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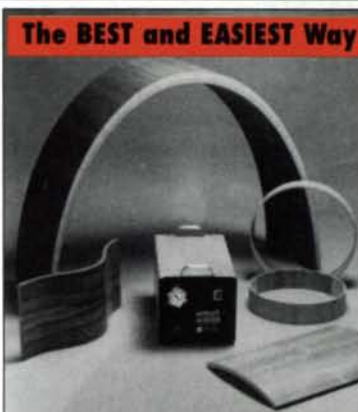
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Photo: Michael Pekovich



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Contributors

For the past couple of years, **John White** ("Jointer Tune-up") has been the shop manager for *Fine Woodworking* magazine. He grew up in New Jersey but settled in Vermont after dropping out of engineering school. He taught himself woodworking from the pages of *Fine Woodworking* and has worked in construction and cabinetmaking. He lives in Newtown, Conn., with his wife, Roxy, an editor at *Threads* magazine, and their son, John. White is currently writing a book—to be published in spring 2001—on tuning up woodworking machinery.



Anthony Guidice (Rules of Thumb) grew up in Bernardsville, N.J., and received an MFA in photography from the Rochester Institute of Technology. He now operates Lake Woodworks in Rochester, N.Y., where he makes custom furniture, teaches workshops and publishes a quarterly newsletter.

Contributing editor **Mike Dunbar's** ("One-Drawer Lamp Stand") life changed course when he bought his first Windsor chair at a yard sale in Worcester, Mass. At the time he was a college



student, with absolutely no woodworking experience, on his way to a degree in French. He studied the chair, trying to figure out how it was made. Hand tools were the answer, and by the end of his senior year, he had orders for 50

chairs. He is the author of seven books, including two from The Taunton Press: *Make a Windsor Chair with Michael Dunbar* and *Federal Furniture*. Every year at his school, called The Windsor Institute, he teaches 350 students the craft of making Windsor chairs by hand. Dunbar insists that his wife, Sue, "is the brains behind the operation." He and Sue live in New Hampshire with their son, Michael.

Kim Carleton Graves ("Duplicate Spindles by Hand") got his start in woodworking by building sets for the Bard College Theater while he was studying physics. For the next 15 years, he worked as a computer programmer but dabbled in woodworking all the while. He took the plunge and switched careers in 1995, launching the



custom furniture business he now runs at his shop in Brooklyn, N.Y. His designs are influenced by images from architecture, sculpture and the natural world. He's most

interested in how furniture can enhance a space for the people who live in it. Graves welcomes e-mail to him at kcg@CWing.com.

Gary Rogowski ("Tenoning Strategies") has been designing and building furniture for more than 25 years, teaching woodworking for the last 20, and a contributing editor to *Fine Woodworking* since 1996. He is currently teaching at his own school,



the Northwest Woodworking Studio in Portland, Ore., and is working on an illustrated guide to joinery, a book for The Taunton Press.

He still manages to coach the local fourth-grade girl's basketball team.

Steve Latta ("Where Door Meets Door") teaches furniture making at the Thaddeus Stevens College of Technology in Lancaster, Pa. The school's program covers both modern cabinetmaking and traditional woodworking. Latta also serves on the executive council of the Society of American Period Furnituremakers, which will sponsor seminars this summer at the college. Latta is looking forward to teaching a class on line-and-berry inlay. During the soccer season, he spends time coaching his son's team.

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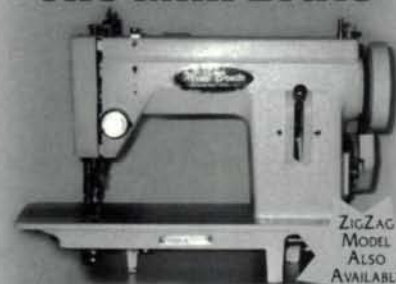
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Letters

Wax recipe measurement clarity—

Stuart M. Altschuler's article, "A Wax Primer" (*FWW* #140, pp. 46-51), has all the hallmarks of excellence: clear writing, great illustrations, summary directions. However, there was no discrimination between liquid and dry measure. Three parts turpentine and one part beeswax might not require the greatest accuracy. And as the article points out: if too thick, add solvent; if too thin, let some solvent evaporate. But more complex mixtures, especially those that add chemicals, do require some precision. Please clarify.

—Ken Leitner, Pottstown, Pa.

STUART M. ALTSCHULER REPLIES: All of the measurements in the article and its accompanying recipes are rough liquid measure, as shown in the photos.

Disagrees with Q&A answer—In your recent Q&A (*FWW* #141, p. 102), Lonnie Bird believes it unnecessary to convert to bearing guides from metal-block guides on a bandsaw. Next to his answer is a picture showing our Iturra Bandroller bearing guides replacing block-style guides, giving the impression that he is directly referring to our product.

Bird says one advantage of block guides is that they "support the blade closer to the work." For some large bearing guides this might be true, but because our small Iturra Bandrollers utilize the same guide holders as the block guides, this disadvantage is overcome. One advantage of bearing guides is that you can allow continuous contact with the blade without creating the heat that would result if blocks were adjusted without clearance.

Bird also says that the most damaging

heat is generated at the tooth tip. We agree. But he does not acknowledge that additional heat is caused by friction generated by metal block guides. Our tests showed that metal blocks in contact with the blade increased heat to 115.9°F, before the blade even touched wood. Bearing guides, as well as ceramic and graphic blocks, all reduce such heat compared with metal blocks.

—Louis A. Iturra, Jacksonville, Fla.

Values integrity—Congratulations on *Fine Woodworking's* 25th anniversary. You are unmatched in excellence of editorial content, photography, layout, paper, printing, courtesy to your readers—and most important, integrity. The only problem is that I find it difficult to file my copies because I'm always reading and rereading them.

Your policy of letting the chips fall where they may in product tests has caused disgruntled firms to cancel advertising. But believe me, your readers value your editorial guts.

In commemorating your anniversary year, please consider printing a special issue, perhaps highlighting some of the outstanding ideas and authors through the years.

—Bruce H. Burnham,
Groton Long Point, Conn.

EDITOR REPLIES: You are in luck. We plan to do just that. Our extra anniversary issue will be sent out later this year.

Don't lighten up—I was browsing through an issue from a few years ago and saw a farewell letter from someone who likes projects lasting only a week-end. I understand his perspective, and I am delighted that there are plenty of

woodworking magazines that cater to that need. If not for *Fine Woodworking*, however, there would be no journal for those of us who are interested in period furniture, higher techniques and projects that require more than a day and a half.

What a world it would be if all woodworking magazines addressed the same market. I have tried almost all wood magazines and have let them all go because they do not cater to my interests. They are toy-, hobby- and weekend-oriented. Please do not lighten up. Choice and variety are important for a healthy woodworking world.

—Paul Brinsden, Houston, Texas

It was a recipe for a bomb—In his Finish Line column (*FWW* #141, p. 130), Chris Minick suggested that for an ebonizing stain, "fill a jar about one-third full with any rusted metal you can find ... add white vinegar ... screw on the cap and let it sit for a week or two."

I did this a few years ago and ended up with a mess when the bottle exploded

About your safety:

Working wood is inherently dangerous. Using hand or power tools improperly or ignoring standard safety practices can lead to permanent injury or even death. Don't try to perform operations you learn about here (or elsewhere) until you're certain they are safe for you. If something about an operation doesn't feel right, don't do it. Look for another way. We want you to enjoy the craft, so please keep safety foremost in your mind whenever you're in the shop.

—Timothy D. Schreiner, editor

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Letters (continued)

and sent shards of glass, bits of metal and vinegar all over my shop. I was not in the shop when the explosion happened, but I heard the noise from several rooms away. I lost some projects in progress, and I could have lost a lot more if I had been in the shop when the bottle exploded. Please alert your readers. Perhaps a hole in the lid would do the trick.

—Tom Horst, Roswell, Ga.

CHRIS MINICK REPLIES: You are right. Iron submerged in an acid, even a weak acid like vinegar, will form hydrogen gas as a reaction by-product. Poking a few holes in the jar lid to allow gas to escape would prevent the bottle from shattering if the mixture produced a lot of gas. However, I have made this stain for the past 25 years and have never had excessive pressure build up in the capped jars; I suspect that my habit of using only thoroughly rusted iron, the kind that falls apart in your hand, is the reason. Thoroughly rusted iron is primarily ferric oxide combined with a small amount of ferrous oxide. Very little

elemental iron is present in the rusty mass to react with the vinegar; thus very little hydrogen gas is produced.

Disagrees with sawblade recommendation—In "All About Bandsaw Blades" (FWW #140, pp. 86-91), Lonnie Bird implies that there is no universal bandsaw blade. He encourages readers to buy an arsenal of different blades and change them as often as needed. This might very well be true in industrial situations where economics and production demand that specialized blades be used for each type of cut. But for most home woodworkers, it makes more sense not to waste time constantly changing blades, but just leave one blade on almost all of the time.

In my own shop and at the college shop I've managed for more than 13 years, we use a single blade (¼-in. tpi, skip tooth) on all of our 14-in. bandsaws for just about every cut—from resawing 12¼-in. logs to making delicate cuts in ¼-in. stock—all with acceptable results. It's hard to imagine a more universal blade

than this. It does just about everything as long as the machine is properly adjusted and the blade is sharp. I rarely have to change to a different blade.

—Walter Stanul, Malden, Mass.

FWW #141 corrections—The Incra miter gauge (p. 36) comes with the Shop Stop as standard equipment.

The 1½-in. dimension in the black-and-white drawing of Charles Durfee's trestle table (p. 77) should run from the bottom of the foot to the top of the beam mortise, not to the bottom of the beam mortise.

The zip code for Cambium Press (p. 28) in Bethel, Conn., is 06801. The toll-free number is (800) 238-7724.

Writing an article

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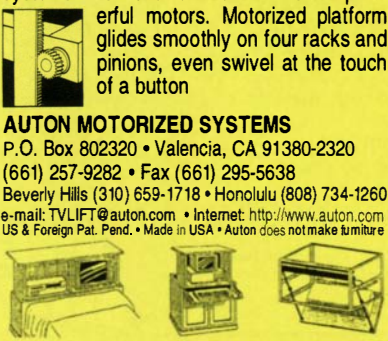
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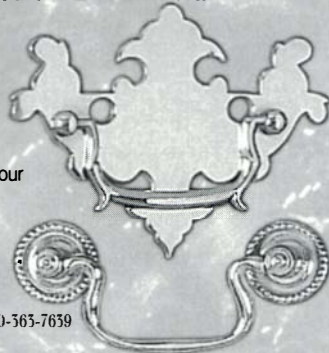
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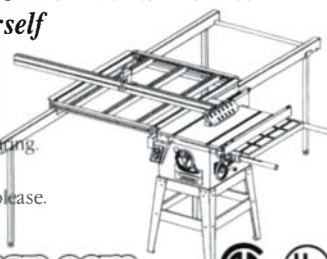
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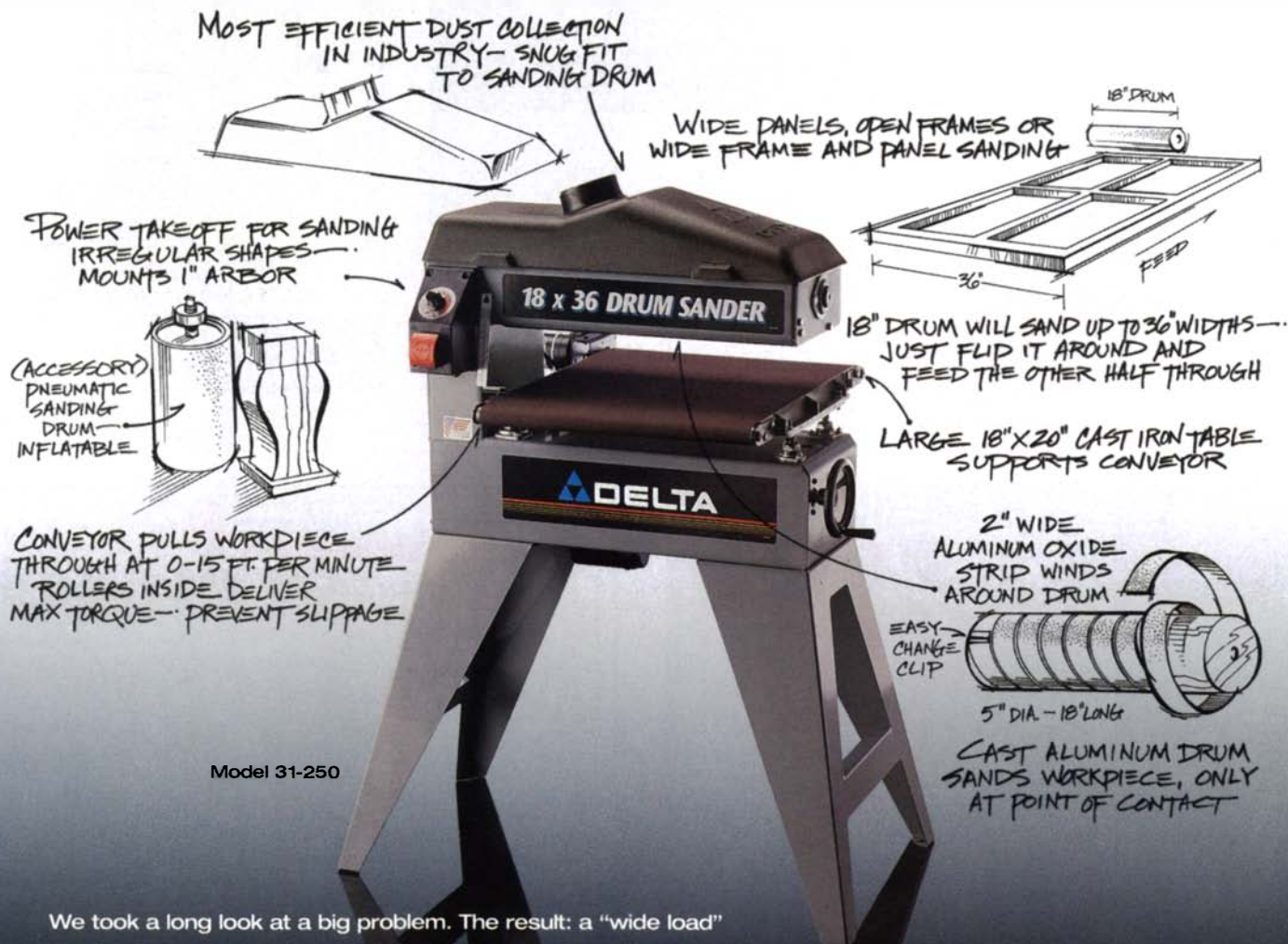
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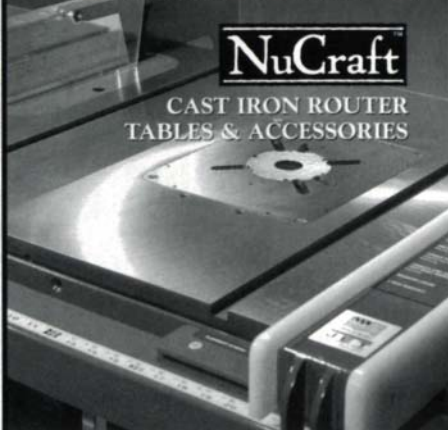
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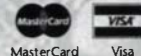
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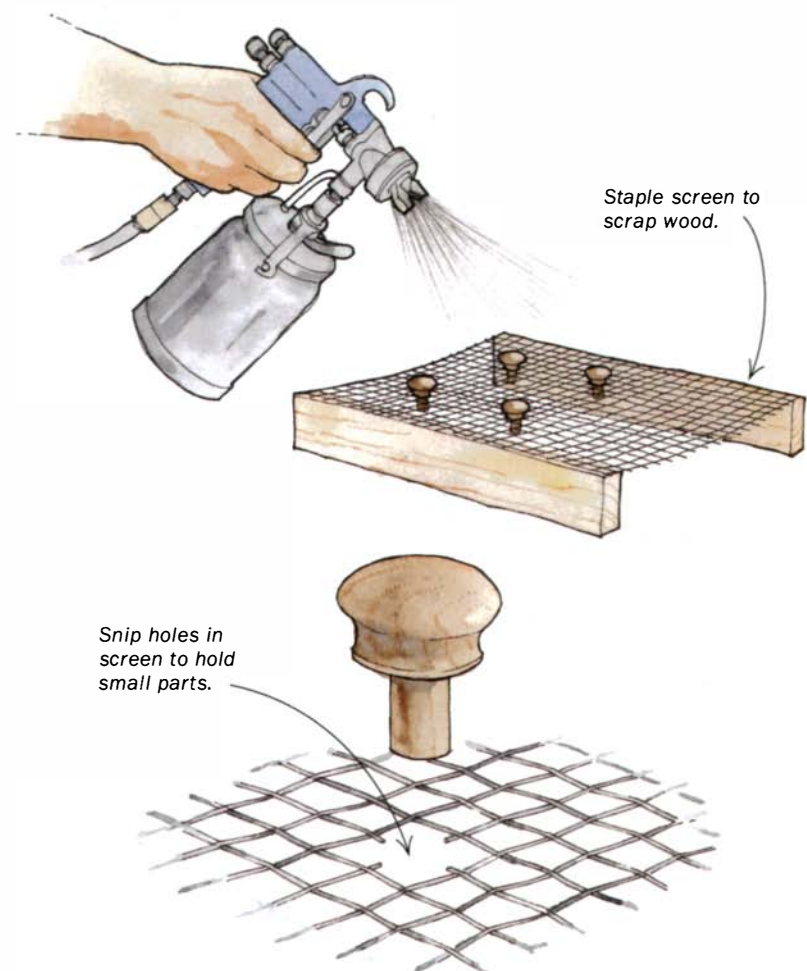
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Methods of Work

EDITED AND DRAWN BY JIM RICHEY

Spray-finishing small parts

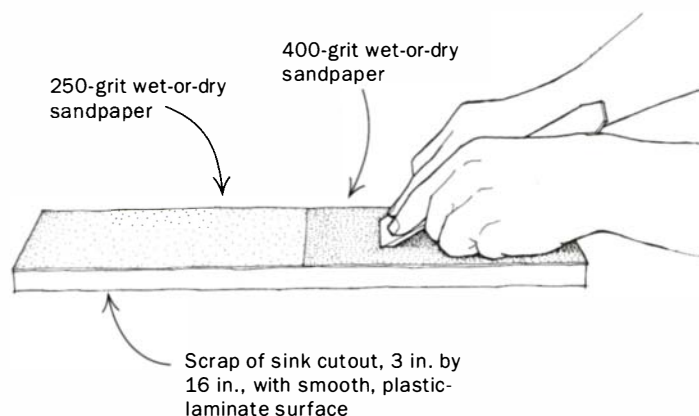
Holding small parts while you spray-finish them can be a problem. Air pressure from the spray gun blows the parts around. And finish blowing back from the surface the parts sit on can create unexpected runs.



A simple solution is to hold small parts with common hardware cloth or hail screen, as it's sometimes called. Cut a suitable piece of the screen and staple it to scraps of wood to produce a stable base. Then simply place items to be finished on the screen and spray (see the drawings above). If you want to make sure the small parts don't move, snip out small sections of the screen to create wire fingers to grip each item. Because of the open nature of the screen, you won't have any problems with finish blowing back.

—R.B. Himes, Vienna, Ohio

Honing boards



I've sharpened tools for years with these emery-paper honing boards. I prefer them over oilstones or waterstones because they put a finished edge on tools faster than stones, the working surface is bigger and they are neater and cleaner to work with, requiring no messy oil. Also, they cost only pennies to make.

Start by getting a sink cutout from a countertop fabricator. I buy these for about a buck apiece. Sometimes they're free for the asking. Pick a cutout with a smooth, plastic-laminate surface. Slice the cutout into strips 3 in. wide by 16 in. long. Then cut 3-in.-wide, 8-in.-long strips of 250-grit and 400-grit emery paper. Glue the paper end-to-end to the laminated side of the cutout scraps with contact cement. The combination of the two grits will give you a fast-cutting surface for shaping and a fine surface for honing. Two sheets of emery paper will cover four honing boards, so make up several while you're at it.

The honing boards will last for months or years, depending on how often you use them. But when the grit gets too worn to renew an edge quickly, just throw the board away and start with a new one. These honing boards also are great in the kitchen for sharpening cutlery.

—Tim Hanson, Indianapolis, Ind.

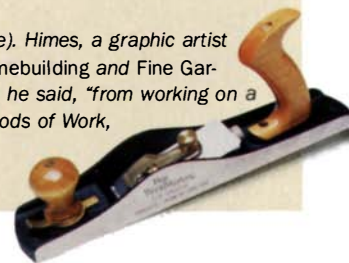
Jig for hand-chopping dovetails

This jig puts your chisel exactly where you want it when chopping dovetails (see the top left drawing on p. 18). It guarantees that shoulder lines will be perfect on both sides of the pins and tails and will be consistent from one workpiece to another.

The jig consists of a 3/4-in.-thick wood or plywood base, two side fences, an adjustable stop and a hold-down. Cut the side fences from 3/8-in.-thick stock or stock that is thinner than any lumber you will be working. One pair of wing nuts tightens the hold-down

A reward for the best tip

R.B. Himes won an engraved Lie-Nielsen handplane for his tip on how to finish small parts (above). Himes, a graphic artist by trade, is also a prolific tipster. Between *Fine Woodworking* and our sister publications *Fine Homebuilding* and *Fine Gardening*, Taunton has published more than two dozen of his ideas. Most of them were inspired, as he said, "from working on a shoestring." Send us your best tip, along with any photos or sketches (we'll redraw them) to *Methods of Work*, *Fine Woodworking*, P.O. Box 5506, Newtown, CT 06470-5506.



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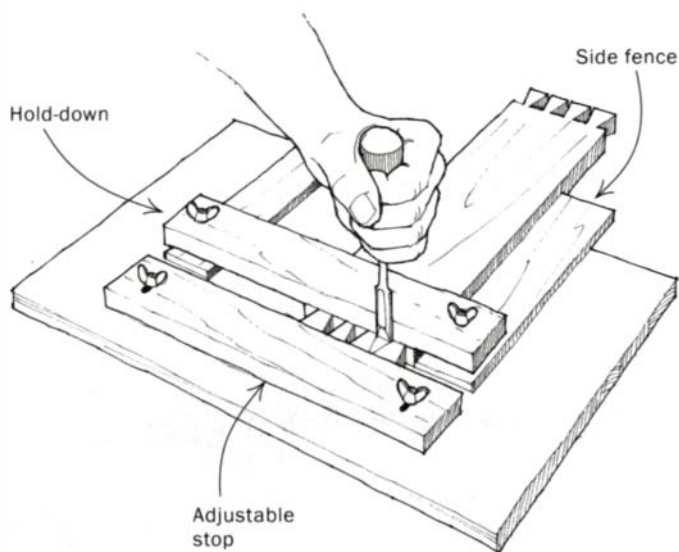
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Methods of Work (continued)

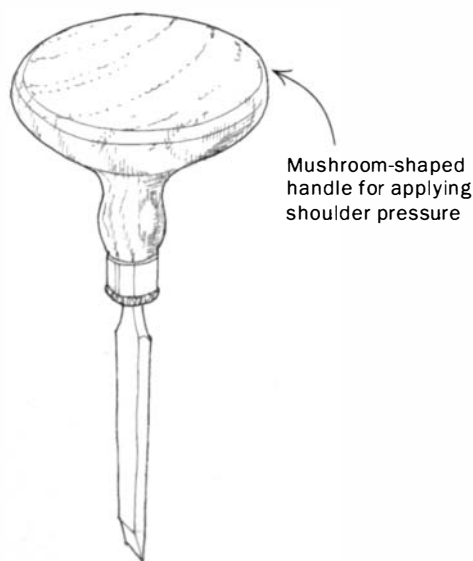


onto the workpiece, and another pair of wing nuts, fit over slots, allows adjustment of the stop.

To use the jig, adjust the stop so that the shoulder line of the pins or tails is directly under the edge of the hold-down. Insert the dovetail workpiece by sliding it against one of the side fences, then tighten the hold-down in place. Once the workpiece is secured, hold the chisel against the edge of the hold-down, where it is registered at a perfect 90°, and chop down halfway through the waste. Flip the workpiece to complete the other side.

—*Jacque L. Dupuy, Ft. Leavenworth, Kan.*

Chisel handle for paring mortises



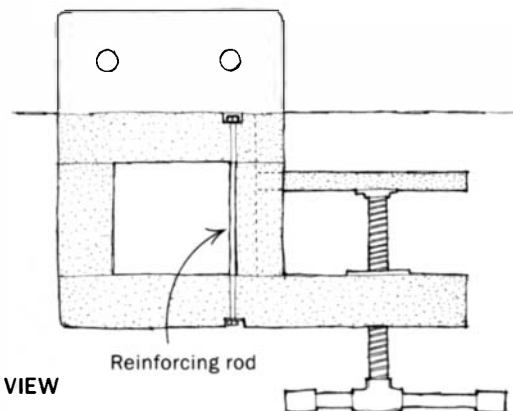
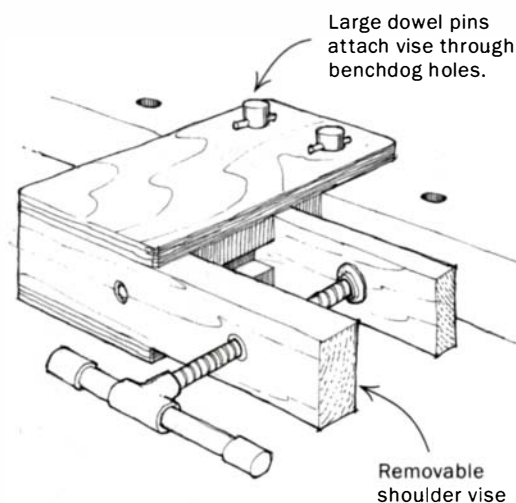
Joining furniture with mortise-and-tenon joints can be a problem if you don't have a mortiser to cut square holes. You must either square up the mortises with a chisel or round the tenons with a rasp. I square up, and I've found that the best way to do this is to guide the chisel with my hands while applying pressure to the back of the chisel with my shoulder. But after spending an entire

day squaring up more than 100 mortises, I had a sorely bruised shoulder from pushing the chisel.

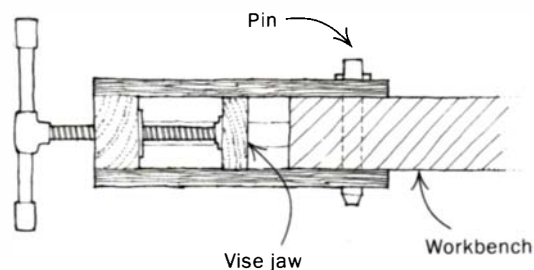
So I dismantled the chisel and made a new handle with a mushroom-shaped end, similar to an old-fashioned hand drill. (I used a nice piece of boxwood that I had never found a good use for.) It works fine now: Pushing the chisel with my shoulder doesn't give me a pain.

—*Rudi Wolf, Les Plantiers, France*

Removable shoulder vise



TOP VIEW



SIDE VIEW

To fit the type of work I do, I designed my workbench around a permanently installed front vise and tail vise. However, I thought it would also be nice to have a shoulder vise for occasional light-duty use. So I came up with a removable design that anchors into the existing benchdog holes (see the drawings above). Use a

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02N01.01 Combination Knife/Rule \$39.95



Spring Loaded Corner Chisel

If you cut your hinge mortises with a router bit, you need to square the corners to fit the hinges. Simply lay this over the corner, strike firmly with a hammer or mallet. The result, a perfectly square 90° corner. The chisel is 3/8" on each side.

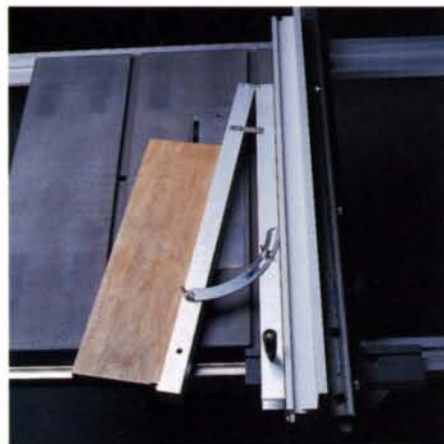
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Methods of Work (continued)

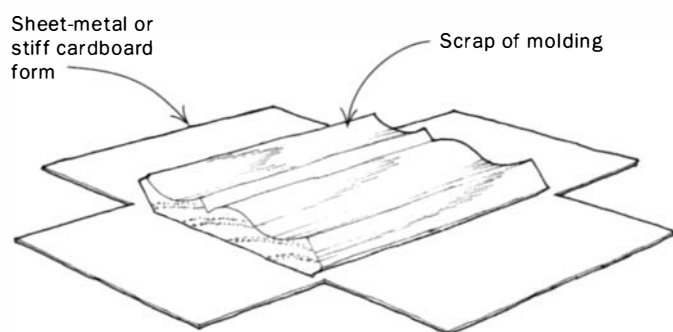
tough wood for the pins that secure the shoulder vise to the bench because they take lots of strain. It is also important that the top and bottom pieces of plywood straddle the benchtop with no play.

—Louis Michaud, Rimouski, Que., Canada

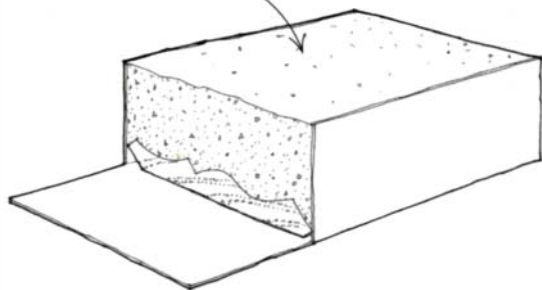
Quick tip: When I added a thin layer of hot glue on the bottom of a bench leg to level it on an uneven ceramic floor, I discovered a second benefit: It kept the bench from sliding around.

—Marty Schlosser, Nepean, Ont., Canada

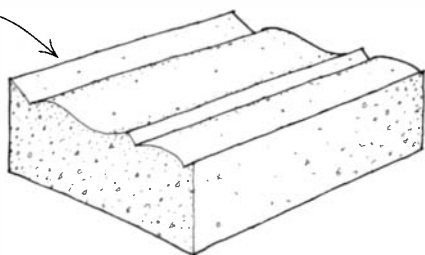
Reverse-profile sanding block for moldings



Fold form around molding and pour latex cement.



Molded sanding block



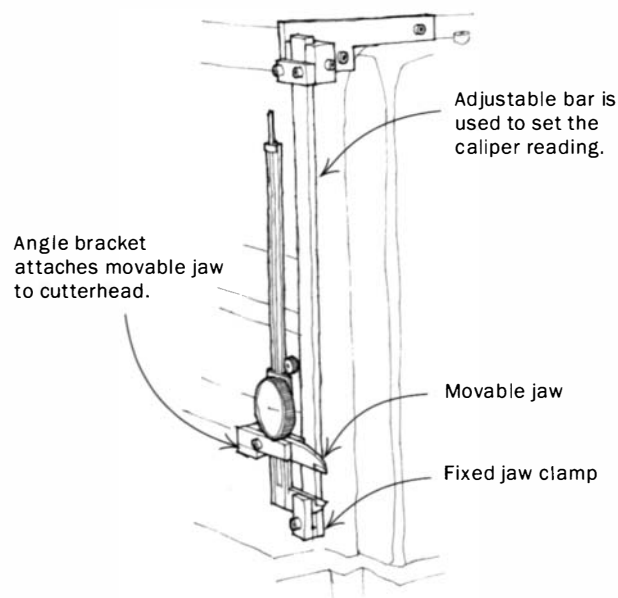
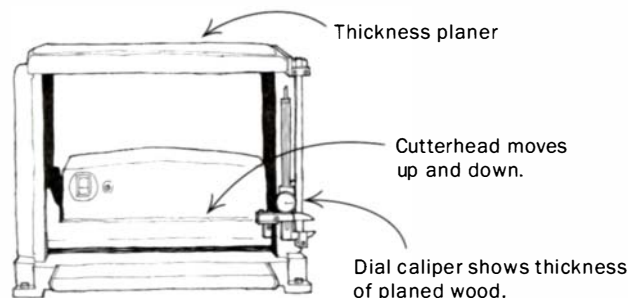
I use latex patching cement to make reverse-profile blocks for sanding moldings. The material costs much less and is easier to work than two-part epoxy compounds and auto-body fillers. Also, it's strong, and it molds easily to the profile of the molding.

To make a sanding block, cut a short length of molding to use as the form bottom. Coat the surface of the molding with wax so that it will separate easily from the patching cement. Make a sheet-metal or stiff cardboard box as shown above to act as a form for

the molding and the patching cement. Mix up a batch of the latex patching cement, using as little water as possible. Press the cement into the form around the molding and then cover with plastic wrap to slow evaporation. After the cement hardens, separate it from the molding and cure it in a plastic bag for a few days to maximize its strength and durability. To use the sanding block, simply wrap a piece of sandpaper around the profile side of the block and start sanding—the paper will conform to the shape of the block.

—Jay Li, Chesterfield, Mo.

Dial caliper monitors planer settings



Most planers have only a crude pointer-and-ruler thickness indicator that is hard to read and approximate at best. I found myself measuring the thickness with a dial caliper after every pass, creeping up on the thickness I wanted. Finally, I decided to attach a dial caliper directly to the planer so that I could quickly read out the exact thickness to be planed beforehand.

To accomplish this, I attached the movable jaw of the caliper to the cutterhead with an angle bracket. I then clamped the fixed jaw of the caliper to a bar that is connected to the top of the planer frame. The bar can be moved up and down and then locked to adjust the caliper's reading. As I raise or lower the cutterhead, it moves the jaw of the caliper to change the reading on the dial.

—Stan Kessler, Fort Wayne, Ind.

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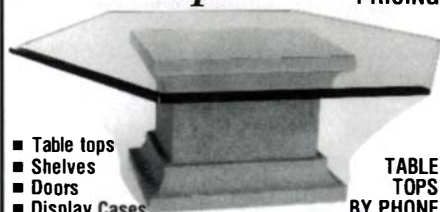
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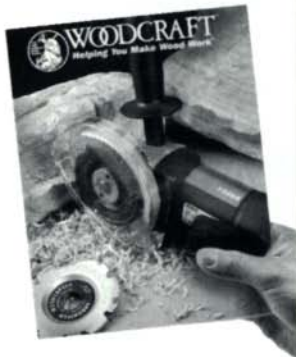
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Notes & Comment

The Thomas Chippendale School of Furniture



A closer look. Instructor Bennett Farrell (right) inspects the fine hand-cut dovetails on a student's Shaker chest.

When Bennett Farrell and his brother decided to sell Two Brothers, their pickle business, Bennett decided to do something he'd long wanted to. He packed up and went to Scotland, where he attended the The Thomas Chippendale School of Furniture in East Lothian. After finishing the 42-week woodworking program and then teaching there for a time, Farrell and Anselm Fraser, who founded the Scottish school in 1985, decided to open a school in the United States.

The Chippendale School's first U.S. branch is on five acres just outside Columbia, S.C., in the small town of Gilbert, a location Farrell loves for its proximity to both Charleston and Asheville, N.C.—two towns rich in furniture history.

Though having opened just six months ago, the school seems vibrant. On a recent Monday morning, one student was working on a Shaker chest, another was bench-side, practicing carving, and the faculty was helping gilding specialist Kanako Fukahara set up for class. Fukahara lives in Tokyo, but like most of the instructors at the Chippendale School, she travels a great distance to teach.

Modest machinery lends a comfortable feel to the workshop. The jointer is an 8-in. Sunhill; the tablesaw is a Delta; and the

bandsaws are the same 14-in. versions you'd find in almost any shop. "We want students to use the same tools here that they use at home or in a small furniture shop," said Farrell, "or at least comparable ones." The one exception, Farrell said, is the huge lathe out back, which is used to turn bowls up to 36 in. dia. "But you can't really get upset about having a lathe that's too big," he said.

The school offers a number of weekend and weeklong courses, on subjects ranging from boatbuilding to chair making to carving, and offers master's courses spanning 16 and 20 weeks. Classes are limited to eight students, which allows plenty of individual attention from instructors. The school can house students in its main building, and there are two shops—one devoted to boatbuilding and one to furniture. And when you finish a day's work, a quiet dock overlooks a small pond chock-full of bream.

Though the South Carolina school is currently the only American branch, Farrell and Fraser are looking to open more schools in other parts of the country. For more information about The Thomas Chippendale School of Furniture or its classes, contact Farrell at (803) 892-4153.

—Matthew Teague is an associate editor.

Wood webs

www.gourd.com

Dogs have been barking "Jingle Bells" for years now, so it's high time that woodworking tools started playing classical music. Woody Phillips' CD *Toolbox Classics* is a collection of easily recognizable classical music performed on common woodworking tools—the "Musette & March" with a ratchet and drill press, "The Ride of the Valkyries" on a jointer and Dremel tool. At this site you can hear a sample of the music or order your own copy (\$12 for the CD).

www.woodbin.com/calcs/shrinkulator.htm

Building in December and want to know how wide your panels are going to be come summer? There's a new addition at woodbin.com called the Shrinkulator, which can help you calculate dimensional changes in all of the commonly—and some uncommonly—used woods.

www.shavings.net/sawtill.html

After having thoroughly discussed the various ways to store handsaws, a group of computer-savvy hand-tool fans, who call themselves the "OldTool Galoots," agreed to work together to develop plans for a tool chest to hold handsaws. They have put the plans on-line and are hoping this is just the first of many worldwide group woodworking projects.

Any bright ideas?

The deadline is fast approaching for the Seventh Annual Wharton Esherick Museum Thematic Woodworking Competition. The theme for 2000 is table and floor lamps, and entries must be received by July 1. Cash prizes will be awarded. For an application and information, send a self-addressed, stamped envelope to Wharton Esherick Museum, P.O. Box 595, Paoli, PA 19301-0595.

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Building for an audience at Colonial Williamsburg

Fine Woodworking editors, contributing editors and authors joined the staff of Colonial Williamsburg in late January for the second annual symposium Working Wood in the 18th Century. Case furniture was this year's topic. More than 200 people attended the four-day event, during which there were numerous lectures and discussions, including a three-day demonstration by the Colonial Williamsburg cabinetmakers of replicating an 18th-century chest of drawers. If you think glue-ups can be stressful, try assembling the long, sliding dovetails of an air-dried walnut case in front of a watchful audience of period furniture makers.

Chair making in the 18th century will be the topic of next year's symposium. If the events of the last two years are any indication, next year's symposium will fill up fast. To be put on a mailing list for information about future woodworking conferences, e-mail Colonial Williamsburg at dcountryman@cwf.org.

—Jefferson Kolle is the managing editor.



A weekend of furniture in Philadelphia

The Philadelphia Furniture and Furnishings Show—the first and largest retail exhibition of its kind in the country—will hold its sixth annual event May 12-14.

This year's show is offering a "Turn of the Century Tour," a program that will give visitors the chance not only to see and buy work from more than 250 juried exhibitors but also to travel to 10 locations throughout Pennsylvania, New Jersey and Delaware to view furniture spanning five centuries. Awards available include \$1,000 to the Best New Artist in Wood, sponsored by *Fine Woodworking*, and \$2,500 from the Cohn Family Trust Apprenticeship Program. For more information about the show, events and awards, call Amy Morais at (215) 440-0718 or visit on-line at www.pffshow.com.

Notes & Comment

We welcome news stories, anecdotes about the triumphs and pitfalls of woodworking, photos of unusual work, information on woodworking web sites—anything you think other woodworkers would like to know about. We pay for some of the material we use. Send submissions to Notes & Comment, Fine Woodworking, P.O. Box 5506, Newtown, CT 06470-5506.

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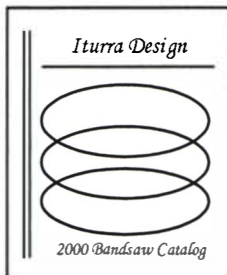
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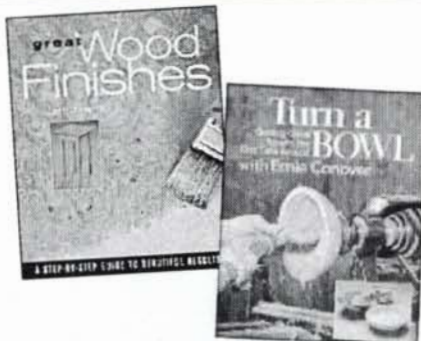
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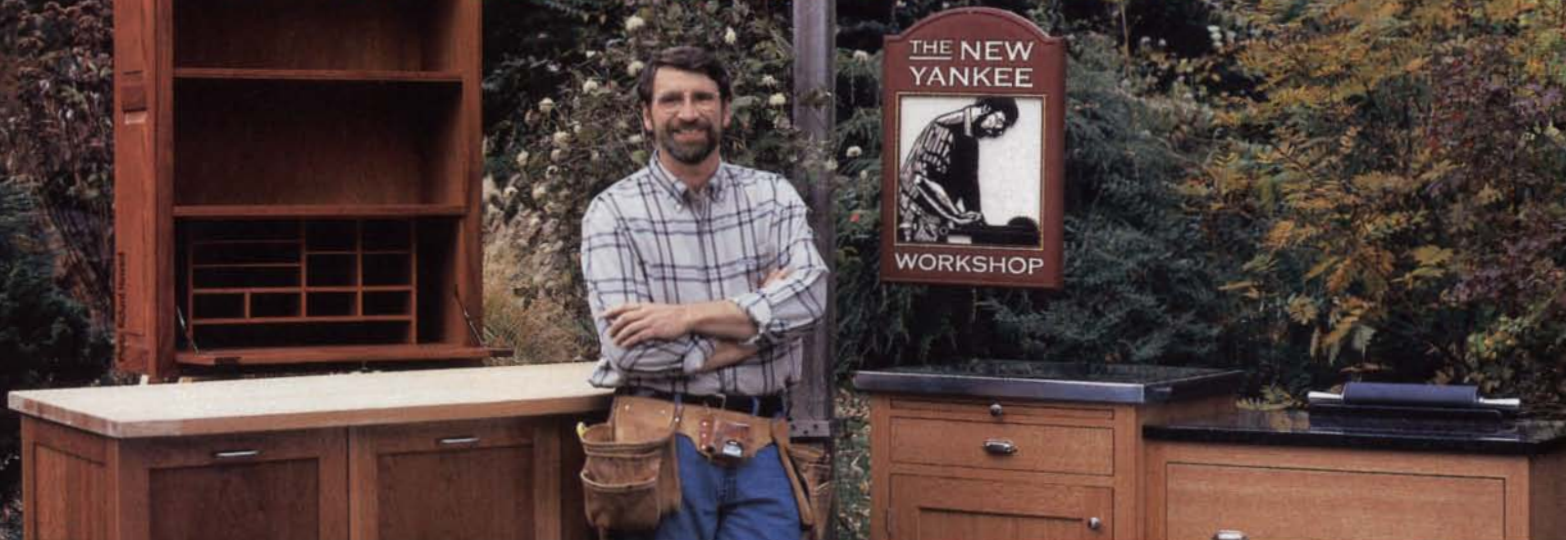
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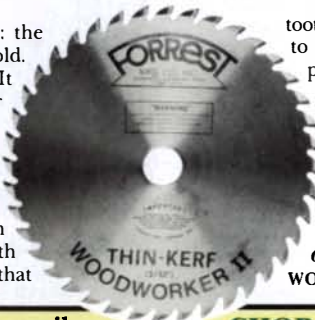
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Tools & Materials

Benchtop planer handles 13-in.-wide stock



Ridgid's portable planer has the widest capacity in its class. A depth-of-cut scale makes it easy to dial in the correct setting.

Ridgid's new model No. TP1300 benchtop planer boasts a 13-in.-wide capacity, and that's just the beginning of the good news. The machine also has an easy-to-read depth-of-cut scale and preset thickness stops for common thicknesses, a nice feature. Like several of its competitor's models (DeWalt and Delta), the Ridgid also has a cutterhead lock that substantially reduces snipe.

When the lock is engaged, and following a shallow cut, the planer left only the slightest hint of snipe at the end of a board, about a few thousandths of an inch. A light scraping or sanding is enough to make it disappear.

An optional dust hood is available, but we found it to be oddly designed. The hood has

an opening on each end, one to fit a shop-vacuum hose and the other to fit a 4-in.-dia. hose. The underside of the hood does not fit tightly against the planer body, and dust extraction is not as thorough as it ought to be. Some double-sided tape or another screw would solve the problem.

Overall, the TP1300 seems well designed. It even comes with a second set of double-sided, disposable knives. The planer sells for \$397 (available only at Home Depot), and the dust hood is an extra \$20.

For more information, see Ridgid's web site at www.ridgidwoodworking.com or call (800) 474-3443.

—Fine Woodworking staff

Drill Doctor from Darex resuscitates dull bits

Like many woodworkers, I used to stash my dull drill bits in a drawer and buy fresh ones instead of attempting to sharpen them. Then the Drill Doctor, from Darex, came along.

I tried the model No. 750SP, which comes with two chucks, one for drills up to ½ in. dia. and the other for ½-in. to ¾-in. drills. The compact tool has a replaceable diamond wheel and will sharpen bits at either 118° or 135°. It can also sharpen (or regrind regular bits into) split-point bits.

The instruction manual and video did a good job of walking me through the process of sharpening. I completed my first bits without a hitch. But when I attempted to sharpen another set, I was unable to get the proper relief angle, so I had bits that wouldn't drill. I took another look at the manual, and it gave me instructions on how to increase the relief angle. Grinding split-point bits requires more skill. It's best to grind away a little at a time and check your progress.

There are a lot of variations among drill bits. But with a little trial and error, it seems most bits can be sharpened successfully. According to Darex, the average user will be able to sharpen about 200 bits before the diamond wheel needs replacing. The Drill Doctor has proved its worth for my shop. With it I was able to resuscitate a collection of dubious drill bits. And every trip that I don't have to take to town in the middle of a project is time in the bank, which is as good as money.

The 750SP retails for \$150. For more information, see the company's web site at www.drilldr.com or call (888) 693-7455. —Nicholas Goulden



With a little practice, most bits can be resharpened. The Drill Doctor comes with a good instructional video and manual.

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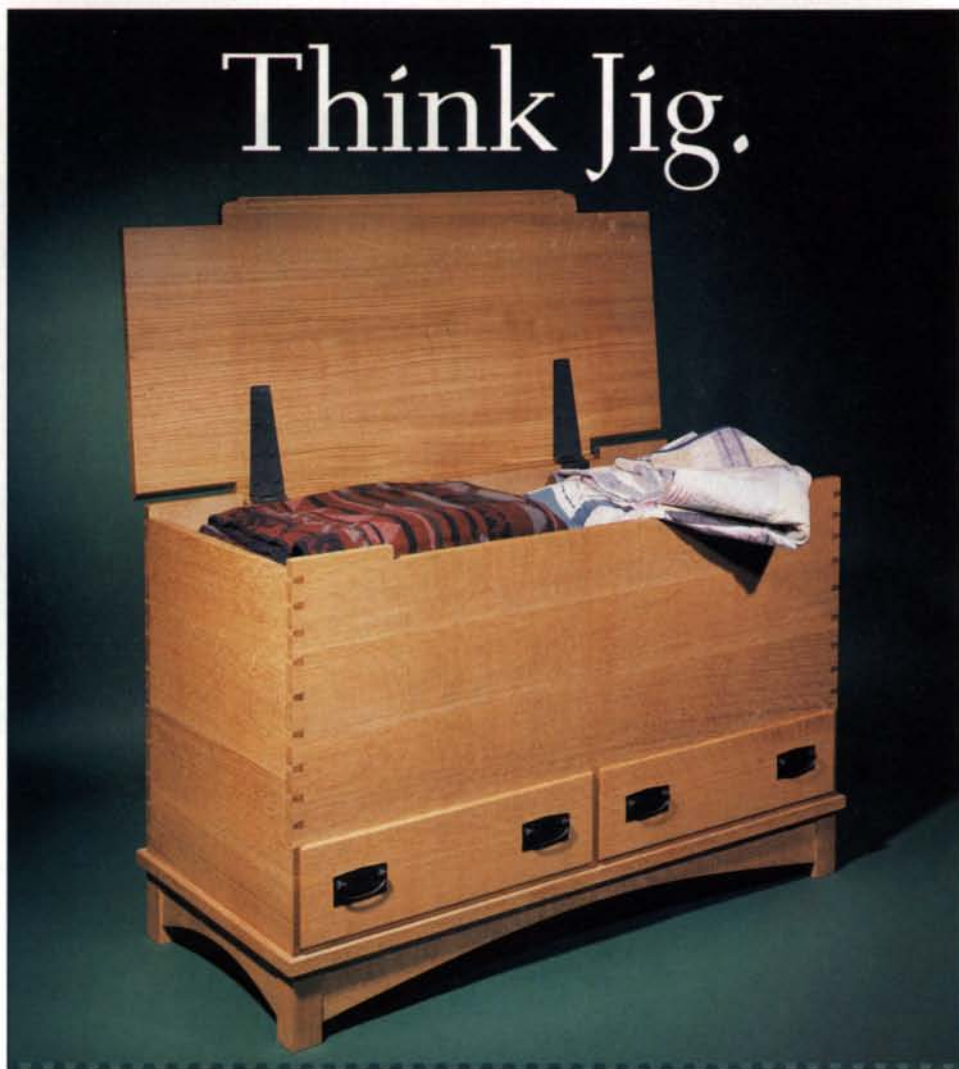
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Reasonably priced Japanese saws

Vaughan Bear Saw Japanese saws are made in several styles, and you can find one to suit any task, whether it be cutting plywood, particleboard, ABS pipe or framing lumber. I tried three of Vaughan's saws and was pleasantly surprised by how well they worked, considering their low cost.

Traditional Japanese pull saws have straight, straw-wrapped handles. Bear Saw handles are made of rubberized plastic, which provides a comfortable if nontraditional grip. The smaller saws have a pistol-type grip, and only the double-edged saw has the typical Japanese straight, long handle. All saws come with blade guards and reusable soft plastic cases.

The saws cut aggressively in all sorts of materials, including hardwoods. I was impressed by how the double-edged (rip and crosscut) saw, which produces the finest kerf, cut dovetails. My traditional Japanese saw, which costs three times as much, cuts a bit smoother, making it easier to control, but one could certainly get by with a Vaughan saw. The teeth on the rip side of the saw are graduated, and that makes it easier to get a smooth start to a cut.

Bear Saws range in price from \$17 to \$24, making them a very good buy and a good introduction to Japanese saws. They are available at many hardware stores; call (815) 648-2446 for more information.—N.G.



Vaughan Bear Saws have replaceable blades. Although modeled after Japanese pull saws, some of the Vaughan saws have a modern pistol grip.

Flashy phone accessory

It's easy to miss a phone call in a workshop when the din of machinery drowns out the ringing telephone. Not so with a Smart Flash, a strobe-light telephone accessory that emits bursts of white light when the phone rings. With only one unit, I can tell when the phone is ringing no matter how much noise I'm making.

Position the unit so that it will not blind you, an obviously dangerous situation in a workshop. I located my strobe on a post near the center of the shop, well above my head. Smart Flash lists for \$74.95 and is available directly from the manufacturer, Fernbrook, at (828) 524-6125 or (800) 625-1315 (press "00" when prompted).
—Jim Tolpin

Delta sliding miter jig for tablesaws



Delta's miter jig will handle stock up to 5 ft. long. The jig rides in the table saw's left miter slot.

The Delta model No. 36-205 sliding miter jig is one big, heavy jig. It resembles a sliding table accessory, but instead of articulating arms and bearings, the miter jig has one rail that slides in the table saw's left miter slot. The rail is adjustable for a snug fit. The jig won't take the place of a true sliding table, which has greater travel and capacity, but it holds stock firmly for accurate miter cuts.

The instruction manual is complete and easy to follow, and assembly takes about an hour. The extruded-aluminum fence can handle stock up to about 5 ft. in length. A sliding stop comes standard and is easy to adjust and flips out of the way for cutting extralong pieces. Although the manual doesn't suggest it, one could easily attach a sacrificial zero-clearance wooden face to the aluminum fence,

which is milled with a continuous T-slot. The jig comes with a ratchet-style quick-release clamp for holding stock. Cutting at an angle produces forces that pull or push a workpiece. Even the slightest movement, a common problem when holding stock by hand, causes inaccurate joints. The jig's clamp will prevent that from happening.

The jig I used had a bit of play in the 45°/90° positive-stop mechanism, something that could be improved. But by putting some pressure against the stops when tightening the thumbscrew, I got consistent results. Other angles are set by lining a cursor up with large, easy-to-read numbers. I only wish the jig had a few more positive stops for common angles such as 22½° and 30°. The jig costs \$180. For more information, contact Delta at (800) 438-2486.
—Roland Johnson

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Lubricant for dusty environments

Called a penetrating lubricant that contains a metal friction reducer made of parasyntetic petroleum, PG 2000 sounds a bit like alchemy. Whatever the stuff is, after a short, successful tryout, I think it might have a place in the workshop.

When sprayed on metal parts, PG 2000 dries to a thin film that isn't as much of a dust magnet as other lubes I've tried. Fine dust will still settle on metal coated with PG 2000, but it won't gather up into sludge balls and gum up the moving parts.

PG 2000 seems to work best for tools that produce more chips than fine dust, such as the screws and other moving parts of a planer. One coating lasted several weeks. PG 2000 contains no silicones, which can play havoc with wood finishes.

A 12-oz. aerosol can costs \$7. For availability, contact the manufacturer, ProGold Products, at (800) 421-5823 or on-line at www.progoldmfr.com.

—Anatole Burkin



PG 2000 for sticky machines. The dry lubricant doesn't attract a lot of sawdust.

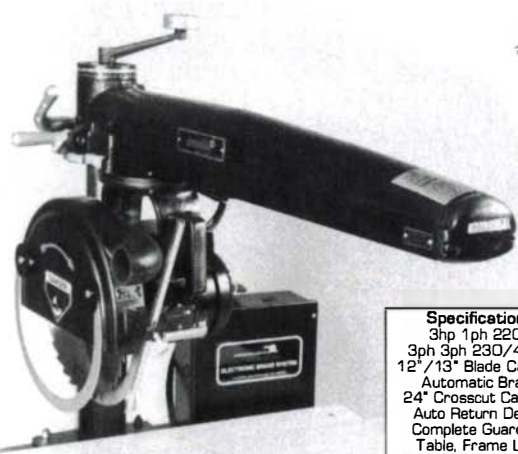
A better extension cord from Sears

Some devices seem so obvious that one wonders why it took so long for someone to invent them. Take, for example, the Craftsman "professional" extension cord. This heavy-duty, three-conductor, 12-gauge cord has an LED in the socket that glows when the cord is plugged into a hot outlet. The light is bright enough to help you find the cord in the dark. The socket also has a lock that crimps the tines of a plug. That's especially useful when you're pulling a tool plugged into a long cord. The cord, model No. 83511, comes in 25-ft. lengths and costs \$25. —Pat Warner

Nicholas Goulden builds custom furniture in Petaluma, Calif.; Jim Tolpin is an author from Port Townsend, Wash.; Roland Johnson has a woodworking business in Sauk Rapids, Minn.; Anatole Burkin is a senior editor; Pat Warner is a writer and woodworker in Escondido, Calif.



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READER SERVICE NO. 36

Jointer

Table realignment and knife adjustments made easy using shopmade tools

BY JOHN WHITE

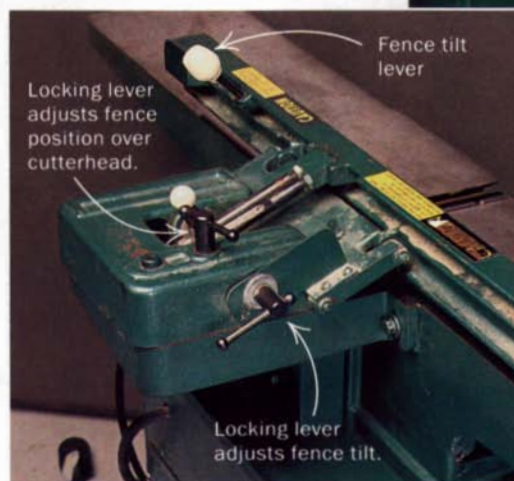
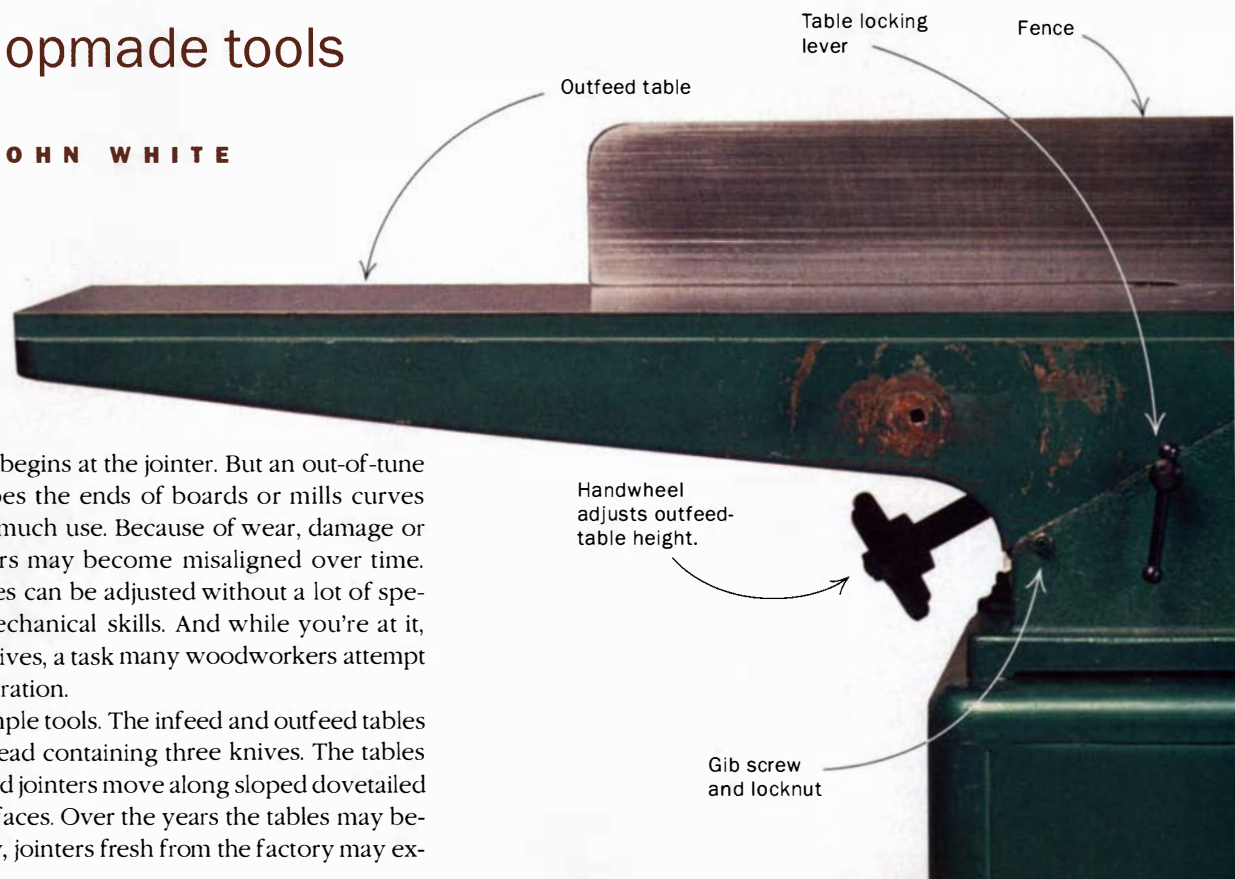
Truing rough stock begins at the jointer. But an out-of-tune machine that snipes the ends of boards or mills curves into stock isn't of much use. Because of wear, damage or imperfect castings, jointers may become misaligned over time. Fortunately, most machines can be adjusted without a lot of specialized equipment or mechanical skills. And while you're at it, consider replacing dull knives, a task many woodworkers attempt only in moments of desperation.

Jointers are relatively simple tools. The infeed and outfeed tables flank a cylindrical cutterhead containing three knives. The tables on most small and midsize jointers move along sloped dovetailed ways, which are wear surfaces. Over the years the tables may begin to droop. Occasionally, jointers fresh from the factory may exhibit these bad traits, too.

The infeed table and fence guide the stock as it crosses the cutterhead. The outfeed table picks up the freshly jointed surface and guides and supports the stock as the pass is completed. The jointed surface is only as straight as the path the wood takes across the cutterhead. If the tables slope, the wood follows the same path. If the tables are misaligned, stock may have a snipe (a deeper cut) or a hump (an uncut section) at the end of the cut or a curve along its length.

The basic tools required for a tune-up are a set of feeler gauges, a small try-square and a good, short straightedge such as the blade of a combination square. A 6-in. dial caliper may come in handy for gauging shim stock, but the job can be done without one. To check the tables for flatness, you'll need a long machinist's straightedge or a test bar (for directions on making and using a test bar, see p. 41) to span the length of both tables.

Unplug the tool before starting. It's also not a bad idea to tape the



Tune-up



Video: Jointer Tune-up

If you want to watch the author tune up a jointer as outlined in this article, a 20-minute video is available for \$11.95 from The Taunton Press (800-888-8286). A preview can be seen at www.finewoodworking.com.

FOUR-STEP PROGRAM



1 ADJUST THE GIBS

Gibs are located inside the dovetailed ways and do not have to be removed (shown here only for clarity). To ensure the tables move smoothly, tighten the gib screws to remove excessive play.



2 LEVEL THE TABLES

Use a straightedge (commercial or shop-made) to check that tables are in the same plane. Metal shims can be inserted along the dovetailed ways to correct for tilt.



3 SQUARE THE FENCE

If the cast-iron fence is warped, attach a piece of plywood or MDF to the fence and shim it flat and square.

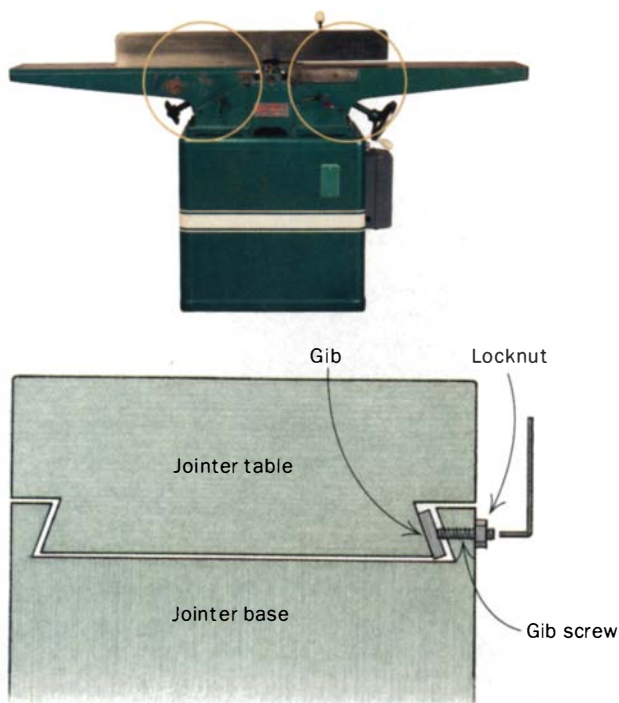


4 SET THE KNIVES

Knives must be parallel to the tables and set to the correct height. Shopmade magnetic holders can assist with the installation.

ADJUSTING THE GIBS

Over time the dovetailed ways may wear and cause one or both tables to go out of alignment. Tightening the gib screws removes slack and may correct the problem.



You need not disassemble a jointer to do a tune-up. The narrow, flat bar is a gib, which takes up wear in the dovetailed ways of the infeed and outfeed tables.



The outfeed and infeed tables have one gib each with two or three adjusting screws. Loosen the locknut and snug up the Allen-head screw to take up any slop. Tighten the screw nearest the cutterhead a tad more than the bottom one.

edges of the knives to protect both you and the knives. It's all too easy to brush a finger or tool across their exposed edges.

Remove excess play from the tables

Each table has an adjustable gib to take up play as the dovetailed ways wear (see the drawing at left). Loose gibs can cause the tables to be out of line with one another. The gibs bear firmly against the dovetailed ways but must slide smoothly. When new, gibs are coated with grease. Over time the grease wears off. A regular shot of penetrating lubricant will keep things moving smoothly.

Each gib has a pair of gib screws that can be adjusted to take up play as the dovetailed ways wear. The screw nearest the cutterhead has to resist the lifting force caused by the weight of the table's overhang, and it should be adjusted tighter than the lower screw. The third screw on many machines has a handle that serves as a locking mechanism.

Start by backing off the locking lever and the locknuts on the gib screws. Then tighten all screws equally until the table is just locked in place, then back off each of the screws about a quarter-turn. At this point the tables should move with little resistance. Now slowly turn the gib screw nearest the cutterhead while moving the table up and down using the adjusting knob or lever. When the screw is properly adjusted, moving the table should require only moderate effort. Once this adjustment feels right, hold the screw against turning and tighten the locknut. Check and readjust, if needed.

Repeat the procedure with the lower gib screw, but apply slightly less pressure. If your machine has a center screw with a locknut, adjust it last and with only light pressure. Getting the gibs adjusted just right is a matter of both technique and feel, much like tuning a musical instrument. If you're lucky, the tables will now be aligned in a flat plane within 0.005 in. or less. Check them using the test bar or a long straightedge. If you have an older jointer, chances are that more will need to be done.

Tables can be shimmed level

Begin by removing the fence. Place a short straightedge across the cutterhead gap and lift both tables until they clear the knives and are in the same plane. Lock them in place. Lay a long straightedge or test bar across both tables. Use feeler gauges to measure any gaps (see the left photo on the facing page).

On an older machine it's a good bet that the tables are sagging. To fix it, place thin metal shims along the dovetailed ways to shift one table into alignment with the other (see the right photos on the facing page). Flat shim stock may be purchased from machine-shop suppliers. Hobby shops also sell thin pieces of sheet brass and aluminum. Aluminum soda cans will also work; they are about 0.005 in. thick. Use a feeler gauge to measure how much the outfeed table is out at the far end. If you measure more than 0.005 in., the table should be shimmed. Anything less than that is probably not worth bothering with for the simple fact that you won't be able to find shim stock thin enough to make the fix.

Shimming is a trial-and-error process. As a rough guide, if your table is out by 0.006 in., start by cutting two pieces of 0.002-in.-thick shim stock that measures about 1 in. by 2 in. and apply a light coat of grease on them. To place the shims, back off the outfeed table's gib screws a turn, lift up on the low edge of the table and slip the shims into place on the lower end of the dovetailed ways. Once the shims are in, adjust the gib screws again. Then realign

LEVELING THE TABLES WITH A SHOPMADE TEST BAR

I had hoped that a builder's level would be adequate for tuning up a jointer's tables, but I found it unfit for the task. Machinists use precision

straightedges that are meant for just such applications, but at \$200 for a 4-ft. version, woodworkers would have a hard time justifying such a purchase.

In search of a shopmade solution, I adapted a machinist's technique for creating precision squares. Technically, the resulting tool isn't a straightedge, because only the three slightly proud screws along one edge are in line. It is more properly called a test bar.

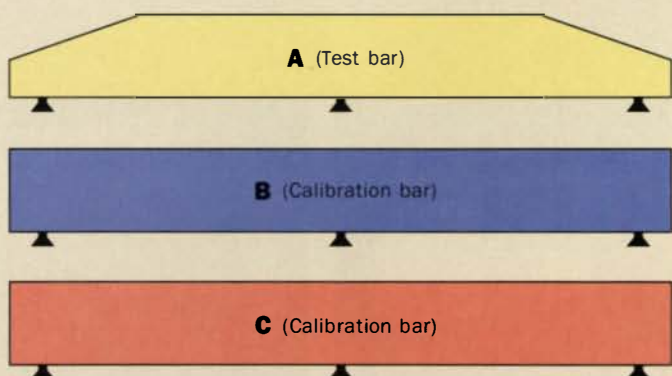
You'll need three bars of the same length and spacing of screws. The screws are adjusted by laying pairs of the bars

flat with the screw heads touching. With each pairing, the height of the center screw is adjusted until all three sets of screws touch without either a gap or rocking. This process is repeated several times with different pairings of the bars until all three mate in any combination. When this is achieved, the laws of geometry dictate that the screw heads on each bar lie in a perfectly straight line.

MAKING A TEST BAR

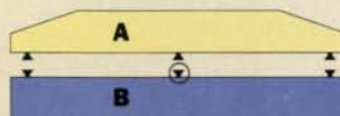
1. Rip three pieces of $\frac{3}{4}$ -in. MDF, each about 5 in. wide and as long as your jointer.

2. Slope the ends of one board (A) to reduce its weight; it will become the test bar.

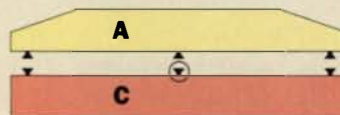


3. Next, predrill the edges of each board and attach three fine-thread, $1\frac{1}{4}$ -in. drywall screws. Place two screws at the far end and one near the center of each board. File the head of each screw to remove any burrs. Adjust them all so that $\frac{1}{4}$ in. of screw is exposed.

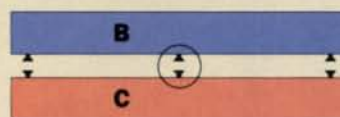
ADJUSTING A TEST BAR



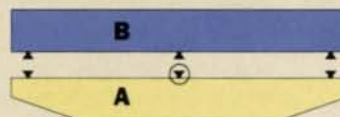
1. Align board A against board B. Adjust only the center screw on board B until all six screws touch.



2. Place board C against board A. Adjust only the center screw of board C until all six screws touch.



3. Place board B against board C. Adjust both center screws an equal amount (in or out) until all six screws touch.



4. Again place board B against board A, but this time adjust only the center screw of board A. Repeat steps 2 to 4 until no more adjustments are needed.

USING A TEST BAR



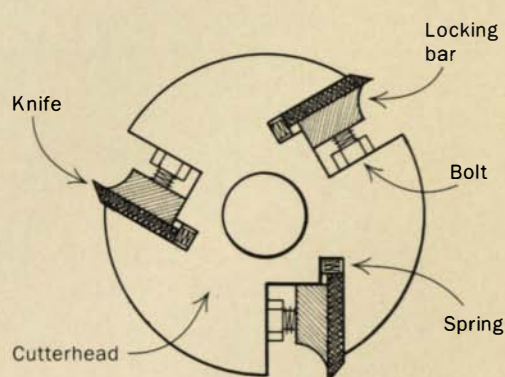
Use the test bar and feeler gauges to check the tables for flatness. Tables may sag over time. New machines, however, may be out of adjustment, too.



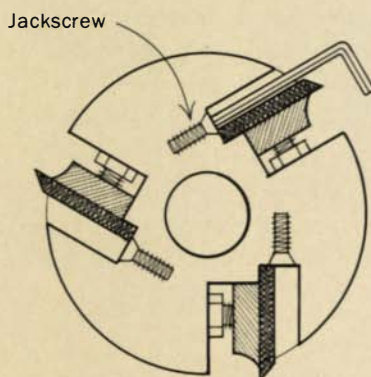
If the outfeed table sags, insert shims on each side of the lower section of the dovetailed ways. If the tables are dished (low in the center), shim the dovetailed ways near the cutterhead.

SETTING THE KNIVES

Types of cutterheads



Some cutterheads use springs to adjust knives up or down. A clean shop floor will help ensure that you can track down an AWOL spring that will inevitably roll off the table.



Some cutterheads use jackscrews to adjust knives up or down. The jackscrews fit into holes bored into the cutterhead slot.



Replaceable, double-sided knives make life easy. Aftermarket kits such as this one made by Esta are available to fit most jointers.

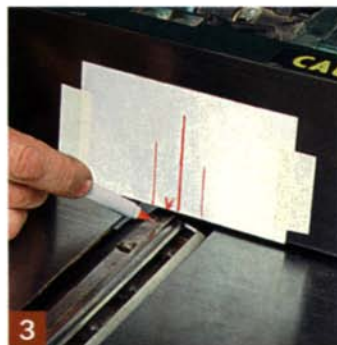
REMOVING THE KNIVES



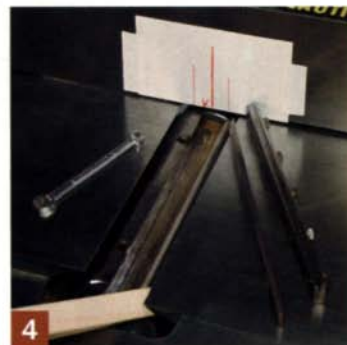
1 First find top dead center of the cutterhead: Slide a flat block of wood with a projecting screw head until the screw butts up against the cutterhead.



2 Mark this spot on the fence. Then do the same on the other side.



3 Using a ruler, split the distance between the marks to locate top dead center. Place another mark to indicate where the cutterhead slot lines up.



4 Align a knife to top dead center and wedge the cutterhead in place. Loosen the locking bar bolts and replace one knife at a time.

both tables flat to one another and check for flatness using the long test bar or straightedge. The process may have to be repeated a few times.

Jointer tables may be tilted the other way and be dished. Follow the same procedure but place shims at the *upper* ends of the dove-tailed ways on the outfeed table. If you notice that the table is twisted, add thicker shims on the low side. Some small jointers may have a fixed outfeed table, in which case you have no choice but to shim the infeed table. Because the infeed table is adjusted frequently, shims may shift position or tear.

The fix for a crooked fence

A small crown or dip over the length of the fence is tolerable as long as the fence remains vertical to the tables. A twist or wind, however, will give you fits, because it will cause stock to rotate as it passes by. To correct the problem, drill holes in the soft, cast-iron fence and attach a piece of cabinet-grade plywood or medium-

density fiberboard (MDF) and shim it flat. Once the fence is mounted back on the jointer, square it up and take a test pass with a board that has a flat face. Check the resulting edge with a square, being sure to place the square against the board surface that ran along the fence. Adjust the fence stop as needed to get a square edge on the board.

Sometimes you have to replace a jointer's knives

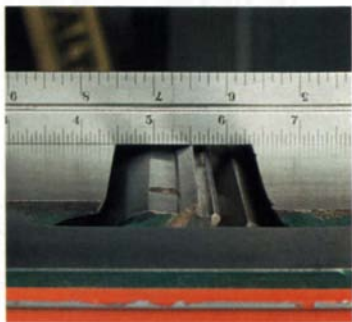
Nobody seems to enjoy replacing jointer knives. That's because it's difficult to keep the knives in alignment when tightening the bolts that are threaded into the lock bars (also called gibbs). Patience is required, no doubt about it. Magnetic knife holders, either commercially bought or shopmade, can help.

First find top dead center—Before replacing the knives, top dead center (TDC) of the cutterhead must be located (see photos 1-4 above). TDC is a point directly above the centerline of the cut-

REPLACING THE KNIVES



On many jointers, the outfeed table should be about 0.015 in. above the cutterhead.



On others (see your manual), set the outfeed table so that it is level with a knife (at top dead center) when about 1/2 in. of metal behind the bevel is exposed.



Bar magnets (available from hardware or electronics stores) glued to a block of wood (do this on a level surface) with silicone adhesive make a decent knife holder/straightedge. Tighten the bolts on the locking bar so that each knife (at top dead center) is level with the outfeed table.

terhead. When a knife's edge is at TDC, it is at the high point of its arc, the ideal spot to align it level with the outfeed table.

Remove one knife at a time—Rotate the cutterhead until the edge of one knife is at TDC. Lock the cutterhead in place with a softwood wedge against the infeed table. Remove the knife and clean all of the parts, including the slot, of sawdust and pitch. Smooth the face of the locking bar and bolts with emery cloth or a stone to remove burrs, which may cause the knife to creep when tightened. It's important to remove and replace only one knife at a time to avoid distorting the cutterhead.

I do a lot of sharpening, but jointer knives take a lot of time and equipment to do well. I keep an extra set of knives on hand and send the old ones out to be resharpened after swapping them.

Adjust the knives—Cutterheads and knives come in various configurations (see the drawings on the facing page). Some cutter-

heads have springs beneath the knives. Better machines may have jackscrews in place of springs. Consider yourself lucky if you own a jointer with a cutterhead that accepts disposable knives, such as those made by Esta (800-557-8092). With these, no depth adjustments need be made after the initial setup (see the top photo on the facing page).

Jackscrews allow the height of knives to be adjusted easily. Each knife rests on a pair of jackscrews that are set inside a hole in the cutterhead slot. Wedge the cutterhead at TDC, remove the first knife, install a fresh one and snug up the bolts, leaving just enough slack for the knife to be moved without slop. Unless the owner's manual says differently, adjust the jackscrews until about 1/2 in. of the back of the knife (measured below the bevel) protrudes above the cutterhead slot (see the top photo, near left).

Next, lay a short straightedge on the fence side of the outfeed table and extend it over the knife. Adjust the outfeed table until the knife just grazes the straightedge. Then place the straightedge along the rabbeting side of the outfeed table and adjust the other jackscrew, if necessary, to bring the knife into line. Rock the cutterhead back and forth; the knife should just kiss the straightedge. Tighten the bolts in progression to avoid warping the cutterhead, and check the setting again. Repeat for the other knives without changing the outfeed-table height.

On some machines the back edge of the cutterhead slot may be machined away so you cannot accurately measure from the back bevel of the knife to set the cutterhead height relative to the outfeed table. Instead, you have to set the outfeed table with a straightedge and feeler gauge 0.015 in. above the cutterhead (see the top photo, far left). Make the measurement along the smooth surface of the cutterhead midway between slots.

On a cutterhead with springs instead of jackscrews, align a knife to TDC and wedge the cutterhead in place. Replace the dull knife, pressing it down against the springs. Snug up the bolts, leaving enough slack so that the knife may be moved but without slop. Place a pair of shopmade or commercial magnetic knife holders over the knife, which will lift it to the height of the outfeed table (see the bottom photo at left). Lower the outfeed table until the back edge of the bevel on the knife drops below the outside surface of the cutterhead, then raise the table until the bevel and about 1/2 in. of the back edge of the knife protrude above the cutterhead. (Be sure to check your owner's manual on this matter.) Tighten the bolts in progression. Repeat for the other knives.

Make a test cut—Before powering up the machine, double-check all of the bolts and screws that were adjusted. Then be sure to remove all tools from the machine. Spin the cutterhead one more time by hand to make sure that it moves freely and that no stray tools or parts have fallen into the slots.

Set the machine for a shallow pass and joint the edge of a reasonably straight board. If the end of the cut is deeper (snipe), raise the outfeed table slightly. If there's a hump of excess material left behind, lower the outfeed table. A lot of chatter marks mean one knife is slightly higher than the rest. Recheck the height of the knives. Aside from occasional knife replacement, the full tune-up may not have to be repeated for years and years to come. □

John White is a woodworker and machinist who maintains the Fine Woodworking workshop.

What Woodworkers Need to Know about Light

Use or avoid its effects
to your advantage

BY JEFF JEWITT



Way too much sun. The cherry kitchen cabinet at the bottom has been bleached from 12 years of direct sunlight through a window facing south. The drawer on top is from another cabinet facing north. The ambient indirect light has given it the deep red patina usually found on the surface of cherry.

For woodworkers, light is a mixed blessing. On one hand, it energizes water, carbon dioxide and chlorophyll to produce the nutrients that make trees grow, providing us with raw material. After a tree succumbs to the chainsaw and the wood has been cut, shaped and finished, light combined with oxygen changes the color of the wood to the patina so sought after by woodworkers and antique dealers. But light can also destroy

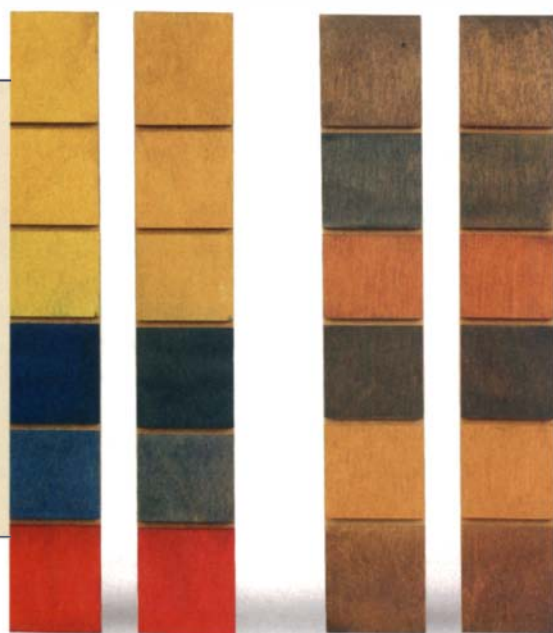
(see the photo above). Left unchecked, it can split, warp and bleach wood and ruin most finishes. To improve the life span of your projects, you need to know how to deal with the beneficial and the destructive aspects of light.

What light is and what it does

To understand what light does to wood, you have to understand just a little bit about light. Light is a form of radiant energy expressed or measured by its wavelength. Those forms of energy that have long wavelengths—radio waves and microwaves—don't seem to pose any problems with wood and finishes. But the concentrated energy in the shorter wavelengths of infrared (heat), visible light and ultraviolet (UV) light can severely affect the surface of wood and most finishes applied to it. This higher energy disrupts the way the molecules of wood and finishes are held together. In combination with oxygen (photo-oxidation), light causes chemical reactions that fade stains, turn finishes yellow and trigger cracks in the finishes as they degrade.

It is the visible light that causes color shifts in wood, making light-colored woods turn yellow or brown, and dark-colored woods turn slightly lighter. Some woods, such as cherry, mahogany, padauk, purpleheart and teak, change dramatically. Cherry and mahogany turn from a light pink to deeper red and brown tones. Padauk and purpleheart start out as bright red and purple before they shift to a

Pigments resist sunlight better than dyes do. The right sample of each of these two pairs of stain-color samples was exposed in a laboratory to the equivalent of two years of sunlight in Florida. Dye stains (left) did not fare as well as the earth-tone pigment stains (right).



DYE STAINS

PIGMENT STAINS

more muted brown. Teak goes from light brown to an orange color. Some of these changes brought on by exposure to light are not necessarily unwanted and may take a long time to occur. By learning to anticipate changes and to minimize the more harmful ones, you can better preserve the fruits of your hard work.

Reduce the exposure

Avoid harsh lighting conditions by keeping furniture away from large windows, especially those that face southwest. If wood is exposed to strong UV light for long enough, it will eventually become bleached. On woods that change color quickly, avoid leaving objects that partially cover the surface for long periods of time. Place tablecloths on large horizontal surfaces such as dining tables, and cover windows with drapes and curtains that will filter out some of the light. Glass and Plexiglas are good at blocking certain longer wavelengths of light, but they are less effective at screening out the damaging shorter wavelengths. You can buy glass treated with chemicals that block the shorter wavelengths by absorbing them. You can also install treated film (see the photo below) over existing glass to minimize damage to furniture. Blue films work best at absorbing the most harmful UV light. (Look in the yellow pages under “Glass Coating and Tinting.”)

Choose more durable finish materials

Dye stains are particularly sensitive to strong light (see the bottom left photo on the facing page). Dye stains that are called *fugitive* are not lightfast, and they will fade even when exposed to the relatively low levels of light found indoors under fluorescent bulbs. Lightfast (also called *metallized*) dye stains can withstand extended doses of interior exposure without visible fading, but there are no dye stains rated for exterior use. While lightfast dye stains are certainly appropriate for most interior woodwork, I’d avoid using them on stationary items, such as window trim, or on cabinets and furniture that will get a great deal of exposure.

Where strong sunlight may be present, it’s always better to use a pigment stain (see the bottom right photo on the facing page).

Pigment stains resist fading, and the class of pigments called iron oxides (or earth colors) are extremely stable. In addition to being lightfast, a surface stain made of these pigments will protect the wood because it reflects and dissipates the energy in UV light. Because iron-oxide pigments naturally appear as red, brown or yellow, they make good wood and deck stains. You can apply a pigment stain over a dye stain on wood to get the benefits of both.

Some finishes are more prone than others to turning yellow and cracking after prolonged exposure to sunlight. Linseed oil and linseed-oil-based varnishes, phenolic resin varnishes (marine and spar varnish), nitrocellulose

Sunlight alters the color of wood	WOOD	EFFECT
	Ash	Yellow
	Birch	Yellow
	Cherry	Deep red
	Mahogany	Deep red
	Maple	Yellow
	Padauk	Dark brown
	Pine	Yellow
	Purpleheart	Dark brown
	Red oak	Dark pink
	Teak	Orange
	Walnut	Lighter brown
	White oak	Darker yellow-brown

Indoors, a moderate amount of sunlight will affect different woods in different ways. Some finishes retard this process better than others. Extreme exposures of sunlight have the effect of bleaching most woods.



Blue shades are best. The color of the tinted film in these pull-down shades shields interiors against the most harmful and damaging UV light.

lacquer and oil-based polyurethane all fit that category. To minimize the effect of yellowing, you can substitute tung oil for linseed oil. Also, varnishes made with safflower oil or soybean oil will not turn yellow as much as those made with linseed oil. A good substitute for nitrocellulose lacquer is cellulose-acetate-butyrate (CAB) acrylic lacquer or butyrate lacquer, which do not turn yellow. Acrylics are also found in water-based finishes, usually combined with nonyellowing polyurethane resin. Most water-based finishes made of these resins will not turn yellow. Catalyzed lacquers and varnishes that incorporate nonyellowing amino and alkyd resins also work well, but catalyzed lacquers that contain nitrocellulose resin and oil-modified alkyds will turn yellow with exposure to sunlight.

Can you really prevent wood from changing color?

You can stall or minimize the change in color, but eventually the wood will change. Lighter woods such as ash, birch and maple all tend to develop a strong yellow color with exposure to light and oxygen. Darker woods develop yellow hues, too, but the effect is not as noticeable—it simply adds a warmer tone to the overall appearance of the wood.

If you want to keep a light wood light, consider bleaching it with a two-part peroxide bleach. If you want to keep any wood dark, use a lightfast stain to color it. So, in summary, there are two things you can do to stabilize the color of your projects as long as possible: Limit their exposure to strong light, and use a finish with acrylic in it. A third thing you could do is displace the oxygen in the room with argon, but I doubt your houseguests would appreciate that.

Jeff Jewitt writes frequently for Fine Woodworking on finishing topics.

Music for Your Ears



With new high-tech earmuffs, you can drown out the drone of machines and karaoke while you cut

BY
ANATOLE BURKIN

Standard hearing protectors make me feel like I'm enveloped in a mushy, foamy sound bubble, cut off from the world. In this state, the boredom of endless repetitive tasks such as power-sanding can lead to a mind-numbing stupor. That all changed recently when I tried the new generation of electronic earmuffs that both protect my hearing and serve up my favorite music.

Most electronic hearing protectors employ passive noise reduction, much like standard shop earmuffs. Foam-enclosed plastic cups that fit snugly around the ear seal out harmful noises. But they have added internal speakers for audio, supplied by either a built-in FM tuner or an outside source, such as a portable CD player.

However, the newest twist in hearing protection is active noise reduction (ANR), a technology

Peltor HT7A-03

If you already own a portable radio with a head-phone jack, this unit makes economic sense. It comes with a sturdy spiral cable to plug into your favorite listening device. The stereo speakers perform well in the mid- and high ranges but don't put out much bass. The NRR is 24 decibels, and the audio output goes to 82 decibels.

Pro: Low price

Con: Lacks bass

Price: \$99

Contact: Aearo at (800) 327-3431 or www.aearo.com



Peltor HTRXS7A

There's something nice about not having any dangling cords around your head, and that's one of the best features of the earmuffs with built-in radios. The HTRXS7A is similar in function to the Elvex (see p. 48). An FM stereo radio is built into the earmuffs, which have decent speakers, although I'd like a bit more bass. Audio output is limited to 82 decibels, and the NRR is 24 decibels. There is no jack for connecting other audio devices. The unit runs on two AA batteries.

Pro: Better-than-average speakers

Con: Limited to radio play

Price: \$150

Contact: Aearo at (800) 327-3431 or www.aearo.com



Noise Cancellation Technologies PA-3000

You'd expect a company that makes acoustical speakers to make high-fidelity earmuffs, and Noise Cancellation Technologies (NCT) doesn't disappoint. Beside the best sound quality, the PA-3000 provides two-tiered hearing protection, both passive and through ANR electronics. The NRR is 21 decibels, but the ANR circuitry may provide up to 20 decibels of additional noise reduction for low-frequency sounds. (The ANR circuit is aimed at frequencies ranging from 50 to 500 hertz.) The electronics are quite effective at quieting rumbling machines such as compressors and thickness planers. In fact, the first time I used the unit, I thought my compressor was broken, so tinny was the sound inside the headset. A portable listening device such as a radio or CD player may be plugged into the PA-3000. Because the audio-input limit is a booming 120 decibels, you have to be careful not to rock too hard and blow your eardrums out. The PA-3000 comes with a rechargeable battery and charger. NCT also makes smaller, low-priced portable headphones with the ANR feature, which are perfect for airline travel.

Pros: Best speakers; cool ANR feature

Con: Exercise caution with the audio volume!

Price: \$189

Contact: NCT at (800) 278-3526 or www.nct-active.com



once available only to pilots. ANR employs clever electronics that mask out unwanted noise by creating opposing sound waves. The sound waves are particularly effective at blocking low-frequency noises that are tough to filter out with foam-filled muffs. Only one brand of earmuffs uses ANR. There are a number of audio headsets on the market with this technology; however, they are not appropriate for shop use. Stick to earmuffs designed for industrial applications.

Some earmuffs have built-in microphones that automatically amplify soft sounds but immediately cut out when noise levels rise. The microphones, which are tuned to midrange tones, allow you to carry on a conversation in a noisy environment while wearing hearing protectors.

All earmuffs have noise-reduction ratings (NRR) expressed in decibels. The higher the number, the greater the protection. In a woodworking-machine environment, earmuffs with an NRR of 20 to 30 decibels are usually adequate.

Listening to music while woodworking may sweeten the experience, but it can turn sour if your concentration wavers. Your hearing can tell you whether machines are running or if something sounds wrong, such as when stock is being fed too quickly. Exercise common sense, and don't totally blot out the sound of machinery. And one more thing: If you're an audiophile, you may be disappointed with the performance of these units compared with \$150 stereo headsets without hearing protection. For truly fabulous audio, get out of the workshop and go listen to your hi-fi. □

Anatole Burkin is a senior editor.



Elvex COM-80R

The Elvex COM-80R has very comfortable ear cups, something you come to appreciate after eight hours of use. The unit has a built-in FM stereo radio, and it works surprisingly well for such a small unit. As with all portable radios, movement may affect the quality of reception. The internal rechargeable battery will last up to 40 hours on one charge, which takes 12 hours. An easy-to-reach volume knob can be adjusted for balance. The audio output is limited to 82 decibels, and the NRR is 27 decibels. Additionally, a CD or tape player may be plugged into the recharging port. (Elvex also makes earmuffs with microphones, but they were not made available for reviewing.)

Pro: Highest NRR

Con: Speakers are weak in bass and high frequencies

Price: \$168

Contact: Elvex at (203) 743-2488 or www.elvex.com

Peltor MRX7A

Wouldn't it be nice if you could carry on a conversation in a noisy environment while still wearing hearing protection? These earmuffs allow just that. With built-in microphones that amplify soft sounds, it's possible to hear someone talking over the din of machinery. (There's also a jack for plugging in other communication devices such as a two-way radio or telephone.) If there's a sudden increase in loud noises, the microphones cut out, protecting one's ears. The unit also comes with a good-quality automotive-like FM tuner with electronic search and preset buttons. The NRR is 24 decibels, and maximum radio audio output is 82 decibels. With nine push buttons, this unit takes a bit of getting used to, but it's designed logically, so you can make all adjustments while wearing the unit. Two AA batteries provide power.

Pro: You can talk over the din of machinery

Con: Be prepared to shell out a few bucks for the privilege

Price: \$245

Contact: Aearo at (800) 327-3431 or www.aearo.com



One-Drawer Lamp Stand



Build this Hepplewhite table
and further hone your hand-tool skills

BY MIKE DUNBAR

This small table is a typical example of a furniture form that became popular in the 1790s and remained in favor through the first half of the 1800s. It is generally referred to by antique collectors as a lamp stand. That name distinguishes it from the tripod tables that had been popular during much of the 1700s. The name also explains this form's sudden development. Tripod stands are commonly called candle stands, from the practice of placing candlesticks on them to illuminate a room. Oil

lamps became popular around 1790. But the lamps used highly combustible liquid fuel and so were more hazardous than a single candle flame.

To provide a more stable and safer resting place for oil lamps, the small, four-legged table was introduced. Outside the antique world, this form is called an end table, indicating the table's popular use at the ends of a sofa or on both sides of a bed. For this reason, many people prefer these tables in pairs. The pair I made are



BACKSAW BASICS



Saw both corners, then connect the cuts. Cutting through a tenon's long grain can be a problem unless you ease into it by making



a diagonal cut through both corners and then connecting those cuts across the middle. Use the same process when cutting the shoulder.



of woods native to New Hampshire—cherry with a curly maple veneer drawer front.

Making one of these tables is an excellent project to help the beginner or intermediate woodworker develop and practice hand-tool skills. It is a natural progression from the more basic joints and work methods introduced in the blanket chest I wrote about in a previous issue (see *FWW* #134, pp. 48-53). Obviously, this table could be built with straightforward machine work, but it is a lot more fun if you do at least some of the tasks by hand. You could prepare the stock with planes and handsaws, as I did when I made the blanket chest; however, for the table I did all of the thicknessing and ripping on machines. Then I moved to the bench to make the actual table. After stock preparation, the table has four major operations—the joinery, the leg taper, the top and the drawer.

Complete one operation at a time

The two most important tools you will use in making this table are the square and straightedge. Slight differences that are easy to overlook in a larger piece are magnified in a table this small. Use the straightedge and square to check everything as you progress.

After cutting all of the parts to size, remove any saw, planer and jointer marks (if you used these machines) and obtain a smooth surface with handplanes. Check to be sure that with all of your handplane work you do not plane out of square.

A mortise gauge is a scribing tool with two points and is used for laying out mortises and tenons. Adjust the two points to the width of the joint, and slide the fence to the thickness of the shoulder. Always run the gauge's fence against the outside

surface on all parts. Doing so will give you a consistent reference that might not be reliable if you were to make some marks off the inside edges and some off the outside edges.

Use a square—again, always on the outside surface—to mark the ends of the mortises and the tenon shoulders. I lay out the mortises so that the rails will protrude above the tops of the legs by $\frac{1}{16}$ in. After the table has been glued up, it is easier to true the rail-to-leg joints by planing the long grain of the rails rather than trying to plane the end grain of the top of the legs.

Notice that the tenons used to join the rails to the legs have just one shoulder (see the drawings on the facing page). In keeping with the Federal period's preference for sleek lines, the rails are flush with the legs. If the tenons were double shouldered, the outside walls of the mortises would be too thin. While the single-shouldered tenons are not as resistant to racking, they are more than adequate for this table. They are also easier to cut.

Backsaw the tenons and chisel out the mortises

I cut tenons with a sharp backsaw (see the photos above). I prefer to cut on the outside edge of the line rather than on the line itself. This usually results in a bit of extra material. Remember the old maxim about wood being easy to remove but hard to put back on. The extra material is easy to trim away.

Start the sawing with the shoulder. Hold the part in a bench hook—an easy-to-make holding device that is very useful in handwork. You can use clamps, but they take more time. Rather than laying the saw across the part and cutting the shoulder at once, tilt the saw so that you start on one



Tabletop attachment. Use a marking gauge to mark $\frac{1}{2}$ in. down from the top edge of the aprons and then use a gouge to cut pockets for the tabletop attachment screws.

CHERRY LAMP STAND WITH CURLY MAPLE DRAWER FRONT

First popularized at the end of the 18th century, tables of this type are often made in pairs and used on both sides of a bed or couch. Plain in form, almost stark, this table is dressed up by the addition of curly maple veneer and cock beading on the drawer front. For cock-beading details, see the drawing on p. 55.



corner. Repeat on the other corner and then connect the cuts. Although I lay out my shoulders with a square, I cut them at a slight angle (1° or 2°) away from the tenon, which helps in obtaining a tight joint between the shoulder and the leg and eliminates a lot of work with the shoulder plane.

Cut the tenon's cheek by holding the rail upright in a vise. It is hard to keep the saw from wandering if you cut straight across the part and straight down the cheek. Once again, start the cut on one corner and deepen it on one side almost to the shoulder. Repeat on the other side. These two cuts will keep your saw straight as

you complete the cheek. To separate the waste cleanly, you may have to deepen the shoulder cut to meet the cheek. Do this carefully because overcutting will weaken the tenon.

Before moving on to the leg mortises, cut the screw pockets in the inside upper edges of the rails. Use a scribe to mark the pockets' upper surfaces. With a gouge, hollow out the pockets (see the bottom photo on the facing page). Drill the screw holes at an angle that will exit through the rail's top edge.

To hold the legs while cutting the mortises, I like the two-clamp system shown in the top photos on p. 52. When I need to knock

MORTISING WITH A CHISEL



Popping chips. A stout mortise chisel is designed to be used as half cutting tool and half prybar. After driving the chisel into the wood with a mallet, you can pop the chip out of the hole. Don't try this with your bench chisels, or you might end up with a bent tool.



A square mortise makes a square table. When you first mortise by hand, it is important to check your work constantly. Hold a square on the table leg and sight along the square and the edge of the chisel to make sure the mortise is square to the face of the leg.



Mortise tuning. If need be, use a wide chisel to pare the sides of a mortise when fitting it to an already cut tenon. The author's two-clamp system holds a leg for mortising; the clamp flat on the bench is set just wider than the leg thickness, holding the leg securely but allowing it to be lifted out easily.

out a reluctant chip from a mortise, all I have to do is loosen one clamp and pick up the leg.

A mortise chisel will make quick work of chopping a mortise. It is a stout tool designed to take a lot of pounding and levering. Make sure your chisel is sharp. Start the mortise back from the end and drive the chisel straight down. Pull it out and move about $\frac{3}{8}$ in. down the mortise for the second cut. The chisel's wedge shape pops out a chip of wood the same width as the tool. Repeat along the mortise, stopping short of the other end.

Begin another, deeper pass along the now well-defined opening. It is important that the mortise be perpendicular to the leg. To avoid wandering to one side, check yourself with a square. Do this frequently in the beginning of the cut. You will probably discover that you tend to lean to one side or another. (I tend to push too far away and usually need to draw the handle toward me.) Very quickly you will develop the feel for vertical, and you will need to check yourself only once in a while.

During the second and subsequent passes, the chips do not easily pop out of the mortise. You have to lever them loose by pulling the chisel so that it rocks on its bezel. This pulling is the reason for stopping short of the mortise's end. The waste will keep the chisel from crushing the end. As the mortise deepens it becomes more difficult to get the chips out. They pry

loose but stick in the mortise. Keep a thin chisel or screwdriver on hand to use as a pick.

Check the mortise's depth with a ruler. It speeds up the fitting if you go just a bit deeper than the tenon. Finally, use the chisel to make two cleaning cuts that bring the mortise's narrow ends up to the scribe lines.

Rotate the leg and cut the second mortise. You will find that it intersects the first. To avoid blowing out large pieces of wood from the wall of the first mortise, drive the chisel with less force as you near the full depth.



Tracing tail. The top drawer rail locks into the top end grain of the two front legs by means of a large dovetail. The bottom drawer rail is secured to the legs with two small tenons.

Getting the right fit

To ease the tenon's fit into its mortise, use a low-angle block plane to ease all of the edges. Where necessary, trim the mortise wall. Use a wide, sharp chisel so that you can make the cut in a single pass, which creates a more uniform surface than trimming in multiple passes with a narrower chisel. This low-angle trimming is called paring. Where necessary, trim the tenon cheek with a shoulder plane. This plane's sides are square to the sole, and its narrow mouth allows it to take very controlled cuts. It is used cross-grain.

Repeat this process of fitting and trimming as necessary. You want a snug fit that will move by hand. You should not have to drive the tenon, and it should not fall out on its own. This friction fit may take a few

tries to achieve, but hand skills develop only with practice. However, if you do trim too much, glue a piece of veneer to the tenon and start the trimming again.

When you can push the tenon to full depth, check the result. The shoulder should be tight to the leg. At the same time check between the rail's lower edge and the leg for square. Do the same along the leg and the rail's outer surface. (This is easy to do before the legs are tapered and impossible afterward.) Make adjustments to the mortise or tenon as necessary. Use a shoulder plane to get a tight fit of the shoulder to the leg. Repeat the fitting until the table is standing on four legs. Do not be too concerned if the rail's outer surface and the leg do not align perfectly. You will plane them after glue-up. Finally, fit the bottom drawer rail.

Lay out the dovetailed tenons that secure the top drawer rail to the front legs (see the bottom photo on the facing page). Cut the tails using a backsaw the same way you did on the rail tenons. Start on one corner and cut down the line. Repeat on the other corner. Use the tails to lay out the pins on the top of the legs and fit and test the joints. Drill and countersink two top-attachment screw holes in the rail.

Dry-fit the table and clamp lightly. Test for square (see the photos at right). Double-check by measuring from corner to corner. Place the table on a flat surface such as a tablesaw to make sure all four legs will touch. Use a straightedge across all four top edges to look for high or low spots. Use a pair of winding sticks to test front to back and side to side. Winding sticks are two straightedges usually of contrasting colors. When sighting across the winding sticks, you can make sure that all four sides are coplanar.

Legs are tapered with a plane

Tapering a leg is very easy to do with a plane. On the lower end of each leg measure in $\frac{1}{4}$ in. per side and connect the lines to make a square. On opposing surfaces of the leg, use a straightedge and pencil to connect the lines on the foot to the location of the rails' lower edges. Use a jack plane to remove the bulk of the waste, paying attention to the grain. Finish to the lines on both sides with a smoothing plane. Rotate the leg and do the same to the other sides. Then lay out the lines for the two remaining straight sides, and repeat the process. You cannot lay out all four sides at once because you would plane away the lines for the second two tapers while making the first two.

Glue and clamp up the table. When it is dry, clamp the table in a vise and plane the leg-to-rail joints flush, as necessary. Be careful, because the grain in the two parts runs in different directions, and any overlap by the plane will leave a rough cut on one surface or



Ruler and square are invaluable. After the joints have been cut, dry-fit the table with clamps and take diagonal measurements across the top of the frame (left). Equal diagonal measurements indicate it is square. Check the rail-to-leg joints for square while the table is clamped but before the legs are tapered (below).



the other. Make sure your smoothing plane is very sharp and well tuned. Use a very low setting. If you do nick an adjacent surface with a cross-grain cut, clean it up with a handheld scraper.

The top's long grain runs side to side

For the table's top you will probably have to glue up two or more pieces. Remember that the joint will run side to side so that you won't see end grain when looking at the table head-on. Make the top oversized and cut it to dimension when the glue is dry. The top is small, so the glue joint can be done very easily with a jointer plane. Although I did it while gluing up boards of the blanket chest, I don't recommend springing the joints for this tabletop because it is made of short, thin hardwood.

Once the glue is dry, joint and square one edge with a jointer plane. You can cut the other three sides on a tablesaw or with a fine handsaw. If you do it by hand, use a large square to lay out two edges square with the first. I had one of my medium-sized handsaws filed to a 14-point crosscut for use on thin hardwood. Using this saw, there is almost no chipping on the lower

SIMPLE VENEERING



Heating hide glue turns it to goo. The pine drawer front is veneered with curly maple. Coat the drawer front with hot hide glue and coat both sides of the veneer, then stick the pieces together. Coating both sides of the veneer keeps the thin wood from curling.



Don't hit with a veneer hammer. The hammer is used more like a squeegee. After the glue-coated veneer is placed on the glue-coated drawer front, use the veneer hammer, starting in the middle and working toward the edges, to push air bubbles out from between the two layers. The hide glue sets in a few minutes.



Flush-cutting veneer saw. The curved, thin blade of a veneer saw has no set to its teeth, making it ideal for flush-cutting across the drawer front's veneer. The saw will leave a crisp edge on the veneer's finished side.

edge. Measure 18 in. up these two sawn sides and lay out the final edge. Test again for square and make any final adjustments while smoothing the sawn edges with handplanes.

Use a jointer plane to remove saw marks from the two edges that are edge grain. A low-angle block plane with a very light setting will clean the end grain. You can do this with a bench plane if it is razor sharp. Be sure to plane in from both edges toward the middle to avoid chipping the corners.

Jack-plane the bottom to remove any planer marks, glue or overlap. This surface is not seen, so there is no point in spending a lot of time on it. Use a smoothing plane on the top to remove any thickness-planer marks and any overlap in the joint. Finish up with a scraper to achieve a perfect surface. I have a Stanley No. 112 scraper plane that I use to produce a glassy surface.

Place the table upside down on its top, protecting the top from damage during this process with a towel or blanket between it and the workbench. Measure to make sure you have the same amount of overhang on all four edges. Once you have the best placement, make some light marks on the top's bottom surface with a pencil, just in case something moves while you are working. Screw the top in place.

The drawer has a veneered front

The drawer front is veneered with curly maple. If exposed, the edges of the veneer would easily chip when the drawer is opened and closed. The veneer is protected with an applied raised edge called cock beading (see the drawing and photos on the facing page). This detail serves another important purpose. With flush rails, the table is sleek to the point of being stark.

Cock beading makes the front three dimensional. The beading is usually the same wood as the table.

The cock beading on the drawer ends are more narrow than those on the top and bottom. The end pieces are fit into rabbets cut across the dovetails. The tails would be weakened if the cock beading were run right up to the scribe line. Of course, the two different widths of the cock beading require the use of a stopped miter joint.

Make the drawer to fit the opening. Smooth-planing machine and saw marks and trimming the leg joints may have made very small changes to the dimensions in the drawing. I made the drawer of pine, as a New England cabinetmaker would have in the 18th century—a southern cabinetmaker would have used poplar—but you can use any suitable wood.

Thickness the wood for the drawer, the runners and the cock beading. Remove the planer marks with a smoothing plane. Then cut the parts to dimension. You can use a square to lay out these cuts, or you can use the edge of a bench hook as a guide. Glue the drawer runners to the lower inside edge of the rails. The glue will dry while you are making the other parts.

To make a drawer that slides smoothly and fits well, it is important to maintain square. For small parts use a shooting board and a well-tuned and sharp handplane. I use a Stanley No. 605 in a shooting board. Its cutter is adjusted laterally so that its edge is at a right angle to the right cheek, ensuring that it cuts a square edge. After ripping the parts to width and cross-cutting them to length, check for square. If they are not perfect, scribe a line with the striking knife where they need to be



Scraper plane for drawer veneer. After cutting the veneer flush with the drawer front, use a scraper plane to finish the veneer.

trimmed. Place the pieces on the shooting board and use the plane to shave the end grain to the scribe line. Keep the high side toward the shooting board's stop so you do not chip the far edge.

Groove the sides and front for the drawer bottom. I did this using a plow plane, which is fast and easy. However, a plow plane is an expensive tool. If you do not have one, use your tablesaw.

When you lay out your dovetails, leave enough room above and below the tails to trim the top and bottom edges of the drawer front to accept the cock beading. Cut and fit the dovetails. When you are satisfied with the fit, run a marking gauge along the top and bottom edges of the front and plane to this line. Using the shooting board gives you good control, and because the scribed line is facing up, it is easier to see.

There are several ways to make a drawer bottom. I used the method favored by period New England cabinetmakers. They used a jack plane to feather the front edge and two sides until they were narrow enough to fit in the groove.

Use a bandsaw to cut two pieces of veneer from a piece of curly maple. That way, the grain pattern on this table and its mate will match each other. Between cuts handplane the wood so that each sheet of veneer has one smooth face for gluing. I applied the veneer with hot hide glue and a shopmade veneer hammer (see the top photos on the facing page). Brush a thin coat of glue on the drawer front and on both sides of the veneer. Place the two pieces together and push a veneer hammer from the center in all directions to remove any air and excess glue. The hide glue hardens by cooling, so the process takes mere minutes. Use the shooting board to joint the veneer flush with the top and bottom. Trim the ends with a veneer saw. This is a special curved saw with no set that allows you to cut veneer end grain flush with an edge.

Holding the drawer front in a vise, plane and scrape the veneer so it is smooth and uniform in thickness (see the bottom photo on the facing page). Glue up the drawer, and while clamping, check for square. When it is dry, test the drawer's fit.

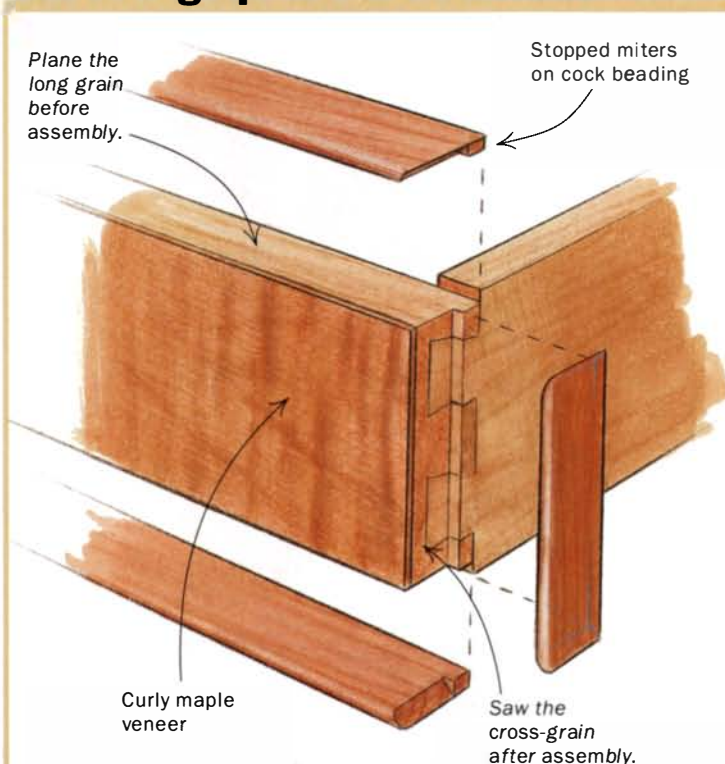
With a marking gauge, scribe the thickness of the cock beading on the ends of the drawer front and scribe its width on the dovetails. Cut this rabbet with a very sharp backsaw and clean it up with a shoulder plane. To avoid chipping the veneer, plane both edges toward the center.

Cut the top and bottom strips of cock beading to the same length as the drawer front. Using the edge of the rabbet as a guide, mark the joint's stopped miter. Stand the cock beading in a small miter box held in the bench hook and cut the miter with a very fine backsaw. Hold the top and bottom cock beading in place with clamps while you miter the two end pieces. Test their fit. Round the inside edges with a block plane and glue all four pieces of beading in place. When the glue is dry, level the cock beading with a block plane, if necessary, then round the outside edge with a sanding block.

The drawer should fit in its opening so the veneer is flush with the legs and the cock beading stands proud. To do this, glue two small blocks of pine to the drawer back to act as stops. Use a block plane to trim these blocks until they hold the drawer at the desired depth. The final decision is the hardware. I used a period brass oval pull. However, a turned knob would also be appropriate. □

Mike Dunbar is a contributing editor.

Dressing up the drawer front



Saw a cutout for the bead strip. All four sides of the drawer fronts must be cut back to fit the cock beading. Cut each end of the drawer with a backsaw and plane the top and bottom to size.



Miniature miter box for cock beading. Once the edges of the drawer front have been cut back, cut the cock beading with a backsaw and a small miter box.



Tape clamps. Cock beading sits proud of the veneer by $\frac{1}{8}$ in. Masking tape works like another set of hands to hold the cock beading in place while fitting the final pieces. After all of the pieces have been fitted, glue and clamp the cock beading in place.



Sweetgum:

As a wood consultant, I am often asked to identify various species of wood. Exotic tropical timbers account for a good many of these requests, but among domestic hardwoods, no species seems to cause as much confusion as sweetgum. The confusion is especially acute if the sample in question has been stained or is old and very oxidized. It's no surprise that so many people are stumped, because sweetgum is a true chameleon, with similarities to many other woods in terms of density, texture, appearance and working characteristics. Sweetgum also takes stain well enough to pass for anything from maple to cherry, even mahogany and walnut. Given all of this, confusion is virtually inevitable. And frankly, it is often intentional. You see, the sad truth is sweetgum is a counterfeiter's delight. As a result, it is often overlooked as a wood in its own right, and this is a great shame, because despite some drawbacks, it is a very fine wood for cabinet work.

One tree, two timbers

Our native sweetgum, *Liquidambar styraciflua*, produces two woods so strikingly different in terms of color that the lumber trade markets them separately. The abundant sapwood tends to be just to the creamy side of stark white in color and is sold as sapgum. The heartwood, by contrast, is a complex reddish-brown with a slight grayish hue and is typically marketed as redgum or simply gum. Unfortunately, the name gum leads to some confusion, because several species of tupelo, or blackgum, also sometimes find their way to market as simply gum. Although sweetgum and tupelo are quite similar in texture and density, and their sapwoods can be easily confused, they are not closely related. Tupelo belongs to its own small botanical family, Nyssaceae, and is more akin to dogwood, while sweetgum belongs to the witch-hazel family, Hamamelidaceae. In fact, sweetgum is the witch-hazel family's only major timber-producing species in North America.



This Dixie star
is a master of disguise

BY JON ARNO

Sweetgum's native range (see the drawing above) extends from Missouri to Connecticut and from the Ohio River Valley south to

Neglected Wood with an Elusive Identity

the Gulf of Mexico, but it grows best on river flood plains deep in Dixie from Louisiana through Alabama. When grown in dense forests, it is a magnificent timber tree capable of attaining heights well in excess of 100 ft. and diameters of up to about 5 ft. Its cork-like grayish-brown bark contrasts with its bright green, star-shaped leaves, which turn vivid red in the fall. The seeds are encased in small, 1-in.-dia. woody burs vaguely similar to those of sycamore. The tree is so attractive that it is a popular cultivar wherever it can be grown, and landscapers have managed to push its range as far north as extreme southern Ontario, where it occasionally suffers from winterkill and seldom attains its full potential.

Much used, somewhat abused

Sweetgum's great beauty as a living tree has not spared it from heavy, long-term exploitation by the lumber trade. Vast quantities of both sapgum and redgum were used in the 19th century for loose cooperage and railroad ties. Demand for these products declined, but equally great quantities have since been diverted to the crating and pallet-making industries. As to the high-volume use of top-quality redgum, this has historically centered in the millwork and plywood industries. Over the years demand has noticeably shifted. It is still an important species, but its use in millwork seems to have peaked in the 1930s. Until that time it had been one of the primary low-cost, paintable hardwoods used for interior trim, and these products were shipped to markets throughout the country. However, as supplies diminished and prices increased, this role has largely been taken over by yellow poplar.

Redgum has much more effectively maintained its market position in the furniture industry as a popular secondary wood. Its role here seems secure, because it is substantially stronger than yellow poplar, and its great versatility when it comes to subterfuge provides a key benefit. In the hands of a skilled finisher, it can be quickly doctored with stains and then used in conjunction with more prestigious woods. The application of dark brown pigments allows it to blend in passingly well for the less noticeable parts in walnut furniture, while red pigments make it one of the better counterfeits for cherry. Sapgum offers some sleight-of-hand opportunities as a blond-wood substitute in birch and maple commercial furniture. I think these efforts at misdirection degrade the image of sweetgum, suggesting that somehow it is an inferior cabinetwood when, in fact, it merits considerably more respect. It may



Suitable for framing. Although often employed as a secondary wood and for paint-grade millwork, redgum, if selected for streaked figure, yields pieces pretty enough to take center stage. Seattle furniture maker Larry Rohan used redgum for the panels of the cabinet above.

Dutch treat. Colonial-era cabinetmakers in New York and New Jersey used sweetgum extensively for large case pieces. This Dutch-influenced linen press from 1790 (right) employs sweetgum as the primary wood; sweetgum was also often used as a secondary wood.

take some looking to find a retailer that carries redgum. Two that do are MacBeath Hardwood in Berkeley, Calif. (800-479-9907), and M.L. Condon in White Plains, N.Y. (914-946-4111).

Sweetgum is appreciated overseas

While we Americans often use our native sweetgum in rather fraudulent ways, this is not a practice shared on the international scene. Europeans are more appreciative of the wood's virtues, welcoming our export of redgum for use as a primary cabinetwood. In England, it is commonly called satin walnut, and it is fair to say that the Brits know a good deal when they see one. Whereas redgum must be stained to approximate the appearance of North American black walnut, its natural color is almost identical to that of Old World walnut (*Juglans regia*, a.k.a. English walnut), which has long been both scarce and very expensive over there.

The fact is redgum has excellent working characteristics, almost identical to those of cherry. It shapes beautifully, and the tendency for it to friction-burn when routed or sanded is somewhat less of a problem than it is with cherry. Like cherry, it contains a natural gum that gives the wood a satiny surface luster, but the gum is not present in high enough quantities to cause serious friction burn or major finishing problems. This natural gum, called Storax, is a commercially important commodity used in the manufacture of medicines and perfumes, but the average sweetgum tree can be coaxed to produce only about 8 oz. of the sticky fluid per year.

It would be a gross exaggeration to suggest that all redgum is



INSIDE THE SWEETGUM TREE

Sweetgum's heartwood and sapwood are so disparate in color and figure that they are marketed as two separate woods. The colorful, often streaked heartwood is sold as redgum; the pale, homogeneous sapwood is marketed as sapgum. In autumn, the sweetgum tree's bright green leaves turn a vibrant red. The two trees at left illustrate the shift, one turning a few days ahead of the other.



SAPGUM



REDGUM

stunningly beautiful, but like maple it often produces some very attractive special figures. Quartersawn stock almost invariably yields a ribbonlike grain appearance. When this feature is especially pronounced, it is exceptionally showy because of the wood's satiny natural luster. Although less common, even flatsawn redgum occasionally yields a wavy, fiddleback figure, or it may also be highlighted with dark, chocolate brown streaks. These more carefully selected examples of sweetgum are very attractive and deserve to be ranked as prime cabinetwoods.

Sweetgum's shortcomings

Like all woods, sweetgum has at least a couple of potentially serious shortcomings. Its very poor resistance to decay represents one of its more important limitations, but this is not a particularly serious problem when it is used for furniture and other interior projects. Of far greater concern is its notorious lack of stability. The reason for its instability is somewhat of a mystery. Laboratory tests indicate that its average volumetric shrinkage is 15.8% green to oven-dry. This is, admittedly, very high compared with most cabinetwoods such as genuine mahogany (7.8%), cherry (11.5%) and walnut (12.8%). It is even high compared with notably unstable species like sycamore (14.1%) and sugar maple (14.7%). But volumetric shrinkage alone does not account for serious distortion. A wood's propensity to warp is better predicted by its T/R ratio (the

ratio between its tangential and radial shrinkage). Woods with a T/R ratio below 2:1 tend to be less prone to distortion. But the surprise here is that sweetgum's T/R ratio is a rather comfortable 1.92:1. Statistically, it should be less prone to distortion than it is.

So why does it have such a high tendency to warp? I suspect the combination of its interlocked grain, with its very high volumetric shrinkage, is at the core of the problem. Similar attributes are shared by a few other woods, such as elm, that distort in much the same way. Because of the interlocked grain, even relatively uniform shrinkage, if it is high enough, appears to induce extreme stress in such woods.

The fact that sweetgum has a significant propensity to distort presents a challenge, but it should not be viewed as a catastrophic shortcoming. In the hands of a skilled cabinetmaker, it is simply an attribute of the wood that must be managed in the same way it is managed when working with maple or sycamore. Care must be taken to allow wide panels to float, and the project should be designed with an eye for counterbalance. In other words, various subassemblies and structural elements should interact in ways that allow them to be mutually restraining. Redgum's many other positive attributes in terms of appearance, working characteristics and affordable price make it well worth the effort. □

Jon Arno is a writer and woodworker in Troy, Mich.

Tenoning Strategies



Finding your way to a well-fitting joint

BY GARY ROGOWSKI

The mortise-and-tenon joint might be the most relied-upon joint in furniture making. After all, a well-fitted tenon can mean the difference between a sturdy table and an embarrassingly wobbly project. Cutting tenons can be approached from a dozen different directions, and the approach you take depends on your tools and how you like to use them. Some folks love the precision and power of their saw or router; others prefer the more contemplative *whoosh* of a backsaw and handplane. The method you choose will determine your speed and the risk factor.

A tenon should fit tightly in a mortise—snug, like a good shoe put on with a shoehorn—not like a ragged old sneaker that you can flip off and across the room as you're sitting down. Regardless of the cutting method you choose, aim for a joint that is loose enough to put together by hand but tight enough that it takes a few mallet taps to get it apart. Leave room for a little bit of glue in the joint, and always cut tenons just shy of the depth of the mortise so there's a gap at the bottom of the joint for excess glue.

Remember that accuracy comes from the patient hands of the builder and that precise joinery depends upon accurate millwork. If your millwork is sloppy—if your stock cups, warps or doesn't have parallel faces—you'll have trouble cutting accurate tenons, no matter what method you choose.

Also, I never cut mortises or tenons without first planning ahead on paper, even if it's just a quick sketch. It's better to risk a few simple eraser smudges on paper than to waste precious wood. A sketch will help you locate the joint for the most strength and best look. For strength, a tenon should be at least one-third the thickness of the stock to ensure there is enough material to support the joint.

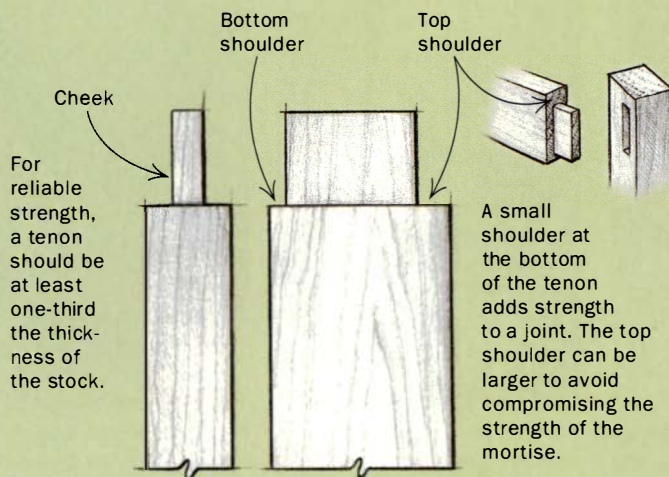
Cutting tenons by hand

In these days of machines, it may seem a waste of time to cut a tenon by hand, but if you have only a few tenons to cut, you may be surprised by how much set-up time you can waste with some machines. When I have to cut only a few simple joints, I'll often reach for a backsaw and a shoulder plane.

Hand-cut tenons require careful setup and layout (see the photos on p. 62). Your method may involve using a marking gauge and square, a mortising gauge or a pencil and square. But whatever your method, be consistent with your approach and always be dead-on accurate. Even if you are using machines to cut tenons,

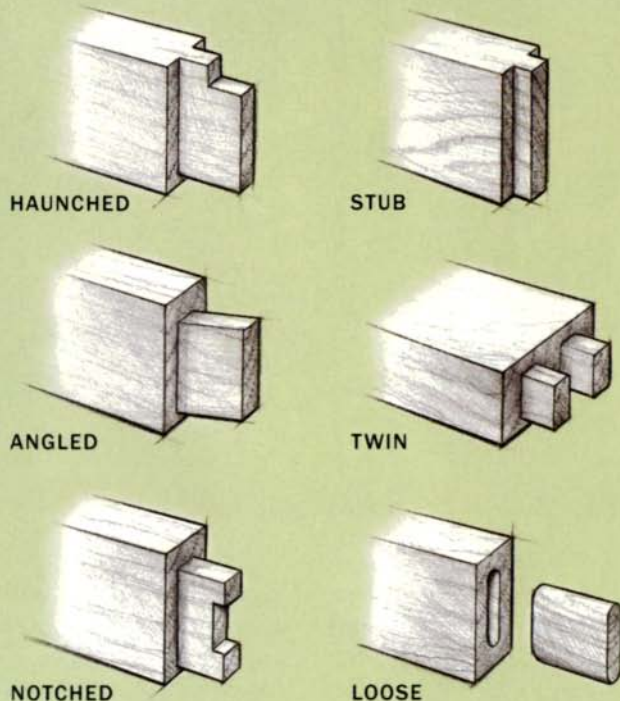
THE BASIC TENON

If it takes more than hand pressure or a few light taps with a mallet, the fit of the tenon is too tight. And if there's too much slop, you're expecting too much of the glue you use. To ensure that the glue adheres well, make sure all faces are clean and smooth. Cut tenons just shy of the mortise depth to allow for excess glue.



A TOUR OF TENONS

Whether you're building a chair or a desk or fitting together a frame-and-panel door, chances are there's a tenon designed to solve your joinery problems.



the same guidelines for marking out hold true.

Use a marking gauge to mark the length of the tenon across its shoulders. Then establish the thickness of the joint by marking out the position and thickness of the tenon. If you cut a 1/2-in.-thick mortise in the center of a door stile, for example, lay out a 1/2-in.-thick tenon centered in the thickness of the door rail. Offset or unequal shoulders become necessary when two tenons meet inside a leg.

A marking gauge will lay out the cheeks of the tenon, but by running a mortise gauge along the face side of the joint, you can mark out both cheeks at once. Use the mortise to set the cutters on the gauge, then mark across the top and sides of the tenon. After cutting the tenon cheeks and shoulders, lay out the width of the tenon and any haunch that is required (if you do this before cutting the cheeks and shoulders, the lines will be removed by the cheek cuts).

Use a backsaw to establish the shoulders. You want to cut right down to the cheek lines, but be careful not to saw past these marks.

Next, cut the faces of the cheeks. Placing the work in a vise allows you to see both the top gauge line and the cheek line nearest you. For a short tenon, cut straight down these lines until you reach the shoulder. For a longer tenon, angle the workpiece so that you can easily see the cheek lines. Cut down to the shoulder line on one side, then flip the piece around in the vise so that you can see the other cheek line as

you cut down to it. Follow the cheek lines as you cut out the remaining wood in the middle of the tenon.

Cut one cheek of the tenon and clean it up with a bullnose or rabbet plane. Then move on to the second cheek and, if necessary, adjust its size before cutting. Or, if caution suits you, cut both cheeks a bit wide and then plane to fit. Once the thickness of the tenon has been fine-tuned with a rabbet or bullnose plane, use

FOR A FEW SIMPLE JOINTS, CUT TENONS BY HAND

If you're cutting only a few small tenons, it can be faster (and quieter) to cut them by hand rather than to set up machines. No matter what method you use, careful layout is key.



Marking out. A pass with a marking gauge (left) lays out the depth of the tenon on all four sides; a mortise gauge marks the cheeks (above).



Backsaw to the line. To cut both the shoulder and the cheek, first saw at an angle on each side (above left), then follow the kerf down the middle until the cut bottoms out (above right).



Trimming for fit.

After a backsaw cuts the top and bottom shoulders of the tenon, a bullnose plane is used to clean up the cheeks (near right). A little handwork with a chisel trims the shoulder for a tight fit (far right).



the same methods to cut any haunches or other shoulders. Then grab a chisel and a plane to help you fit the tenon exactly to the mortise, trimming only a little at a time and test-fitting frequently.

Cutting tenons by hand doesn't take as long as you might think, and it is a great way to improve your hand-tool skills. Even as you turn to machines for efficiency, you'll find that it is often easiest to do the final fitting and cleanup with a chisel and plane.

Using the radial-arm saw and bandsaw to cut tenons

The radial-arm saw probably crosscuts more efficiently than any other machine, and the bandsaw rips better than any tool in my shop. You can take advantage of both features to save time cutting tenons (see Method 1 on the facing page). If you have a few tenons

to cut, use a pencil to mark out one tenon shoulder and cheek. Set a stop for the shoulder cut on the radial-arm saw table or fence. Adjust the depth of cut on the radial-arm saw and cut all of the shoulders to the proper depth.

Move to the bandsaw for the cheek cuts, and be sure to use a blade that suits your material. A 4-tpi (teeth per inch) blade works fine for most tenon cuts. But if you're cutting tenons in something hard like oak or mushy like green cedar, use a 3-tpi blade, which will push chips away and allow you to get through the cut more easily. On especially narrow tenons, a 6-tpi blade will work fine.

The bandsaw fence helps guide the cheek cuts. Set the fence so that the waste falls off harmlessly to the side instead of becoming trapped between the blade and fence. To play it safe you can

clamp a stop onto the fence so that your cut ends before the blade runs into the shoulder. But with the shoulder cuts already established on the radial-arm saw, you should be able to stop when you push through the cut. If you don't have a fence, clamp a block of wood to the table at the proper distance to serve as a fence, or simply pencil-mark your cheeks and freehand the cut. Once you check for blade drift, angle your fence to match the drift angle. There still will be a little cleanup to do with a chisel and plane, but the bandsaw can get you pretty close.

When you use this method, you can move the bandsaw fence over and cut the top and bottom of the tenon and any haunches. Then clean them up with a chisel.

Cutting tenons using a tablesaw

By using various blade setups and jigs, there are several ways to cut tenons on the tablesaw. When choosing a method, consider

speed, safety and accuracy—and make sure that the blades and jigs you use are running true.

A dado-blade setup for quick work—The fastest way to cut tenons using a tablesaw is with a dado blade (see Method 2 below). Set to the proper height, a dado blade will cut your cheeks and shoulders while you hold the stock flat on the saw table. Be careful while using a wide dado setup on the tablesaw, because these blades can take a big bite out of your board. Move slowly through the cut, and keep the board flat on the saw table.

Set up the blade for any reasonable width—it's really not that important. Crucial here are the height of the dado blade and how flat-bottomed a cut it makes. Take some practice cuts in scrap and set the blade height just under what you think you need. That way, there's just a little wood to remove for cleanup. Use a miter gauge with a long fence to push the board through the blade. If needed,

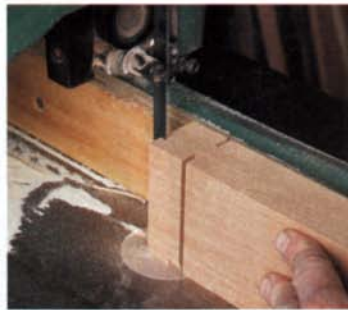
THREE WAYS TO CUT TENONS USING POWER SAWS

With proper setup, almost any machine can cut tenons reliably. To achieve smooth joints and efficient working times, sometimes you have to use a combination of machines.

Method 1 CUTTING TENONS ON THE RADIAL-ARM SAW AND BANDSAW

Radial-arm saw establishes a shoulder kerf.

The saw is set to the correct depth, and a stop block is clamped to the saw table. A single pass cuts a kerf on the tenon shoulder.



A bandsaw trims the cheek. With the fence set in place, a quick pass cuts to the shoulder line. After adjusting the fence, another cut establishes the top and bottom of the tenon. A backsaw and chisel are used to clean up the shoulders.

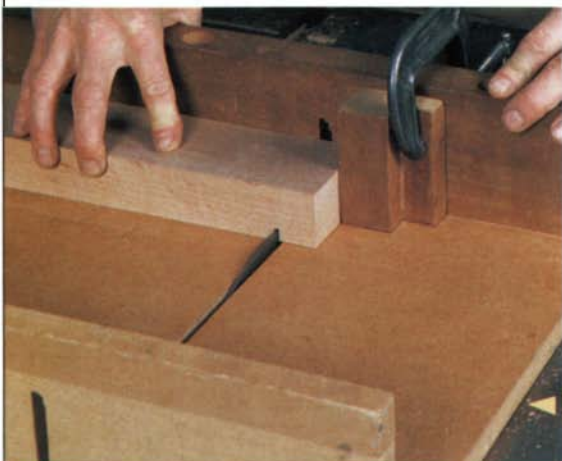
Method 2 CUTTING TENONS ON THE TABLESAW



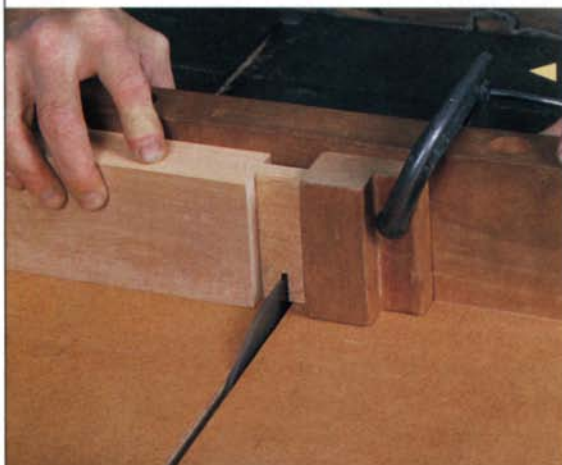
A dado blade hogs off the waste.

A stop block clamped to the fence sets the depth of the tenon while a miter gauge holds it square. Just a few passes over a dado blade cuts the tenon cheeks and shoulders. The same setup with the stock held vertically cuts the top and bottom of the tenon.

Method 3 CUTTING TENONS VERTICALLY



Making the shoulder cut. With a stop block clamped in place, a quick pass with a crosscut sled cuts the tenon shoulders (1). After a bandsaw hogs off the cheek waste, a tenoning jig—shopmade or aftermarket—holds the stock vertically to fine-tune the cut (2). Another pass with the crosscut jig cuts the top and bottom shoulder and any haunch (3).



Store-bought or shopmade. Aftermarket jigs, like the Delta at left, ride along the miter-gauge slot and secure the board vertically for tenoning, but the author often uses a simple shopmade jig (inset). The shopmade version is nothing more than a piece of plywood with a backer board screwed in place at a right angle.

you can mount an auxiliary fence on the miter gauge for better support. Clamp a stop on the fence to locate the shoulder cuts.

Make the passes for one side of all of the boards first. If your blade cuts well, you'll need to clean these cheeks very little; but if your blade cuts like my dado blade, you'll have to take some time to plane the cheeks smooth. Then move to the second cheek cut and set the blade height for just under what you'll need.

After the tenon has been cut to its correct thickness, you can also use the same dado setup to cut a haunch or to establish the top and bottom shoulders of the tenon. Reset the blade height, rotate the stock in the miter gauge and cut to fit. Approach these cuts carefully to make sure the shoulders line up.

Tenons cut vertically—Because switching to a dado-blade setup takes some time, it doesn't always make sense for small jobs. The

method I've used most often calls for a combination blade on the tablesaw (see Method 3 above). I cut the shoulders with a crosscut jig, rough-cut the cheeks on the bandsaw, then trim the tenons to fit perfectly by holding them vertically on the tablesaw and passing them through the blade using a shopmade tenoning jig.

Cutting the shoulders on a crosscut jig ensures accuracy from one tenon to the next. Set a stop on the jig fence closest to the shoulder. That way, if any dust gets stuck between the stop and the board, it pushes you away from the blade, not into it. (This problem can be remedied easily with another pass.) Next, rough out the tenons on the bandsaw. Everyone cuts a tenon undersized at some time or another. If you make this mistake, simply glue the perfectly matched offcut back on.

Make the cheek cut next with a shopmade tenoning jig. The jig I made is simply a piece of ½-in.-thick plywood with a stout right-

angle fence screwed to it. The tenoning jig holds the workpiece vertically as I pass it through the blade. It probably took me five minutes to make the jig, and I've used the same one for years. Just make sure you keep the screws high enough in the fence that there's no risk of ever running them into the sawblade. Set the blade height so that it cuts just under the shoulder cut. Keep the board tight against the fence and jig either by hand or with a clamp, and make sure you don't tip the piece; otherwise, the tenon will have a taper cut into it.

Cut one cheek and check its placement by holding the cheek of the tenon against the face of the mortised piece. If the rail and stile are designed to be flush, you can see how close your first cut has come. If the mortise wall lines up with the face of the tenoned piece, you know your first cheek cut is perfectly placed. Then flip the board around and cut the cheek on the other side. If the tenon doesn't quite line up, you can also determine how much more you need to trim off the tenon cheek. If it covers the mortise wall so

you can't see it all, you'll need to glue on one of those tenon off-cuts from the bandsaw.

You can also use an aftermarket tenoning jig to make and fine-tune tenon cuts. It works the same way as my shopmade jig, but this metal jig has a screw-adjust system for very fine adjustments. It also locks the tenon stock in place for a safer cut. Just make sure there's no slop in the fit of this jig to your tablesaw slot.

You can cut haunches for tenons very simply with a single blade on the tablesaw. Clamp a stop on the crosscut-sled fence to locate the cut, and set the blade height for the proper depth of cut. Go back to the bandsaw to trim the haunch until it just fits inside the mouth of the mortise. On a smaller tenon, you can use the tenoning jig to make this pass.

Cutting tenons using a router table

Given the proper amount of patience and set-up time, tenons can be cut successfully using a router table, and this setup really comes

THREE WAYS TO CUT TENONS USING A ROUTER

Whether you're cutting wide tenons or multiples of smaller tenons, a router leaves smooth faces that come off the machine ready for glue-up.

Method 1 ROUTER-TABLE TENONS

Ganging up on the router table. A router table allows you to gang up two or more boards, making fast work of cutting uniform tenons (near right). If the mortises are cut with a router as well, the author uses chisels and files to round the tenon (middle), checking his progress with a template routed to match the top and bottom of the mortise (far right).



Method 2 PLUNGE-ROUTING WIDE TENONS

An edge guide helps rout tenons on wide boards. When cutting breadboard ends or fitting a headboard to bedposts, wide tenons can be a beast to cut. A router with an edge guide (or registered against a temporary fence) does the job in a few passes (near right). After the shoulder has been established, a backsaw and coping saw rough out notches to allow for wood movement (middle and far right), and a final pass with the router evens out the notch.





Method 3 **PLUNGE-ROUTING LOOSE TENONS**

Loose tenons for long stock. Sometimes lengthy boards are difficult to muscle around machines, but using loose tenons is a simple solution. A mortising template (left) guides a bearing-guided straight bit to cut mortises in both pieces you're trying to join. Tenon stock is cut to width and thickness, then the long edges are rounded (top right) to fit the mortise. Short sections are trimmed to length and glued in place (bottom right).



in handy if you have quite a few tenons to cut. This tenoning method is similar to the dado-blade setup on the tablesaw in that you need to set the bit height for a perfect cut. But with a good bit chucked in the router, you get a much smoother cut than you get with a dado blade on the tablesaw. You can work the stock slowly toward the fence, or to save some wear and tear on your router bits, you can rough out the cheeks first on the bandsaw. Then set a fence for the proper shoulder distance, and set the bit height for the first cheek pass.

With a router table you can package two boards together for a more stable pass by the bit (see Method 1 on p. 65), or you can use a backer board to support the cut and to prevent tearout on the back of the cut where the bit emerges. Make the first cheek pass and then check it against the mortise. Raise the bit for a deeper cut. Even with a wide bit, it will take several passes to get back to the shoulder cut. This is an end-grain cut, which tends to burn when you cut too slowly, so move relatively quickly through the bit, making sure you don't leave uncut any patches of wood on the cheeks of the tenons.

If you're cutting mortises using a router, you'll either have to

square up the mortises or round over the tenons. When I opt to round over the tenons, I do it quickly with a chisel and file. A simple jig (nothing more than a short cut made with the router bit used for mortising) tells me when I've trimmed the tenon to the correct shape.

Plunge-routing tenons on wide stock

To cut tenons on a wide board, use a plunge router with a fence mounted on it (see Method 2 on p. 65). A breadboard end with multiple tenons is the perfect situation to use this method, but it also works well for narrow boards. You just have to package a few of them together to get better support for your router base.

Place a large-diameter straight or spiral bit in your plunge router and mount your fence to it. For better support, attach a longer auxiliary fence to the router fence. Fuss with the bit depth until you are pretty close to the final depth and then cut the first side of all of the cheeks. Work from the outside of the tenon in toward the shoulder, so you have good support for the router base. With thick stock, take several passes until you get to the correct depth and then move the router closer to the shoulder for the next series of

passes. Save the shoulder cut as a final trim pass so you can concentrate on it being accurate. Move the router into the work from both edges to prevent tearout as you exit the cut.

Just like the other horizontal-cut methods, cut one cheek first and check to see that it's correct before moving to the second cheek. Because plunge routers typically have very fine adjustment features, it's pretty simple to take that second pass, check the fit and fine-tune as needed for a perfect fit.

Cutting multiple tenons on wide stock requires haunch cuts as well. Leave these cuts for last; this way, you can use the material to be cut away to test-fit against the tenons. Once the tenons fit, cut them to width on the band-saw or with a handsaw. Reset the fence to cut the haunches to length, and set your bit for a full depth of cut. Plunge to depth and make the cuts, being sure you don't rout into the edges of the tenons. You'll be left with a round corner between the tenon and the haunch, which can be cleaned up with a chisel.

Plunge-routing loose tenons on long stock

When your stock gets too long to cut tenons, you can use loose tenons (see Method 3 on the facing page), which are simply two mortises joined together with a long spline (for lack of a better word). The mortises are easy to cut using a mortising template and a plunge router mounted on a template guide. Make up loose-tenon stock out of the same material as your mortised pieces and trim it to fit in thickness (at the planer) and width (on the table-saw). Then take it to the router table and, with a roundover bit, round the stock on all four long edges. Next, cut a glue-escape slot on the tablesaw before crosscutting it to length. When cut to length, the loose tenons should fit smoothly into the mortises.

Using a horizontal routing machine to cut tenons

When a job calls for cutting a large number of tenons, it might be time to call out the big guns. When set up properly, a horizontal routing machine outfitted with a router can save you a lot of time and work (see the photos above). The machine does an excellent job of cutting a large number of tenons very quickly. You can use standard-sized tenon templates or design the joint to whatever dimensions you want. Another advantage is that the machine can cut angled tenons with ease simply by angling the worktable. But with

TENONING USING A ROUTER MACHINE

There aren't many faster ways to cut multiple tenons than with a horizontal routing machine. What's more, the same machine cuts mortises just as quickly. Though the prices can be high—these machines start at about \$1,500—the time you save might be worth it.

STRAIGHT TENONS



ANGLED TENONS



Routing machines for production work. Guided by templates or set by hand, the horizontal routing machine takes a little work to set up but can cut countless tenons in no time at all. The table also tilts to make easy work of angled tenons.

prices starting at around \$1,500, you have to be able to justify the cost of the machine.

Start by making a right-angle fence to locate all of the tenon pieces. With a simple, shopmade end stop, you can also set each tenon board in exactly the same location each and every time.

Mount a spiral-flute bit in the router and set its height to cut the tenon. Then set the table stops for both depth of cut and length of travel. With a good routing machine, cutting the tenon actually takes less time than the setup.

There are countless ways to cut tenons. The methods you choose should depend on the tools you have in your shop and on the number of tenons you have to cut. For a single small tenon, you can probably cut it quickly by hand. If you're cutting hundreds of tenons, a horizontal routing machine could save you hours and hours. For many of the jobs you encounter, you might find a happy medium with routers and saws. Just remember that what matters isn't how you cut tenons; it's how they fit. □

Gary Rogowski's video, *12 Ways to Make a Mortise & Tenon*, is available from The Taunton Press.



Duplicate Spindles by Hand

Getting good results at turned copies doesn't
mean they all have to be exactly alike

BY KIM CARLETON GRAVES

If you're a furniture maker, duplicating parts on a lathe is as fundamental a skill as duplicating parts on a tablesaw. Hobbyists and small custom shops usually have only a few spindles to duplicate: four legs for a table, 16 front legs for a set of eight chairs. You are much better off doing this work by hand rather than on a mechanical duplicator. The results are superior because edges are crisper and shapes are better defined. Also, for small runs, handwork is almost always faster.

To demonstrate standard hand duplication, I've chosen a stool leg designed by my friend and client, Anatoli Lapushner, owner of Anatoli's Restoration in New York City. This design has four elements—the pommel, the large swell, the taper and the foot—that make it particularly challenging (see the left photo on p. 70).

Duplicate parts don't have to be identical. More precisely, only some dimensions must be identical. In this example, only the length of the leg and the placement of the mortises are critical. The turning can be less accurate. The human eye wants to see symmetries. If the major diameters and the vertical placement of elements are relatively close, no one will notice if you're off by $\frac{1}{16}$ in. dia. or even $\frac{1}{8}$ in. dia. Identical parts have a dead, cookie-cutter look.

Duplicating spindles is a simple procedure: Make a pattern, mill the blanks, transfer the pattern to the blanks and turn the work.

Make the pattern first

A full-sized pattern can be used to copy an existing spindle or to create an original one. Simply set, check and reset calipers and dividers against the pattern (see the photos at right). Also, you can hold the pattern against the rounded blank, like a story stick, to mark the position of turning elements. Another advantage is that you can compare duplicates against the pattern. If you compare duplicates to each other, any errors made in the early duplicates will be compounded in the later ones. I make patterns using a computer drawing program, but as an alternative you can use graph paper, a ruler, triangle, compass and French curve set.

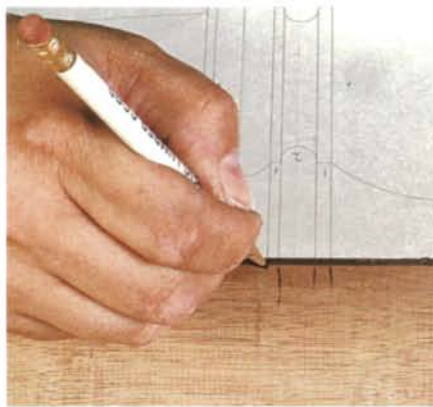
Paste the pattern, whether printed or drawn, to a thin but stiff piece of material. I use Masonite or lauan because it's cheap, and I usually have plenty of scraps. Cut the scrap into a rectangle so that the top and bottom of the drawing correspond to the ends of the scrap. Orient the drawing so that the end going into the headstock is toward your left. Draw "turning lines" for all of the major and minor diameters to function as a story stick, marking the position of the spindle's turned shapes on the rough blank.

Number the turning lines so that those with the same diameters have the same number. The spindle illustrated here has eight diameters. Holding your calipers against the pattern, match each of the calipers to each of the different diameters on the pattern. For easy reference when I'm turning, I put masking tape on all of the calipers to be used and number them to correspond to the numbers on the pattern. For the eighth diameter, at the bottom of the spindle, set a pair of dividers instead of a caliper. (The sharp point on the dividers will score the end grain of the foot, showing you where to stop the taper.) Altogether, for this pattern, you'll need seven calipers and one pair of dividers. With your pattern complete and your calipers set, you are ready to duplicate.

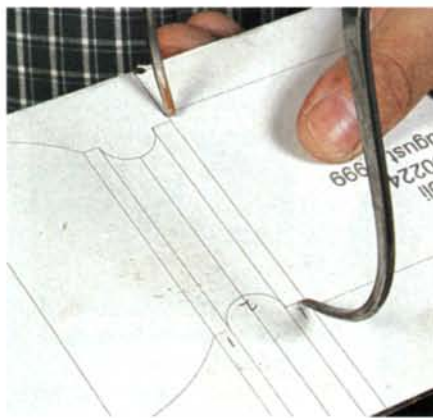
Mill the blanks

This design calls for 4-in.-thick mahogany. The thickest kiln-dried mahogany commercially available is $16/4$, which is 4 in. in its

FULL-SIZED PATTERN IS THE KEY



This step is worth every minute. Taking the set-up time to mark the turning lines prominently on the blank will help you avoid costly mistakes.

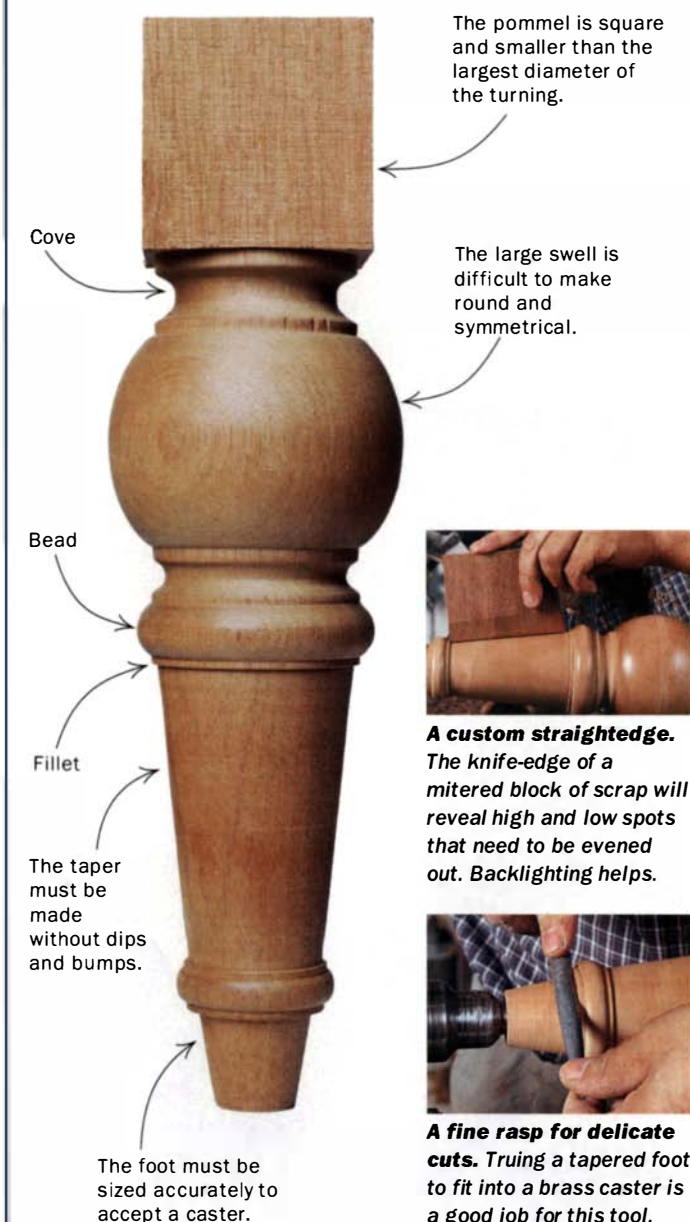


A pattern is a map and a story stick. You can use a full-sized drawing of the workpiece to set calipers and to monitor your progress after you start turning.



Make it simple with a system of numbers. The author codes his calipers to correspond to different finished diameters on the workpiece.

SOME SHAPES PRESENT CHALLENGES



A custom straightedge.
The knife-edge of a mitered block of scrap will reveal high and low spots that need to be evened out. Backlighting helps.



A fine rasp for delicate cuts. Truing a tapered foot to fit into a brass caster is a good job for this tool.

roughly milled state. However, to cut the pommel accurately, the blank must be jointed and planed square, so this project requires a larger blank that can be planed to the proper dimension. In addition, turning is easier if the blank is slightly oversized. I glue up 10/4 stock to get a 5-in.-square blank and, when possible, use the same board for both halves of the blank for a good color match.

Joint the raw stock and cut it to length $\frac{1}{2}$ in. oversized. Glue up the blanks. Don't scrimp on glue or clamps. Once the glue is dry, joint and plane the blanks. It doesn't matter how oversized the blanks are, as long as they're square and the same size. Set a stop on your saw and cut all of the legs to the finished length. Don't try to part the legs to length on the lathe because they won't all end up the same, and length is a critical dimension.

Mark the centers on both ends of all the blanks, and mark the

outline of the pommel on one of them. Cut the pommel's shoulders on the tablesaw, using a miter gauge with a stop. Cut out the pommel on the bandsaw, using a fence with a stop attached. Mark and cut the mortises. The blanks are now ready for turning. Mount the workpiece between centers and turn it to round. Watch the pommel—if you cut into it, the workpiece is ruined.

Transfer the pattern

Stop the lathe and hold the pattern against the blank. Then transfer the position of the turning lines to the workpiece. A quick flick of the pencil is all that is needed. Hold your pencil against the blank as you turn the lathe on and off, leaving pencil marks completely around the workpiece. Many experienced turners don't bother to stop the lathe. They simply hold the pattern against the workpiece while it's rotating and mark it. I stop and start the lathe because I've found that it's easy to damage the corners of the pommel when I don't.

Take the No. 1 caliper and—using a diamond-shaped parting tool—turn all of the No. 1 diameters. Don't put your finger through the caliper spring. If the workpiece catches the caliper, it could take off your finger. Continue parting with the remainder of the calipers. When you get to the No. 8 dividers, mark the end of the workpiece simply by touching the left arm of the dividers to the end grain. This scored line will show the size of the small end of the tapered foot. (Don't touch the right arm, or it might snap over onto your fingers.)

Determine a cutting sequence for the turning

Whether you are establishing your diameters or turning the workpiece, always make your most difficult cuts first. That way, if you make a mistake you can't repair, at least you won't have invested much time. This spindle has four risky cuts, so I perform them in the order of their difficulty.

The square shoulder next to the pommel—On the leg shown here, the pommel will be covered by upholstery. But ordinarily, the pommel and its shoulders are highly visible. If you knock off a piece of the pommel, you'll have to repair it or discard the piece. This cut should be your first part when establishing diameters.

The large, round swell—After roughing, turn this element first. If you cut too many times and flatten the shape, you won't have enough material to recover. As you turn, compare the work to the pattern. I mount the pattern right behind the workpiece, so I just have to glance up to see it. It takes a practiced eye to see that the turning is different from the pattern. (Strangely enough, it's also hard to see when they're the same.) When the pattern and turning look the same, stop. Resist the temptation to take one last cut.

The large bead and the bottom bead—The large bead should be cut next because you must remove the material of the swell to get access to the material of the bead. Don't move the tool rest. Finish the coves, then the fillets on the top half of the workpiece. Move the tool rest to the bottom half of the workpiece and cut the bottom bead, which is the fourth risky cut.

Once you have established the diameters for the fillets at the top and bottom of the taper, you can eyeball the diameters of the top and bottom of the taper. I hold a straight-edged pattern

Seven rules for duplicating parts



Concentrate on developing consistency rather than speed. If you work on consistency, speed will come. Some elements of consistency and speed are closely related. Here are my basic rules for achieving consistent results while duplicating parts on a lathe.

1. Go as fast as you can without making a mistake, and no faster. Speed comes from establishing and maintaining a

rhythm. Making a mistake takes you out of your rhythm and slows you to a crawl. Once you've established a rhythm, look for ways to be more efficient. Try to push yourself. Increase your pace. Maintain your rhythm.

2. Limit the size of your tool set. Usually no more than three to five tools are needed for any given spindle—parting tool, skew, roughing gouge, one or two spindle gouges. Don't change tools unless you have to. Use one tool for different kinds of cuts (for example, I use a skew to turn the blank round and to turn beads).

3. Limit movement of the tool rest. The fewer times you stop to adjust the position of the tool rest, the faster the job will go.

4. Use the same cutting sequence for each turning. If you cut an element in three passes for the first spindle, cut it in three passes for subsequent spindles.

5. Have enough calipers and dividers that you don't have to reset them. These

tools fall into the same category as clamps—you can't have too many of them.

6. Learn to sharpen your tools freehand at the grinder. Sharpening a tool shouldn't take more than 10 seconds.

7. Power-sand where possible. I mount sanding discs to quick-change bits so that I can change grits in seconds. Power-sanding is fast and also improves the finish markedly.



You don't need a wall-full of tools. Gouges, a skew and a parting tool were the only turning tools used to make the legs for this article.



Hand drill as power sander. The author uses quick-change sanding discs in the final stages of shaping each leg.

against the workpiece to see if the taper is flat (see the top right photo on the facing page).

You might suspect that the tapered foot is risky, but it isn't. Casters are forgiving in terms of sizing (length is more important than diameter) because they're held to the foot by screws. If you're trying to turn a tenon for a glue joint, size the tenon accurately by getting close with a skew, then finish up with a fine rasp (see the bottom right photo on the facing page). You can also make what's called a "go/no-go" gauge, so you know when you've just got it, by drilling the correctly sized hole in a piece of scrap.

Finish the work on the lathe

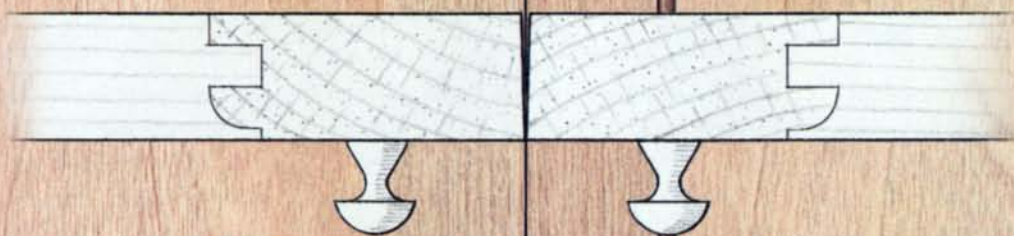
I usually power-sand the larger areas, then hand-sand the details. It's important that you don't oversand. It's easy to ruin the crisp de-

tails of a turning by rounding them over. As a last step, take a handful of shavings off the floor and hold them against the spinning work to burnish it, but keep your hands away from the sharp corners of the pommel.

You can apply a finish (shellac, lacquer or oil) directly to the work while it's spinning on the lathe, but never wrap a finishing pad around your fingers or your hand. If it gets caught on the spinning workpiece, serious injury could result. You can achieve a French polish by building up shellac or padding lacquer against the spinning work. □

Kim Carleton Graves designs and builds custom furniture, cabinetry and wood turnings in Brooklyn, N.Y. His web site (www.CWWing.com) features pictures of his work and includes helpful shop tips.

Where Door *Meets* Door



Minimizing the gap
between stiles,
choosing and installing
appropriate hardware

BY STEVE LATTA

Double doors may be found on cabinets large or small, but the one constant that shouldn't change is the hairline gap between the center stiles where they meet. Ideally, the door stiles should hang in the same plane with a heavy $\frac{1}{2}$ -in. gap running between them. Wood movement or other problems may thwart this scenario, but fortunately, there are a few tricks to hide or at least disguise imperfections.

Double doors may be lipped (overlapped), where the center stiles are both rabbeted, or unlipped, meaning no rabbet is present. Both styles of doors can be made with or without a bead. Unlipped doors can be plain or fitted with an astragal, an applied molding that covers the center gap. My approach to teaching students how to make these doors begins by asking them to consider the following questions early in the design of a cabinet.

1. Will the doors require locks?
2. Will the cabinet have glass doors?
3. Should access to the cabinet be easy; i.e., should the doors swing open independently?
4. If the cabinet is a period piece, what traditional details ought to be incorporated?

UNLIPPED DOORS

To avoid any confusion, when I refer to lipped doors, I am not talking about how they fit to the opening, as in the case of lipped overlay doors that are rabbeted along all of their outside edges, but rather how they fit to each other. The examples in this article all incorporate inset doors, and the cabinets do not have center dividers.

Traditional cabinets, such as secretaries or those designed for valuables, require locking doors, which are usually lipped along the center stiles. Glassed cabinets may or may not require a lock, but their doors should be lipped or covered with an astragal to keep light from peeking through the two center stiles.

Doors that open independently of one another are preferred for units that are used primarily for storage. That rules out lipped doors, except in the most traditional designs.

Careful stock preparation can prevent problems

Regardless of the style of door, take precautions at the start of the project to reduce the possibility of the doors twisting. It is a horrible feeling to see your carefully selected mahogany parts peeling off in every direction as you rip them to size.

To minimize such mishaps, lay out all of the pieces for the entire project on rough stock at the same time. Also, pay close attention to the grain, and make sure all of the rails come from a single piece of stock with the grain flowing door to door. The center stiles should be cut from one board ripped in half. Mill this piece long so that you can adjust the grain match up or down to get the best transition across the stiles.

Door stock should be milled in two steps. Rough-cut all of the parts $\frac{1}{4}$ -in. oversized. Then sticker them to relieve any stresses and allow the stock to acclimate. Then mill the stock to final thickness and machine the joints. Make the doors about $\frac{1}{8}$ -in. oversized in length and width and fit them to the case opening. This extra $\frac{1}{8}$ in. comes in handy for a case that may be out of square.

Unlipped doors have their place

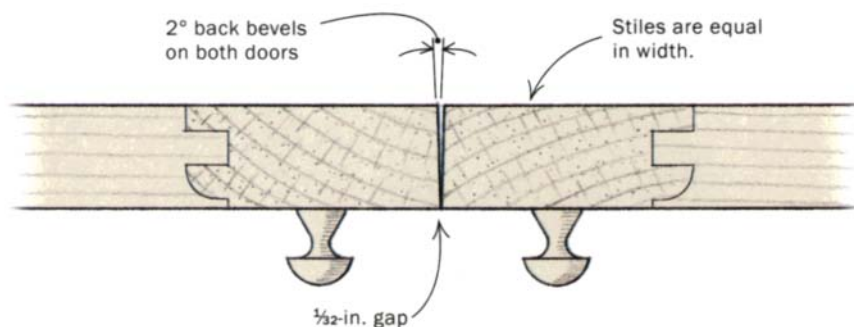
As much as I like the aesthetics of lipped doors, they don't make a lot of sense in a case with doors that don't latch or lock to each other or for pieces that are more functional than formal. Quite frankly, most of the things we place in cabinets don't need



Use when both doors need to be opened independently of one another.



Back-bevel the edges of the center stiles. A 2° bevel will prevent the stiles from scraping when a door is opened.



to be locked up anyway. And it is awkward having to open one door and unlatch the second to retrieve a plate or book.

If executed properly, unlipped doors look very clean. To minimize the gap, back-bevel the inside edges of the center stiles so the doors can swing without hitting each other. The back bevel is slight, about 2°, and is shaped using a jointer, edge sander or handplane. Final sanding should open it up to a heavy $\frac{1}{2}$ in.

A lot of hardware is available for cabinetry. The European hardware, particularly 35mm cup hinges, offers three-way adjustment, which allows for a lot of fudging when aligning a wall of doors. For furniture, I prefer traditional brass hardware, which allows for a little adjustment as well if mounted properly. For more on mounting catches, see the story on pp. 76-77.

Hiding the gap with an astragal

An astragal is a piece of molding added to an unlipped door to cover the center gap.

Astragals are usually found on full-sized French doors where they serve as both a design detail and as a doorstop. On cabinetry, they are sometimes added to prevent light from shining through a gap between doors. Although I generally think they look like an afterthought, astragals have their place. An astragal should be centered over the gap between the two stiles and glued to the front (right) door.

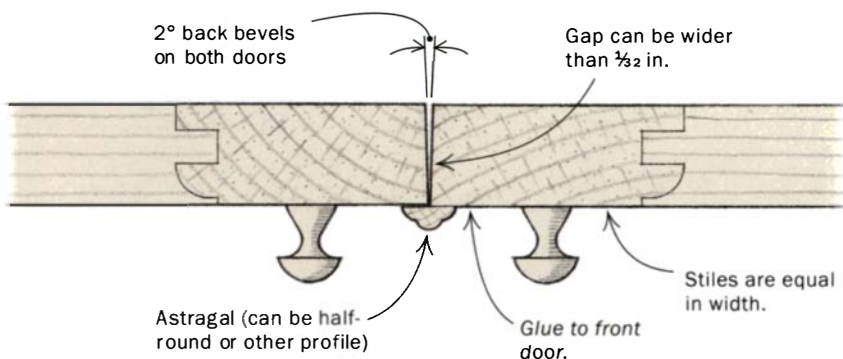
Lipped doors are traditional

I really like the look and action of lipped doors. For sophisticated pieces such as secretary desks or breakfronts, lipped doors are the rule, and I wouldn't build these pieces any other way. A lip is essential on a cabinet with glass doors and interior lighting. Light shining through the gap between the center stiles looks like a detail the cabinetmaker simply forgot to consider.

Lipped doors should be set up so that the rear door (the one that opens last, generally the left door) is secured to the cabinet by

UNLIPPED DOORS WITH AN ASTRAGAL

Appropriate for period pieces or when the gap is too wide and must be hidden.



Astragals can be milled on the router table. The shape can be a simple half-round or a more complex shape as shown here. Use a wide board for better control when shaping, then rip off the molding.



Glue the astragal to the front (right) door. An astragal will hide an oversized gap or a slight twist in the doors.

a flush bolt or elbow catch. The front door (typically the right one) opens first and should lip over the rear door and latch or lock to it. This arrangement keeps the hardware from getting mangled or from scratching the doors.

It is essential to calculate the lip into the initial dimensions of the piece. When the doors are hanging, the width of both stiles should look the same. Because the rear door is partially covered by the front, the rear door's center stile must be about $\frac{1}{4}$ in. wider than the front door's center stile. The rear door should receive a rabbet $\frac{1}{4}$ in. wide by half the thickness of the stock. The front door should have a corresponding $\frac{5}{16}$ -in.-wide rabbet cut into the back of the center stile. The extra $\frac{1}{16}$ in. allows for final fitting and keeps the doors from binding.

After trimming the doors to fit the opening, mount them so that the front door hangs up slightly on the rear door. Make the final fit using a block plane. Shave away until there's a $\frac{1}{2}$ -in. gap down the center, back-beveling the edge about 2°. If the doors bind on the inside, shave a tad off the rear door using a rabbet plane.

The rear door needs some sort of catch—An elbow catch or a flush bolt can be used to secure the rear door to the case. For a really clean look, locate a flush bolt at the top and bottom of the door. Flush bolts can also help hold the doors true should a slight twist ever develop.

Elbow catches typically mount to a fixed shelf located toward the bottom of the opening. Give some thought to the placement of the catch to prevent it from chipping china or stemware. Don't skimp on the hardware; opt for cast brasses. Cheesy, stamped and plated hardware detracts from the entire piece.

Regardless of the catch, I always mount a little stop block to prevent the doors from swinging into the opening. I either mount a small block at the top of the case or mortise a small half-moon into the bottom shelf.

When choosing a lock, pick one that fits the character of the piece. For period work or fine furniture, I typically use a surface-mount lock, not a mortised lock. For a mortised lock to work properly, a very unattractive notch needs to be cut into the rear door. Not so with surface-mount locks. Choose the lock by width so that the key-hole ends up near the center of the stile. As

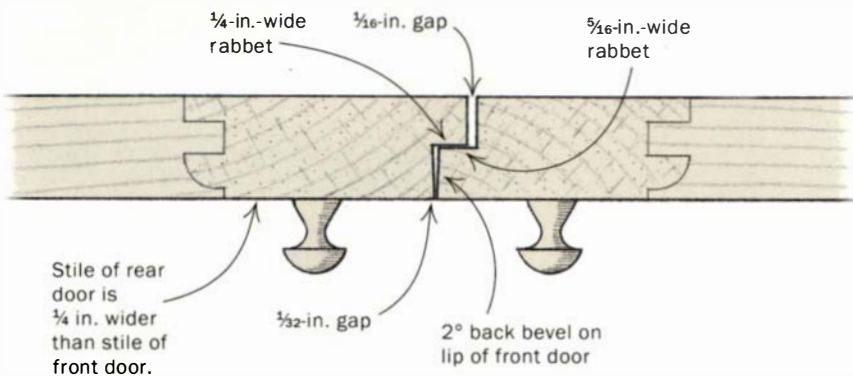
LIPPED DOORS



The traditional approach for period pieces or when the cabinet has glass doors and light would shine through the gap between center stiles.



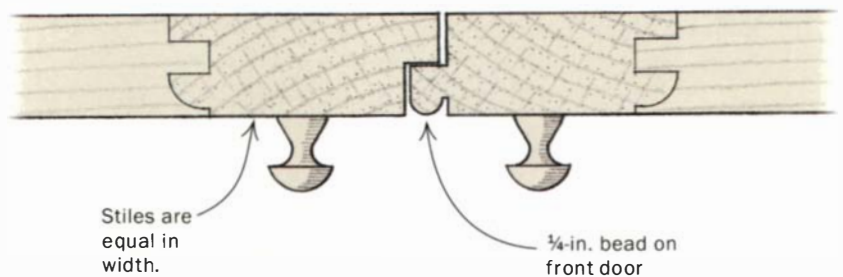
The lips may be milled on the tablesaw using a dado blade. Make the lips half the thickness of the stile stock.



Plane the lip of the front (right) door with a slight back bevel. Keep stock oversized so that parts can be planed to fit for a fine gap.

ADDING A BEAD

Use as a design element or to help draw attention away from doors that are slightly twisted.



Fine beads are best made using a beading tool. Router bits usually leave a wide groove or quirk. The bead goes on the front (right) door.

an alternative to locks, pivoting knobs with catches work well, too.

A few good reasons for beads

In terms of design, a bead can tie to other details on a piece or stand alone. A bead will break up a pair of two wide stiles and bring balance to a piece. A bead can also help if the grain match between the center stiles is less than ideal.

When two doors meet in the middle, it looks sloppy if the doors don't close flush to each other. A bead is a good way to hide a little twist. If you're using a router to cut beads, pick a small bit. I prefer to grind a scratch stock (see *FWW* #134, p. 42) for my beading tool to create a fine bead with a very narrow quirk or groove. Most router bits cut a rather wide quirk.

With lipped doors, I always put the bead on the front (right) door. By doing so I can make both center stiles the same width. (The front bead is the same width as the rabbet on the rear stile.)

To keep the width of the front stile looking the same, the width of the bead needs to be considered from the very beginning. It's not a good idea to add a bead at the last minute to compensate for twist. But there has been a time or two when I needed to hide a twist on a set of doors that didn't call for a center bead. I took an equal amount off each door to keep things balanced. I then filled the gap by gluing a bead onto the front door. Not the best strategy, but it solved a problem!

The approach depends on the project

The strategy for a single piece of furniture is very different than for a room full of cabinets. For a fine piece of furniture, I lip the doors and use a pair of flush bolts with a lock or pivoting latch. I usually buy my hardware from Londonderry Brasses because the company produces historically accurate hardware. I'll add a bead if it's part of the design or if I have to hide some twist. For a less formal piece, I may or may not lip, depending on the customer's storage and lighting needs. It always comes down to those original four questions: Is a lock needed? Will the cabinet have glass doors with light coming through? Should the cabinet be easy to access? And is it a formal, period piece? □

Steve Latta is an instructor at the Thaddeus Stevens College of Technology in Lancaster, Pa.

Installing bolts, catches and locks

Traditional hardware requires precise mounting and doesn't offer the user very much in the way of follow-up adjustments. There are, however, a few tricks to simplifying installation. And some hardware can be modified slightly to allow for a little tweaking.

DOUBLE-BALL CATCHES

Use a double-ball catch when doors need to be opened independently of one another. This type of catch also acts as a doorstop. Ball catches are available in a number of sizes. I prefer to use only the smallest catches, no matter the size of the door, because the larger units are too clunky.

A ball catch has two parts; the teardrop male plate mounts to the door, and the female half, which contains a pair of spring-loaded bearings, mounts inside the case. In many instances, a block must be added at the top of a case to mount the hardware. The female part has a pair of screws for adjusting the spring tension.

To mount a ball catch, first place a piece of double-sided tape on the back (the face that will mount against the door) of the male piece, then engage it with the female part. Mount the female part to the case with screws. Close the door, then back off the adjustment screws to allow the parts to disengage easily. The tape will hold the male part in position. Drill the holes for the male plate and attach it. Do the same for the other door.

If a catch closes too abruptly, open the body cylinder and clip a bit off the spring. If you have several to install, buy lighter-duty springs, available at hardware stores.

WOODEN STOPS

Flush bolts and bullet catches won't stop a door from swinging in and banging against a shelf. Doors with this type of hardware require a stop. I use stops on most doors regardless of the hardware. I usually make my own, a simple half-round button slightly tapered at the base. It fits into a mortise chopped into the base of the case and is held there by a drop of glue. The button is centered and acts as a stop for both doors.



Double-ball catches can be used with lipped or unlipped doors. The female part, shown with the male half engaged, is screwed to a block inside the top of the case.



Temporary fastener. Double-sided tape on the male half will hold it in place on the door so that accurate pilot holes may be drilled.



Doors with latches and elbow catches require a doorstop. Mortise the stop into the base of the case, keeping it centered.

FLUSH BOLTS AND ELBOW CATCHES

A flush bolt goes on the rear (left) door, the one that opens last. Install the bolt first. Mark the location using a knife, then rough out the mortise with a chisel or laminate trimmer and finish off with a chisel. To locate the mortise for the pin, put a piece of masking tape in the general vicinity of where the pin will strike. Then place a drop of machinist blue or correction ink on the tip of the bolt, retract it, close the door and extend the bolt, which will leave behind an accurate mark. Then drill the hole a hair toward the back of the



Flush bolts require a mortise to be cut on the inside face of the door. Hog out most of the material with a router, then chisel to fit.



Locate the hole for the bolt using correction fluid or ink. Paint ink on the end of the bolt, then close the door and press the bolt against the case, leaving a mark.

case. Last, use a small chisel to enlarge the hole just enough toward the front of the case until the pin fits snugly.

The alternative to a flush bolt, for less formal applications, is an elbow catch. It is easier to mount because it attaches directly to the surface of the door and to a fixed shelf or bottom of the case. No mortises are required. Just close the rear door, lay the parts in place and drill pilot holes for the mounting screws. Always use a wooden stop with these.



An elbow catch is easy to mount. It is flush-mounted on the rear (left) door.

BULLET CATCHES

The only bullet catches worth using are made by Brusso. I generally use their smallest model. I mount the half with the spring-loaded bearing (bullet) to the case and the socket to the door. I prefer to mount the hardware to the bottom of the case so that drag marks aren't visible. The bullet is mounted first. Measure carefully and drill a hole into the case to the correct depth. Follow up with a narrower drill bit and counterbore the hole all the way through the case. That way you can use a drift to pound out the hardware and shim it up (or drill deeper), if necessary, to achieve a perfect fit. Without the counterbore, the bullet cannot be removed without damaging the surrounding wood. The bullet need only

be pressed into place. No glue is required.

Before mounting the socket, cut a shallow slot in it with a hacksaw that fits the blade of a screwdriver. Then put a piece of tape on the bottom of the door and swing it to the closed position. The drag mark left by the bullet shows where the hole for the socket should be located. Mount the socket a little to the side of the bullet. This allows you to cam the door a little in or out by pivoting the socket with a screwdriver. These are a bit tricky to mount. Figure out your hole size on a piece of scrap, and take it slow.



Bullet catches require precision. Drill the hole for the bullet into the case at the precise depth, then extend the hole all the way through the case using a narrower bit.



The through-hole allows the bullet to be knocked out without damaging the case. After removal, the hole can be deepened or shimmed, if necessary, to adjust the fit of the bullet.



Locate the position for the socket. Tape the bottom corner of the door and swing it into the bullet, which will leave a mark.



The socket is mounted to the underside of each center door stile. By adjusting the angle of the socket, the door can be moved in or out about 1/8 in. to correct a minor twist or hide an imperfect installation.

HARDWARE

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Master a Classic Style

Innovative techniques for making five crucial elements
of French country furniture

BY CHRIS GOCHNOUR



Most French furniture reproduced in books of furniture history is high-style French, extremely ornate stuff more suited to a palace than to personal use. The French furniture I like comes from the countryside. It is furniture made by and for common people. French country pieces are personal; from the hand-carved moldings around the doors to the marks of the molding planes used to make the crown to the roughsawn cabinet interiors (cleaned up in a hit-and-miss fashion with a handplane), you can see the fingerprint of the maker in every detail. Although country-style French furniture is very popular among American consumers, it is not much made by craftsmen here, so what you see is mass-produced, and it shows; the subtle imperfections in an original French armoire give it far more warmth than the flawless versions you can buy at a local furniture store.

As a self-taught furniture maker, I have learned how to make various styles of furniture by studying antiques and reproductions and by reading a variety of reference sources. But when it came to learning about French country furniture, I was stumped. When I had wanted to know more about how original Shaker, Queen Anne or Arts and Crafts pieces were made, there were plenty of places to go. But with French country furniture, my inquiry was stifled by the lack of information about traditional techniques. I did find coffee-table books on the subject, but there was very little written about how to make French country furniture. Now that I've

built a number of pieces, I'd like to pass on some of the information I've gathered and techniques I've developed for building this furniture. In the five sections of this article, I've examined five elements characteristic of French country style: a crown that curves around the corners; a door with a complex molded frame; deep-mortise French hinges; fluted posts; and a curved and beaded apron. I haven't tried to cover every detail but instead zeroed in on the least familiar or most difficult parts.

Finding out about French country furniture

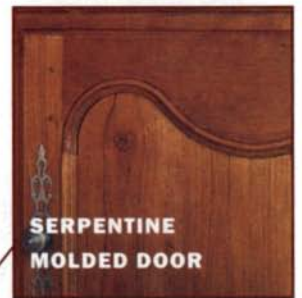
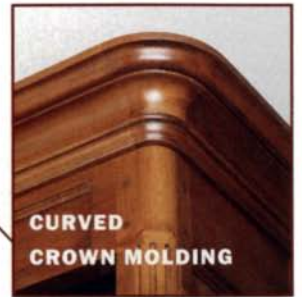
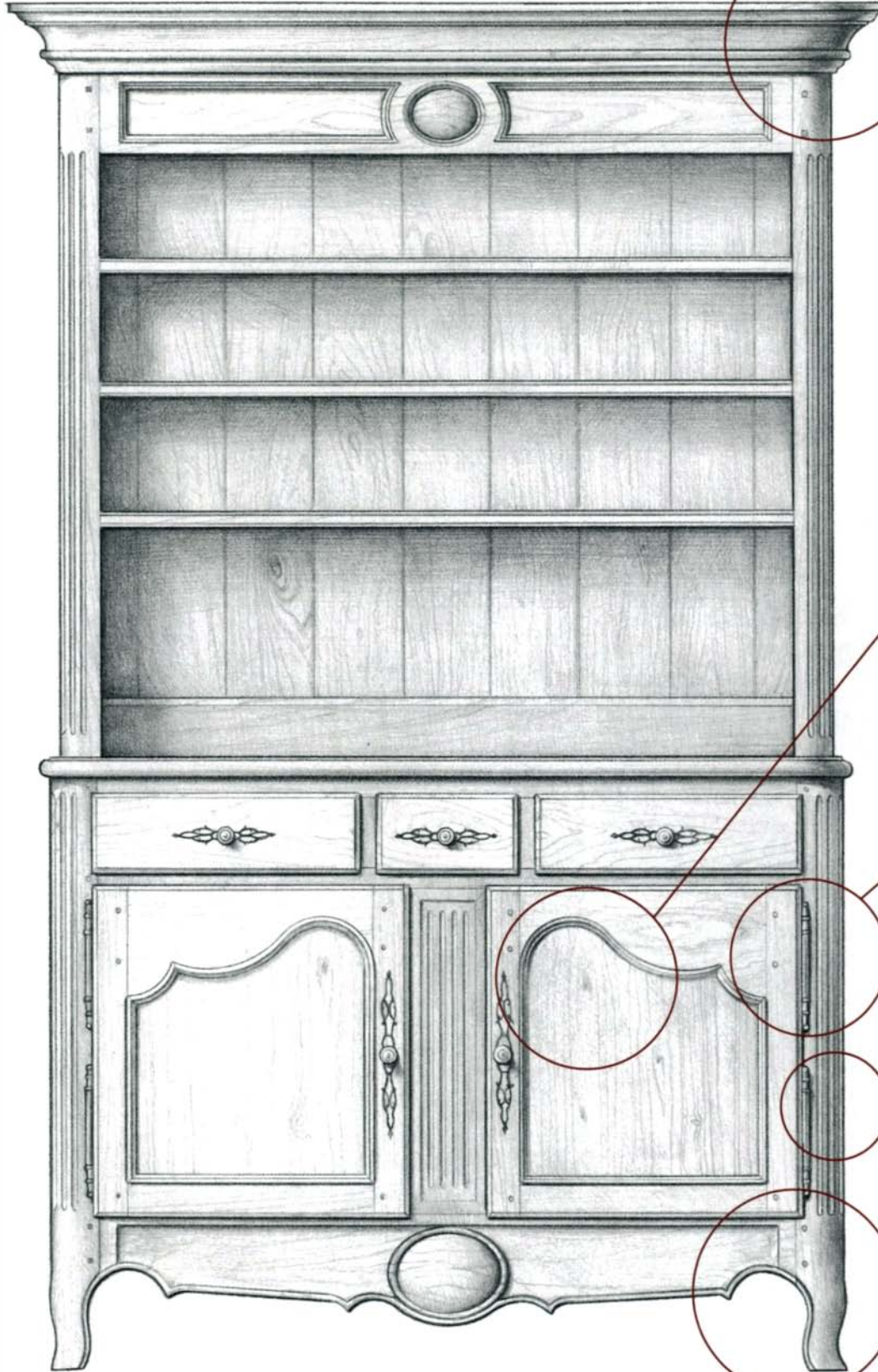
Two pieces of good fortune helped enormously in my quest to make

French country furniture myself. I hit a gold mine when I found a series of books put out by the French publisher Massin (www.massin.fr), which includes several volumes on regional French furniture. Yes, the text is in French, but I was desperate. (A picture is easily worth a thousand words when you can't read the words.) I purchased books from the regions I liked and studied the elements of design that appealed to me. I've designed several pieces based on what I learned from the Massin books.

I also received help from a friend who restores beautiful antiques from all over the world. In his shop I've been able to scrutinize the style and construction of outstanding pieces, many of them fresh off the ship from France. I was fascinated by the beauty and strength of these pieces. They were typically quite large, solidly built, and every one unique. Seeing these pieces up close allowed

FIVE KEYS TO FRENCH COUNTRY STYLE

Rather than describe how to build a particular French country piece from start to finish, the author focuses on five elements characteristic of the style. For each one he presents techniques he's developed that simplify some tricky terrain.



me a greater opportunity to view and understand the qualities of French country furniture.

Reading the fingerprints on French country furniture

French country furniture is notable for beautiful lines and form, but up close it is clear the pieces were built with efficiency and utility in mind; they were made to be used, not just admired. Craftsmen weren't afraid to leave scrub-plane marks in the interior or subtle chatter from a spokeshave or smoothing plane on a leg or panel. Following in the footsteps of these craftsmen, I feel free to leave these same marks on the French pieces I make. For someone who typically tries to avoid any imperfections, it is liberating to work this way, and the irregularities really do add to the character of the piece.

The original craftsmen were not afraid to use whatever wood they had on hand. Generally they chose oak, fruitwoods or walnut. Although they frequently used premium, beautifully figured woods for the focal points of a piece—door panels or buffet tops—some flaws were acceptable even in these pieces, and wood with tight knots was used often, sometimes throughout a piece. Economizing did not stop there. I've also seen French tabletops and cabinet panels glued up from boards whose sides were not cut parallel. A plank would be 8 in. wide at one end, say, and 6 in. wide at the other. Perhaps the taper reflected the thickening at the base of the tree or was the result of cutting out some serious defects. Whatever the explanation, the frugal cabinet-maker didn't feel compelled to rip every board parallel just for uniformity's sake. I take this resourceful attitude as a challenge and try to find for my French pieces great wood that might otherwise go unused. One of



A CROWN THAT CURVES

Tall French country case pieces are notable for their fine crowns. Some of my favorite French crowns, rather than being mitered at the corners, flow right around the case. Builders of the original pieces, I assume, after making the straight sections of the crown with a series of molding planes, would have used carving tools to shape a curved corner block that would carry the same profile around the corner. I make straight sections of crown molding with an overarm router and a handful of bits (see the photos below left). It is a clean and efficient method, but I couldn't do the curved corners using the same setup. Once I tried carving corner blocks by hand, but it took quite a bit of time. Then I developed a method of turning the corner blocks with a faceplate on a lathe. If you can turn a bowl, you can turn corner blocks that will match your straight molding.

I start by gluing up a turning blank, preferably from the same stock used on the straight sections of molding. Then I make a simple move that ensures an exact match of the straight sections to the curved corner pieces: I bury a slice of the straight molding in the turning blank. On the tablesaw, I cut a saw kerf into the side of the turning blank. This kerf must be centered on one edge. Next, I cut a slice off the straight molding. It should fit snugly into the saw kerf. Using a bright marker, I color the molded edge of the slice. Then I spread a little non-water-based glue (cyanoacrylate or epoxy) in the kerf and insert the slice. I avoid water-based glue because it can swell the slice, making it more difficult to fit it into the kerf.

With the slice glued in, I mount the blank on a faceplate and, much the way you would turn a bowl, turn until I have unveiled the bright edge of the slice. As the colored edge begins to disappear, I know I have achieved the desired profile.

The blank is now ready to be divided into quarters, two of which will become corners on the crown. I temporarily glue the blank onto a backer board, a square of ¼-in.-thick MDF or plywood slightly larger than the blank. The backer helps with measuring out the quarters and cutting them apart on the tablesaw. My tablesaw yields an accurate cut, but the blade can't be raised high enough to cut the piece completely through. I finish the cut with a handsaw or bandsaw and smooth out any roughness with a block plane. Last, before removing the corner molding from the backer, I band-saw out the interior radius so that the block will mate with the curved corner of the cabinet.

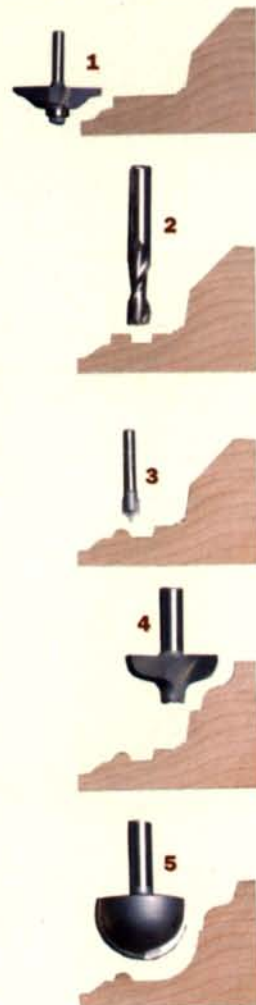
To make the crown easily removable,

MAKING STRAIGHT MOLDING



Rip, hog, contour. Cut two blanks from one board (top) for the best yield and grain match. Start at the tablesaw and finish at the bandsaw. Remove the bulk of the waste on the tablesaw (middle). An overarm router creates the final contours (bottom).

STRAIGHT MOLDING BIT SEQUENCE



AROUND THE CORNERS



TURNUED AND QUARTERED

The key to a quick corner. After kerfing the turning blank (far left), fit a slice off the end of your straight molding into the kerf (middle). Color the contoured edge with a marker to make the lathe work easier. Turn the blank using the slice as a guide. Have a second slice nearby to make roughing in easier.

I attach it to a subframe that sits on registration dowels. The whole business can be lifted right off the case. To get an exact fit of the subframe to the cabinet, I build the frame slightly larger than the case. I set it in place on the dowels and flush-trim it with a router to the precise dimensions of the case.

Then it is simply a matter of attaching the moldings to the frame. I do this right on the piece to be sure I will get a tight fit of the molding to the case. To avoid accidentally gluing the frame to the case, I apply a strip of packing tape around the perimeter of the case just below the frame.

The sequence for attaching the molding is as follows: front section first; corner blocks second; side sections last. I secure the front section with screws from inside the frame. Then, working one corner at a time, I glue the corner blocks to the front molding. I use one biscuit for the joint, which aids in alignment while still permitting adjustment in one plane. This is an awkward glue-up to clamp. I use packing tape, stretched tightly across the joint, to secure the parts. After the glue has dried, I drive a screw into the corner block from inside the frame. Then the side sections go on. I cut the biscuit joints for them by placing the biscuit machine right on the side of the case. When the crown is complete, I reinforce each corner-block joint with a butterfly let in from above.



Quartered, then carved out. Hot-glued to a square backer board, the turning is quartered on the table-saw. The tablesaw cuts can be finished with a handsaw or bandsaw and any roughness smoothed out with a block plane. Before removing the quartered sections from the backer, bandsaw a curve on the inside corner. This will mate with the curved corner of the cabinet. Many relief cuts make the job easier.

SLOW DOWN AT THE CURVES FOR A CLEAN INSTALLATION

Hold still for your biscuit. Biscuit joints link straight and curved sections of the crown. To cut the slot that will mate with the front piece of molding, hold the corner in a bench vise.

Great clamp—comes in a roll. Packing tape provides plenty of pressure to keep the two odd-shaped parts together while the glue dries. Be sure to stretch it tightly across the joints.

Some light filing. If all goes well with the lathe and the biscuitry, there will be only a little filing and scraping required to smooth the transitions around the corners.



my favorite species for this use is knotty alder, a beautiful material with many small, tight knots. When I build in white oak or cherry, I'll often use a #2 grade because the imperfections found in these boards add character and authenticity to a piece of furniture.

Another aspect of French country furniture that I appreciate is the individuality in the design of each piece. It seems that craftsmen adhered to design details native to their region but still felt the freedom to add unique characteristics of their own making. Decisions like how high to take the fluting up the legs of an armoire or how to shape the door panels vary greatly from piece to piece. This creativity led to some wonderful design innovations, as well as, inevitably, some rather awkward results. I take this design freedom as a challenge. Once I've studied and absorbed a range of similar pieces, I design my own piece very much in the style of the originals but take the liberty to make some of the design decisions myself.

The hardware on French country case pieces is prominent and distinctive. Hinges and escutcheons are uncommonly long and beautifully curvilinear. Typically made of iron or brass with a matte finish, they strike an attractive contrast with the wood. Hinges are particularly prominent, sometimes spanning 6 in. or more. Fittingly, these distinctive hinges have an unusual method of attachment. Instead of being face-mounted, as typical leaf hinges would be, these hinges are mounted by inserting their thin leaves edge-wise into deep mortises.

All of these characteristics appealed to me, but they also presented challenges. It was easy to admire this furniture; but I needed to build it. Many of the details I most liked would traditionally have been produced



SERPENTINE MOLDING: MATING

Stylish frame-and-panel doors with beautifully curving top rails and deeply molded frames are a hallmark of French country case pieces. Such doors have most impact, I think, when the molding

stands proud of the rest of the frame. The doors I designed for my hutch are of just this type.

The trickiest part of the job is making the serpentine top rail, with its proud bead, and that is what I'll describe here. (For a good discussion of the same type of door but without the curves, see *FWW* #135, pp. 75-79.) The molding can be made as a separate piece, or it can be made integral with the frame. I like to make the molding integral. It makes the job a bit less dicey and will certainly hold up better in long-term use. The technique I use to make integral molding involves first making a pair of mating templates.

I begin by designing the doors full size on paper. Based on this full-sized layout, I make positive and negative templates of the curved upper rail. I make the negative template first and trace it to generate the positive template. I cut them out of $\frac{3}{4}$ -in.-thick MDF on the bandsaw. I cut slowly, staying tight to the waste side of the line. When bandsawing the positive template, I take care to save the offcuts—I'll need them later to help guide the router. I clean up the concave curves of the templates with a sanding drum fitted on the drill press and smooth the convex curves with files.

At this point I put the templates aside and turn to

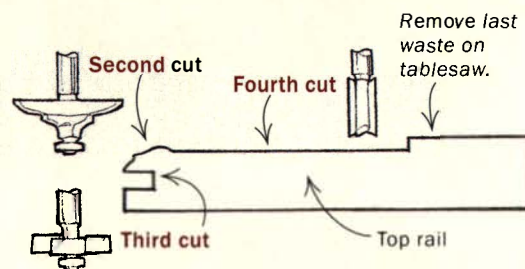
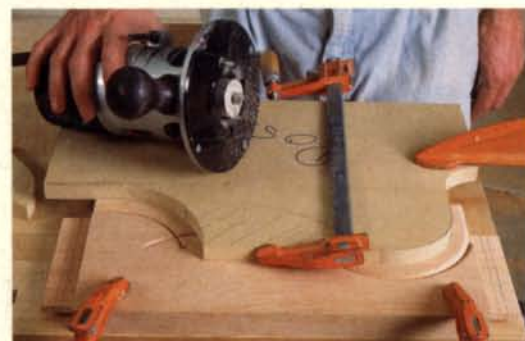
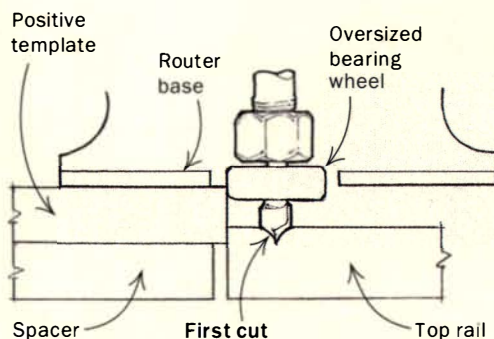
Good mates. Mating MDF templates are cut out on the bandsaw, then drum-sanded and filed to fit. Nest the templates to check the fit.



Creating the curved top rail. First trace the shape from the negative template to the rail stock. Use a straight bit with a top mounted bearing, and flush-trim the top rail.

CUT SEQUENCE FOR TOP RAIL'S SERPENTINE MOLDING

For cutting the proud bead, the positive template, elevated on a spacer and snugged up to the workpiece, provides the surface for the router's bearing wheel to run against. To get a sharp corner where the bead forms an apex, make crossing V-grooves. A waste piece of the template clamped back in place provides bearing surface beyond the apex.



TEMPLATES ARE THE KEY

milling the molding on the straight frame pieces—the stiles and the bottom rail. I cut the ogee-and-ovolo with a handheld router and a bearing-guided bit (Eagle No. 180-3322), and then cut the proud bead (Eagle No. 139-0602) at the router table using a fence to guide the workpiece. I'll relieve material later to make the bead stand proud, but for now I leave the parts full thickness, which makes it easier to cut the mortise-and-tenon joints. At this point the top rail is still a plain rectangle—it will be cut to its curved shape and molded only after the joints have been cut.

The joinery occurs in this sequence: First, I cut away the molding at both ends of the stiles to receive the rails. Then I cut the mortises in the stiles using a hollow-chisel mortiser. And then I cut and fit the tenons on the rails.

With the joinery complete, I cut the top rail to its distinctive shape. I trace the curve from the negative template and cut out the shape on the bandsaw, leaving $\frac{1}{8}$ in. or so of waste. Then I clamp the negative template to the workpiece and use a router with a flush-trimming bit to perfect the shape.

That done, it is time to create the molding. The ogee-and-ovolo can be routed with a bearing-guided bit just as the straight frame pieces were. But the proud bead presents a problem—its back side, inset $\frac{1}{2}$ in. from the curved edge of the rail, can't be cut using a typical bearing wheel or a fence. I solve the problem with my positive template and a beading bit fitted with an oversized bearing wheel. (A rub collar attached to the router base would work as well.) I nest the positive template into the workpiece and run the bearing against the template (see the drawing on the facing page).

This method works well, but there is one trouble spot—where two shallow curves in the bead meet and form a point. Riding over this point on the template with the oversized bearing wheel will create a rounded corner on the workpiece. To retain the nice, sharp corner, I

make this cut in two crossing passes, one from the right, one from the left (see the bottom photo on the facing page). To avoid rounding the point, before making each cut, I temporarily clamp on a bandsawn offcut, which provides bearing surface beyond the apex.

With the serpentine edge molded, I miter the top rail at each end, which completes the joinery. That done, I can assemble the door and cut the panel groove with a bearing-guided slot cutter. This makes for perfect alignment of the grooves, but it rounds the inside corners. I square them up with a chisel.

The last step in milling the door frame is to remove the waste from the stiles and rails to make the bead molding stand proud. The stiles and lower rail are straightforward: I hold them on edge and run them against the fence of the tablesaw. I clean up any saw marks with a rabbet plane. The top rail is a bit more involved. Most of the waste on the top rail must be removed freehand with a router. I use a flat-bottomed bit and work my way from the molded edge toward the straight edge. I stop when the strip of wood supporting the router is down to a couple of inches wide. Then it's back to the tablesaw to remove this strip.



Hog away. Once the molding has been shaped, most of the waste is hogged out with a router and a flat-bottomed bit. Leave an uncut strip a few inches wide to support the router. Then take one pass on the tablesaw to remove the last swath of waste.



Miters next. The wide end of the top rail gets a 45° miter. On the narrower end, where the molding recurves, and no angle is strictly necessary, it should be cut just 5° to make assembly easier.



Dry-assemble the door for final flushing. Use a rabbet plane to clean up machine marks and level the surfaces of the rails and stiles. A cabinet scraper does the final finish work and handles heavier work in areas the plane can't reach.

using handsaws, chisels and planes. Did I possess the necessary skill or have the time to produce these details in the traditional way? I wasn't interested in turning out work like the contemporary factory-built pieces; the factories obviously got the job done quickly enough to make a profit, but the pieces lacked the character I loved. On the other hand, I couldn't afford to spend months on each piece, replicating all of the techniques of the period.

I developed an approach that combines modern tools and techniques with handwork where it is appropriate. I save time and labor with machines where I can, but I also use hand tools throughout the process, and I use them with a certain deliberate risk and roughness. The last tool that touches all of the primary surfaces is a smoothing plane, one whose blade is slightly crowned to create a subtle washboard effect on the workpiece and produce some light tearout and chatter. Secondary surfaces (such as drawer bottoms and the cabinet back) I texture with a scrub plane, leaving a pattern of even deeper furrows. And I soften the edge of the piece using a chisel or a spokeshave.

I work this way with hand tools in part to give the piece a tang of authenticity but also to partake of the spirit of the original makers. When I open the door of an old French country piece and find that the inside of the panel looks almost to have been hewn out with an ax and only slightly smoothed with a plane, it delights me; I can almost see the craftsman at work. In our time of flawless machined surfaces, it may feel natural to aim for perfection. But in doing so we may be wiping away our own fingerprints. □

Chris Gochmour makes custom furniture in Salt Lake City, Utah.



GET THE HANG OF FRENCH HINGES

Most French country cabinets have overlay doors and drawers. To hang overlay doors, the French have traditionally used a class of often highly decorative barrel hinges known today as *fiche* hinges. Hanging *fiche* hinges takes some practice. And because the hinges are so visually distinctive, there really is no alternative if you want to make authentic-looking French country furniture.

A *fiche* hinge swings open on a barrel like a butt hinge, but its leaves, instead of being mounted flat, are inserted edge-wise into deep mortises and then cross-pinned, much the way you would pin a mortise-and-tenon joint. A second type of *fiche* hinge for overlay doors has rods in place of leaves. For this hutch, I chose the leafed *fiche* hinge.

The most challenging part of installing these hinges is chopping the mortises for leaves that are only $\frac{5}{64}$ in. thick. Traditionally, these mortises were cut with special barbed chisels, which were pounded into the wood and then used to pry out the waste. Such tools are still manufactured, but I have not successfully applied the technique. I tried a number of alternative methods for cutting such a thin mortise, but none was satisfactory. In the end, I devised a method in which I cut a wider mortise with a router and then insert a filler piece to create a tight fit for the leaf.

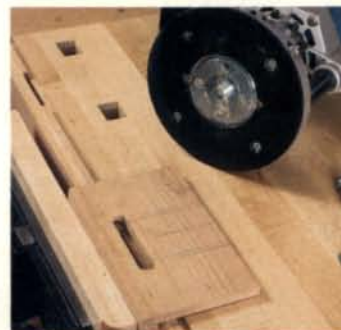


Starting with the door hinges, I cut the oversized mortises with a plunge router and guide the cut with a simple two-board mortising jig. I use a shim between the jig and the workpiece to determine where the mortise will be cut. With the door mortises cut, I make a long hardwood strip and round its edges to fit the mortise. I run a dado in one face of the strip that is just wide enough and deep enough to snugly accept the hinge leaf. I cut the strip into short lengths and glue one into each mortise.

The leaves of a *fiche* hinge come predrilled to accept cross pins. After I cut the mortises and insert the filler strips, I mark the location of those pin holes by holding the leaf up to the surface of the workpiece, beside the mortise. Then I insert the leaf and drill the pin holes. In place of pins, I use small screws to secure the hinge.

Once the door hinges are in place, I hold the door up to the opening and mark the positions of the case hinges. I use the same jig to cut the oversized mortises for the case, but I remove the shim to adjust for the overlay of the doors.

Fiche hinges are available from Gerber Hinge (213-651-0976), Imported European Hardware (702-871-0722) and The Golden Lion (www.goldenlion.org).



Start with a wide mortise. Creating the narrow mortises these hinges require is a two-step process. First, a wider mortise is cut using a router with a collar guide and a simple, right-angle mortising jig.

Filler strips make snug hinge mortises. The second step is to glue filler strips—dadoed to the width and thickness of the hinge leaves—into the mortises to create a snug, narrow mortise (left).

Case hinges come later. Hold the door in place to determine the correct location for the mortises on the posts. Once the mortises have been cut, mark the pin locations through the hinge and install.





FLUTED POSTS WITHOUT A LATHE

Fluting on a rounded post is frequently accomplished on a lathe with either a scratch stock or a router on some sort of carriage. My fluting setup, a low-tech affair, is based on the lathe-fluting concept but takes place on my workbench. I

clamp two blocks of wood to the bench to simulate a lathe's headstock and tailstock. I mount the workpiece between these scrap-wood centers and cut the flutes with a trim router strapped into a simple cradle that rides on the bench.

I use a #10 screw through each end block to serve as the axis on which the posts are rotated. Another screw driven through one of the end blocks an inch or two out from the axis screw locks the post in place during the fluting.

The cradle for the router is a block of hardwood with a deep V-groove cut into one side. I lay the router on its side in the V-groove and use a hose clamp to secure the router to the block. I wax the bottom of the cradle and check the workbench for flatness and clear it of any debris before cutting the flutes.

I lay out the centerlines of the flutes on one end of the post. And on the front edge of the end blocks, I mark a reference line that corresponds precisely with the center of the router bit.

Scraps of wood clamped to my bench serve as stops, limiting the length of the flutes. Using light, plunging cuts, I rout the first flute in several passes. Then I loosen the locking screw, rotate the post to the next mark, lock it into position and cut the next flute.



Fluting engine. A hose clamp and a block of wood with a V-groove cut into it make a cradle that turns the author's laminate trimmer into a fluting tool. The bench surface must be flat and free of debris. He clamps scraps of MDF to the bench to act as stops. The router is plugged into a variable speed controller, and the rpm is lowered to keep the bit from burning in the cut.



POWER SCRATCH STOCK BEADS THE APRON

The pretty curved aprons on French country case pieces often have a bead along the bottom edge. Traditionally, these beads were either completely hand-carved or roughed out with chisels and gouges and refined with a scratch stock. I

devised an auxiliary base for my trim router that enables me to rough out the bead quickly. I switch to handwork with a V-parting tool and gouge for the final shaping of the bead, for any work in tight corners and for beading the cabriole legs.

The auxiliary base has a dado cut into the bottom side fitted with a narrow piece of stock that acts as a fence. Attached with a bolt that rides in a slot, the fence is adjustable in and out and can follow the contours of curved work.

The tool is a time-saver but takes some practice to master. I bead small sections at a time. And, just as I would with a hand scratch stock, I start a cut by mating the fence to the workpiece and making several light plunging cuts.

Scratch stock in action. A bar riding in a slot in the shopmade auxiliary subbase (inset) acts as a fence, turning this laminate trimmer into a power scratch stock. The end of the fence near the bit is slightly concave, providing two points of contact to steady the cut. Getting smooth results while following curves with the narrow fence takes practice.





Routers for Router Tables

Choose
a fixed-base
model over
a plunge router

BY PATRICK WARNER

Although originally designed as a portable electric tool, the router performs just as well, if not better, as a stationary machine. Most of my routing is done with the tool attached to a small table made of medium-density fiberboard (MDF). Configured this way, the router can sometimes take the place of a shaper, a heavier-duty, more-costly tool that many of us can now do without.

Using the router inverted, however, poses some problems. The router was not designed for upside-down use. It's no surprise that most of the routers on the market are awkward to use in a table.



GOOD TABLE MANNERS

These features make some routers better suited than others to be used as stationary tools:

1. Large-diameter mounting screws
2. Easy-to-read adjustment scale
3. Aftermarket locking lever
4. Lots of travel
5. 1/2-in. collet
6. Motor detaches from base



I'm frequently asked what router works best in a table. Over the years I've tried just about every brand of router, and I can recommend five that work very well in a table.

Criteria for choosing a router

If you work fast or wish to use large panel-cutting bits, a large, powerful router is the way to go. Deeper cuts are possible with a 3-hp router. On the downside, a big router is also heavier and involves more of a wrestling match to get out from under the table. So depending on the work you do, a 1 1/2-hp or 2-hp machine might

A fixed-base router is easily removed from its base, unlike a plunge router. That feature makes it a snap to gain full access to the collet and locknut when changing bits.

be all you need. I look for three essential criteria in a router to be used in a table.

1. The router should be easy to remove from its base. The easiest way to change a bit is by removing the router from its base and setting it on top of the table in plain view (see the photo at right).

2. The router should have a ½-in. collet. A machine with a ½-in. collet can take heavier loads than a router with a ¼-in. collet. Additionally, I prefer to use ½-in.-dia. shank router bits, which are also more durable and less prone to flexing under load.

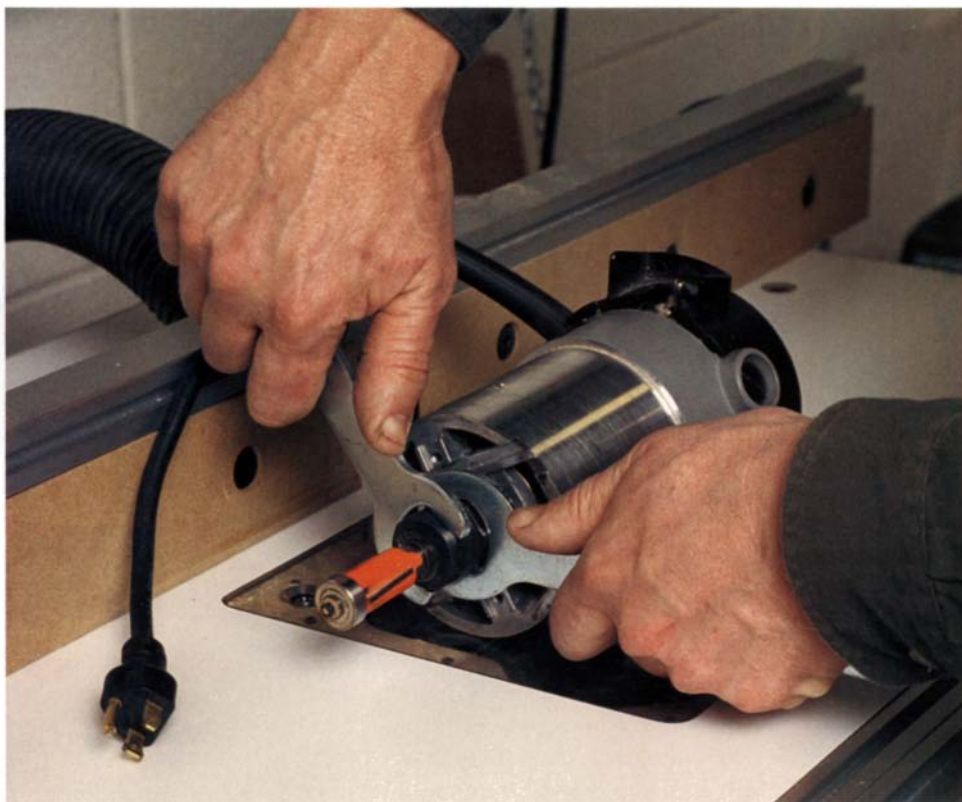
3. The greater the range of depth adjustment, or travel, the more versatile the machine. Remember, the actual reach of a router will be minus the thickness of the tabletop to which it is attached.

Another feature worth considering—but it's not essential—is variable speed. If you plan to use 1½-in.-dia. or larger bits, go with a variable-speed machine. Otherwise, you won't get much out of this feature, which adds to the cost of the router.

For heavy-duty use, I rely on a 3¼-hp router—For heavy-duty router-table work, there is only one fixed-base machine that fits all of my criteria: the Porter-Cable Speedmatic 7518, a 3¼-hp, variable-speed machine. The 7518 also has the largest base, biggest base-plate screws and the capacity to soak up more heat and run longer than any other router, fixed base or plunge. (Except for the variable-speed feature, it is similar to the Porter-Cable 7519.) The Porter-Cable motor has four pins that ride in matching spiral grooves cut into the base. Depth changes are made simply by spinning the motor up or down (see the photo at right). Minute depth-of-cut adjustments are easy to make using the tool's adjustment scale (a large ring), which is marked off in ¼-in. increments.

Although the 7518 is tough enough to do raised panels in one pass, I generally take two or three passes when I have to remove a lot of material. Limiting cuts to the equivalent of about ⅜ in. by ⅜ in. at a time produces little tearout, and stock is easy to control when feeding by hand.

When routing upside down, a lot of fine dust can make its way into the spirals in the motor housings of Porter-Cable routers and cause them to jam. To avoid jams, after routing, screw the motor up, toward the tabletop to eject dust from the grooves. Then screw downward to remove the dust; if you encounter resistance, go back up, then down again.



I know many woodworkers use a large plunge router in a table, but I've yet to find one that's as convenient to use as the 7518. The spring-loaded base of a plunge router is meant to be used right-side up, and it can be a struggle to make adjustments upside down. Additionally, a plunge router cannot easily be removed from its base, which means you have to change bits with the tool attached to the table.

Midsized routers—For medium-duty work, I like the Milwaukee 5680, Bosch 1617, DeWalt 610 and the Porter-Cable 690. To avoid



Depth changes made easy. All fixed-base Porter-Cable routers have four pins protruding from the motor housing that engage with two spiral grooves cut into the wall of the base. An adjustment scale is graduated in ¼-in. increments.

The Bosch 1617 router has a lever (left) that allows for coarse adjustments and a screw dial for fine adjustments. The larger lever (right) locks the base to the motor.



The Milwaukee 5680 router has a stop screw that must be removed to withdraw the motor from its base.



straining the motor of a midsized router, I don't cut more than the equivalent of $\frac{1}{4}$ in. by $\frac{1}{4}$ in. in a single pass. The Bosch, DeWalt and Milwaukee routers have the greatest amount of travel. The Bosch and Porter-Cable machines also have the most friendly depth-adjustment systems, something you appreciate every time you use it.

The Porter-Cable 690 is designed along the same lines as its bigger brother (the 7518) and employs the four pins on the motor housing. An easy-to-read scale is graduated in $\frac{1}{64}$ -in. increments but is readable to $\frac{1}{128}$ -in. increments because of the wide spaces between graduations. Vertical travel is about $1\frac{3}{4}$ in.

Most routers employ a thumbscrew to lock the base to the motor.

The Bosch 1617 is designed differently. It has a two-stage system, consisting of a pair of locking levers. A pull of the main lever loosens the motor. The spring-loaded second lever provides a coarse adjustment and also prevents the motor from coming loose from the housing unless pressure is maintained while the motor is twisted. A screw dial allows for fine adjustment. The dial is graduated in both $\frac{1}{64}$ -in. and $\frac{1}{10,000}$ -in. increments, with easy-to-read lettering. Travel is about $1\frac{7}{8}$ in.

The DeWalt 610 has a rack-and-pinion adjustment mechanism. A dial on the end of the gear shaft is graduated in $\frac{1}{64}$ -in. increments, but the dial is very small, and the cursor mark, cast into the base, is

Five routers that fit the bill

Although any router can conceivably be fitted to a table, these models excel at the task. A fixed-base router is preferable over a plunge router because the motor is easily removed from the base.



PORTER-CABLE
690 (1½ HP)



DEWALT 610
(1½ HP)



MILWAUKEE
5680 (2 HP)



BOSCH 1617
(2 HP)

rather wide, so you can't rely on these components for highly accurate adjustments. Rubbing white crayon on the numbers will improve readability, but for fine adjustments, make a trial cut and measure. The machine has 2¼ in. of travel.

The Milwaukee 5680 has a flat-head screw attached to the motor that prevents it from detaching from the base. I remove that screw for router-table work so that I can change bits with the motor out of the base. Use that screw as a guide when reassembling the router to the base. If there's not enough base wrapped around the motor, it may vibrate loose. The Milwaukee has a depth-adjustment scale, which is graduated in ¼-in. increments. The black bars on the black dial are not as easy to read as some other routers that have white lettering on a black background.

There's one thing about the Milwaukee to be aware of: The motor housing has a spiral-cut groove, but that is for the adjustment scale only. The motor moves up and down in a straight line. Don't try and spin the motor to change depth as you would a Porter-Cable router. Because of its design, the depth adjustment is a bit awkward with the router inverted because the adjustment scale is really designed to work with the tool in the upright position. The Milwaukee has about 2 in. of travel.

Router safety and maintenance

The potential for a router motor to eject itself accidentally from the base is always a possibility with a fixed-base router whether it's being used upside down or right-side up. This kind of accident is typically the result of not fully tightening the thumbscrew that fastens the base to the motor.

I've replaced the thumbscrews on some of my Porter-Cable

routers with adjustable levers, which are easier to grip and allow greater locking forces. The levers (including the bronze sleeve and flange nut) cost less than \$10 and are available from Reid Tool Supply Co. (800-253-0421). The holes in the base for the locking lever will have to be reamed or drilled out slightly to accept the larger-diameter replacement part. Also, a flat must be filed on the nut to fit it to the base, which will keep it from spinning freely when the lever is moved.

The DeWalt 610 has a rack-and-pinion adjustment system. The numerals on the depth-adjustment scale can be made easier to read by wiping them with white crayon or ink.



□

Patrick Warner is an author and woodworker. His web site, www.patwarner.com, offers many tips on routing.

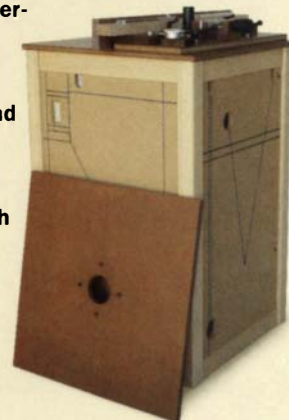
Why I don't like base-plate inserts

When I started woodworking, the routers sold in the United States were all fixed-base machines. Router tables were still new, and there weren't lots of accessories, such as base-plate inserts, available. My router table consisted of a solid piece of stock. To change bits, I simply unscrewed the router motor from its base attached to the underside of the table.

I still prefer a solid router tabletop because a base-plate insert introduces its own problems. True, a base-plate insert allows you to use any type of router, including a plunge router, because the tool and base can be removed from the table to access the machine's collet. But I find it difficult to adjust a plunge router when it is turned upside down.

A base-plate insert compromises any router table. Cutting a big hole in a table invites twist and cup. An insert must be perfectly level to get a smooth transition from table to insert. Additionally, some inserts themselves may bend under load.

I made a simple, inexpensive table from a piece of ¾-in.-thick MDF (sealed on all faces and edges with three coats of Watco oil). Sanding thickness tolerances of cabinet-grade MDF are very high (0.002 in. to 0.004 in.), which ensures a flat table. Instead of using insert rings to keep the opening around the bit to a minimum, make two or more tops with different-sized openings. Attach the MDF to a wooden table with several cross braces underneath to ensure that it stays flat.



**PORTER-CABLE
SPEEDMATIC 7518 (3¼ HP)**

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Richard B. Myers

A computer-aided design program was invaluable to Myers in figuring out the cut angles for the coopered top of this blanket chest. Cherry and bird's-eye maple are used in its construction. The chest, 19 in. deep by 43 in. wide by 22 in. high, is finished with wipe-on polyurethane (rubbed out with steel wool and rottenstone).

William Vick

Vick calls this cherry media cabinet "a post-modern wannabe." The raised-panel skin covers a birch-plywood interior. The tapered corner pillars use a paper joint so that the waste can be removed after turning to provide the square inside corner that is needed to glue the pillars to the case. The cabinet, 24 in. deep by 32 in. wide by 62 in. high, contains two video-cassette pullouts, a VCR shelf and a shelf for a television.



Charles T. James

Designed and built to house a computer, this rolltop desk has a pull-out keyboard table, internal raceways for wiring and a roll-out shelf (behind the right-hand door) for a hard drive. The desk, 36 in. deep by 60 in. wide by 48 in. high, is made of cherry with a walnut interior and is finished with Danish oil.



James Macdonald

Macdonald started this cabinet, 13 in. deep by 30 in. wide by 63 in. high, at a workshop given by marquetry master Silas Kopf. The Chinese princess is taken from a 1920s illustration by the French artist George Barbier. The cabinet doors are veneered with bubinga. The case is made from a plank of unidentified, ribbon-grained, dense tropical wood that Macdonald bought at a salvage center. When cutting this wood, he said, "You catch a whiff of Kiwi shoe polish and PEZ candy." The cabinet stand is made of Philippine mahogany.

R.A. Laufer

"I was on my third plastic department-store desk chair with a wobbly seat," said Laufer, "when I decided it was time [to make a desk chair from wood]." The cherry chair, 21 in. deep by 26 in. wide by 46 in. high, is finished with oil. Swivel mechanisms similar to the one Laufer uses are available from Abacus (713-861-4011).





Jim McRoberts

Pulverized pipestone (a heat-hardened, compacted red clay stone) mixed with epoxy was laid into routed grooves to make the inlay on this bookcase. The case, 14 in. deep by 66 in. wide by 31 in. high, is made of madrone and madrone burl and finished with a combination of varnish, tung oil and linseed oil.

William C. Block

The top of this demilune table is Australian lacewood veneer over medium-density fiberboard, and the curved apron is Honduran mahogany veneer over bending plywood. The legs are Honduran mahogany. The table—11 $\frac{3}{4}$ in. deep by 22 $\frac{3}{4}$ in. wide by 34 in. high—was the first project in which Block used vacuum-bag veneering.



Jonathan C. Der

This small, tansu-inspired walnut chest, 12 in. deep by 22 in. wide by 13 in. high, is designed to hold jewelry as well as other dresser-top knickknacks. Halfway through the project, Der found a piece of walnut crotch, destined for the firewood bin, that became the book-matched drawer fronts. The chest is finished with three coats of oil and a topcoat of microcrystalline wax.



J. Paul Hansen

When he lived in a 1922 Arts and Crafts-style house, Hansen built this cherry coffee table (25 in. deep by 43½ in. long by 16¼ in. high). The shelf is set into an overlong mortise cut into the stretcher, and it is glued only in the center to allow for seasonal wood movement. The table is finished with four coats of Waterlox.



E. Jeff Justis Jr.

Built for Justis' youngest grandson, this cradle, 27 in. deep by 36 in. long by 36 in. high, is made of walnut and has a removable poplar bottom. In the stand the cradle swings from side to side; when removed and set on the floor, the cradle rocks on its runners. A locking mechanism in the stand keeps the cradle stationary.

David Pollak

Based on his client's photo of a pair of double doors in Thailand, the pattern-grade Honduras mahogany carving on this 44-in.-wide by 96-in.-high entry door took 138 hours to complete. Pollak's client colored the carving using tinted Sikkens Cetol 23 Plus.



Tips for photographing your furniture

1. Use 35mm color print (negative) film of moderate speed (ISO 200-400).
2. Clean and dust the furniture.
3. No matter how you light the furniture, it will appear more three-dimensional if each plane has a different brightness. Take care, however, to avoid excessively bright highlights or dark shadows.
4. To be sure the photos will be free of distortion, avoid the use of wide-angle lenses, and photograph with the camera positioned even with the center of the furniture both vertically and horizontally.
5. Photograph the furniture from several angles. Include some head-on shots, as well as some shots that show both the front and side of a piece.
6. Keep the background simple. A cluttered or otherwise distracting background may draw the viewer's attention away from the subject.

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READER SERVICE NO. 135

Four-squaring with hand tools

In my woodworking classes, before I let students use machines, they are required to rip, crosscut, surface and edge-joint boards—a process called four-squaring—by hand. Hand-tool methods bring students closer to the process. They can understand wood easier—grain characteristics and vagaries—when they work it by hand. Hand tools make wood more of a sensitive material you pay attention to, not some impersonal matrix you ram through a machine. Plus, hand-tool work will stand you in good stead some day if one of your machines is down and you can't get parts for a week.

Most problems students have with hand tools stem from using lousy, dull tools. You can't do serious work with grandpa's old, rusty plane, and even lots of new tools aren't very good. I use a five-point German bowsaw for dimensioning. It cuts fast and accurately. I use Lie-Nielsen planes. Sharpen them, and they cut beautifully right off the shelf. No other metal planes do. These planes have solid castings, thick blades made of good steel and are manufactured to close tolerances. Nothing is more infuriating than

cut bread. But if you make an effort to angle your wrist outward and away from you, cutting squarely will be much easier. It's just a matter of practice—like hitting a tin can with a BB gun.

If it seems daunting to cut accurately in two planes at once—the face and the edge—you may be using the wrong saw. A bowsaw has a thin, 1 $\frac{3}{8}$ -in.-wide blade that is held in tension in the frame. It cuts very quickly, won't whip or kink in the kerf and is easy to control. You can cut to a line—an essential skill—easily with a bowsaw. Small wonder the bowsaw is a staple tool in Europe. I don't know why we haven't heard more about this tool in the United States.

Flatten with a scrub plane

The scrub plane is the most crucial plane in the mix, yet it is the most overlooked and misunderstood. A scrub plane flattens a board; that is, it takes out the twist, warp and bow. A jack plane can remove high spots left by the scrub plane, but you can't flatten a board with one. A jointer plane can square an edge and remove



Crosscut with a bowsaw. Keep your wrist angled outward, and with a little practice, you'll be able to make square cuts.



Scrub plane is for flattening. Using a scrub plane, with its radiused blade, work the board diagonally in one direction and then the other.



Check a board's flatness. Place your fingers on diagonal corners of the board. If the board rocks on the bench, move your fingers toward the center. When the board rocks no more, the high spot is between your hands.

trying to do sustained, serious work with a plane that has a wavy sole and a tinny blade that won't stay sharp or with a clumsy saw that has too-thick a blade and an uncomfortable handle.

Good tools will solve 90% of problems in hand-tool use. Keeping them razor sharp will solve another 5%. Most students think they are at fault as they try to chip and bang their way through a board. Then they try my tools and discover their cheap planes and saws were the culprits—not them. The last 5% of hand-tool problems can be alleviated with practice. Think of how awkward you felt the first time you drove a car.

The beauty of the bowsaw

Start the four-squaring process by using a sharp pencil or a razor knife to mark a line across a board, then crosscut the board to a rough length. (You'll cut the board to final length as the last step.) Lop off the first 4 in. or so of the board to remove end-grain cracks.

When you first start using a handsaw, the tendency is to angle the blade in toward you. The same thing can happen when you hand-

the last high spots from the face, but it can't flatten a board, either. A board can be flattened only with a scrub plane.

Lots of woodworking students think they can use a jack plane to do the work of a scrub plane. Forget it. It won't work. To flatten wood you need to remove unwanted areas in big pieces. If you try it with a jack plane, you'll end up with a smoothly surfaced, unflat board. It's like giving coffee to an inebriated person—you'll get a wide-awake drunk. The intentions are good, but the result is bad.

Scrub planes are designed to do one thing: flatten wood. The scrub-plane blade is radiused—it scoops like a gouge. It doesn't shave like a regular plane. Most problems arise from trying to take too big a cut with it. I regrind my Lie-Nielsen scrub-plane blade to a 2 $\frac{1}{4}$ -in. radius, then sharpen and polish it with waterstones.

Clamp the board on the bench. With about $\frac{1}{16}$ in. to $\frac{1}{8}$ in. of the blade showing, plane the board diagonally all the way in one direction, then the other. If the board has any pronounced bulges or high ends, plane those spots more. Flip over the board, and with your fingers on opposite corners, try to rock the board on the

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Rules of Thumb (continued)

bench. Try one pair of corners, then the other. If the board rocks, there is a high spot. It's easy to find by bringing your fingers in from the corners toward the middle of the board while continuing to rock it. When the board stops rocking, the high spot is between your hands. Flip the board over again and remove the high spot with a scrub plane.

Plane the high spots

Next, jack-plane the high spots—the crest of the waves left by the scrub plane. I use a No. 5 jack plane, about 14 in. long and set for a heavy cut—it will take off a big piece. If the cut is too light, this step will seem to take forever. My jack plane has an adjustable throat, so I open that up a little, too. Work the plane on the board the same way: diagonally, first in one direction, then the other.



Jointer plane is the last one to use. With a long jointer plane, work the board with the grain, removing the marks left by the jack plane.

Use more pressure on the front handle to start the cut, equal pressure front and back in the middle, and more pressure on the rear tote as you finish. This technique will keep you from rounding down the edges. If that happens, the board will rock again when you flip it over, and you'll have to start over.

After taking off the high spots with the jack plane diagonally, plane with the grain using the jointer plane. If you use a good jointer plane, it will take up long, thin shavings easily (a lousy, dull one will skip and jump). Because grain always seems to change direction in the middle of a board, you may get some tearout. But tearout isn't all bad—you are doing handwork; the piece should look handmade, not manufactured. After using the jointer plane, flip over the board again and make sure it doesn't

rock. No need to be fanatical; you're working wood, not uranium. If it doesn't rock noticeably, it's good. That side is done.

Set a marking gauge for the final desired thickness. Bearing the fence on the face you've just done, mark a line all the way around the board. Clamp the board in the bench with the now-flat side down, and plane to the mark, working in sequence as before. Work the scrub plane to a little less than $\frac{1}{16}$ in. of the line. The jack and jointer planes will get you to it.

Joint one edge

With the faces of the board surfaced, plane one edge flat and square to the faces with the jointer plane. Clamp the board sideways in the bench. Take long passes with the jointer plane until the edge is straight and square.

Hold the jointer plane by the front handle and the rear tote, and guide it over the edge 90° to the face by eye. With a little practice, you'll also be able to see and feel a 90° cut here. Check it with a square from time to time, but don't use jigs, a fence or any other nonsense. And don't hold the plane so that you can guide it with

your fingers underneath. Hold the plane by the handles. Your eye-hand coordination is better than any gimmick or trick grip. Learn the correct way once, and you'll always know.

Rip the opposite side

With one edge straight, the next step is to make the opposite edge straight and parallel to it. Use a combination square and pencil to draw a continuous line for a rip cut with the bowsaw. Clamp the board in the bench horizontally, with the edge to be cut hanging off the side. Turn the bowsaw blade askew to the frame, and saw down the line. Keep the blade cutting just outside the line—about $\frac{1}{2}$ in., then plane it to the line afterward. The large teeth and long blade of the bowsaw make this fast work. When the board has been ripped to width, clamp up the newly sawn edge in the bench and plane to the edge using a jointer plane. The last step is to use the bowsaw again, this time to square up the ends of the nice, flat board with the parallel sides.

Using hand tools to do this kind of work is important, not so



Marking gauge determines thickness. After one face of the board has been planed flat and smooth, run a marking-gauge fence along the finished side to mark the board's final thickness. Repeat the three-plane process on the rough, unfinished side.



Use a straightedge to mark a parallel edge. Hold a pencil against the blade of a combination square, set to the desired width, and mark a line on the opposite side.



Bowsaw for ripping to final width. The saw's long blade makes it easy to take long strokes. Cut to within $\frac{1}{16}$ in. of the marked line. Finish the sawn edge with a jointer plane.

much because it makes the wood different but because it makes the woodworker different. You'll gain an acuity and respect for wood that you cannot get by being a machine operator. When you can dimension a board flat and square by hand, you'll have achieved something that only a small percentage of woodworkers can do or will even bother to attempt. You'll be a different woodworker, too. A better one.

DELTA TOOLS

Model	Description	List	Sale
31-750	Bench Random Orbit Sander	189	
28-150	9" Bench Band Saw	195	155
50-860	850 CFM Air Cleaner	291	239
31-695	6" Belt/9" Disc Sander	441	299
23-710	Sharpening Center	228	155
31-460	4" Belt/Disc Sander	168	119
40-560	16" 2 speed Scroll Saw	320	129
40-540	16" var/spd Scroll Saw	243	159
11-990	12" Bench Drill Press	237	184
11-090	32" Radial Bench Drill Press	417	279
43-505	1/2" Bench Router/Shaper	398	299
22-540	12" Bench Top Planer	518	259
22-560	12-1/2" Planer w/ extra knives	572	329
36-865	Versa Feeder Stick Feeder	337	249
36-220	10" Compound Miter Saw	294	199
37-070	6" var/spd Bench Jointer	362	265
14-650	Hollow Chisel Mortiser with chisels and bits	380	249

17-900	16-1/2" Floor Drill Press	490	329
17-924	Mortise Chisel Kit	500	345
34-555	Sliding Table	518	339
36-250	10" Slide Compound Saw	696	455
31-780	Oscillating Spindle Sander	261	194
40-650	Q3 18" Scroll Saw	600	389
36-905	30" Unifence	363	259
36-906	30" Unifence	454	319
36-444	10" Contractors Table Saw	852	589
33-830	10" Radial Arm Saw	851	799
37-285	6" Jointer w/ stand	424	345
37-380	8" Professional Jointer	1500	1095
31-250	NEW 18" Drum Sander	500	345
40-680	NEW 20" variable speed Scroll Saw	489	339
36-475	10" Platinum Edition Contractors Table Saw w/ 30" unifence, cast iron wing, table board & carbide blade	849	589
22-680	15" Planer with stand	500	345
28-275	14" Band Saw 3/4 HP	500	345
28-255	14" Platinum Edition Band Saw - 1 HP w/ mobile base, 18" rip fence, & 3/8" blade	849	589
31-280	Sanding Center w/stand	1012	789
37-190	6" Deluxe Jointer	615	445
37-195	6" Professional Jointer	625	539

Single Stage Dust Collectors

50-850	1-1/2 HP, 1200 CFM	395	295
50-851	2 HP, 1500 CFM	588	495

MILWAUKEE TOOLS

6527-6	Sawzall with case	343	169
6537-226527	w/quick lok blade change	362	179
6521-21	Variable speed orbital Sander	375	185
0224-1	3/8" Drill 4.5 amp magnum	240	138
0234-6	1/2" Drill 4.5A mag 0-850 rpm	255	134
0235-6	1/2" Drill w/keyless chuck	255	142
0244-1	1/2" Drill 4.5A mag 0-600 rpm	255	142
0222-1	3/8" Drill 3.5 amp 0-1000 rpm	221	129
0228-6	3/8" Drill 3.5 amp 0-1000 rpm	214	125
0375-6	3/8" close quarter Drill	255	148
6176-20	14" Chop Saw	340	179
6546-6	Skewdriver 200 & 400 rpm	150	89
6547-6	6546-6 w/bits, 1/4" chuck & cs190	115	89
6390-21	7-1/4" Circular Saw w/ cs	267	139
5397-6	3.8" v/spd Hammer Drill Kit	275	145
5371-6	1/2" v/spd Hammer Drill Kit	360	194
6145	4-1/2" Grinder 10,000 rpm	182	105
6494-6	10" Compound Miter Saw	595	329
6266-21	Top Handle Jig Saw w/ case	319	159

FREUD CARBIDE TIPPED SAW BLADES
5/8" Bore - Industrial Grade

Item	Description	Teeth	List	Sale
LU82M010	Cut-off 10"	60	93	32
LU84M011	Comb 10"	50	78	45
LU85R010	Super Cut-off 10"	80	114	69
LU85R012	Super Cut-off 12"	96	185	99
LM72M010	Ripping 10"	24	69	39
LU87R010	Thin Kerf 10"	24	72	49
LU88R010	Thin Kerf 10"	60	85	55
LU98R010	Ultimate 10"	80	128	79
LU91M008	Compnd Mitr 8-1/2" 48	89	40	40
LU91M010	Compnd Mitr 10" 60	88	54	54
F410	Quiet Blade 10"	40	95	54
SD308	8" Carbide Dado	230	119	89
SD506	6" Carbide Super Dado	279	154	99
SD508	8" Carbide Super Dado	344	175	109
FB100	16 piece Forstner Bit Set	338	194	109
94-100	5 pc. Router Bit Door System	320	169	89

HITACHI TOOLS

C8FB2	8-1/2" Slide Compound Saw	1169	449
C10FS	10" Slide Compound Saw	1627	579
C15FB	15" Mitr Saw	1346	659
C10FCD	10" dual bevel Compound Mitr Saw	550	265
NV45AB	Coil Roofing Nailer	935	369
FN50AE	Pinner 3/4" - 2"	1078	429
EC12	2 HP, 4 gallon Compressor	561	289

MAKITA TOOLS

Model	Description	List	Sale
5090DW	3-3/8" Saw Kit 9.6 volt	213	139
DA391D	3/8" angle Drill 9.6V	142	95
DA391DW	3/8" angle Drill Kit 9.6V	216	139
6095DWE9	6 volt Drill Kit w/ 2 batt	240	125
6095DWE2	6095DWE w/flashlight	263	139
632007-4	9.6 volt Battery	55	30
632002-4	7.2 volt Battery	45	28

18 VOLT MAKITA TOOLS

6343DWA6	1/2" Drill Kit	458	255
5620DWA	6-1/2" Circular Saw Kit	458	255
DK1016	1/2" Drill & 6-1/2" Saw combo kit	698	389
DK1021BL	1.8 volt Combo Kit. Includes drill, 6-1/2" Circ. Saw, Recipro Saw, and flashlight	579	

CORDLESS DRILLS

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6213DWAE	12V 3/8" Drill Kit	293	169
6233DWAE	14.4V 3/8" Drill Kit	358	205

9900B	3"x21" Belt Sander w/bag	322	165
9924DB	3"x24" Belt Sander w/bag	333	169
N1900B	3-1/4" Planer with case	268	142
1912B	4-3/8" Planer	360	209
N9514B	4" Disc Grinder 4.6 amp	106	65
DA3000R3/8"	Angle Drill	328	185
6013BR	1/2" Drill Rev. 6 amp	268	149
9401	4" x 24" Belt Sander w/bag	416	219
5007NBK7-1/4"	Circ Saw w/ case	238	125
LS1011	10" Slide Compound Saw	807	429
LS1211	12" Slide Compound Saw	1370	695
3901	Plate Joiner Kit	318	159
3612C	3 HP Plunge Router	503	265
LS1040	10" Compound Miter Saw	547	249
LS1013	10" Dual Compound Slide Miter Saw	1087	599
BO5010	5" Random Orbit Sander	121	69
LS1220	12" Compound Miter Saw	678	379
9227C	7/9" Polisher	338	195
2702	8-1/4" Table Saw	538	299
2703	10" Table Saw	568	309

SENCO AIR NAILERS

SFN30	Finishing Nailer w/ case	459	249
SNS45	Stapler 7/16" crown, 1" - 2"	540	369
SLP20	Planner w/cs 5/8-1-1/8"	422	189
SKS	Stapler 5/8 - 1-1/2"	390	259
SN70	Framing Clip Hd 2 - 3-1/2"	725	449
SN65	Framing - Full Hd 2 - 3-1/2"	709	359
SN600	NEW Framing 2 - 3-1/2"	699	339
SFN40	Finish Nailer 1-1/4 - 2-1/2"	569	329

BOSTITCH AIR NAILERS

Model	Description	List	Sale
N80S-1	Stick Nailer	545	255
RN45	Coil Roof Nailer 3/4 - 1-3/8" with case, oil, & brads	279	119
N60FN-2K	Finishing Nailer w/ case	557	239
BT35-2K	Brad Tacker 5/8" - 1-3/8" with case, oil, & brads	279	119
MIIFS	Flooring Stapler 15 gauge	902	539
S32SX-1K	Finish Stapler 1-1/2" - 1-3/8" with case & oil	269	135

JORGENSEN ADJUSTABLE HANDSCREWS

Item#	Length	Opening	List	Sale
#0	8"	4-1/2"	20.35	12.95
#1	10"	6"	23.30	14.50
#2	12"	8-1/2"	26.75	16.25
#3	14"	10"	33.85	20.25

PONY CLAMP FIXTURES

Model	Description	List	Sale
50	3/4" Black Pipe	15.45	8.50
52	1/2" Black Pipe	12.65	6.95

PANASDNC CORDLESS

EY6431NOKW	1/2" 15.6V drill kit with two 3 amp-hr Ni-Mh batteries, 45 minute charger, & case	372	205
EY6431FOKW	1/2" 15.6V drill kit with two 2 amp-hr Ni-Cad batteries, 30 minute charger, & case	342	189
EY6407NOKW	1/2" 12V drill kit with two 3 amp-hr Ni-Mh batteries, 45 minute charger, & case	339	189
EY6406FOKW	3/8" 12V drill kit with two 2 amp-hr Ni-Cad batteries, 30 minute charger, & case	305	169
EYC133	5-3/8" 15.6V Wood Cutting Saw and Drill Kit	650	379

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B-50	50" Commer. Saw	443	325
T-SQUARE 52	52" Homeshop	360	275
T-SQUARE 40	40" Homeshop	335	255
T-SQUARE 28	28" Homeshop	325	245

AIRY AIR NAILERS

Model	Description	List	Sale
024ISK	Brad Nailer 3/8" - 1-9/16"	180	79
0626SK	1/4" Crown Stapler 3/8" - 1-1/4"	194	89

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25010	10" die cast Torpedo Level	21.95	12.95
24640	24" Level w/ hand holes	54.95	34.95
24670	48" Level w/ hand holes	54.95	34.95
03050	Compact Laser Level	299	
03100	Compact Laser Level with prism	359	

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DEWALT TOOLS

Model	Description	List	Sale
DW124K	1/2" right angle Drill	590	329
DW321K	Top Handle Jigsaw Kit	300	164
DW364	7-1/4" Circ. Saw w/brake	294	155
DW376G	7-1/4" Framer's Saw	210	149
DW610	1-1/2 HP 2 handle Router	266	149
DW411K	1/4 sheet Palm Sander w/ cs88	58	
DW682K	Biscuit Joiner with case	448	169
DW705	12" Compound Mitr Saw	734	339
DW621	2 HP Plunge Router	400	199
DW677K	3-1/4" Planer with case	268	155
DW431	3 x 21 v/spd Belt Sander	338	188
DW421	5" Palm Ran. Orb Sander	144	75
DW423	Palmgrip Random Orbit Sander - variable speed	170	92
DW272	Drywall Gun, 0-4000, 6.3 amp	160	95
DW276	Drywall Gun, 0-2500, 6.5 amp	160	99

DEWALT CORDLESS DRILLS

DW972K-2	3-3/8" variable speed w/ two 12V XR batteries	362	175
DW991K-2	3-3/8" variable speed w/ two 14V XR batteries	415	199
Above drill kits come w/ charger & steel case!			
DW991K-2	DW991K drill, DW935 trim saw, 2 XR batteries & case	340	345
DW911	Jobsite Radio & Charger	139	

DEWALT 18 VOLT CORDLESS TOOLS

DW933K	Jigsaw Kit	468	275
DW938K	Recipro Saw Kit	520	269
DW995K-2	1/2" Drill Kit w/ 2 batt.	454	259
DW997K-2	1/2" Drill/Hammer Drill Kit	454	249
DW936K	5-3/8" Saw Kit	458	249
DW995K-2	DW995K Drill, DW936 Saw and case	532	399
DW995K-2	DW995K 18V drill kit, DW938 18V reciprocating saw, & case	599	

NEW 24 VOLT DEWALT TOOLS

DW006K	1/2" Drill/Hammer Drill Kit	560	299
DW007K	6-1/2" Circular Saw	560	299
DW008K	Reciprocating Saw	560	299

DEWALT BENCH TOP TOOLS

DW708	12" Slide Mitr Saw	540	649
DW788	20" Scroll Saw	540	699
DW733	12" Planer w/ extra blades	540	699
DW744	10" Portable Table Saw	540	699

DAVID WHITE INSTRUMENTS

Model	Description	List	Sale
LP6-20A	Sight Level package-20x, 329	245	
LP6-20XLA	LP6-20A with 9056 tripod and 7620 rod	409	275
LT8-300P	Level Transit - 26x	739	579
LT8-300P	above Level with optical plumb	869	649
ALT6-900	Automatic Level - Transit	869	519
ALTP6-900	above Level with tripod & rod	799	559
ALP8-22	Automatic level - 22x with tripod and rod	854	315
ALP8-26	Automatic level - 26x	854	315
ALP8-26	Above level with tripod & rod	854	315

BOSCH

Model	Description	List	Sale
1587VS	Top Handle "CLIC" Jig Saw	292	139

1587AVSC	1587VS Saw Kit with case and Progressor blades	500	345
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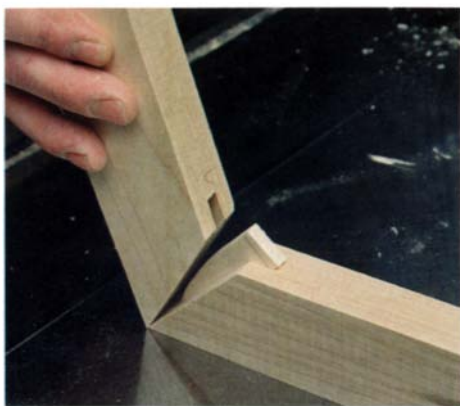
1584VS	Barrel "CLIC" Jig Saw	288	164
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Bosch Metal Case for above Jig Saws	24		
Bosch 30 blade assortment for Jig Saws	29.99		

1584VS or 1587VS	with steel case and 30 Bosch blades	310	
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1295DH5	5" Random Orb Palm Sndr	155	89
1274DVS	3"x21" v/spd Belt Sander	326	1

Hidden-spline miters



I'm designing a tabletop that has a mitered frame and a floating panel. What is the best way to reinforce the miters, without using splines that show on the outside of the frame top?

—Logan Sanderson, Eau Claire, Wis.

Dan Faia replies: There are many different ways to strengthen a miter joint: dovetails, mortise and tenons, half laps and, of course, splines. I would recommend that you use a hidden-spline miter. This joint is used quite frequently by many furniture makers because it is quick and easy and adds incredible strength.

Cutting the hidden-spline miter is as simple as setting up your tablesaw. First, cut and fit the miters as you would on any other project, saving the miter waste for later. Make a simple 45° sawing block that

is a little thicker than the frame stock, tall enough to give you a good reference and long enough to clamp to the rip fence (see the photos below). Like your miters, the sawing block should be exactly 45°.

Adjust the dado set on your tablesaw to about one-third the thickness of your stock. Set the distance from the rip fence to the center of the dado set, which should be the exact center of the frame stock. It is helpful to draft a plan view of a corner to determine blade height and cut length. Tracing the dado set with these two dimensions figured out will give you the exact shape of the spline.

Once the rip fence has been adjusted properly, pass the sawing block through the dado set. Set the block to the appropriate locations determined by the drawing. Mill a couple of sample pieces while you are milling the frame stock. This way you can test-cut all of your settings and adjust, if necessary.

Using the sawing block as your guide, gently plunge the miter into the sawblade, then pull back on the stock to remove it. The piece will not kick back because the block acts as a stop. Repeat this on all of your miters to achieve the slots for the splines.

Mill spline stock to fit the slots snugly but not too tight. Oversized splines could split the stock. Take the time to glue on the miter cutoffs from the first step. This allows you to get great clamping pressure

on all four corners, with the flexibility to use the clamps for adjusting the frame. After the glue has set, the clamping blocks may be removed. Bandsaw or handsaw off the blocks close to the frame and flush the excess with a handplane. [Dan Faia teaches woodworking at The Windsor Institute in Hampton, N.H., and at North Bennet Street School in Boston.]

A warped butcher-block

I recently completed an end-grain maple butcher-block. During construction I noted some warping (¼ in. over the entire 19-in. board) that went away after a few days of airing. Now, after seasoning with olive oil, the warping has returned and, in fact, has increased to about ½ in. I also noticed that the wood seems to absorb an excessive amount of oil. How can I correct this situation?

—Don Jacobs, Bloomington, Ill.

Chris Becksvoort replies: You have one of three potential problems. First, I assume that you're working with rock maple, which is not exactly the most well-behaved wood. Traditionally, end-grain butcher-blocks were made of rock maple, sycamore or beech.

The second problem, as I read it, is that you have an end-grain "board," and, assuming that your board is 19 in. by 19 in. and 1 in. or 2 in. thick, there is almost no way to keep it flat. A butcher-

A HIDDEN SPLINE FOR MITER JOINTS



Careful setup. Cut a sawing block to 45° and pass it over a dado set, with its kerf adjusted to about one-third the thickness of the stock. The distance from the fence to the center of the blade should equal half the stock thickness.



Clamping down. Set the block into place over the blade, making sure that the blade kerf won't cut through to the outside end of the miter. Once the positioning is correct, use a heavy clamp to hold the block in place.



Plunge-cut into the blade. Lower the mitered workpiece onto the blade, using the block as a guide. Once the kerfs have been cut on two mating pieces, spline material is thickened, shaped and set into place.



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block was usually just that: a block of equal dimensions in all three directions. Rest assured that a 19-in. by 19-in. by 19-in. block will not warp noticeably.

Finally, be sure that you're oiling both sides equally. Nothing guarantees warping more than uneven moisture intake—six coats of finish on one side and two on the other.

My suggestion would be to start over and glue up a block 6 in. to 10 in. thick. Let it sit in the shop for a few weeks to get acclimated. Then true up the faces with a block plane (yes, that's where the name comes from). Finally, oil both sides equally. Remember that end grain soaks up a lot more oil than face grain does. [Chris Becksvoort is a contributing editor.]

Mortises of different widths

When I make mortises with my router, there is often considerable variation in the width of them, to the point where I sometimes have to fit each tenon individually. I use a jig for the router to ride against, so it doesn't seem possible that the mortises could be that different. What am I doing wrong?

—Daryl Alexander, Wilmington, Ohio

Lon Schleining replies: If you are using the plastic base plate as a guide, and assuming your piece is staying put relative to the jig, I'd bet your router bit and your base plate are running in different circles.

Even the best routers aren't always concentric. Though the base plate might be perfectly round, the bit may not be running exactly in the center of this circle. As a consequence, the distance from the base plate to the line of cut will vary, depending on the rotation of the router itself. There are two ways around this.

Try making a mark on the base plate. Now run this mark in the same direction each time without rotating the router. This should ensure greater consistency with your cuts.

If you want to fuss with your machine a little, unplug the router, then insert a bit with a bearing. Measure with a dial caliper from the edge of the base plate to the bearing in several places. Chances are you'll find a good deal of difference.

Find and mark the lowest spot. Begin filing away the plastic base plate on either

side of this low spot, filing and measuring as you go, until the measurement is the same all around. Now recalibrate your jig with the smaller-diameter base plate, and it should produce consistent mortises, regardless of the machine's rotation.

[Lon Schleining teaches woodworking at Cerritos College in Long Beach, Calif.]

Is hickory a furniture wood?

Hickory is a beautiful and affordable wood, but is it good for making furniture? What is it like to work with?

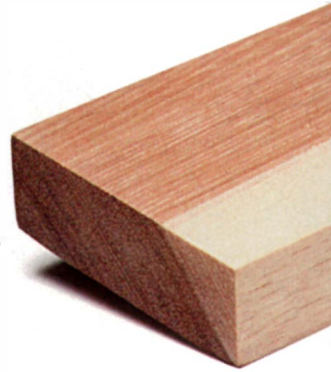
—Jason Humphries, Wilmington, N.C.

Jon Arno replies: If you are prepared to put out a little extra effort, hickory is a perfectly acceptable furniture wood. In fact, due to the growing demand for lighter-colored woods in both the furniture and cabinetmaking industries, the popularity of hickory has increased in recent years. However, to think of hickory as just one wood is a serious misconception.

The hickory genus, *Carya*, belongs to the walnut family and, with the exception of a couple of minor species native to China, this is a uniquely American group of timbers. The problem is that we have almost a dozen native species, and most find their way into the lumber trade without much care being given to preserving their identity. In fact, the trade segregates them into only two kinds of lumber: pecan and true hickory. Those species marketed as pecan tend to be slightly softer and a little darker in color, perhaps best described as a warm tan. The true hickories also have tan, rust-brown or amber-orange streaks in the heartwood, depending upon the species. Their plentiful sapwood is typically creamy yellow in color—the dominant hue of most hickory lumber.

Because of the differences in the appearance, density and stability of the woods, knowing which of the various species you're dealing with can be important. It also helps to stick with one species if you can. The best approach is to buy all of the stock you will need for a given project at one time and from one source. There is no guarantee this will ensure that the boards you buy will all be cut from the same species, but it definitely improves the odds.

The hickories are heavy and strong woods. They boast a tan heartwood and a blond sapwood, but they are quite elastic and difficult to work with hand tools.



While the species differ, they do share some basic similarities. For example, all hickories are heavy, strong, elastic and hard to work, especially when using hand tools. Although not particularly significant in furniture making, none of the species has good decay resistance. This certainly limits hickory to interior projects and even makes it a questionable choice for use in high-moisture interior applications such as bathroom vanities.

Also, all hickories experience high shrinkage, resulting in a lot of in-use movement and a rather serious tendency to cup and warp. Careful consideration must be given to using joinery techniques that allow wide panels to float while employing joints that do not require broad cross-grain glue-ups. Regardless of which species you end up with, hickory presents some interesting challenges. On the other hand, its very attractive, mellow, semi-ring-porous figure and its bright blond, natural color offer equally interesting rewards.

[Jon Arno is a woodworker and wood consultant in Troy, Mich.]

Locating knife hinges

Where can I find solid brass knife hinges for cabinet doors that overlay their case?

—Michael Fiveash, Alexandria, Va.

Matthew Teague replies: WhiteChapel (800-468-5534) and Lee Valley (800-871-8158; request the hardware catalog) both carry knife hinges in assorted sizes and designs.

[Matthew Teague is an associate editor.]

Do you have a question you'd like us to consider for the column? Send it to Q & A, Fine Woodworking, P.O. Box 5506, Newtown, CT 06470-5506 or e-mail it to fwqa@taunton.com.

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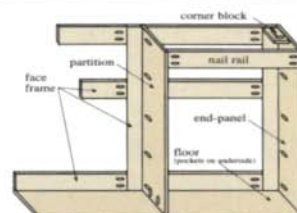
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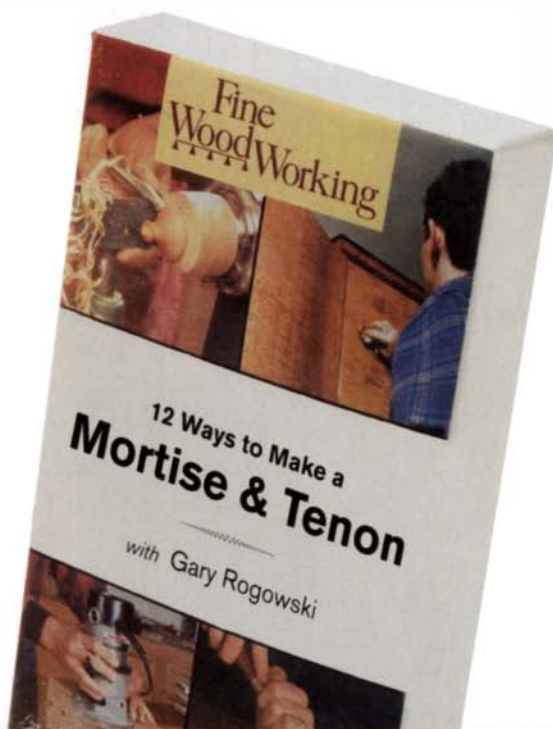
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Master Class

Resurrect a coffin smoother

BY ALLAN BREED



Wooden smoothing planes, the workhorses of the past, are available for \$10 or \$15. They are easily repaired and restored to fine working condition.

I came into possession of my first hand-planes in my early teens. I soon discovered that the cap iron was not a spare blade, and I have made considerable progress since then. These days I'm familiar with planes of all sorts. As a reproduction cabinetmaker, I have occasion to use a wide range of them.

Even with prices for old tools rising rapidly, there are still bargains for those who believe that a plane doesn't have to outweigh a bowling ball and cost more than a titanium racing bike to function well. In fact, my favorite type of smoother is so low on the food chain that it is rarely mentioned: the wooden smoothing plane, or coffin smoother.

Coffin smoothers are surprisingly cheap—often selling for \$10 or \$15—and turn up in yard sales, junk shops, antique stores and in box lots at auctions all the time (my favorite source: M.S. Carter Antiques, Portsmouth, N.H.; 603-436-1781). Most people don't think reconditioning these planes is worth their while. More of them are probably made into table lamps than restored to their original use. But as a woodworker, you can repair just about any problem you may encounter with a wooden plane. Assuming you find a plane with a body free of large cracks and rot, a wedge that fits reasonably well, a usable

blade and a cap iron that's not cracked, you'll soon have yourself a fine, lightweight plane with high-end performance and some history, too.

Iron work

Don't get scared off by rusty blades and cap irons. With a little cleanup, most will be perfectly serviceable. But make certain there is no pitting on the back of the blade at the cutting end. Any pitting there will produce a ragged edge and a terrible cut.

Commonly, old blades were made by fusing a short section of steel to a long blank of iron. You can often see the line near the cutting end of the blade where the steel meets the iron. Be sure you get a blade with at least ½ in. of steel left.

Clean the worst of the rust off the blade and cap iron with fine wet-or-dry sandpaper and finish up with steel wool or a Scotch-Brite pad. Check the blade for flatness. If it is twisted or bent, set it in a bench vise and gently unbend it using a hand-screw clamp for leverage.

The cap iron must fit snugly to the blade. File the underside of the cap iron flat, and file the top so that it immediately rakes back away from the edge. Any dents, flats or gaps will prevent the quick exit of shavings. Sometimes a plane's blade and cap iron are difficult to insert due to binding on the sides. In that case, grind some width off the blade and cap iron.

Body work

Very few old coffin smoothers will be perfectly flat when you buy them. Fortunately, flattening the sole is a snap. It can be accomplished with another handplane, preferably a longer one, or with sandpaper glued to a flat surface. This is convenient, but it leads to a problem. As the sole of a wooden plane is worn away by use and the thick end of the tapered iron is ground

FLATTEN AND HONE THE IRON



Not much polish but plenty of life. Be sure the blade is usable before buying the plane. Rust and pitting are acceptable as long as there is a good amount of unpitted steel left at the cutting end of the blade.



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down, the plane's mouth gets wider and wider. Because a plane works best with a narrow mouth, which provides support right near the cutting action, this widening leads to deteriorated performance.

You can remedy the problem by letting in a hardwood patch that closes up the mouth. Make the patch from wood as hard or harder than the plane. After making the patch, trace it on the sole of the plane and then cut the mortise to receive it. Make the patch about 1/4 in. thick, let it in 3/16 in., and plane it flush when the glue dries.

Once the patch has been flushed to the sole, define the mouth by filing the patch. Copy the original throat angle and repeatedly check your progress by inserting the blade and cap iron. Stop filing when there is a hairline of light visible between the



Quick fix for cracks. Cracks sometimes develop in a coffin smoother's thin cheeks. This two-knife technique guarantees you'll get the glue in. If the crack has been repaired before with hide glue, work more hide glue into the crack. Otherwise, yellow glue works fine.

blade and the patch, with the blade just perceptibly proud of the sole. With its newly narrowed throat, the plane should regain the ability to take nearly transparent shavings even in tangled grain.

Wedge work

For a coffin smoother to perform well, its wedge must mate tightly with the blade and the plane body. The wedge of an old plane will usually need some tuning to achieve this fit.

The underside of the wedge has a slot to clear the cap screw. If there is any evidence of binding here, use a gouge to clear more space for the cap screw. Then slide the blade and cap iron into place and tap the wedge in. To check the fit, cut a piece of carbon paper the width of the

PATCH THE SOLE FOR BETTER PERFORMANCE

Big mouth. As the sole of a wooden smoother wears and is reflattened, the plane's mouth widens, undermining performance. This plane is in need of a patch.



Forstner takes the first bite. With the plane upside down on the drill press and propped flat with a scrap, drill out most of the waste.



Carbon paper refines the fit. Lay carbon paper ink-side down over the mortise and tap the patch in until it bottoms out.



Put the squeeze on. Before applying clamp pressure, press the patch into place and use a light hammer to tap the patch forward into tight contact with the cheeks of the mortise.



Scribe the patch. After cutting and filing smooth a patch of hardwood, scribe its shape into the sole of the plane with a razor knife.



Chop and pare. Establish the perimeter of the mortise with downward chops of the chisel, then clean up with paring strokes.



Fine tuning. Take down the high spots indicated by the ink. Use a wide chisel to preserve the flatness of the mortise.



One smoother smooths another. Plane the patch flush with the sole using a block plane or smoother.



File the mouth. Use a file to refine the fit of the mouth. Insert the blade and cap iron often to check your progress, and stop when you can see a sliver of light through the mouth.

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CARBON PAPER AIDS IN FITTING WEDGE



Wedge fitting. Use a strip of carbon paper to find the high spots that keep the wedge from mating snugly with the blade and the plane body. Then plane or chisel away the ink. Repeat the process until you get a good fit.



A little off the sides. If the wedge sticks going in, use carbon paper to find out where it's sticking and trim off the high spots.

wedge. Remove the wedge, place the paper ink-side down on top of it, and tap the wedge in. Remove the wedge and plane off any ink—the high spots. Then try the fit again. Repeat until the wedge fits perfectly.

If the prongs at the end of the wedge bind in the throat, you may have to trim them back with a chisel, paying attention to their original shape. The fit of the wedge is most critical closest to the tip of the blade. If the wedge isn't snug, the blade will bounce up and down, causing chatter.

Adjusting the blade

If you were raised on mechanical adjusters, a coffin smoother's manual blade

adjustment may take a little getting used to. Start by placing the blade and cap iron in the body and tapping home the wedge with a light wooden mallet. Then hold the plane upside down with the front toward you. Point the wedge toward a light source and sight down the sole of the plane from front to back. The blade will appear as a tiny stripe of light.

Make any lateral adjustments that are necessary by tapping the side of the blade at the top end. Tighten the wedge once more and test the plane. If the plane digs in and stops, tap the rear face of the body. By doing this you are pushing the body away from the blade, effectively retracting the

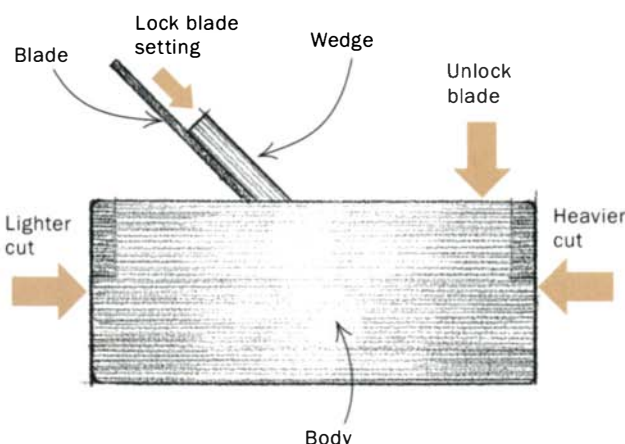
blade. With practice you'll recognize the snapping sound of a productive tap. Tap the wedge again to lock in the setting and try another pass.

If on the first pass the plane takes no shaving, tap the front face of the body to extend the blade and test again until you get a shaving. Remember that this is a smoothing plane and you are taking a very fine cut, so you won't have to push hard to produce fine shavings.

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1. Chips exit, but the plane chatters:

- sharpen the blade
- try a finer cut
- check the fit of the wedge for vertical play
- make sure the plane's sole isn't hollow

2. Plane chatters, then chokes on chips:

- sharpen the blade
- back off the cap iron; it may be curling the shavings too early
- check the prongs of the wedge; if chips are bunching there, the prongs may need to be reshaped
- the throat may be tight; enlarge it slightly
- check the cap iron for flat spots or spaces between it and the blade
- wax the throat and the top of the cap iron

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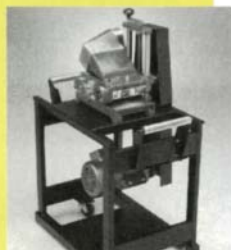
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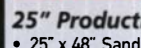


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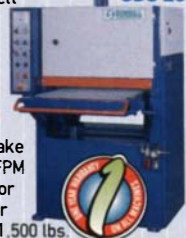
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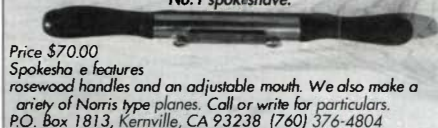


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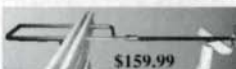
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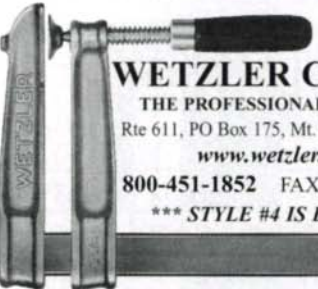
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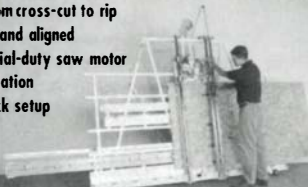
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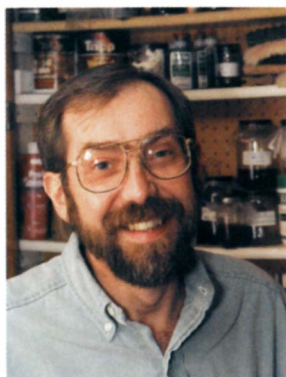
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Tips for coloring wood



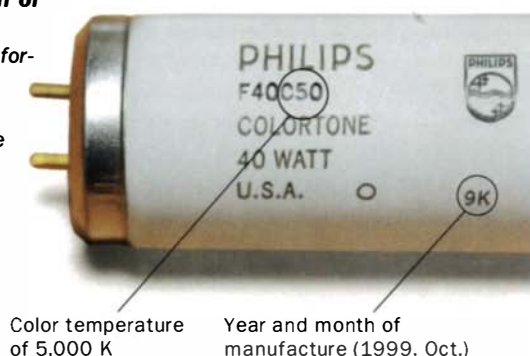
If you have to repair previously finished furniture, or if you're simply not satisfied with a particular store-bought stain color, you can learn how to mix exactly the color you want. I'm not going to tell you that it's easy. Color matching can be tedious and frustrating. It can require the eye of an artist and the patience of a saint. Professional formulators who own colorimeters that cost thousands of dollars often have trouble making an exact match. However,

tweaking a stain to get a color close enough is something any woodworker can learn to do.

Proper lighting is crucial

Paints and stains appear colored to us because the pigments contained in them absorb some of the visible light spectrum and reflect the rest. We perceive the reflected portion of the spectrum as color. For example, red paint looks red to us because the paint pigments absorb the blue-green portion of the visible light spectrum and reflect the red portion. However, the light source used to illu-

Label tells you half of what you need to know. The coded information on this bulb lists the color temperature but not the color-rendering index value (92 for this bulb). You have to ask the electrical supplier for that information.



minate an object can affect the apparent color of that object. My green car looks green during the day, but at night—under the streetlight in front of my house—it appears dark blue because the light emitted by the streetlight does not contain the green part of the spectrum. There is no green light to reflect, and so the car appears to be a different color. Color scientists have a name for the color shift caused by a light source: metamerism.

The normal cool-white fluorescent bulbs in shop-light fixtures emit light that is heavy in the blue end of the spectrum, and light from regular incandescent bulbs is distinctly yellow. So two pieces of furniture stained with two different stains may look the same in the shop but appear entirely different when you bring them into your home. Metamerism strikes again.

Natural sunlight, which contains all of the colors of the spectrum, is the best light source to use for color-tweaking. But my shop, like

many others, has small windows and no skylights. So I rely on full-spectrum, color-corrected fluorescent light tubes that mimic natural sunlight (available at lighting specialty stores and most large home centers). Two important considerations to keep in mind when you're searching for shop lights are the color-rendering index (CRI) and the color temperature of the fluorescent light tubes.

The CRI is a measure of how accurately the light from a fluorescent lamp represents the actual color of an object. A CRI rating of 100 is perfect, 90 is good, 80 is fair, and below 70 is poor. For comparison, the CRI of a cool-white fluorescent shop light is 62—not very good for color-tweaking. The color temperature, expressed in degrees on the Kelvin (K) scale, is a measure of the color of the light emitted from a fluorescent lamp. As a rule of thumb, a lamp with a color temperature of 2,000 K is orange, 3,000 K is yellow, 4,700 K is white, and 7,000 K is blue. To put this in perspective, an incandescent bulb has a color temperature of about 2,700 K, a cool-white fluorescent bulb has a temperature of 4,100 K, and a skylight pointed to the north at noon provides light that is 8,500 K. The fluorescent lamps in my shop (costing about \$8 each) have a CRI of 85 and a color temperature of 5,000 K.

You'll need at least a basic color kit

You can put together a basic color-tweaking kit with a relatively small assortment of dyes and pigments. My color arsenal is fairly complete: It contains red, yellow, blue, green and orange concentrated dyes as well as raw umber, burnt umber, raw sienna, burnt sienna, yellow ochre and black pigments. But you can accomplish an adequate job with just red, yellow and blue dyes plus burnt umber, burnt sienna and black pigments. Green and orange dyes are just mixtures of the primary colors (red + yellow = orange; blue + yellow = green), so you can mix them up as needed. I rarely use raw umber, raw sienna and yellow ochre for color-tweaking, but they're nice to have on hand when you need them. Buy colorants that are compatible with all types of finishes. (I buy them from Woodcraft Supply: 800-225-1153.)

My dyes are concentrated non-grain-raising (NGR) type dyes

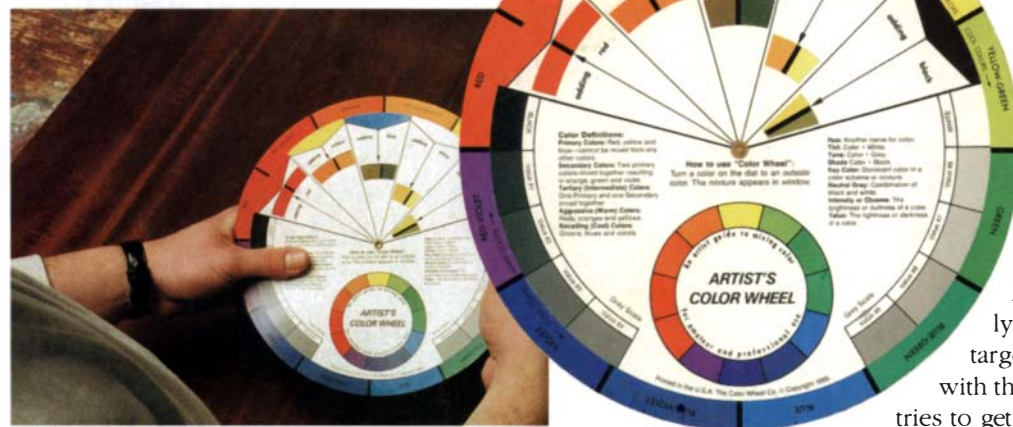
The most basic color kit. These non-grain-raising stains (left) and universal pigments (right) will blend readily to tint all types of common wood finishes.



that will blend readily with oil-, water- and alcohol-based finishes. Likewise, the pigments in my color-tweaking kit are universal tinting colors (UTC), which are finely ground pigments dispersed in a glycol-ether base, and they are compatible with all common finishing materials. Avoid using dry powdered pigments and Japan colors. Dry pigments are difficult to mix without getting clumps, and Japan colors are only compatible with oil-based materials.

Learn to use a color wheel

An artist's color wheel is handy in the shop. The three primary colors—red, blue and yellow—along with mixtures of the primary colors make up the 12 colors on the outside of the wheel. A rotating inner disc shows the effect of mixing one of the three primary colors, or black and white, with any color on the outside of the wheel. Using the color wheel is fairly simple. Suppose you have a maple stain that is too orange for your tastes. Hold the wheel with the orange section in the 12 o'clock position. Rotate the inner wheel and



A color wheel brings scientific order to artistic guesswork.

By rotating the smaller inner wheel, you can see ahead of time what effect you'll get by mixing colors. Note that the colors that are opposite each other on the large outside perimeter (red and green, yellow and violet, blue and orange) always produce brown.

observe how adding one of the primary colors will affect the color of the stain. Notice that adding blue to the stain will change the color to brown, while adding black maintains the overall orange hue but tones down the brightness to a more acceptable level.

As a general rule, primary colors will change the overall color of the stain, but adding black will only decrease the brightness. The colors opposite each other on the perimeter of the wheel produce a brownish gray when mixed. Thus, a golden-oak stain that is too yellow can be made browner by adding violet (a mixture of blue and red) to the stain. The color wheel will not solve all of your color problems, but it will point you in the right direction and take a lot of the guesswork out of color-tweaking.

Keep in mind that to assess the final stain color accurately, you must apply a coat of finish to a test sample. An aerosol can of shellac or lacquer is perfect for applying a quick, fast-drying finish to a sample board. Spray on a coat or two of finish and let it dry before passing final judgment on your stain concoction. The stain needn't be completely cured when you finish the sample, but al-

low enough time for the stain solvents to evaporate before spraying on the finish.

Practice a systematic procedure

Color-tweaking is a lot easier if you can bring the piece of furniture, or at least a part of it, that you are trying to match into your shop. Select a stain that appears close to the desired color. Choose one that is a tad lighter than your target: Tweaking the color often darkens the stain. Sand a scrap of the same wood species as your target, then stain and finish it with your chosen stain. Don't skimp on size: Large sample boards are easier to judge than small ones.

Place the dried and finished sample board on your target piece of furniture and closely observe the color difference. Here is where it gets tricky—you have to make a judgment call. Is the sample too red or too blue? Maybe it is not yellow enough, or

perhaps it is too brown. Whatever you decide, use the color wheel to choose the appropriate color to use for making an adjustment. For example,

if the sample stain is too red, rotate the inner wheel until a brown color shows up in the "adding red" window. In this case, two brownish colors appear in that window: Combining green with red produces a neutral brown; yellow-green produces an orange-brown. Now for the tweaking: Add 10 to 15 drops of concentrated green dye (or yellow-green if you prefer) to a pint of stain and mix it thoroughly. Make another sample board with the freshly tweaked stain and check it against your target. Repeat the process until you are satisfied with the results. Typically, it takes me four or five tries to get the color close enough for an acceptable match. Here are a few things to keep in mind when you attempt to tweak a color for the first time:

- Dyes can be added to pigment stains, and pigments can be added to dye stains.
- Black will decrease the brightness of a stain without affecting the color.
- Green added to red makes brown.
- Blue added to orange makes brown.
- Violet added to yellow makes brown.
- Burnt umber is a nice, warm brown.
- Burnt sienna is a reddish brown. (Adding it to walnut stain produces brown mahogany.)
- Keep accurate records so you can duplicate the stain later.

Warning

In the Finish Line of issue #140, I wrote about making a black stain by mixing vinegar with rusted iron. Several readers wrote in to suggest caution with such a mixture—and they're right—hydrogen gas can form as a by-product of mixing vinegar with iron. It would be a good idea to puncture the jar lid with a few holes to prevent any gas buildup.



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And a state-of-the-art front and rear locking, seamless extruded aluminum rip fence system for ultra accurate rips 24 inches left and right. Topped off by a micro-adjust trunnion to easily eliminate any out of square heel tolerance with merely the turn of a set screw.

Built with pride in the USA and backed by the RIDGID lifetime warranty against defects in material and workmanship.

So check out the RIDGID TS2424. The rock solid saw that turns on a dime.



One step to 360° mobility.



Fine tune micro-adjust trunnion.



For more information call 1-800-4-RIDGID, visit our website @ www.ridgidwoodworking.com or your nearest Home Depot store
* Make sure your guard is properly installed.

Building on a Grand Scale



For more than 150 years, Steinway and Sons has been seeking out the country's best furniture makers to design and build its Art Case Series of pianos. James Schriber, who's been turning out one-of-a-kind furniture since the early 1970s, was surprised when Steinway asked that he propose a piano design. "The whole thing was very mysterious to me," Schriber said. "I'd never even thought about a piano before." But a few months later Schriber presented four drawings and scale models. Steinway decided on the *Pianissimo*, a light, flowing design built in pearwood with curly maple accents. Such a success was *Pianissimo* that Schriber is now hard at work on another piano of the

same basic design, only slightly larger—just under the size of a grand piano. Photos and history of earlier Art Case pianos can be found in Ronald V. Ratcliffe's *Steinway* (Chronicle Books, 1989).



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