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APRIL 2006
ISSUE #154

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- Cutting capacity: 8" left, 54" right
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6" JOINTER

New!

- Motor: 1 HP, 110V, single-phase
- Table size: 6" x 46"
- Max. depth of cut: 1/8"
- Max. rabbeting capacity: 1/2"
- Cutterhead knives: 3
- Cutterhead dia.: 2 1/2"
- Cutterhead speed: 4800 RPM
- Cuts per minute: 14,400
- Cast iron fence
- Approx. shipping weight: 270 lbs.

BUILT-IN "KICK STAND" MOBILE BASE!

INCLUDES A FREE PAIR OF SAFETY PUSH BLOCKS

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- Motor: 2 HP, 110V/220V, single-phase, TEFC, 3450 RPM
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- Cutterhead speed: 5500 RPM
- Cutterhead diameter: 3"
- Max. depth of cut: 1/8"
- Max. rabbeting depth: 1/2"
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8" X 76" JOINTER

- Motor: 3 HP, 220V, single phase, TEFC, 3450 RPM
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- Cutterhead knives: 4 HSS, 8" x 3/4" x 1/8"
- Cutterhead speed: 4900 RPM • Cuts / minute: 19,600
- Cutterhead diameter: 3 3/16"
- Max. depth of cut: 1/8"
- Max. rabbeting depth: 1/2"
- Approx. shipping weight: 461 lbs.

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- Max. cutting height: 8"
- Min. stock thickness: 3/16"
- Min. stock length: 12"
- Max. cutting depth: 1/8"
- Feed rate: 16 FPM & 30 FPM
- Cutterhead diameter: 3"
- Number of knives: 3
- Cutterhead speed: 5000 RPM
- Approx. shipping weight: 661 lbs.

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- Motor: 1 HP, 110V, single-phase, TEFC
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- Spindle sizes: 1/4", 5/8", 1 1/2" & 2"
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- Approx. shipping weight: 180 lbs.

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New!

- Sanding motor: 1 1/2 HP, 110/220V, single-phase
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- Max. stock size: 12" w x 3 3/4"
- Min. stock length: 8"
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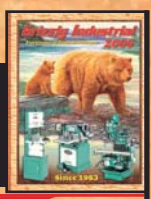

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14" BANDSAW

- Motor: 3/4 HP, 110V/220V, single-phase, TEFC
- Precision ground cast iron table
- Table size: 14" x 14"
- Table tilt: 45° right, 15° left
- Cutting capacity/throat: 13 1/2"
- Max. cutting height: 6"
- Blade size: 92 1/2" to 93 1/2" (1/8" to 3/4" wide)
- Blade speed: 3000 FPM
- 4" dust port
- Approx. shipping weight. 163 lbs.

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INCLUDES QUICK BLADE RELEASE SYSTEM, 3/8" BLADE, FENCE & MITER GAUGE

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THE ULTIMATE 14" BANDSAW

- Motor: 1 HP, 110V/220V, single-phase, TEFC
- Precision ground cast iron table
- Deluxe extruded aluminum fence
- Cutting capacity/throat: 13 1/2"
- Max. cutting height: 6"
- Blade size: 92 1/2" - 93 1/2" long (1/8" – 3/4" wide)
- 2 blade speeds: 1500 & 3200 FPM
- Approx. shipping weight: 198 lbs.

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- Precision ground cast iron table
- Table size: 17" x 17" x 1 1/2"
- Max. cutting height: 12"
- Blade length: 131 1/2"
- Blade sizes: 1/8" - 1"
- Blade speeds: 1600 & 3300 FPM
- Dust port: (2) 4"
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20" PLANER

New!

BUILT-IN "KICK STAND" MOBILE BASE!

- Motor: 5 HP, 220V, single-phase
- Max. cutting width: 20"
- Max. cutting height: 8"
- Min. stock thickness: 3/16"
- Min. stock length: 7.5"
- Max. cutting depth: 1/8"
- Feed rate: 16 FPM & 20 FPM
- Cutterhead diameter: 3 1/8"
- Number of knives: 4
- Cutterhead speed: 5000 RPM
- Table size: 20" x 25 3/4" (20" x 55 5/8" w/ extension)
- Approx. shipping weight: 935 lbs.

INTRODUCTORY PRICE!

G0454 ONLY $1175.00 $165 shipping ANYWHERE IN LOWER 48 STATES

1½ HP SHAPER

SHOWN W/ OPTIONAL G1706 WING

- Motor: 1 1/2 HP, 110V/220V, single-phase
- Precision ground cast iron table
- Table size : 20 1/4" x 18"
- Spindle travel: 3"
- 2 interchangeable spindles: 1/2" & 3/4"
- Spindle openings on table: 1 1/4", 3 1/2" & 5"
- Spindle speeds: 7000 & 10,000 RPM
- Max. cutter diameter: 5"
- Approx. shipping weight: 221 lbs.

INCLUDES MITER GAUGE & FENCE WITH SAFETY GUARDS & HOLD-DOWN SPRINGS

G1035 ONLY $515.00 $65 shipping ANYWHERE IN LOWER 48 STATES

3 HP SHAPER

INCLUDES MITER GAUGE & FENCE WITH HOLD-DOWN SPRINGS

- Motor: 3 HP, 220V, single-phase w/ reversing switch
- Precision ground cast iron table
- Table size w/ standard wing attached: 30 1/2" x 28 1/4"
- 3 interchangeable spindles: 1/2", 3/4" & 1"
- Spindle travel: 3"
- Spindle openings on table: 1 3/8", 2 3/4", 4 & 5 1/2"
- Spindle speeds: 7000 & 10,000 RPM
- Approx. shipping weight: 357 lbs

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24" VARIABLE SPEED DRUM SANDER

- Drum motor: 5 HP, 220V, single-phase
- Conveyor motor: 1/4 HP
- Conveyor speed: variable, 0 - 20 FPM
- Max. stock thickness: 4 1/4"
- Sandpaper: 3" hook & loop
- Control panel with amp load meter
- Dust ports: (2) 4"
- Approx. shipping weight: 489 lbs

INCLUDES A HEAVY-DUTY RUBBER CONVEYOR BELT!

Z SERIES

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2 HP CYCLONE DUST COLLECTOR

- Motor: TEFC Class "F", 2 HP, 220V, single-phase
- Amps: 12.5
- Cycle/RPM: 60 Hertz/ 3450 RPM
- Intake hole size: 7"
- Impeller: 13 1/2" steel, riveted
- Suction capacity: 1354 CFM @ 2.5" SP
- Static pressure: 10.4"
- Filtration: 0.2-2 micron, 99.9% efficiency
- Filter surface area: 86 sq. ft.
- Collection Drum: Steel, 35 gallons
- Approx. shipping weight: 315 lbs.

G0440 ONLY $745.00 $85 shipping ANYWHERE IN LOWER 48 STATES

3 HP CYCLONE DUST COLLECTOR

- Motor: TEFC Class "F", 3 HP, 220V, single-phase
- Amps: 19.5
- Cycle/RPM: 60 Hertz/ 3450 RPM
- Intake hole size: 8"
- Impeller: 15" steel, riveted
- Suction capacity: 1654 CFM @ 2.0" SP
- Static pressure: 14.2"
- Filtration: 0.2-2 micron, 99.9% efficiency
- Filter surface area: 108 sq. ft.
- Collection Drum: Steel, 55 gallons
- Approx. shipping weight: 396 lbs.

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contents

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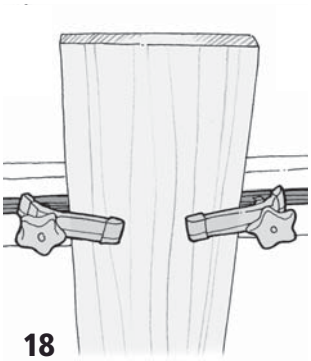
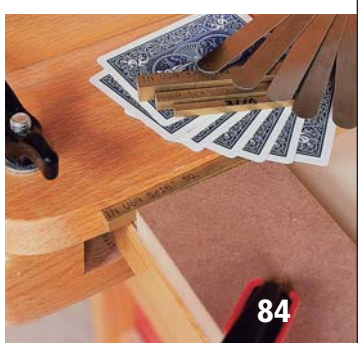
IN EVERY ISSUE


18


29


30

26


84

90

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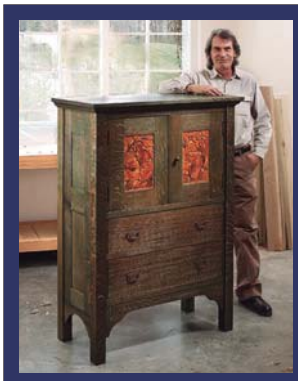


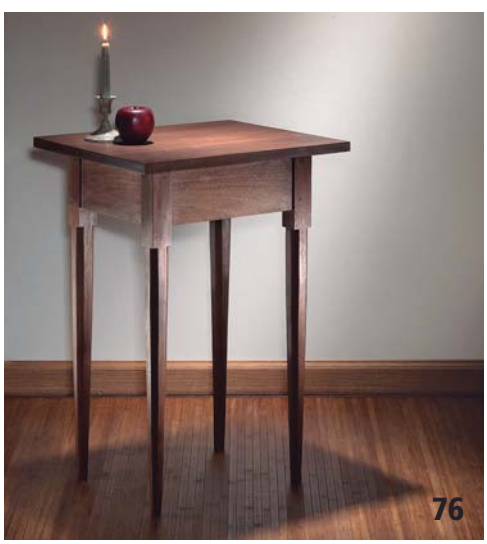
ON THE COVER

Built by craftsmen in a utopian community during the Arts & Crafts movement, this unusual (and unusually beautiful) linen press will test all your skills and reward all your senses.

Cover photo by Al Parrish

DEPARTMENTS

PROJECTS, TOOLS AND TECHNIQUES

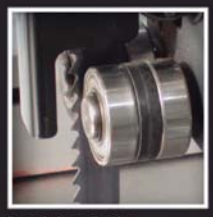


NEW

RESAW IN AWE!

18" JET DELUXE BANDSAW

- Motor: 1-3/4 HP, 1 Ph, 115/230V
- Cut Max (H): 12-1/4"
- Cut Max (W): 18-3/8"
- Table Size: 19" x 19"
- Blade Speed: 3,000 SFPM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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*, 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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2 YEAR WARRANTY

15" PLANER with OPEN STAND

W1723

This planer delivers the power, speed, smooth cuts and features to make your planing jobs easy!

FEATURES:

- 3 HP, 220V, single-phase motor
- Maximum width: 15"
- Maximum thickness: 6"
- Feed speeds: 16 & 20 FPM
- Cutterhead speed: 5000 RPM
- Cutterhead diameter: 3"
- Cuts per minute: 15,000
- Approx. shipping weight: 400 lbs.

Head moves up and down while table height remains stationary!

5 HP, 20" PLANERS

The heavyweight champion of planers! This machine has all the features you'll ever need, plus a few more!

FEATURES:

- 5 HP, 220V, single-phase TEFC motor
- Precision ground cast iron tables
- Table size: 25¾" x 20"
- Cutting height: 8"
- Max. depth of cut: W1683 - ⅛", W1718 - 5/64"
- Cutterhead speed: 5500 RPM
- Cutterhead diameter: 3⅜"
- Feed rates: 18 & 23 FPM
- Anti-kickback design
- Approx. shipping weight: 778 lbs.

W1718 Spiral Cutterhead

W1683 20" Planer

W1718 20" Planer w/ Spiral Cutterhead

10" LEFT-TILT TABLE SAW with EXTENSION KIT

The ever dependable W1677 Left-Tilt table saw is even better with this extension kit to increase ripping capacity!

FEATURES:

- 3 HP, 220V, single-phase motor
- Precision ground cast iron table with T-slots
- Maximum blade height: 3"
- Ripping capacity: 52"
- ⅝" arbor accepts dado sets up to 13/16"
- Heavy-duty cast iron miter gauge
- Approx. shipping weight: 474 lbs.

Includes 7' extension rails, extension table, legs & SHOP FOX® Classic Fence

W1677EXT1

6" x 89" OSCILLATING EDGE SANDER

This sander is packed with so many fantastic features that we just don't have room to list them all! Here are just a few:

W1730

FEATURES:

- 2 HP, 220V, single-phase TEFC motor
- Precision ground cast iron tables
- Table size: 26⅞" x 12"
- Table travel: 3¾" vert., 5" horiz.
- Aux. table travel: 10"
- Sanding belt speed: 3150 RPM
- Oscillation stroke: ¾"
- Drive drum diameter: 7"
- Platen with graphite pad: 6¾" x 30¼"
- 3 spindle drums: 1½", 2" & 3" x 4½" high
- Approx. shipping weight: 462 lbs.

Includes adjustable miter gauge & removeable fence

¾ HP MORTISING MACHINE

W1671

FEATURES:

- ¾ HP, single-phase motor
- Adjustable depth stop rod
- Gas spring return
- Double support columns
- Jacobs taper #2 spindle
- Heavy cast iron construction
- Micro adjustable fence
- Approx. shipping weight: 90 lbs.

Unique swiveling head assembly!

We designed this Mortising Machine to address all the frustrations found in other models on the market.

2 HP SHAPER

W1674

We designed this 2 HP Shaper to give maximum performance.

FEATURES:

- 2 HP, 110V/220V, single-phase motor
- Large precision ground cast iron table: 24" x 21"
- Heavy-duty miter gauge
- ½" and ¾" spindles included
- 3" spindle travel
- Heavy cast iron construction
- Cabinet stand with powder coated paint
- Approx. shipping weight: 270 lbs.

Shown with D2057 Adjustable Mobile Base (not included)

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Consider the Source Of that 'Wisdom'

My favorite quote about woodworking came from the pen of John Brown, a maker of Welsh stick chairs and columnist for the British magazine *Good Woodworking*.

Here it is: "By all means read what the experts have to say. Just don't let it get in the way of your woodworking."

You'd think that something like that would anger the editor of a woodworking magazine, but I actually find it a great comfort.

As I've delved deeper into the craft each year, I've discovered a tension between the people who insist that we must stand on the shoulders of the old masters, and those who are happy to kick the old masters in the shins to find an easier, faster or more accurate way to build furniture.

The truth is, you can find a wide variety of published opinions on almost any woodworking topic if you dig deep enough in the historical record. And that's because the world of woodworking publishing has always been filled with two kinds of people: those who think a lot about woodworking and those who actually do a fair amount of it.

Let's look back. Way back.

In 1678, Joseph Moxon published the first known "how-to" manual in English called "Mechanick Exercises," and for some woodworkers it is the doctrine and the basis for how woodworking should be done.

I've read Moxon's chapters on joinery and house carpentry many times and enjoy them immensely. But whenever I pick up my dog-eared copy, I keep in mind that there's no evidence that Moxon was a woodworker, either by vocation or avocation. He worked as a printer, cartographer and globe-maker. He was an observer and documentarian of the trades. But did he take up a try plane and attempt to straighten an edge? We don't know.

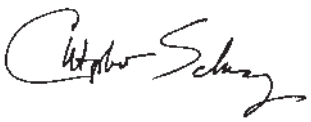
Another early chronicler of 18th-century woodworking was Jacques-Andre Roubo, who wrote the four-volume "L'art du Menuisier," first published in 1769. There's no English translation (yet, we're working on that), but here's what's important to note: Roubo was a joiner who achieved the title of "master joiner" – no small thing at the time.

So when it comes down to differences between these two early works, you have to consider the source.

The same goes for woodworking advice today. I'm not saying that you should listen only to modern professional cabinetmakers – their advice could be colored by trying to do a job in the absolute least amount of time for the least amount of monetary outlay. That's not always the goal of the hobbyist home woodworker.

What I'm saying is that you should listen to Virgil, a Roman author and poet (there's no evidence he was a woodworker either): "Believe one who has tried it."

So why is Brown's admonition a comfort? It's because I hope that every reader of this magazine will take it to heart. Read what's written here in these pages. Consider it carefully. But don't follow us blindly – editors have their own set of biases and opinions, too. Keep your mind open and try different techniques whenever you can. And then you'll know for sure what's going to get in the way of your woodworking and what is truly useful. **PW**

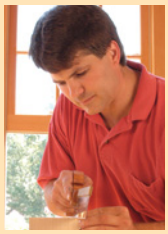


Christopher Schwarz
Editor

CONTRIBUTORS

ROB COSMAN

If you've been to a woodworking show in North America, chances are you've encountered Rob Cosman in the Lie-Nielsen Toolworks booth – cutting dovetails, sharpening or planing. He's an extraordinary dovetailer, but he's also equally adept at teaching all aspects of hand woodworking. His "Training the Hand" classes have taught many woodworkers how to build furniture to a high degree of craftsmanship entirely with hand tools. In addition to his show and teaching schedule, Rob has hosted six DVDs, is the father of nine children and even made time to explain how he cuts the sexy houndstooth dovetail in the article that begins on page 66.



CRAIG BENTZLEY

In the early 1970s, Craig worked as a designer for a company that made contemporary furniture components and his early work reflected that contemporary aesthetic. But after being exposed to fine antique furniture, he immediately became fascinated with the methods and tools used by early craftsmen. His subsequent work reflected an old-fashioned approach (see his "Queen Anne Table" on page 53). Now his primary woodworking interest is in the reproduction and conservation of American period furniture, particularly pieces from his native southeastern Pennsylvania. When he's not busy woodworking, he's busy writing about it and teaching about it.

Long History Defends 'Radical' Technique

Questioning a Curved Cutting Edge

I have been woodworking, designing, teaching, building and writing for more than 30 years, and was dismayed when a fellow professor and amateur woodworker asked me to comment on the article "Learning Curves," by David Charlesworth (August 2005, issue #149). The traditions of using hand tools, especially planes, are alive and in daily use in our shop, and I think we can agree that mastery of these instruments is a prerequisite for one who wishes to use "craftsman" alongside his name. A plane is a challenging device; the last thing those wishing to surmount those challenges needs is an article that defies traditional tenets and justifies itself by creating difficult solutions to straw-dog concepts of its use.

The last thing woodworkers who wish to learn the nuances of the plane need is an article in a respected magazine that attempts to rewrite the tried-and-true methods of hand-plane use. A straight cutting edge is the bedrock principle on which virtually all bench planes, minus the scrub plane, is based. Endorsement of a suggestion to the contrary is misguided. To suggest the use of holding jigs to construct a three-tiered micro-bevel and shimming to flatten the back of the iron at a slight angle defies the logic of the tool and discounts the hand-eye skill which when refined, is known as craftsmanship.

I will be the first to disclaim that my way of doing things is the right way or the only way. Creativity, after all, is the human force that drives so much of our passion. I will always, however, encourage the dismissal of overly tedious revisionist methods of work, regardless of their origins. The highly efficient and well-practiced method of joining two boards simultaneously is impossible with anything other than a correctly straight plane iron. It is difficult enough for a developing craftsman to control a straight edge without having to worry about either honing or shooting with one which is curved. Non-straight edges belong in the domain of planes whose sole profile demands such a condition.

I suggest *Popular Woodworking* do its readers a favor and refer them to "Planecraft: Hand Planing by Modern Methods," written by C.W. Hampton and E. Clifford, reprinted most recently by Woodcraft in 1972. In it, readers will find comprehensive, authoritative descriptions of the proper methods for the setup and use of hand planes. The publication in national journals of overly personal methods of work renders too much significance to "boutique methodologies" and does a great disservice to aspiring craftspeople and the perpetuation of honest workmanship.

Richard E. Preiss
Director of Laboratories
UNC Charlotte College of Architecture

It is difficult to respond to prejudice of this scale. I have a 1959 copy of "Planecraft" beside me and although it is an excellent book, it offers virtually no practical advice to assist the amateur or beginner with the intricacies of precision hand planing.

I would like to quote the sum total of their advice for removing wind from the face of a board and for planing a face edge: "As a board in winding is bound to cause serious trouble in fitting up later on, elimination of the wind cannot be too seriously stressed.

"… now proceed to plane the edge. This must not only be straight in length and breadth, and free from winding, but must also be 'square,' i.e. at right angles, to the first or 'face' side. Although this sounds a difficult proposition, its accomplishment is easy, provided the plane is held correctly."

My articles, books and DVDs provide detailed, practical advice to readers that will enable them to understand how wind is removed and how a twisted edge can be corrected, using a curved blade. I have been teaching and writing about this method for nearly 30 years. Hundreds of students have acquired these skills in a short time and have been able to achieve precision results, which had previously eluded them.

I cannot imagine why Mr. Preiss would wish to reject a method that has been used by many of the United Kingdom's finest craftsmen for at least 100 years. It was taught at Loughborough College in 1947, where many of the country's best craft teachers were trained, and is included in Robert Wearing's excellent book "The Essential Woodworker" (Trafalgar Square Publishing).

In addition, "The Practical Woodworker," first published about 70 years ago (Ten Speed Press), states that a trying plane for jointing should be "very slightly round," and as to the act of joining, it notes that the fingertips should run on the face of the board "so as to act as guides and keep the plane iron in the middle, either for the whole length of the board or for a portion only as may be needed."

And if further evidence is required, in "Woodwork Joints" (Evans Brothers, 1950), Charles H. Hayward goes into great detail on the technique of using a cambered iron for edge jointing. He explains exactly how to remove an edge in wind and admonishes anyone who would rock or cant a plane to correct an edge.

As to my sharpening technique, it is indeed somewhat radical by traditional standards, but it works extremely well and allows beginners to consistently achieve a razor sharp edge within a very short time. The assertion that this "does a disservice to aspiring craftspeople" is quite frankly outrageous. **PW**

— David Charlesworth

WRITE TO US

Popular Woodworking welcomes letters from readers with comments about the magazine or woodworking in general. We try to respond to all correspondence. Published letters may be edited for length or style. All letters become the property of *Popular Woodworking*. How to send your letter:

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The Trouble Buried In the Branches

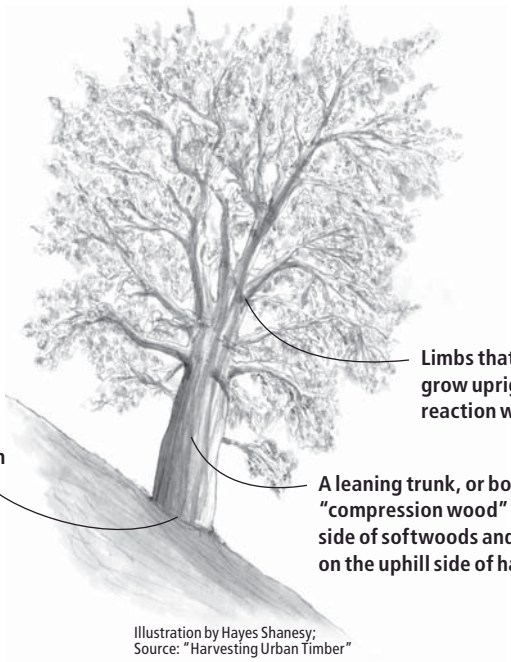

Illustration by Hayes Shanesy;
Source: "Harvesting Urban Timber"

Why Can't I Use Branch Wood in My Woodworking Projects?

I have started harvesting timber locally. Everything I read says to stay away from large limbs because they're stress wood. If you cut them into boards they are going to warp. I believe that. But how can you, in good conscience, make firewood out of a 15"-diameter 15'-long piece of red oak. Isn't that sacrilegious?

Couldn't you cut the wood to use the warp? How about rocking chair rockers? How about a floor lamp that arches gently up and over your easy chair? Why are all those artistic woodworkers trying to bend wood instead of getting wood that wants to bend? Have I lost it or is there some meat to this thinking?

Bill Hook
Weatherford, Texas

Branch wood, which can be called "reaction wood" or "compression wood," is bad news. Our first experience with branch wood came when we were working with a couple University of Cincinnati professors on an urban lumber project. They had harvested an enormous oak tree and the branches were 30" or so in diameter.

Of the hundreds and hundreds of board feet of lumber they harvested from those enormous limbs, little was usable. When they dried it, it shrank and twisted. When they cut it, it stopped their tools – sometimes to the point where they had to use a crowbar or a chainsaw to free it.

One of those professors, Sam Sherrill, wrote a book about the experience called "Harvesting Urban Timber" (Linden Publishing) and in it he discusses the perils of branch wood. Here are a couple facts from his book:

- *Reaction wood can shrink along its length, and it's not uniform shrinkage.*
- *The wood can shrink five times as much as normal wood.*
- *Because the wood cells are distorted, the wood can take finishes unevenly.*
- *And because of all the wild grain, the wood can end up "fuzzy" no matter how you sand it.*

Sorry to be discouraging, but I think that sometimes you need to fire up the fireplace.

— Christopher Schwarz, editor

Can You Drawbore Loose Tenons?

How's this for a hybrid of old and new: Have you ever considered combining loose-tenon joinery and drawboring? At first glance, it seems heretical, but it would combine the speed of loose tenons with the strength of drawboring. You could use a simple peg for the tenon in the rail and drawbore the peg in the stile. I think I'm going to go with that joint on the bed I'm assembling. I have 10 mortise-and-tenon joints to knock out in hard maple. That would add up to a lot of chiseling and dry-fitting with traditional tenons.

David Brown
Washington, D.C.

I would be a bit wary of this technique and the variations it could produce. Whatever you do, I would avoid drawboring the rail joint. Drawboring might split it – the peg would act as a wedge and the orientation of the grain would encourage a split. You suggest a simple peg through the rail, which would be the best way to go.

Part of my problem here also is that I'm not a fan of loose tenons. They are a good option for some special applications, but I really don't see them as easier than the traditional joint. Mortising that end grain is no small thing (in my opinion) and the jiggery to mortise the ends of rails is sometimes complex.

— Christopher Schwarz, editor

When Learning Hand-cut Dovetails, Should I First Learn to Cut Box Joints?

I have in the past turned to my small router jigs for dovetail joints. However, the size and layout of joints possible with this jig is limited.

So I've decided to learn how to cut these joints by hand. My strategy is to start learning box joints, as I figured doing so would force me to master sawing to a line and paring a straight edge with my chisels. Once I've got the box joint "mastered," I will then proceed to the dovetails. Does this sound reasonable?

Greg Long
Corvallis, Oregon

I'd skip the box joints. I think they're actually tougher to cut by hand and get them to look correct. Any angle slightly off 90° looks like a mistake. Once you get to 7° off vertical, however, it doesn't look wrong. It looks like a dovetail.

I'd start by doing what Frank Klausz and Lonnie Bird say to do: Practice cutting square.

continued on page 16

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Q & A

continued from page 14

Just cutting. Lots of 90° cuts. Get good at cutting square and to a line – and then cut dovetails.

Box joints are a fantastic machine joint designed for the advantages that machines provide (repeatable square cuts in this case). Dovetail joints are designed to be made by hand. The complications arise when we try to cut a hand joint by machine or a machine joint by hand.

— Christopher Schwarz, editor

How Should I Secure the Joints For a Door Frame That Will Be Outside?

I have a pair of 150-year-old, massive mesquite doors from Mexico and am building them into a courtyard wall. I've framed them using heart pine beams that are mortised together. To fix the heart pine mortise-and-tenon joints, would you recommend:

- Hardwood dowels, possibly drawbored through the tenons?
- "Bed bolts" through the horizontal beams, tenon and into the vertical members?
- Something else?

Bob Owen
Junction, Texas

First, I'd pick up a copy of "Modern Practical Joinery" (Linden) by George Ellis. This inexpensive book is a gold mine of traditional joints for both cabinetry and house joinery. Ellis shows door frames for large doors (such as those for a warehouse) built using through-tenons that are then wedged. He also shows pegged tenons as an alternative. For your doors, which would be outside, I would avoid using bolts, which will certainly rust and will not expand and contract with the frame like a solid-wood solution.

— Christopher Schwarz, editor

Finishing Tips Needed for Turned Pens

I recently started turning pens, and am using Hut Crystal Coat (a mix of shellac and wax), applying two coats and heating each coat in. This stuff seems to be reacting with my body oils because it tends to dull after use. Some guys at Woodcraft told me to seal the wood with cyanoacrylate glue before applying the finish. This doesn't seem right to me. A couple books recommended a French polish, but then didn't provide a formula. What do you recommend? What is the formula for French polish?

Tim Miller
Milford, Ohio

I'm not an expert by any stretch of the word on finishes, but I've determined what works well for me on various items.

I agree that using cyanoacrylate glue isn't a great idea. At best it would be smelly and expensive, and it could make a mess of your lathe bed and face shield. Having said that, it would make a very hard, shiny finish, but should be used with great care.

There are many finishes on the market that are used as a French polish-type finish (Hut Crystal Coat is one of them); most are shellac-based sealers. I'm not all that happy with these as a final finish on a pen, perhaps because too many labor-intensive coats would be required to achieve a good result.

For my pens, I use one of the sealers first (Hut Crystal Coat, Behlen's Woodturner's Polish and Mylands Friction Polish are examples; there are other brands), applied with a clean rag as the piece spins on the lathe, then buff it dry. I follow this with a coat of hard wax (I use Hut Pen Polish), also applied with the workpiece on the lathe and buffed out. This finish is very smooth and even, and has a nice sheen, which I prefer to a hard gloss.

It seems very durable, but keep in mind the finish on a pen probably receives harder use than that on almost any other item made of wood. Along with the natural darkening of the material, this means the appearance of the pen is likely to change over time regardless of the finish used.

Also, any user who wanted to keep the pen as pristine as possible could regularly apply and buff a paste wax finish on top of this or any other finish. **PW**

— Judy Ditmer

WRITE TO US

Every day we get questions from readers on all subjects about their woodworking. Some are letters; many are e-mail messages. We are more than happy to share our woodworking experience with you by answering your questions or adding some clarity to whatever aspect of the craft you are unsure about. In addition to the hundreds we answer privately every month, we want to share the best questions here with readers.

Send your questions via e-mail to popwood@fwpubs.com, or by mail to:

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Compiled by Paul Anthony
Illustrations by Matt Bantly

T-track Bench Tricks

THE WINNER:

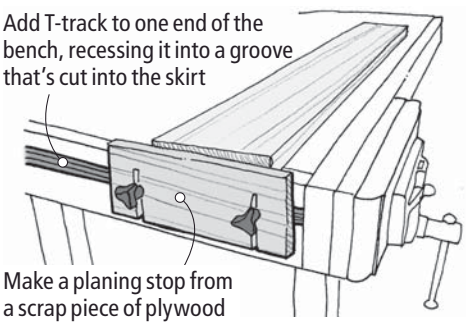
When I built my new workbench, I outfitted it with typical front and end vises, but I also added T-track to one end of the bench, recessing it into a groove that I cut into the skirt. I mounted two 12" lengths of track in the groove, leaving a 4" gap between them to allow room for inserting T-bolts for holding various accessories.

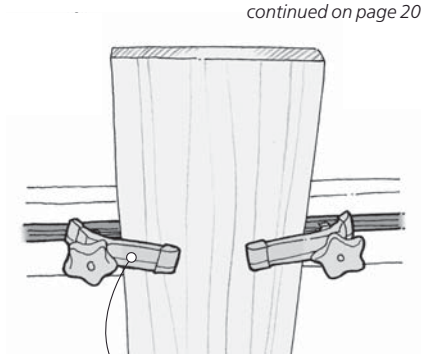
The two accessories I regularly use are a planing stop and a pair of hold-downs. The planing stop, which is made from a scrap piece of ½"-thick Baltic birch plywood, is slotted, and attaches with two T-bolts and knobs. This allows me to adjust the height of the stop as needed to suit the thickness of the wood I am working. When planing or scraping, I find it's much more convenient to simply butt a workpiece against the stop rather than pinch it between bench dogs.

I use T-track hold-downs to mount a workpiece vertically at the end of my bench. This method works much better than trying to hold a piece in just one side of a vise, which tends to rack the jaws. With my bench, I am able to vertically hold a piece as wide as 26" for marking out and cutting dovetails and other joints. I'm not sure what other accessories I'll use over time, but the T-track provides a measure of flexibility for my workbench as my woodworking skills develop.

Steve Sampson
Wilbraham, Massachusetts

continued on page 20




Use T-track hold-downs to mount a workpiece vertically at the end of the bench

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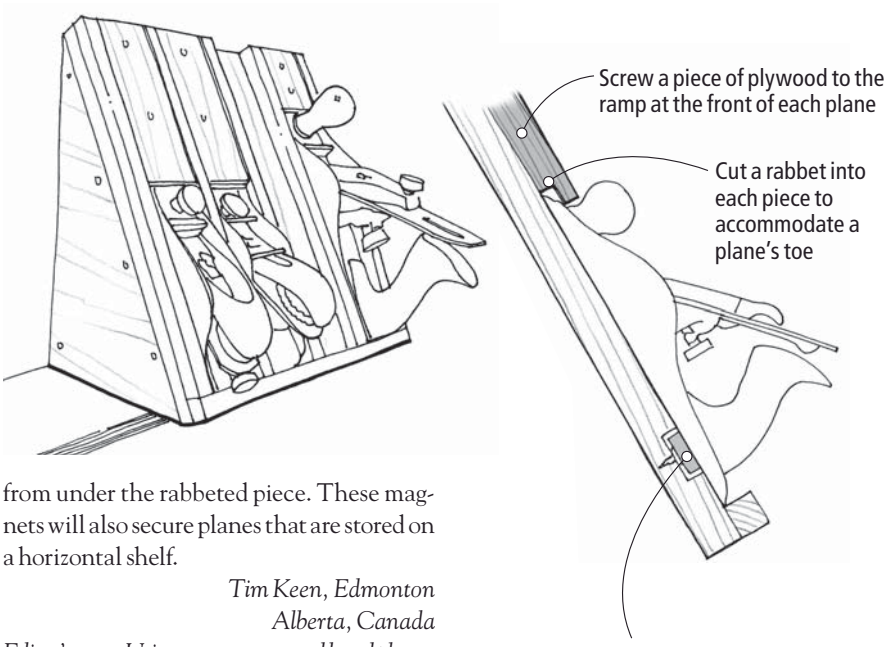
continued from page 18

A Safer Plane Ramp

A while ago, I built a wall-mounted ramp for storing my hand planes. This time-honored shop fixture keeps my planes organized and within easy reach because they all sit together at an angle on a board, divided by wood strips, and ready to grab in an instant.

Unfortunately, while cleaning my shop recently I bumped into the ramp, knocking my favorite bench plane loose. It fell to the floor with a sickening thud, cracking the casting at the throat. To keep this from happening again, I countersunk ½"-diameter rare earth magnets and matching cups (available at leevalley.com) into the ramp board under the heel of each plane. I also screwed pieces of ½"-thick plywood to the ramp at the front of each plane, having cut a rabbet into each piece to accommodate a plane's toe.

Now my planes are still out where I need them, but I no longer have to worry about them crashing to the floor. A firm tug is required to lift the heel, while the toe slides out easily from under the rabbeted piece. These magnets will also secure planes that are stored on a horizontal shelf.



Tim Keen, Edmonton
Alberta, Canada

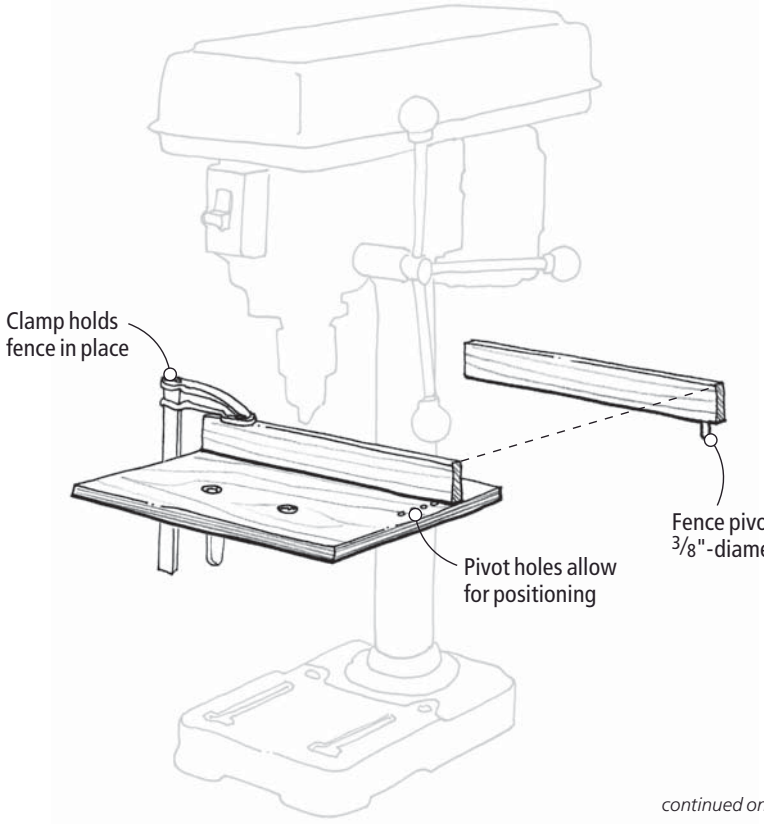
Editor's note: Using magnets around hand planes can impart magnetism to the plane's parts, which may attract metal filings when sharpening the tool's iron.

One-clamp Drill Press Fence

A typical drill press can be greatly improved by the addition of an auxiliary table to increase the working area. A larger table also provides easier attachment for a fence when one is needed. To secure the fence, I used to simply clamp it to the table at both ends, but I found that the clamp would often get in the way of the machine's rotating lever handles.

So I ended up devising a fence that pivots on a 3/8"-diameter pin that inserts into the table near the right-hand edge. This solves the problem of clamp interference, and makes setting up and adjusting the fence a snap because it only has to be set and clamped at one end. A row of pivot holes spaced a couple of inches apart along the right-hand edge of the table allows positioning the fence closer or farther from the bit, as desired. (On a drill press, it doesn't matter if the fence is parallel to the edges of the table.) This sure has made working at the drill press much more convenient.

Jim Riley
Port Orchard, Washington



continued on page 22

continued from page 21

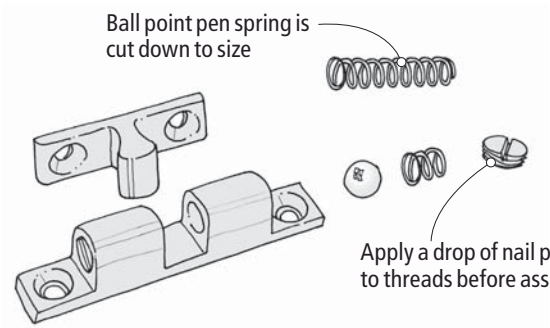
A Better Brass Ball Catch

I often like using brass ball catches for fine cabinetry. The hardware is low-profile, classy looking and can be mounted in a variety of orientations. Being brass, it's also rust-resistant, making it ideal for any high-humidity environments such as bathrooms.

However, I have experienced a couple of problems with these catches over the years. The first is that the springs exert too much pressure for most circumstances, making you tug too hard on a door. Yes, I know you're supposed to be able to reduce the tension by backing off the end caps, but that just doesn't do the trick; the springs are simply too stout. What I do to correct the problem is to replace the heavy springs with a couple of ball-point pen springs that I've clipped to the same length. Works great.

The second problem with the catches is that the end caps can back out by themselves over time, just from the vibration of use. To solve this, I dip into my wife's make-up kit for some fingernail polish. I've found that applying a drop of it to the threads of an endcap keeps it in place over time.

Paul Anthony
PW contributor



A Solvent Solution to Pitch

One of my students decided to make his class project from pine. It was lovely, clear stuff, but the pitch in some of the boards seriously gummed up the wrap-around belt on my stationary drum sander. Unfortunately, I've found in the past that commercial "eraser-type" crepe belt cleaners don't work very well to remove clogged pine resin, so I experimented with various solvents.

When I tried lacquer thinner, I knew I had found the magic solution. It dissolved the pitch within seconds. Dipping a large toothbrush in a jar of the thinner, I very quickly and lightly scrubbed across the length of the drum, working in narrow bands, and rolling the drum as I advanced. By the time I came back around to the beginning, the thinner had flashed off, leaving a softened pitch residue which quickly and easily came off with a large scrub brush. Cleaning the whole 18"-long by 5"-diameter drum took all of about three minutes, and it restored the sanding belt back to prime condition. In fact, the operation was so efficient and effective that I did it several times during the course of sanding the boards.

Paul Anthony
PW contributor

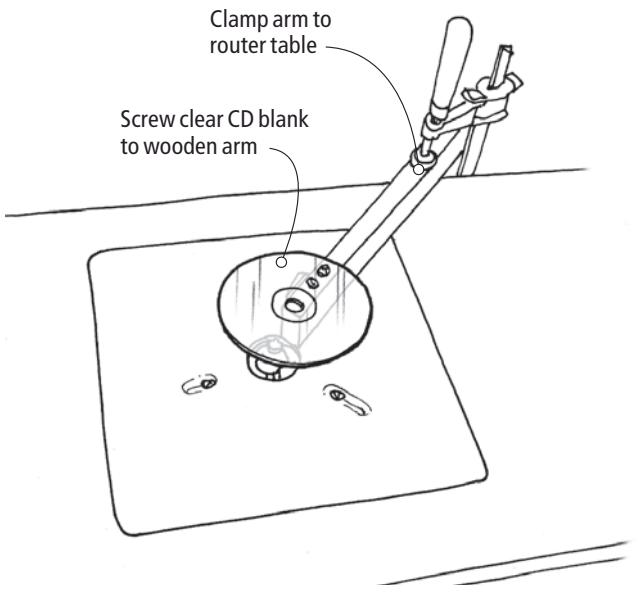
A CD Router Bit Guard

Router table operations that involve the shaping of curved edges can be dangerous because curved-edge work doesn't allow the use of a fence, so there's no convenient place to mount a guard. This puts your fingers in harm's way whenever doing freehand routing that involves guiding the workpiece against the bearing on the bit.

While preparing to shape the edges of some curved pieces recently, I decided to make and install a guard over the bit, screwing it onto an arm that clamps to the edge of the router table's top. Unfortunately, I discovered that I was out of clear acrylic to use for the guard. Always one to use whatever's at hand, I grabbed one of the protective clear plastic discs that come with a spindle of CDs. After screwing it to the wooden arm, I discovered that it worked great. It's just about the perfect size, and transparent enough to see the router bit. Best of all, it didn't cost anything, so I was able to maintain my reputation for being cheap … um, I mean frugal.

Doug Price
Fredericksburg, Virginia

Editor's Note: The plastic discs packaged with CDs are made of simple plastics rather than polycarbonate that is usually used for guard devices. This plastic should not be considered shatterproof.



Put a Sock on It

The one hand plane that I always bring along to the job site is my block plane. Fortunately, it's small enough to tuck in any tool box. Unfortunately, it is then subject to collision with other hard, sharp toolbox items. To protect it, I first slip it all the way into a thick, old sock. Doubling the top, elastic section of the sock back over the bottom section that contains the plane compresses the sock onto the plane and offers a double layer of cloth as a covering.

Mike Jordan
Butte, Montana

continued on page 25

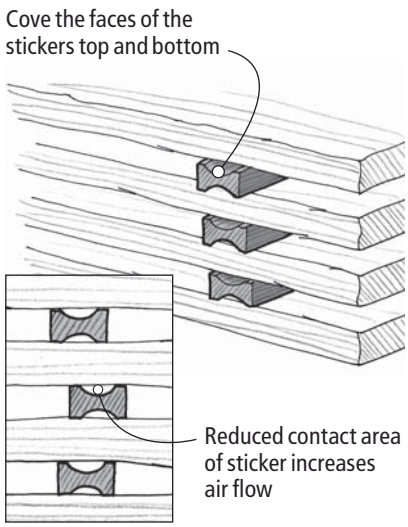
continued from page 23

Preventing Sticker Stain

As most woodworkers know, it's important to "sticker" lumber when air-drying it, to allow air to circulate fully around the boards. However, using square sticks as stickers can lead to "sticker stain," because mold tends to grow between the surface of the sticks and the wet lumber. Unfortunately, the stain can penetrate the lumber fairly deeply.

To prevent this, my local sawyer coves the faces of his stickers as shown. The cove minimizes wood-to-wood contact, and helps improve air circulation. If you aren't up to routing a lot of narrow strips, a shallow dado will work almost as well, although the strips may be more likely to split at their raised edges if not handled carefully.

Jules Wachowicz
Chicago, Illinois



Easy Sliding Skew Chisel

The square shank on some skew chisels and other turning tools can cause the tool to temporarily hang up on rough spots on the lathe tool rest, leading to catches and other mishaps. To prevent this, I file a slight roundover on the edges of the shank, which helps it slide more easily on the rest. It's also wise to file the top of your tool rest as necessary to remove any nicks or notches in it. Smooth sliding helps ensure smoother turning. **PW**

Charles Fluck
St. Louis, Missouri

Powermatic 701: The New Benchmark in Small Mortisers

Most hollow-chisel mortisers do what they are supposed to do, but there are usually some features or functions that aren't quite right. On our old mortiser, we won't change the fussy fence unless we absolutely have to, and a pair of Vise-Grips supplements the inadequate depth stop.

Powermatic has done a remarkable job of rethinking every feature of the machine and has set a new benchmark for small mortisers. The depth stop locks solidly to the dovetail ways, and the fence moves on a rack-and-pinion system, and locks solidly in place with two cam clamps. Once the bit is set parallel to the fence it stays that way no matter how the fence is moved. These two features alone had me sold, but there are many more.

There are two built-in spacers for setting the gap between the bit and the chisel that swing in when you need them and out of the way when you don't. The handle can also be used on either the left or the right side of the motor, and can be set in 10 different positions on the shaft. Behind the motor is a rack for storing the chuck key, bushings, extra chisels and a cone-shaped diamond sharpener. The 3/4-hp, 1,720 rpm motor delivered plenty of power quietly, without undue vibration.

The hold-down is L-shaped and can be reversed to hold wide or narrow material. There are also two rubber wheel hold-ins to keep material against the fence. These work extremely well as they can be adjusted to hold the stock firmly while cutting, yet allow it to slide easily sideways between each plunge. I cut numerous 3/8" and 1/2" mortises in white oak, and found this system a bit faster and more convenient than the sliding table on our old floor-model mortiser.

This machine costs about $150 more than the typical benchtop mortiser, and it doesn't come with chisels. But it is larger, heavier and more powerful than the benchtop models, and the user-friendly features make it well worth the additional cost. It compares favorably in performance to floor-model machines that cost twice as much, and it leaves all other benchtop models far behind.

— Robert Lang

For more information, circle #178 on Free Information Card.

SPECIFICATIONS

Powermatic 701 Mortiser
Street price: $399.99
Motor: 3/4 hp, 1,720 rpm
Maximum chisel capacity: 3/4"
Maximum chisel stroke: 5 1/2"
Performance: ●●●●●
Price range: $$$$
Powermatic: 800-274-6848 or powermatic.com

New Small Backsaws from Gramercy Tools

Small straight-handled saws have a tarnished reputation these days. Except for the Lie-Nielsen versions, most are poorly made, sharpened and set. Like any saw, their problems can be fixed, but repair takes significant skill when dealing with such fine teeth.

Lucky for us, Gramercy Tools has introduced a new line of small saws that are well-made, hand-sharpened and properly set. Called "beading saws," they are available in 4", 6" and 8" lengths that are filed for crosscutting. The 8" saw is also available with rip teeth, allowing it to work as a good small dovetail or tenon saw.

All of the Gramercy saws have 15 teeth per inch and are surprisingly heavy thanks to the 1/4"-thick brass backs. The turned rosewood handle (3 7/8" long) is comfortable in use – the bulbous end nestles into your palm and your thumb rests perfectly against an upswept area near the blade. The blade itself is .021" thick and set to leave a kerf of .03".

For the last two months I have been test-driving the 6" saw and the 8" rip-tooth saw. Both saws cut quickly and track a line perfectly, which isn't surprising considering these are premium tools with a premium price ($100 to $110 each). But what was surprising about the saws is how often they ended up in my hand day-in and day-out.

Most furniture projects require a good deal of trimming, and that is where these saws excel. When used in conjunction with a bench hook or a bench vise, I found them remarkably useful for notching corners, cutting tenon shoulders and cheeks, and performing the myriad other small cuts that continually crop up.

In the past, I would make do with a larger saw or with a small Japanese pullsaw. But now that these excellent small Western backsaws are available, I'm sticking with them and making a space in the tool rack above my bench.

— Christopher Schwarz

For more information, circle #179 on Free Information Card.

SPECIFICATIONS

Gramercy Tools Beading Saws
Street price: $99.95 to $109.95
Back: 1/4" thick x 11/16" wide
Depth of cut: 1 3/8" (6" saw), 1 9/16" (8")
Weight: 8.4 oz. (6" saw), 9.9 oz. (8")
Performance: ●●●●●
Price range: $$$$$
Tools for Working Wood: 800-426-4613 or toolsforworkingwood.com

Micro Plunge Precision

Like many woodworkers, I tend to be a closet machinist. It's fun to see how close to perfection I can get, and I'm a sucker for anything that reads or adjusts to a thousandth of an inch. For those who share this affliction, Micro Fence has just introduced a new plunge base for laminate trimmers that is the ultimate in tweakability. And when it's combined with the Micro Fence system you can do extremely accurate work with a minimum of fuss.

I tested the base with the new Bosch Colt, and it is available to fit several other laminate trimmers. I found myself trying it in more and more applications simply because it was so much fun to use. I used it for relieving the background of a carving, letting in hinges, and I even made 1/4"-wide by 1"-deep mortises. The base is incredibly well-made, and simple and intuitive to use. The LED light and effective dust collection were icing on the cake.

My only complaint is that the shaft lock for the router can't be reached when mounted. But this is within .0001" of perfection. — *RL*

For more information, circle #180 on Free Information Card.

SPECIFICATIONS

Micro Fence Portable 3-Axis Mill
Street price: $399.99
Vertical travel: 2 3/4", 3-position stop
Adjustment: to .001"
Features: LED light and vacuum hookup
Performance: ●●●●●
Price range: $$$$$
Micro Fence: 800-480-6427 or www.microfence.com

Impact Power Now In a Screwdriver

A handy occasional-use screwdriver should be inexpensive, reasonably powerful, retain a charge (or charge quickly) and be compact.

Craftsman has answered some of our requirements by offering a cordless screwdriver with impact capabilities, offering torque and control never before available in a tool this size.

Despite the fact that this driver is rated as a 4.8-volt tool, it is capable of driving a 1/4" x 1 1/2"-long lag screw into 1 3/4"-thick poplar. Number 10 screws also proved no problem, and the included 3/16" drill bit also dug in without hesitation. The screwdriver isn't fast, but it also doesn't require any excessive force to drive a screw. The drilling feature works without the impact mechanism kicking in, but with just a little extra pressure, you're in impact mode.

While the performance of the screwdriver is good and the dual-position handle offers ergonomic options, the driver is still oversized for my tastes. And, unfortunately, the drill still includes a no-frills three-to-six hour charger, meaning you'll have to plan ahead. This is a good start but we're confident a better impact screwdriver is possible. — *David Thiel*

For more information, circle #181 on Free Information Card.

SPECIFICATIONS

Craftsman Impact Power Driver
Street price: $50
Speed: 1,800 rpm
Stated torque: 175 in./lbs.
Charge time: 3 - 6 hours
Performance: ●●●○○
Price range: $$
Craftsman: 800-549-4505 or craftsman.com

STARRETT 505A-7 PROSITE PROTRACTOR

We reviewed the 12" version of the Starrett ProSite Protractor in December of 2004 and were generally impressed with the quality and abilities of the tool. It proved accurate, well-made and featured an easily read and understood scale.

We did, however, have two gripes with that model. We found the 12" length a little large for some of the operations we would consider using it for (machinery setup in particular) and the markings on the scale were only in whole numbers, even though half-degree markings are important in many woodworking applications (such as crown miter settings on a miter saw).

Starrett now offers a smaller version measuring around 7" in length; each leg measures only 1/4" x 5/8" in cross section. The original ProSite Protractor weighed in at 20 ounces, while the 7" model is a handy 7.2 ounces.

Though we're pleased with the smaller size of this model, the scale still offers accurate markings only for whole numbers, leaving some precision to speculation.

While the weight and size have been significantly reduced, the price has only changed by about $5. Expect to pay around $35 for the 7" version.

For more information contact Starrett at 978-249-3551 or starrett.com. — *DT*

TOOL RATINGS

Performance is rated on a one-to-five scale. You likely won't see a low rating ("one or two") because we don't publicize inferior tools. "Five" indicates the leader in the category. Five dollar signs indicates highest price in the category. Three indicates an average price. If you have tool questions, call me at 513-531-2690 ext. 1255, or e-mail me at david.thiel@fwpubs.com. Or visit our web site at popularwoodworking.com to sign up for our free e-mail newsletter.

— David Thiel, senior editor

DeWalt DW718: Excellent With Minor Demerits

When it comes to miter saws, it's fair to say we're some of the toughest customers around. We have things we'd like to change on even our favorite saws, and that's probably because we demand cabinetmaking precision from a carpenter's tool – and we use the things so darn much ever since we sold our radial arm saw.

The good news here is that the DeWalt DW718 is the best 12" miter saw I've ever used. The bad news is there are still a few more tweaks I'd like to see.

First, the good stuff. Woodworkers rejoice: This is the easiest miter saw on which to square the blade to the fence. You don't mess with the fence; you simply loosen four screws and shift the miter scale that includes the stop detents. Genius. And speaking of the fence, one of the other major advancements with this saw is that the fence sits in a shallow rabbet on the saw's table. It doesn't sound like a big deal, but it is. Unlike many other saws that have passed through our hands, the fence on this saw is flat on both the left and right side of the blade. That's a big deal for accuracy.

And speaking of the blade, it's good. DeWalt has made significant leaps in blade technology in recent years and this blade is a keeper, not a junker. It cuts smooth and does not deflect in heavy cuts, like in other saws.

So what would I change? The dust collection is quite poor – a common defect in miter saws. The throat plate is difficult to adjust – I recommend you make your own zero-clearance plate. And I personally wish there was a safety switch, though my shopmates disagree with me.

Bottom line: This saw has as much crosscut capacity as you could want (16" with a special setup) and is accurate enough for the most demanding woodworker. In the world of miter saws, that's high praise in our shop. — *CS*

For more information, circle #182 on Free Information Card.

SPECIFICATIONS

DeWalt DW718 Sliding Miter Saw

Street price: $649
Max miter: 50° right, 60° left
Max bevel: 48° left and right
Max baseboard height: 6½"
Performance: ●●●●○
Price range: $$$$$
DeWalt: 800-433-9258 or dewalt.com

Craftsman 14.4v Cordless Drill – Our New Best Value!

When we ran our 14.4-volt cordless drill test in our December 2005 issue, Craftsman was in the process of reworking its cordless line and did not have one of the new models available during our testing. We're glad to be able to update our information after testing Craftsman's 14.4v professional drill.

Compared to the other 11 drills in the test, the $160 price of the Craftsman drill is lower than all the competition save the Skil drill ($79.99). The Craftsman drill is powered by a 1.7 amp hour NiCad battery (with a one-hour smart charger) and weighs in at 4.8 pounds, making it lighter than all but two other drills in the test.

The drill shares many features with the other drills in the test: A ½", single sleeve chuck; multi-position clutch; two-speed motor with variable-speed control through the trigger and an integral brake.

We ran the Craftsman through the same tests used in the December test: Driving a 1" spade bit through 1¾"-thick poplar and sinking ¼" x 1½"-long lag screws in the same poplar boards.

The December test results ranged from nine to 25 holes and six to 164 lag screws. The Craftsman posted a decent number in the hole-drilling competition (17), putting it in sixth place. But when it came to lag screws, this drill outperformed all but one of the competitors with 124 screws sunk on a single charge. Impressive!

When running the hole test, we also checked temperature readings at the motor and battery to gauge user comfort. With a reading of 160° at the motor and 123° at the battery, the Craftsman posted lower than average temperatures. Another good sign.

During testing, the drill proved comfortable, well balanced and reasonably sized for a 14.4v drill. I would have preferred a chuck with jaws that closed a little tighter and a ratcheting (locking) chuck would also be a nice addition, but considering the price and performance, this drill earns our new Best Value Award in the test. **PW** — *DT*

For more information, circle #183 on Free Information Card.

SPECIFICATIONS

Craftsman 27084 14.4-volt Drill

Street price: $160
Speed: 0-350/0-1,400 rpm
Stated torque: 410 in./lbs.
Weight: 4.8 lbs.
Performance: ●●●●○
Price range: $$
Craftsman: 800-549-4505 or craftsman.com

Blue Spruce Marking Knife

Handmade and perfect in every detail.

Photo by Al Parrish

When people ask for my recommendation on almost any kind of tool, I attempt to give them several choices: I'll recommend Tool A if you're this kind of woodworker; Tool B if you're another kind of woodworker.

However, this is not the case when it comes to marking knives. I have only one recommendation: Buy a marking knife from Blue Spruce Toolworks of Oregon City, Ore.

In the last decade I have used more than a dozen different marking knives from all over the globe – some antique, some newly manufactured, some shop-made. After I sharpen them and force myself to use them for a month or so, I put them in the top left drawer of my tool cabinet with all my other marking knives.

My fingers always go back to pick up the Blue Spruce for my day-to-day work. It's not just because it's an attractive and shiny tool (though it has good looks in spades), it's because it is perfectly suited to so many tasks, is well-balanced and well-made by hand. It is the embodiment of what I try to achieve when I build a piece of furniture.

I know you're probably thinking, "Yeah, right. What could be so special about a piece of steel in a stick?" Let's take a close look, starting at the business end of the tool.

The blade is unique. It's remarkably thin at just 1/32" thick and stiff. Why is thinner better? If you cut dovetails you already know the answer – the thin profile allows you to sneak into the tightest dovetails to mark the mating section of the joint. Most knives (and marking awls) are simply too thick to get into London-pattern dovetails. The spear-point shape of the cutting edge is also a big advantage when dovetailing. It allows you to mark on the left and right side of a tail or pin without resorting to another knife. Put the flat side of the blade against the joint and mark – you don't need to tip the knife like you do with an X-acto or jack knife.

The blade is just the right length – it's 1 5/16" from the ferrule to the tip. That length allows you to reach into deep places some knives won't go. And, as I mentioned earlier, the blade is quite stiff – this is thanks to the two brass ferrules on the tool, which lend a bit of extra (and needed) support.

Another sometimes-overlooked detail is the angle of the spear point itself. The two edges form a 55° angle on the latest version of the Blue Spruce. This is a good balance. Knives with higher angles work better for marking dados and tenons. The lower angles work better for dovetailing, allowing you to apply more downward pressure as you mark your joints. The middling angle works well for both operations.

The handle of the knife is available in a variety of woods. Cocobolo and rosewood are the standard choices, though Dave Jeske, the owner and maker, is happy to customize a handle's shape or species.

ABOUT OUR ENDURANCE TESTS Every tool featured in our Endurance Test column has survived at least two years of heavy use in our shop here at *Popular Woodworking*.

SPECIFICATIONS

Blue Spruce No. 2 Small Marking Knife
Street price: $40
Overall length: 6 7/8"
Blade width: 5/16"
Steel: A2, hardness of Rc 60-62
Options: A larger Blue Spruce marking knife with a 1/16" x 1/2" blade is available for $55.
For more information: Blue Spruce Toolworks, bluesprucetoolworks.com or info@bluesprucetoolworks.com

And that detail is one of the other delights of this tool. Each knife is made to order by one person, a long-time woodworker who does excellent work. The handle is an exquisite piece of turning and finishing. The blade comes well sharpened and ready to use.

I cannot say that the knife will make you a better woodworker, but it sure feels like it does. The Blue Spruce marks more precisely than any pencil, and as you pick up the tool for the hundredth time during a project, its excellent workmanship will encourage you to bring your own work to that high level. **PW**

— Christopher Schwarz

Making and Using Sawhorses

Start your woodworking education right.

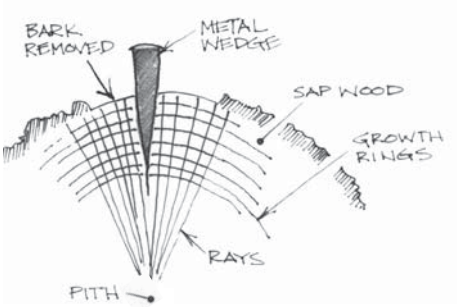
Photos by the author

Sawhorses may not be terribly sexy, but they're terribly important to have in your shop. Building a set of horses is also an excellent way to practice on your basic 18th-century woodworking skills, build a better relationship with the wood, and provide your shop with a couple of much-needed fixtures.

What's the best sort of workbench to build? What hand tools should I buy first? How many coats of polyurethane are needed to stop a board from cupping? Arts & Mysteries readers e-mail me these and other questions (OK, I made up the last one) and like every woodworker, I'm happy to offer my opinions. I'm just not convinced I'm really helping. As odd as it may sound with all our modern technology and magazine articles like this one, learning to work wood by hand is harder today than it has ever been. People I know who work by hand will often say, "I'm not doing anything new; it's all been done before." But that isn't true. Never before have beginning woodworkers had such high expectations and so little training. The masters of the 18th century developed their skills as apprentices in commercial shops where all the tools were sharp. I think making sawhorses is a great place to start developing your skills.

Selecting and Splitting a Log

You don't need a perfect veneer-quality log to make a sawhorse (or a shave horse for that matter). You'll need something at least 30" long. Choose a strong local species, but don't be afraid to try something unfamiliar. Trying to work with different species is an important part of your education.



Anatomy of a good split – always align your wedge with a ray.

Splitting a Log

Splitting a log into pieces is relatively simple. I prefer to start by removing a section of bark along the length of the log where the split will run. Bark can conceal your work.

The first wedge is placed in the sap wood on a ray, (pointing toward the heart. When that crack hits the pith, it may jump to any other ray, leaving you with uneven sections of log. So I tap the first wedge in lightly, then, depending on the size of the log, either set another wedge opposite the first (for smaller logs), rolling the log in the process, or pop a wedge into the end grain a little below the pith (for big logs). A long crack connecting the two wedges may not yet appear. That's fine. A few more firm taps on the first wedge will produce a crack in the sapwood, running lengthwise down the log. Set a wedge just at the end of the crack in the sapwood made by the first wedge.

Now hit all three and see if you can't get a good crack going. Once that crack develops you can lengthen it by adding additional wedges or gluts (wooden wedges) or simply playing leapfrog with your wedges. Don't try to correct a spiraling crack. That's the way the tree grew.

You'll have to sever fibers in the crack with a hatchet. Be careful not to stick your hand in the crack and try not to hit any metal wedges with your hatchet. This operation is one reason wooden gluts are nice to work with.

Continue to split in halves until you are left with a pie-shaped piece that will be approximately 2" thick at the small end and 6" or so inches wide with the sapwood removed for the top of the saw horse. Try to split 2" x 2"s for the legs and try not to use sapwood for them. Now you are ready to build sawhorses.

by Adam Cherubini

Having no power tools, Adam relies on hand saws for the construction of his furniture. You can contact Adam at adam.cherubini@verizon.net

BUILD A SAWHORSE

Begin by bucking your splits into sawhorse lengths and leg lengths. Then, flatten one side of the stock. I used my Grandfather's ship adze, but you could use a plane or hew it with your broad hatchet.

I'm using the technique Roy Underhill discussed, chopping right under the sole of my shoe. I don't do this often enough to be confident, so I proceed with caution. I find the adze to be both rewarding and frightening to use. It's an exhilarating experience – the 18th-century version of bungee jumping.

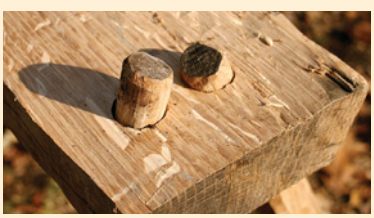
The finished board is now amazingly smooth and flat. The white sapwood is clearly distinct from the heartwood and must go. I'll hew it away with my trusty broad hatchet after I'm done flattening the heart side.

Because of the wide stance or splay, these pieces are the right length for the legs of a knee-high sawhorse (note my accurate knee-high measuring device). Splitting in halves gives nice, even-sized pieces.

With the stock prepared, it's time to attach the legs. I'm boring an $1\frac{1}{4}$" hole, but anything in this neighborhood would work. I eyeball the first hole, then stick a leg in it. Matching the angle of the next hole to the previous leg is pretty easy with this long ship auger. But don't worry if the leg angles vary.

I use my hatchet to rough shape the leg tenons. The fit is perfected with a drawknife. Drawknives are difficult to use without a shave horse but not impossible.

I'm using scrap wood for a sort of bib while holding the stock with my legs. If you weren't convinced that you needed a shave horse before this project, you will be by the time you're finished.



Chamfer the tops of the legs before inserting them to prevent breakout. I prefer to run the legs right through then saw them flush. In time, these legs will shrink and get loose. When that day comes, I'll beat them in a little deeper and maybe wedge them. I see no reason to wedge them now though.

I've moved to the flat floor of my shop to saw the legs and level the horses. With the horse inverted (the protruding tops have been sawn flush already) I measure up from the floor. You'll need a 3'-Starrett machinist's straightedge for this, but I left mine in my other breeches, so I'm using a walnut stick instead. I'll transfer a mark to each corner of each leg and connect the dots with a pencil. Sawing the legs off is easier if you have a helper to hold the legs steady. If the top of the horse isn't flat, it can rock and cause you to cut one leg wrong. To find the problem with your rocking horse, put it on its legs and check each corner of the top with your stick. Before you saw anything, try hitting the offending legs with a maul. With the horse stable, you can check the height above the floor and plane away any high spots. You can saw the ends square if you wish. You should chamfer the top edges and maybe plane the rough hewn edges smooth. I'm so proud of my adze work that I think I'll leave the tops as they are, with no finish. The next time I use linseed oil, I'll have the perfect place to spread out my oil-soaked rags. — *AC*

THE PERFECT CUT

I know you're not dying to learn about sawhorses. And I'd just as soon write about 18th-century carcase construction, or the use of the golden section in Philadelphia's early baroque furniture. But I think we're all better served by focusing on basic skills and developing a more intimate relationship with wood. I can't think of a better way to achieve those two goals than to make a useful set of sawhorses and use them to saw wood by hand.

The trick to using sawhorses is keeping the saw as close to a horse as possible. This allows your effort to go into cutting as opposed to bending the wood. You can also cut faster and more accurately when the stock is held securely.

The height of the sawhorses is important. I like a horse roughly the height of the top of my patella. This way, I'm not crouching in a sort of deep knee bend. In the "over-hand stroke" picture below, notice that both of my legs are pretty straight. Many woodworkers don't give much thought to such things. Then again, most woodworkers plug in their saws. The rip through this 4/4 pine took less than five minutes. But thick hardwoods take considerably longer. So it's good to have sawhorses that are made well and fit your body.

I don't move the horses when I'm sawing. And because I slide the stock across the horses, I prefer that my horses are heavy and stable.

The length of your sawhorse isn't critical. In this column last year, the article "The Plane my Brother Is" (November 2005, issue #151) shows me straddling my horse chopping and making dowels with a dowelling plate. I think it's a good idea to make your horse long enough to do this sort of work.

When ripping long boards, I always place my sawhorses 4-5 feet apart. I begin the cut with just a foot or so of the board overhanging the front horse. As the cut progresses, I push the board forward. Just before the board is ready to fall off the rear horse, I slide the board back and repeat the process at the rear horse.

I usually stand behind the horse, steadying the stock with knee or foot, especially when the sawing is going quickly. But if the stock is thick and hard, you can stand right in front of the rear horse.

To finish the cut I either use an overhand stroke as shown, or turn around and lay a new kerf in the uncut end.

Ripping short stock requires a horse with a broad top. For this reason, I prefer horses without aprons or lower stretchers. Sawing around the splayed legs isn't difficult. One might be tempted to eliminate the splay on one side of the horse. I've tried horses like this and don't care for them. As Ben Franklin once said, "The fool who sacrifices stability for ease in ripping short stock deserves neither." I think it was Ben Franklin. It may have been Shakespeare.

I prefer to crosscut on the bench hook on my workbench. But when the offcut is long or heavy, it's best to use sawhorses. As you can see, both sides of the cut are supported by a sawhorse. In this instance, it's nice to have both sawhorses the exact same height. *Popular Woodworking* editor Christopher Schwarz was taught to kneel on the stock with his left leg, and allow the stock to bump against his right leg. In this way, the stock is completely immobilized and secure. —*AC*

Conclusion

Of course, you could make a pretty good set of sawhorses out of construction lumber and it would probably take you half as long. And you can rip a long board on a table saw pretty quickly, too. But working wood as I have shown should be an important part of every woodworker's education. Although it may not be the most productive method, it helps us develop that intimate relationship with wood that I mentioned earlier. Planing, sawing, and "green woodworking" (as John Alexander, the author of "Build a Chair from a Tree," calls it) are all excellent ways to come to know wood in terms of the strength of its grain, its varying density and its deepest desire to become shaped like a potato chip. These methods help us decide which cuts are good, which species are good, which finishes are good and which joints are good. Yes it's true, you could make a perfectly usable set of sawhorses much faster with construction lumber, and that's what most people do. But I think that's a decision to skip an important, possibly critical class in woodworking.

I don't split wood with axes. I drive in metal wedges and wooden gluts with a 5-pound maul.

Dedication

Rapidly changing light and weather were a brutal master, forcing me to use the utmost haste with little-used, razor-sharp tools to both finish this project and get the pictures for this article. In a flash of inattentiveness, Grandpop's ridiculously sharp adze sank $\frac{1}{2}$" into the side of my shoe's thick leather sole; a near miss. As the project drew to a close, the article almost finished, it was my patternmaker's rasp that drew the only blood I would see. I stared deeply into my wound, and instantly knew what I must do: I wish to dedicate this article to the patron saint of hand tools, Roy Underhill, who, with charm and wit, has inspired countless woodworkers and without whom, this article and indeed this entire column would not be possible. Thank you St. Roy.

Despite chopping toward my foot with an adze, I avoided drawing blood while building my horses – until I picked up my patternmaker's rasp .

For more information read books by Roy Underhill, Drew Langsner, John Alexander and Bruce Hoadley. **PW**

Byrdcliffe Linen Press

Recreating a classic cabinet that breaks the rules of Arts & Crafts.

The history of most pieces of furniture can be traced back to one individual – usually the designer, the maker or the client. The roots of this linen press spread to include a fascinating group of people at an early 20th-century art colony known as Byrdcliffe, located near Woodstock, N.Y.

With its carved door panels and distinctive colors, this unusual cabinet is one of the finest examples of the Arts & Crafts period. The basic form can be traced back to English designs of the period, but the stylized carving and overall proportions make it unique. The original is part of the collection of the Metropolitan Museum of Art in New York.

Fewer than 50 pieces of furniture were made at Byrdcliffe between 1903 and 1905. Fewer than half of those found buyers; the remaining pieces were found in various buildings at the colony after the 1976 death of the founder's son. Many of these had been left unfinished, the idea being that the buyer could choose a color when purchasing.

The Cast of Characters

Byrdcliffe was founded and financed by Englishman Ralph Radcliffe Whitehead. He inherited the family's felt fortune at age 32, and was a follower of John Ruskin. Although not an artistic man himself, he married a painter, and enjoyed the company of many prominent artists and intellectuals.

In the early 1890s, he wrote about an idealized community of artists, but didn't act on these plans until the birth of his two sons gave him a desire to do something useful with his fortune. He purchased 1,300 acres of land, built about 30 buildings, including a well-equipped woodshop and surrounded himself with a talented group of artists and writers.

Although Whitehead held artists in high esteem, he had a rather low opinion of craftsmen. In his written plan for his community he stated: "Now, in order to have anything good made in stuff, or in hard material, we must seek out the artist to provide us with a design, and then a workman to carry it out as mechanically as possible, because we know that if he puts any of his coarser self into it he will spoil it."

Who actually made and carved the furniture produced at Byrdcliffe is not known. Apparently there were several different cabinetmakers, as the quality of construction varies from piece to piece. Although Byrdcliffe was intended to be self-supporting, Whitehead was wealthy enough to abandon the furniture-making part of his plan after a little more than a year of dealing with the "coarser" workmen.

Many of the artists in residence created furniture designs. Apparantly Whitehead selected a general form, and drawings were made by individual artists. Decorative panels were a common feature, although most were painted, not carved. Among the most talented designers at Byrdcliffe were Edna Walker and Zulma Steele. This piece was designed by Walker.

The designs by Walker and Steele are the most beautifully proportioned and distinctive pieces of Byrdcliffe furniture. This cabinet in particular is a refreshing break from the mass and machismo of many Arts & Crafts pieces.

100 Years Later

Usually when I make a reproduction of an existing piece I try to stay as close as possible to the original. In building this cabinet, however, I had to make some guesses, and I made a few changes to suit my own taste. I had only a photograph of the front of the cabinet and overall dimensions to work with, so the layout of the side

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Photo by Al Parrish

panels and the details of construction are my best guesses.

In the original, the carvings are very flat. They are simply outlines of leaves and branches with the edges rounded over. I originally carved the panels this way, but just wasn't happy with the effect. I thought they seemed rather lifeless and static, so I recarved the panels and added more relief.

Additionally, the crown moulding on the original comes flush to the bottom edge of the top, apparently attached to the edges. The closest router bit I could find (Freud 99-406) had a small fillet at the top. I thought this looked nicer, and rather than wrap the crown around the perimeter of the top, I set it below, letting the top overhang by 1/8". This added one more shadow line, and if the top expands or contracts, then the joint between the moulding and the top won't show.

The third change was to the color. The oranges and reds on the panels are the same as the original, but the green stain is darker and deeper in color. The finish on the original varies in color, and I suspect that it may have faded or been refinished at some point. I decided to use a richer forest green, similar to a color that can be seen in another Byrdcliffe piece, a fall-front desk designed by Steele.

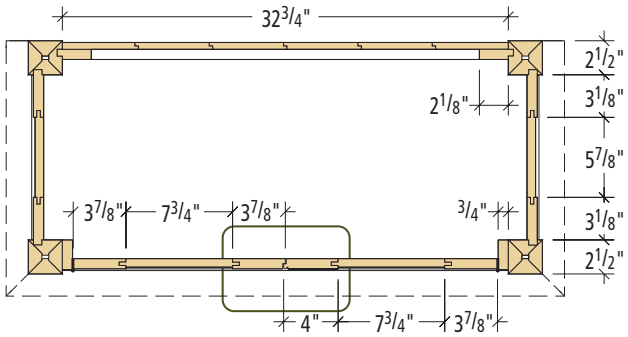
Oak and (not) Sassafras

Like the original, the visible parts of this cabinet are made of quartersawn white oak. The carved panels are often described as being made from sassafras, but they are obviously not. The carving depicts the leaves of a sassafras tree and in the original the panels are either poplar or basswood. I used basswood for the carvings, soft maple for the drawer boxes, and poplar for the interior web frames and back of the cabinet. The dust panels are birch plywood.

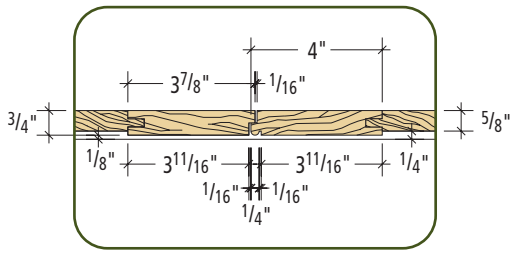
BYRDCLIFFE LINEN PRESS

	NO.	ITEM	DIMENSIONS (INCHES) T	W	L	MATERIAL	COMMENTS
CARCASE							
❑	8	Leg front & back	1	2 1/2	54 1/4	Quartersawn white oak	Miter long edges
❑	8	Leg sides	1 1/8	2 1/2	54 1/4	Quartersawn white oak	Miter & rabbet long edges
❑	4	Side panel stiles	3/4	3 1/2	44 1/2	Quartersawn white oak	
❑	2	Side panel top rails	3/4	6 1/2	8 3/8	Quartersawn white oak	1 1/4" TBE
❑	2	Side panel middle rails	3/4	5 1/8	8 3/8	Quartersawn white oak	1 1/4" TBE
❑	2	Side panel bottom rails	3/4	3 5/8	8 3/8	Quartersawn white oak	1 1/4" TBE
❑	2	Lower arched rails	7/8	5 1/8	8 3/8	Quartersawn white oak	1 1/4" TBE
❑	2	Top side panels	5/8	6 7/8	13	Quartersawn white oak	1/2" TAS
❑	2	Bottom side panels	5/8	6 7/8	18 1/4	Quartersawn white oak	1/2" TAS
❑	1	Top	3/4	18 3/4	41	Quartersawn white oak	
❑	1	Front top rail	7/8	2 5/8	34 3/4	Quartersawn white oak	1" TBE
❑	2	Drawer rails	7/8	1 1/4	34 3/4	Quartersawn white oak	1" TBE
❑	1	Bottom front rail	7/8	1 3/8	34 3/4	Quartersawn white oak	1" TBE
❑	1	Bottom apron	3/4	6 3/4	34 3/4	Quartersawn white oak	1" TBE
❑	2	Stiles @ doors	3/4	2 3/16	19 3/4	Quartersawn white oak	
❑	2	Stiles @ top drawer	3/4	2 3/16	7 1/2	Quartersawn white oak	
❑	2	Stiles @ bottom drawer	3/4	2 3/16	8 1/2	Quartersawn white oak	
❑	1	Drawer rail support	3/4	1 3/8	32 3/4	Quartersawn white oak	
❑	2	Fill behind crown	3/8	1 5/16	12 1/8	Quartersawn white oak	
❑	1	Fill behind crown	1/4	1 5/16	32 3/4	Quartersawn white oak	
❑	6	Web frame stiles	3/4	2 1/2	35 1/2	Poplar	
❑	9	Web frame rails	3/4	2 1/2	10 7/8	Poplar	3/4" TBE
❑	4	Web frame panels	3/4	10 3/8	14 3/4	Plywood	
❑	2	Crown moulding	1	2	48	Quartersawn white oak	
DOORS							
❑	2	Door hinge stiles	3/4	3 7/8	19 3/4	Quartersawn white oak	
❑	1	Left lock stile	3/4	3 7/8	19 3/4	Quartersawn white oak	
❑	1	Right lock stile	3/4	4 1/8	19 3/4	Quartersawn white oak	
❑	2	Door top rails	3/4	3 7/8	9 3/4	Quartersawn white oak	1" TBE
❑	2	Door bottom rails	3/4	3 7/8	9 3/4	Quartersawn white oak	1" TBE
❑	2	Door panels	5/8	8 3/4	13	Basswood	1/2" TAS
DRAWERS							
❑	1	Top drawer front	3/4	7 1/2	31 1/4	Quartersawn white oak	Opening size trim to fit
❑	1	Bottom drawer front	3/4	8 1/2	31 1/4	Quartersawn white oak	Opening size trim to fit
❑	2	Drawer sides	3/4	7 1/2	14 1/4	Maple	Dovetailed to front
❑	2	Drawer sides	3/4	8 1/2	14 1/4	Maple	Dovetailed to front
❑	1	Drawer back	3/4	7 1/2	32 3/4	Maple	In dado in sides
❑	1	Drawer back	3/4	8 1/2	32 3/4	Maple	In dado in sides
❑	2	Drawer bottoms	1/4	14 1/2	30 3/8	Plywood	
❑	4	Drawer runners	1	1 1/2	14 1/4	Quartersawn white oak	3/4" TOE
BACK							
❑	3	Back frame rails	3/4	2 1/2	30	Poplar	3/4" TBE
❑	3	Back frame stiles	3/4	2 1/2	43 3/8	Poplar	
❑	2	Back planks	1/2	4 7/8	43 3/8	Poplar	1/4 " rabbet one edge
❑	4	Back planks	1/2	4 7/8	43 3/8	Poplar	1/4 " rabbet both edges

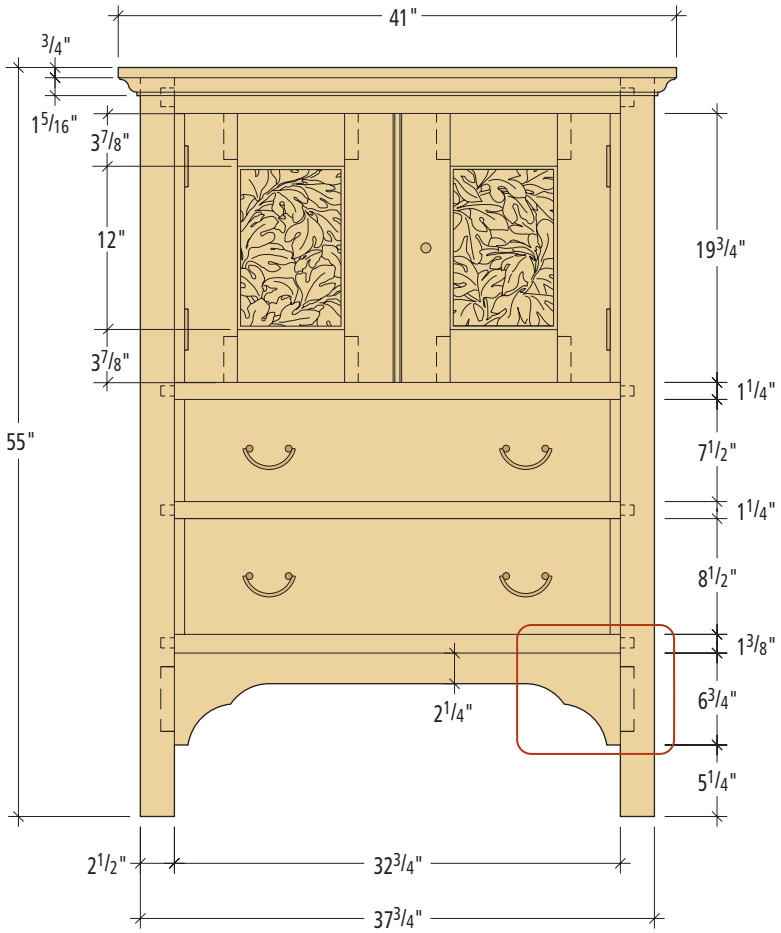
TBE = Tenon Both Ends; TAS= Tenon All Sides; TOE= Tenon One End



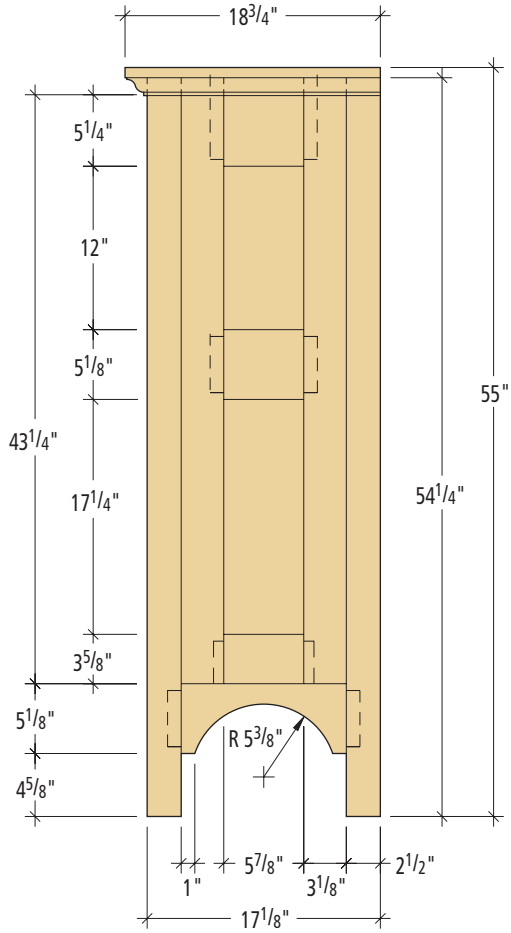
Plan section at doors



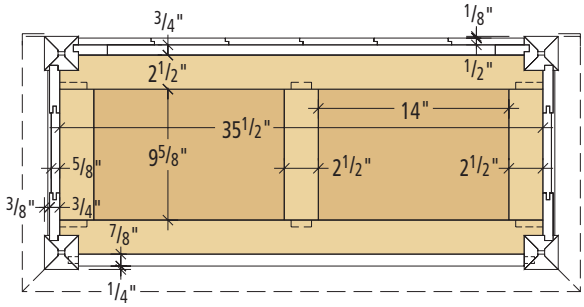
Door stile detail



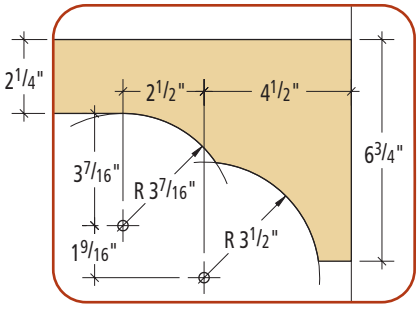
Front elevation



Side elevation



Web frame & dust panel plan



Apron detail

I brought the rough white oak into the shop and let it acclimate while I worked on carving the panels (below). I'm a decent carver, but not a fast one, so the oak had plenty of time to adjust. *Popular Woodworking* will be running some articles in the coming months on basic carving techniques, and full-size patterns for the panels are available in pdf format from our web site, popularwoodworking.com. Click on "Magazine Extras" in the menu bar on the left side of the page.

I gave the completed panels a thin coat of blonde shellac before coloring them with watercolor pencils, available from any artist's supply store. The colors are applied dry, then blended with an artist's brush dipped in water. I let the panels dry for several days, then gave them two coats of amber shellac to seal in the color and warm up the background.

The Real Work Begins

I milled all of the oak parts slightly oversized, and let them sit for a few days before planing them to finished dimensions. Absolutely straight stock is essential for a project like this. The side panels are all joined with mortises and tenons. Once these were assembled, I cut a rabbet on the long edge of each panel so that the faces of the stiles fit in a stopped groove cut in the legs as seen at right (next page). This makes the sides of the case very strong, and if the stiles shrink in width over time, the joints won't open up.

The web frames and dust panels are also mortise-and-tenon construction. I clamped the stiles together to lay out the mortises and then realized that leaving them clamped together would provide a stable base for the small plunge router I used to cut the mortises (above).

A group of stiles for the web frame is clamped together to lay out the joints. Leaving the stack clamped together provides a stable base for the router used to cut the mortises.

Impossible Legs

Like a lot of Arts & Crafts furniture, the legs are an important element. The problem with quartersawn oak in this situation is two-fold: Thick stock usually isn't available, and the edge grain is ugly compared to the face grain. There are several ways to work around this, and the method I

DOORS CARVED, THEN COLORED

After tracing the pattern on the basswood panels, the design of sassafras leaves is carved.

The completed carving is given a wash coat of shellac, then colors are applied with watercolor pencils.

The colors are blended with an artist's brush dipped in water.

After the coloring is complete, the panels are allowed to dry several days before being finished with amber shellac.

The side panels are assembled as a unit, then fit in a groove in the leg, and butted at the bottom to the thicker arched rail.

developed shows quartersawn figure on all four faces of the legs, and is relatively simple to mill and assemble.

I could have laminated the legs from thinner stock and then veneered the edges, but I have seen too many old pieces constructed this way that have cracks in the veneer. Quartersawn wood moves more in thickness than in width, so there's a good chance that this method will eventually fail.

The web frames are notched around the legs and attached to the side rails with pocket screws. The front and back edges will be glued to the rails as they are assembled.

Mitering four pieces together is a logical alternative, but without some way to keep the pieces from sliding during glue-up, assembly can be very difficult. In the early 1900s, Leopold Stickley developed a method that used rabbeted miters to form what he called a quadralinear leg. It's a good method, but without the custom-made shaper cutters he used it is difficult to mill.

Looking for a simpler method, I realized that by making the front and back pieces of the legs a different thickness than the sides, I could make two of the pieces with simple miters, and use a small rabbet on the thicker pieces to keep the parts from sliding during assembly. The photos on pages 40-41 show the steps I took.

When I had the legs assembled, I used a plunge router with a fence to cut the stopped grooves for the side and back panels, then laid out and cut the mortises in the front legs for the rails at the front of the carcase.

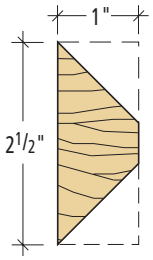
The side panel assembly is placed in the groove in the leg, and the arched bottom rail is placed in its mortise. The two pieces are then glued and butted together where they meet before the second leg is put in place. With the left and right leg and panel sides together, the entire carcase can be assembled.

With one side panel and leg asssembly face down on some horses, I notched the corners of the web frames around the legs, and held them in place with pocket screws. The back frame was then put in the groove in the rear leg, followed by the front rails in their mortises. The butt joints between the rails and the front edge of the frames were glued and clamped at this time, as were the joints between the web frames and the back frame.

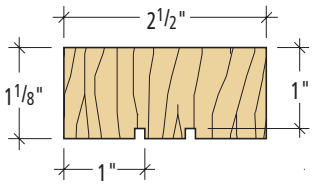
Putting the second leg and panel assembly on is straightforward, but there are a lot of parts that need to come precisely together. I made a dry run, and then got some help to fit it all together and apply the clamps.

Several joints must be fit at one time as the second panel and leg assembly is put in place. Get some help so both sides can be fit and clamped at the same time.

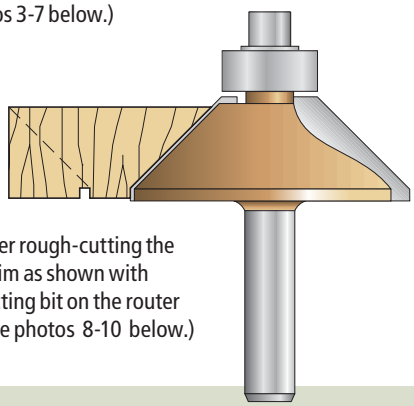
MAKING THE LEGS



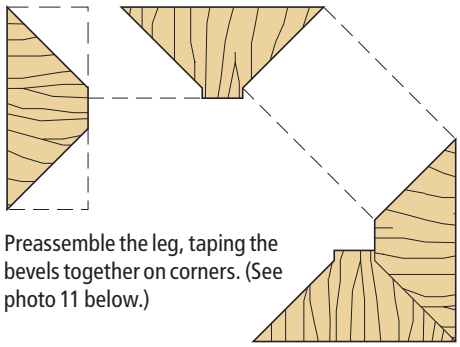
First, bevel the edges of the thinner piece without reducing the width. (See photos 1 and 2 below.)



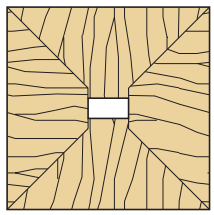
Second, cut grooves in the bottom of the thicker piece. (See photos 3-7 below.)



Third, after rough-cutting the bevels, trim as shown with bevel-cutting bit on the router table. (See photos 8-10 below.)



Preassemble the leg, taping the bevels together on corners. (See photo 11 below.)



The assembled leg shows quartersawn figure on all four faces. (See photo 12 below.)

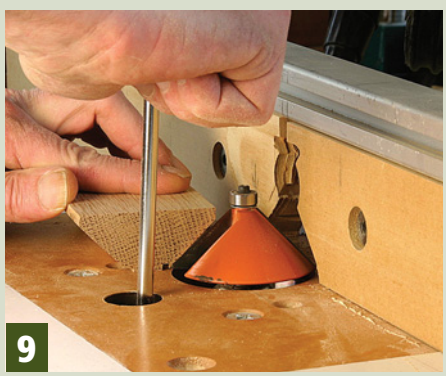
After ripping all the parts to finished width, cut a 45° bevel on both long edges of the thinner parts. Cutting the second bevel brings the part to its finished width.

Be careful ripping the second bevel. After the leading edge clears the blade, use a push stick centered in the stock's width to move the material past the saw blade without tilting it.

Set up to cut the grooves in the bottom of the thick pieces. With a thin piece of scrap against a thicker one, draw a line to indicate the difference in thickness. Flip the thicker piece over and use the pencil line to set the height of the saw blade.

With the blade height and fence settings adjusted, cut two grooves in the back of the thicker leg parts.

After the grooves are cut, the saw is again tilted to 45° and the waste is removed. Leave about 1/4" of flat on the edge to ride against the router table fence.



The 45° bevel bit is set to intersect the corner of the groove and the edge of the workpiece. The goal is to create the bevel without reducing the width on the face of the piece.

Not Done Yet

Usually, getting the carcase assembled means that the end is in sight, but this cabinet contains several details that require additional work. Much of the interest of this design comes from the varying setbacks of the faces of the parts, particularly those on the front elevation.

The side panels are set back 3/8" from the face of the legs, and the arched rail below it is 1/8" thicker. On the front of the cabinet, the rails are back 1/4" from the legs. At the top of the cabinet, filler strips were glued on so the back of the crown moulding would be flush with the outside edges of the legs.

The lower front rail and the stiles for the door hinges are 1/16" back from the rails, as are the vertical pieces beside the drawers.

The hinge stiles allow the doors to swing clear of the legs, and this detail is seen in many pieces of Arts & Crafts furniture. The doors and drawer fronts are 1/16" back from the front edge of the stiles. On the doors this offset is accomplished when locating the hinges. The placement of the stopped groove in the side of the drawer boxes locates the face of the drawer fronts.

The drawers and drawer fronts are fit before finishing the cabinet. After hanging the doors, I mark where the right door overlaps the left before cutting the rabbet.

4

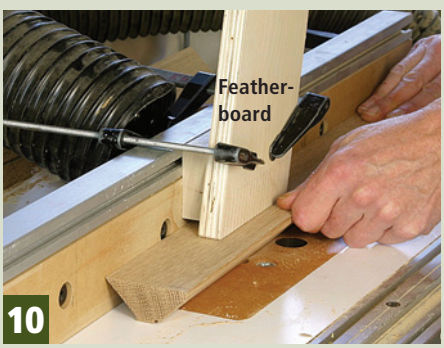
Set the distance from the blade to the fence by lining up the edge of a thin piece of stock to the left side of the blade. I use the saw cut in the table saw's zero-clearance insert as a guide.

5

Make some test cuts in scrap. Check the width of the groove by placing the edge of the scrap against the fence, and a thin piece of scrap on top. When the corner of the thin piece meets the far edge of the groove, the fence is set correctly.

6

Check the depth of the groove by placing a thin piece on the saw table, and butt the thicker piece against it. The face of the thin piece should meet the bottom of the groove.

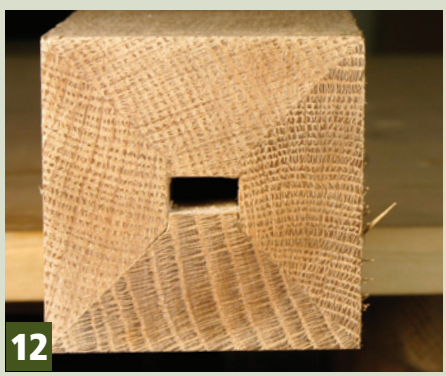


10

After making some test cuts and fine tuning the router table setup, the edges are beveled. The block behind the featherboard holds it away from the fence, so it is pushing down on the narrow flat left between the two bevels.

11

After all the parts are milled, I assemble the corners and hold them together with packing tape. All but the last corner is taped before gluing. I then flip the taped parts over, put glue on the edges, then fold the parts back together, taping the last corner.



12

The completed legs have a small rectangular hollow in the center, and show quartersawn figure on all four sides. This is a stable assembly, relatively quick to make and easy to assemble.

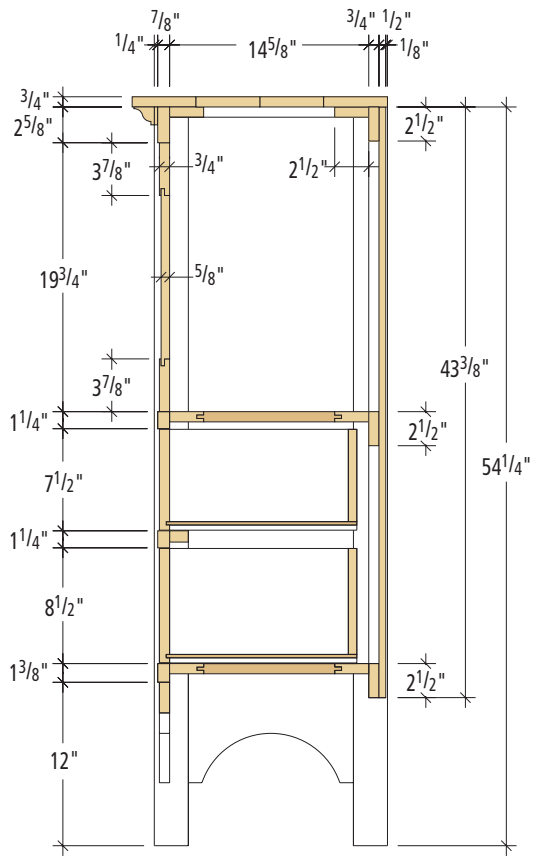
The drawer runners have a tenon on the front end that fits in a mortise in the stile. These are placed in position before the stile is glued in place.

The back of the drawer runner is screwed to the back leg after being squared to the front of the cabinet. A groove in the side of the drawer box lets the drawers slide nicely.

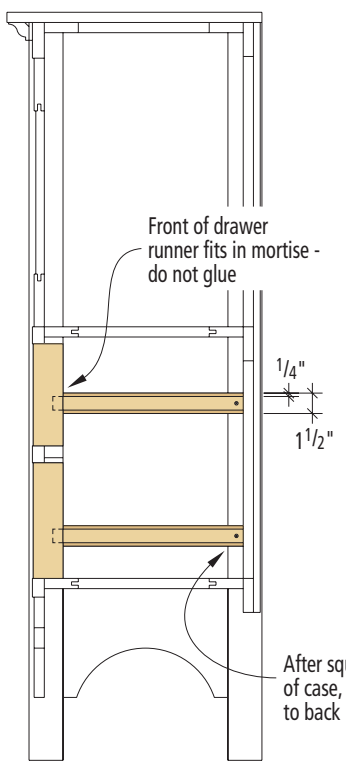
The stiles for the hinges were cut and put in place, and the doors were assembled without glue so that all of the cutting for the hinge mortises could be done conveniently. Once I was satisfied with the fit of the doors, I marked where the right door overlaps the left, took everything apart and then glued the hinge stiles in place.

Drawer Runners

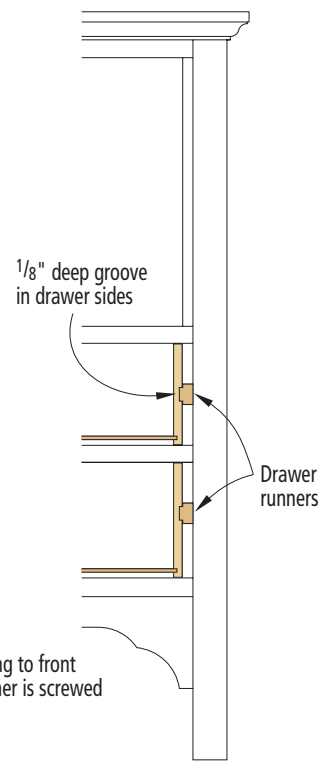
The drawers are rather wide, so I decided to use wood runners to guide them in and out without the bottoms of the drawer box sides rubbing on the web frames or the front rails of the cabinet. At the front of the cabinet, the runners fit loosely in mortises in the stiles beside the drawers. At the back, the runner is held to the back leg with a screw. This method allows minor adjustments to be sure that



Cabinet section



Drawer runner detail



Drawer runner detail

the runner is square to the face of the cabinet.

After securing the runners, I used a plunge router with a fence attached to cut the grooves in the sides of the drawer boxes. Squaring the ends of the grooves with a chisel and some test fitting allowed me to fit the drawer fronts precisely. I rubbed a pencil on the edges of the runners and moved the drawers in and out several times. This marked any high spots on the runners and the grooves. I used a shoulder plane to fine-tune the fit of the drawers and runners. I then rubbed a block of paraffin on the runners to let the drawers move effortlessly.

I fit and mitered the three pieces of crown moulding together, and attached them as a unit to the cabinet. I glued the front edge in place, and attached the returns to the sides of the cabinet with a few 23-gauge pins. The top is attached to the cabinet with pan head screws through the web frame in oversized holes from below. With everything complete and fitted, I hand sanded the entire cabinet to #150 grit before staining.

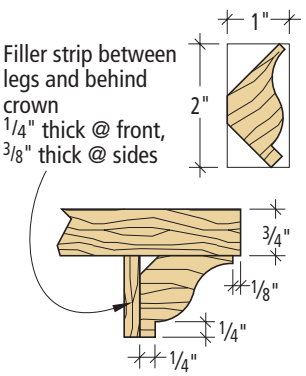
It's Not Easy Being Green

At the art supply store, I picked up two 1.25 oz. tubes of artist's oil color; one phthalo blue and one chrome yellow. To make the green stain, I mixed half of each tube together with a pallet knife on a scrap of wood and added this to a pint of natural Watco Danish Oil, an oil/varnish blend. While stirring the mixture I added one-third of a pint of mineral spirits. This turned out to be twice as much liquid as I needed, but it's better to have too much than to run out halfway through.

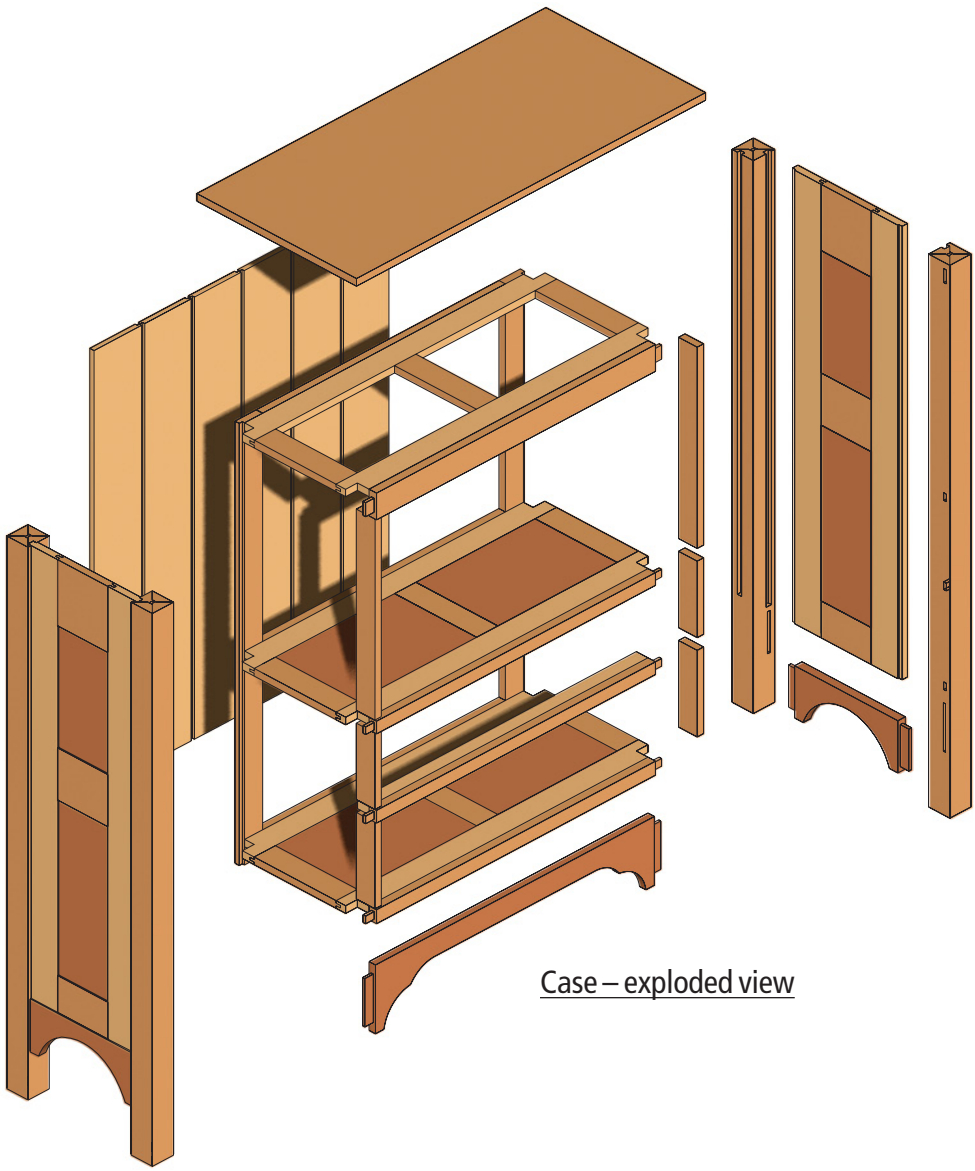
I applied this stain to the cabinet, saturating the surface. After letting it sit for 15 minutes, I wiped off the excess with a clean rag and allowed the stain to dry overnight. I dissasembled the doors and stained the stiles and rails separately before gluing them together so that I wouldn't get any stain on the finished panel.

The stain dries to a rich deep color and leaves some pigment in the open pores of the oak. The stain was followed with a coat of natural Watco. This coat was rubbed on sparingly with a rag. This tends to float the color off the harder, smoother areas, changing the color to more of an olive tone and highlighting the flakes and rays of the quartersawn oak. This coat was allowed to dry on the surface for 48 hours, and then the cabinet was scuffed with a Scotch-brite pad.

Some areas were a little too green, so I used some medium walnut Watco in those areas, carefully blending the color. This was allowed to dry on the surface overnight, and once dry these areas were scuffed with the abrasive pad. The entire cabinet was then given two additional coats of natural Watco, followed by a coat of paste wax.



Crown moulding



Case – exploded view

The stain, a mixture of artist's oil colors and Watco Danish Oil is liberally applied. After letting it soak into the surface for 15 minutes the surface is wiped dry.

After staining, the wood is a rich green color and the open pores of the wood are filled with pigment.

I finished the inside of the cabinet with shellac, then installed the shiplapped back planks, screwing them at top and bottom to the cross rails of the back frame.

I wanted the hardware to look old, so I soaked it in lacquer thinner and scrubbed the finish off with a nylon abrasive pad. I then put the parts in a plastic container along with a smaller container. I poured some ammonia into the smaller container, and put the lid on the larger one. Fumes from the ammonia oxidized the hardware in a few hours, giving me the patina I wanted.

I hung the doors on the cabinet, used a pair of ball catches at the top to keep them closed, and installed the pulls and knob.

SUPPLIES

Whitechapel Ltd.
800-468-534 or
whitechapel-ltd.com

4 • 3" x 1 5/8" butt hinges
#205H1, $5.28 ea.

4 • polished rosette pulls
#5PR14, $12.11 ea.

1 • hollow brass knob
#98KSB9, $5.48

Lee Valley
800-871-8158 or
leevalley.com

2 • ball catches
#00W12.01, $1.80 ea.

Cornell University
museum.cornell.edu/byrdcliffe/

• Byrdcliffe: An American Arts & Crafts Colony, online exhibition

Prices correct at time of publication.

Post Script

As a commercial enterprise, the furniture made at Byrdcliffe was a dismal failure. As examples of fine design, however, they were a tremendous success. In making this piece, I wanted to add the finest craftsmanship I could to this wonderful design, paying some respect to the anonymous craftsmen that Ralph Whitehead assumed would spoil the work if left unattended.

I knew I had succeeded when I showed my wife the finished cabinet. She looked at it for a while and then said, "It's like looking through pine trees on the edge of a forest on a perfect day in the fall." When craftsmanship evokes poetry, it's been a pretty good day. **PW**

The stain is followed by a coat of natural color Watco, which lightens the color and highlights the figure of the quartersawn wood.

WOODWORKING ESSENTIALS

BY DAVID THIEL

CHAPTER 5

Casework Construction: Doors and Drawers

Casework, by its very nature, exists for storage. That storage can range from china to rare books, or simply be a place for your children to store their puzzles or you to file your bills. Regardless of the ultimate purpose, casework storage frequently requires hiding the stored materials from view for aesthetics or need. That aesthetic leads us to the topic of this chapter: doors and drawers.

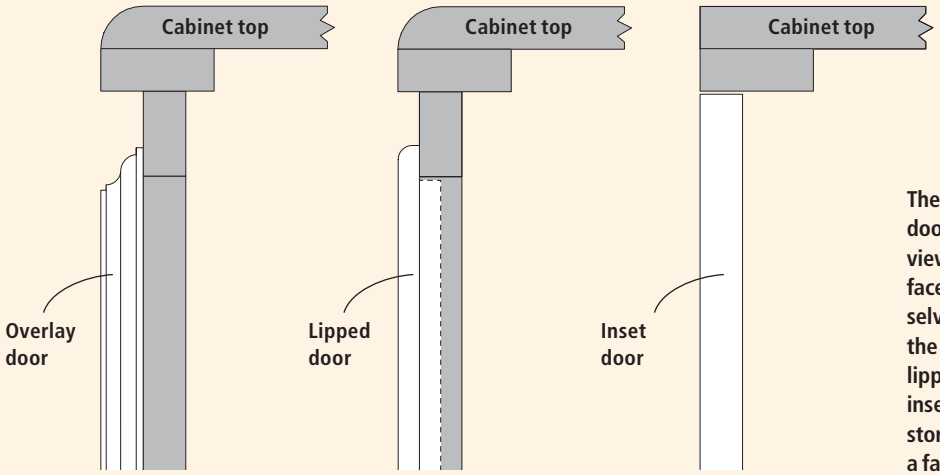
If a cabinet is shallow in depth, simple shelving is a practical method of storage. By adding doors to some or all of the storage areas in the cabinet, the storage is kept tidy to the casual view even if things inside the cabinet are anything but orderly.

If a cabinet is deeper it offers a greater capacity for storage, but the depth makes it difficult to access items that are stored (or accidentally pushed) to the rear of the cabinet. This is when drawers can be valuable. They allow you to store items the full depth (and height) of the cabinet in a tidy fashion, but still allow access to everything with little fuss. Yes, building drawers does complicate the case construction process, but there's little doubt that the extra work is worth the effort.

Depending on the style of the case the doors and drawers can be complex, both in appearance and construction, or very simple. Most traditional case furniture designs involve frame-and-panel doors that are a small construction project in their own right. Add to that the edge profiles commonly added to drawer fronts and doors, and these storage accessories often carry the larger weight of the final design of the piece.

When a more clean, contemporary look is the goal, doors and drawers are usually required to essentially disappear and blend in to the casework with as little adornment as possible. That

Shown are a pair of inset drawers designed to close with the drawer fronts flush to the front of the cabinet. The top drawer uses traditional half-blind dovetail joinery to attach the front to the drawer sides. The lower drawer uses more contemporary and commercial rabbet joinery to attach the front. Both styles allow the primary drawer wood (walnut in this case) to be viewed, but the secondary (white pine) wood on the sides remains hidden.



The three illustrations at left show an overlay door, a lipped door and an inset door. The views are side sections of the cabinet top and face frame (shown in gray). The doors themselves are shown in white. The overlay makes the cabinet slightly more shallow, while the lipped door gains some interior depth. The inset door allows the most amount of interior storage and makes it possible to build without a face frame on the cabinet.

sounds easy but in practice allows less room for error.

We're going to discuss different types of doors and drawers used in case furniture, as well as take a look at the most common joinery methods to create both. We'll also discuss the proper fitting of doors and drawers, but we'll save the hardware used to attach them until the next chapter.

Fitting the Cabinet

Before we get into details on doors and drawers, let's take a look at a generality for both categories that needs to be addressed. Both doors and drawers can fit into a cabinet in three ways: overlay, lipped or inset.

These fittings are a function of both design and application. But that's not to say that one style fits only one type of furniture design. Inset doors and drawers can be found on contemporary furniture as well as Shaker furniture. But their location does affect the appearance of the piece.

The storage aspect is small, but interesting. Both overlay and lipped doors and drawers are designed for use with face-frame cabinets. The frame itself constrains the size of the opening for accessing the storage space. By using a lipped door or drawer you can gain about 3/8" of storage depth in the cabinet. Again, not huge, but it's extra storage.

The inset door can also be used with a face frame cabinet, but its most significant advantage is obvious in contemporary frameless cabinets. The inset door allows full access to the top and bottom of the cabinet opening, and can offer a clean, finished look.

Any type of drawer or door construction can be used in any of the three designs, so as we move on to discuss the different doors and drawers we aren't going to focus on that detail, but look more closely at the construction itself.

Drawer Types and Joinery

We're going to focus on three types of drawer joinery for this article: dovetails, rabbets and down-and-dirty butt joints. While there are probably dozens more to discuss, these three versions comprise 90 percent of the drawers used in case construction. The purpose of this chapter isn't to show you how to build each drawer, but rather discuss the benefits (and deficits) of each. We will drop a few hints we've learned over the years that will make construction easier.

Dovetails

The first type of drawer is a dovetailed drawer. As mentioned earlier these drawers can be made as overlay, lipped or inset and except for odd occurrences the front joint is traditionally a half-blind dovetail, while the back joint can be either a half-blind or a through dovetail. Half-blind dovetails are more difficult to create because you're carving out a precise three-sided alcove rather than just cutting a two-sided channel. The half-blind type is necessary, however, if you want to see only the primary wood at the front of the cabinet. There's always more than one way to skin a cat, and the

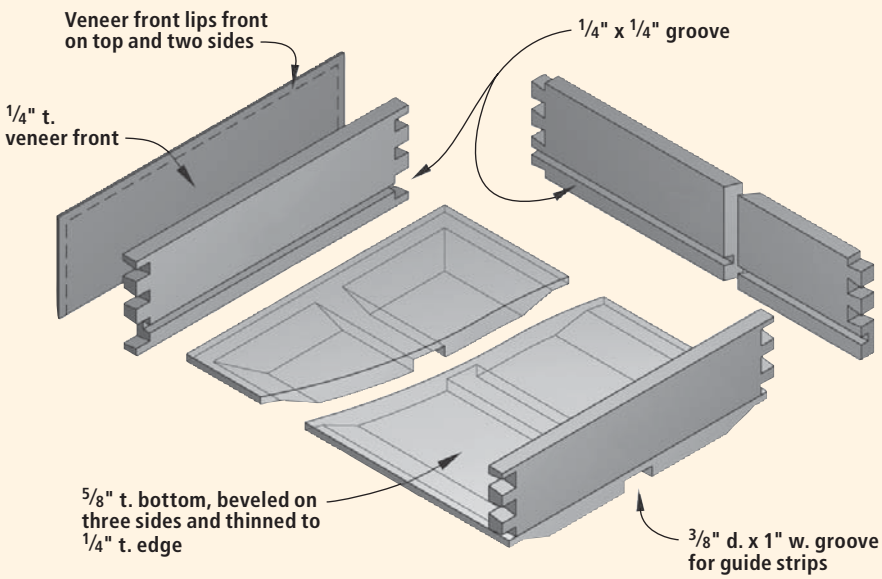


Illustration by John Hutchinson

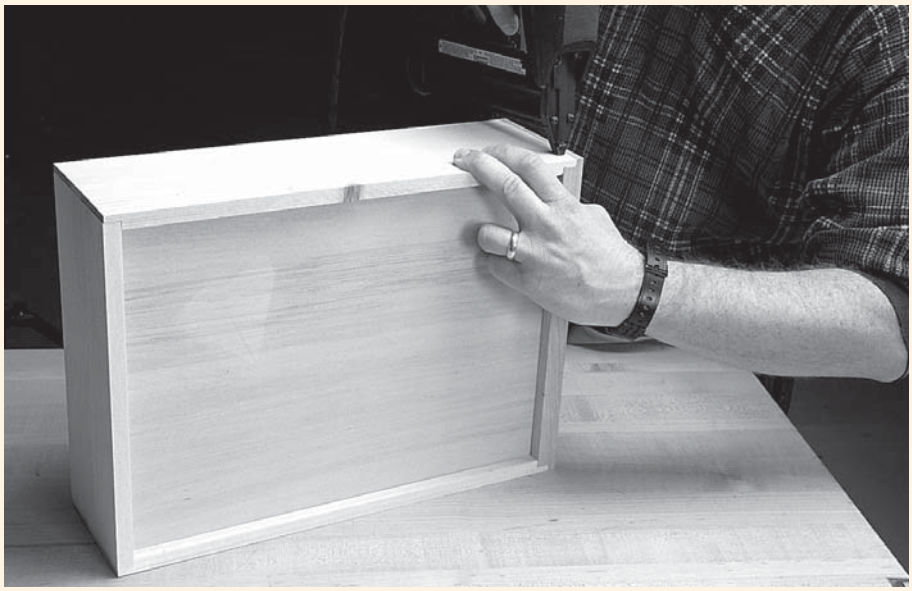
This drawing shows a typical dovetailed drawer, but with a twist. Through dovetails are easier to cut than half-blind dovetails. So in this case the drawer is made with through dovetails and a veneer front is added to make the front look like half-blind dovetails.

illustration below left shows a trick to make half-blind dovetails easier.

Dovetails are used for drawers because of the great strength offered by the interlocking joint. This is important in a drawer because as the loaded drawer is opened and shut, lots of stress is transferred to the front and back pieces of the drawer as the contents shift against the motion. The interlocking dovetail provides better strength than any other drawer joint. And, of course, they look great, are very traditional and continue to be a hallmark of quality woodworking.

If you plan on making dovetailed drawers there are two general methods of creating the joint available to you. You can cut the joints by hand or you can use a commercial dovetail jig used together with a router. Both will create dovetails and both have learning curves to surpass.

But once you've passed the learning part, which do you use routinely? The answer may be the method you enjoy most, but my rule of thumb is that if I'm going to make one or two drawers for a project, then hand-cutting dovetails is just as fast and effective. If you're making a bank of drawers for a dresser, break out the router and jig!



Two rabbeted joints are shown on this drawer. Simple in the back, with the rabbet cut only in the sides, while the front joint incorporates a dual-rabbet joint. In either case a nail (with glue, of course) will make the joint much stronger.

Rabbets

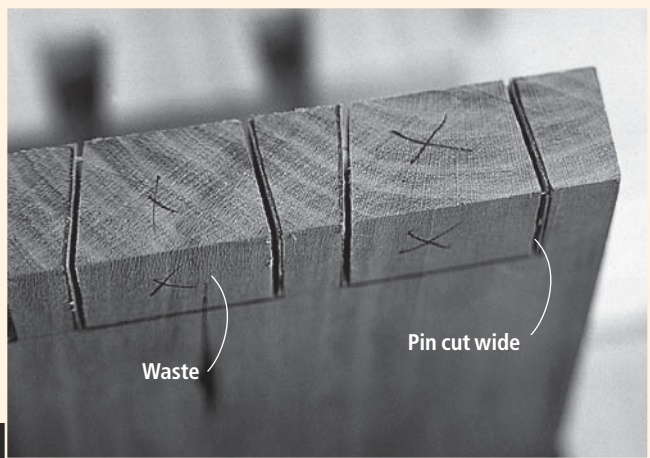
The second drawer type we'll look at is a more commercially applicable drawer with rabbeted joinery at front and back. While a rabbet joint is more simple to create than a dovetail joint, it also offers less strength and is frequently reinforced with both glue and nails.

While I'm referring to this drawer style as more commercial, I also consider it a perfectly adequate drawer joint for any number of case furniture pieces that you would build for your home or office. Beyond the issue of strength, a rabbet joint isn't as attractive as a dovetail. When looks and strength are preferred, whether in kitchen cabinets or china cabinets, dovetails are just right. There are a couple of different ways to approach the rabbet joint. The simplest is to cut a rabbet on the inside edge of both ends of the drawer front and back and leave the sides straight. While you want to leave the primary wood running across the front of the drawer, you can vary the location of the rabbet at the back. In either case, you want to make sure you're nailing the joint through the drawer sides into the front and back pieces to provide the greatest strength.

Another option is to rabbet both pieces so they overlap in both directions adding more gluing surface in the joint. This variation is shown at the front joint on the drawer above, while the simpler single rabbet joint is used at the rear of the drawer.

Another rabbeting option that I like is a one-setup joint. Using the simple rabbet joint at both the front and rear of

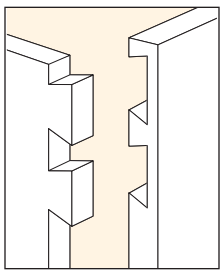
Two good tips for hand-cutting dovetails. The photo at right shows how cutting your pins just slightly wide of the line will force them to compress the tails cut from softer wood. The photo below shows the benefit of using a coping saw to clean out waste between the pins. The saw lets you cut right up to the corner cleanly.



Drawer Joinery

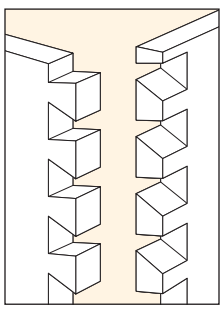
Half-blind Dovetail

The preferred joint for drawer fronts, providing strength and a quality finished appearance. But also the most difficult to create.



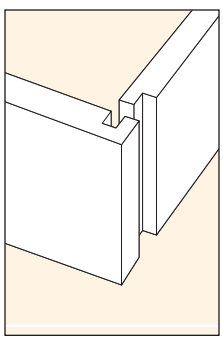
Through Dovetail

Through dovetails also provide good strength, but the joint is visible from both sides making it preferable for drawer backs, not fronts.



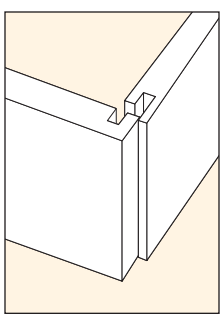
Tongue & Rabbet Joint

A good interlocking option that requires less skill to create than a dovetail. The tongue would be on the side piece, and nails and glue are required.



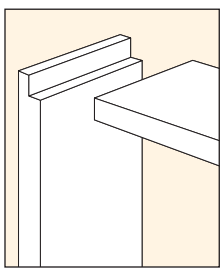
Locking Rabbet Joint

By adding another interlocking element, this joint gains strength by adding gluing surface – as well as an extra step to create.



Rabbet Joint

A simple, but effective drawer joint, the rabbet increases gluing area and adds strength against racking. Glue and nails are a must with this joint.



the drawer and a 1/4"-, or 1/2"-thick bottom, the drawer can be created with only one setup on the table saw. All you need is a dado stack. (See the step illustrations below.)

■ Butt Joints

I also want to discuss a third option, the butt joint, that is more utilitarian and serves well in shop furniture for its ease of production and lack of hardware.

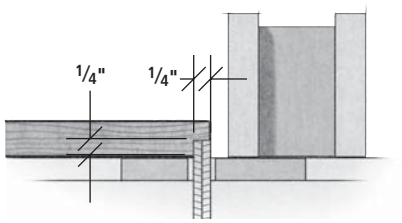
While a butt joint is by far the weakest drawer joint possible, if appearance is way down on the importance list while expediency is high, this joint can serve well when backed up with nails.

The drawers shown above have the benefit of using no machined joinery. The four sides are nailed together and the bottom is nailed to the drawer box. The only joinery occurs in the cabinet itself where dados serve as the drawer runners. Simple, quick and efficient.

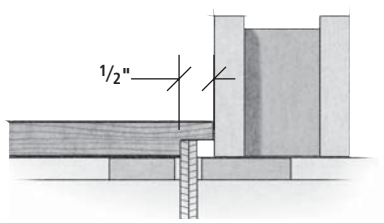
One last drawer comment. Another way to make a drawer is to build a drawer box (front, back, two sides and a bottom) using whatever joinery method you prefer, and then add a drawer front to the box. This makes it easier to fit the front without having to fight with the drawer itself and offers other fun alternatives. These are called "false-front" drawers.

These no-joinery/no-hardware drawers make great utility drawers. The drawer sides are simple butt joints glued and nailed together. The bottom is cut oversized to either side of the drawer to form a tongue that fits into dados in the cabinet sides. A little wax on the tongues and they work very well. The hole in the front even removes the need for a handle. And they're really fast to make!

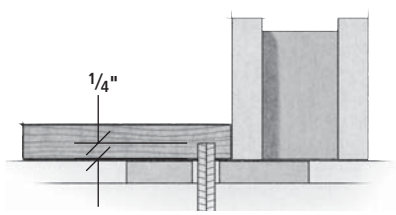
Building a Drawer with One Setup



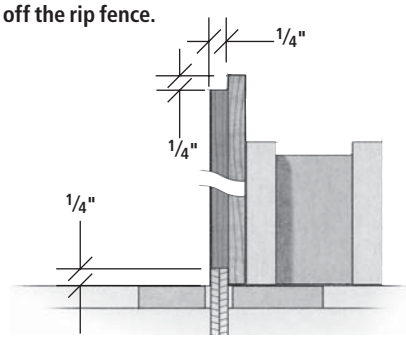
1 For the front and back pieces, start with a 1/4"-wide dado stack in your saw. Set it for 1/4"-high and with a 1/4" gap between the fence and dado. The first cut trims the end of the rabbet.



2 The second cut completes the 1/2"-wide rabbet, with the drawer edge referencing off the rip fence.



3 Using the same setup on your saw, the 1/4" x 1/4" groove for the bottom is cut in the sides and front in one pass.



4 If you're using a 1/2"-thick solid bottom, you can also groove a rabbet around the three sides of the bottom to allow it to fit easily in the 1/4" groove in the drawer sides and front.

Illustrations by Matt Bantly

Door Types and Joinery

As we start talking about cabinet doors, let me work the opposite pattern as with the drawers. We'll start simple with a slab door and move up to a frame-and-panel door and finally we'll look at a frame door with divided lights for glass.

Slab Doors

The simplest door to make for cabinetry is to cut a piece of plywood or a glued-up solid-wood slab to the correct size and mount it to the cabinet. If it's a solid-wood slab you can leave the edges plain or add an edge profile with a router to class it up a little.

If you're working with plywood for your drawers, the naked ply edge is considered unattractive by almost everyone. So let's look at three ways to dress up that edge. (By the way, the following approaches will work for plywood drawer fronts as well.)

Veneer tape is still most commonly found in an iron-on design. This is effective, but you have to work fast on larger pieces to get the glue to soften and then cure at an even pace along the whole piece. Otherwise the tape may be loose in places. Newer peel-and-stick tape is easier to work with and is becoming more common.

With either tape variety, you still need to trim the excess. While there are a few tools available that offer simple trimming, I still prefer the look you get using a fast-cut file. Just remember to only trim down toward the tape or you'll end up pulling the tape loose and likely end up with some tear-out along the edge. Just take it slow and smooth.

It's been my experience that planing a wood edge to the plywood face is easiest. Sanding can lead to burning through the plywood veneer and routing takes too much setup time.

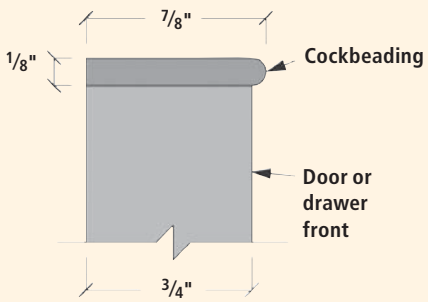
If you don't miter the edging, a low-angle block plane will help you achieve a smooth fit at the end of the strip, but trim it close on the table saw first or you'll be planing all day.

The first method is to use a veneer tape. Veneer tape is available in almost every wood species to match your casework. It's available with an adhesive applied to the back that lets you iron on the tape, or there is also a newer self-adhesive tape that I strongly prefer over the iron-on type.

The tape is sold in rolls and is oversized in width to allow trimming after application. Veneer tape offers a fairly inexpensive option to solid-wood doors and it leaves a clean look to the door, showing only a thin line at the edge.

Another option uses solid wood rather than veneer tape. By gluing a 1/8"- or 1/4"-thick piece of matching solid wood to the plywood edges you create a more visible edge, but it's also more durable than the veneer tape. Application of the wood edging uses glue and clamps and can take more time than veneer tape, but also offers the opportunity to add a decorative profile. The wood edge can be cut to just wider than the door thickness and then planed, sanded or trimmed with a router to a flush fit against the door face.

One other solid-wood option is cockbeading. The solid-wood edging is cut wider than the door thickness and then a decorative detail (typically a bullnose profile) is added to one edge (with a nosing plane or router). That edge is then allowed to extend beyond the front of the door. Simple.

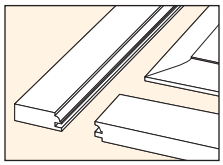


Cockbeading is a great way to make good looking plywood doors in a hurry. Simply hold the back edge flush to the plywood and affix the edging. Mitered corners help complete the finished look. And if you're in a real hurry you can use a 23-gauge pin nailer to attach the edging, avoiding the need for clamps.

Door Joinery

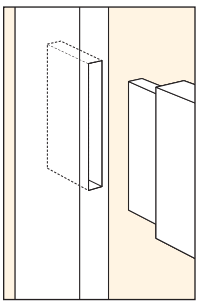
Cope and Stick

The preferred joint for doors, the cope and stick provides a strong interlocking joint with matched profiles and leaves a groove to fit the door panel.



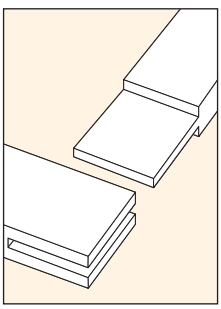
Mortise and Tenon

This joint offers great strength, but with a simpler appearance. It can be used at corners or in joining intermediary rails to stiles in multi-panel door frames.



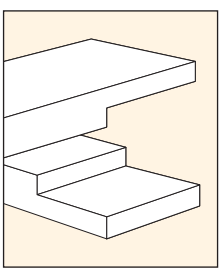
Corner Bridle

Providing lots of gluing surface, the bridle joint leaves visible joinery and can be created on a band saw or table saw.



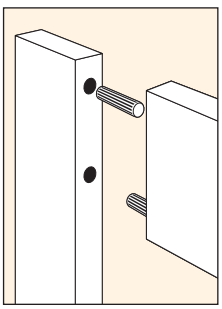
Half Lap

A quick door frame joint, the half lap offers only acceptable strength and requires careful setup to leave a flush surface on the door frame face.



Dowels

Dowels create a good looking door frame but only offer minimal strength. They also require a good jig and smidgen of luck to do them well.



Raised-panel Doors

When most people think of cabinet doors, a raised-panel door appears in their mind. As with a dovetailed drawer, the raised-panel door means quality and style. And, as with a dovetailed drawer, they take more work to create.

Panel doors in general are made of vertical (stiles) and horizontal (rails) components joined at the corners using a variety of methods. The long edges of the rails and stiles can be left plain or decorative edge treatments can be added with a shaper or router. The center of the door (panel) can be raised (which really means the edges of the panel are lowered, leaving the look of a panel that is rising to the level of the frame) or left flat and recessed below the plane of the door's face components.

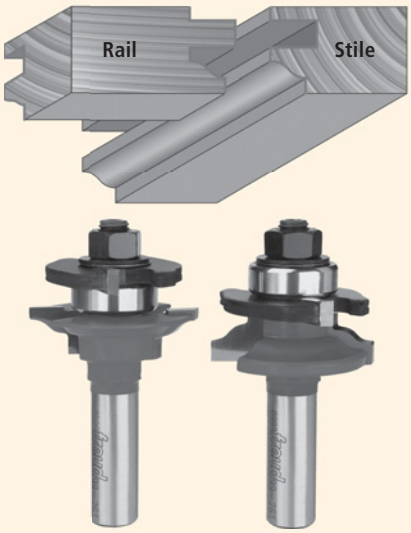
For a decorative panel door a cope-and-stick joint is most often used. This is created using a router or shaper cutter to create mating joinery on the rails and stiles (see the illustration at right). The bits take much of the difficulty out of this process, but they must be accurately set up to achieve a tight, attractive joint.

The panel that is fit into the grooves created in the door frame also requires some special care to create. Because of the wood movement that occurs in solid panels due to changes in humidity, the panel must be fit into the door to allow room for expansion, but also leave a fit that is snug enough to keep the panel from rattling in the door frame when opened or closed.

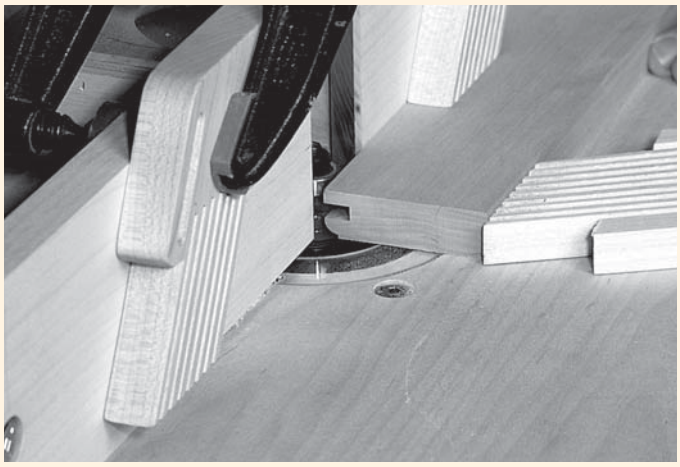
If this sounds like a lot of work but you still want a frame-and-panel door, consider a flat-panel door. This design occurs often in Shaker, Arts & Crafts and what many call "country" furniture pieces. The rails and stiles are free of decoration and the panel is most often a 1/4"-thick piece of veneered plywood glued into a stopped or through groove in the frame.

A variety of joinery methods are available for the more simple frame-and-panel doors, including mortise and tenon, bridle and even dowels (see list at left for some of these options). Most are

A classic raised-panel door is shown here. The rails (the horizontal frame pieces) and stiles (the vertical frame pieces) are joined using cope-and-stick joinery, with the decorative profile at the interior corners appearing mitered and perfectly matched. The panel itself is raised (cut on a bevel) from the full thickness to a thinner width at the edge to allow it to fit in grooves cut in the rails and stiles.



The most traditional method of creating a cope-and-stick joint for a door frame is by using a cope-and-stick bit set. One bit is designed to cut the edge profile and panel groove on the stiles as well as the inner edge of the rails. The matching bit (the cope part) is shaped to cut the negative version of the edge profile and to leave a tongue on the end of the rail to interlock with the groove in the stile. There are single cope-and-stick bits with interchangeable cutters to switch between cope or stick, and others that have all the cutters in place, but you simply use a separate section of the bit for each procedure.



When making cope-and-stick joinery, a router table is the tool of choice. Make sure the router has a large enough motor (more than 2 horsepower) to supply enough torque to provide a clean cut. Also variable speed is an important feature as these larger bits perform better at slower speeds (16,000 rpm or slower). Lastly, these bits take off a lot of material in a single pass, so it's important to keep the wood steady during the cut and also make sure you are safe from kickback. Appropriately placed and adjusted featherboards will make this process safer and also more accurate.

easy to create, but offer varying degrees of strength for the door.

One of the strong benefits to the flat plywood panel is removing the concern of panel expansion. Plywood panels won't move with humidity, so they can be made to fit snug to avoid rattling. And the ability to add a snug-fitting panel allows you to use a frame joint with less strength, relying on the panel to add some stability.

With two of the joints shown at far left, stability is a concern. The bridle and half-lap joints offer a fair amount of gluing surface, but don't interlock tightly to offer a self-squaring feature.

To improve either of these joints you can dowel the joint after squaring the frame during glue-up. The dowels can be made of a matching or contrasting wood species as to your preferences. When doweling the joint, always work from the show surface of the door. Tear-out as the drill bit exits the back of the doors isn't attractive. You can also minimize the tear-out by using a scrap piece of wood as a backing board behind the door frame as you drill.

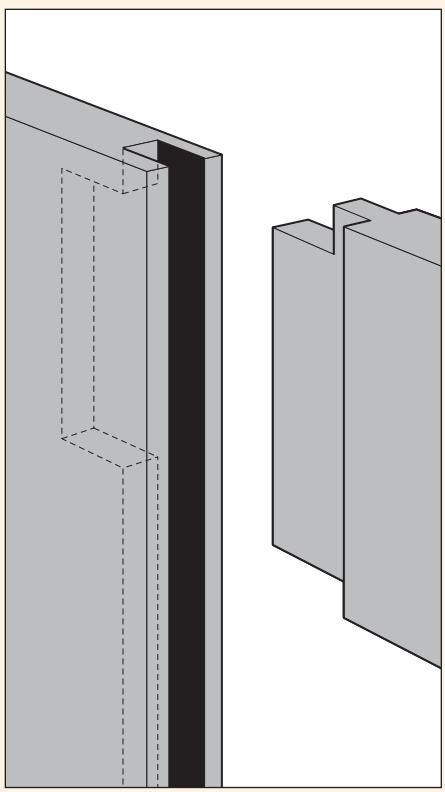
Glass-paned Doors

One type of casework door that seems to strike fear into many woodworkers' hearts is a glass-paned door. Glass isn't a medium that woodworkers are always comfortable with, so adding it to their woodworking seems scary. But the truth is, if you're comfortable with a frame-and-panel door, you're only a few steps away from a glass-paned door.

What we're adding to the door's frame are muntins. Muntins are lighter weight strips of wood that divide the glass panes. They can be vertical, horizontal or run at angles. The traditional manner of adding muntins is to form half-lapped frames that fit into mortises formed in the door's rails and stiles. Rather than a door panel groove, a rabbet is formed in the rails and stiles. In cross section the muntins look like a T with the glass panes resting into the corners formed by the T's cross bar. Retaining strips are added behind the glass pane and nailed in place in the rabbets, or glazing putty can be used to hold the panes in place.

Creating the rabbet in the frame pieces is no more difficult than creating a groove, but creating and fitting the muntins does take extra time and can honestly be confusing unless you keep your wits about you.

Contributing editor Glen Huey came up with a shortcut to door muntins that takes much of the time and confusion out of the equation. Rather than create T-shaped muntins and mortises, Glen glues wood strips together to form the T shapes and glues those same strips into the rabbets to attach the muntin frame to the door.



Stopped grooves are complicated to create and require more cleanup time with a chisel than most of us would prefer. But allowing the groove to run through the piece (as shown on the stile above) creates a gap when using a standard tenon. That's where the haunched tenon (shown here) comes into play. By simply removing only part of the tenon's edge a haunch is left that fits in to the end of the groove, hiding the gap.

A traditional muntin assembly is built by first milling T-shaped strips and then carefully cutting half-lap joinery to allow the pieces to nest together (right). The assembly is then installed in mortises formed in the door frame (above), making the muntin assembly a permanent part of the door assembly.

With Glen's method (shown below) the legs of the Ts are first glued horizontally across the door, resting in the rabbets in the frame pieces. Next, the T crossbar pieces are glued into position vertically in the door, across the first horizontal pieces. Finally the remaining leg and crossbar pieces are fit between the pieces already in place and then glued to those pieces.

This process provides a true divided-light door, but requires only strips that can easily be milled by any woodworker and works more like a jigsaw puzzle than a complicated joinery process.

Thank you for the idea, Glen! **PW**

Above, Glen is placing one of the leg sections of a muntin in place on the already installed crossbar section. At top left you can see an assembled T section.

Photos by Paul Anthony

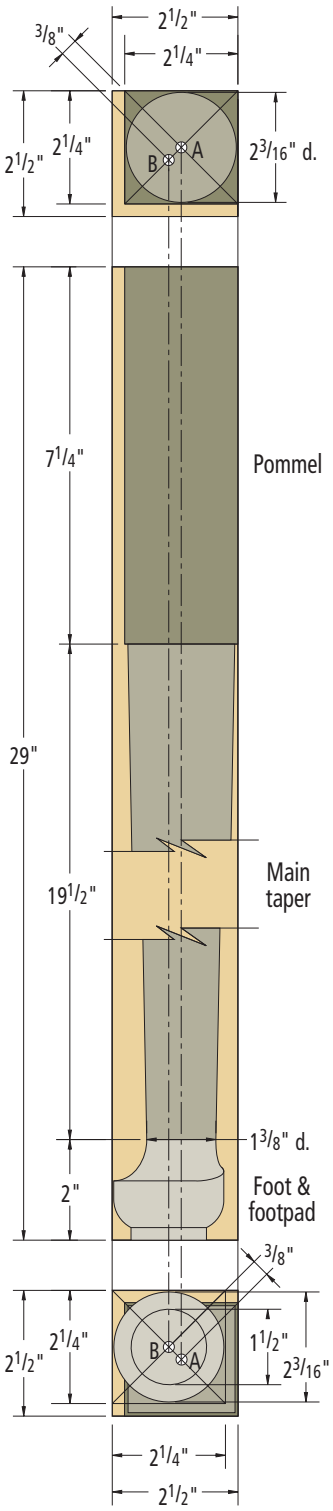
After 250 years, this design hasn't lost its practicality or its distinctive appeal.

Queen Anne Table

As with most of my reproductions or "adaptations," as I like to refer to them, I did a fair amount of research before beginning the design task for this Queen Anne-style tavern table or worktable. I found several examples of rural southeastern Pennsylvania period pieces (1740-1760) that I liked. I took what I considered to be some of the best features of the pieces and melded them together into a cohesive design. The asymmetrical drawer arrangement and the removable top with clamped (or breadboard) ends are a holdout from the William & Mary era. No one knows for certain why the tops on these tables were removable, although many of them were fairly large, and this feature would make moving them easier.

by Craig W. Bentzley

When he's not busy writing about and teaching woodworking, Craig builds reproduction American period furniture with a focus on southeastern Pennsylvania pieces.



Parallel axis leg

2¼"-square pommel is cut from back right corner of 2½"-square stock.

Main taper is turned on axis "A."

Foot and footpad are turned on axis "B."

Since it was to be painted, I chose poplar for the base material. I decided to use curly maple for the top because I felt it would really complement the base. Most of the period pieces I liked had turned cabriole legs using what is known as the converging axis method. On larger pieces, this can give a "bow-legged" appearance. I was after a bolder, sturdier look for my piece, so I opted to use the parallel axis method.

Turning the Legs

Construction of the base begins with turning the legs. When turning parallel axis legs, the blanks need to be larger in cross-section (2½" x 2½") than the pommel (2¼" x 2¼") to accommodate the projecting foot. The blanks need to be perfectly square. After squaring up and trimming the blanks to length, the outer faces of the legs need to be determined. If you are not going to paint the base, grain orientation will be a factor here. Next the turning centers need to be determined and marked on the tops and bottoms of the blanks. Strike a diagonal between the rear of the foot and the intersection point of the two "show" faces. Measure and mark a line ¼" in from each of these faces. Now strike another diagonal through the center of this new square on both ends of the blank and mark the intersection point with a sharp awl. This will be the center used for turning the main taper of the blank and the ankle/foot intersection. We'll call this "axis A." Measure out ⅜" from this point (towards the outer faces of the blank) and mark another center point with the awl, on the top and bottom of the blank. We'll call this "axis B." This center will be the one used to turn the foot and footpad.

Now ¼" of stock must be removed on the two outer faces of the leg blank to a point 2" up from the bottom of each blank. This material is removed by stop ripping on the table saw. Use a sharp blade and a zero-clearance insert to minimize cleanup of the outer faces of the pommel. Be sure to position the blank so that it will be supported when the second cut is made. At the end of each rip, the saw is turned off and the blank is lifted and rotated to rip the adjacent face. The remaining flap of material is removed with a couple cuts with a handsaw. Extend a line around the blanks at the 7¼" pommel length.

The blank is initially mounted in the lathe on "axis B." I use a standard four-prong drive center and a ball bearing cup center and I orient the blank so the foot is at the tailstock. A few notes of caution here. First, rotate the blank by hand before turning on the lathe to make sure that it clears the tool rest. Second, start the lathe at a slow speed. Initially you will only be cutting at the rear corner of the foot, which makes for a bumpy ride. I use a 1¼" roughing gouge to do the job. Take your time. Also, occasionally check that the blank is still secure. The jarring nature of this operation will require you to snug up the blank a couple of times during the procedure. Once you begin to remove material from all

First the blank is mounted on "axis B" and the foot is made round with a roughing gouge.

The leg is then remounted on "axis A" to cut the pommel shoulder and to turn the main portion of the leg.

four corners of the blank, you can increase the speed. You will only be rounding the lower 2" of the blank. When you have eliminated the flats from the outer faces of the foot, stop turning and mark the 1 1/8" foot height on the blank.

Now re-mount the blank on "axis A." The shoulder of the pommel is normally cut with a skew chisel. If you don't turn frequently, you may want to try the following trick. First, scribe around the bottom of the pommel with a sharp knife. Next, double wrap the left side of the scribe line with blue masking tape. This serves a dual purpose. One, it is very visible and helps avoid cracking your knuckles on the rotating pommel, and secondly it helps prevent splintering when plunging in with a parting tool to form the shoulder. Now, use a sharp backsaw to cut 3/8" into the corners of the pommels on the right side of the scribe line. This will help prevent any blowout that can occur during the plunging operation. Now you can plunge straight in with a sharp 1/4" parting tool until you reach a diameter of 2 3/16".

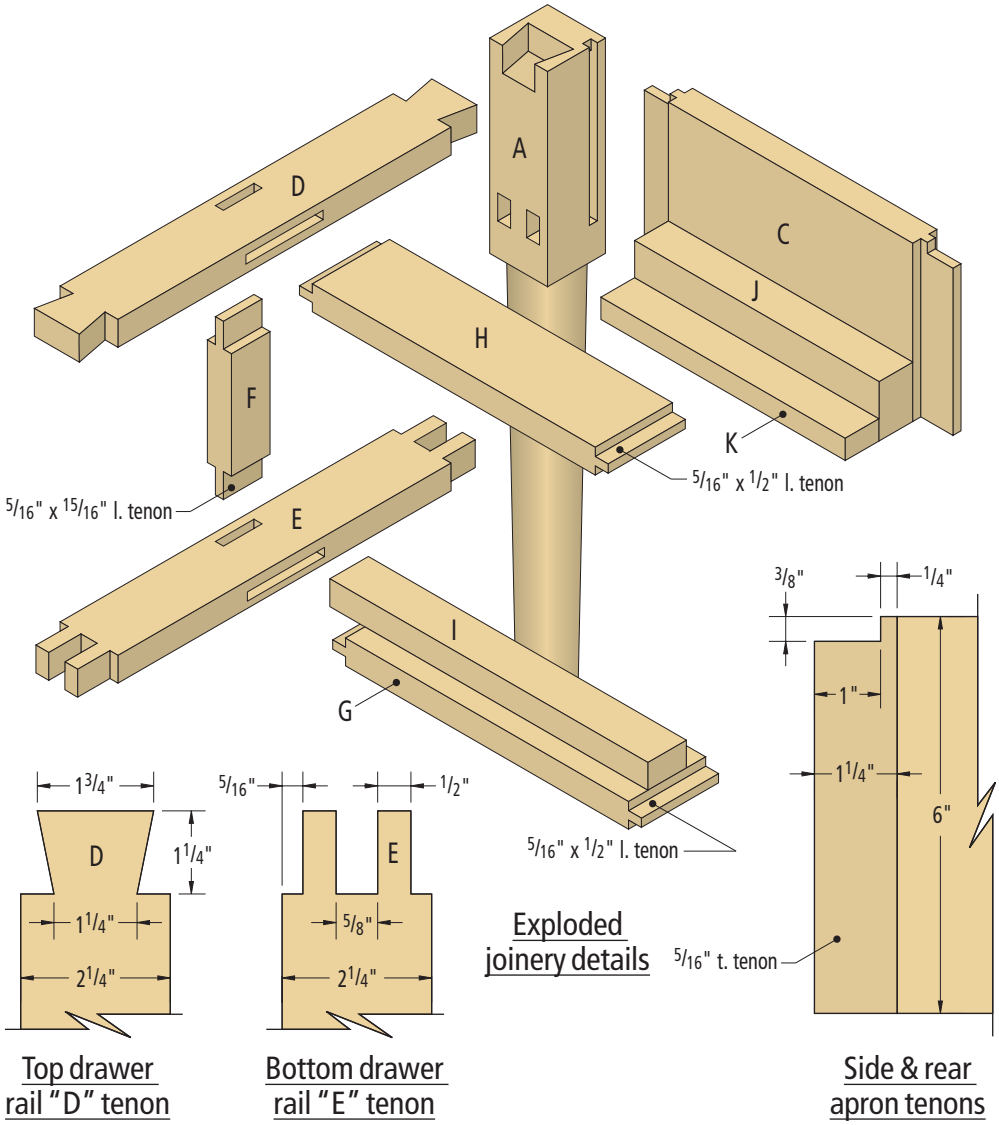
I turn the main leg shaft cylinder and subsequent taper from the pommel to the ankle with a 2" roughing gouge. Checking your progress with a 19"-long wooden straightedge will help to develop a nice straight, smooth taper. As you begin to remove more material from the ankle area, you will need to remove more material from the top of the foot. I use a sharp 1/2" round-nose scraper to remove this material. I leave about 1/8" of material above the top of the foot line for the final cleanup.

The top of the foot and intersection with the leg is finished using a sharp round-nose scraper.

Once the intersection of the foot, ankle and taper look fairly clean, you can finish off the top of the foot and ankle transition with the round-nose scraper, taking light, deliberate cuts. If the top of the foot or the rear ankle transition is a little ragged, these areas can be cleaned up using a half-round file.

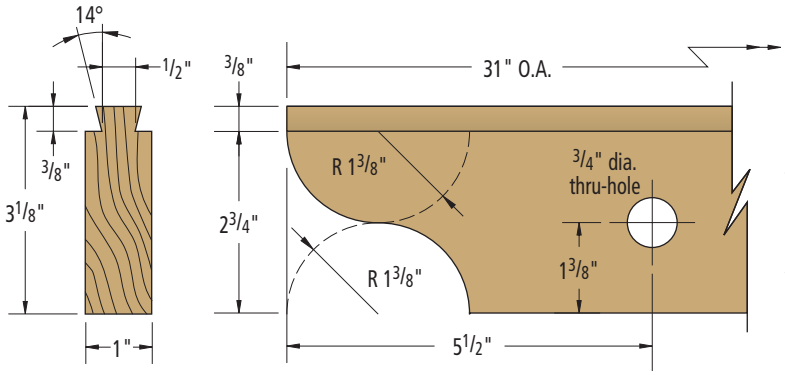
Now the leg needs to be remounted on "axis B" to complete the foot. I use a 1/4" parting tool to take the footpad to the final diameter. Then I complete the bottom curve of the foot with round-nose scraper and finally a skew chisel to get into the pad intersection.

After final sanding, the legs are ready to mortise. In order to prevent mistakes, I recommend marking the tops of the legs as to the final orientation. Although I cut these joints on a horizontal mortiser, I still used a mortise-marking gauge to lay out the mortises. After mortising, I squared up the corners with a chisel and cut the haunch at the top of the pommel with a backsaw. The dovetail sockets on the top insides of the front legs are hand sawn and then the waste is removed with a chisel. The double mortises for the lower drawer rail were chopped by hand.

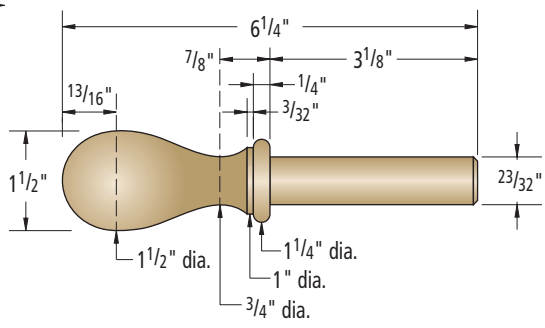


Making the Rails, Aprons And Frame Assembly

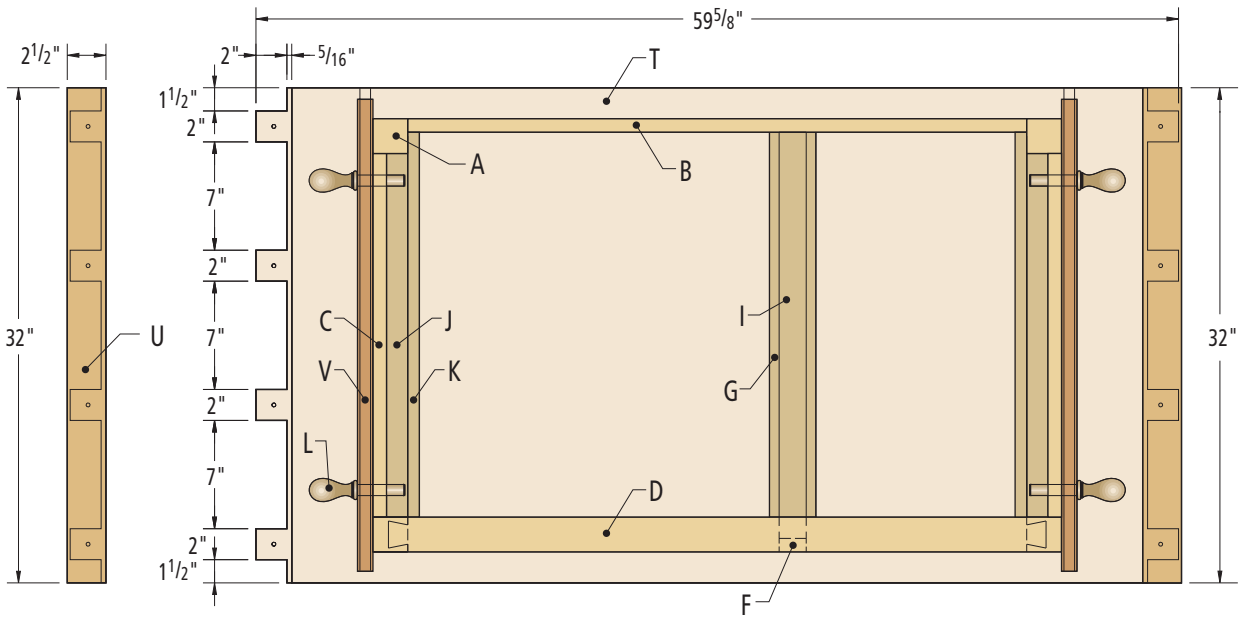
Dress all of your rail and apron stock to 15/16" thick, and cut the parts to width and length. Now you can bead the aprons and the lower drawer rail. I used a 1/8"-radius corner beading bit (CMT #861.532.11) on a router table to do the beading. I cut my tenons on the table saw using a tenoning jig. Use a fine saw to cut the small haunch at the top of each tenon. Don't forget to drill the two 3/4"-diameter holes for the top attach-



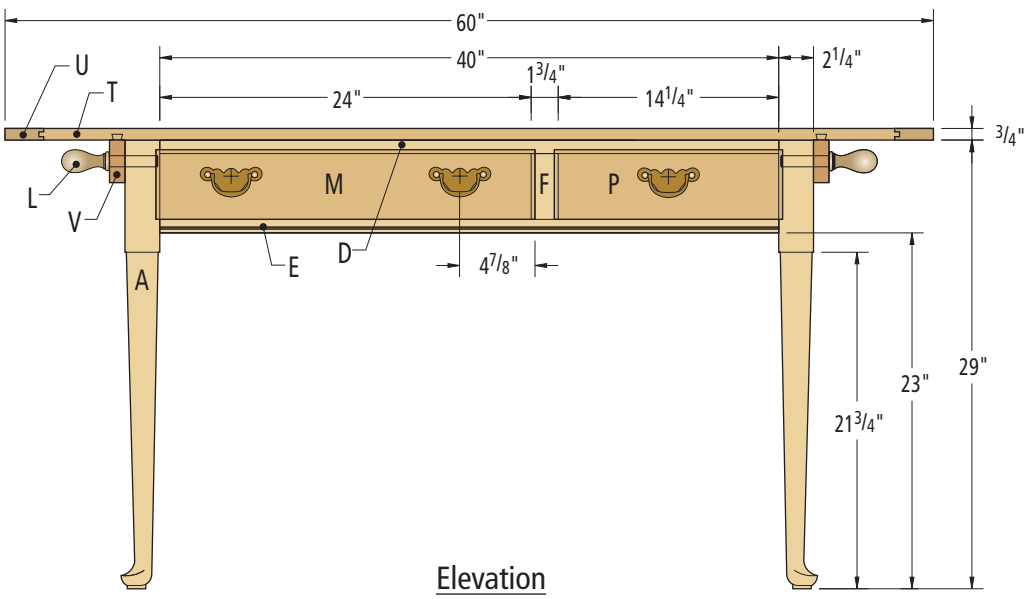
Top attachment cleat "V"



Top attachment pin "L"



Plan



Elevation

QUEEN ANNE TABLE

	NO.	LET.	ITEM	DIMENSIONS (INCHES) T	W	L	MATERIAL	COMMENTS
BASE								
❑	4	A	Legs	2 1/2	2 1/2	29	Poplar	
❑	1	B	Rear apron	15/16	6	42 1/2	Poplar	1 1/4" TBE
❑	2	C	Side aprons	15/16	6	26	Poplar	1 1/4" TBE
❑	1	D	Top drawer rail	15/16	2 1/4	42 1/2	Poplar	1 1/4" DBE
❑	1	E	Bottom drawer rail	15/16	2 1/4	42 1/2	Poplar	1 1/4" TBE
❑	1	F	Drawer divider	15/16	1 3/4	6	Poplar	15/16" TBE
❑	1	G	Central drawer runner	15/16	3	26 1/16	Poplar	5/8" TBE
❑	1	H	Central kicker strip	15/16	3	26 1/16	Poplar	5/8" TBE
❑	1	I	Central drawer guide	15/16	1 1/2	26 1/8	Poplar	
❑	2	J	Side drawer guides	1 15/16	2	23 1/2	Poplar	
❑	2	K	Side drawer runners	15/16	3/4	24 3/4	Poplar	
❑	4	L	Top attachment pins	1 1/2	1 1/2	6 1/4	Walnut	
DRAWERS								
❑	1	M	Large drawer front	15/16	4 3/8	24 1/2	Poplar	
❑	1	N	Large drawer back	1/2	3 1/2	24	Poplar	
❑	1	O	Large drawer bottom	7/16	26 1/4	23 5/8	Poplar	
❑	1	P	Small drawer front	15/16	4 3/8	14 3/4	Poplar	
❑	1	Q	Small drawer back	1/2	3 1/2	14 1/4	Poplar	
❑	1	R	Small drawer bottom	7/16	26 1/4	13 7/8	Poplar	
❑	4	S	Drawer sides	1/2	4 1/8	26 1/2	Poplar	
TOP								
❑	1	T	Top main body	3/4	32	59 5/8	Curly maple	2" TBE
❑	2	U	Breadboard ends	3/4	2 1/2	32	Curly maple	
❑	2	V	Cleats	1	3 1/8	31	Curly maple	

TBE: Tenon Both Ends; DBE: Dovetail Both Ends

ment pins (see illustration on page 56) on the side aprons. Now you can turn your attention to the top and bottom drawer rails, drawer divider and infrastructure.

The bottom drawer rail was fitted first. The double tenons were hand sawn and the waste between the tenons was chopped out with a chisel. The mortise for the drawer divider and the central drawer runner were chopped out by hand.

The top drawer rail mortises are identical to the bottom drawer rail and were prepared in the same fashion. The large dovetails on either end were hand sawn and

SUPPLIES

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

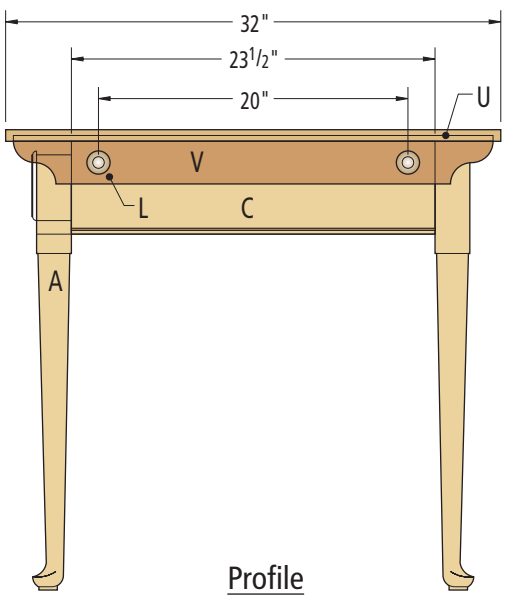
3 • 3"-boring antique finish pulls
#QA-2X, $9 each

The Real Milk Paint Co.
800-339-9748 or
realmilkpaint.com

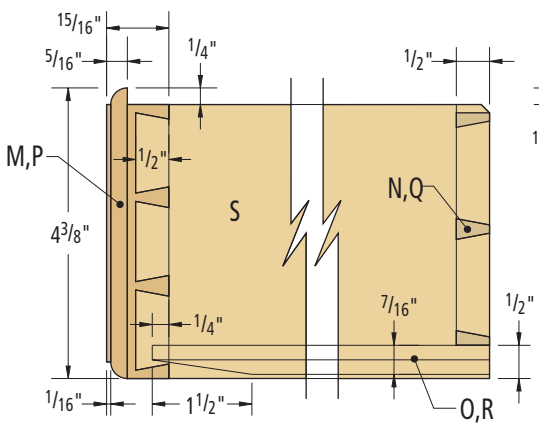
• "Green Earth" milk paint
#MP26, $10.50/1-pint bag

CMT
800-868-4268 or cmt-tools.com

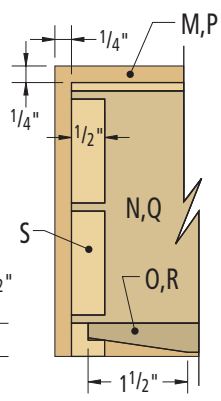
Prices correct at time of publication.



Profile



Drawer – profile



Drawer – rear view

then pared with a chisel for a snug fit in the leg sockets.

The rear apron mortises for the central drawer runner and central kicker strip were also chopped by hand. With all the mortises done, the drawer divider, central drawer runner and kicker-strip tenons were cut and fitted to their appropriate mortises.

Now you can assemble your base. I prefer to glue up the whole assembly in one shot and I use cold fish or hide glue to give me plenty of time to work.

The central drawer guide and side drawer guides were glued in place. I then attached each of the side drawer runners with four Tremont 4d clout nails in predrilled holes, equally spaced.

Making the Drawers

Construction of the lipped drawers is fairly straightforward. For an in-depth treatise on the subject, refer to *Popular Woodworking* issue #152. The thumbnail edge was created on the router table with a 1/4"-radius beading bit (CMT #839.754.11). When the fronts are complete, locate and drill the holes for the pulls. I did not nail the backs of the drawer bottoms due to the deep depth of the drawers and resulting seasonal movement.

Making the Top

I make my rough glue-ups a little wider and longer than they need to be and then I use hand planes to flatten the top and bottom. Finally, I square up to finished length but leave the extra width on. The breadboard ends should also be prepared at this time, making them a few inches longer than needed and slightly thicker than the top. They are planed flush after they are attached to the top.

The method I use to do my breadboard ends requires some extra effort but is well worth it, considering what you get back in looks and strength. The full-width stub tenon keeps everything in place and the large tenons make the joint amazingly strong.

First, lay out the tenons and the breadboards' shoulder line in pencil on the top only. Next, center the breadboards on the ends of the tabletop and transfer the tenon lines and tabletop edge lines to the breadboards' edges. I make my center mortises about 1/16" wider than the tenons and 1/4" wider on the outer tenons to allow for seasonal movement. I experience about 1/8" total movement annually on my top so this formula worked well. If you use a different material for your top, you should take this into account.

The 1/4"-wide x 5/16"-deep groove for the stub tenon is cut on the table saw with a dado blade, then I chopped the mortises by hand. One tip I can offer if you do this is to adjust your dado width to match the actual width of the chisel you are going to use.

I used a plunge router and a 1/2" spiral downcut bit (CMT #192.506.11) to cut the tenons and stub tenon on the ends of the top. Be sure to accurately transfer your shoulder lines all of the way around the top with a knife. Use a good straightedge as a fence for your router and clamp it in place. You should set your plunge depth stop to the tenon thickness but don't cut to the full depth. Make a couple of passes the full width

Hand chopping mortises isn't difficult but with mortises this deep, a swan neck chisel will help clear out the waste and save you a lot of frustration.

PEGS AND PEGGING THE JOINTS

I have found that most quality period furniture has tapered pegs, roughly octagonal in cross section, riven from straight-grained stock and whittled to shape – which makes them very strong. This takes a lot of time so I developed a low-tech way to mass-produce them and made the pictured jig.

The materials and dimensions aren't critical. My jig is pine and about 15" long. On the table saw, I ripped a 3/16"-deep V-groove down the center. Then I added a "fence" on either side, equal to the width of the plane. I then added 1/2"-wide runners, the thickness of which is determined by trial and error – but 3/16" is a good place to start. Each side of the plane iron needs to clear the runners. Finally, a small brass flathead wood screw centered at one end of the V-groove serves as a stop for your stock. I pick the straightest grain stock I can find (walnut in this case) and rip out a bunch of 1/4" x 1/4" strips on the table saw. I lay the strips in the V-groove of the jig to plane off the corner, rotate and repeat until I have an octagonal stick. I then cut the peg stock to desired length and chamfer one end with a hand-held pencil sharpener. To install the pegs, I drill 1/4" holes, put a bit of glue on the chamfered end and drive them home with a hammer. I leave them slightly proud of the surface and sand them smooth with a block wrapped with sandpaper.

The peg planing jig is a simple and effective way to mass-produce octagonal pegs.

After the initial dado is cut, a dovetail bit is used to form the dovetail slot. In this photo the breadboard is not in place so you can get an idea of the tenon arrangement.

I cut the sliding dovetail on the router table. It is easier to fit a piece of scrap cleat material (right foreground) than it is to try to fit the full-length cleat.

of the tabletop and finish up with a light cut at the full depth. You should now have a ½"-wide x ¼"-deep groove 2" in from the edge. Now excavate the area of the tenons. Don't remove the waste between the tenons because it helps support your router and subsequent use of a jigsaw.

When you have completed this task on both ends, top and bottom, you can use a small square to lay out the actual tenon locations. I drill a ¼" hole on the waste side of each tenon/stub tenon intersection and then I use a jigsaw to remove the waste between the tenons. I clean up the edge of the stub tenon with a sharp chisel. If everything went well, the breadboard should fit snugly. If not, you may have to do some cleanup with a shoulder plane. The extra breadboard length comes in handy to help tap the breadboard on and off of the top while doing the final fitting work.

Once you have a good fit, locate the peg hole locations in the breadboards, insert scrap wood into the mortises to prevent blowout and drill ¼" diameter through-holes on a drill press. Remove the scrap, put the breadboards back in place and use them as a drilling jig to drill the tenons. Remove the breadboards again and elongate the two outer tenon holes ⅛" in either direction with a small round file. Put some glue on the inner tenons only, install the breadboards, clamp, drive in the pegs, and trim them flush. When the glue is dry, trim off the extra length from the breadboards and plane them flush with the rest of the top.

The final phase of the top construction is making and installing the top attachment cleats. On period tables, the sliding dovetail slot goes completely across the underside of the table. I wanted a cleaner look for the front edge so I deviated from that detail and stopped the slots ½" in from the front edge. First I roughed out the stopped ⅜"-deep dados with a ½" spiral downcut bit.

Then I used a ½" 14° dovetail bit (CMT #818.628.11) to form the dovetail slots. When complete, the slot should still be ½" wide at the top. I squared up the stopped end of the slot with a chisel.

I cut the profiled ends of the cleats on a band saw and cleaned them up with a file and sandpaper. I then took the same dovetail bit that I used for the slots and installed it in my router table. I used a piece of scrap cleat material to test and tweak my fit. The top attachment pin holes must be located and drilled before installing the cleats. To install the cleats I put a small amount of glue in the last two inches of the slot (stopped end), and drove them home with a shot-filled rubber mallet.

I finished up the top by shooting the long edges to final width with a jointer plane and softening up all of the edges and corners with a minute bevel. Clean up, sand and you're almost done.

I turned the top attachment pins out of walnut because I liked the contrast it provided with the curly maple. A word of advice … little people like to remove the pins and play with them. In order to help circumvent this, I roll neoprene O-rings over the inside ends of the pins. This makes them more difficult to remove.

Finishing the Top

The top has a multiple-step finish to help "pop" the curly maple figure. I started by raising the grain with a damp rag. When dry I sanded lightly with #320-grit paper. Then I stained it with medium amber maple aniline dye water stain. When dry, I removed any additional raised grain and then I applied a second application of the stain.

Next I mixed a tablespoon of Transtint medium brown liquid dye stain with a tablespoon of Methyl Ethyl Ketone (MEK) and added this to a pint of boiled linseed oil. I applied this liberally to all surfaces of the top and kept applying it until no more would soak in. I let this sit for about an hour and then wiped off all the excess. I then allowed the top to dry for several days.

Then I sealed the top with a coat of one-pound cut of extra dark dewaxed shellac. After a light sanding, a coat of brown glaze was applied. When the glaze started to set up I lightly wiped it off and allowed it to dry. I sealed the glaze with another coat of shellac.

Finally, I top coated with four coats of alkyd satin varnish, rubbing out with 4/0 steel wool between coats and after the final coat. The end result was a rich, low sheen finish.

The top attachment pins were finished with several coats of Waterlox sealer finish.

Finishing the Base

I started by raising the grain with a damp rag and sanding with #320-grit paper when dry. Next I applied walnut aniline dye water stain to the entire exterior.

Next I applied four coats of "Earth Green" milk paint from The Real Milk Paint Company. I used a gray finishing pad to "sand" between coats and to smooth the final coat.

I sealed the paint with a coat of one-pound cut super blonde shellac. When the shellac was dry, I rubbed it out lightly with 4/0 steel wool. I then applied the brown glaze that I used on the top. When it started to set up I lightly wiped most of it off. I allowed some to remain in crevices, on the tops and undersides of the feet, in the bead grooves and around the drawer bead and pull areas. This gives the base a mellow "aged" look. I allowed it to dry for about a week.

This is what I call a "soft" finish, meaning that is not super abrasion resistant. If the paint is damaged, the walnut stained poplar will show, adding to the antique look of the piece. **PW**

You'll Poke Your Eye Out!

Mom was right to worry about your eyes – and you should too, especially as a woodworker.

Photo by Al Parrish

Every day there are an estimated 1,000 eye injuries reported in the American workplace. The Bureau of Labor Statistics also reports that three out of every five workers injured were not wearing eye protection at the time of the accident. While these statistics are for industry, it's not too far a stretch of the imagination to assume that similar laxness also occurs in many home workshops.

So why aren't we wearing safety glasses? In my informal focus group (I talked to a bunch of woodworkers), I gleaned that: "they're ugly and uncomfortable"; "they fog up"; "I wear glasses and they don't fit over them"; "I wear glasses, so I don't need them"; and my favorite, "I can blink fast enough to avoid getting hit!"

Let me tackle that last one first. While you *might* be able to blink fast enough to avoid something hitting your eyeball, I'm pretty sure your eyelid isn't made of Kevlar and it isn't going to stop a ricocheting brad nail like the one shown here. In all honesty, it was pretty difficult to get that brad nail to puncture the safety glasses. I had to get within 1" of the lens to produce a puncture. Everything else just bounced off. That's protection that appeals to me.

Now, for those of you who wear prescription glasses and feel you're protected, think again. Safety glasses almost universally include lenses made of polycarbonate materials. As is also shown in the photo on this page, a severe puncture doesn't shatter the lens. What will your glasses do? (You can find out from the video at www.aosafetysrx.com, which shows glass, plastic and polycarbonate lenses under impact.) Even more important, it's not just the lenses that are tested to withstand impact. The frames of safety glasses have to stand up to the impact as well (see "Testing Standards" on page 63). Prescription frames are not designed to hold up to

by David Thiel

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From the MSA Safety Works museum, the side shield goggles at right go back more than 50 years. The glasses at left are part of the current MSA Safety Works product line and look (and perform) significantly better and are designed for comfort.

those standards, as anyone who's accidentally sat on their glasses will attest to.

Fogging, comfort and appearance? Today's safety glasses aren't your grandfather's heavy, black-framed shades with strainer-style side shields. In fact many of today's safety glasses are so good-looking you might want to wear them just to be fashionable. A number of the safety glasses designs are also appropriate for wearing inside or outside, providing a certain amount of glare protection. You can wear them instead of your sunglasses, look good doing it, and they'll protect your eyes.

Today's Shades

If you walk into a home-center store today, you'll be able to find a number of options in safety glasses, from the very basic models (priced between $2 and $6) to some more fashion-conscious glasses (some are shown at right) ranging in price up to $50. Many of the glasses shown on these pages look as good or better than many of the high-fashion sunglasses sold today. And good for us! Even better, they're less expensive. A really nice pair of safety glasses with multiple lenses and a protective case may cost you $45. A new pair of Ray-Bans will run you more than $200 – and they're not safety glasses.

Even basic safety glasses are now designed with comfort in mind and they offer quality distortion-free lenses with excellent safety features – usually priced under $5. Too good to be true? Not at all.

I had the opportunity to visit two major manufacturers of safety glasses and a variety of other safety gear, MSA Safety Works in Pittsburgh and Aearo Co. in Indianapolis. While some of these companies' products are commonplace in home centers, many more of their products are sold for the industrial workplace and are in fact designed and built for firefighters, police and the military. These products need to perform in desert warfare as well as in the middle of a five-alarm fire. Many of the people making these products have Ph.D.s in one specialty or another, and some *are* rocket scientists. The benefit to us is the information from their tests led to technological advances incorporated into military safety gear. And that same technology ends up in our safety glasses as well.

Comfort

Safety glasses are only useful if you wear them. Along with attention to fashion, safety manufacturers are also spending a fair amount of time making glasses comfortable. The glasses should rest on your ears evenly, not pinch your head (but still not slide off), and should rest comfortably on your nose.

Before we go any further, I want to address another "I can blink fast enough" shop concept. Keeping your glasses handy is a good idea, but unlike your sunglasses, using a lanyard or neck strap to have your glasses within reach is not an acceptable option. Not in a shop. It's just like wearing a necktie. If you've got something dangling from your neck, you stand a very good chance of getting caught or pulled into a machine by the neck.

Back to comfort. There are three major ways manufacturers have gone about improving safety glasses' comfort: articulating arms, flexible materials and padding.

Three very cool safety glasses from Aearo include glasses with indoor/outdoor lenses for a balance of working conditions. Two pairs of these glasses have three sets of interchangeable lenses. Safety can be stylish and even cutting-edge.

Everyone's head is different in size and in where things are located. In fact you might be surprised to find that your ears aren't on your head evenly. Articulating arms make everyone equal and are available on very affordable safety glasses. These arms allow the earpieces to move forward and back so the earpiece will rest comfortably right on the ear. The arm also rotates at the temple of the glasses to adjust for those differing ear heights, or simply to allow the nosepiece and browpiece of the glasses to fit tightly (but comfortably) against your face.

Another design option is flexibility. Manufacturers are now designing glasses that don't rely on ear position, but on the tension of the arms pressing against the head to hold the glasses in place. The trick is in making a material that's flexible enough to provide adequate tension, while still offering a comfortable fit. The Chisel glasses from MSA are in that category. While still offering all the protection required (and necessary) for a workshop, these glasses are lightweight, comfortable and offer unobstructed visibility. All for only $6.

Padding is not only in place for comfort, although it certainly does offer that. Another benefit to padding is keeping dust and sweat out of your eyes. Padded brows divert sweat, and some glasses (such as the Maxim 2x2 model from Aearo on page 61) offer a padded seal around each lens for dust protection rivaling that of less-attractive goggles.

And women, if you've never been able to find a comfortable pair of safety glasses, hope is just around the corner. New glasses are now available with a smaller overall frame, to better fit a smaller head. Of course this change is coming about because of the growing do-it-yourself female population, but there are lots of men out there who will also benefit from the smaller-framed glasses.

I Wear Prescription …

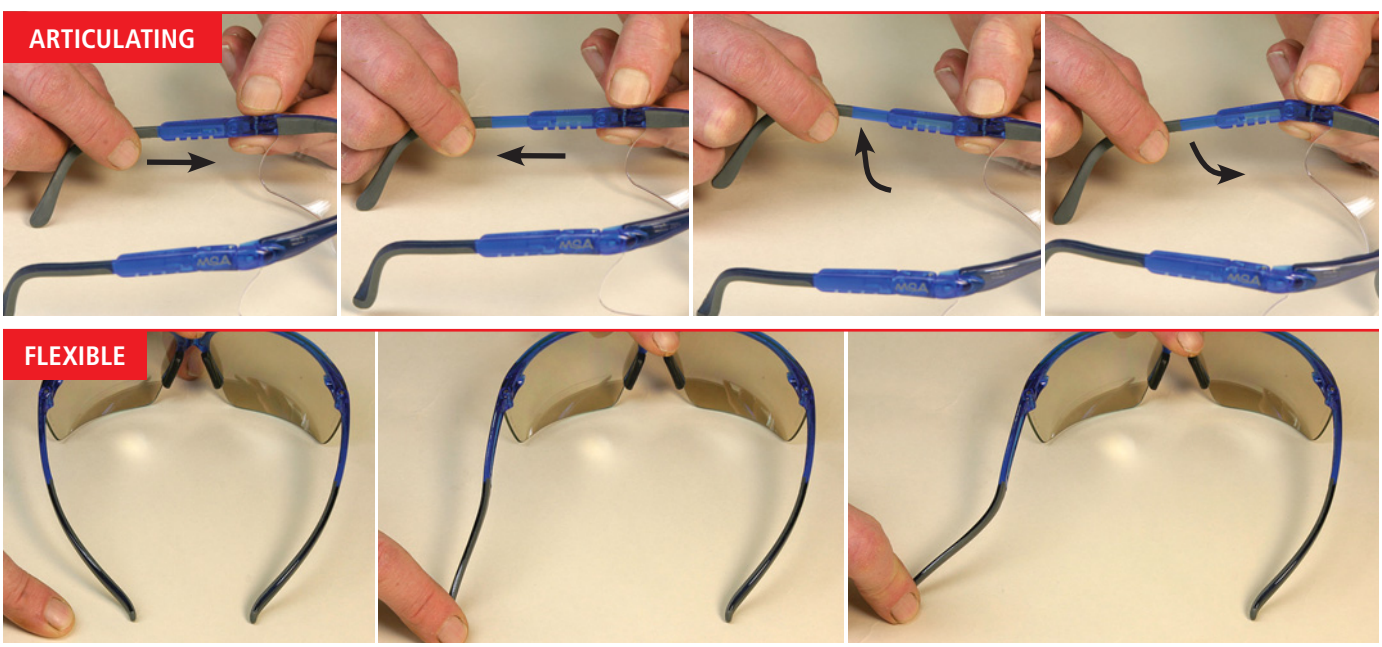
Are your eyes not as sharp as they used to be? Safety glasses with bifocal lenses aren't new, but there are many that look and fit better than they ever have before.

MSA Safety Works Chisel
($6)

With about half the weight and twice the flexibility of a normal pair of safety glasses, these still offer great protection while providing terrific visibility.

MSA Safety Works Padded Brow
($13)

The padded brow and nosepiece on these glasses make them more comfortable to wear. The brow also keeps sweat and some dust out of your eyes, while the nosepiece keeps the glasses from slipping.



Two types of earpieces are now available on safety glasses for increased comfort and improved fit. On an articulating earpiece, the arm moves in and out of the sleeve and can be stopped in one of four positions to better fit the distance from ear to brow. The earpiece also swings up and down because all our ears are not created equally (or placed on our heads in the same place). The flexible pair uses a rigid arm, but one that is bendable enough to comfortably fit any size head without pinching.

If you wear prescription glasses, you probably think your only choices are to wear a pair of safety glasses designed to cover your existing prescription glasses (which can be uncomfortable and distorting), or to shell out some serious cash to buy prescription safety glasses.

Well, the truth is we still aren't impressed with the over-the-glasses option. They are still too bulky. But we did discover something that caused a good deal of excitement from the "visually challenged" on our staff. You can order a pair of prescription safety glasses that

Aging is a reality for all of us and when reading glasses are necessary we shouldn't use that as an excuse to not be safe. Bifocal lenses are available in magnification strengths from +1.00 to +3.00 and still offer comfort, style and safety.

DeWalt Reinforcer Rx
($12)

MSA Safety Works Bifocals
($20)

Aero Readers
($15 - $20)

TESTING STANDARDS

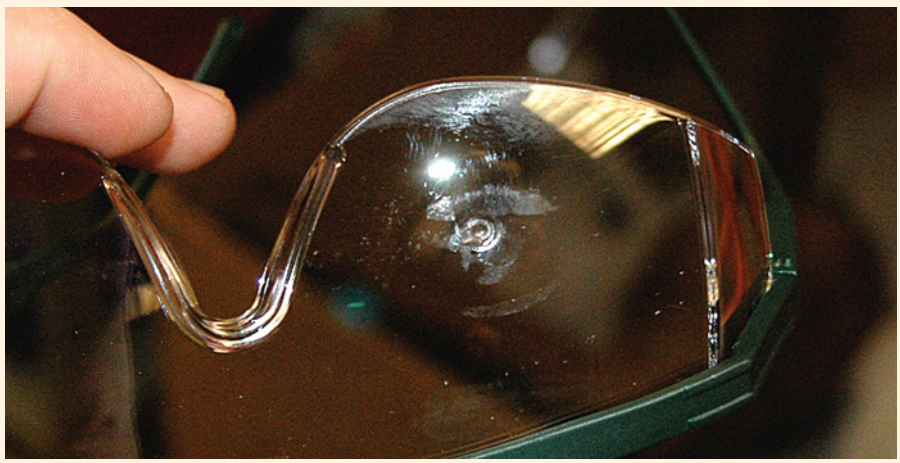
Safety glasses have to meet certain construction standards before they can be sold, right? Wrong.

The most current eye safety standards (ANSI Z87.1-2003) were actually written by the American Society of Safety Engineers (ASSE). ANSI (the American National Standards Institute), the group most usually assumed to "control" standards serves as an accrediting body for those standards. OSHA (the Occupational Safety and Health Administration) governs and enforces safety standards in the workplace requiring safety equipment meeting ANSI standards.

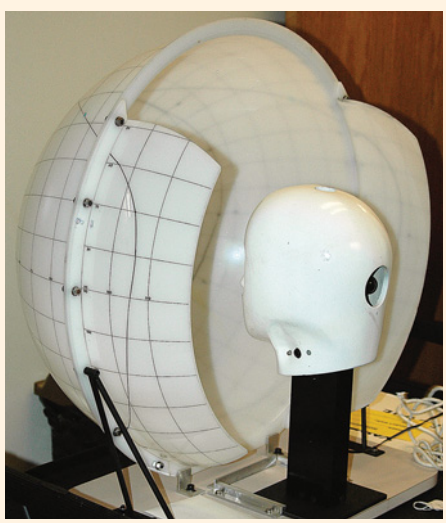
Manufacturers of safety glasses aren't required to build glasses to ANSI standards, though most do. When safety glasses meet ANSI standards the manufacturers will imprint a Z87 on the glasses. But what are the standards? Let's take a look at some.

- **HIGH MASS IMPACT:** The eyeglasses frame has to be capable of resisting an impact from a pointed projectile weighing 500 grams (17.6 oz.) dropped from a height of 50".
- **HIGH VELOCITY IMPACT:** The lenses must be capable of resisting impact from a ¼"-diameter steel ball traveling at a velocity of 150 feet per second without any failure.
- **DROP-BALL IMPACT:** Both frames and lenses need to resist the impact of a 1"-diameter steel ball dropped from 50".
- **PENETRATION TEST:** Lenses must be capable of resisting penetration from a projectile weighing 44.2 grams (1.56 oz.) dropped from a height of 50".

Other ANSI standards cover the prismatic, refractive and hazing properties of the lenses as well as the optical quality itself. All of these can cause image distortion that could create an unsafe working situation. *— DT*



The dimple shown on this lens is the result of the the High Mass Impact Test The lens is intact and the projectile didn't penetrate. Good enough for me.



One of the visibility tests is for peripheral obstruction. A pair of glasses are placed on the mannequin and a light shown from behind. The hood shows where the light is obscured by the glasses, giving an indication of how vision would be obscured.

The magic marker freckles on this fellow are actually indicators of the parts of the head and face that need to be covered by the safety glasses to meet ANSI standards. Canadian and United States standards have been slightly different but are moving toward common ground.

actually look decent for around $100. That can be approximately one-quarter the price of your daily prescription glasses! Heck, you might even end up wearing the safety glasses all the time.

To view the styles available, or for more information on this program, visit the Aearo web site at www.aosafetysrx.com.

MSA Safety Works Indoor/Outdoor
($11)

Sometimes you end up working in two different types of light, such as in and out of your garage workshop on a sunny day. These lenses are designed to cut some glare, but not be too dark for indoor use.

MSA Safety Works Amber Lens
($12)

Side shields are valuable on a pair of safety glasses, but this amber-tinted pair has turned the side shield into a stylish feature and improved visibility. The tinting actually brightens your view of the workspace.

Specialty Lenses

Colored lenses in the shop? Well, you shouldn't be wearing lenses darkened for use out-of-doors, but yes, yellow is a decent option: Amber-lens safety glasses help improve visual acuity and can actually improve your mood. If it's overcast, or you're working on a project in a poorly lit area, amber lenses can have a positive effect on your disposition.

Another lens option is indoor/outdoor lenses. These lenses are tinted just enough to take the glare off of a sunny day, but aren't tinted to the point where indoor applications are a problem. And many of the indoor/outdoor lenses will block nearly all harmful ultraviolet rays.

Maxim 2x2
($45 - $50)

Designed for the military, these fully padded frames keep out dust while still providing a very comfortable fit. They're also equipped with clear, dark or amber lenses (as shown) for any work environment.

Aearo LED
($16)

Who hasn't had to work in a poorly lit corner or under a sink at some time? These glasses equipped with LED add-ons put the light just where you need it and still provide comfort and safety.

While we're discussing lenses, let's talk about one of my major gripes with safety glasses: They scratch up too easily! I tend to find a pair that fits well, and before I realize it, they're scratched and need to be replaced.

There are two things going on here. One is I don't take very good care of my safety glasses. Tossing them onto the workbench (unless I miss and they end up on the floor) is not going to lengthen the life of the glasses. And if your bench is like mine, the glasses have a pretty good chance of having a few tools tossed on top once they're on the bench. So that's my fault.

Some of the safety glasses are now being sold with a hard-shell case or a cloth bag to help protect against scratching. These are good ideas, but you'll still have to make sure the glasses get back into the protective gear.

But why can't they make safety glasses more resistant to scratches? It goes back to the polycarbonate lenses. Polycarbonate is a better material than standard plastic or glass. It protects against shattering or splintering and still keeps the price down. However, polycarbonate is a slightly softer material and is prone to scratching. Most manufacturers are offering protective coatings on many of their glasses to protect against scratching. But you are still the best line of defense in keeping your glasses in good shape. And if that still doesn't satisfy you, remember this: they cost less than $10! Buy a new pair.

Specialty Applications

Remember the accident statistics at the beginning of the article? One of the other statistics reported was the type of eye injury. And while we're spending a fair amount of time protecting our eyes from flying pieces of wood, three-fifths of the accidents involved airborne objects that were smaller than a pin head! Dust and small debris are as much a problem as larger pieces of wood.

Because of those statistics, side shields, or glasses that wrap around the eye are a better idea for protecting yourself against all dangers. To offer even more protection there are safety glasses that incorporate dust seals around the frames to keep the little particles out of the eyes.

SOURCES

Aearo Safety Products
800-327-3431
aearo.com

DeWalt
877-723-4267
radians.com/dewalt

MSA Safety Works
888-672-4692
msasafetyworks.com

Of course, the most effective protection against particles is still a pair of goggles rather than glasses. Goggle designs have changed some, but to balance fashion, comfort and protection you should look to a goggle-like pair of safety glasses such as the Maxim 2x2 from Aearo.

Specialty doesn't end with the lenses or frames. How about working in the dark? We've all climbed under our dusty table saw to try to fix (or find) something. Why not wear safety glasses that will not only keep dust from falling in our eyes, but also help put some light on the project? Safety glasses are now available with built-in LED lights that are remarkably bright. The lights can be adjusted to shine exactly where you're looking, regardless of the position of your head. Very handy!

And if you hadn't already decided the cool-looking shades at the beginning of the article looked good enough to buy, pay attention to the interchangeable lenses. One pair of glasses can be used for indoor, outdoor or just for fun by simply changing out the lenses. Now that's special.

Conclusion

It's hard to put a price on safety, but that's what we're going to do here. Your vision is an important part of your woodworking experience. Protecting your eyes should be as basic a response as making sure the guard is on your jointer and that the bit is tightly chucked in the router.

For less than $15 you can protect your eyes with space-age technology good enough to protect our armed forces. Add comfort that continues to improve and there's no excuse to not be safe. And if you need to be fashionable, spend a few dollars more and put away your expensive Ray-Bans for a special occasion. **PW**

THE ESSENCE OF WORKSHOP SAFETY

"Let's take a moment to talk about shop safety. Be sure to read, understand and follow all the instructions that come with your power tools. Knowing how to use your tools safely will greatly reduce the risk of injury. And remember – there's no more important safety rule than to wear these: safety glasses."

This is how Norm Abram starts out his "New Yankee Workshop" shows. He is correct that safety glasses are important to eye safety. But personal safety equipment, such as glasses, hearing protection and breathing protection are not the be-all and end-all provider of safety. These items are the last line of defense, not the first. Safety glasses, in combination with guarding of woodworking equipment and reasonable care, form a three-part system to protect your eyes.

Eye safety begins with defining your space and determining to what hazards you may be exposed. Next, determine their sources. Once that's done, all reasonable means should be employed to contain the hazard right there. For example, a spray of sawdust, splinters, knots and even chunks of wood may come off a running table saw blade. It's reasonable to direct this spray downward and away from the operator with a guard. Essentially, the guard confines this hazard, denying you access to the danger zone. This reduces exposure to the hazard and reduces the likelihood of injury. If something escapes the guard, the glasses are there for further protection.

The notion that safety glasses represent the last line of defense is not a new one. As early as 1959, the National Safety Council stated:

"A machine so designed, for instance, that it effectively confines flying particles eliminates a cause of accidents. This is a more basic treatment of the problem than the use of goggles designed to prevent injury, for confinement stops particles at their source.

"Only when engineering revision and guarding have been considered and found impractical should dependence be placed upon personal protective equipment."

Industry has long been aware of the systematic approach to hazard control. The highest order of hazard control is achieved when the hazard is eliminated. Designing the hazard out of the equipment or workplace will result in the highest order of protection. If a hazard cannot be designed out, the next order of protection is to guard against the hazard. A table saw must be capable of cutting; therefore one cannot design out the cutting action. Thus, the hazard must be guarded. In the event that guarding is not feasible, warnings are provided so that the user has the information needed to use the product safely and to avoid the hazard. One cannot guard a hammer or design out the hazard. Therefore, you will find the following safety instruction label adhered to a hammer:

WARNING PROTECT YOUR EYES
WEAR SAFETY GOGGLES

"Use this tool to drive or pull common nails only. This tool may chip if struck against a similar tool, hardened nails, or other hardened surfaces, resulting in not only damage to this tool but possibly cause eye or other bodily injury."

Warnings and safety instructions represent the third order of hazard control. Warnings provide people with the information needed to avoid hazards. This warning points out the proper use of the hammer and instructs people how to avoid hazards. This information is needed so that people can be trained in the proper use of a hammer. This warning also instructs people to wear personal protective equipment – safety goggles.

The following list represents an effective hierarchy of hazard control:

1. Hazard Elimination
2. Safety Guards and Enclosures
3. Warnings and Safety Instructions
4. Personal Protective Equipment
5. Training and Supervision

Now that we've established the order of protection, it is essential that we adhere to that specific order. The highest order of protection must always be provided. From a safety point of view, it is not acceptable to rely upon a lower order of protection when a higher order is available. This makes a lot of sense from a practical point of view. You may not always be able to exercise complete control over your workplace. A family member, friend or co-worker may decide to use your shop when you are not around. And that person may have forgotten his safety glasses. That is why you need to ensure that your table saw is guarded and that the saw and guard are well maintained. A warning or training program can never be an acceptable substitute for a guard. Remember, guards not only protect people from physical hazards, they protect us from human error caused by distraction, fatigue, etc.

Finally, as mentioned above, maintenance is important in any safety program. Keep those machines and guards in good working order!

Harry Ehrlich, Industrial Engineer
Les Winter, Professional Engineer
Robson Forensic Incorporated

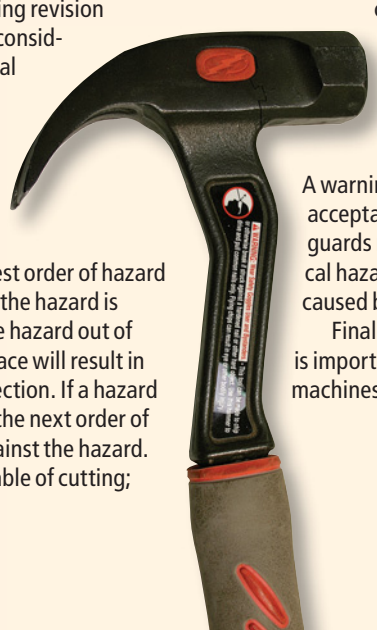


Photo and step photos by Wolfgang Busse

Photo by Al Parrish

Houndstooth Dovetails

This joint adds strength and beauty to any corner. And it's easier to cut than you might suspect.

I first saw this joint illustrated in "The Encyclopedia of Furniture Making," by Ernest Joyce (Sterling). I was fascinated by the complexity of it and for years wished I could cut them myself.

When I finally cut the joint, I realized the only difficult part was the initial layout; the rest was a matter of sawing and chiseling to the line.

by Rob Cosman

Rob is the Canadian representative for Lie-Nielsen Toolworks and has built custom furniture since 1983. At Brigham Young University, he worked as Dale Nish's teaching assistant. Rob has produced six DVDs on handwork, including his latest, "Hand-cut Mortise and Tenon." Visit robcosman.com for more information.

I have since been teaching others to cut them and most would agree that it is not as hard as it looks. If you have mastered the through dovetail, this is like cutting two of them at once. There are some tools that will make the job easier. In addition to the proper tools, there are a few tips I have picked up that should help the novice – and maybe the professional.

Why Use the Joint?

In considering strength, any well-done dovetail will usually be stronger than the application requires. However, the houndstooth adds more long-grain-to-long-grain glue surface as well as increasing the amount of pin wood in the joint. In a through dovetail, adding pins to create extra glue surface can make the baseline of the tail board the joint's weak spot.

However, with two scribe lines, one at the base of the small tails and one at the base of the large tails, the tail board strength is not compromised with the houndstooth. For this reason it could be considered the best way to make a strong corner even stronger.

The Tools

Choosing the right tools for cutting dovetails will result in less frustration. (For a detailed discussion of the tools, please visit popularwoodworking.com and click on the "Magazine Extras" button on the left side of the screen.)

In short, you need a dovetail saw with a straight blade and little set to the teeth. I prefer a rip-tooth configuration. You also need a well-tensioned fret saw, a sharp marking gauge, dividers, a marking knife, a device for marking the slope of your tails, and chisels with small side bevels that allow you to get into the tight corners of the tail section of the joint.

Cutting the Houndstooth

I cut all my dovetails' tails first. I begin by hand planing the surfaces of each piece flat, smooth and square; this is the first step to an accurate joint and it makes it easier to see pen and knife marks. I label the face side of each piece (my guide here is simply to put the best face out).

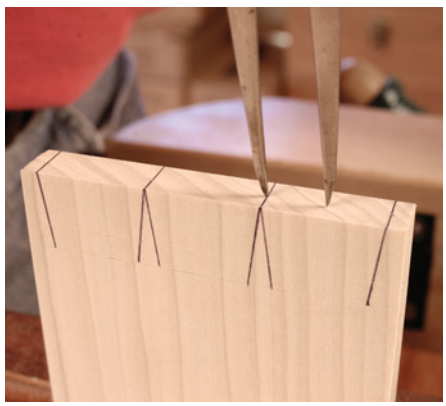
I set the marking gauge for the exact thickness of the pin board and scribe this dimension all around the tail board.

After teaching hundreds of people to cut dovetails, I found the biggest problem (after sawing technique) was the transfer of tails to pins. To make this easier and more accurate, I use a technique borrowed from Ian Kirby. I use my skew block plane to cut a shallow ($\frac{1}{32}$"-$\frac{1}{64}$") rabbet on the inside edge of the tail board. This shallow rabbet provides perfect registering for the tail board when it is set on the end of the pin board prior to scribing the pins.

Cutting a shallow rabbet on the tail board will help you mark your pin board later. The pin board will drop into the rabbet, which will increase your speed and accuracy.

The skew block is convenient to use because of its built-in fence. I set the fence so that with it riding against the end of the tail board, the far point of the blade (set to clear the edge of the plane) cuts right on the scribe line. One or two passes will usually do; however, if the wood is prone to tearing in this cross-grain cut, then a few shallow passes are more effective than one heavy cut. Most important to keep the rabbeted surface parallel to the inside face of the tail board. The next step is to set the marking gauge to establish the baseline of the small houndstooth pins. I find it best to start with hound's teeth that are two-thirds

Use dividers to lay out the location of the half-pins on the tail board. Mark a half pin on one edge as shown; then repeat the process on the other edge.



Use your dividers to step off three tails as shown (and marked in ink). Then reset your dividers to divide those tails in half for the houndstooth.

You will save yourself a great deal of frustration if you mark all your waste lines with crosshatching.

the thickness of the pin board. With this setting, I scribe the two faces of the tail board; then, with the same setting, I scribe the end of the pin board referencing off the face side. I now set the gauge to be 1/32" less than the thickness of the tail board at the rabbeted end and scribe this on the two faces of the pin board.

I use a pair of dividers to establish the width of the half pins in the end grain of the tail board. I want these half pins to be thick enough to prevent them from breaking or splaying during assembly. On a 5"- to 6"- wide joint, I would make the half pins about 1/4" at the top. I use one leg of my dividers to register on the outside edge of the tail board and I make a point in the end grain with the other leg.

With the interior pins just the width of my saw blade, I use another pair of dividers to step off the number of large tails I want between the half pins. Starting on one half-pin point, I walk to the other half-pin point using the number of tails as the spacing. I adjust the width of the dividers one way or the other until they land right on the opposite half pin point.

Until you have the exact setting, be careful not to leave any points in the end grain. To lay out the small houndstooth tails, I split each of the large tails in half (dividers make this easy). Then, using a dovetail marker, I mark out the tails. With my pen in the first half-pin point, I slide the marker over to it and strike a line across the end and up the face from the second (or furthest) scribe line. On the second point, I strike a line across the end and up the face starting at the first (or closest) scribe line. The third point starts at the second scribe line, the fourth at the first, and so on until I reach the second-to-last point. On the last point, I turn the gauge around to mark the opposite slope of each tail, the first one starting at the second scribe line, the next one at the first, and so forth. I also take the time to clearly mark the waste. A moment invested here can save frustration and expense as a result of having to start over because of an errant cut.

The tails are then ready to cut. I secure the tail board in the vise so it's plumb and keep it low to reduce sawing vibration. I use a shoulder-wide stance and my right foot makes about a 60° angle with the front edge of the bench.

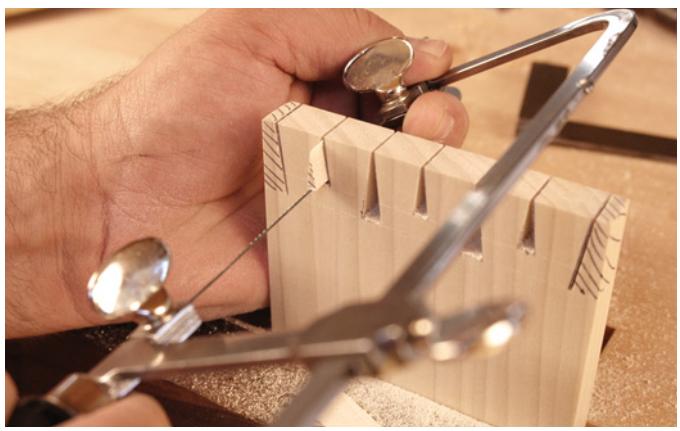
I grip my dovetail saw loosely with three fingers, index finger pointing down the saw. I want my sawing motion to be in a straight line from the tip of the saw to my shoulder. Think of the drive piston on an old steam engine for this. I use my left thumb and forefinger as an anchor point to start my saw. I pinch the top of the board with the bottom third of my thumb and forefinger. This keeps the end point of each digit above the set of the saw teeth. Light lateral pressure with the saw against my thumb and finger will ensure the saw starts cutting where I want it to rather than skirting across the end of the board.

With my thumb and finger pinching the end of the board, I can "inchworm" them one way or the other to move the saw closer and parallel to the line. Lifting to take most of the weight of the saw gives me a smoother start. I start my cut on the forward stroke; once the kerf is started the weight of the brass back will supply the needed downward pressure. Although I add a little extra to speed things up. My job is to aim the saw and move it forward and back. One of my students came up with the five "Ps" to sawing: 1) Pinch the wood; 2) Press the saw against the fingers; 3) Position the blade against the line; 4) Pull up on the saw taking most of the weight; 5) Proceed with the cut.

It can help the new sawyer to first get a shallow perpendicular kerf started across the end grain, then pause, aim the saw to match the angled line and begin sawing. Don't try to correct an errant cut. It is better to continue off a few degrees and have a straight cut than to mess up the kerf by trying to change direction halfway in. Developing the skill to hold the saw level during the cut comes with practice; so in the beginning, saw to the face scribe line then carefully tilt and saw to the inside scribe line. Cutting to the line will help when cleaning out the waste between the tails – particularly between the small houndstooth tails. I make all the cuts angling the same way before changing and coming back the other way. This gives me a better chance of getting the angles right.

Removing Waste

Before I reposition the board to cut off for the half pins, I use the fret saw to remove the bulk of the waste between the tails. I slip the blade down the kerf to the bottom; feeling the bottom of the kerf with the fret saw blade gives me an idea of level. I then rise up just a bit and begin sawing as I turn the blade.



After you define your tails with your dovetail saw, remove as much waste as possible with a fret saw.

Sawing off the half-pin waste on the ends of the tail board is a critical operation. Make sure your layout lines are precise and deep.

The closer I saw to the scribe line with the fret saw, the easier my chiseling will be. I take care not to cut into the side of the tail.

My next step is to orient the tail board horizontally in the vise to cut off the half pins. This is the first critical cut. The shoulders have to be on the mark. When I cut out the tails, I am creating a template to which pins will be made to fit. However, this cut already has a template – the inside face of the half pins. The inside of the half pin must meet exactly with the scribe line to ensure there's no gap.

The marking gauge line plays a big role here. If it has been scored deep and clean, as I start to move the dovetail saw across the wood on the waste side of the line, any material between the saw and the line will disintegrate. The saw will magically slide over to the shoulder line, providing a reference point for the saw. Now all I have to do is continue to saw vertically and be careful not to scar the side of the tail as I finish the cut.

Chiseling Between Tails

With the tail board flat on the bench, it is time to chisel out the waste. I always start chopping from the inside of the board and finish from the face side. This is always a two-step process, half from each face. Because the final chop eventually breaks through the waste, should the chisel get away from me the damage will be confined to the inside of the joint. I always use a backer piece to protect my bench.

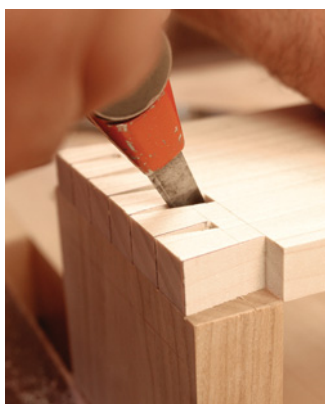
While some authors advise undercutting this part of the joint, I instead hold my chisel vertical to avoid two problems. The first problem with undercutting is the possibility of exposing a gap should more face-grain material need to be removed than was planned for. These gaps can be fixed but are hard to disguise. The second problem comes from what I call "push back." The wedge shape of the chisel creates a fair bit of pressure from the waste side of the chop. If the chisel is angled as in undercutting, the wood left supporting the chisel edge at the scribe line is a mere point. Holding the chisel vertical provides the maximum amount of wood at this critical spot. Also, the more waste there is, the greater the pressure on the chisel. For this reason, I try to saw as much of the waste away as I can.

If I have sawn to the line on both sides of the tails, my corners will be clean. If not, I use the corner of a narrow chisel to clean them up.

Cleaning up the bottom between the small tails is a bit more difficult because of the limited space. With the waste removed, I use a wide chisel to clean the outside half-pin corner. This spot usually has a bit of material left because the square-bottomed saw can't cut into the angled corner.

Chiseling the waste between the tails. Notice the body position. This allows me to ensure my chisel is indeed vertical when chopping.

A small bevel-edge chisel allows me to remove any additional waste between the tails.



Position the tail board rabbet on your pin board. Use a marking knife to transfer the tail board layout onto your pin board.

Starting the Pin Board

The next step is "make or break" – transferring the tails to the pin board. I like to clamp the pin board upright in the shoulder vise, setting the business end flush with the top of my smoothing plane set on its side. With the pin board firmly held, I move the plane back 7" or 8" so I can create a bridge between the two using the tail board. I reference the edge of the tail board rabbet against the inside edge of the pin board. I make sure the long edges of the tail and pin boards are flush. The downward pressure I now apply with my left hand on the tail board is transferred to a much smaller surface area (the end of the pin board and edge of the plane) which makes it easier to keep the tail board from moving while I mark the pins. I approach the side of the tail with my marking knife on a

20° angle. As I bend the knife to lay the blade flat against the side of the tail, the force of the angle holds it tight while dragging the point through the end grain of the pin board. I explain this to my students this way: 80 percent of your effort and concentration needs to be on keeping the knife tight to the side of the tail; only 20 percent is on the mark being cut in the pin board.

Scribing the small tails takes even more care; the space is small and keeping the knife tight to the tail is difficult. Once all the marks are made and before I remove the tail board, I use my bench lamp to inspect the scribe lines to make sure none wandered away from the sides of the tails. As a final procedure on the tail board, I chamfer the inside edges of each tail.

Chamfering the inside edges of your tails will make your joint assemble more easily. I use a chisel.

This is done with a chisel and I start the chamfer in about 1/16" from the end. Although it may change depending on the thickness of the piece, I usually run the chamfer an 1/8"-wide down the side of the tail. I use the chisel to clip off the pieces where they meet the scribe line.

Sawing the Pins

Before I start work on the pins, I make sure the board is standing plumb in the vise. The easiest way to check this is with a square against the benchtop and the board. Because I make my vertical cuts by feel, it is critical that the work is plumb. Developing this ability is probably the best sawing skill to have. It helps if you own a pistol-grip dovetail saw because it will register in your hand the same way each time you pick it up. Round-handle saws don't offer this advantage. I have my students practice making multiple vertical cuts 1/16" apart in the end of a plumb-standing board. Doing this helps spot any left or right drifts that can be corrected.

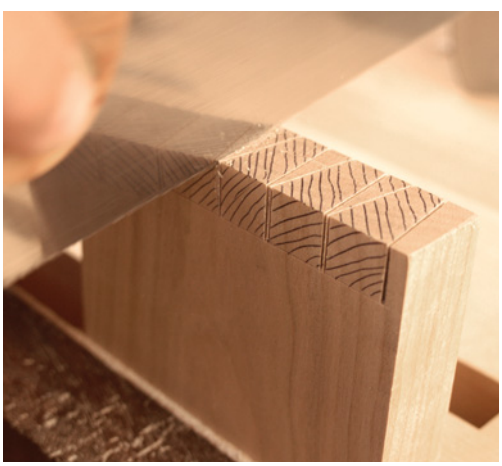
To lay out the vertical pin lines, I find it easier to draw starting from the scribe than trying to stop on it. For this reason, I strike my lines from the scribe up to the knife marks. I use my dovetail marker on its side to do these. I know from experience it is easy to be so focused on sawing to the line that if the line was drawn past the scribe, I could accidentally saw past it as well. Because of this, I make sure my lines stop where I want my saw to stop.

At this point, it is important to mark the waste clearly and carefully. I take the time to draw hatch marks on all the waste; this is my best bet against cutting on the wrong side of the line, because knife marks are not that easy to see in the end grain of some woods. While some authors advocate rubbing chalk dust into or dragging a pencil through the knife mark to highlight it, I find these suggestions make it harder to be precise. I use my bench lamp to shine light across the end of the board creating a bit of a shadow in the knife marks, which makes them easier to see.

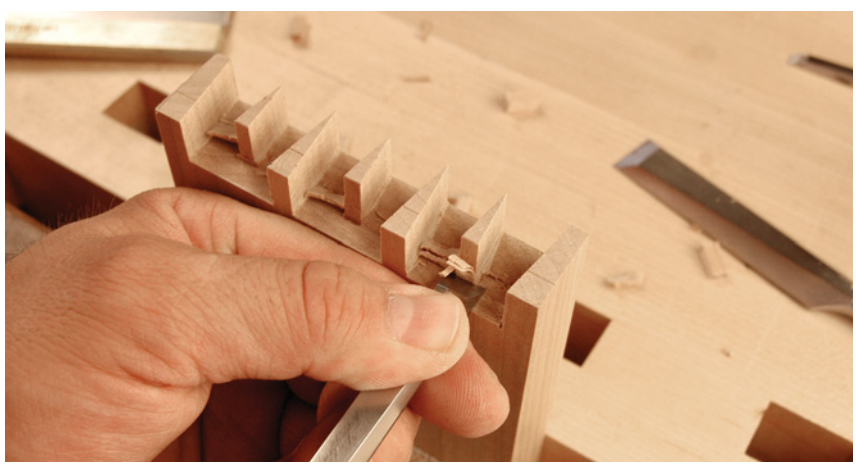
The knife mark leaves a V in the end of the pin board; half of the V must remain with the pin and the other half is wasted in the kerf. If any of the pin half of the V is removed, the joint will be loose. If any of the waste half of the V is left the joint will be too tight. In drawer work where two different species of wood are used there can be some leeway.

Usually the secondary wood (drawer sides, internal components) is a mildly hard species. The primary wood is often the harder and denser of the two. In this case, the mild wood will compress a little allowing for a good fit even if some of the waste half of the V is left attached to the pin. In casework where both pieces are of the same species that same excess would cause a split in one of the components. Knowing how much you can leave with different woods can only come with experience. For this reason I find it best to shoot for perfection with each cut. Now using the same 5 "Ps" of sawing, I split the knife mark.

Having the small pin scribe line across the end of the pin board can be a bit confusing, so as soon as I have made all my vertical cuts, I carefully saw out the waste with the fret saw. I then use the fret saw to undercut the waste portion at the back of the small pin. I use a chisel to vertically pare away most of the waste. This makes it easier to tell what is waste and what stays.



Mark your waste areas on your pin board and saw out the waste – trying to split the knife line in half with your saw.



Once you have removed most of the waste with your fret saw, you'll need to remove an extra chunk of waste behind the houndstooth by chopping and paring it out.

A pallet knife allows you to apply glue quickly and in the right places. Coat all the long-grain surfaces.

A pounding block distributes your blows evenly across the joint.

Chopping the Pin Board

With the pin board face down on the bench, I chop the waste and am careful to chop in the scribe and down almost to the back of the small pin. I flip the board over, then with a chisel narrow enough to get between the large and small pins, I chop from the scribe until I break through the waste. It helps to tilt the chisel to ride the angled edge of the pin; this produces a clean corner between the side of the pin and the bottom of the socket. It also means less work in the next step.

Then I clamp the piece vertically and remove any waste. I want the corners to be clean and sharp. I am also careful not to leave a bump in the bottoms of the sockets. The final procedure requires that I turn the board around to finish paring to the back of the small pin. A narrow chisel is easier to use here and requires less force to cut the end grain. I first make a vertical pare with the chisel in the scribe at the back of the small pin, with the bevel facing the waste. If the grain is angled in the wrong direction for a clean pare, I take shallow pares to sneak up on the scribe. A quick horizontal clipping of the pared wood at the base, and the joint is ready to assemble.

Don't Dry Fit the Joint

If you've worked accurately, dry fitting will only make the final fit less than it could have been. As stated earlier, I start with stock that is square, flat and smooth. Accurate layout lines allow for accurate sawing. The tail cuts have to be perpendicular across the end and straight to the scribe; exact angles aren't critical.

Transferring the tails to the pins must be accurate, and inspecting before moving the tail board will let you know if the lines in the pin board are where they should be. The pin-saw cuts must be perpendicular to the end and must split the knife marks. It is easy to see if you have left too much of the knife mark. You can check the bottom of the pin sockets with a straightedge to be sure there are no bumps that would keep the joint from seating. Providing the chisel work has been done to the scribe lines, this joint will fit. Everything a dry fit would tell you can be read from your cuts and scribe lines before assembly.

Tips for Glue-up

Having everything handy makes the glue up less stressful and all but ensures a successful finale. Steel hammer, small square, pallet knife, glue, wiping rag, pounding block (an extra one is wise) and a few clamps just in case. I apply the glue sparingly; you don't want a lot of excess glue running down the boards nor do you want it collecting in the bottom of the pin sockets.

I glue all the mating long-grain surfaces and a touch on the end-grain shoulders of the tail board. The wet glue will act as a lubricant to help you to get the joint together. The extra surface area in a houndstooth adds substantially to the assembly friction, so any help is welcome. With the pin board firmly in the vise, I get the joint started with just hand pressure.

Once things are lined up, I use a pounding block and hammer to completely seat the joint. The pounding block needs to be wide enough to cover the entire joint; this will prevent splitting the tail board should part of the joint go together more easily than another. I always orient the block so that I'm pounding through the end grain. This offers a much more positive transfer of force. It is a good idea to have the end of the block smooth and square. You don't want any unnecessary dents caused by a rough block.

If the marking gauge was set for a little less than the thickness of the tail board, the joint will seat before the pounding block starts running into the ends of the pins. This is a lot easier than trying to pound around all those small pins to seat the joint. At this point I remove the piece from the vise and check it for square. If it has to be adjusted, I always reseat it when I am done. If it's necessary, a clamp across the joint, squeezing the half pins together, will help hold it square and seated.

I wipe away any excess glue from the outside right away; planing will do the final cleanup. Any glue on the inside is best removed once it has skinned over enough so it doesn't stick to everything in sight. If there are noticeable gaps, they are easier to repair while the glue is soft. These are always repaired in the end grain and from the side that will show the most.

Wedges cut along the grain and from the same species will almost disappear. Some woods are more forgiving with this procedure than others. Mahogany end grain is the best I have seen at absorbing a wedge. With a bit of practice, it won't take long before repairing gaps is something of memories. **PW**

Sharpen a DRAWKNIFE

The biggest obstacle to mastering this traditional tool is getting it razor sharp.

Photo by Al Parrish

If you visited a crafts school that specialized in traditional woodworking, you'd almost certainly run across at least one student seated at a shaving horse, drawknife in hand, coaxing a chair leg out of a length of green hardwood. Chairmakers are among the first to sing the praises of this uncomplicated but versatile hand tool, but it's only one of many trades that has put it to good use.

Once available with blades in many different lengths and in a variety of straight and curved patterns, drawknives have been used to make everything from ship masts and barrel staves to gunstocks, wheel spokes and wooden shovels. Some patterns disappeared long ago, along with the trades that used them. For example, you won't find a crumming knife (a cooper's tool for shaping staves) at your local Ace hardware. But drawknives are still available from mail-order suppliers and having one around is an advantage even if it's used only for fitting an occasional hammer handle or sculpting the edge of a tabletop. They are also fairly safe to use, making them a good choice for children who are just learning how to use hand tools.

by Scott Gibson

Scott, author of "The Workshop" (The Taunton Press), is a writer and woodworker in East Waterboro, Maine.

Step photos by the author; some photos are from Taunton's "Complete Illustrated Guide to Sharpening."

Just as if you were sharpening a chisel or plane blade, start with the back of the drawknife. This #220-grit water stone will remove material quickly.

Follow the coarse stone with a succession of finer stones to remove scratches and create a smooth, uniform surface.

When you're finished, the back of the knife should be almost flat. Hone in a very gentle crown in the blade so you can start a cut when working with the bevel side up. A perfectly flat back will allow only very light cuts.

Like any edge tool, a drawknife works best when it's razor sharp. There are many approaches to sharpening them, depending on whether the blade is straight or curved and exactly what kind of equipment you have on hand. Large-diameter grinding wheels, like the one on the water-cooled Tormek, or a 1" belt sander with an adjustable tool rest are both well adapted for sharpening drawknives, but most of us will turn to the sharpening stones or sandpaper that we already use to sharpen plane blades, chisels and other common edge tools.

First, Get the Back Of the Blade Flat

A drawknife has a flat back and a single bevel on the opposite side of the blade. But sharpening both parts of the tool can be complicated because of the handles bent at right angles to the blade. They tend to get in the way when you try to sharpen the edge on a bench-mounted stone or a grinding wheel. Instead, you can make a jig that allows the handles to straddle a stone, or sharpen the blade by clamping it to a workbench or simply prop the drawknife up at a convenient angle with one hand and guide the stone with the other.

Start by flattening the back. Like a plane blade, it should be free of pits and other imperfections that would degrade the quality of the honed edge. Experts like Thomas Lie-Nielsen, the Maine planemaker who wrote "The Complete Illustrated Guide to Sharpening" (Taunton), suggests starting with a circular axe stone made from silicon carbide. A fairly coarse sharpening stone, such as a #220-grit Japanese waterstone, also works well. Follow that up with successively finer grits. I used #1,200- and #4,000-grit stones on the back of my drawknife until the surface looked flat and uniform.

There is such a thing as too flat. Kentucky chairmaker Brian Boggs says a drawknife with a perfectly flat back will be hard to use with the bevel up for anything other than very light cuts. A blade must be turned slightly as it starts a cut, and a very gently crowned back makes this possible. But because most of us won't succeed in flattening the back to a machinist's tolerances, Boggs says the best approach is to try to make the back as flat as you can. Chances are it will have the right amount of crown when you're done. (A DVD from Lie-Nielsen Toolworks explains in detail how Boggs uses and sharpens these tools.)

Although you can use a belt sander to flatten the back of a drawknife, you may end up removing more material than you want. Moreover, Boggs says the technique often results in a back that's rounded or crowned too much.

Lie-Nielsen recommends grinding a slight hollow in the back of the blade with the large-diameter wheel on a Tormek – if you own one. The hollow created by the wheel's radius makes it easier to sharpen the back because you only have to remove material near the front and back edge of the tool's backside, not all the way across (the same idea behind the design of a Japanese chisel). But if you have only a 8" or 6" grinder, skip this step because the hollow would be too pronounced.

Sharpening the Bevel On a Straight Blade

Bevel angles vary, but they generally range between 30° and 40°. You may want to experiment with the bevel to find the optimum angle for the kind of work you do and the wood you're working with. Whatever angle you choose, it will be difficult to form the bevel on a standard bench grinder because the tool's handles are likely to get in the way. Instead, you can use a bench stone and hold the drawknife with one handle propped up on the bench, clamp the tool to a bench or cradle one end against your shoulder. Or use a belt sander secured in a vise. If you do use a belt sander, be careful to orient the blade so the edge can't dig into the belt and make sure to wear safety gear.

If you'd rather work the tool over a stationary bench stone, a simple jig will help. It consists of a block of wood that holds the stone and an attached leg that can be

Some woodworkers advocate grinding a slight hollow in the back of the knife with a large-diameter grinding wheel, like the one on this water-cooled Tormek.

A belt sander clamped upside down on the bench quickly forms a new bevel. Use very light pressure so you don't remove too much material, and be sure to orient the blade so the edge can't dig into the belt.

A bevel reshaped with this #150-grit belt will need work on several stones to remove the deep scratches.

One way of securing the knife while working on the bevel is to clamp the tool to a workbench. Face the cutting edge away from you.

Another approach is to hold the drawknife with one hand against the bench, and to hold the sharpening stone in the other as you work the bevel.

clamped in a bench vise. You can make the jig from scrap lumber by tracing the outline of a bench stone on a short length of board, nailing on strips of wood to hold the stone, and then attaching the leg with a couple of wood screws. Alternately, you could trace the outline of the stone on a board and use a router or laminate trimmer to carve a shallow depression for the stone. The hollow doesn't have to be very deep to hold the stone in place. However you do it, the jig will give you more control in keeping a consistent bevel angle because you can use both hands to guide the tool. (See "Making a Sharpening Stone Jig" at right.)

If the edge is in relatively good condition, you can start with a #1,200-grit stone and work up from there, finishing off with a #4,000-grit or higher stone. As a wire edge develops, flip the stone to the back and hone the wire edge away. Whichever method

You can also hold the knife with one handle pressed against your shoulder, as if you were playing a fiddle. Keep the sharp edge up and watch your fingers.

A 1" belt sander with an adjustable tool rest makes short work of regrinding a bevel on a drawknife. The tool's handles won't get in the way.

To work the outside of a sharply curved drawknife-like tool, such as a scorp or an inshave, glue a piece of sandpaper to a length of wood with spray adhesive.

you use, keep the sharp edge of the blade facing away from you as you hone it. If the blade faces you, a slip or miscalculation could lead to a nasty cut.

Drawknives are not usually given a secondary bevel, but some people think a small back bevel makes a drawknife a little easier to use. If you want to try one use a fine stone to hone one on the back.

Sharpening Curved Blades

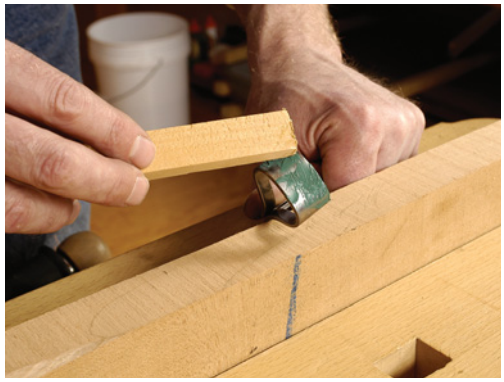
Drawknives intended to scoop out hollows have curved blades. One surface of the blade is flat; the other has a bevel. Some drawknife patterns have mild curves, but others, such as inshaves and scorps, have a pronounced bend that can't readily be sharpened on a flat stone.

A 1" belt sander does a good job of grinding the outside of a sharply curved blade. It can be followed up with stones to remove the scratches left by the belt. If you don't own a belt sander, the blade can be stoned by hand or flattened with sandpaper that's been glued to a flat board with spray adhesive. Start with a grit that's appropriate for the condition of the blade – #60- or #80-grit paper for blades that need a lot of work, finer paper for blades in good condition.

After using the sandpaper, hone the outside of the blade with sharpening stones.

For final polishing, Lie-Nielsen uses diamond paste and a small block of wood.

To sharpen a bevel on the inside of the blade, use a curved slipstone or a piece of plastic pipe on which you've glued silicon carbide sandpaper with spray adhesive. If there is a lot of material to remove, you can also use a sanding drum mounted in an electric drill and finish up with finer grits of paper mounted on a section of pipe or with a slipstone. **PW**



You can finish the outside of an inshave with diamond paste and a piece of softwood for a very polished surface and a keen edge, as Thomas Lie-Nielsen does here.

A sanding drum mounted in an electric drill is an effective first step for dressing the unbeveled face of a curve.

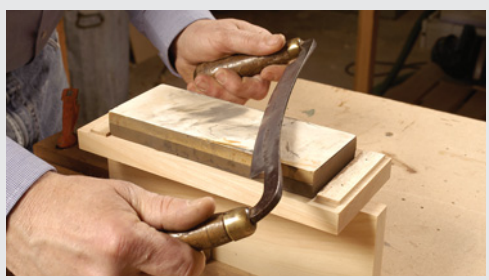
Sandpaper glued to a length of PVC pipe makes a good tool for working the inside of a curved drawknife, inshave or scorp.

MAKING A SHARPENING STONE JIG

To make a jig for a sharpening stone, first lay the stone on a scrap of wood and mark the ends.

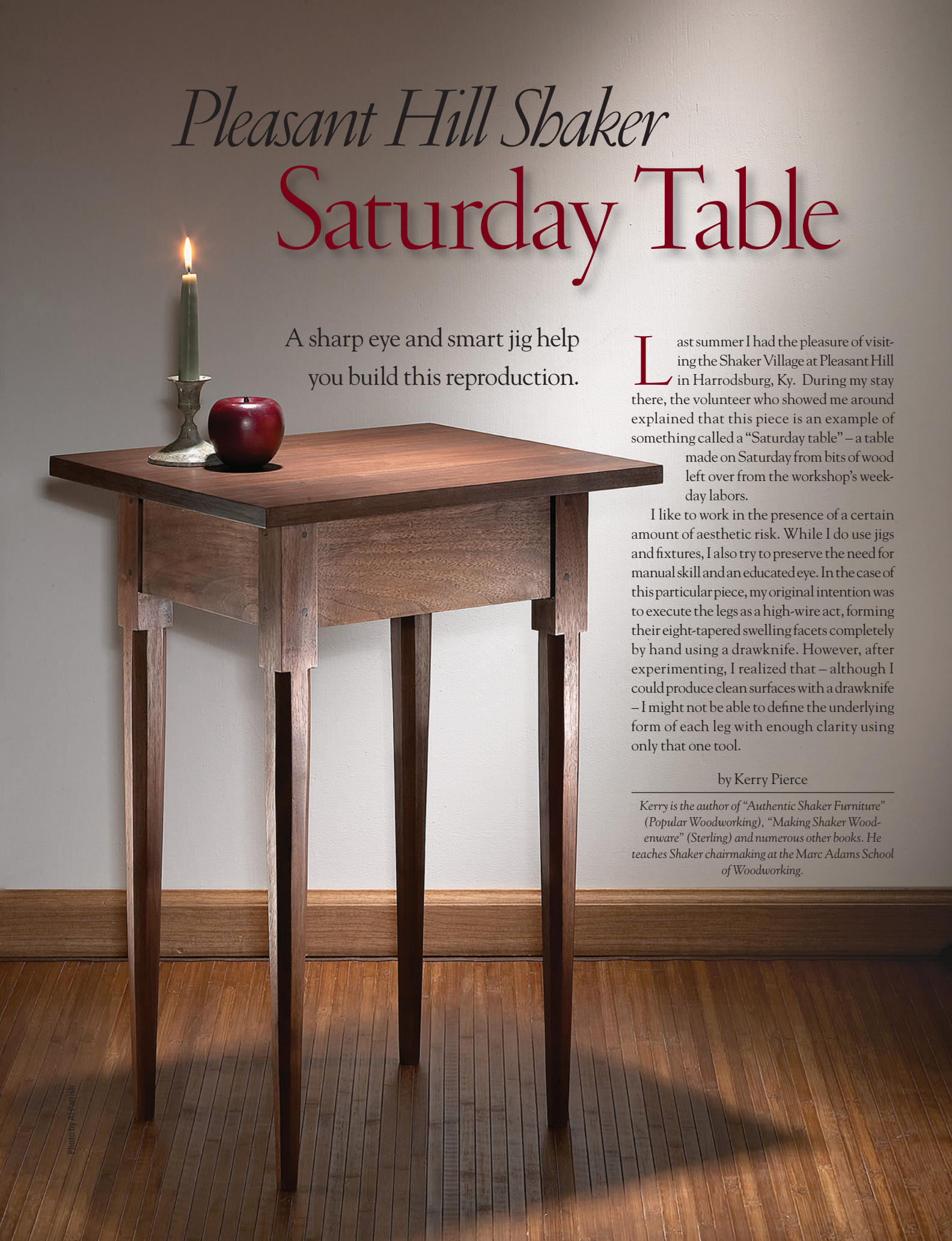
Scraps of wood nailed to the board with brads will serve as stops and hold the stone in place.

Another piece of scrap forms a leg that can be slipped into a bench vise or clamped to a workbench.



Now the full length of the knife can be worked on a stone without interference from the handles. Using both hands also allows more control and a more consistent bevel angle.

Pleasant Hill Shaker
Saturday Table



A sharp eye and smart jig help you build this reproduction.

Last summer I had the pleasure of visiting the Shaker Village at Pleasant Hill in Harrodsburg, Ky. During my stay there, the volunteer who showed me around explained that this piece is an example of something called a "Saturday table" – a table made on Saturday from bits of wood left over from the workshop's weekday labors.

I like to work in the presence of a certain amount of aesthetic risk. While I do use jigs and fixtures, I also try to preserve the need for manual skill and an educated eye. In the case of this particular piece, my original intention was to execute the legs as a high-wire act, forming their eight-tapered swelling facets completely by hand using a drawknife. However, after experimenting, I realized that – although I could produce clean surfaces with a drawknife – I might not be able to define the underlying form of each leg with enough clarity using only that one tool.

by Kerry Pierce

Kerry is the author of "Authentic Shaker Furniture" (Popular Woodworking), "Making Shaker Woodenware" (Sterling) and numerous other books. He teaches Shaker chairmaking at the Marc Adams School of Woodworking.

Photo by Al Parrish

That's when I decided to build a cradle that would allow me to use the band saw to rough in the eight surfaces of each leg, surfaces I would then finish with planes, chisels and sandpaper.

First Things First

Begin by carefully prepping the lumber for the top and apron. Glue up the top, set it aside and turn your attention to the legs.

After milling leg blanks that finish out 1¾" on a side, turn your attention to the band saw cradle (see next page). This doesn't have to be anything fancy. All you need is something that will hold the blank above the band saw table at a great enough height to allow it to be rotated on its centers.

Once the cradle is made, drill a ⅛" hole through each of the cradle's end pieces. These holes will mark the legs' axes of rotation. On the inside surface of one of the cradle's end pieces (which I'll call the headstock end), draw a square 1¾" on a side centered on the legs' axes of rotation with its bottom line parallel to the bottom of the cradle. Then draw a second square exactly the same size and also centered on the legs' axes of rotation that is rotated 45° from the first square. Finally draw a square on the inside surface of the cradle's tailstock end that is centered on the legs' axes of rotation and parallel to the bottom of the cradle. These squares will allow you to align the leg blanks for the sawing of each leg's eight faces.

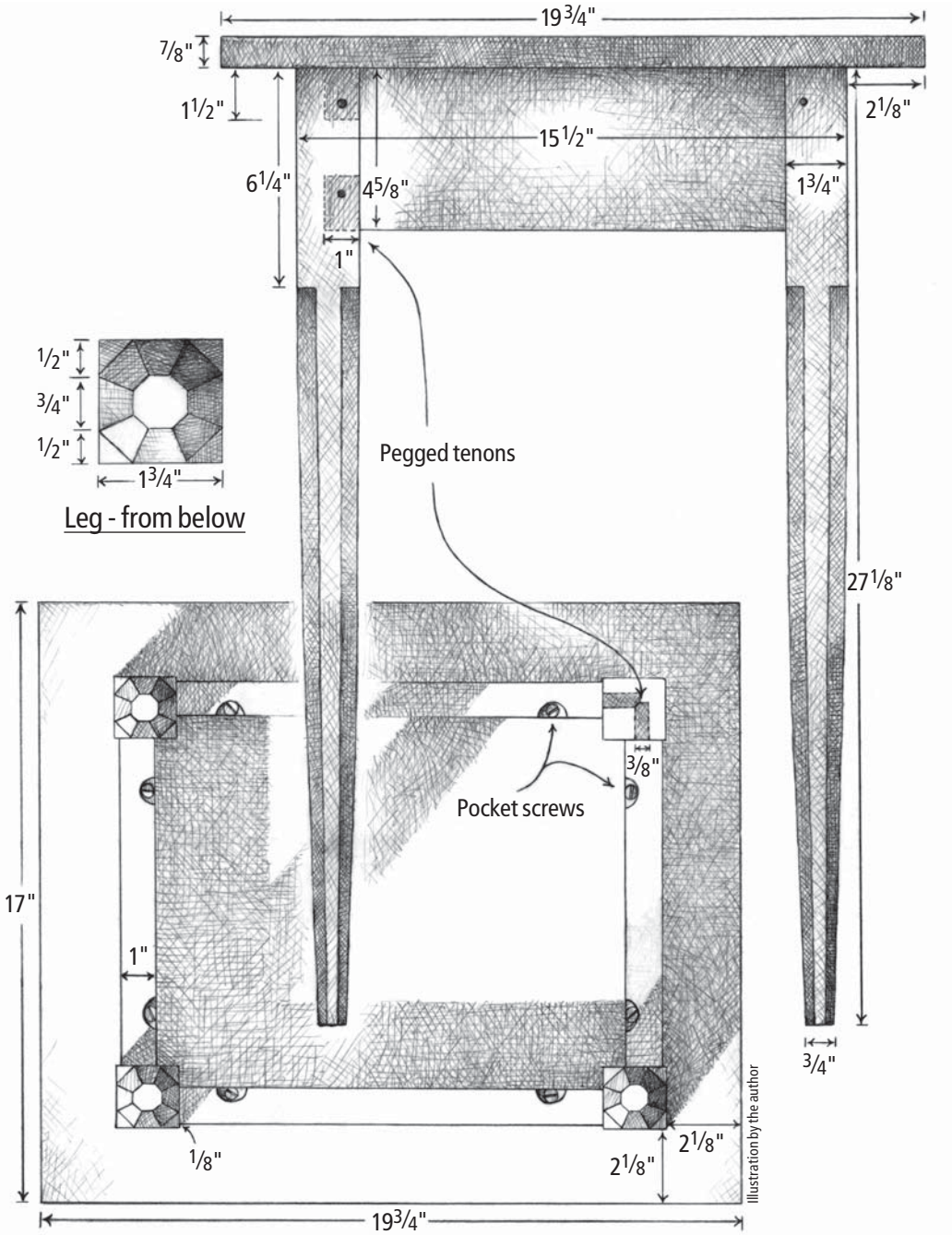
Then drill an extra hole through the end piece on the headstock end. This hole should be placed so that it is apart from the center hole and still inside each of the two squares you drew on the inside of the headstock end piece. The screw you turn into this extra hole will hold the blank in the proper alignment for each pass over the band saw.

Find the center of each end of each leg blank and mark it with a pencil. Then drill a shallow hole in the centers of each leg (½" deep, ⅛" in diameter).

Turn a 1¼" #6 drywall screw through all three of the cradle end piece holes so that the points of each screw can just barely be felt

SHAKER SATURDAY TABLE

	NO.	ITEM	DIMENSIONS (INCHES) T	W	L	MATERIAL
❑	1	Top	⅞	17	19¾	Walnut
❑	4	Legs	1¾	1¾	27⅛	Walnut
❑	2	Short aprons	1	4⅝	11¼	Walnut
❑	2	Long aprons	1	4⅝	14	Walnut



Bottom view of table

on the inside surfaces of the cradle's end pieces.

Hold a leg blank in place so that its centers are positioned directly in line with the center points you marked on the inside of the cradle's end pieces. Then turn the drywall screws on each end of the cradle into the centers of each end of the leg. With the leg blank positioned so that it aligns with the single square you drew on the inside of the tailstock end of the cradle, turn the extra screw on the headstock end of the cradle into the end grain of the blank. This third screw – the set screw – will hold the blank in the correct rotational alignment for cutting the first of the leg's eight facets.

Next, you need to make a flexible pattern for marking the leg's facets. I made mine from 1/4" birch plywood, but stiff cardboard would work just as well. The pattern should be as long as the full length of the leg's lower section – 20 7/8" – and the full width of the blank – 1 3/4". The taper you mark must retain enough of the leg's thickness so that after you've made the band saw cuts, you can plane away the saw marks without removing any of the leg's finished thickness. After some experimentation, I settled on a width of 1 1/4" at the foot of the pattern.

Lay the pattern on the blank so that its straight side aligns with one side of the leg blank and the narrow end of the pattern aligns with the foot of the blank. Then draw a line along the taper.

Place the cradle (with the leg blank attached) on the band saw and cut the first taper. Place the cradle back on the bench, back off the set screw enough so that the leg can be rotated, then rotate the blank 90° (using the squares drawn on the cradle's headstock end piece as your guide), then turn the set screw into this new position to lock the blank in place. Use your pattern to mark the next taper, return the cradle to the band saw and saw this next facet. Repeat until the first four facets are sawn.

Then remove the blank from the cradle, plane the four sawn tapers until they're smooth, and reinstall the blank in the cradle.

Before you go any further, take a close look at the drawing of the leg and the photo of the finished table. Notice that the facets you've already cut are simply tapering extensions of the four sides of the leg's upper, apron section. Notice also the next four facets – those you're about to cut – begin at shoulders which are cut in a way that connects adjacent faces of the table's square apron section.

If you haven't already done so,

MAKING THE TAPERED OCTAGONAL LEGS

1

The eight sides of the tapered legs are cut on the band saw using a cradle (which can be seen in its entirety below). On one end, the headstock end, draw two squares 1 3/4" on a side. Each should have the same center point. One should have its bottom side parallel to the bottom of the cradle. The other is canted 45° from the first.

Step photos by the author

2

The leg blank is held in place by turning a screw into the center point of each end of the leg blank. The second screw on the headstock end keeps the blank in the same rotational position.

3

Use a pattern to draw in the first four tapers.

7

Working both ways from the middle, saw each of these facets by passing the cradle past the band saw blade.

8

This photo shows the leg blank in the cradle after the second set of four facets have been sawn. Notice that the top of the leg blank is aligned with the second of the two squares I drew on the inside of the headstock end piece.

with your try square and a pencil, mark the bottom of the leg's four-sided apron section. Then mark a location 3/8" in from each end of each of these lines on the leg blank. This will be a total of eight marks, two on each side of the apron section of the leg. Next, with a fine-toothed backsaw, cut the shoulders marking the top of the leg's other four facets. Each saw cut should connect two marks, each 3/8" from the outside edges on two of the leg's adjacent faces. Be sure to cut shy of the shoulder's finished location so that you'll have material you can pare away in order to produce a finished end-grain surface.

The foot of the leg should now be a finished square measuring something in the area of 1" on a side. If it's a little more or a little less, that's fine. Make a mark 1/4" from the outside of each side of the foot. Here, too, there should be eight marks.

Working by Eye

Working freehand, draw a line connecting the mark (1/4" from the outside) at the foot with the mark (3/8" from the outside) at the bottom of the apron section of the leg. The cut along that line will form the next facet of the leg. Remember that you're going to further define this line with a plane, so don't worry if it's not absolutely perfect.

Position the blank so that the top section aligns with the second square you marked on the headstock end of the cradle. Turn the set screw into the end grain of the leg blank. Working from the middle of the marked taper, saw toward both ends of the cut.

Repeat this process until the other four sides of the octagon have been roughed in.

Remove the blank from the cradle and plane this second set of facets smooth. Holding the blank in your bench vise, use a couple of your favorite planes – and a good paring chisel up under the sawn shoulders – to fine-tune the tapers on the four legs.

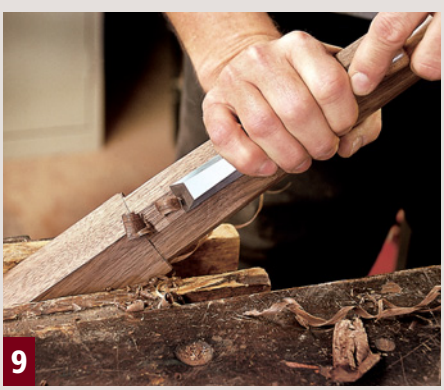
If possible, resist the temptation to reach for a measuring tool. This process works best if the only measurements are those made by your unassisted eye. Take a shaving or two from a facet that seems a little thin. (Remember that when you take a shaving, you actually increase the width of the facet.) Then rotate the blank in your vise. Take another shaving from another facet if you think you need to.

In the 15 years I've been writing for woodworking magazines, I've had the pleasure of visiting the shops of some of this coun-

Cut those first four tapers by passing the cradle past the band saw blade.

After the first four tapers have been cut, fix the untapered apron section of the leg blank in your vise. Then plane away the saw marks on the taper.

After defining the shoulders of the other four facets with a backsaw, sketch in the next set of tapers freehand.



The top section of each of the second set of facets can't be reached with a plane. Clean up these saw marks with a sharp paring chisel.

The two legs in front have been finished. The one immediately behind them has had the second set of facets sawn but not planed. The leg at the rear has had only the first set of facets sawn and planed, although the shoulders for the second set have been defined by a backsaw cut.

try's greatest craftsmen, and every single one routinely demonstrated the ability to find the right line – not only by measuring – but also by working with tools that were guided by the unassisted human eye. This isn't a skill they'd had since birth. This was a skill they developed over the course of many years of practice, and it is, I believe, the most important tool in their woodworking arsenal. If a line looks right, it probably is right, even if your rule shows you could make it little righter by taking off one more shaving.

Mark and cut the mortises for each of the apron tenons. (This time you should measure.)

The tenons can be fine-tuned with a shoulder plane or a rabbet plane.

Paring chisels will cut the flat in each screw pocket. The rounded excavation can be made with a gouge.

Making the Apron

The apron sections of the Pleasant Hill original were made, I suspect, from material left over from other jobs. One apron section is 1" thick. Another is 1⅛" thick, and all four sections taper in thickness. I decided to make my aprons a consistent 1" thick.

Create the tenon thickness with a couple of passes of each apron section over a stack of dado cutters on your table saw. Then on the band saw cut away the waste to separate the two tenons on each end of each apron section.

The tenons should come off the table saw a little thicker than needed so you have some material to plane away during the final fit. Fit each tenon to each mortise.

The screw pockets on the inside of the apron should be cut before you assemble the table. These can be made on the drill press using a Forstner bit, but I chose to use chisels and gouges as the Pleasant Hill maker had done.

I started by drawing lines on the inside face of the apron sections 1" from the top edge. I then made two marks along each of these lines 1" from the shoulders. I used the intersection of these marks as the center points for 1"-diameter half circles I scribed with a compass. I used a paring chisel to cut the flat area at the top of each pocket. This flat was tilted about 70° from the outside surface of the apron. I made the round half circle with a couple of carving gouges. You don't need to get fancy with these pockets. The ones on the original table were pretty crudely executed.

Finish each pocket by drilling a through 3/16" hole in the center of each pocket's flat spot at an angle about 90° from the surface of the pocket's flat. This will create an angle that will keep the hole from breaking out on the outside face of the apron and allow you to use 2" #6 drywall screws (coarse threaded) to hold the ⅞"-thick top in place without breaking through the top and marring the surface.

Gluing it Up

The apron sections are fairly narrow, and if your material is thoroughly dry, I think there is little chance of any cracking in response to seasonal changes in humidity, even for a table housed in a home with forced-air heat.

Nevertheless, I did take one precaution to account for any possibility of shrinkage. I undercut by ⅛" the middle edges of each tenon (the edges adjacent to the waste you removed between the tenons). This provides a little breathing room if the apron does begin to shrink across its width.

Then swab a little glue into each mortise and on each tenon and assemble the base.

Check the frame for square (when viewed from above) by measuring the diagonals of the frame. If the measurements aren't identical, apply a little pressure along the longer diagonal.

Each tenon is then further secured via a round peg tapped into a drilled hole that passes through the post and through the tenon.

These pegs are best riven, splitting them out with a chisel and paring them to approximate size. They should taper from a diameter of a bit less than ¼" on one end to a bit more than ¼" on the other. The peg holes on the original were bored – I suspect – without measuring because there was a fair amount of variation in their placement. I bored mine in measured locations: ½" from the tenon shoulder and ¾" from the top and bottom of each apron section.

Put a dab of glue on the thinner end of your peg and tap the peg – thinner end first – into the hole until it is firmly seated.

The holes on the original were bored clear through the post so that one end of the peg pokes through on the inside. I decided that mine would go in only ⅞".

Invert the top on your bench protecting it with a towel or blanket. Then center the undercarriage and join the two parts with eight 2" #6 drywall screws. Sand and finish to suit.

Split out the pegs. Then shave them to size with a paring chisel.

Just One More Thing

If you ever get the chance to measure a piece of 18th- or early 19th-century furniture, you'll notice that – despite the solid engineering and execution you will likely see – there is far less of the obsessive perfectionism that is characteristic of some modern work and some modern woodworkers. Each side of each dovetail might slant at different angles. Each section of a table's apron might be a different thickness. Cabinet backs of even magnificent high-style work might consist of unplaned boards of random widths simply nailed into a rabbet.

In part, such imperfections are simply a reflection of the craftsman's need to get work out the door so he could get paid. But more often than not, I think, they result from the craftsman's knowledge that their clients didn't evaluate their work with a ruler and a set of dividers. They knew their clients would judge the beauty of the work with their eyes. It's not surprising, then, that often the craftsman did too. **PW**

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WEB: *heartwoodschool.com*
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WEB: *woodschool.org*
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WEB: *woodschoolNH.com*
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langsner@countryworkshops.org
WEB: *countryworkshops.org*
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WEB: *conoverworkshops.com*
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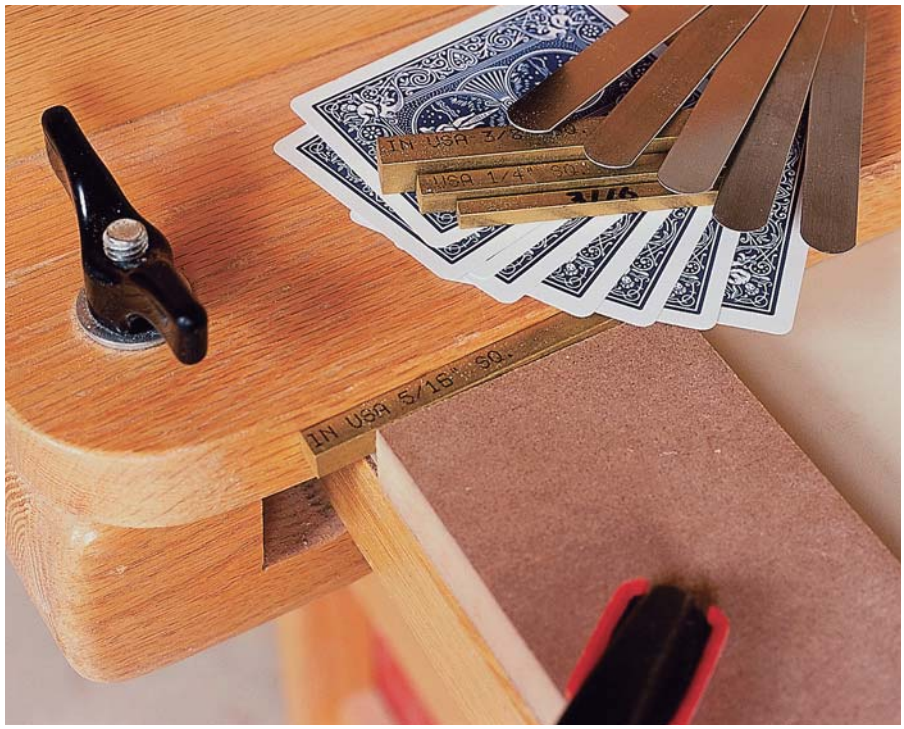


Photos by the author

A reference block and shims allow controlled tweaks to both fences and stops. The reference block can be almost any scrap. Suitable shims range from playing cards and scraps of plastic laminate to precision-thickness gauge blocks (the brass bars in the photo) and feeler gauges.

When you are using power tools for cutting parts and joinery, accuracy has less to do with laying out individual workpieces and more to do with mastering setups.

I have a simple routine. Whether I'm cutting parts or joints for a project, the routine helps me achieve good results with a minimum of fuss:

- Set the cutter and the guide device.
- Make a test cut and measure the result.
- Tweak the setup.

Do the initial setup carefully, keeping a few guidelines in mind that will simplify the inevitable tweaks. But don't get nuts about it. It's easy to waste time trying to get a perfect setup. For the initial setup, close is enough.

The test cut is your best means of evaluating the setup and making effective adjustments. Practice does make you better at this. Your "eye" improves, and your hands become more deft. Once you understand the routine, the whole process becomes second nature.

OK, What are the Guidelines?

- Start BIG. If you are cutting parts, for example, you want your test cut to leave the part oversized so you don't waste material. Once it is too short or too narrow, you can't go back. You've got to start over.
- Account for the "backlash" that's inherent in adjusters. Backlash is excessive play between adjacent moveable parts in a mechanism. Many of us are familiar with the looseness in a table saw's blade-height adjustment. Crank the blade up, then lower it. As you reverse the direction, there are several degrees of free movement before you feel the resistance of the gears meshing. That slack is the backlash and it is a real problem.

The way to deal with it is to stage the setup so the adjuster is moving against the pressure that results when the tool is turned on and the cut begins. If you neglect to lock the crank on the table saw, the blade is going to slowly drift down. Make the initial setting and your tweaks by elevating the blade. Begin the setup with the cutter below the saw's table. Raise it for the initial test cut, but deliberately leave it low. You want to creep up on the setting.

Remember that backlash isn't a problem only on the table saw. It affects the adjustments on routers, router lifts, edge guides, radial-arm saws, planers and many other tools.

- Use stops wherever you can. Stops do more than arrest movement. They establish limits. When you use a stop for an operation, you have a good means to ensure consistent, accurate results. You also have a good base from which to tweak your setup.

by Bill Hylton

Bill is the author of several books about furniture construction and router operations. When he isn't writing about woodworking, he's doing it in his home shop in Kempton, Pennsylvania.

Initial Setup

Initial setup can be done with a rule. Here are some examples:

- Almost every table saw's rip fence has a scale giving you a reading on the distance from the fence to the blade. But you can't use it for every setup. If you are setting up for the shoulder cut of a rabbet, you need to include the blade in the measurement. The scale, though, doesn't give you that.
- For crosscuts, whether on the table saw or a power miter saw, use a rule butted against a tooth (not the plate) of the blade to set a stop (see photo at right). A tape measure is usually on my belt, right at hand for all sorts of measuring. But for this task, I use a steel rule, whether a 6" pocket rule, a yardstick or something in between.
- Set a router table fence with a square. Hold the head against the fence with the rule extending just above the bit. Measure either to the cutting edges or to the axis of the bit.

When possible, eschew measurement entirely and use a setup gauge. The obvious example here is using an existing part to set a cutter height, fence position or stop so you can make a duplicate.

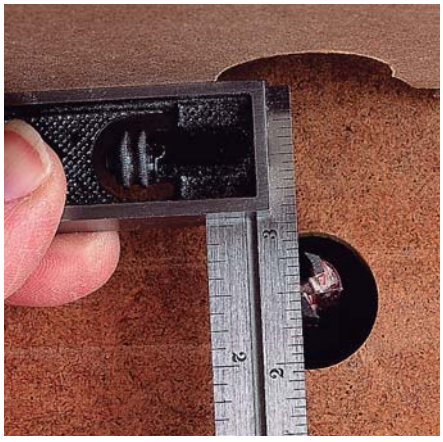
You can set the bit height using a rule but sometimes using a workpiece is more accurate. Here a mortising bit is being set to cut tenons. Whether you use a rule or a mortised workpiece, leave the bit just a bit low. Cut a test tenon and fit it to the mortise. Fine-tune the bit height based on the fit.

Use a steel rule to set a stop for crosscuts on the table saw. Butt the rule against a tooth (not the plate), align the block over the target graduation, and clamp the block to the fence.

Machinists use a multipurpose gauge system for accurate setups. A one-two-three block is precisely 1" thick, 2" wide and 3" long. A machinist's version is steel, but you can make your own using a stable hardwood. Setup gauges are slivers of steel, aluminum or brass in precise thicknesses.

Want to rip a 3"-wide stile? Butt the end of the one-two-three block against a tooth of the saw blade, then slide the rip fence against the other end. Want the stile $2\frac{5}{16}$" wide? Turn the block so its 2" side is against the blade and supplement it with a $\frac{1}{4}$"-thick gauge and a $\frac{1}{16}$"-thick gauge.

When you are making a two-part joint (tongue-and-groove, cope-and-stick and half-lap are prime examples), use the first half of the joint to reset the cutter height or fence position for cutting the mating part.



To accurately set a router table fence for a precision test cut, use a machinist's small adjustable square. Rotate the bit to align the cutting edges, then get the rule as close as possible to the appropriate edge.

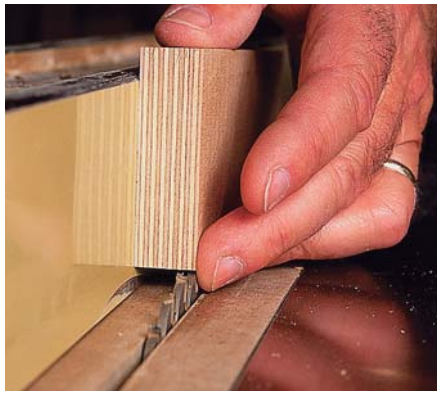
Gauge blocks can be used to set a fence in relation to a cutter. Here the gauge is a scrap of $\frac{1}{4}$" hardboard and the tool is a mortiser. Just hold the gauge against the fence and slide the fence into contact with the chisel.

The Test Cut

All this gets you close. Sometimes that's good enough, but where accuracy is essential, you've got to check things with a test cut. Follow-up tweaks are usually needed.

Don't make the test cut in just any old scrap from the offcuts bin. If you are simply checking the width of a rip cut or the length of a crosscut, by all means use scrap. But think it through. If you're testing a joinery cut, the actual girth of the working stock is of critical importance. Yes, using a real workpiece can be risky. As you plan a project, you can foresee this situation, so make it a point at the outset to prepare extra pieces for testing setups.

Evaluate the resulting cut. If it is a joint, see if the mating parts fit together properly. If it is a



Sawing a rabbet in two passes? Forget the fence's scale when setting up the shoulder cut; you have to measure from the outside of the blade. Use a scrap of the stock that will be housed in the rabbet. Your touch will tell you when the scrap's face is flush with the blade's cutting tips.

When readjusting the blade for the bottom cut, a shoulder-cut sample is going to be the most accurate gauge. Raise the blade so its teeth just skim the shoulder; you don't want a ridge of waste where the shoulder meets the bottom.

part, see if it fits the assembly. If measurement is required, use a precision tool. Your trusty tape measure isn't it. In many instances, dial (or digital) calipers are.

With a standard 6" caliper, you can measure inside and outside dimensions, as well as depths. You can measure the thickness of a piece of plywood or a scrap of veneer, the width of a dado, the depth of a rabbet. You can make the measurements quickly, and with unmatched accuracy.

Machinists use dial calipers to measure in thousandths. Fractional dial calipers do the conversion from decimals to more familiar fractions for you. If you can measure a part or a cut with the calipers, and you have the means to move the cutter, fence, or stop a precise distance, you can tweak setups efficiently.

Tweaking Your Setup

In many woodshops, a gentle bump with a fist or the heel of a hand on a fence is what passes for a tweak to a setup. If that works for you, fine. I do it too sometimes, but the results are seldom really satisfactory. Your aim is precision. Having done the initial setup so it would be tweak-able, and having made and precisely measured your test cut, you should follow through with the same mind-set.

At this point, the question is: What's the difference between the cut you want and the cut you have? Is the cut you have too deep or too shallow? Too wide or too narrow? Is the piece too long or too short? The answers tell you how much and in what direction to adjust your setup.

Most table saw rip fences (and some commercial router table fences) have a scale to aid in positioning. The scale works for adjustments of 1/32" but precise movements smaller than that are iffy.

One helpful trick for fence adjustments is to scribe a pencil line on the tabletop along the fence during the initial setup. This line gives you a way of assessing the movement. If you move the fence away from the line, you may be able to actually measure the gap. The risk in moving the fence toward the pencil line is that once the line disappears under the fence, you have no way of determining how far past the line the fence has moved.

On a router table, you can often put geometry to work for you. Did you know that if you move only one end of the fence, the distance you move it at the edge of the table is halved at the middle of the table? That means swinging one end of the fence 1/16" moves it only 1/32" at the bit.

When you must machine both halves of a joint, use the first part to set up for cutting the mate. Set up for cutting a tongue by aligning the slot cutter against a sample of the grooved stock. "Prove" your setup with a sample cut before cutting all the work.

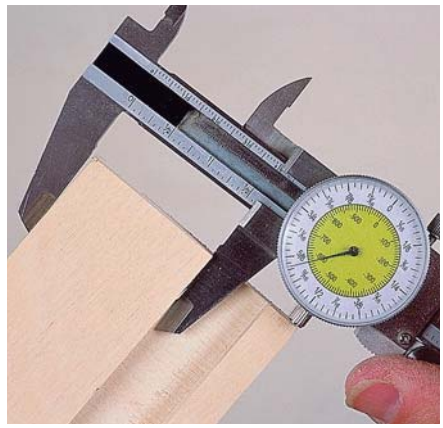
The Reference-block-and-shim System

Let's say you want to move the fence 1/16" closer to the cutter. First place a block of wood against the back of the fence and clamp the block to the table. Now unlock the fence and move it far enough to drop a 1/16"-thick shim between it and the block. Slide the fence back, pinching the shim between it and the block. Re-lock the fence.

If you need to move the fence away from the cutter, the tweak is just as simple. First pinch the shim between fence and block as you first position and clamp the block to the table. Then unlock the fence, remove the shim, shift the fence directly against the block and re-lock the fence.

Depending on how far the fence must be moved, you can use scraps of MDF as shims at one extreme and feeler gauges at the other extreme. The machinist's setup gauges I mentioned earlier are perfect for this. By combining the various thicknesses, you can range from 1/16" through a full inch by 16ths. For smaller increments, I use feeler gauges, playing or business cards, alone or in combination with other shims.

I use this block-and-shim approach primarily for adjusting the fences on my router tables, but it works equally well with a few jigs and fixtures I use with portable routers, and with the table saw's rip fence.



Use dial calipers to measure a test cut. The tool's jaws accurately capture the measurement, and it displays the dimension in increments as fine as one thousandth inch (.001"). Fractional dial calipers eliminate the need to convert from decimals.

A variation is a block with a machine screw threaded through it. Clamp the block with the screw against the fence. Turning the screw one way pushes the unlocked fence toward the cutter, while backing the screw away from the fence allows it to be pushed back away from the cutter.

Using a commonplace 3/8"-16 bolt or screw in your block provides a measured adjustment – 1/16" per full turn. I use a cap screw and turn it with an Allen wrench. You can make adjustments of 1/128" pretty easily. It's 1/8 of a turn – just 45°. **PW**

Use a reference block and shims to move a router-table fence closer to the bit. Unlock the fence and slip your shims between the fence and reference block. Push the fence tight against the shims and the block and re-lock it. The movement at the bit will be half the thickness of the shims.

PRODUCT INDEX

	PAGE #	CIRCLE #	WEB ADDRESS
ADHESIVES			
EpoxyHeads	8	118	epoxyheads.com
Franklin International	33	122	titebond.com
Gorilla Glue	16	126	gorillaglue.com
Liquid Nails	21	140	liquidnails.com
Old Brown Glue	94	148	patrickedwareds.com
BITS, BLADES & CUTTERS			
Amana Tool	8	103	amanatool.com
CMT	87	112	cmtusa.com
Forrest	19	121	stores.yahoo.com/forrestman
Freud	15	123	freudtools.com
Infinity Tools	87	131	infinitytools.com
Routerbits.com	94	156	routerbits.com
Woodline USA	25	168	woodline.com
BOOKS			
Astragal Press	95	106	astragalpress.com
BUILDINGS			
SteelMaster Buildings	95	158	steelmasterusa.com
FASTENERS			
Arrow Fasteners	93	105	arrowfasteners.com
McFeely's	17	144	mcfeelys.com
FINISHES & SUPPLIES			
Critter Spray Systems	93	114	wwdc.com/critter
FURNITURE & PROJECT PARTS			
Adams Wood Products	18	100	adamswoodproducts.com
Architectual Products	94	104	archpro.com
Osborne Wood Products	17, 24	151, 175	osbornewood.com
HAND TOOLS			
Alisam Engineering	94	102	alisamengineering.com
Bob's Rule	87	110	bobsrule.com
Fine Tool Journal	95	120	finetoolj.com
Japan Woodworker	89	132	thejapanwoodworker.com
Lee Valley	20	138	leevalley.com
Lie-Nielsen Toolworks	89	139	lie-nielsen.com
Robert Larson	89	155	rlarson.com
Tools for Working Wood	24	160	toolsforworkingwood.com
Traditional Woodworker	94	161	traditionalwoodworker.com
Wood Artistry	94	166	woodartistry.com
HARDWARE			
Ball & Ball	87	108	ballandball-us.com
Whitechapel Ltd.	93	164	whitechapel-ltd.com
Woodworker's Hardware	87	171	wwhardware.com
KITS & PLANS			
Glen-L Marine	95	125	glen-l.com
Pygmy Boats	95	154	pygmyboats.com
Texas Knifemaker	94	159	texasknife.com
U-Bild.com	95	162	u-bild.com
POWER TOOLS			
Delta Machinery	4-5	115	deltamachinery.com
Fein Power Tools	C3	119	feinus.com
General Mfg.	23, 82-83	124, 185	general.ca
Grex USA	13	128	grexusa.com
Grizzly Industrial	C2-1	129	grizzly.com
Jet Tools	7	176	jettools.com
Makita USA	C4	142	makitatools.com
Oneway	18	150	oneway.on.ca
Powermatic	2	153	powermatic.com
Wilke Machinery	13	165	wilkemach.com
Woodstock International	9	170	woodstockinternational.com
POWER TOOL ACCESSORIES			
Beall Tool	95	109	bealltool.com
Craftsman Gallery	95	113	thecraftsmangallery.com
JDS	17	134	thejdscompany.com
JessEm Tools	22	135	jessem.com
Keller & Company	24	136	kellerdovetail.com
Kreg Tool	22	137	kregtool.com
Leigh Industries	23	—	leighjigs.com
Mule Cabinetmaker	87	145	mulecab.com
Mystic Works	94	146	featherbow.com
Speed-Cope	18	157	speedcope.com
Woodpeckers	87	169	woodpeck.com

	PAGE #	CIRCLE #	WEB ADDRESS
SAWMILLS & KILNS			
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Granberg International	94	127	granberg.com
Norwood Industries	95	147	norwoodindustries.com
SCHOOL/INSTRUCTION			
Center for Furniture Craftsmanship	89	—	woodschool.org
Marc Adams School	24	143	marcadams.com
SHOP ACCESSORIES			
Airware America	94	101	airwareamerica.com
Diefenbach Benches	94	116	workbenches.com
Oneida Air Systems	13	149	oneida-air.com
TURNING SUPPLIES			
Augums Pen Works	94	107	augumspenworks.com
Packard Woodworks	95	152	packardwoodworks.com
WOOD & VENEERS			
M.L. Condon	94	141	—
Wall Lumber	24	163	walllumber.com
Woodfinder	95	—	woodfinder.com
Woodworker's Source	94	172	woodworkerssource.com
WOODWORKING CATALOGS			
Hartville Tool	87	130	hartvilletool.com
Woodcraft	11, 17	167, 177	woodcraft.com
Woodworker's Supply	93	173	woodworker.com
WOODWORKING SHOWS			
Woodworking Show, The	24	174	thewoodworkingshows.com
Woodworks Shows	82-83	—	woodworksevents.com

ADVERTISER INDEX

What is Oil?

Understanding just a little chemistry will teach you a lot about this finish.

Photos by the author

Commercial brands of oil/varnish blend are widely available and very popular with woodworkers because these blends are easy to apply and produce very pleasing results with little risk of problems.

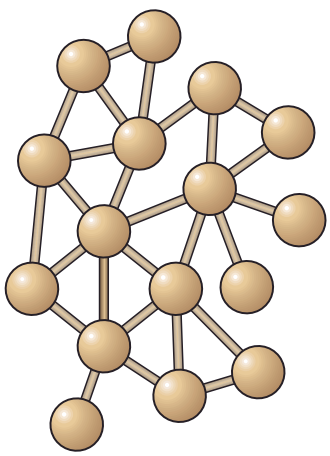
At a recent wood-finishing seminar, a participant asked, "What is oil?" The question caused me to remember my own confusion a number of years ago. The term "oil" can seem confusing because there are many very different finishing products labeled and marketed (or mis-marketed) as oil.

Here's an explanation of oil.

The Nature of Oil

You've probably noticed that some oils stay liquid forever while others get sticky after a while and still others dry completely. The explanation is that some oils have more "reactive sites" than others, and it is at these sites that the molecules in oil form a chemical bond, or "crosslink," or "hook up," when exposed to air (more specifically, to oxygen in the air).

Oils that never dry have very few or no reactive sites; oils that dry only to a sticky state have a few reactive sites; and oils that dry completely to a soft film have sufficient reactive sites to make curing possible.



The drying of oils can be represented by Tinker Toys. Upon exposure to the oxygen in air, the molecules of oil crosslink or "hook up" to form chemical bonds (represented by the sticks). When enough of the molecules have crosslinked, the liquid oil changes to a soft solid.

I find it helpful to picture the method of drying as Tinker Toys on a molecular scale. The sticks in the Tinker Toys represent the chemical bonds, or crosslinks, at the reactive sites. The more "sticks," the tighter the network and the better the drying.

The two large families of oils used in finishing are mineral oil and vegetable oil.

Mineral Oil

Mineral oil (or with an added scent, baby oil) is distilled from petroleum and has no reactive sites. So mineral oil never dries.

A number of companies sell mineral oil labeled to make it seem more exotic. Examples include mystery oil, butcher-block oil and sometimes "teak" oil. If an oil product sold as a wood finish stays liquid no matter how long you leave it exposed to air, then it's almost surely mineral oil.

If you apply mineral oil to wood and wipe off the excess so the surface isn't smeary, the oil that remains continues to penetrate. This may take a very long time, so what you experience over several months is the wood losing its color and looking drier until eventually it looks raw.

If you continue applying mineral oil to the wood, eventually you "fill it up" so that the surface remains in a semi-permanent oily state. The surface feels oily and smudges when you touch it.

Washing at any point along the way removes the surface oil, of course, leaving the wood drier and more colorless.

Mineral oil is ineffective as a protective or decorative finish for wood.

Vegetable Oil

Vegetable oils are pressed from plant seeds and nuts, and are made up of a glycerol mol-

by Bob Flexner

Bob is author of "Understanding Wood Finishing" now in its second, fully revised edition. To purchase, visit amazon.com, your local bookstore or a woodworking supply store.

HOW TO APPLY OIL

Oil is the easiest of all finishes to apply with good results. Simply wipe or brush the oil onto the wood (or pour on the oil and spread it around), let the oil soak in for a few minutes, then wipe off all the excess before it dries.

This direction applies to all types of oil and all blends of oil and varnish. The only thing you can do wrong is not wipe off the excess. (If a little oil "bleeds" back out of the pores after you have wiped off the excess, continue wiping every 30 minutes or so until the bleeding stops.)

If you are using a non-drying oil such as mineral oil, there is no need to apply multiple coats except after several weeks or months, or whenever the surface begins to appear dry.

If you are using a semi-drying oil (such as walnut oil), a drying oil (such as boiled linseed oil or tung oil), or a blend of oil and varnish, the best procedure is to allow each coat to dry before applying the next. Each additional coat then adds a tiny bit of build to what is already there, which improves the moisture protection to the wood. The second and sometimes third coats also improve the sheen (that is, shine) to make the wood look better.

Unfortunately, some of the most popular brands of oil/varnish blends instruct to apply the second coat 45 minutes after the first. The second coat then merely mixes with the first because it hasn't had time to dry. There's no improvement in protection or sheen.

As a general rule, you should allow each coat to dry overnight in a warm room before applying the next. But with tung oil, it's best to wait several days between coats because it takes longer to dry.

Walnut oil, raw linseed oil and some proprietary brands, such as Tried & True (based on raw linseed oil with no driers added), take a very long time to dry, sometimes weeks, so they have questionable use as wood finishes. They owe their survival as wood finishes primarily to the continued existence of the "food-safe" myth – that oils with driers added are unsafe to eat off of.

The drying of all oils (all finishes for that matter) can be accelerated by raising the temperature. You can do this by turning up the heat, putting the object under a heat lamp or, if the object is small, putting it in an oven set on low for a short time. *— BF*

1 Sand the wood to remove mill marks and other flaws. Sand with a grit sandpaper (usually #80, #100, or #120 grit) that removes the problem efficiently without creating unnecessarily deep scratches. Then sand up through the grits to #180 or #220 grit, removing the scratches created by each previous grit.

2 Apply a wet coat of any oil or oil/varnish blend to the wood with a cloth or brush. Allow the finish to penetrate a few minutes and apply more oil to any spots that dry due to penetration. Then wipe off the excess finish. (No benefit is gained by heating the oil first or rubbing it "into" the wood; the oil penetrates all that it can on its own.)

3 For subsequent coats, wait until the previous coat has dried, then sand with very fine sandpaper (#400 or #600 grit) just enough so the surface feels smooth. Follow by applying another coat like the first and wipe off the excess.

You can also apply a wet coat of finish first and then sand the surface lightly while it is still wet, as I'm doing here. The oil serves as a lubricant for the sandpaper, creating a slightly "softer" sheen and smoother feel. The sanding dust isn't a problem because you're wiping off all the excess. (Using very fine sandpaper to sand between or within coats produces the same ultra-smooth results as pre-sanding the wood to #600-grit, but with much less work.)

Apply additional coats after each previous coat has dried until you don't notice any improvement. Usually two to four coats are all that are necessary, but you can apply as many coats as you like. To reduce scratches to the surface, you can apply paste wax after the finish has dried.

CAUTION: With any drying oil, or blend of drying oil and varnish, hang the rags you use or drape them over the edge of a trash can or table to harden. Drying oils have the potential to spontaneously combust if rags are piled up so the heat that is created in the drying can't dissipate.

ecule with three fatty acids attached. This compound is called a "triglyceride," a term you're probably more familiar with in the context of blood tests and what is more or less healthy to eat.

There are many different fatty acids, each containing from zero to four reactive sites. Sometimes all three fatty acids attached to a glycerol molecule are the same, but usually they are mixed.

So the best way to figure the number of reactive sites in any given triglyceride or oil is to use averages.

Oils with fatty acids containing an average of zero-to-one reactive site per fatty acid don't crosslink enough to ever dry. So these oils, which include olive, castor and coconut, are similar to mineral oil. In the context of wood finishing, they are called "non-drying" oils.

Oils with an average of one-to-two reactive sites per fatty acid dry better. But the drying takes a very long time, often never getting past the sticky state. These oils are called "semi-drying" oils. Examples include walnut, soybean (soya) and safflower oil.

Oils with fatty acids containing an average of two or more reactive sites dry fully to a soft film and are called "drying" oils. The most common examples are linseed oil (pressed from seeds of the flax plant) and tung oil (pressed from nuts of the native Chinese tung tree). Drying occurs faster when metallic driers are added.

These driers, which are often sold separately as "Japan Drier," are catalysts that speed the introduction of oxygen into the oil. (Lead was once used as a drier in wood finishes, but it isn't anymore.)

Driers are commonly added to raw linseed oil to create "boiled" linseed oil. Driers aren't added to tung oil because they can cause it to take on a frost-like appearance when dry.

A myth persists in the woodworking community that finishes with driers added are unhealthy for contact with food or children's mouths. This is not the case as long as the finish has fully dried; the rule of thumb for drying is 30 days, but the time can be reduced significantly in warmer temperatures.

The difference between linseed oil and tung oil can be explained quite easily as the difference in the number of reactive sites on their respective fatty acids. Linseed oil has an average of about two reactive sites on each fatty acid, whereas tung oil has an average of about three.

With more reactive sites, tung oil dries significantly faster than raw linseed oil – but not as fast as boiled linseed oil with the driers added. Tung oil also dries to a tighter Tinker Toy network than either raw or boiled linseed oil, so tung oil is more water resistant.

Unfortunately, many finish manufacturers label varnish thinned about half with mineral spirits "oil," usually "tung oil." Varnish is about as different from oil as two finishes can be. Varnish, even when thinned, dries hard, so each coat can be left wet on the surface to create as thick a film build as you want. Oil and blends of oil and varnish have to have all their excess removed after each coat or they will dry gummy.

Make your own oil/varnish blend by mixing some boiled linseed oil and/or tung oil with varnish. A higher ratio of varnish increases scratch, water and stain resistance, and raises the gloss. A higher ratio of oil slows the drying so you have more application time. Add mineral spirits to make the finish easier to spread.

Oil/Varnish Blend

Linseed oil (rarely tung oil because it's much more expensive) is often combined with varnish to create an oil/varnish blend. Blends of oil and varnish are very popular finishes with woodworkers.

You can easily make your own blend, of course, by mixing any varnish, including polyurethane varnish, with boiled linseed oil and/or tung oil. To make spreading easier, you can add mineral spirits (paint thinner) to thin the finish. Begin with one-third oil, one-third varnish and one-third mineral spirits, and adjust from there to your liking.

Adding a drying oil (which dries soft) to varnish (which dries hard) prevents the mixture from hardening. So oil/varnish blends have to be applied like straight oil. All the excess must be wiped off after each application or the result will be a soft, gummy finish.

Only a miniscule build can be achieved with any of these "oils," which is the reason linseed oil, tung oil, and blends of oil and varnish offer much less protection for wood than do finishes that cure hard and can be built up to greater thicknesses.

But the thin build makes these finishes easy to repair. Simply apply another coat of oil. You don't need to use the same brand – or even the same type of oil. For that matter, as long as the surface is clean and totally dry, you can apply any finish over an oil finish.

Some suppliers of oil/varnish blends make pretty ridiculous claims for their products – that they make the wood harder, protect the wood from the "inside" or provide some other magical effect. In fact, these blends do nothing to wood; they simply crosslink and cure like any straight drying oil or varnish. **PW**

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The Changing Laws of Physics

Here's hoping they're cyclical.

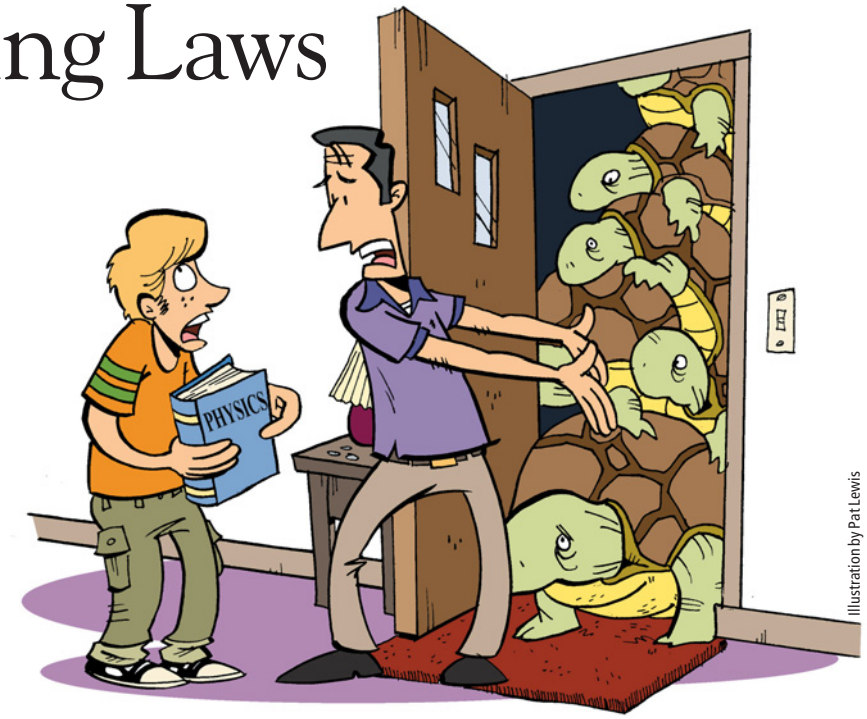

Illustration by Pat Lewis

When my son complained how high school physics was dull and difficult, I reminded him how important it is.

"I use physics every day in the shop."

"Like how?" grunted Gary from the recliner.

"Well, umm … figuring the moisture content of a board."

"That's chemistry and algebra."

"Say I'm making a futon and I need to calculate the area of an adjacent rhombizoid …"

"Geometry."

"How about calculating the holding power of a screw in cherry?"

"You'd consult an engineering table."

"How about the amount of calories I consume next time I tan your hide for talking back to your father?"

"Force equals mass times acceleration. Although if an old man runs at velocity V and son runs at $2v^2$, the trajectories never intersect," said Gary as he ejected himself from the recliner and sped away. I took his seat. Adults are so much smarter than kids.

In my lifetime, the laws of physics have changed noticeably. This mutability of physical laws may be the greatest discovery since the quantum theory. Ancient scientists said the earth was flat and supported by elephants standing on a stack of turtles. Maybe they were right. Maybe one day the earth fell off. The elephants and turtles caught fire and started rotating around the earth just as the medieval scientists believed. Gravity shifted everything around to the way you see it today. The great scientists, Copernicus, Newton and Einstein were just the first people to notice.

I first observed the increase in gravity about 10 years ago, while lifting a large plank of green 16/4 cottonwood. A cracking sound came from my lumbar vertebrae. The board weighed 250 pounds. Now, for anything over 120 pounds, I get the forklift (or a kid).

Gravity isn't the only law that has changed. One day Gary interrupted me as I explained how centrifugal force could throw a carbide tooth out of a saw blade and hurt someone.

"Dad, there's no such thing as centrifugal force."

"Of course there is. I learned about it in physics class 30 years ago."

"Well, I'm taking physics and my teacher says there's no such thing."

"How do you explain why the earth doesn't plunge into the sun then, mister smarty-pants?"

"Duh, Dad. That is just simple gravitational acceleration."

"How about when you swing a bucket of water over your head? You need an equal and opposite …"

"… acceleration caused by a constant perpendicular force."

by Peter Sieling

Peter owns Garreson Lumber Co., a hardwood supplier in Bath, New York.

Now I'm afraid to turn on the table saw. If a tooth comes loose, there's nothing to prevent it from shooting out of orbit and possibly hitting a space shuttle.

Lumber properties have changed, too. Wood used to be a lot softer. My great grandfather cut rabbets, dados and mouldings with hand planes. He even tongue-and-grooved floors by hand. I sharpened a couple of his planes and tried them out, but finally had to give up – I couldn't find the on/off switch. Now I'm stockpiling basswood. In a few years it will be the only wood light enough to lift and soft enough to work.

Thirty years ago nothing could surpass the speed of light. Now scientists claim they can slow it down and speed it up. I've observed a decline in light quality over time. Only a few years ago, I could look across the room and read the directions on a can of varnish on a shelf. Now I have to remove my glasses, close one eye and hold a container four inches from my eyeball.

Philosophers argue whether history is cyclical or teleological. I'm hoping it's cyclical. If I live long enough, I may be able to once again lift 250-pound boards and swing a bucket of water over my head without getting soaked. Who knows, maybe I'll be able to look over the edge of the earth and see the giant turtles. **PW**

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