full-blown treatment by grabbing every architectural detail nearby and making the furniture look like the house in miniature. More often, though, they leaned toward just trying to capture a hint of the neighborhood by subtracting architectural ornament. A doorway, fireplace, or cabinet will compliment the setting if it has a faint echo of the surrounding architecture. There's no set recipe for subtracting. Just how much to get it right is a matter of personal preference.

Or you might think of it in reverse and ask yourself, "How can I take a simple form like a bookcase and add just a small detail to make it sing with its surroundings?" I look at the architectural details in my surroundings and ask myself if there is something I can echo in my furniture design. It can be a curved archway opening between rooms that is translated into an arched door panel on a cabinet. It can be something as subtle as a chamfer treatment on an edge that reflects a chamfer on a nearby fireplace mantle.

Even a small detail can make a big impact. In fact, my goal when I build furniture is to make these small, subtle elements become little surprises that guests in our home often just stumble upon by accident. I like designs that contain little sparkles to discover rather than yelling for attention, like a noisy Jack Russell yapping at you from across the room. Take some time to look closely at details in a room that give it character, and experiment with how those details might be woven into a design. **PWM**

George R. Walker is the co-author of three design books and writer of the By Hand & Eye blog (with Jim Tolpin).

Built to fit. These Arts & Crafts chairs and built-ins were designed specifically to compliment the architecture.



Progressive omission. All versions of the same design retain its proportions and a shadow of its architectural details even as the details fade from view.



Breaking free from surroundings. This Modernist chair showcases material rather than architecture by celebrating the possibilities of using polymers in furniture.

ONLINE EXTRAS

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BLOG: Read more from George R. Walker on his By Hand & Eye Blog with Jim Tolpin.

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About This Column



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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On Wood Selection

Both fast- and slow-growing wood present good opportunities.

Wood selection is an important part of any woodworking project. I sometimes feel like I take it to an extreme, like I'm some kind of oak snob. Sometimes people see pieces I reject and they can't understand what's wrong with me. Too much twist, a bow here or there. Not straight enough grain. I'm spoiled from decades of using the straightest-grained, radially-riven oak boards I can get. And I wouldn't have it any other way.

When I'm selecting my wood right from the log, many factors help determine which piece of wood goes into which project. Recently I got some nice clear fresh red oak for a weekend workshop I was helping to teach through Plymouth CRAFT, a group I'm involved with in Plymouth, Mass.

At first glance, the log looked perfect, even too good maybe. Oak is the principal timber I work with making reproduction furniture, and I had my eye on any leftovers after the class was done. But even after splitting logs for 40 years, I can sometimes pick losers. This log was nearly a total loss. The minute we drove the first wedge into



This log looks ideal. Once we started to split it, however, it was so twisted it was almost useless.

the end grain, I saw that the split was going to twist very badly over the 5' length of the log.

We were able to salvage, with too much effort, the stock we needed for the workshop in making garden hurdles, but all my hopes for some new joinery stock were out the window. With so much twist, there is a lot of labor and waste trying to get flat radial boards from stock like that. You also run the risk of spending that time and effort, only to have the flat board twist as it dries. The best way to make flat boards from green wood is to split trees that grew nice and straight to begin with.

In addition, the tree had grown relatively fast, resulting in a very stripy-looking pattern on the radial face. For the carved furniture I make, I want the carving to carry the day, not the "figure" in the wood. The fine growth rings from a slow-growing tree blend together visually, making a nice ho-

mogenous surface that doesn't compete with the carved patterns I use.

Technically speaking, the fast-growing oak is stronger than the slow-growing, so I hit on a good use for this wood. Rather than my usual joined oak furniture, I'd use this stock for some ladderback chairs made using wet/dry joints. These chairs are how I began my woodworking career 40 years ago. You can very easily shape all the parts while the wood is fresh and full of moisture (in this case with drawknives and spokeshaves). Then dry the rungs (which causes them to shrink), bore holes in the still high-moisture content posts and drive home the dry rungs. The dry rungs pick up moisture from the posts and swell a bit, and the posts shrink as they dry out. You get yourself a chair for the ages this way.

Traditionally, these chairs were usually turned and made with rungs of ash or hickory, sometimes oak. The posts were often made of soft maple. It was my



***Finer grain.** The carved piece on the left is slow-growing oak. Its consistent fine grain is a pleasure to work with. The piece on the right is stronger, but visually distracting.*

CONTINUED ON PAGE 28



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An ash plane. This little plane is based on Dutch examples from the late 17th-18th centuries. It's about 9" long and 2 1/4" wide.

friend and first woodworking teacher, Jennie Alexander, who championed making them from all oak – usually white oak in Alexander's case.

The faster-growing wood is a good choice for the chairs in part for the strength, but also for its bending quality. Very slow-growing oak can break across the grain while bending. Thicker growth rings are more likely to stay intact during that process. I don't bend enough chair posts to bother making bending straps. My pieces are steamed then bent on forms to dry and "take" the shape.

In my joinery work, I use wooden-bodied planes both new and old. Here in New England, the most common timber for 18th- and 19th-century planes was beech, followed by yellow birch. Both of these are diffuse-porous woods. Earlier plane making was more varied in its wood selection.



A great use for fast-growing oak. Rear posts for ladderback chairs, some in the bending form, others just mortised for the slats. These posts are 1 1/4" in diameter and have about 6 growth rings.

The archaeological finds from the warship the *Mary Rose*, which sunk off the south coast of England in 1545, show a wide range of woods used in making planes. I've tried riving and hewing thick pieces of beech for plane making, but had limited success in drying it without defects. After seeing the *Mary Rose* planes, I felt liberated so I chose some very fast-growing ash to make myself a small scrub plane, based on Dutch style planes from the period. It's held up quite well, having been used daily for more than 10 years.

I wouldn't use slow-growing ash for this work at any point, but I have often pounded apart the growth rings

of such an ash tree for basket making. In that case, the thicker rings of fast-growing trees work against you. For splint pounding I want the slower, thinner growth rings. When pounding ash splints, you're crushing the porous springtime growth, and the more solid summertime growth becomes the splints from which I weave baskets. **PWM**

Peter Follensbee has been involved in traditional craft since 1980. Read more from him on spoon carving, period tools and more at pfollensbee.wordpress.com.



A fast way to make strips. Pounding an ash tree for basketry is a "green woodworking" technique. Freshly worked wood delaminates easily under the hammer blows.



ONLINE EXTRAS

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BLOG: Read Peter Follensbee's blog.

ARTICLE: "The Best Oak Money Can't Buy"

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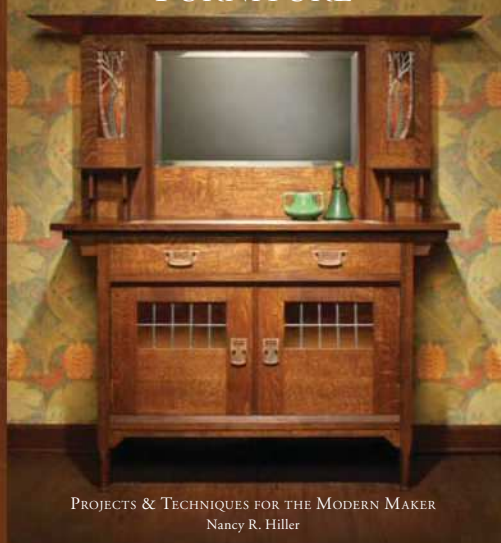


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offers fresh perspective on a movement whose influence continues to shape thinking about craft a century and a half after it first emerged. In addition to three step-by-step furniture projects, Nancy Hiller challenges the widespread understanding of Arts & Crafts as primarily a style; she offers an interpretation of John Ruskin's "Moral Elements of Gothic" as a corrective to the movement's association with a naïve perfectionism.

Echoing the larger organization of the book, each project is preceded by a look at the designers and artisans associated with the original piece. Hiller explains how each project – a chair, a sideboard, and a dining table – illustrates particular dimensions of the Arts & Crafts movement. A bibliography and detailed index make this book a valuable reference.

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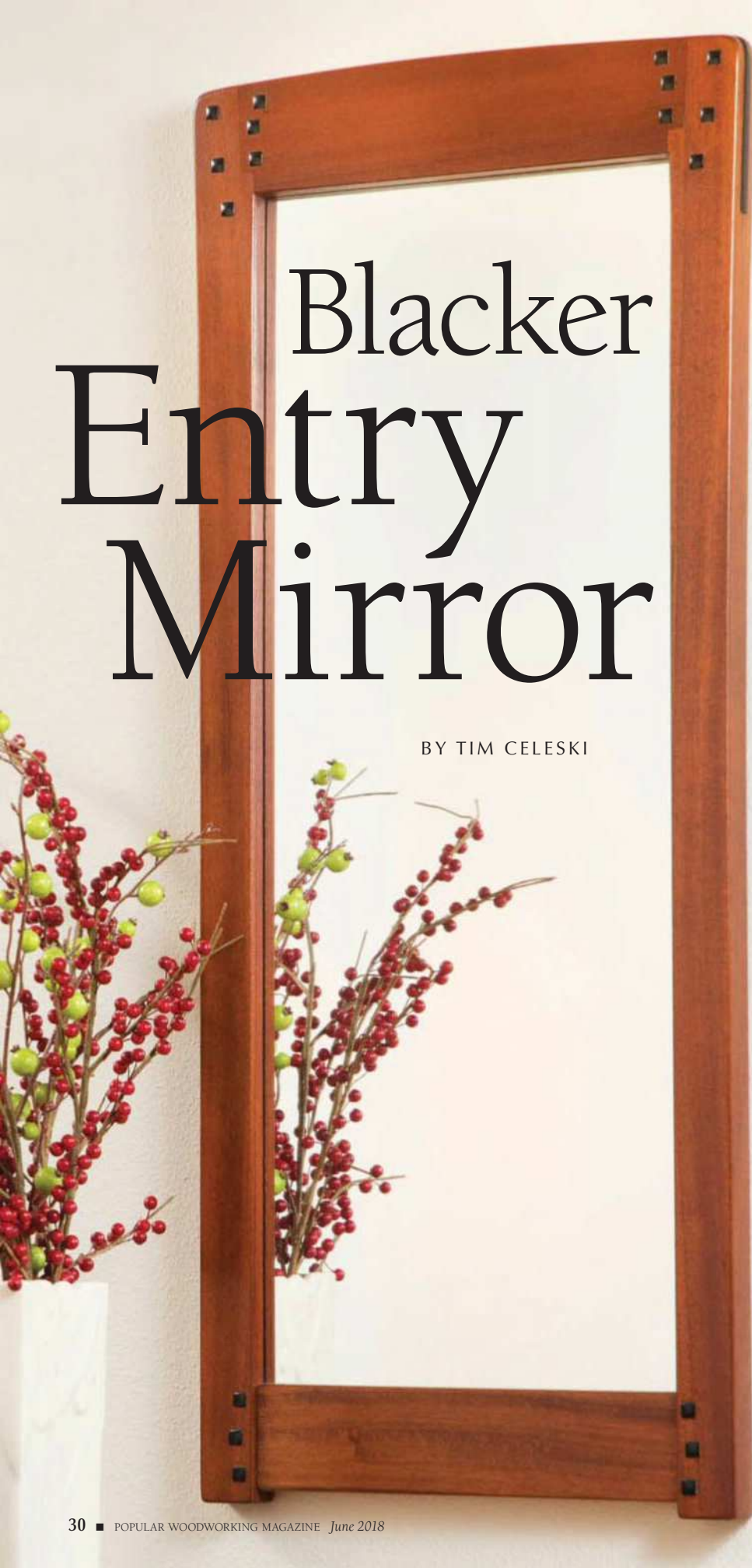
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Blacker Entry Mirror

BY TIM CELESKI

Flex your skills and build this iconic Greene & Greene entry mirror.

The 1907 Robert R. Blacker House in Pasadena, Calif., is a masterpiece. The architecture and furniture inside can only be described as breath-taking. One of the lesser known pieces of furniture is my personal favorite – a small vertical mirror that hangs above a beautifully carved cabinet. It's a great woodworking project with some interesting challenges.

The sides gently flare outward near the top, ebony splines wrap around from the top to the sides and square plugs seem to be everywhere. It's sized perfectly to hang near the entrance of any home, but if you'd like a dressing mirror version, just add 10" to the bottom of the mirror – the proportions still work wonderfully.

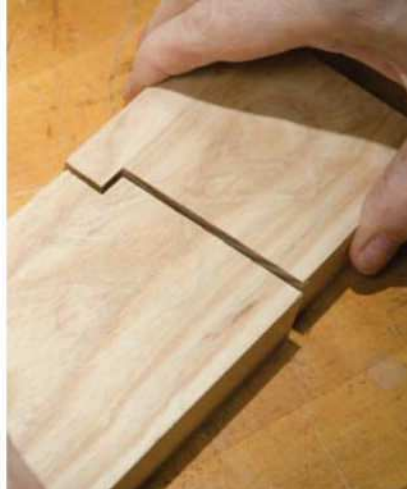
I make a precise copy of the mirror with just two minor changes: On the original, a few of the 18 square plugs are slightly smaller than the others. I find them distracting and prefer all plugs to be the same. I also leave off the leather hanging straps.

The mirror may seem straight-forward, but it's not. At the top is an unusual angled haunched joint – a joint with a few challenges. Over the years I've tried six different methods for making that joint. Most require a lot of fussing, fitting, fine-tuning and corrections. I've found that with a careful approach, and a few simple-to-make jigs, it's easy. This is a project where accuracy is particularly important because the jigs and the parts have to match perfectly. Take your time, use rulers, squares and calipers and check all measurements.

Because the project requires very little wood, yet involves a lot of steps and setups, I highly recommend building more than one at a time.



Make it perfect now. This jig will register on your blank parts. Use it as an aid to hand cut the angled haunched joint.



Alignment is key. By making the joint in pieces, you can make it so perfect that it's light tight.



Assemble the jig. The long crest rail is glued and nailed together with the notch set back $\frac{1}{2}$ ". Assemble the side jig tight to the rail jig.

Materials

You'll need less than six bf of 6/4 material, ideally from a single board, per mirror. Sapele or Khaya mahogany are ideal choices. A good domestic alternative is cherry with its deep warm color. Figured, loud or exotic woods distract from the Greene & Greene details; let the design speak for itself. For plugs and splines, a small amount of black, Gabon ebony is needed. Look carefully for crack-free pieces that will net out 4 strips that are $\frac{3}{8}$ " x $\frac{3}{8}$ " x 8".

For the patterns, I use $\frac{1}{2}$ " MDF. Make pieces that are $3\frac{1}{2}$ " x $13\frac{1}{4}$ " and one or two sides that are $2\frac{1}{8}$ " x 38" – the same dimensions as your blank mirror parts. Because the pattern blanks are the same, cut the pattern parts at the same time. But hold off on cutting to shape for now. We'll use them for joint practice while they're square.

Stock Preparation

All of the major steps in building the mirror are done while the parts are straight and square. Only after all joinery is complete and the square holes cut do parts gets shaped and finished.

Start by face planing and squaring up your material. While you're at it, mill up a few spare hardwood pieces 12" long the same thickness and widths of the crest rail and side for joint cutting practice – I usually use poplar. Finally, mill your 6/4 material to $1\frac{1}{4}$ " thick. Keep the offcuts to use later for setups.

For final dimensions, the crest rail needs to be $1\frac{1}{4}$ " x $3\frac{1}{2}$ " x $13\frac{1}{4}$ ". For the

two sides, two pieces cut $2\frac{1}{8}$ " x $1\frac{1}{4}$ " x 38". The bottom rail is $2\frac{3}{4}$ " x 13 " x 1" – slightly thinner than the other three parts and shorter than the top. To keep the color and grain the same, start with the same $1\frac{1}{4}$ " material and mill down to the final 1" thickness. Hold off on preparing the ebony until the square holes are cut.

Jigs Make the Difference

To make the angled joint at the top of the mirror, we're going to make a two-part jig that's basically a perfected version of the joint. One is an assembled perfect version of the joint on the crest rail. The other is an assembled version of the joint on the side of the mirror.

Prepare a piece of scrap hardwood for a final dimension of 1" x $4\frac{1}{2}$ " x 18". From this board use your table saw to rip a $\frac{5}{8}$ " piece. Rip the remainder to $3\frac{1}{2}$ ". Set up a miter saw or a miter gauge setup on a table saw to make an 87 degree cut. Measure from one end of $3\frac{1}{2}$ " wide board and mark at $12\frac{1}{2}$ ". This will be the long end of the 3° angle



Trim to size. Two-part jig nailed, glued and ready to be trimmed.



Add a fence. The two-sided plywood fence overhangs both sides of the jig. Use a $\frac{1}{2}$ " piece of MDF to raise it up. On the crest rail jig, inset the jig $\frac{1}{16}$ " from the jig fence.



Mark for loose tenons. Joint center positions are $1\frac{3}{4}$ " from the ends. Transfer center lines from rails to sides.



Cut carefully. Hold your parts to your bench with two clamps. When cutting across the precut mortise, use a Domino or loose tenon to keep it from collapsing while you cut.



Check and check again. Check your work to make sure the joint is square and true in both directions. The goal is to make the joint disappear.

you're about to cut. Once you've reset everything back square, cut a 13" piece from the $\frac{3}{8}$ "-wide strip cut earlier. These are the major parts you need to assemble the jig.

From the short side of the angled end of the $3\frac{1}{2}$ " piece, use a square to mark a line along the 1"-thick bottom of the board that's $\frac{1}{2}$ " from the end. To assemble the jig, we're going to attach the $\frac{5}{8}$ " piece to the larger piece. I prefer to use a brad nailer (because it's quick). The finished jig is under a lot of pressure under use, so apply glue before you attach the smaller strip at the $\frac{1}{2}$ " line on the bottom of the larger piece. Once the strip is aligned to the mark and everything is flush on the sides, nail it in place. The extra wood hanging off the end will be trimmed off later.

For the second part of the jig, clamp the part you just completed on your workbench long side down. Move the angled cutoff section of the wide board



Trim the bottom rail. Once the top joints are tight and the mirror is square, measure the gap for the bottom rail. The bottom rail is thinner than the other mirror parts.



Transfer the pattern shapes. It's easiest to do this while the parts are clamped up. I use a $\frac{1}{4}$ " machinist center punch to mark my square hole positions.

until it's tight to the assembled crest rail section being held down. Now, move what's left of your small strip on top until it meets up with the inset piece that's already glued and nailed. The idea here is to reassemble these parts into what is essentially, a solid board. Before nailing, place a lamp behind the assembly to check for light leaks. Once you can't see light coming through where the two jig sections intersect, hold everything tight and glue and nail it together. Then it's time to trim the jig.

With a miter saw, trim the end of the larger section flush on the end. For the smaller section, mark precisely $2\frac{1}{8}$ " from the overhanging $\frac{5}{8}$ " strip. A piece this small is tricky to handle on a miter saw, so I align the cut line to the blade and hold the assembly down tightly with a clamp. Cut slowly, watching that the piece doesn't move during the cut.

The fence registers the jig to the square parts. For the two-sided fence,

rip enough $\frac{3}{8}$ " or $\frac{1}{2}$ " solid core or Baltic birch plywood for a 2" x 20" long piece and cut the pieces to fit. On the larger assembly, inset the solid wood $\frac{1}{16}$ " from the end of the plywood fence. For the side jig, note that plywood wraps around two sides so it can rest on the corner of the square part. Use a $\frac{1}{2}$ " piece of MDF to support each section while you glue and brad nail the fence parts into position.

Loose Tenon Joinery

I prefer to use loose tenon joinery for the mirror. This kind of joinery is accurate, strong and with a Festool Domino, fast. If you want to make a real haunched tenon by hand, just extend each side of the crest rail 1", mark out your tenon and mortise, and the jig will take you the rest of the way.

From the top of the still-square blank mirror sides, measure down and mark at $1\frac{3}{4}$ ". Using a square, mark a line across the width. Do the same with the other blank side, and clamp the blank crest rail between the sides and flush up at the top. Carry the line into each side of the crest rail. If you're using a Domino, use a 10mm bit and set it up and test cut so that it cuts in the center of the $1\frac{1}{4}$ " thick stock. On the crest rail side set to 35mm depth. On the sides setup to 40mm. Once cut, use 50mm x 25mm x 10mm Dominos for a test.

Joinery Practice

As any serious musician will tell you, effective practice improves your work. The same is true for hand-tool work, especially this joint, so it's good to do a little warm up. In my classes, students start by using their square MDF patterns as first tests. For the sides, flush the jig to the corner of the MDF and use a pencil to mark the line you'll be cutting. At the band saw, cut to $\frac{1}{16}$ " from the line. After securing jig and pattern to your bench with two clamps, hold your chisel tight to the 1"-thick wall of the jig and press and make a line along the lines of the cut with your chisel. Well outside that line, start to shave off the excess with chisel and mallet. Don't be too aggressive. A little at a time is the way to go. Once you're close to

the scribed line, then hold your chisel tight to the jig and cleanly shave off the rest until your cut is flush. On the crest rail, flush to the top wall and position the part at the end of the jig fence that hangs out $\frac{1}{16}$ " past the core. When both parts are done, check your fit.

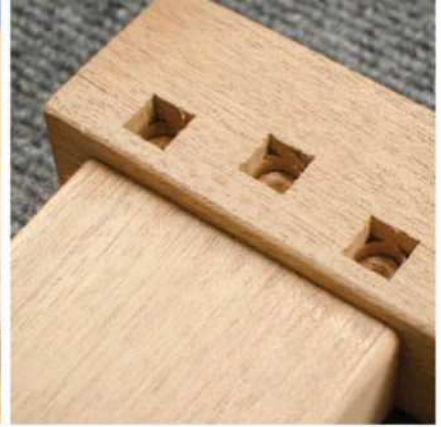
Once satisfied, move on to the extra hardwood pieces you milled up earlier. Again, it's critical that the blank parts and jigs are held firmly to your bench with two clamps. After marking and rough cutting, sharpen your chisels for final practice. Check your work with a small square and chisel edge to make sure you're cutting evenly across the cut and not drifting. Thanks to the thick and rigid jigs it's easy to perfect both sides of the haunched joint. Once you're satisfied with these practice sessions, it's time to go to work on the real parts. If the part has drifted a bit you may have to shave a little off the sides of a Domino or loose tenon to get the joint to come together. Clamp everything together and check to see if the insides of the mirror are 90°.

Once ready, take a measurement of the opening at the top of the mirror. Use this measurement for cutting the length of the 1"-thick bottom piece.

Because the thickness of the bottom piece is thinner for visual relief than the other two parts, I mark centerlines on the back of the mirror where the parts are flush. Mark a line $1\frac{3}{4}$ " up from the bottom of each side. Mark a centerline on the $2\frac{3}{4}$ "-wide bottom piece. These are your alignment points. If using a



Hand-powered mortiser. If you don't have a hollow chisel mortiser, Lee Valley makes a square punch that works well. Use the punch to define the outside of the mortise and drill out the waste.



Domino, reset to center on 1"-thick stock and a 25mm depth of cut. Once all this done, test fit and clamp your still-square mirror frame. If something is off, shave a little off a tenon so that everything comes together square and tight.

Complete the Patterns

To complete the patterns, use the grid in the illustration (page 37) as reference. A more accurate method is to print from the PDF plan available in the Online Extras. Then, spray glue the paper drawings to attach to the square pieces of $\frac{1}{2}$ " MDF.

To complete the patterns, rough cut outside the line, and smooth with rasps, files and sandpaper. Use a $\frac{1}{4}$ " drill bit to cut all the plug locations. Once everything is smooth, remove the paper and your patterns are ready to go to work.

Hold the patterns on your blank parts and with a pencil, transfer the outer shapes to your square parts. To

transfer the plug locations, I like to use a $\frac{1}{4}$ " machinist center punch. It just fits in those $\frac{1}{4}$ " holes and when lightly tapped with a hammer, your marks should be dead center.

Cut Square Holes While the Parts are Still Square

All of the square holes in this project are $\frac{3}{8}$ ". There are a variety of methods to cut square holes. If you don't have a hollow chisel mortiser, a Lee Valley square punch works great. Using it involves a combination of tapping the punch and drilling out the inside excess. You go back and forth between punch and bit until you reach desired depth.

Take particular caution as you punch square holes above your mortises. Too much pressure or hard tapping could cave in the thin side walls. Place a Domino or dummy tenon in the mortises while cutting your square holes. When all the holes are cut, clear the corners of excess with a small chisel.

Shaping

On a band saw, rough cut your parts close to the lines, but not over. Once the major parts are ready to go, it's time to shape your wood parts to your smooth patterns.

If you've not shaped before or are uncomfortable doing it, you can use the patterns as reference and use hand tools to arrive at the final shape. But, if you have a router table, a flush bearing bit and a jig for holding parts as you shape, the process goes very quickly.

Align your pattern to the part and hold the two together, then shape from left to right, always downhill, never



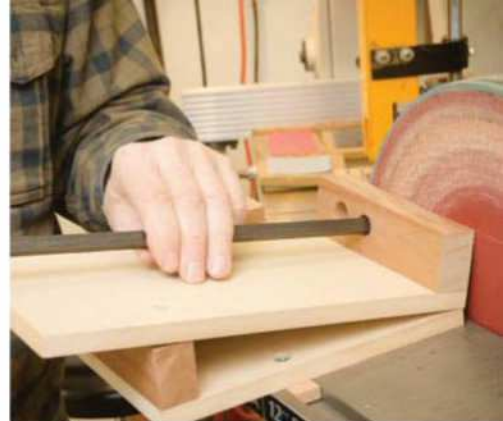
Start shaping. Shape your parts on a router table or shaper. You can also use the patterns to guide your handwork if you'd rather shape the parts by hand.



Detail work. Clean up the edges of the mirror by hand with scrapers or sanders. An edge sander or belt sander comes in handy for blending the sides and top of the mirror.



A dual-purpose jig. This simple jig is for scraping down ebony to thickness. To pillow your strips, insert a thin spacer under your ebony and use block plane to pillow the strip over slowly.



Pillow your plugs. Rapidly spin each end of your square stock at a slight angle, cut off the pillowed end at the bandsaw and repeat.

up-hill. Begin 1" in from the starting end. You will have to flip your crest rail to stick to the downhill rule, but this is the proper way to do it. You can use sanders and a block plane to take off any excess that wasn't shaped.

Once the parts are shaped, scrape and sand to get everything smooth along all the outside edges. Dry assemble the mirror with tenons and clamps to check the transitions of the crest rail and sides and take off the bulk of the excess. After the mirror is glued up you'll get a final chance to smooth the transitions.

Mirror Glue-Up

At this point in the project, I like to round over the sides with an $\frac{1}{8}$ " roundover bit and sand the bottom rail. Also, round over the two top inside edges of the sides, stopping short of the top intersection. We'll finish the rest up later.

After a final dry fit to check the front

and back of haunched joint, it's time for final assembly. Be careful how you apply your yellow glue. Any oozing out at the offset intersection of the bottom rail and sides will be hard to cleanup later.

When clamping, use soft wood clamping pads so that the clamps don't damage the surfaces. I use 18" clamps at the top and bottom and a 40" clamp from top to bottom to draw the joint tight.

Once dry, it's on to finish sanding. All sanding has to be done before adding plugs because they sit above the surface. Blend the intersection at the top of the mirror between the sides of the crest rail until it's smooth. Round over the rest of the mirror, stopping short of the top inside intersection. It's best to blend those by hand so that the inside corners are crisp. Sand progressively from 120 to 320 grit.

Stepped Rabbet in Two Passes

With a router and a standard $\frac{3}{8}$ " rabbeting cutter and bearing, I prepare to rout out an area in the back of the mirror for glass, packing and a panel. I place leftover, same-thickness material inside the mirror to help support the router. It's important to take this cut slowly and step down tiny amounts at a time. Start the cut away from any wood, slowly move in to start the cut and move the router around the inside clockwise. Once you complete a lap, check your work and reset down another $\frac{1}{8}$ ". As you approach your final depth, take off $\frac{1}{16}$ " for the final passes. This edge touches the mirror glass, and any chips or defects will show.

Once the main rabbet is cut, it's time for the second rabbet. For this, you need to have a sample of your backing board available. I use hardwood plywood for my backs. I set my rabbeting bit to the plywood depth plus a bit more and use the previous rabbet as the bearing reference. The result is a stepped rabbet.



Fit the back. Rout out the rabbet on the back of the mirror to hold the glass, packing and back cover. Because the mirror is so thin at this point, the router is tippy and hard to stabilize. Use scrap that is the same thickness as the mirror to help support it. You'll make two passes with the router to create a stepped rabbet.

Pillowed Plugs and Splines

To make enough plugs and splines for this project, you need to end up with four, 8" strips of $\frac{3}{8}$ " x $\frac{3}{8}$ " Gabon ebony. A small piece from a supplier should provide enough to work with. If you can find a long piece, say 12" or more, it's easier to work with. I start with a piece that's under $\frac{1}{2}$ " thick by 2" wide. I set up my jointer to the thinnest possible cut and joint one wide side and adjacent thin side. Mark these as reference surfaces I put squiggly pencil lines all over them.

JIG FOR CUTTING SPLINE SLOTS

The splines are cut with a plunge router using a simple jig made from $\frac{1}{2}$ " MDF and 1"-thick scrap. On your router table, install a $\frac{5}{8}$ " bit. Clamp your 1"-thick piece of scrap to the fence, and adjust the fence to rout a groove in the middle of a $1\frac{1}{4}$ " piece of scrap stock. With your fence locked in place, attach your 1"-thick scrap piece to the $\frac{1}{2}$ " MDF, slowly lower it onto the $\frac{5}{8}$ " bit, and cut your groove into the jig.

Then, lay out your slots on the mirror, align your jig, and cut. Use a $\frac{5}{8}$ " bushing with a $\frac{3}{8}$ " spiral bit, cutting $\frac{5}{16}$ " deep. Repeat for the rest of the slots on the mirror.



Find your center. Clamp the jig fence (1" scrap) to the router table and use a $\frac{5}{8}$ " router bit and $1\frac{1}{4}$ " test piece. Rout halfway through the piece, flip and repeat. If your cuts are off-center, there will be overlap in the groove.



Cut the slot. After marking positions on the underside of the MDF, mount it to the 1" fence, flush to router fence and lower slowly onto the $\frac{5}{8}$ " bit. Complete the cut by routing to the lines.



Start routing. Mark splines top and sides. Then, mount the mortising jig to the mirror. Cut about $\frac{5}{16}$ " or so deep with a $\frac{3}{8}$ " spiral bit and a $\frac{5}{8}$ " bushing. Reposition on other side of the corner and then square the ends of the slots with a chisel. Repeat for the other corner.



The next challenge is to size the flat stock to just fit in the plug holes. First we need some square holes to test with. With scrap from the mirror frame I punch a couple of test $\frac{3}{8}$ " square holes to the same depth as the holes on the assembled mirror. Cutting this ebony to thickness is a little challenging because the pieces are so small. There are a number of ways to do this—I have an old tabletop planer that I use for delicate work like this. When I'm about $\frac{1}{32}$ "

away, I do final thicknessing on a wide belt sander, but you could complete it on a small planer or drum sander if you have one. When I'm close, I start testing a corner of the ebony block in my test holes. When I can just barely fit a corner in, I'm very close. It's important to not overdo this (and wind up with loose plugs), so go slowly. Once satisfied, it's time to head to the bandsaw.

On the band saw, I use a fence and cut plug strips a little too thick. I cut off

a strip and back at my jointer, I joint a new clean edge on the rest of my stock and put a pencil line on it. Back to the band saw for another cut and so on until you have the strips you need. To clean up that one ragged edge on each strip, it's back to my wide belt sander until the entire square profile strip just fits in a test hole.

If you don't have the convenience of these kind of power tools, for final passes, you could make a simple jig out of pieces of very dense hardwood. Just mill a few 1" strips to the exact thickness you need to fit in a square hole. I use a pin nailer and glue to tack them to small pieces of plywood with enough room between them for ebony strips. The harder wood strips will support the scraper and keep it square while the softer ebony is being shaved with a hand scraper until you get to the thickness needed. Set aside two strips for splines and the rest for pillowed plugs.

Pillowing Plugs

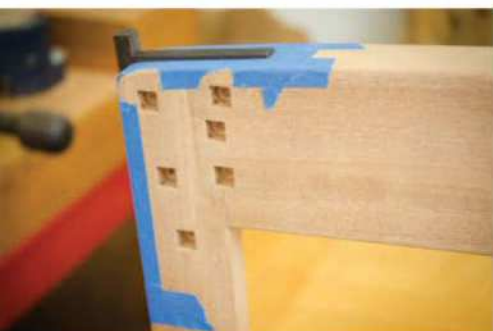
Once you have enough ebony strips that fit your square holes, there are a number of ways to pillow plugs. In my case, I use a simple jig, designed to hold the plug stock at a shallow angle. This jig mounts in the miter slot of my disk sander. I put the stock in the hole and rotate it as fast as I can. When you pull the stock out, it's round and pillowed on the end, but still a little rough. So, I set-up 3 or 4 grits of sander paper resting on foam pads, and using a sweeping motion, I brush back and forth and rotate 90° and brush again. I step my way up to 400 grit to get a very smooth pillowed surface. If you have a buffer wheel handy, take it another step.

I have a tiny micro adjustable cut-off sled for my band saw. It, too, rests in a miter gauge slot to keep it in line. Once I make a few test cuts for depth of the pillows, I pound them into my test square holes. When everything is set up just right, then it's back to disk sander and sanding pads, the band saw and back again until I have the 18 plugs I need for the mirror.

I make installation easier by putting a tiny bevel with a chisel on the bottom of each plug. It only takes a few minutes



Fit the splines. Cut the side spline piece longer than the top of the mirror and mark the remainder for the top. Mark it over length slightly. You'll sand to trim to final length. The pieces are delicate, so saw carefully.



Mask the surface. While you have your splines in place, put on two layers of masking tape to protect the surface when gluing and shaping. When cut to final size, your splines should look like this. The nub at the top helps you remove the splines before glue-up.



Final shaping. After your glue has dried, trim off the excess material with a hand saw. Then blend the pieces together with fine rasps, files and sandpaper. Make sure your pillow extends around the corner. Finish up with sandpaper all the way to 400 grit.

to prepare all 18. It's always a good idea to make a handful of extras for testing or just in case you need to replace one during installation. Lastly, I use a fine brush to collect the ebony dust around my band saw and sanders for use later.

Splines

To make the pillow strips used for splines, you can use the jig made earlier for thickening your stock. Put a thin piece underneath your strip to raise it up and, with a block plane, slowly take off the edges until the profile matches your pillowed plugs. Smooth with sandpaper up through 400 grit.

Final Cleanup

I hand-sand the mirror with sanding blocks from 120 all the way through 400 grit. I put a lot of emphasis on softness and make sure that every rounded edge is smooth to the touch.

Once edges and surfaces are smooth to the touch, it's best to raise the grain of wood first so that you end up with a glass-smooth surface before finishing. I use a sponge and water and wipe all surfaces of the mirror and set it aside to dry overnight. To knock down the raised nibs, use sandpaper with a gentle touch with very little downward pressure, otherwise you're just pushing the fibers back down to the surface.

Fitting Splines and Plugs

Pounding in plugs might disturb a freshly glued spline, so glue the splines first and let them dry. Each corner spline is two parts, a vertical and a sloping horizontal piece. Mount your mirror vertically in your bench vise. Start by tapping in a pillowed strip until it bottoms out on the squared-up side slot. Make sure the strip is just proud of the mirror edge and positioned so you just see the edge of the strip along the side of the mirror.

Then about $\frac{1}{2}$ " above the top of the mirror, mark the strip. Remove it and cut with a hand saw. Put the cut piece back in place. Next we'll fit the horizontal strip until it flushes up to the vertical piece. Final fitting is done with sandpaper, so cut over length. Once it all fits together, take this time to put two layers of painter's tape around all edges of the splines. This protects the mirror during glue up and when you're blending the ebony pieces around the corner. Remove the ebony pieces, mark their locations, set aside and repeat for the other side of the mirror. Then, it's

time to glue them into place.

Using a cut-down flux brush, I very carefully apply glue only to the inside walls of the slot (and not the ebony). Then gently tap in the top piece until it's just right. With a tiny dab of glue on the end of the horizontal piece, tap in the vertical piece until positioned and touching the horizontal piece. Do the same with the other side of the mirror and let dry.

Once completely dry, it's time to blend the two pieces into one. Start by cutting any excess on the vertical piece with a hand saw. With rasps, files and sandpaper, shape the pillowed surfaces around the bend to match the curve of the mirror. Once blended, the jet black ebony looks like a single piece of wood. If there are any cracks showing at the top, you can use cyanoacrylate glue and ebony powder to fill. Sand the splines smooth through 600 grit.

Installing Plugs

Use a soft plastic or rubber-faced hammer to install the plugs. Use a trimmed flux brush and paint the inside edges with glue. Do only a few square holes at a time. Put a square plug in place and very gently tap the plug into position until the edge is just barely visible from the side. It's important to not tap too hard as you could drive the plug too deep. If you do, you'll have to remove it before it dries.

Finishing the Mirror

With Sapele or mahogany, I prefer to stain the wood with water-based dyes before applying final finish. I like a mix of medium brown mahogany with a little red mahogany. Wipe the dissolved dye on with a staining sponge and wipe it off before it dries. The color needs to be built up over a few applications.

Water-based dyes may raise the grain a bit. Use steel wool to smooth it out, vacuum or blow off any dust and follow up with a tack cloth. Then, use a hand applied, satin rubbing varnish. The first coat is thinned with mineral spirits, resulting in a sealing effect, not unlike shellac. When dry, build up three more thin coats, sanding if necessary. I apply one or two coats to

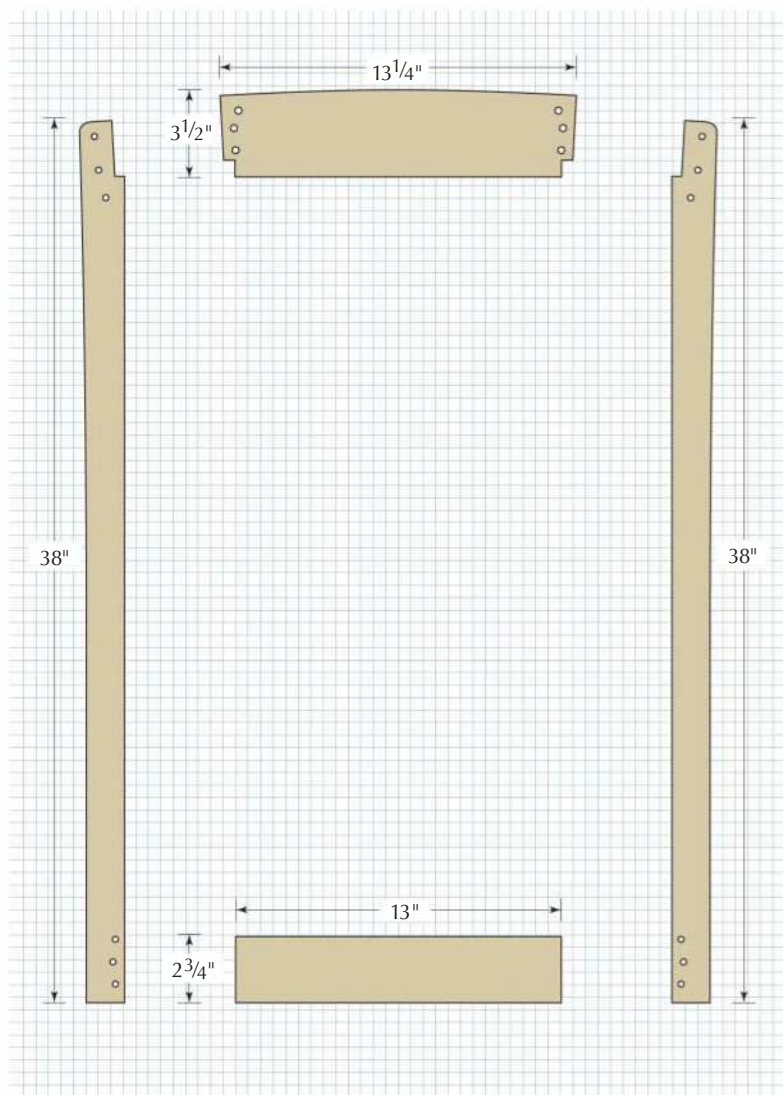
Blacker Entry Mirror

NO. ITEM	DIMENSIONS (INCHES)			MATERIAL	COMMENTS
	T	W	L		
❑ 2 Sides	1 1/4	2 1/8	38	Sapele	
❑ 1 Crest rail	1 1/4	3 1/2	13 1/4	Sapele	
❑ 1 Bottom rail	1	2 3/4	13	Sapele	
❑ 18 Square plugs	3/8	3/8	3/8	Ebony	Trimmed to fit*
❑ 2 Spline blanks	3/8	3/8	8	Ebony	Trimmed to fit**
❑ 1 Backboard	1/4	14	38	Plywood	Trimmed to fit‡

*Each plug will be trimmed and fit to each hole. **Splines are cut oversized and then trimmed to fit once installed. ‡The backboard should be cut to size and fitted after mirror frame is fully assembled.



A durable finish. I prefer building thin layers of rubbing varnish finished with a thin gel topcoat. Then, a couple of layers of buffed hard wax will make the frame shine.



BLACKER ENTRY MIRROR
One square = 1/2"

the plywood mirror back. For depth, finish the frame with thin coats of gel varnish applied with a cloth. The final result resembles an oil/varnish hand-rubbed finish, but it's bulletproof. After a few coats of wax, the mirror frame is complete.

After assembling all the parts, add D-rings near the top to attach the wire to hang the mirror. I use 1/16" braided stainless steel wire and soft metal oval sleeves crimped with a swaging tool. Because of the mirror's weight I always recommend owners use two medium-sized hooks.

The Blacker Entry Mirror has stood the test of time and looks as good now as it did 100 years ago. Now that the secrets of the joint are revealed, this is a great project for the hobbyist to take on. Just remember, a little warm-up and practice helps, and, with all the steps involved, always build more than one. **PWM**

Tim Ceeski is a furniture designer and artist based in Seattle, Wash. See more of his work at ceeski.com.

ONLINE EXTRAS

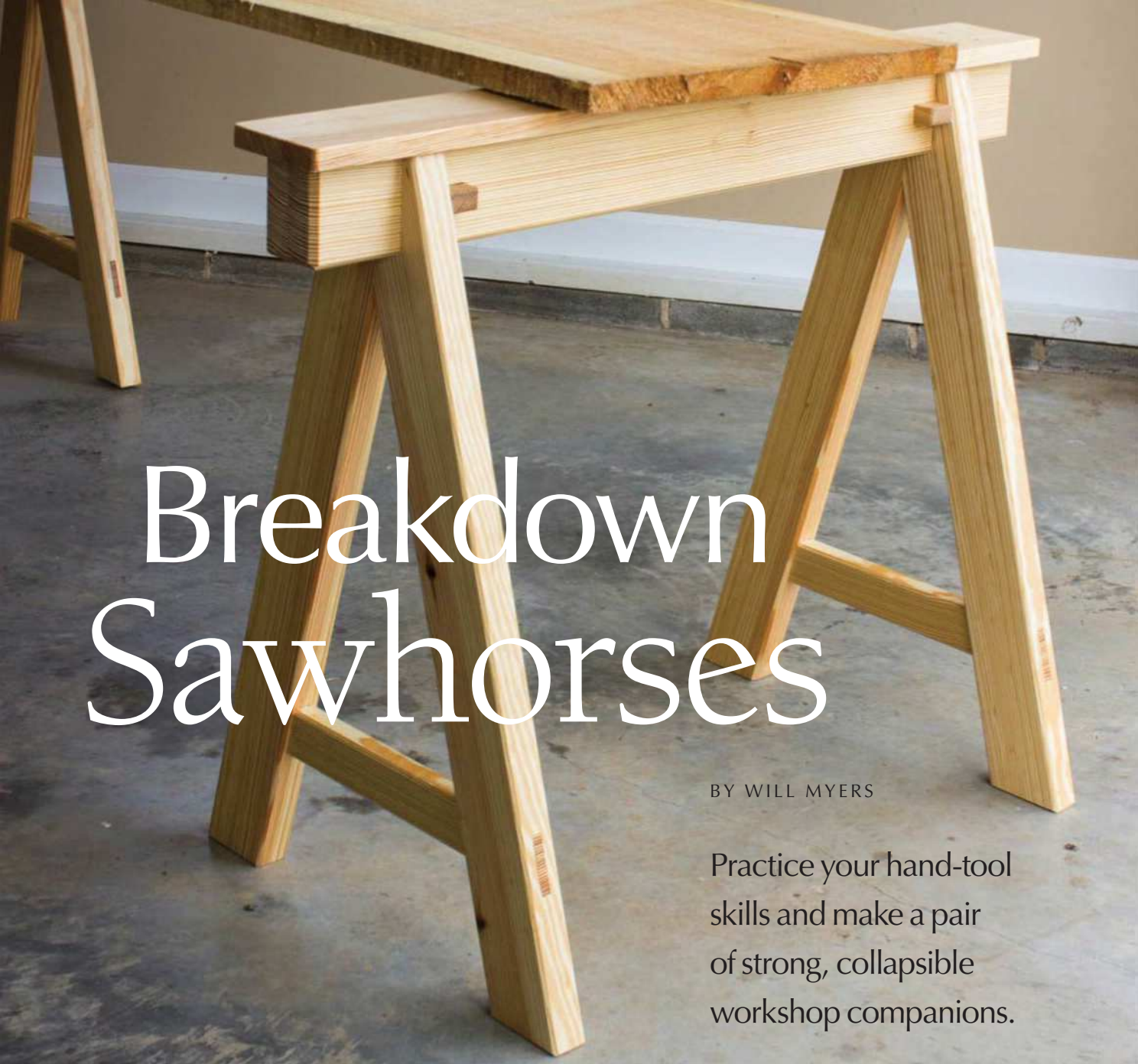
For links to all online extras, go to:

■ popularwoodworking.com/jun18

BLOG: Get bonus images, jig plans and full-size templates for making this mirror.

Our products are available online at:

■ ShopWoodworking.com



Breakdown Sawhorses

BY WILL MYERS

Practice your hand-tool skills and make a pair of strong, collapsible workshop companions.

About a year and a half ago my wife took a job in eastern North Carolina. My work is still on the western end of the state, so most weeks I travel back and forth from one end of The Old North State to the other. To help deal with the 4½" hour trips up and down I-40, I spend my time thinking about something constructive. It was on one of these trips that I first started thinking about these sawhorses.

There are many designs out there for different styles of knockdown or fold-up sawhorses; a lot of them are

very good and would serve the purpose perfectly. The biggest problems with most designs I have seen, is that their construction tends to get complicated and heavy. It is just a lowly sawhorse; should it really take a month to make two of them?

This design is the culmination of things my previous sawhorses lacked. I wanted a sawhorse that was relatively lightweight (could be moved one handed), could be broken down or assembled simply and quickly, to lie flat for storage or transport, no tools

needed other than a hammer or mallet and most of all, strong with no wiggle.

Materials

These sawhorses are made from 2x yellow pine construction lumber. I find it worthwhile to pick through the pile to find quartersawn stock, but flat-sawn stock will do just fine. If yellow pine is unavailable, use whatever cheap and relatively strong species you can get your hands on. I picked up two 16' 2x10s to build these two sawhorses and had a good bit of stock left over.

One more thing to consider is moisture content of construction lumber. Straight from the home center, it tends to be a bit on the wet side. Let it acclimate for a little while and dry out before you start to mill it.

Beam Glue-Up

I usually build these in pairs; one sawhorse is about as useful as a water hose with no spigot. Mill out the stock for the beams first; you will need four pieces about $3\frac{3}{4}$ " x 36". This is slightly larger than final size and will be milled to final specs after glue-up.

We want to keep the beams as thick as possible. Because we are starting with $1\frac{1}{2}$ "-thick stock, joint just one face of each of the four pieces that will meet when glued, taking just enough material off to get a flat surface. Align the pieces and draw a triangle on one pair and two triangles on the second, so as you are gluing you will know which pieces go together. Apply glue to the meeting faces of each pair, assemble and clamp the two beam assemblies as one. While the glue sets, you can get the legs started.

Legs Assemblies

The plans for these sawhorses call for a total height of 30" – you can, of course, make them taller or shorter to suit your needs. You will need eight legs for two sawhorses. These are jointed and planed to $1\frac{3}{8}$ " x $3\frac{1}{4}$ " x 32". (The 32" length is slightly over long – you'll cut them to size later). Arrange the legs in pairs and mark the faces, it is a



Choose lumber wisely. It's worth digging to find quartersawn yellow pine – it's a perfect material for sawhorses.



Square your stock. A powered jointer makes for fast work flattening stock.



Glue it up. A small foam roller works well for spreading the glue evenly and quickly.

good idea to number the pairs as well. Start by cutting the tops of the legs at a 15-degree angle.

Clamp a pair of legs together with the inside edges up then measure down from the top $5\frac{1}{2}$ " and square a line across both legs.

Unclamp the legs, on the face side of the leg place a try square on the angled top of the leg, line up the beam of the square to the line you just made on

the side and pencil a mark to the top of the leg. This will be the meeting face between the legs.

Now, measure over from the line on the face $\frac{3}{4}$ " toward the outside of the leg and make a tick mark. Use a machinist square with the rule set to project $3\frac{1}{2}$ " from the fence. Line the square up to the tick mark, pencil a mark down the rule and around the end. This notch will become the saddle that the top beam will rest in.

With the layout on the ends of the legs complete it's time to rip! Start by ripping the $3\frac{1}{2}$ " line first down to the baseline then make a crosscut at the baseline of the saddle to remove the waste.

With the saw cuts complete check for square. If the notch needs any tuning a chisel will make quick work of it. The lower angle needs to be flat and square; a block plane works well here.



Clamp the beams together. Clamp both beams at once. I also have a scrap piece on the outside of the stack to prevent the clamps from damaging the beam surfaces.

Stretcher Mortise and Tenons

For the stretchers that run between the legs you will need four $\frac{7}{8}$ " x 2" x 18"



Lay out both legs together. Laying out the legs in pairs ensures perfect alignment.



Add the angle. Square off of the 15° cut at the top of the leg.

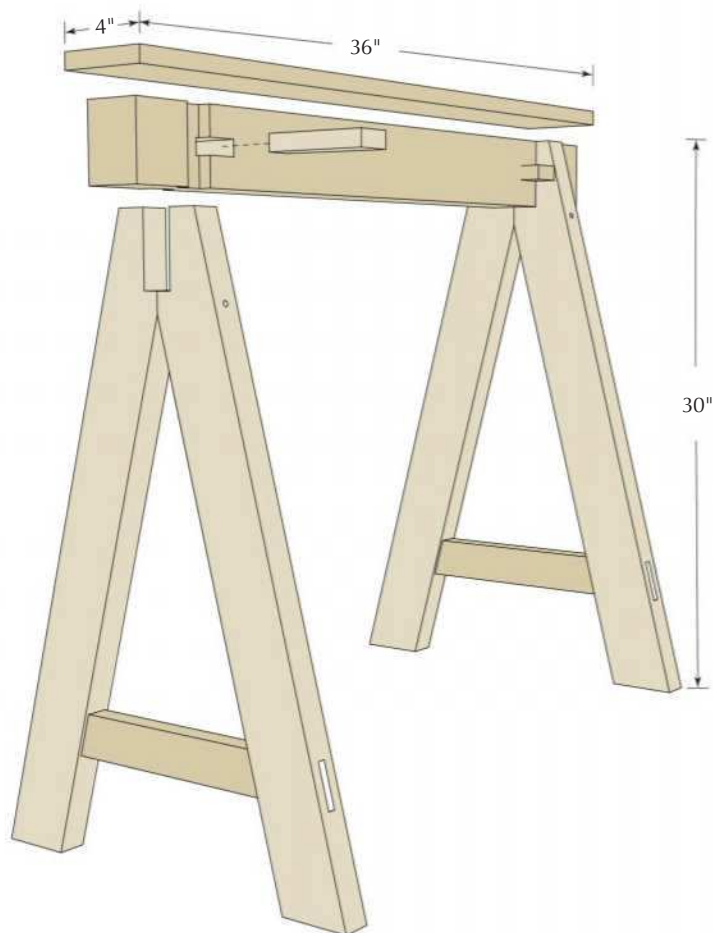
pieces of stock. These keep the bottoms of the legs from spreading when under heavy load. To lay out the mortise and tenons, start by clamping the pair of legs to be joined in the vise with the outside edge up and the top angles aligned with one another. Measure down 22½" from the top of the leg and square a line across the two. Remove the legs from the vise and lay them out flat on the bench with the face side up. Align the top meeting surfaces of the legs and use a clamp to hold them in alignment.

Lay the stretcher on top of the legs with the line you just made aligned with the top edge. Hold the stretcher in place and trace with a pencil around the upper and lower sides of the stretcher onto the faces of the legs. Before removing the stretcher also trace from the inside of the legs to the underside of the stretcher for the tenon shoulder location. Laying out the joints this way assures perfect alignment even though both elements of the joints are angled.

Sawhorse

NO.	ITEM	DIMENSIONS (INCHES)			MATERIAL	COMMENTS
		T	W	L		
❑ 1	Top Cap	¾	4½	36	SYP	
❑ 1	Beam	3½	2¾	5	SYP	
❑ 4	Legs	1⅜	3¼	32	SYP	Trimmed to length.*
❑ 2	Stretchers	7/8	2	18	SYP	
❑ 2	Wedges	¾	1¾	6	White Oak	

*Give yourself extra length here. The legs are best cut to final length after assembly.



SAWHORSE ASSEMBLY

I usually cut the tenons first. Line up a bevel to the trace mark on the face of the stretcher and knife the shoulder line in. Use a square to knife the line across the edges, and finish by knifing the shoulder on the opposite face with the bevel. To lay out the thickness of the tenon use a mortise gauge set to ¾".

Center the gauge teeth to the thick-

ness of the stretcher, with fence to the face side, gauge around the sides and end of the tenon. Then, saw a kerf for tenon wedges ¼" from the top and bottom edges of the tenons.

For the mortise layout, transfer the marks made earlier across the edges of the legs with a square. The leg is thicker than the stretcher so you will



Two-part layout. You can lay out the side and bottom of the saddle notch at once.



Cut the angle. A full-size rip saw makes quick work of cutting these angles.



A crucial cut. This short rip cut needs to be accurate; the top of the legs attach to one another here.

need to readjust the fence on the gauge to center the teeth on the leg stock. Gauge the mortise width between the pencil marks on the inside and outside edges of the legs.

Chop out the waste, working half-way from either side, meeting in the middle. The ends of the mortise are at an angle, as you are chopping you can eyeball down the back of the chisel to the layout lines down the side of the legs to help get an accurate angle through the mortise.

With the mortises complete, dry fit the assembly. Check the tenon shoulders fit to the insides of the legs, use a chisel or shoulder plane to pare away any offending material. The tenons will need to be cut to length so while assembled trace the length from the side of the legs onto the tenon. Also check the tops of the legs where they meet one another, this area can be tuned with a block plane or sawing between the legs while assembled with a tenon saw to close up the joint.

The area at the top of the legs where they meet will be secured by a single #14 x 4" wood screw (a hex head lag bolt could be substituted here). While dry fitted, use a bevel set at 15° and make a reference line through the middle of the pad on the face of the legs where they meet and then square the line around the side of the leg. Clamp the legs together to hold them in alignment.

With a 1/2" auger centered on the leg, bore in to a depth of about 1 1/4" using the bevel line to sight the angle. Next use a 1/4" drill to bore thru the center of the auger hole until it just starts into the adjoining leg.

Disassemble and finish by pre-

boring the adjoining leg for the threaded portion of the screw with a 3/16" drill bit.

Before final assembly of the legs there are a couple of tasks that are better done now than later. Finish plane all four sides of the stretcher. These

sawhorses are meant to be used and not fine furniture so I cut the chamfered edges with a jack plane eyeballing a 45° angle. If the bevel is rough, make a final pass or two with the block plane. I also hit the inside edges of the legs that



Direct layout. Transferring the stretcher mortise locations to the legs using the stretcher itself is the most accurate method.

OPTIONAL LEG ASSEMBLY METHOD

Another version of leg assembly I have used that has worked well involves nails instead of mortise and tenons. In this version the legs are made the same as described above, the difference being there is a short upper stretcher attached with nails and glue to the side of the legs at the top, replacing the screw. The lower stretcher is also just nailed in place eliminating the mortise and tenons. While the nailed leg assemblies are not as elegant a solution to joining the legs together as the mortise-and-tenoned version, it is much faster to build and plenty strong.





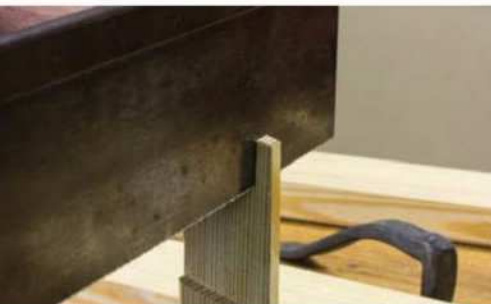
Tenon width. Set your gauge teeth to the width of your mortise chisel.



Gauge the mortise. Gauge the mortise width between the pencil marks on the insides and outsides off the legs.



Lay out the shoulders. A crosscut-filed backsaw takes care of the shoulder cuts.



Wedged tenons. A saw kerf a $\frac{1}{4}$ " or so from the top and bottom edges of the tenons will make starting the wedges easy.

cannot be reached once assembled with a smoothing plane and chamfer these edges as well.

The legs also need to be cut to final length by measuring down from the top 30" then use the bevel to lay out the same 15° angle as the top. Saw the line; the legs will look like a parallelogram when laid out correctly. If it looks like a trapezoid it won't work!

Assembly of the Legs

Spread a good coat of glue on the tenons, mortises and the area at the top of the legs where they meet as well. Assemble the tenons to their respective mortises.

Align the tops of the legs, place a clamp across to hold the faces flush with one another and install the screw.

Last, drive the wedges into the stretcher tenons. As you drive the wedges in be sure the leg stays tight against the stretcher shoulders.

Finish the Beams

Once the glue is dry on the beams, joint and plane them to their final dimensions of $3\frac{1}{2}$ " x 35" x $2\frac{3}{4}$ ". There are four short dados that need to be cut into the beam that capture the legs. Measure in from both ends 4" and knife a line around all four sides.

Now measure in $1\frac{3}{8}$ " from the first line and square it around all four sides as well. Set a single pin gauge to $\frac{5}{8}$ " and on the top and bottom of the beam gauge a line between the two knife marks for the depth of the dados.

Check the fit and insert the leg assemblies in the dados. They should just slide in; a little loose is better than too tight.

Wedges

Use as hard a wood as you can get your hands on for the wedges; I am using

white oak for these shown. To make the wedges, start with a piece of wood 6" x $\frac{3}{4}$ " x $1\frac{3}{4}$ ". The wedges are a little long at 6", this gives some leeway for fitting, and they will be shortened later. Measure down $\frac{5}{8}$ " on the face of the wedge stock on one end and make a tick mark. Use a straightedge, align it with the tick mark and the arias at the opposite end and mark down the length with a pencil.

It is a good idea that the wedges be identical to one another so that they will seat up the same in any mortise in which they're placed. To accomplish this, make the final passes with the jointer plane while all four wedges are aligned to one another, clamped up in the vise.

To layout the mortises for the wedges, assemble the legs to the beam while upside down on the bench. Lay the wedge against the underside of the beam, straight side against the inside face of the legs. Make a pencil mark down the angled side of the wedge onto the beam. Disassemble and, using a



Join the legs. Use a $\frac{1}{4}$ " drill centered in the auger hole; stop drilling when it just starts in the opposite leg. Just the one screw is all that is needed to secure the tops of the legs together.



Cut the dado. Saw the sides of the dado first, down to the depth mark, then chop out the waste. Finish by paring down to the baseline.



Define the angle. Use the wedge to transfer the angle.



Mortise for the wedge. Lay out your angled mortise and then auger out most of the waste.

square, bring the line up both sides. Gauge with the fence to the bottom side and mark from the pencil line to the dado. Using an auger slightly smaller than the width of the mortise bore halfway through from both sides and then chop out the remaining waste with a $\frac{3}{4}$ " chisel.

Finishing Up

Finish plane the sides and bottom of the beam. You can also chamfer the lower edges and end to match the legs if you like. Assemble the legs to the base and drive the wedges up tight. The wedges will also be extending past the legs a

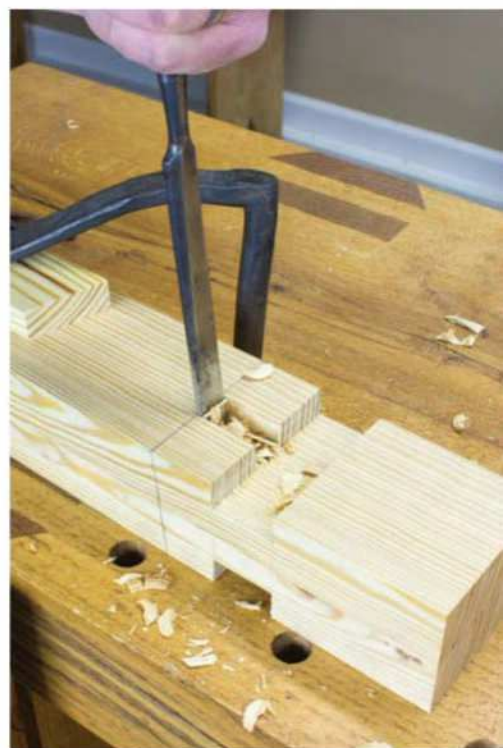
bit; mark where they meet the legs and saw off the extra length. Chamfering the ends of the wedges will help keep them from mushrooming as they are driven in and out. If the legs are projecting above the top of the beam plane them flush or a shade below. Last but not least, I nail (no glue) a $\frac{3}{4}$ " x $4\frac{1}{4}$ " x 36" board to the top of the beam.

I wiped a coat of oil on these for a finish, but no finish at all is just fine too. PWM

Will Myers is a woodworker who makes his home in North Carolina.



Cleanup with a plane. After the glue sets, saw the wedges off flush, plane the faces and outside edges to smooth and remove any layout and milling marks left behind.



A little extra room. Chop an extra $\frac{3}{16}$ " into the dado. The wedge should push against the leg and not bottom out in the mortise.

ONLINE EXTRAS

For links to all online extras, go to:

■ popularwoodworking.com/jun18

ARTICLE: *Making Clean Through Mortises*

BLOG: *Building Sawhorses with Graham Haydon*

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5 Tricky Hinges

BY NANCY HILLER

In the April issue (#238) I wrote about several types of hinges commonly in use and described various techniques for installing them. For the second article in this series, here are five hinges with more specialized uses.

95° Stop Hinges

Stop hinges are an excellent choice for box or chest lids in cases where you want to avoid extraneous hardware, such as stays. Precision-engineered, they will hold a lid securely open at 95°. You can use these hinges on chests with lids that overhang at the ends and front, but for the simplest installation, the lid should be flush with the case's back.

Start by marking the back and lid for foolproof identification. It's important to keep these parts oriented consistently. Next, lay out the position of each hinge on the top edge of the back. Depending on the length of the lid you

may be fine with two hinges; longer lids should have three. These hinges will be mortised into both parts – the chest and the lid – very much as you would mortise a traditional butt hinge. You can start with the mortises on either part, as you prefer. In this example I started with the piece that would be the back of the chest.

It's useful to have two marking gauges for the mortise layout. With stop hinges, at least 50 percent of the barrel must remain proud for the hinge to operate. For this example, I left the entire barrel proud, because I like the look.

Chop the mortises in the top edge of the chest. When you have removed all but the thinnest slice of waste near the gauge lines, pare out the corners, holding your chisel vertically.

With the hinge fitted in the first mortise, transfer the hinge positions to the lid and repeat the same series of steps.



On your marks. Mark the end of each outside hinge. If using three hinges, mark the centerline and mark one end of the hinge by measuring to the left or right from that centerline.



Crisp end. To determine the other end of each hinge mortise, set a hinge hard up against the first mark and trace the other end with a sharp pencil. You may also use a marking knife. In either case, you will scribe the line with a knife before chopping the mortise.



Width first. Set one marking gauge to the width of the hinge leaf, then mark the leaf width between the end lines.



Thickness second. Set the second marking gauge to the thickness of one leaf, then gauge the leaf thickness onto the back of the chest.



Last step. Use a marking knife to score the fibers from the top edge of the chest down to the leaf thickness line. Make a series of cuts with a chisel and mallet, staying shy of the leaf thickness line. The point of this step is to break up the grain, making the material easier to remove. Stay away from the ends of the mortise. Don't go down to the gauge line yet.



Stand up. After you have removed most of the loose material, hold your chisel vertically toward the back of the mortise (the inside of the box's back) but still shy of the leaf width line, and tap gently with the mallet to divide the main part of the mortise from the back edge. This will help you avoid marring the back edge as you continue to remove waste.



Nice pare. Don't chop to the gauge lines; pare, to maximize precision. Do the same to cleanup the ends of the mortise, finishing at your knife marks. Insert the hinge to check the fit. Trim away more waste as necessary.

Rattail Hinges

Rattail hinges are ideal for reproductions of Early American furniture. Then again, with their distant echo of European hardware, they're so striking that they can also lend themselves to other imaginative applications.

When designing your cabinet, keep the following points in mind: First, these hinges are handed – i.e., they are made for left- or right-handed installation. They also come in inset or offset (half-overlay) versions. Order accordingly.

Second, make sure that the face frame stiles are wide enough to accommodate the width of the “tail” section of the hinge. Lay the hinge on a piece of paper or scrap and measure the width from the end of the tail to the opposite edge of the eye (the ring that will hold the rat's tail), which will be closest to the opening in the frame. Make sure you have a little on each side to keep the hinge from appearing squeezed into a too-small space.

Finally, the face frame should protrude into the door opening, not be flush with its edge, so you'll be able to thread a nut onto the eye bolt to fasten it in place.

After you have completed the basic fitting of the door, shim it in its opening and start by laying out the positions of the hinges. There are no fast rules about this with rattail hinges; the vertical position on the door can be based on your preference.

HINGE REFERENCE GUIDE

HINGE TYPE	GOOD FOR	NOTES ON INSTALLATION & USAGE
Rattail hinge	Inset or half-overlay doors Specialty period (or other cultural) applications, such as when matching original hardware on vintage cabinetry	Your face frame and door stile must be wide enough to accommodate the tail and flag, respectively. Also, to secure the hinge bolts with nuts, your cabinet's face frame should protrude into the door opening.
95° stop hinge	Ideal for lids on chests and boxes when you don't want to use a stay	These require precise installation because they do not offer any integral means of adjustment.
Bi-fold European hinge	Inset or full-overlay doors for inside corner installation, such as traditional Lazy Susan cabinets	These offer a variety of options, among them a door opening angle of up to 165° and self-closing feature (so that your door won't require a catch).
Architectural door hinge	Capable of carrying heavy loads, these oversized hinges can be used to great decorative or fun effect.	You may need to beef up the thickness of your door stile, face frame, or both.
Knife hinge	Ideal for fine furniture and cabinetry. Minimally visible hardware with smooth, precise operation.	When choosing hinge size, make sure that your door is at least 1/4" thicker than the leaf width to prevent blowout.



Eye first. Mark the center of the hole for the eye bolt, top and bottom.



In deep. The eye bolt may need to be let into the face of the cabinet so the tail will lie flush.



Hold it. Use a square to hold the leaf while you drill the holes.



Needs adjustment. Any adjustments mean redrilling holes. Luckily, they'll most likely be covered by the hardware.

Once you have determined the vertical position for both hinges, mark the center point of the eye and square with a pencil line across the stile. The distance of the eye from the edge of the face frame is also largely a matter of preference. Some people put them $\frac{1}{2}$ " from the face frame's inside edge, others less. I installed mine at $\frac{5}{16}$ ".

Now set a marking gauge to the vertical center of the eye (in my case this was $\frac{5}{16}$ ") and mark the intersection with the line indicating the vertical position. This will be the center of the hole for the eye bolt.

Drill the Hole for the Eye Bolt

For inset applications the hinge pin needs to be drawn up as close as possible against the face of the cabinet in order for the door to hang flush and not protrude from that plane. Use a narrow chisel to make a small hollow

to accommodate the back of the eye. Now insert the bolts in their holes and fasten with nuts from the back. Drop the tail into each eye, hold it parallel with the face frame stile edge and use a bradawl to start a hole for a screw in the tail. (I like to use a temporary screw smaller than the final screw in case I need to adjust the position.)

Next, set the door back in its opening on shims. I find it helpful also to shim the hinge stile, taping pennies or dimes in place. Drop the leaf (or "flag") onto each hinge pin and mark the holes in pencil on the door. At this point I remove the door because it's far easier to drill the holes with the door lying down than propped up in the cabinet. I use a square to double-check that the leaf is square to the edge of the door. Drill just two holes in each leaf at this point and insert the screws.

Hang the door and check the fit. If

necessary, you can adjust the fit by shifting the position of the tail on the face frame or by moving the leaf (or both leaves) on the door. (Yes, doing so will mean adding more holes, but in most cases they'll be hidden by the hardware, and it's worth it to have a well-fitted door.) When everything looks good, drill and insert the last screws.

European Hinges for Bi-Fold Doors

European hinges come in numerous forms, each suited to a range of applications. One handy variety is the bi-fold hinge. Well, it's actually a pair of hinges: one to attach the primary door to the cabinet and the other to attach the secondary door to the first.

These are especially handy for full-overlay applications, though you can also make them work for inset doors by using a thicker mounting plate.

As with any of the doors in this article, you should have the doors largely fitted before turning to the hinges. Decide which door will be hinged to the cabinet. I'm going to refer to this as the primary door. The secondary door will be the one you'll pull when opening the doors to reach the cabinet's interior.

Note: The job will be simpler if you have the luxury of installing these hinges before you apply the cabinet back.

Start by laying out, then drilling the 35mm holes for the hinge cups as you would for any European hinge. I spaced these $3\frac{1}{2}$ " from the top and bottom of the door. Screw the hinges in place with #6 wood screws.

Next, clip the mounting plate onto each hinge and set the door in its opening. If the door is inset, shim it up on pennies or other material to create the gap you desire. If the door is full overlay, shim as necessary. While holding the door in place (if you have access to the cabinet interior via the back), drill one hole in the top hinge and one in the bottom hinge, using a #5 Vix bit, then insert screws. If you don't have access from the back, hold the door in its open position and line up the mounting plates on the cabinet side; insert one screw in each, check the fit, and adjust as necessary. (Alternatively, you can make a simple



Press. A drill press is handy for drilling the hinge cup holes. The edge of the hole should be $\frac{1}{8}$ " in from the hinge stile's edge.



Square up. Use a square to position the hinge while drilling with a Vix bit.



All set. The secondary door is attached by means of the bi-fold mounting plate.

template based on measurements taken from a mock-up.)

The next step is to mark and drill for the hinge cups of the bi-fold hinge that will attach the primary and secondary doors. These hinge cup holes will be drilled on the back (or inside) face of the primary door, at the opposite side.

Insert the hinges and screw in place as before. The secondary door will be attached by means of the bi-fold mounting plate. Hold the secondary door in place and transfer the center point of each hinge arm. The center of the front holes will be 37mm (or $1\frac{15}{32}$ ") back from the edge of the door. Mark a line at this distance, intersecting with the center point of the hinge arm location, then hold the door in place against the mounting plates and drill one hole for each mounting plate using a Vix bit.

opening with a slight gap on all sides. It's common to use the gap between the hinge leaves, which is created automatically at the top and bottom of the door by the built-in washer, as a guide to the gap size at the sides.

One leaf is mortised into the edge of the door at the top and bottom; the other is mortised into the cabinet.

Next set a mortise gauge to the width of the leaf. For most applications the hinge will be centered in the thickness of the door; adjust the gauge accordingly.

Hold the router squarely on the door's edge to prevent it from tipping. Rout close, but not right up to, the scribed and gauged lines. It will be more precise to cleanup the rest with a chisel, and the lines you've made with knife and gauges will guide your chisel tip for a clean cut.



Mind the gap. You can adjust the gap between the doors by turning the adjustment screws. The vertical slot on the mounting plate allows for adjustments in height. The other two large screws allow for lateral adjustment and front-to-back tilt.

Knife Hinges

Knife hinges come in different sizes, configurations and finishes. The most common varieties for fine furniture are center pivot hinges, for doors that overlay a cabinet's sides but are enclosed within the top and bottom, and offset pivot hinges, for fully inset doors.

With knife hinges, the stakes are high: In most cases you will mortise the door and cabinet before gluing the cabinet together, and there is little opportunity to modify the fit once the cabinet is glued up.

This is an installation technique that uses a small router and chisels.

Start by clamping your cabinet together without glue. Make sure the opening is square, and fit the door to the



First mark. With the pivot end flush to the edge of the stile, mark the location of the other end using a knife. Also mark the edge of the pivot knuckle. Remove the hinge and scribe a square line across the edge of the door at both points.



Transfer time. Set a mortise gauge to the width of the leaf and scribe the leaf width onto the door.



Rout. Set a small router cutter (I used 1/8" diameter) so its depth is equal to the thickness of the leaf. Rout out the bulk of the waste.



Final cut. Clean up mortise edges with a sharp chisel.



Repeat, with one difference. This time the distance from the door's edge will be offset by the width of your door gap. I used two layers of thin cardstock as a shim.



Slide into home. Slide the door onto the hinges, insert a screw in each, and test the fit. You can adjust the fit by modifying the mortises as necessary, but doing so is awkward and best avoided.

Architectural Hinges for Furniture and Cabinetry

Every so often I have a client ask if I will build a piece using salvaged architectural hinges instead of conventional furniture hinges. If you've ever looked through bins of old hinges at a salvage yard, you can probably appreciate why. Between their finishes (shiny chrome! flashed copper!) and their finials (balls! acorns! menacing points!), salvaged architectural hinges offer a world of quirky decorative possibilities. Because they're made to support full-size doors, they are also uncommonly strong.

The basic installation method is the same as that for swaged butt hinges: One leaf gets mortised into the cabinet, the other into the door, with the barrel protruding. Due to their size, though, you should keep a few considerations in mind when designing a piece that will use them.

Decide which leaf will go on the cabinet and which on the door based on the end with the loose pin. The fixed finial should be at the bottom; otherwise the pin will simply fall out.

Even on full-size doors that are a standard 1⁵/₁₆" thick, architectural hinges are customarily fitted with the barrel protruding. When used on a cabinet door, which is more likely to be between 3/4" and 1" thick, the barrel will protrude to an ungainly degree unless you set the leaves back so that they overhang on the interior of the cabinet. The door will look better if you thicken it with a strip of matching material on the inside face of the hinge stile. There's nothing technically wrong with having the hinge protruding into the cabinet, but it looks less than thoroughly thought out.

If the inside edge of your face frame is flush with the cabinet side, there's no need to thicken the face frame stile as you did with the door. If these parts are not flush, add the necessary material before proceeding. Drill and screw the second leaf onto the cabinet, then try the fit. **PWM**

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near Bloomington, Ind.



Pick your battles. Here I have the hinge flush at the back of the door, which makes it protrude awkwardly at the front. I glued a 7/16"-thick strip of the same material to the back of the hinge stile.



Plan for the gap. If your leaf mortises are equal to the leaves' actual thickness, you will end up with a large gap between the door and cabinet. I like to make one of the mortises a little deeper to make the gap more appropriate to a cabinet.



Clear cut. If your mortise is the same width as the new thickness of the door (minus the protruding barrel), as mine is here, you can begin removing waste with a saw. Stay just clear of your gauged depth line.

ONLINE EXTRAS

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ARTICLE: Check out Hiller's guide to eight common hinges.

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But *Ultra-Shear* goes even further, delivering a spectacular surface finish with a technique called **shear scraping**. Roll the tool right or left on your tool rest and you will feel it land solidly on a secondary bearing surface. This sets your cutting edge at 45° to the stock. Coming into the work at this angle, the wood fibers slice cleanly, virtually eliminating sanding. The exclusive shape of the *Ultra-Shear* shaft allows you to switch from aggressive stock removal to super-fine finishing in the blink of an eye.

The Sharpest, Longest Lasting Inserts

On the "business end", Woodpeckers® development team worked hand in hand with the best carbide manufacturer in the country to give you the best inserts on the market. It starts with a **nano-grain** carbide material. This extremely fine-grained carbide can be polished to a mirror finish, yielding a cleaner, sharper edge. Yet it is tough enough to hold that edge longer than virtually every other insert on the market.

Solid Support for the Insert Means Chatter-Free Cuts

The alloy steel shaft undergoes a two-step hardening process giving you a tool that floats smoothly across your tool rest and resists vibration, even when extended well over the tool rest. The tool pocket machined into the shaft supports the insert with three-point contact, not just the clamping force of the screw. You get a tool that feels and responds even better than most conventional tools.



Keep the tool flat on the tool rest and level to the ground for fast stock removal and basic shaping cuts.



For ultra-fine finishing cuts, roll the tool right or left until it lands on the 45° bearing surface. Now, take a light pass with the tool still level. You'll be amazed at the clean cut and smooth finish.



Detail tool has two styles of tips, full sharp (supplied as standard) for creating precise vee lines and radius point for making small beads and coves (optional).



Whether you're a beginner or an experienced turner, turn large bowls, pens or tiny miniatures, you'll find *Ultra-Shear* tools will eliminate the drudgery of sharpening and dramatically increase your confidence and success at the lathe. For more details and to see the tools in action, visit our website Woodpeck.com/Ultra-Shear



Folding Bookstand

BY CHRISTOPHER SCHWARZ



It starts out the size of a smartphone and opens to make your reading (or cooking) easier.

How-to books, cookbooks and sheet music are inconvenient to use while you're in the workshop, kitchen or concert hall. That's why bookstands (and music stands) were invented.

These, however, can be bulky. And so the mechanical minds of the 19th century devised several clever ways to fold up a bookstand so it can fit in your pocket.





Make a hole. Glue up the rails and stiles of the middle section to create a hole for the kickstand and foot of the project.

This version is based on several British and Chinese versions I have studied and is designed to be robust and easy to make with standard workshop equipment. It requires less than one board foot of wood to build, so root through your scrap pile and get started.

How It Works

The bookstand is basically a bunch of sticks that have been glued or riveted together. The middle section of the bookstand is created by gluing up three pieces of wood, which creates an opening to hold the kickstand and the foot of the piece – these bits of wood make the bookstand adjustable.

Around the middle section are sticks

that are attached with copper rivets, which work like hinges and allow the whole thing to unfold. If you've never used copper rivets, don't worry. Installing them is as easy as drilling a hole and hammering a nail.

Note: To make the nomenclature easy for this project, I call horizontal members "rails" and vertical members "stiles" – just like in a door or a face frame.

Begin with the Middle Section

The middle section of the bookstand is what everything else is attached to, so it's a good place to start. Cut the rails and stiles of the middle section to size according to the cutting list, then glue

and clamp the parts together. After the glue is dry, square the ends of the assembly and make a jig to drill the counterbores and holes for the rivets.

Note that each rivet requires a counterbore for the head of the rivet and a counterbore for the "burr" – the washer-like part of the rivet. On the middle assembly you need counterbores on the front face of the top, and on the backside of the bottom. It sounds confusing, but you'll figure it out when you study the photos.

The holes for the rivets are $\frac{1}{8}$ " in diameter. The counterbore is $\frac{3}{8}$ " in diameter. I used a special boring bit from Timberline (No. 630-100) that bores the hole and counterbore in one operation.

The jig is made from scraps and allows you to bore all the holes and counterbores in the middle section with one set-up.

The two fences on the jig are $2\frac{5}{8}$ " apart. This allows the center assembly, which is $1\frac{3}{4}$ " wide, to slide left and right so you can bore your holes exactly $\frac{7}{8}$ " apart. Set the depth stop of your drill press so the counterbore is $\frac{1}{8}$ " deep. Drill all your holes.

Next you need to create hinges so the kickstand and foot of the bookstand can pivot out. The "hinge" is merely a $\frac{3}{32}$ " hole through the middle section with a nail pushed through to act as the barrel. To do this, press the kickstand and foot into the hole in the middle section. They should fit snug inside. Center them in the opening as best you



Quick work. The two fences on this jig allow you to slide the center assembly left and right to bore the holes and counterbores exactly $\frac{7}{8}$ " apart.



Make a hinge. Drill a $\frac{3}{32}$ " hole through the middle assembly and kickstand. Then use a nail as the barrel of the hinge.

can. Then mark a location for the hinge barrel. It should be $\frac{3}{32}$ " from the face of the middle assembly and in a place that allows the pieces inside to pivot. The exact location isn't critical otherwise.

Drill the hole for the kickstand, then flip everything around and drill the hole for the foot.

The last step on the middle assembly is to cut a $\frac{7}{8}$ "-radius curve on the bottom edge of the middle assembly. Mark it with a compass and rasp or sand it to shape.

Rails & Stiles

The rails and stiles that attach to the center section are simple in comparison. The first thing to do is make a drilling jig to hold the rails and stiles so you can drill a hole and counterbore for a rivet in the ends that is centered on the piece and located $\frac{7}{16}$ " (on center) from the end. And you need to sand a $\frac{7}{16}$ " radius on the ends of some of the pieces.

There are three different kinds of parts—top rails, bottom rails and stiles. Here are the operations you need to do to each piece:

- Top rails: Bore a hole and counterbore on one end. Flip the piece over and turn it around. Bore a hole and counterbore on the other end. Sand a curve on both ends.

- Bottom rails. Bore a hole and counterbore on one end. Sand a curve on that end.

- Stiles. Bore a hole and counterbore on one end. Sand a curve on that end.

The Ledge

One last little bit of work is to create the bottom ledge, which is what your books or sheet music will sit on. These ledges are simply glued to the bottom edge of the bottom rails.

Feel free to decorate the ledges as you like. I planed a $\frac{1}{8}$ " bead on the front edges.

Finish Before Assembly

It's best to finish all the pieces before riveting them together. Remove all the machine marks. Clean up the edges. Break any sharp corners with sandpaper. You need to saw the kickstand to final shape. Its exact shape isn't important, but it does need to end in a $\frac{1}{4}$ " x $\frac{1}{4}$ " point.

Then apply a finish to all your parts. I used a linseed oil and beeswax finish that is good for items that won't see hard use.

After the finish dries, it's time to put things together. The first step is to connect the center assembly to the kickstand and foot. Push nails through the $\frac{3}{32}$ " holes you drilled earlier. Tap the heads with a hammer to set them. Snip the heads off and file what's left flush.

On Riveting

Riveting is easy. My best advice here is to take it slow and don't use too much force; it's easy to split the work. The first step is to ream out all the holes with a $\frac{9}{64}$ " drill bit. This reaming will allow the shaft of a No. 12 copper rivet to fit perfectly.

Press the shaft of the rivet through the pieces you wish to join. Press the "burr" onto the top of the shaft. It should stop after $\frac{1}{16}$ " or so. You need to "set" the rivet by pressing it onto the



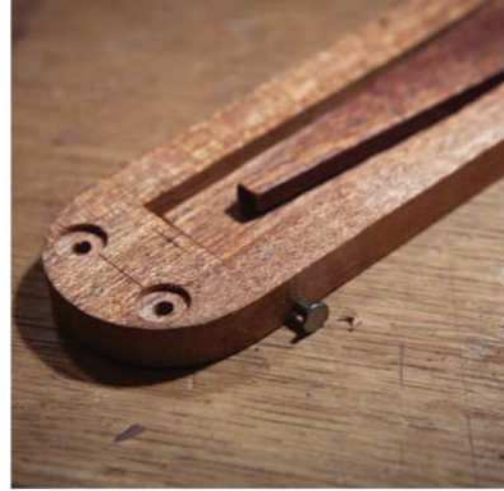
Sand the curve. Mark the $\frac{7}{8}$ "-radius curve on the end of the middle assembly and sand it to shape.



Even simpler. The jig for drilling the holes and counterbores in the rails and stiles is similar to the other jig, but the workpiece doesn't slide.



Around the end. Shape the $\frac{7}{16}$ "-radius curve on the rails and stiles with a rasp or a belt sander.



The right nail. This 6d nail is $\frac{3}{32}$ " in diameter and fits perfectly in the hole. A few hammer taps sets the nail for good.



Safety ream. Opening up the hole by $\frac{1}{64}$ " makes it less likely that your riveting will split the work.



Cheap rivet setter. A $\frac{1}{4}$ " dowel with a hole in the end makes an excellent (if temporary) rivet-setting tool.



Swift snip. Nail snips make quick work of soft copper rivets.



Careful pounding. Tap the rivet with care. Each hammer strike could send your nail set skittering toward the finished wood (and disaster).



Bore with care. I used a $\frac{3}{8}$ "-diameter Forstner for this job. Run the drill up to full speed before plunging into the foot. A fast-turning bit ensures a clean entry hole.

shaft. You can buy a rivet-setting tool, or you can make one from a $\frac{1}{4}$ "-diameter dowel.

Here's how: Take a 3"-long section of dowel and drill a $\frac{9}{64}$ "-diameter hole into the end. Then place the dowel over the shaft. Tap the dowel until the rivet stops moving. Snip the excess of the shaft as close as you can get. Then file the top of the rivet flat. Then mushroom – aka peen – the top of the shaft with a nail set or other tool.

The Final Bore

With all the parts assembled, bore holes in the foot of the bookstand to receive the kickstand. We saved this step for the end to ensure that the holes were in the right place for the final user.

Stand the bookstand on a flat surface and adjust the kickstand until the project is at an ideal angle for you. Mark the foot where it meets the kickstand and drill a shallow $\frac{3}{8}$ "-diameter hole at that location. The foot of the kickstand should drop right in. If you like, move the kickstand to another location, perhaps one ideal for a thicker book, and repeat the process. Then, dress the rims of the holes with fine sandpaper and apply a little finish.

This bookstand can be altered to hold books (or digital tablets) of almost any size. The only principle that has to be obeyed is that the stiles cannot be longer than the rails – otherwise it won't fold up nicely. Obey that simple rule and you'll be able to hold almost any reading material without an assist from your hands. And that's an idea that will never go out of style. **PWM**

Christopher Schwarz is the editor at Lost Art Press and a furniture maker in Covington, Ky.

ONLINE EXTRAS

For links to all online extras, go to:

■ popularwoodworking.com/June18

BLOG: Read the author's blog for a glimpse into his workshop.

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Folding Bookstand

NO. ITEM DIMENSIONS (INCHES)

	T	W	L
❑ 2 Stiles	$\frac{3}{8}$	$\frac{7}{16}$	$7\frac{1}{2}$
❑ 2 Rails	$\frac{3}{8}$	$\frac{7}{8}$	1
❑ 1 Tongue	$\frac{3}{16}$	$\frac{7}{8}$	$4\frac{7}{8}$
❑ 1 Foot	$\frac{3}{16}$	$\frac{7}{8}$	$5\frac{1}{4}$
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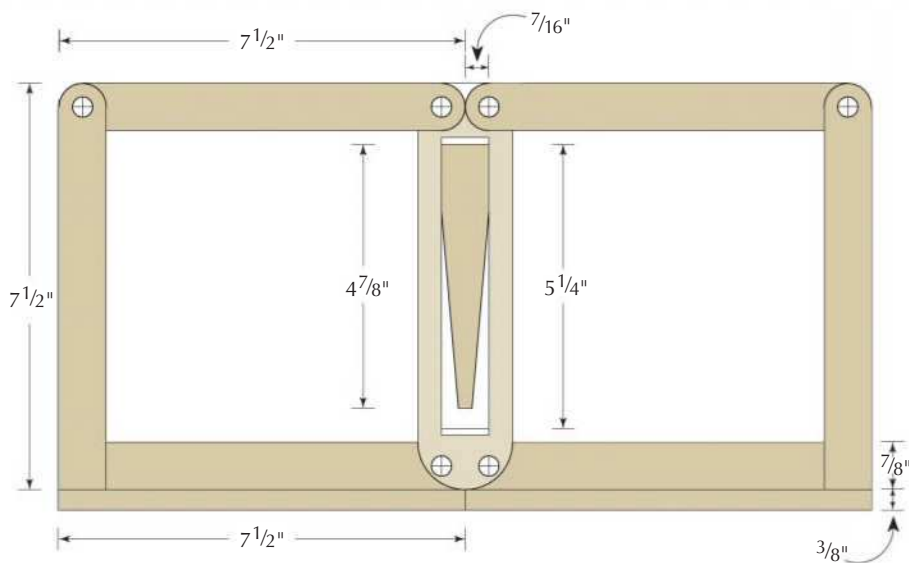
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Grain Raising

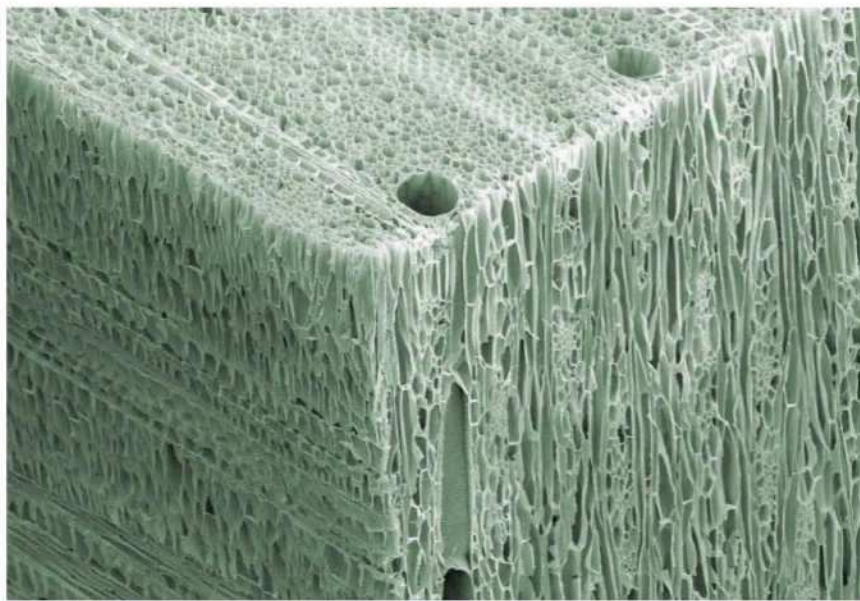
A better understanding of what causes grain raising will help you manage it.

Grain raising, including its causes and how to handle it, is not well understood by woodworkers. This leads to instructions that result in your sanding more than necessary to remove it and often not making the problem better. Understanding what's happening in the wood will help you improve your work. First, some definitions.

To begin with, the very term “grain raising” is a little misleading. When we speak of grain in wood, we usually mean the visible boundaries between the tree rings. So, for example, with plain-sawn oak the boundaries are wide and clearly visible.

To understand the grain raising that creates fuzz on the wood you need to take a different perspective of grain. The grain that's being referred to here is the tiny cells or fibers that make up the wood. These cells are way too small to be visible except under magnification. So to make this explanation clearer, think of them as a bundle of miniature soda straws.

Like the soda straws, the cells in wood are largely hollow and much longer than they are thick. In wood the cells are held together by a “glue”



Magnified wood grain. When viewed through a microscope, the grain of wood becomes clearly visible. Think of it as miniature soda straws.

called lignin, which also contains the extractives that give wood its color.

When you saw or plane the end grain of wood, you have to use very sharp blades or the sides of the cells tear and collapse.

When you saw or plane the long grain, a similar thing happens, just much less so. Still, if your saw blade

or jointer or planer knives aren't sharp, they cause the cell walls to collapse or the cells to press into layers of cells underneath.

The same thing happens with dull sandpaper. Sandpaper is expensive, so it's natural to use it for much longer than we should. The dull grains of abrasive tear the walls of the cells and press them into the cells beneath rather than smoothly cutting them off.

When moisture is then introduced in the form of humidity or, especially in the form of liquid water, these pressed and torn areas swell so the surface feels like peach fuzz. This is what we refer to as grain raising.

If you want to try an experiment, run one piece of wood over a jointer and hand plane another with a very sharp plane iron. Don't sand either. Then dab some water on each and feel them after the water has dried. There should be much less grain raising on



Wetting wood. One way to deal with raised grain is to raise it before applying the finish. Use a rag, sponge or spritz bottle to wet the wood, then let it dry.

CONTINUED ON PAGE 60

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Sanding raised grain. After the wetted wood has dried, sand it just enough to remove the raised grain, no more. Use a fine grit sandpaper, for example, #320 grit as I'm using here.



Water damage. If you haven't raised the grain and sanded it smooth under an oil finish, a puddle of water can get through the finish and raise the grain, which will show up lighter if the light reflection is right.

the hand-planed wood because the cell walls have been cut clean.

Thin Finishes

Many years ago I was sitting in the office of a prominent woodworker who was raving about the qualities of a popular brand of oil finish. He was making the point of how resistant this finish was to moisture.

He had a couple of bookcases in his office that he had finished several years previously with this finish. So I walked over and ran my hand over the surface. I expected it would feel rough because I had experienced that at home on wood that I had finished with the same oil finish after several years. But the surfaces were smooth like they had just been sanded.

It was not until I got home that I realized the explanation. This friend lived in the desert where there was almost no humidity. There is a lot of humidity

where I live (though not nearly as much as near the Gulf Coast).

So the explanation was that an oil finish, with no build, isn't thick enough to block humidity from getting to the wood and causing the pressed and torn cells to expand enough to be felt.

The lesson I learned from this experience was that the best practice when using an oil (or for that matter, wax) finish with no build is to raise the grain first by wetting the wood and sanding it smooth after it has thoroughly dried.

How Much to Sand

Here's the critical point. The cells or fibers that get smashed and torn by the pounding they get from a jointer or planer or from dull sandpaper are only a few cells deep. If, in sanding the raised grain smooth, you sand deeper than this damage, especially if you're using dull sandpaper, you will expose fresh wood that will have almost the

same susceptibility to grain raise again.

So in removing raised grain from wetted wood you need to use fresh sandpaper of a fine enough grit so you just make the wood feel smooth. Don't sand deeper than this. Appropriate grits are usually between 220 and 400.

If you are applying a film-building finish such as shellac, lacquer, alkyd or polyurethane varnish, or especially a water-based finish, another way to deal with raised grain is to "bury" it with your first coat. Simply apply this coat, then sand it smooth after it has dried. Then continue with your additional coats.

The same procedure works with a water-based stain or water-soluble dye. Apply the first coat of finish to bury the raised grain, then sand this coat smooth after it has dried.

If you are finishing with alkyd varnish or lacquer, especially on multiple or large objects, you may want to use a varnish or lacquer sanding sealer for the first coat. Sanding sealer powders when you sand it in contrast to alkyd varnish and lacquer, which gum up the sandpaper, slow you down, and cause you to use more sandpaper.

Polyurethane varnish and water-based finish don't gum up sandpaper as long as you let them thoroughly dry, so there's no need for a sanding sealer. In fact, it's not wise to use a sanding sealer with these finishes because it weakens the bond to the wood.

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

Sanding sealer powders. When using a film-building finish such as alkyd varnish or lacquer on large or multiple objects, you can speed your work by applying a first coat of varnish or lacquer sanding sealer and sanding it smooth. Then apply several coats of the finish.



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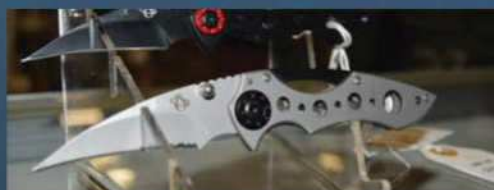
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Drug Companies Fear Release of the New AloeCure

Big Pharma stands to lose billions as doctors' recommend drug-free "health cocktail" that adjusts and corrects your body's health conditions.

by David Waxman
Seattle Washington:

Drug company execs are nervous. That's because the greatest health advance in decades has hit the streets. And analysts expect it to put a huge crimp in "Big Pharma" profits.

So what's all the fuss about? It's about a new ingredient that's changing the lives of people who use it. Some call it "the greatest discovery since penicillin!"

The name of the product is the AloeCure. It's not a drug. It's something completely different. And the product is available to anyone who wants it, at a reasonable price. But demands may force future prices to rise.

TOP DOC WARNS: DIGESTION DRUGS CAN CRIPPLE YOU!

Company spokesperson, Dr. Liza Leal; a leading integrative health specialist recommends AloeCure before she decides to prescribe any digestion drug. Especially after the FDA's stern warning about long-term use of drugs classified as proton pump inhibitors like **Prilosec®**, **Nexium®**, and **Prevacid®**. In a nutshell, the FDA statement warned people should avoid taking these digestion drugs for longer than three 14-day treatment periods because there is an increased risk of bone fractures. Many people take them daily and for decades.

Dr. Leal should know. Many patients come to her with bone and joint complaints and she does everything she can to help them. One way for digestion sufferers to help avoid possible risk of tragic joint and bone problems caused by overuse of digestion drugs is to take the AloeCure.

Analysts expect the AloeCure to put a huge crimp in "Big Pharma" profits.

The secret to AloeCure's "health adjusting" formula is scientifically tested **Acemannan**, a polysaccharide extracted from Aloe Vera. But not the same aloe vera that mom used to apply to your cuts, scrapes and burns. This is a perfect strain of aloe that is organically grown under very strict conditions. AloeCure is so powerful it begins to benefit your health the instant you take it. It soothes intestinal discomfort and you can avoid the possibility of bone and health damage caused by overuse of digestion drugs. We all know how well aloe works externally on cuts, scrapes and burns. But did you know Acemannan has many of other health benefits?...

HELPS THE IMMUNE SYSTEM TO CALM INFLAMMATION

According to a leading aloe research, when correctly processed for digesting, the Aloe plant has a powerful component for regulating your immune system called **Acemannan**. So whether it's damage that is physical, bacterial, chemical or autoimmune; the natural plant helps the body stay healthy.

RAPID ACID AND HEARTBURN NEUTRALIZER

Aloe has proved to have an astonishing effect on users who suffer with digestion problems like bouts of acid reflux, heartburn, cramping, gas and constipation because it acts as a natural acid buffer and soothes the digestive system. But new studies prove it does a whole lot more.

SIDE-STEP HEART CONCERNS

So you've been taking proton pump inhibitors (PPI's) for years and you feel just fine. In June of 2015 a major study shows that chronic PPI use increases the risk of heart attack in general population.

UNLEASH YOUR MEMORY

Studies show that your brain needs the healthy bacteria from your gut in order function at its best. Both low and high dosages of digestion drugs are proven to destroy that healthy bacteria and get in the way of brain function. So you're left with a sluggish, slow-to-react brain without a lot of room to store information. The acemannan used in AloeCure actually makes your gut healthier, so healthy bacteria flows freely to your brain so you think better, faster and with a larger capacity for memory.

Doctors call it "The greatest health discovery in decades!"

SLEEP LIKE A BABY

A night without sleep really damages your body. And continued lost sleep can lead to all sorts of health problems. But what you may not realize is the reason why you're not sleeping. Some call it "Ghost Reflux". A low-intensity form of acid reflux discomfort that quietly keeps you awake in the background. AloeCure helps digestion so you may find yourself sleeping through the night.

CELEBRITY HAIR, SKIN & NAILS

Certain antacids may greatly reduce your



body's ability to break down and absorb calcium. Aloe delivers calcium as it aids in balancing your stomach acidity. The result? Thicker, healthier looking hair...more youthful looking skin... And nails so strong they may never break again.

SAVE YOUR KIDNEY

National and local news outlets are reporting Kidney Failure linked to PPI's. Your Kidney extracts waste from blood, balance body fluids, form urine, and aid in other important functions of the body. Without it your body would be overrun by deadly toxins. Aloe helps your kidney function properly. Studies suggest, if you started taking aloe today; you'd see a big difference in the way you feel.

GUARANTEED RESULTS OR DOUBLE YOUR MONEY BACK

Due to the incredible results people are reporting, AloeCure is being sold with an equally incredible guarantee.

"We can only offer this incredible guarantee because we are 100% certain this product will work for those who use it," Says Dr. Leal.

Here's how it works: Take the pill exactly as directed. You must see and feel remarkable improvements in your digestive health, your mental health, in your physical appearance, the amount inflammation you have throughout your body – even in your ability to fall asleep at night!

Otherwise, simply return the empty bottles with a short note about how you took the pills and followed the simple instructions and the company will send you...Double your money back!

HOW TO GET ALOECURE

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Important: Due to AloeCure's recent media exposure, phone lines are often busy. If you call and do not immediately get through, please be patient and call back.

Learning Happens Through Doing

At Women's Woodshop, no one has to prove themselves to be a maker.

I fell in love with woodworking because of the material itself; wood's movement with the seasons, its reactions to metals and oxidation and a grain that holds a history of seasonal storms, heavy branches and fungi. I work primarily with green wood. I love to relinquish control to the material, allowing my bowls to dry in oblong shapes and warp with knots.

I have been working with wood for the past 13 years, some in the craft world, some in the sculpture world. As a woman in the field, I have experienced some setbacks based on my gender: men taking tools from my hands during class or making cuts for me, experiencing sexism at the lumberyard and hardware store and having to prove my ability in order to gain trust. Some assume that, because I am a woman, I don't know what I am doing.

Woodworking is a tough field to get into. It's highly technical, dangerous and expensive. And then you add a gender dynamic on top of it, and it's no wonder why women haven't felt welcomed in the past. But, the field is rapidly changing as more women and nonbinary makers embrace woodworking and more men are asking how to help them.

I had been brainstorming Women's Woodshop for the past five years, and 2017 felt like the right time to launch it. The shop was founded on creating a supportive community and producing positive experiences for people of all genders. I believe woodworking is extraordinarily empowering. I want to share information and give access to women and nonbinary makers that haven't felt comfortable with learning woodworking in the past.

My woodshop is a tiny 600-square-foot storefront in south Minneapolis.



We've hosted more than 300 women, trans and male bodied students in less than a year for classes such as birch bark weaving, power tools 101, bowl turning and joinery 101. Daily, I receive emails from women and trans folks asking for more woodworking classes, opportunities to teach or for advice on how to start a WTF (women trans femme) space in their own communities. Women's Woodshop has become a beacon for women and non-binary makers to connect with one another. They are not anomalies, but actually a part of a greater movement. Spaces like mine are popping up everywhere, including A Workshop of Our Own in Baltimore, Lower 48 in Oakland, Calif., and She Skills in Australia.

How can we make this shift gracefully into equal treatment in the woodshop? I think of a beautiful quote by Sarah Marriage: "It's not about the absence of men, it's about the presence of women." The goal isn't to drive men out of the shop, but to work alongside one another in a way that feels comfortable for everyone. Women's Woodshop is

built upon an ethos of non-competition and inclusivity. No one has to prove themselves in order to be a maker. You can come into the shop as an expert or a beginner and your skills are not determined by your gender. For the men out there, wanting to encourage the women woodworkers in their lives, remember this: Learning happens through doing. Let your daughters, sisters and mothers use the table saw. If you are taking a class alongside a woman, don't question her ability. Women know how to ask when they need help. She may have a decade of experience under her belt.

The future of woodworking is exciting. It's also a space where we can see gender equality rapidly grow. I am grateful to all my male counterparts for supporting the endeavor rather than feeling excluded (I do offer co-ed classes), and even more grateful to the women and non-binary students that are showing up in droves with a powerful enthusiasm. **PWM**

Jess Hirsch is an artist, teacher and owner of Women's Woodshop. Learn more at womenswoodshop.com.

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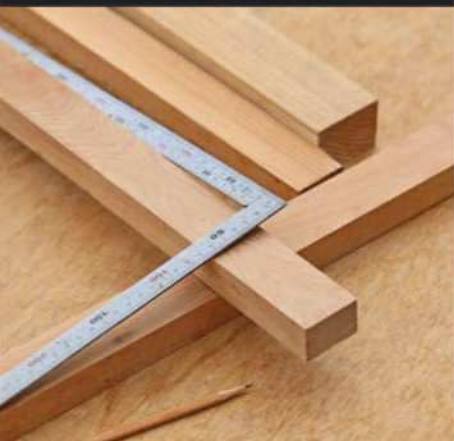
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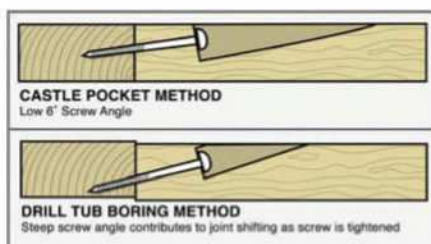
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