

TOOL TESTS: BENCH VISES; JET PLANER/MOLDER; WOODMARK FILTER SYSTEMS

WOODWORKER'S JOURNAL

Vol. 21, No. 5 September/October 1997

CRAFTSMAN-STYLE ROUND TABLE

A WEEKEND PROJECT WITH
STICKLEY TRADITION Page 54

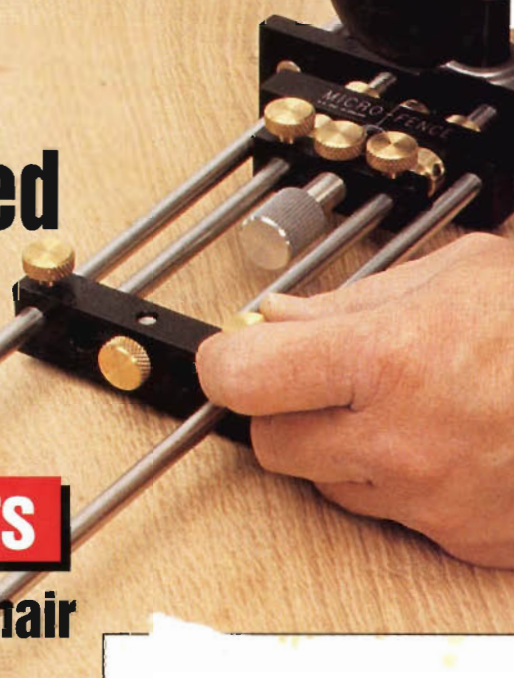
HOW TO:

Laminate a Curved Table Apron

Page 64

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- Plantation Shutters
- Artist's Easel
- Oak Night Stand



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Delta 9"x80TX5/8"	\$204 \$119
Ryobi-Makita & all 10"x80TX5/8"	\$207 \$129
DeWalt, Makita, B&D, Hitachi 12"x80TX1"	\$229 \$139
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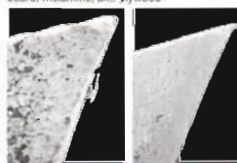
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Fine Woodworking Magazine test Oct. 96 page 43

After installing your blade and
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Rick Price

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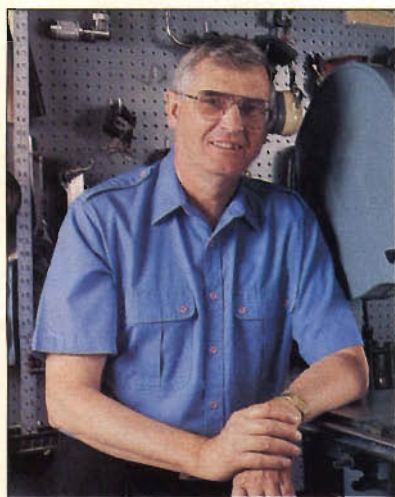


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SHOP TALK



Not Just Another Home Improvement Project

I recently took on a home remodeling adventure. The primary problem—trying to consolidate several impractical areas into a dream kitchen—presents a serious challenge. Already, I'm way behind schedule. If it weren't for the deck and patio projects I started at the same time, and a garden that needs constant attention, I might stand a chance of making deadline.

But the exercise is producing tangible rewards. A lot of woodworking "purists" refuse to acknowledge any form of

home improvement as "real" woodworking. I'd have to disagree. Using our skills and design sense to upgrade our living spaces strikes me as woodworking of the highest order. And isn't it true for most of us that an urge in this direction was what prompted our earliest forays into woodworking?

One of my first efforts was a simple two-step stool that folded out of the bathroom vanity. It didn't win any awards for sophistication of design, but it did enable my then two-year-old son to reach the faucet by himself.

Sometime later, I built a pair of swinging cafe doors for the kitchen. At the time, you couldn't buy the type I had in mind (not in mahogany anyway), so I designed and made my own. Before they were done, I had chalked up several "firsts" in my personal woodworking history: first construction and use of a complex jig, and first time setting up and using a shaper, to name a couple.

The most demanding project was the wall-to-wall cabinets I built in the family room. This lowly, pedestrian project made life easier and more organized for every member of the family and, in the process, taught me some crucial lessons in cabinetry.

As you've probably noticed in recent issues, we obviously feel that quality home-improvement projects have a place in *Woodworker's Journal*. Even the purists will take a second glance at Sven Hanson's elegant entry door in our July/August issue. I'm also excited about the neat plantation shutters you'll find on *page 46* of this issue. They improve on both the appearance and action of the traditional design, and after you've dusted them a few times, you'll especially appreciate the unobstructed louver surfaces.

My thanks to Dick Coers for giving these traditional shutters a refreshingly new look while at the same time simplifying their construction. No expensive hardware or complex jigs required. What's so revolutionary about Dick's design? Well, for one, he put square pegs in round holes!

Charles Sommers

WOODWORKER'S JOURNAL

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TOOL-PRIZE DRAWING WINNER!

I often search back issues of your magazine for projects to build, and I recently found another gem—the dovetail stool in the Jan./Feb.'87 issue. I had enough cutoffs and scraps to build a dozen of these beautiful little stools. They have become a very popular and treasured gift among friends and family.

*Paul Stotler
Leonardtown, Md.*



Tool Prize

For being selected as the winner of the tool-prize drawing, Paul Stotler will receive a Makita model 6233DWAE 14.4-volt cordless drill.

The names of readers whose project photos appear in Reader Letters are entered into a tool-prize drawing for each issue. To become eligible, send us a good photo and description of a project you've built from the pages of *Woodworker's Journal*. Send your submissions to: Reader Letters, *Woodworker's Journal*, P.O. Box 1790, Peoria, IL 61656.



READER LETTERS



I was so impressed by the classic beauty of the music stand in your May/June '91 issue that I had to build one. I added a piece to the upper portion of the frame to make it wide enough to inlay the first measure of the "Hallelujah Chorus." I also enlarged the pivot bracket to allow a wider range of tilt. This piece was presented as a gift to our church choir director and now holds a place of honor at the front of the church sanctuary.

*Tom Dillman
Levittown, Pa.*



Here is a photo of the Classic Old-Time Ice Box that was featured in your Nov./Dec.'93 issue. I recently constructed this project and donated it to a benefit auction for a hospitalized family friend. The ice box was purchased by a group of area residents for \$1,200. They in turn donated it back to the auction and it was sold a second time for \$700. Your plans were excellent, and I enjoyed building it so much that I plan to build another for myself in the future. My only modification was the use of a solid top rather than plywood veneer.

*Scott Lake
Rio, Ill.*

Enclosed are photos of a dulcimer that I made using instructions from your Nov./Dec. '85 and July/Aug. '91 issues. The dulcimer body is made from book-matched cherry, and the nut and bridge are made from cocobolo. I entered the dulcimer in a local arts and crafts festival on Memorial Day weekend and won first place—which explains the medal you see in the photo.

*Harold Bevels
Donelson, Tenn.*



New Source For Lawn Glider Wheels

A number of readers have called trying to find a source for the wheels specified for the lawn glider project in the July/Aug. '92 issue of *Woodworker's Journal*. We're pleased to report that we've located a source. E. Massey and Sons of Bethlehem, Conn., sells a set of four for \$76 plus shipping. (It was Everett Massey, in fact, who originally designed the glider.) To order a set, call the firm at 203/266-5406. To order a copy of the lawn glider article, call us at 800/521-2885, extension 5059.

EuroShop C-300 Update

Thank you for the positive review of the EuroShop C-300 in the July/August '97 issue. However, please inform your readers that the photo on page 16 shows the sliding table rails in the wrong position. These should extend out the rear of the machine, not the front. This lets the operator move to the side to avoid injury from possible kickback. I'd also like to add that we now have dado capability for the C-300.

Scott Geurin, President
Old World Machinery

Editor's note: Scott, you're right in stating that one should never stand directly in front of a tablesaw blade. The EuroShop C-300 we tested was shipped with the rails mounted to the sliding-table assembly in the correct position. But when we attached the sliding table assembly to the body of the machine, we followed an illustration in the manual which showed the rails extended to the front. EuroShop C-300 owners please note that the rails should extend fully to the rear.

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PRODUCT NEWS

Grizzly G1022ZFX 10"
Super Premium tablesaw



Two New Tablesaws Loaded With Features

Following the launch of its successful Z series, Grizzly Imports has expanded its tablesaw line with two additional offerings: the G1022ZF 10" Premium and the G1022ZFX 10" Super Premium saws.

The G1022ZF combines the popular G1022Z—including its heavy-duty, wide-base stand, see-through blade guard, and cast-iron extension wings—with Grizzly's new Shop Fox fence, an adjustable cast-iron miter gauge, a 1½hp U.S.-made motor, built-in dust chute, machined steel pulleys, and power-twist belt. The G1022ZFX Super Premium incorporates all of the aforementioned goodies plus a 2hp U.S.-made motor.

G1022ZF 10" Premium tablesaw, \$599 (suggested retail); G1022ZFX 10" Super Premium tablesaw, \$699. Grizzly Imports, 800/523-4777 (east of the Mississippi) or 800/541-5537 (west).

Dremel Contour Sander



Dremel Adds Contour Sander To Line

Dremel's new contour sander will help you sand tight spots and intricate shapes with a lot less effort than hand-sanding requires. This 1.75-lb. lightweight comes with 10 different pre-shaped sanding contours that adapt to deep grooves, moldings, intricate carvings, or just about any other profile you've invented.

To make the sander extra-easy to use, the designers incorporated a quick-release lever for changing accessories. Users will also find other refinements, such as variable speed control (4,000 to 8,500 strokes per minute), an easy-grip housing, hook-and-loop sandpaper attachment, a generous 10' power cord, and a ball-bearing motor with replaceable brushes. Look for the new sander at hardware stores and home centers.

Dremel Contour Sander, about \$79. Dremel Tool Co., 800/437-3635.

Black Light Reveals Glue Spots

If you're frequently bothered by glue spots that show up after staining, switch to the black light (ultraviolet) glue system marketed by Woodworker's Supply, Inc. It could save you a lot of work and aggravation.

The firm's Blacklite glue contains an additive that fluoresces when exposed to the Smartlite, an ultraviolet-rich lamp developed especially for use in the woodshop. Expose a project assembled with the additive-carrying glue to the black light, and any glue contamination present on the surface will emit an eerie blue glow. Taking a few minutes to check your work for glue contamination before finishing could save you hours of rework.

Blacklite glue, 16 oz., \$4.95; Smartlite black light, \$59.95. Woodworker's Supply, Inc., 800/645-9292.



Blacklite glue and Smartlite.



Blacklite glue contamination fluorescing under the Smartlite.



Bosch 3612K 1/2" cordless drill/driver

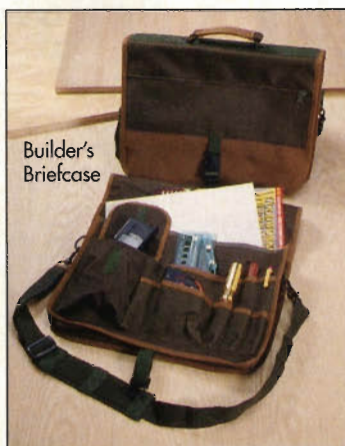
Cordless Drill Sports A 1/2" Chuck

If you've been wanting to jump the gap from a 3/8" to a 1/2" chuck, the new Bosch 3612K cordless drill/driver might be the unit for you.

On this new release, the firm has beefed up the gear train with four steel planetary gears and a 15-position clutch to deliver the torque needed for heavy jobs. Their 14.4-volt, 2.0 amp-hour battery teams up with a matched motor to provide 255 in.-lbs. of torque and a longer run time than possible with smaller 1.3 and 1.7 amp-hour batteries.

Bosch offers the drill, two batteries, a one-hour charger, driver bit, and a carrying case in a kit retailing for \$219.

Bosch 3612K 1/2" cordless drill/driver. S-B Power Tool Co. 800/301-8255.



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For full-time desk jockeys, almost any briefcase will do, but some woodworkers, architects, and contractors often carry a few small tools in addition to papers and pencils.

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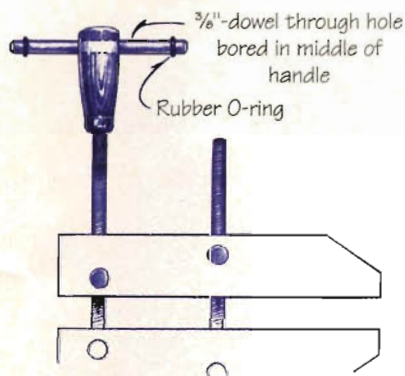
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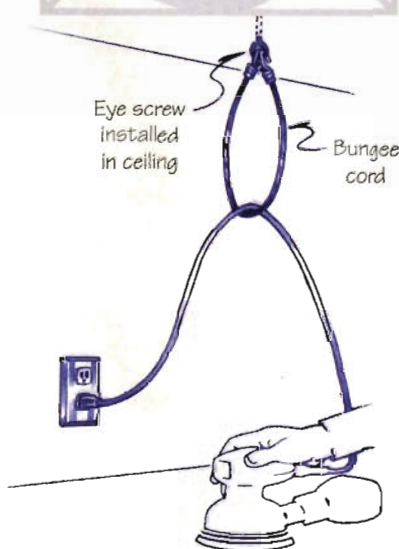


Dowels Act As Levers To Tighten Handscrew Clamps

Handscrews are the only clamps that will lie flat on your bench. But in that position, they're difficult if not impossible to tighten.

I solved this problem by drilling $\frac{7}{16}$ " holes through my handscrew handles and inserting $\frac{3}{8}$ " dowels in the holes. The dowels act as levers for turning the handle—just like the wooden handle on a bench vise. To prevent the dowels from falling out of the holes, turn or cut a groove around the perimeter near each end of the dowel and roll a rubber O-ring into each groove as shown.

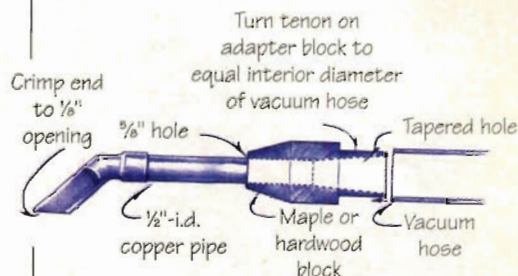
*William MacTiernan
Schenectady, N. Y.*



Bungee Keeps Electrical Cord Out of Harm's Way

To prevent a tool from running over or accidentally cutting its own electrical cord, I hook a bungee cord to an eye screw in my shop ceiling. I run the tool's cord from the outlet through the looped bungee. This keeps the cord up out of the way, and the bungee stretches easily so I can maneuver the tool over a good portion of my bench.

*Joe Rose
Victoria, B. C.*



Craft Your Own Crevice Tool

To build a crevice tool for my shop vacuum, I turned an adapter block for the hose on my lathe, then made the nozzle from copper tubing. For the adapter, start with a turning square about 6" long and a bit wider than the outside diameter of your shop-vacuum hose. Attach a faceplate to the snout end of the block and a live center to the other end. At the live-center end, turn a tenon to a diameter that fits snugly inside your hose. Chamfer the other end to form a tapered snout as shown.

Remove the live center and bore a centered hole clear through the piece that matches the outside diameter of your copper pipe. (A $\frac{5}{8}$ " hole usually works for $\frac{1}{2}$ "-i.d. pipe, but check to be sure.) To finish the block, taper the airway using a scraper, then separate the snout end from the faceplate with a parting tool.

Epoxy the copper tube into the snout end of the adapter. Use a length that suits your needs. On the end of my nozzle, I use a short 45° elbow connector that's crimped on the open end, but you can also use a right-angle or straight piece for different applications.

*John Summer
Silver Spring, Md.*

Get Paid For Your Advice

For submitting the best shop tip in this issue, William MacTiernan will receive a Bosch model 1614EVS electronic plunge router. Powered by a 1 1/4 hp/7.8-amp motor, the router features a six-position variable-speed switch with speeds from 12,000 to 23,000 rpm. Its electronic variable speed controls provide a soft start and maintain the selected speed under load.

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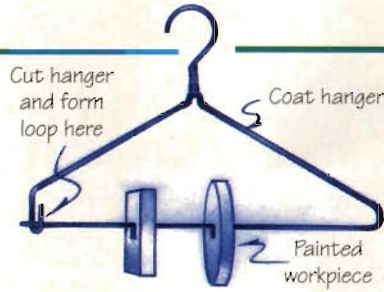
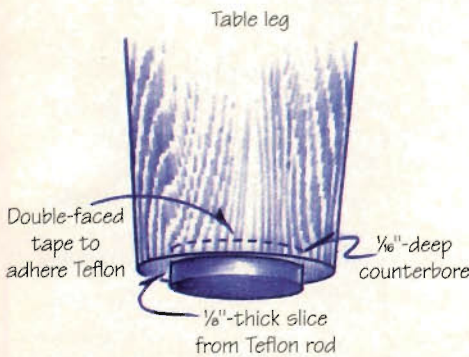


Make Non-Marring Furniture Glides from Teflon™

For an inexpensive yet durable glide, I slice a $\frac{1}{8}$ "-thick disc from a Teflon rod and insert it in a shallow counterbore in the bottom of each leg. Double-faced tape and the weight of the furniture piece hold the disc in place. The non-marring Teflon slides with little friction across wood or other hard-surface floors. You can also solve a rocking problem at the same time by cutting one disc slightly thicker than the others.

Purchase Teflon rods from Small Parts, Inc., P.O. Box 4650, Miami Lakes, FL 33014-0650, telephone 305/557-8222. A 12"-long rod costs between \$6 and \$20, depending on the diameter, and will yield about 60 discs when cut on a bandsaw.

Wayne Mitzner
Baltimore, Md.



Coat Hanger Converts To Drying Rack

I build a lot of toys and have found that an all-wire coat hanger makes a helpful holder for drying painted wheels. To convert the hanger, simply cut one of the ends and form a loop as shown. Then, as you paint the pieces, thread them onto the long bottom wire of the hanger and secure the end of the wire in the loop.

Roland Oesterle
St. Louis, Mo.

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See Page 22



No Picnic In Albuquerque, But...

New Mexico group stays focused on working wood

The Albuquerque Woodworkers' Association doesn't do picnics. "A woodworking club's business," says founding member and past president Sven Hanson, "is to socialize seriously about working wood." You may not find these words inscribed in the club's by-laws, but the no-nonsense attitude that prevailed at the club's first meeting has become tradition. The group centers all activities around its favorite pastime.

But don't take this to mean that AWA members are a humorless, anti-social bunch. They maintain a lively schedule of 12 meetings and at least 12 workshops a year. By cultivating the sponsorship of several prominent woodworking suppliers, the club has established a sustainable education program and enjoyed member discounts and other benefits as well. The

officers take care to make these relationships mutually beneficial, and the sponsors keep coming back.

Local Suppliers Support Activities

Club members, for example, hold an annual Toy Crafters' Drive, for which they set a goal of producing 1,000 or more safe wooden toys, which then get distributed during the holidays to youngsters in need. The Crafters seek out a sponsor for each year's drive, then meet at the sponsor's location and build a batch of toys as a promotional event.

This year, Woodworker's Supply, Inc. is sponsoring the Toy Crafters, who in turn, staged one of their toy-making sessions as part of the firm's annual Father's Day sale.

Woodworker's provided the tools and some of the materials. Last year, Paxton Woodcrafter's Store sponsored the toy drive.

For the last 10 years, Woodworker's Supply and Paxton's have also taken turns hosting and sponsoring the club's workshops. At these three-hour events, held on the second Saturday of each month, a club member or outside guest presents a lecture or demonstrates a woodworking technique. The sponsoring firm hosts the event on site, loans tools for the demonstration, and pays the \$150 presenter's fee. Between 40 and 60 members usually attend, and the workshops also draw a number of non-member guests. After the presentations, members usually make liberal use of the discount offered them by club sponsors.

Education Designed To Help All

From time to time, the Education Committee invites nationally known craftsmen to make presentations. More often, though, the club draws on the large population of professional woodworkers who make their home in Albuquerque, some of whom, like Michael Mocho and

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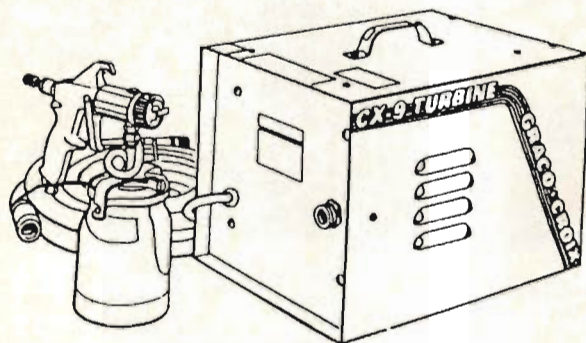
In recent years, the AWA Toy Crafters have met their goal of producing 1,000 toys for kids in need. Here, they assemble their output for holiday distribution in front of Paxton Woodcrafter's Store, sponsor of the drive.

AWA member Sandy Sandoval plays Santa Claus at Isleta Pueblo Day Care Center, handing out toys made by the AWA Toy Crafters.



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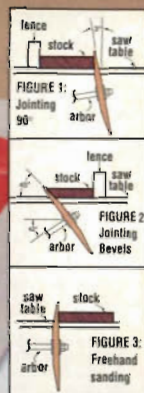
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CLUB SPOTLIGHT

Continued from page 12



Sven Hanson, AWA member and frequent *Woodworker's Journal* contributor, presents his technique for making raised panels at a recent workshop hosted by Woodworker's Supply, Inc., one of the club's sponsors.

Marc Coan, have also developed a widespread reputation. For the April workshop, hosted by Paxton's, Mocho spoke on "Wood Characteristics and Design Considerations." In May, Coan presented "Elaborately Decorated Wood Boxes and Furniture" at Woodworker's Supply.

The AWA roster includes an unusually large number of professionals, and this has had a noticeable effect on the atmosphere of club gatherings. "We've never had trouble maintaining a professional level of interest," says Hanson. "Members don't heckle the presenter or try to monopolize the floor with trivia—they know they'll get a lot of icy stares."

Hanson sees a professional vs. amateur dynamic at work in the club. The amateurs feel pressured to do their best work to show that they can keep up with the pros. "Which is ironic," he adds, "because those of us who've made a living at woodworking know that it's not always profitable to do our very best work on a job. Usually, it's the amateurs who have the time to do 'professional-quality' work."

This dynamic has a beneficial effect. Professionals sometimes

continued on page 16

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CLUB SPOTLIGHT

Continued from page 14

hesitate to join woodworking clubs for fear they'll get besieged by beginners who have a million questions and want to borrow tools. But the exchange of ideas and skills between amateurs and professionals in the AWA works both ways. Many of the amateurs attend every workshop and make it a point of honor to learn all they can and stretch themselves on every project. "In our club," says Hanson, "you're just as likely to see a professional asking an amateur for advice at a meeting."

The handful of acquaintances who started the club in 1981 acknowledged certain universal traits among woodworkers and tried to allow for them in setting up the club. It's almost impossible, they agreed, to get a group of woodworkers very organized. For this reason, they avoided forming unnecessary committees and encouraged individual initiative instead.

The founders also observed that woodworkers tend by nature to be shy but competitive. For this reason, the club traditionally promotes an atmosphere of sharing and trust. This does not always come easy, especially when members compete against each other in juried shows or make items for sale at crafts fairs. "We also do what we can to avoid formation of an in-crowd," says current present Brian Smith. There will be conflicts that threaten to dissolve any group, he adds, but one hedge against this is to encourage regular and open communication.

To this end, the club meets every month, come holidays or high water. At each meeting, one member demonstrates a technique or tool, which helps break the ice but also maintains an educational footing. Early on, it became customary to hold the meeting at a different member's shop each month. This spreads the burden and also seems to boost attendance.

Continued on page 18

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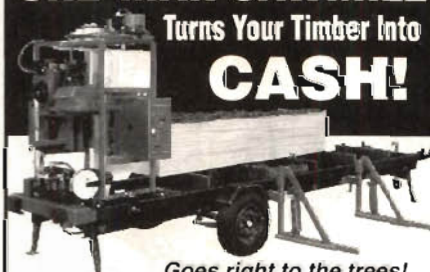
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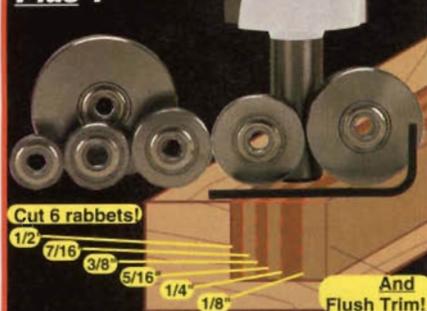
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Continued from page 16

Newsletter Keeps Everyone Informed

To further advance communication, the group publishes and mails a monthly newsletter. The AWA currently has about 260 paid members on its roster, but only about 20% of these show up at any monthly meeting. So, the club publishes a monthly newsletter to keep that other 80% informed of what happened at the last meeting and workshop, and what's slated for the coming month.

Printing and mailing the newsletter costs about \$300 per issue. In spite of the expense, the club also distributes as many as 250 non-member copies to local woodworkers, schools, other groups, and potential sponsors as part of an active recruiting effort. This extravagance has, however, proved cost-effective. "It reminds them that we're still here and are doing some things that might interest them," says Smith. "We also have more success soliciting new sponsors if we can tell them our publication reaches an audience of 500 instead of 250."

Although the club actively solicits new members, it levies a comparatively steep \$30 for annual dues. With this kind of money, members tend to take the club more seriously. They expect to get something, but are also more apt to get involved. "If you set the dues too low," says Hanson, "you tend to encourage those who just want to drop in now and again to shoot the breeze."

If you'd like to join or learn more about the Albuquerque Woodworkers' Association, write the club at P.O. Box 36133, Albuquerque, NM 87176, or contact Brian Smith at 505/286-1802. If you'd like to see your club featured in this column, write us at *Woodworker's Journal*, PJS Publications, Inc., P.O. Box 1790, Peoria, IL 61656. 

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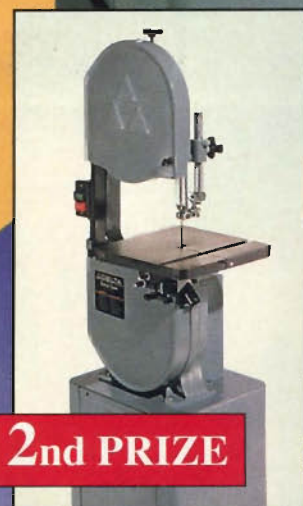
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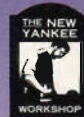
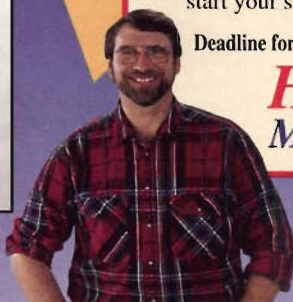
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Jet Planer/Molder

Versatile new machine bridges the gap between benchtop and stationary units

The Jet JPM-13 Planer/Molder occupies an unusual niche among woodworking machines. It has more heft than benchtop units, but it's less expensive than many stationary planers. It also cuts moldings, which adds considerably to its versatility. We recently had the opportunity to work with Jet's new machine, and here's what we found.

Out of the box, the planer/molder assembled without incident. The stand, with its four locking casters, conveniently comes as standard equipment. Jet calls the dust hood "optional," but we wouldn't try to get by without it. When not in place, chips tend to clog the feed rollers and there will be a lot more airborne dust to clog your lungs. As part of the standard package, the manufacturer supplies an excellent tool kit that also includes knife-setting and molding-cutter gauges.

Measured with a straightedge and feeler gauge, the cast-iron bed proved very flat—less than .001" variance from front to back and .0015" side to side. The 19¼"-long bed provides more stock support than the shorter beds you find on most benchtop machines. The four steel corner posts on which the bed raises and lowers measure a full 1" in diameter to keep the head, bed, and base plenty rigid. The unit incorporates segmented anti-kickback pawls and adjustable, rubber-coated infeed and outfeed rollers. We also appreciated that the planer handles stock up to 13" wide and 6½" thick.

SHOP TEST

The three-knife cutter head arrived accurately set up from the factory, although the blades had some minor nicks. Improper handling may have caused these. Fortunately, the knife nicks did not align so they didn't affect cutting performance. A knife-setting gauge provided with the unit makes accurate installation of freshly sharpened blades a breeze.

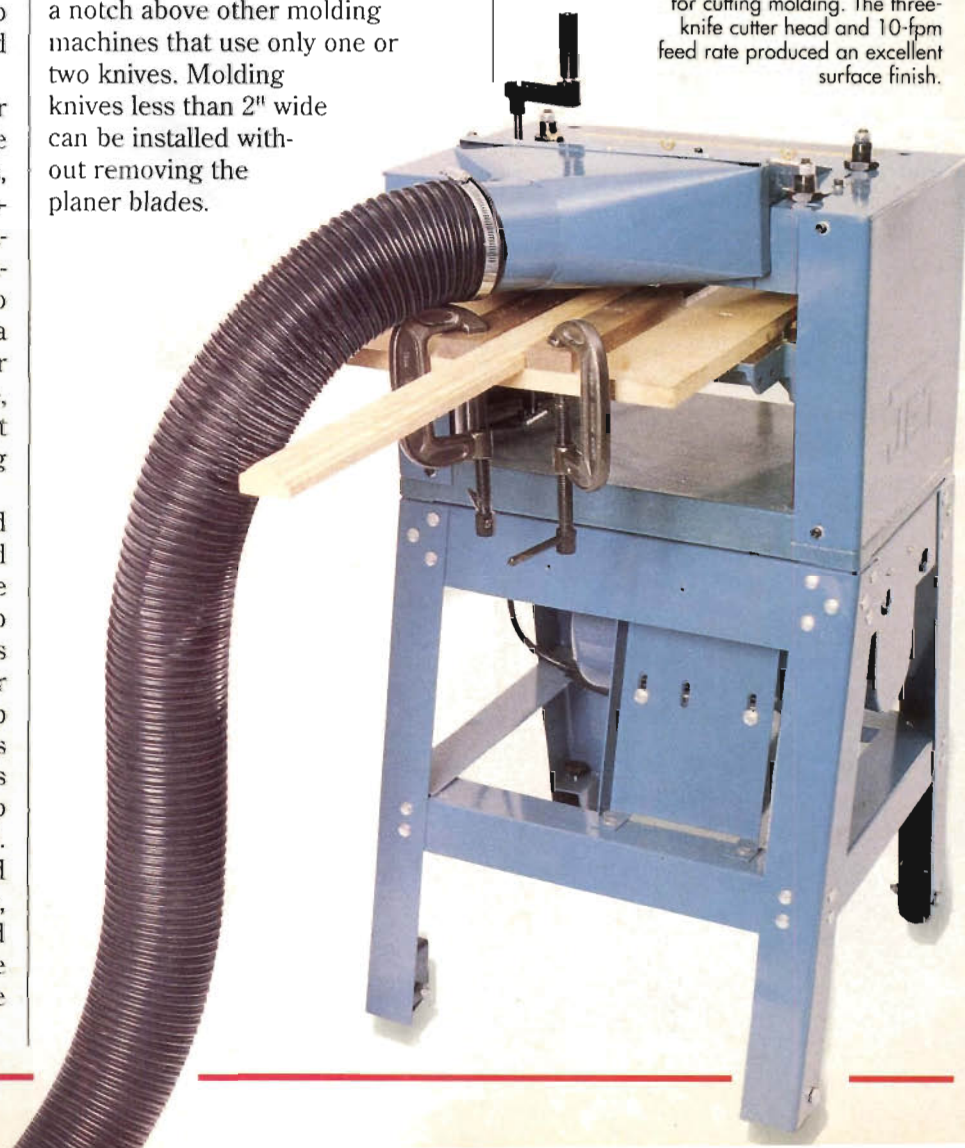
The Jet's cutter head accepts three molding knives, which sets it a notch above other molding machines that use only one or two knives. Molding knives less than 2" wide can be installed without removing the planer blades.

This saves time, although centering these knives will eventually wear grooves in the feed rollers. To set the knives, you bottom them out in the cutter head, then align them with a bolt on the gauge. The three-knife setup, combined with the machine's slower feed rate (10 fpm), produced an excellent surface finish. Jet sells more than 40 different molding knives.

The unit normally feeds stock at 20 fpm. To change speeds on the feed rollers, you switch two gears,

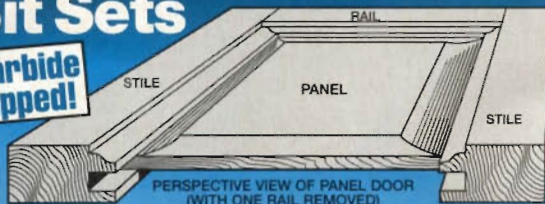
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The Jet JPM-13 Planer/Molder shown here set up with an auxiliary bed and guide boards for cutting molding. The three-knife cutter head and 10-fpm feed rate produced an excellent surface finish.



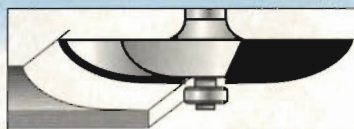
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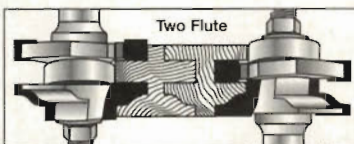


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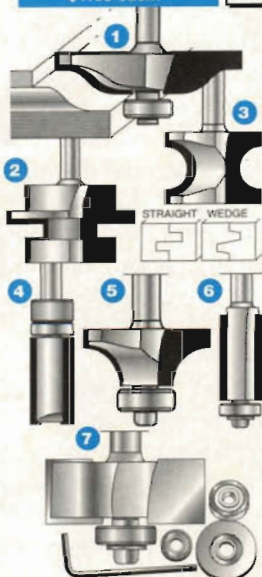
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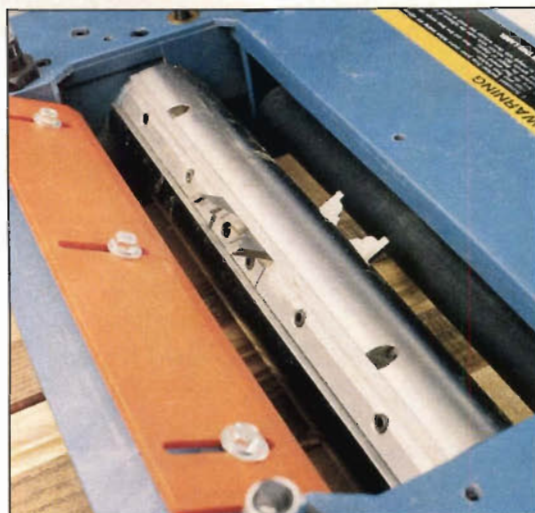
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SHOP TEST

Continued from page 20



With the dust chute removed, you can see the cutterhead (here fitted with a set of molding cutters) and the orange-colored chip deflector. The chip deflector directs wood chips up into the dust chute, but markedly increased the noise level of the machine when positioned close to the cutterhead.

which takes about a minute. A small key on each shaft holds the gears in place.

In the planing mode, we encountered a small amount of snipe on the stock we surfaced. Like most benchtop machines, this unit does not have a pressure bar or chip breaker, so we didn't expect totally snipe-free results.

The Jet's 1.5-hp totally enclosed, fan-cooled (TEFC) motor gobbled up wood with gusto. A pair of metal tabs on the cabinet's infeed edge, however, limit stock removal to $\frac{1}{16}$ " on wide stock and $\frac{7}{64}$ " on narrow stock. This seems overly conservative, since the motor never bogs down on such shallow cuts. We found that these tabs made planing roughsawn stock a lengthy task.

Planers are by nature hard-working machines, and this one runs with the quiet efficiency of a solidly built machine. However, when we switched on the dust collector, the rush of air over the chip deflector sent the decibel level soaring and us rushing for our hearing protection. We found that adjusting the deflector away from the head reduced the noise, but it also diminished the collector's effectiveness.

Overall, we were well pleased with the Jet Planer/Molder's performance. For a reasonable price (about \$800) it provides good planing quality and capacity, gives you the option of cutting dozens of moldings in any type of wood, and just plain carries more beef than the average benchtop to hog through all kinds of wood. **W**

Tested by: Dick Coers

Written by: Tom Jackson

Photographs: Kevin May

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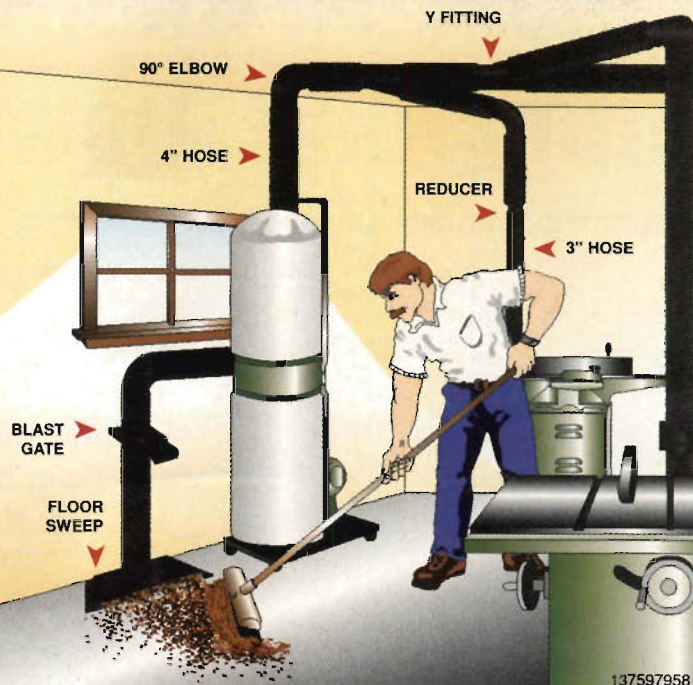
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WoodMark Offers Powerful Ceiling Unit, Downdraft Bench

My two-prong approach to shop dust control *by Jim Tolpin*



Photo A: WoodMark's ceiling unit filters 1100 CFM and draws air from all four sides, making it one of the most powerful and efficient machines in its class. Note the two-bulb fluorescent light on the underside.

Airborne wood dust—hazardous to your health. It's not the stuff you can see that does the damage but those insidiously tiny particles that lodge in your respiratory passages and lungs, causing inflammation and other more serious symptoms.

The best defense: Capture as much dust at the source as possible. Connecting an adequately powered and properly piped vacuum to all dust-generating power tools, including handheld sanders and routers, works wonders. For additional protection, wear a good face mask—at least the two-strap, double-layer

paper type. Better yet, a positive-airflow helmet.

At-Source Collection Can't Do It All

A vacuum system and face mask can keep a lot of dust out of your lungs. However, a significant amount of fine dust can still escape and hang in the air. These minute particles, so small that gravity scarcely affects them, can stay aloft for several hours after you've turned off the machines (and have long since taken off your mask). This gives you ample opportunity to suck them into your lungs.

Two solutions that have been used for years in large commercial shops are finding their way into home shops: ceiling-mounted air filters, and downdraft work tables and benches.

A ceiling unit draws ambient air through a filter and returns clean air to the room. This type of unit should exchange the air in your shop at least five or six times per hour. Properly sized and operated, it can help keep the fine dust out of your lungs and also reduce the amount of dust that settles on shop surfaces. This "fall-out" dust often gives you a second shot because it's easily stirred up later as you do other tasks that don't involve dust-generating tools.

The downdraft table, used mostly for sanding, captures dust at the source and also acts as an ambient-air filter if left running. In fact, a table-mounted system can be more effective than a ceiling unit because it usually puts the filtration closer to the dust source.

WoodMark's Ceiling Unit

The WoodMark Company of Bedford, Texas, makes some of the best machines for small shops that I've come across. The firm's ceiling unit, rated at 1100 CFM, exchanges the air in my shop space almost 12 times per hour. Unlike some units, it draws from all four sides, so particles don't have to work their way around to the "front" of the unit. This makes it more efficient than most of its competitors.

This power and efficiency doesn't, however, come in a small package. The unit measures nearly 3' square by 18" deep and weighs 145 lbs. Installation was an ordeal. I ended up rigging a scaffold that enabled me to wedge the machine against the ceiling, taking the load off my grateful helpers. Since you'll probably work directly under the unit, you definitely don't want to miss any studs when installing the lag screws. To compensate for its shadow-casting bulk, the designers thoughtfully attached a two-bulb fluorescent fixture to the bottom surface.

A Serious Downdraft Workbench

While shopping for a downdraft sanding table, I also kept an eye out for a primary workbench for my new

CALCULATE YOUR NEEDS BEFORE YOU BUY

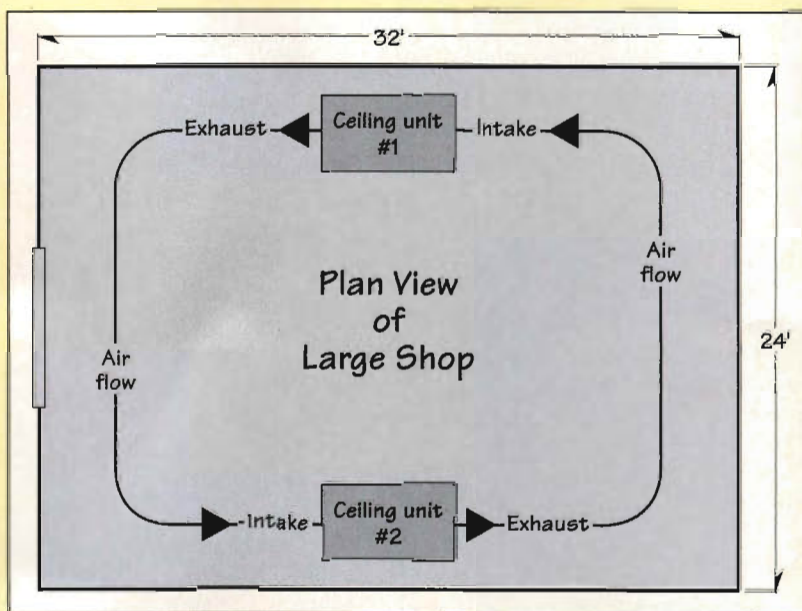
Before you buy any ambient-air filtration device, calculate how much capacity you need. The machines are rated in terms of cubic feet per minute (CFM) capacity. Calculate the volume of ambient air in your shop, then decide how often you want to exchange that volume. Generally, the higher the exchange rate, the less time the particles stay in the air and the less chance they'll have of settling out on shop surfaces.

To calculate your shop's air volume, multiply floor width by length by ceiling height, then subtract the cubic footage of any large structures such as cabinets. Multiply this figure by the number of times you want the air changed, then divide by 60 (minutes) to find the CFM capacity you'll need.

My shop, for example, measures 20x32x9 feet high, so it contains 5,760 cubic feet. I wanted eight air exchanges per hour, so I multiplied the air volume by this rate and found that 46,080 cubic feet of air has to be filtered every hour. Dividing that by 60 (minutes), I found that I needed a unit capable of handling at least 768 CFM.

Many units in the \$500 price range have this capacity. However, if your shop is large or if you prefer a brisk exchange rate, you may need more than one unit. Having two machines can be a plus:

If you orient their exhausts so the air loops from one unit to the other, the air flow pattern will help keep particles suspended until one unit or the other can filter them out. (See the drawing *below*). Generally, though, it's best to locate the unit(s) near the dust-producing sources. I mounted my unit directly over my main work area.



covered, supplies both in a single product. With its 2"-thick hard maple top and a Veritas double-crank, full-width end vise, the 300-lb. unit answered my need for a massive, durable bench. The nearly 3-sq.-ft. gridded duct centered on its work surface only hints of the 930 CFM downdraft triple-filter system hidden inside. (WoodMark offers 1600-CFM capacity as an option.)

Now that I'm experiencing their benefits, I don't plan ever to work without a ceiling filter and downdraft table again. I raise clouds of fine sanding dust at my bench that never even make it as far as my dust mask. If I'm sanding a panel that covers the grid, I prop it up on 1/2"-thick gripper pads (a WoodMark option) or open the intake duct on the side of the bench.

I keep my WoodMark ceiling unit running most of the time I'm in the shop. It's so quiet that I hardly notice it's on, but I do notice how much cleaner my shop stays. If I leave both the ceiling unit and bench system running over my lunch break, the air smells almost outdoor-fresh when I return, even if I've been sawing and sanding most of the morning.

WoodMark ceiling unit, \$499; 30x54" downdraft bench, \$889 (without vise); 30x69" deluxe downdraft bench with vise (shown in photo), \$1,445; other bench models measuring up to 33x95" priced accordingly. 

Photographs: Craig Wester

Photo B: The WoodMark downdraft bench draws 930 CFM and provides the mass and durability of a serious, professional-quality work surface.



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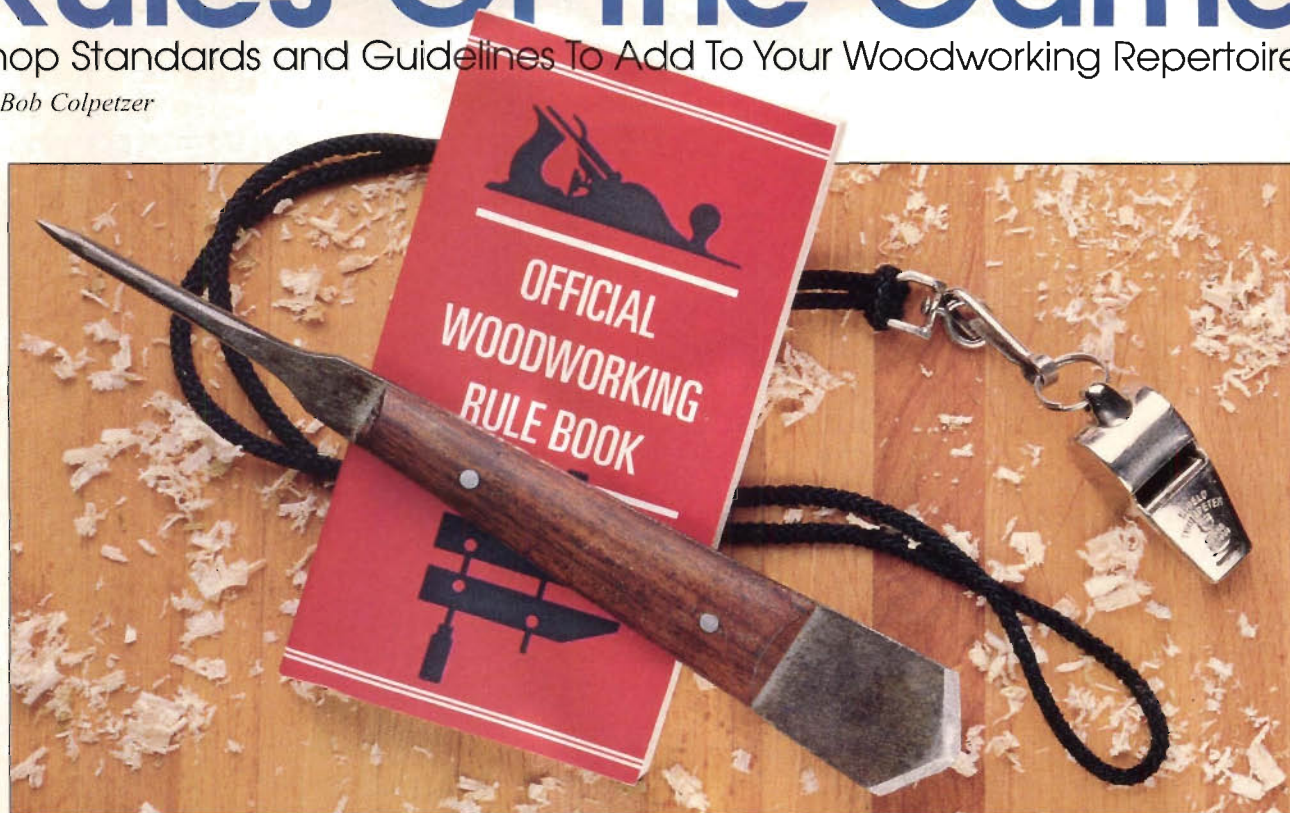
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Rules Of the Game

Shop Standards and Guidelines To Add To Your Woodworking Repertoire

by Bob Colpetzer



Thorough Project Planning

Before starting any project, make a drawing or sketch of it. You don't need to be a professional draftsman, but a detailed drawing makes it a lot easier to size the parts, determine the joinery, and outline the assembly sequence. Next, prepare a bill of materials using a format like the one

shown in *figure 1*. List each part by name and indicate both initial and finished dimensions. Include the type of material and the number of pieces.

Even if you're working from an existing drawing that includes a materials list, it helps to redo the bill using your own form. This gives you a chance to list the parts and mentally build the

project. I've found that this reduces errors and usually helps make construction go more smoothly.

On complex projects, it's easy to make a mistake adding up dimensions or omitting a dimension. That results in

Figure 1

BILL OF MATERIALS

Name of Part	Kind of Wood	# of Pcs.	Cutout Size			Finished Size		
			T	W	L	T	W	L

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Name of Part	# of Pcs.	T	W	L



Photo A: A story stick precisely locates the position of parts and reduces the chances of misreading a measuring tape.



Photo B: Laying out rough-dimensioned parts lets you work around defects and select the best grain. It also ensures that you won't run out of stock in the middle of the project.

wasted materials and time—not to mention frustration. To avoid such problems, I like to make a layout or “story” stick to verify the dimensions of the various parts at each step (*photo A.*)

Calculating Initial Dimensions

Once you've determined and double-checked finished dimensions for the parts, calculate the initial or rough dimensions you'll need to start with. If you plan to edge-join panels from narrower stock, surface the boards $\frac{1}{8}$ " thicker initially

than the finished panel thickness. Then, you can plane $\frac{1}{16}$ " from both faces of the glue-up.

Likewise, make the initial glue-up at least $\frac{1}{4}$ " wider and long enough that you can trim away any planer snipe or end checks from the finished panel while squaring and trimming the part to finished dimensions. For parts that don't require edge-joining, you can usually get by with only an additional $\frac{1}{8}$ " of rough width.

Getting the Most From Your Lumber

Calculate the board feet you'll need for the project based on the rough dimensions of the parts. Then, add a minimum of 25 percent extra for waste from cutting, jointing, grain-matching, and working around small defects. Trying to avoid buying an additional board is often false economy. A second trip to the supplier can waste a lot of time, and you also risk the possibility that the dealer may no longer have suitable matching stock on hand.

To plan your cuts, make a preliminary layout of the rough parts on the boards using chalk or a soft pencil (*photo B*). This way you can work around defects in the stock and set aside the best-looking grain for the most prominent parts. It also ensures that you won't run out of stock in the middle of the project or end up having to use a sap-streaked or knotty board for some of the high-visibility parts.

Years ago, I found it best to establish a standard procedure for preparing all stock and then stick to it for every project. The same holds true for cutting parts to finished size. I've listed the steps I follow in the box at *left*.

Roughing-Out Stock: Bob's Routine

Chalk out a tentative cutting scheme on your rough lumber to determine the best use of the stock.

Cut stock to manageable rough lengths. Use a portable circular saw, radial-arm saw, or jigsaw and proper procedures to make rough cuts. On extremely warped stock, proceed cautiously.

Joint one face to flatten stock and remove warp. (See the drawing at *left*).

Plane the opposite face parallel to the jointed face. If the stock will be used to make up an edge-jointed panel, plane to finished thickness plus $\frac{1}{8}$ ". Plane equal amounts of material from both faces.

On wider pieces, joint one edge and then rip part to rough width. If edge-joining is

required, rip stock to narrower widths for glued-up panels.

Joint one edge if part is to be ripped to width. For edge-joining, joint both edges square to the faces.

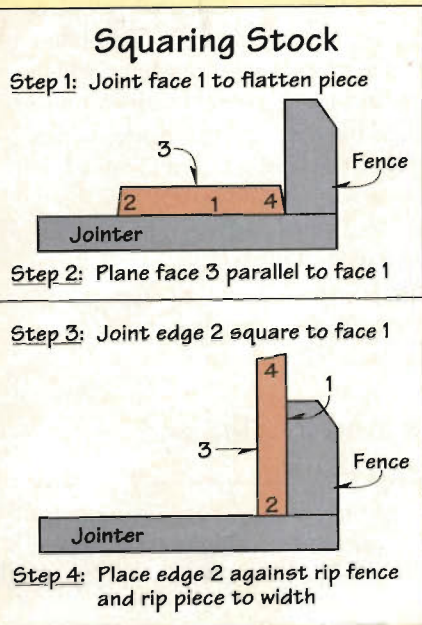
Cutting Parts To Finished Size: Standard Procedure

- Set the tablesaw rip fence to finished width plus $\frac{1}{16}$ ".
- Place the jointed edge against the fence, then rip.
- Set the jointer to $\frac{1}{16}$ " depth of cut and joint the ripped edge.
- Place the miter gauge in the tablesaw's slot and square it to the blade.
- With the board's better face up, place one edge firmly against the miter gauge, then crosscut one end square.
- Starting at the square end, mark the finished length of the board. With the better face up, place the board's opposite edge against the miter gauge and crosscut to length. If more than one part is to be cut to this length, set a stop to ensure identical length of all parts.

Cutting On the Tablesaw

Select and mount the proper saw blade for the job at hand. Don't use a 60-tooth crosscut blade to rip a lot of rough stock—the excessive heat generated will quickly dull the teeth. Instead, spend the extra couple of minutes to mount a rip blade.

Even if you have a combination blade on the saw, switch to the rip blade if you have several boards to rip, especially if they're rough stock. You



will get better performance now, and over the long term, lengthen the sharpened life of all your blades.

To cut plywood and other sheet stock on the tablesaw, place their good faces up on the table. If using a portable circular saw, cut with the good face turned down. This minimizes chipping and splintering of the good face. You can also improve plywood cuts by using a zero-clearance insert and full-length rip fence on the saw table, by taping or scoring the cut line, and by using a special plywood or other fine-cutting combination blade.

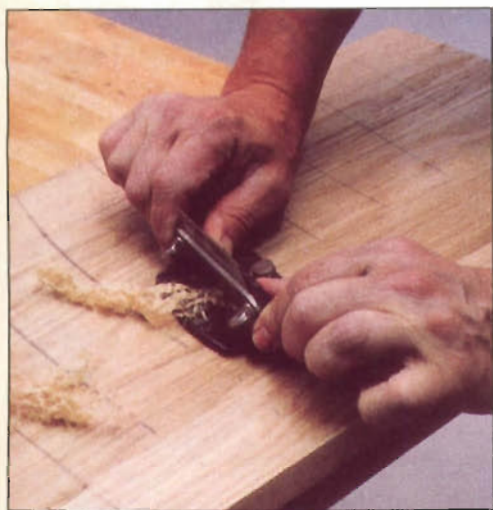


Photo C: To ensure uniform surface scraping and sanding, scribble pencil lines across the workpiece surface at regular intervals. When the lines have disappeared, the mill marks will be gone.

Basic Mortise-and-Tenon Joinery

For sturdy mortise-and-tenon joints, choose tenon dimensions that are appropriate for the structural requirements of the joint. A door frame with a heavy plate-glass panel, for example, requires wider frame stock with longer, wider tenons to ensure the joint's integrity. I usually make the mortises one-fourth to one-half as thick as the stock.

A $\frac{3}{4}$ "-long tenon will suffice for $1\frac{1}{4}$ "-to 2"-wide frame stock. For 2"-to 3"-wide stock, increase tenon length to 1". Pinning a tenon will help reinforce the joint. Cut the mortise $\frac{1}{16}$ " to $\frac{1}{8}$ " deeper than the tenon length to allow room for excess glue.

My Sanding Rules

To remove glue, scratches, and machine or mill marks from your stock, start sanding with a grit just coarse enough to remove the flaws with reasonable time and effort. I find that 60- to 80-grit abrasives will remove moderately deep marks and scratches in many hardwoods. If you start with too coarse an abrasive, you'll also have to remove the scratches it makes.

To ensure uniform sanding, first scribble pencil lines across the surface at regular intervals, then sand. When the lines disappear, the mill marks should also be gone. For a quieter alternative, I use a cabinet scraper to remove mill marks. Keep the pencil lines as a guide for even scraping (*photo C*).

Once you've removed the mill marks, switch to the next finest grit and sand until all visible scratches are gone. Continue sanding up through successively finer grits to remove the scratches left by the previous sandpaper until you've achieved the desired smoothness.

Some woodworkers finish-sand to 180-grit, others to 220-grit or even finer. I prefer to sand to the point that all marks and imperfections are removed and the surface is compatible with the finish to be applied. If you intend to apply a water-base stain or finish, sand to final grit, then apply a tiny bit of moisture by cloth or mist to raise the grain. Let it dry, then lightly finish-sand again.

Vacuum, blow, or brush off all sanding dust and residue before each sandpaper grit change. I prefer to vacuum the surface because it does a better job of removing loose dust and abrasive particles so you can see if the problems have been removed. Don't change grits until you have removed the problems.

Dull abrasives can glaze the surface of the wood, so switch to fresh sandpaper when necessary—especially on your final round of sanding. A glazed surface can affect how the wood absorbs stain, and may create unwanted color variations on your project. Also, sand every piece to the same final grit to ensure even stain absorption.

To make thorough sanding easier, I recommend using a portable inspection light. A bright side light directed onto the sanded surface at a low angle immediately shows up surface flaws and imperfections.

Staying Sharp

Learn the recommended sharpening angles for the various tools you use: plane irons, chisels, cabinet scraper blades, hand scrapers, and lathe tools. (See *figures 2 and 3*.) If you haven't committed them to memory, make a reference chart to hang in your shop, or, cut blocks to the correct angles and use them as guides.

Keep all cutting tools sharp for your safety as well as work quality. Think of dull tablesaw and bandsaw blades as accidents waiting to happen. They also, of course, give lousy cuts. Dull tablesaw blades generate more heat, which burns the stock, which causes more resin to build up on the blade, which increases the likelihood of kickback.

If your jointer knives start to "hammer" stock, sharpen them immediately. Dull hand tools require more force behind them, making it more likely that you'll damage the project or injure yourself.

Best Way To Glue and Clamp Panels

Preparing panels is one of the most frequent chores you'll probably encounter in your woodworking.

Figure 2 Forming the hook on cabinet scrapers

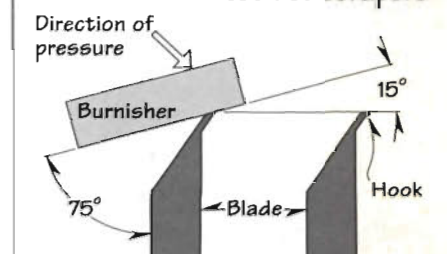


Figure 3 Standard bevel angles

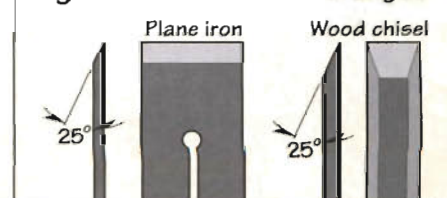




Photo D: Lightly clamped cauls keep edges of boards aligned when clamping.

Therefore, it's important to learn the correct procedures and follow them.

After cutting the boards to rough size, arrange the individual pieces for a pleasing, natural-looking grain pattern. I try to avoid abrupt changes in grain or color contrast between boards. To minimize cupping of the panel, flip-flop the pieces, alternating the annual rings. However, watch the direction of the face grain; make sure that it runs in the same direction on all parts to prevent tearout during planing. When I'm satisfied with the appearance of the panel pieces, I'll lightly pencil a triangle over the top so I can arrange them in the same order when gluing.

You want glued-up panels to be flat and the glue joints to be invisible. To achieve this, the edges of the pieces must be jointed flat and square. Also, the edges should be free of blade marks, torn grain, or burn marks that can interfere with the glue's adhesion. To get the desired edge, use either a sharp hand plane or jointer.

When gluing up a panel, place clamp cauls parallel to the bar clamps to keep the panel flat as shown in *photo D*. I place waxed paper between the cauls and the panel so they don't get glued together. The cauls don't need to be so tight that they grip the board—just firm enough to keep the edges aligned.

To clamp, place your bar clamps 12" or less apart. Position the panel in the clamps, aligning its centerline with the center of each clamp's screw. This centers the clamp pressure on the



Photo E: When dimensioning parts for a project, use the same rule for all critical measurements.

panel's center. You can also alternate the clamps from top to bottom to help equalize clamping pressure and minimize buckling. Apply enough clamp pressure to join the pieces firmly, but not so tightly that you squeeze out all of the glue.

Figure 4 Use rabbeting bit instead of trying to match plywood and dado

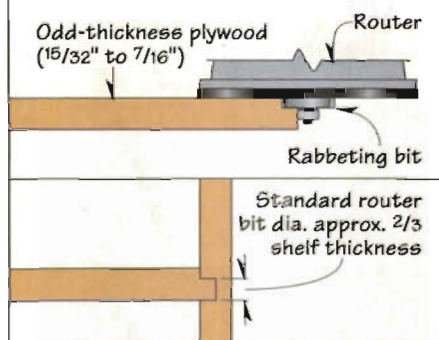


Figure 5

WOOD-SCREW DRILLING CHART

No. of screw	Head size	Shank hole	Pilot hole	No. of screw
0	1/8	1/16	3/64	0
1	5/32	5/64	3/64	1
2	11/64	3/32	1/16	2
3	13/64	7/64	1/16	3
4	15/64	1/8	5/64	4
5	1/4	1/8	5/64	5
6	9/32	9/64	3/32	6
7	5/16	5/32	7/64	7
8	11/32	11/64	7/64	8
9	3/8	3/16	1/8	9
10	25/32	13/64	1/8	10
11	7/16	13/64	9/64	11
12	7/16	13/64	9/64	12
14	1/2	1/4	5/32	14
16	9/16	19/64	3/16	16

Colpetzer's Reminders

When possible, machine identical parts of a project to thickness, width, and length at the same time using the same machine setups and stop blocks.

Mill a scrap piece of stock along with the finished pieces.

Then, use this same-sized scrap piece to test additional machining setups.

Plywood thicknesses tend to be odd and unpredictable these days, so I recommend rabbet dados instead of conventional dados. (*Figure 4*.) A rabbet dado accepts a tongue on the mating part, which you cut to positive thickness. This way, you don't have to spend a lot of time shimming your dado head to match an odd plywood thickness.

Save samples of complicated moldings and jot down a few notes listing the steps and names of the shaper or router cutters used. This makes it easy to duplicated them later.

Always scrape dried glue thoroughly from glued-up panels before jointing or planing. Cured glue is several times harder than the wood itself and will dull and nick the knives.

Take the time to edge-glue your waste rippings. This yields extra mater-

Continued on page 30

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In the Shop

Continued from page 29

ial and will help keep your scrap bin from overflowing.

Acquire and use a drilling chart that lists proper drill-bit diameters for shank and pilot holes. (See figure 5.) An undersized shank hole will prevent the parts from drawing together. An oversized pilot hole reduces the screw's holding power or causes it to strip out the wood. An undersized pilot hole, on the other hand, can cause the wood to split.

Do not plane stock that is shorter than the distance between the infeed and outfeed rollers on your planer. If your project calls for short parts, keep them consolidated in longer boards of planeable length. Cut them to proper length after planing.

When dimensioning parts for a project, use the same rule for all critical measurements (photo E). This is especially important if you're using a retractable steel tape.

Safety First and Always

Study and follow the safe work practices established by the manufacturer for each tool you own. Remember: No job is ever more important than your own safety. If you think you can't afford the time it takes to do it the safe way, think how much time you'll lose mending cut or mutilated fingers.

If you ever feel the slightest doubt about the procedure you intend to use for an operation, yield to your instincts. Stop, think through the operation, do a dry run, look up the proper procedure, or seek a qualified opinion. **W**

Photographs: The author, Studio Alex

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DW999K18v1/2" ham dr k 249
DW938K 18v recip saw kit 299

DELTA

22-560
12-1/2"
Portable
Planer
\$399

22-540 12" port. planr, knife 329
31-780 osc spindle sander 194
36-250 10" sliding comp. 499
28-230 12" cmpd mitr sw 309
36-210 10" cmpd mitr sw 219
11-99012" bench drl press 189
46-700 12" vs wood lathe 469
43-505 router/shaper 299
11-090 rad drl press w/std 309
14-650 mortising machine 249
37-070 6" vs bench jointer 259

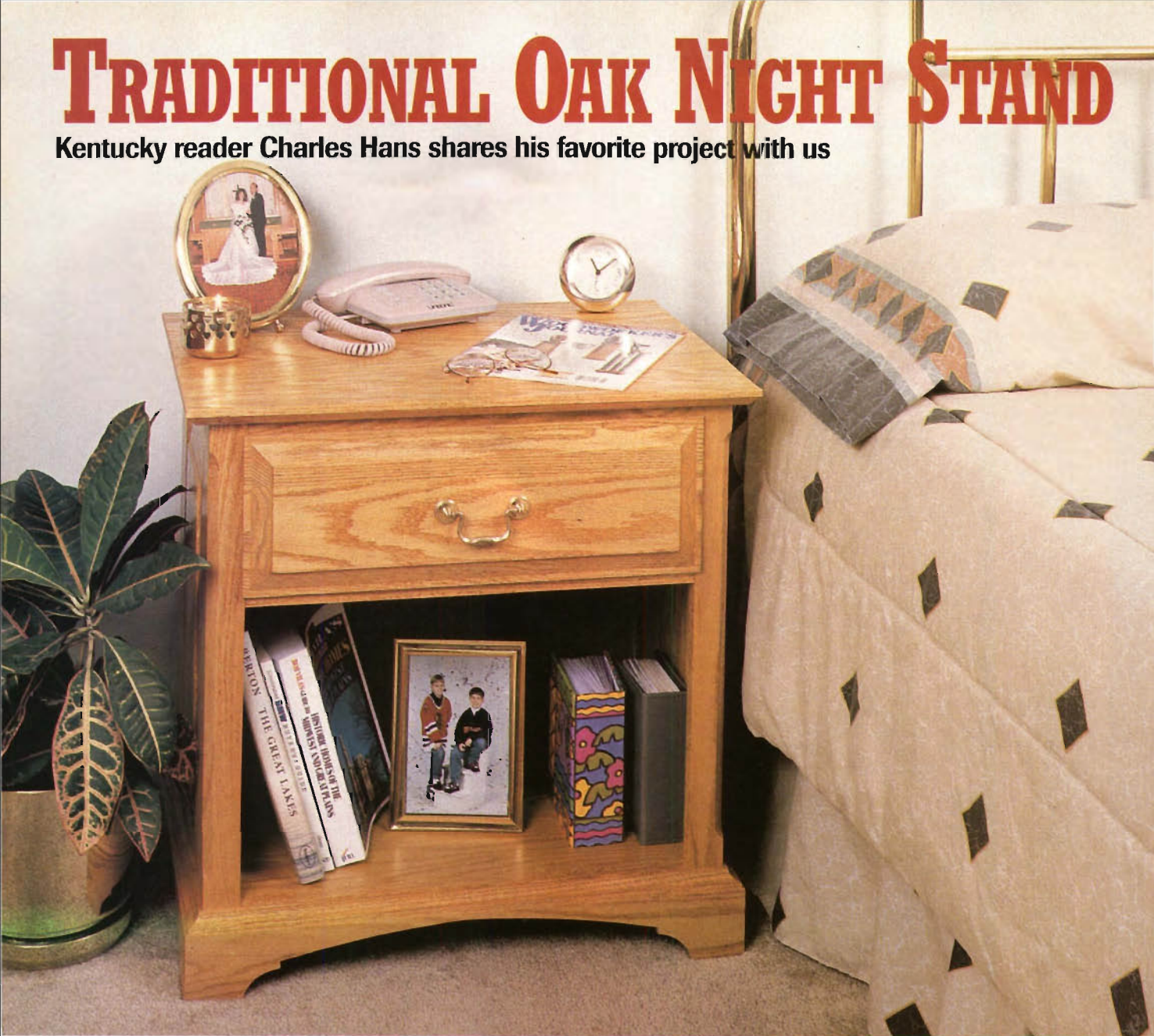
POWERMATIC INT

1660760
66 Saw 3 HP
w/50" Accu-fence
\$1999

1791210 64Artsn.Accu-fnc 749
1791208 osc. spndle sander 199
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TRADITIONAL OAK NIGHT STAND

Kentucky reader Charles Hans shares his favorite project with us



Before You Start

We selected the straightest-grained red oak stock we could find to minimize cutter tearout, then sorted the material, keeping the best for the most visible parts. We also tried to match the grain and color as closely as possible in the sides and top, and saved the straightest, least-warped pieces for the stiles, rails, and panels.

To simplify construction, we chose to join the side and back frames using routed cope-and-stick joinery. These joints are easy to cut and produce strong, rigid frames. We cut them using a two-piece stile and rail router-

bit set. To raise the side panels, we used a vertical panel-raising bit and a table-mounted router.

If you don't own stile-and-rail bits, see *page 10* in the Nov./Dec. '95 *Woodworker's Journal* for an alternative cope-and-stick technique. If you don't have a panel-raising bit, you can cut both the raised panels and the false drawer front using a tablesaw and a tall fence.

To help minimize wood movement problems, we used oak plywood for the cabinet bottom. Note too that the drawer has been mounted with metal drawer slides. While this may not

qualify as purist woodworking, it does simplify drawer installation and provides smooth, dependable drawer action. (See Sources at the end of the article for a mail-order supplier.)

Machine Frames For the Side and Back Panels

Step 1. Face-joint and plane red oak stock to $\frac{3}{4}$ " thick. From it, rip and cross-cut four side stiles (A), two top side rails (B), two bottom side rails (C), two back stiles (D), one top back rail (E), and one bottom back rail (F) to the dimensions listed in the Bill of Materials.

Note: You may have to adjust the rail lengths if your stile-and-rail bits cut a profile different from ours. Measure the difference in diameter between your cope cutter and its bearing. If the difference is more or less than $\frac{1}{16}$ ", adjust your rail lengths accordingly.

Step 2. Sort and group the stiles and rails into two side frames and a back frame, arranging them for best grain and color match. Mark each piece for identification.

Step 3. Test the setup of your stile-and-rail bits. (We used the two-piece MLCS set, no. 843.) If you know that your bits cut a snug-fitting joint as set, proceed. If the set is new or if you're not sure the bits cut matching profiles, test and adjust the cutters before routing. (See *figure 1* for our cutter setup.)

Note: Our cutters came with a shim pack installed at the factory and had extra shims for adjusting the cut profile. If your bits don't match, move the wing cutter either closer to or farther away from the profile bit on the cope-cutting bit by adding or removing shims. This adjustment changes the tongue thickness.

Step 4. Rout the cope profile (and tenons) on the side rail ends. Next, rout the stick profile on the front inside edge of each rail and stile. For assistance, see "How To Rout the Cope and Stick" below. (We made the cuts on a table-mounted router and used a scrap backing block to minimize tearout.)

BILL OF MATERIALS

CABINET

PART	T	W	L	MTL. QTY.
A Stiles—side	$\frac{3}{4}$ "	2 $\frac{3}{4}$ "	21 $\frac{1}{4}$ "	O 4
B Rails—side top	$\frac{3}{4}$ "	3"	9 $\frac{5}{8}$ "	O 2
C Rails—side bottom	$\frac{3}{4}$ "	4 $\frac{3}{4}$ "	9 $\frac{5}{8}$ "	O 2
D Stiles—back	$\frac{3}{4}$ "	3 $\frac{1}{2}$ "	21 $\frac{1}{4}$ "	O 2
E Rail—back top	$\frac{3}{4}$ "	3"	15 $\frac{5}{8}$ "	O 1
F Rail—back bottom	$\frac{3}{4}$ "	4 $\frac{3}{4}$ "	15 $\frac{5}{8}$ "	O 1
G Panels—side*	$\frac{3}{4}$ "	9"	14"	O 2
H Panel—back**	$\frac{1}{4}$ "	15"	14"	OP 1
I Top frame—stretchers	$\frac{3}{4}$ "	3"	20 $\frac{3}{4}$ "	H 2
J Top frame—spacers	$\frac{3}{4}$ "	1 $\frac{3}{4}$ "	8"	H 2
K Bottom	$\frac{3}{4}$ "	14"	20 $\frac{3}{4}$ "	OP 1
L Top*	$\frac{3}{4}$ "	16 $\frac{1}{2}$ "	23 $\frac{1}{2}$ "	O 1
M Face frame—stiles**	$\frac{3}{4}$ "	1 $\frac{1}{2}$ "	21 $\frac{1}{4}$ "	O 2
N Face frame—rails**	$\frac{3}{4}$ "	$\frac{3}{4}$ "	18 $\frac{1}{2}$ "	O 2
O Drawer rail**	$\frac{3}{4}$ "	2 $\frac{3}{4}$ "	20"	O 1
P Base—sides**	$\frac{3}{4}$ "	2 $\frac{7}{8}$ "	16 $\frac{1}{4}$ "	O 2
Q Base—front**	$\frac{3}{4}$ "	2 $\frac{7}{8}$ "	23"	O 1
R Base moldings** †	$\frac{5}{8}$ "	$\frac{5}{8}$ "	58"	O 1

DRAWER

S Front/back	$\frac{5}{8}$ "	5"	17 $\frac{1}{2}$ "	H 2
T Sides	$\frac{5}{8}$ "	5"	13 $\frac{1}{2}$ "	H 2
U Bottom**	$\frac{1}{4}$ "	13 $\frac{3}{8}$ "	16 $\frac{5}{8}$ "	OP 1
V False front	$\frac{3}{4}$ "	6 $\frac{1}{2}$ "	19"	O 1
W Spacers	$\frac{3}{4}$ "	2"	14"	H 2

* Parts edge-glued from narrow stock.

**Parts cut to size during construction. Please read all instructions before cutting.

† Multiple lengths required.

MATERIALS LIST

O—red oak
OP—oak plywood
H—hardwood

SUPPLIES

#6x1 $\frac{1}{4}$ " flathead wood screws; #6x1 $\frac{1}{4}$ " self-tapping face-frame screws; brass drawer pull; two 14" drawer slides; stain; finish.

HOW TO ROUT THE COPE AND STICK

With a matching two-cutter set, one bit cuts the cope, the other cuts the stick. To visualize the process, think of the cope as a crosscut on the end grain of the workpiece. The sticking cut resembles a rip that you make with the grain along the workpiece edges.

Secure the coping bit in your table-mounted router, then notch an auxiliary wooden fence to fit over the bit. Place one of the rails against the bit, then elevate the bit so it will cut the desired profile. Using a straightedge, align the front of the fence with the front of the bit's bearing, then clamp the fence in place.

Set the router to the recommended speed. Place the rail facedown on the table with one end squarely against the fence. From scrap, cut a square backing

block and use it to hold the rail perpendicular to the fence when feeding it across the bit. Cope both ends of each rail. Note: By making the cross-grain coping cuts first, you'll clean up any residual splinters when you make the sticking cuts.

Switch to the sticking bit. Set its height by placing a coped rail facedown on the router table. Elevate the bit until it matches the coped profile, then test the position by just nicking the corner of the stub tenon on the rail end. Adjust the router up or down so the bit fits squarely on the tenon. Now, cut the sticking along the inside front edge of each rail and stile. Note: Before routing, check each piece for grain direction and feed the workpiece in the direction least likely to produce splintering.

Step 5. Dry-assemble the frames to check for fit. When satisfied, sand the joints flush. Note: Sanding the dry-assembled frames won't spoil the joints, but don't sand frame parts separately.

Make Panels For the Sides and Back

Step 1. Measure the openings in the dry-assembled side and back frames. Add $\frac{1}{2}$ " to both width and length for the grooves. (These dimensions allow $\frac{1}{8}$ " for panel movement.)

Step 2. Edge-glue and clamp enough $\frac{3}{4}$ "-thick stock to make two side panel blanks measuring at least $\frac{1}{2}$ " wider and

longer than the dimensions you determined in the previous step. After the glue has dried, scrape off the squeeze-out, then plane and belt-sand both panels to $\frac{5}{8}$ " thick. Trim and square the panels (G) to final size.

Step 3. Raise both side panels, leaving a $\frac{1}{4}$ "-thick tongue along each edge to fit in the frame grooves. (See *figure 2*. We used an MLCS vertical panel-raising bit, no. 8682.) Next, dry-assemble the sides to test-fit the panels in the frames. Adjust parts if necessary, then finish-sand the routed profiles to remove any machine marks. Finish-sand the panels to 220-grit, lightly breaking the sharp edges.

Step 4. If you intend to stain the cabinet, pre-stain the panels before assembling. Staining the panels now eliminates any problem of unstained wood showing if the panels shrink or move.

Step 5. Glue, assemble, and clamp the side frames, allowing the panels to float in their grooves without glue. Omit glue from the last $\frac{1}{2}$ " of the frame joints so it won't squeeze out into the grooves and lock the panels. Check each assembly for square and flatness.

Step 6. From $\frac{1}{4}$ " oak plywood, cut a panel (H) to fit the grooves of the back frame. Then, glue, assemble, and clamp the back frame around

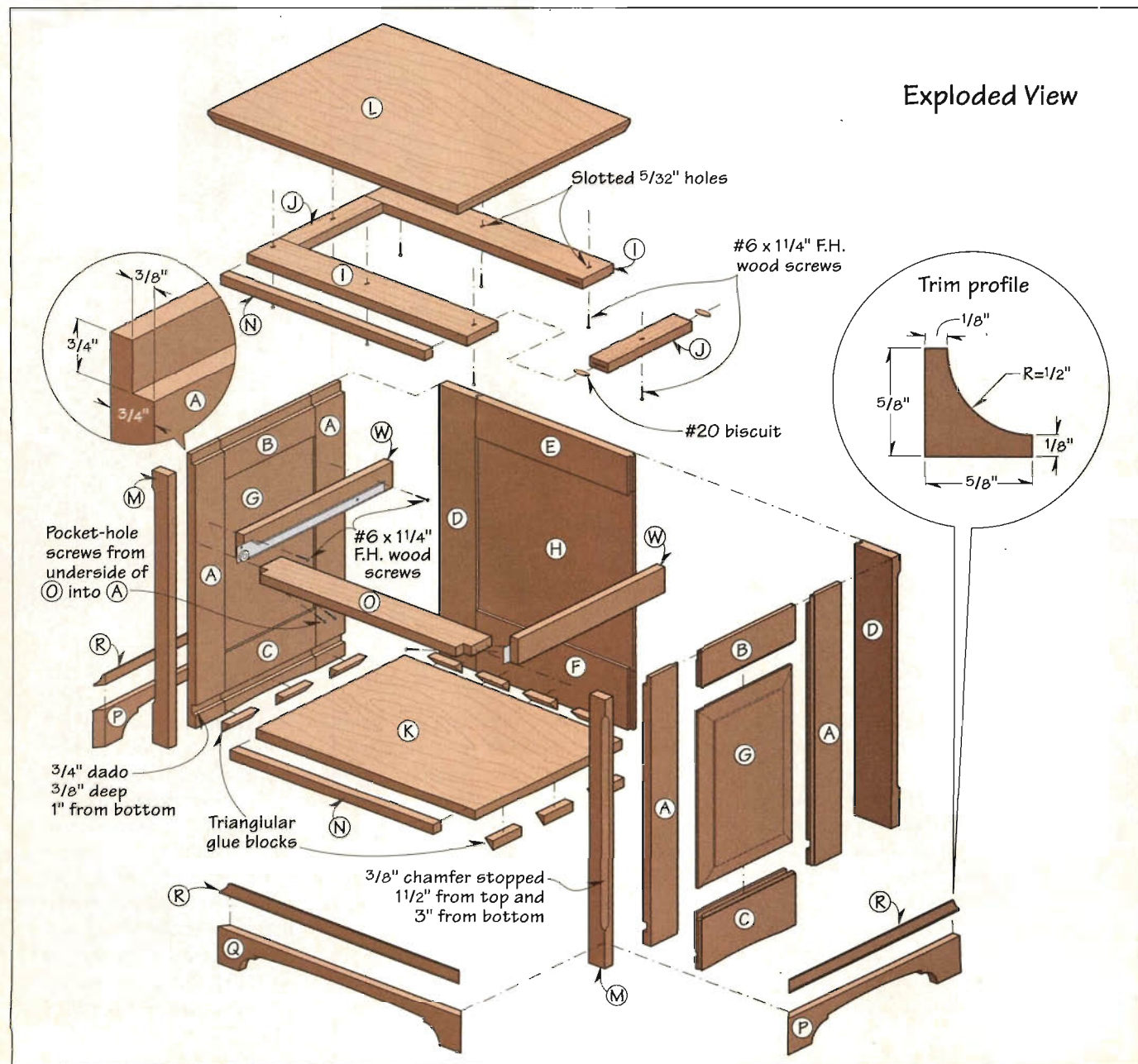


Figure 1

The diagram is divided into two horizontal sections. The top section shows a router bit labeled 'Cope cutter' mounted on a 'Router table'. The bit is positioned to cut into a piece of wood labeled 'Rail' which has a thickness of '3/4\"'. The bottom section shows the same router bit setup, but the bit is labeled 'Sticking cutter'. It is positioned to cut into a piece of wood labeled 'Stile and rail' which also has a thickness of '3/4\"'. The router table is indicated in both sections.

Figure 2

Vertical raised panel ogee bit

5/8"

Notched fence

1/4"

Router table

This diagram illustrates the setup for routing a vertical raised panel using an ogee bit. The bit is mounted in a router table. A notched fence is positioned against the workpiece, with a 5/8" gap between the bit and the fence. The workpiece is held against the fence by a 1/4" thick piece. The router table is shown with a hatched pattern.

Make the Top Frame, Bottom, and Top

(J) for the top frame to finished length plus $\frac{1}{8}$ ". Cut a slot for a #20 biscuit in each corner joint. Then, glue, biscuit, and clamp the frame.

Step 2. For the cabinet bottom (K), rip and crosscut a 3/4"-thick piece of oak plywood to final dimensions. Using the same setups, trim the top frame to identical size. Finish-sand the inside face of the bottom to 220-grit.

Step 3. Measure the actual thickness of the plywood bottom panel. Mount a dado head matching this thickness on your tablesaw. Cut the $\frac{3}{8}$ "-deep dado on the inside face of each side frame (A, C) where dimensioned on the Exploded View. Next, mount a full $\frac{3}{4}$ " dado head and rabbet the top end of both side frames (A, B).

Step 4. To make the top (L), edge-glue and clamp your best ¾"-thick oak stock from the material you sorted earlier. (We initially made the blank 1" longer and wider than final dimensions.) After the glue has dried, scrape off the squeeze-out, then belt-sand. Now, trim and square the top to final size.

Step 5. Chamfer the front edge and both ends of the top as dimensioned on the Front and Side Views. (We used a table-mounted router and 45° chamfer bit, routing the ends first, then the front edge.)

Assemble the Cabinet, Then Add the Trim

Step 1. Dry-assemble and clamp the sides, bottom, and top frame as shown on the Exploded View to check for fit. Adjust parts to fit if necessary.

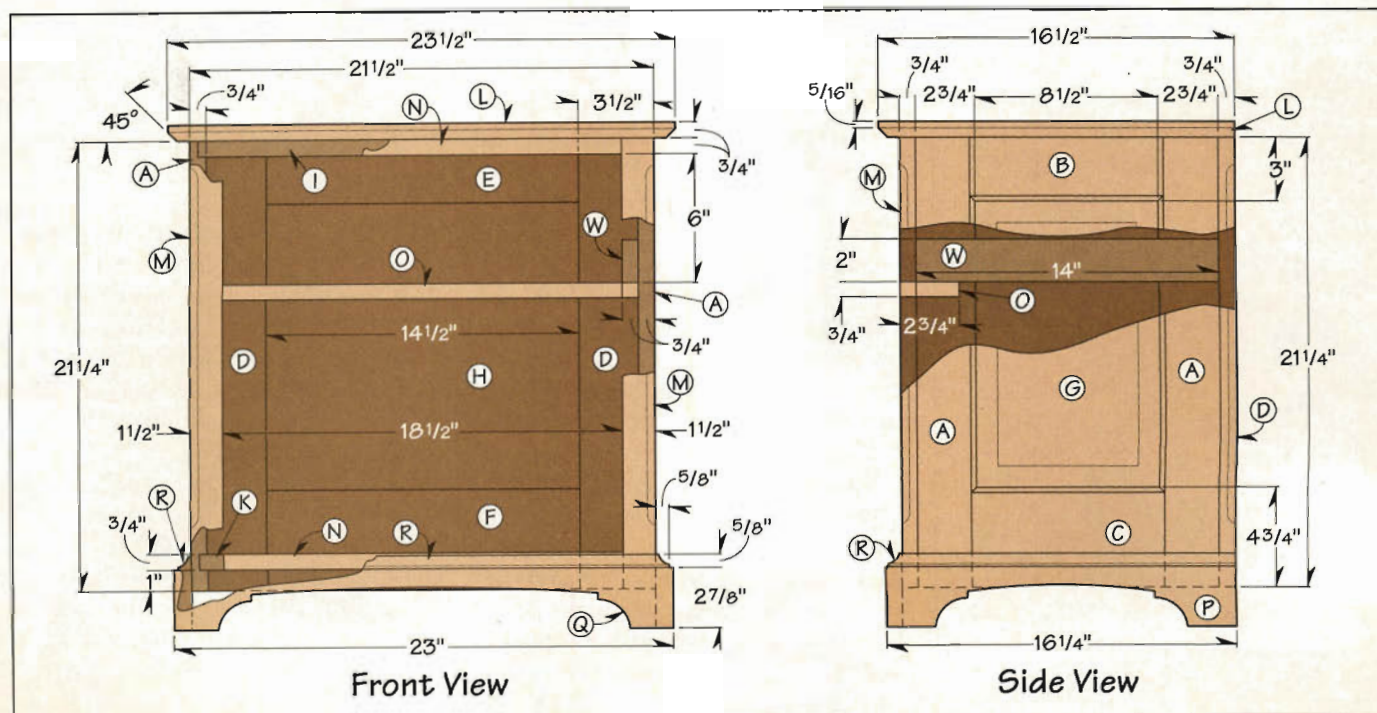
Step 2. Glue, assemble, and clamp these parts. Square the assembly by measuring the diagonals.

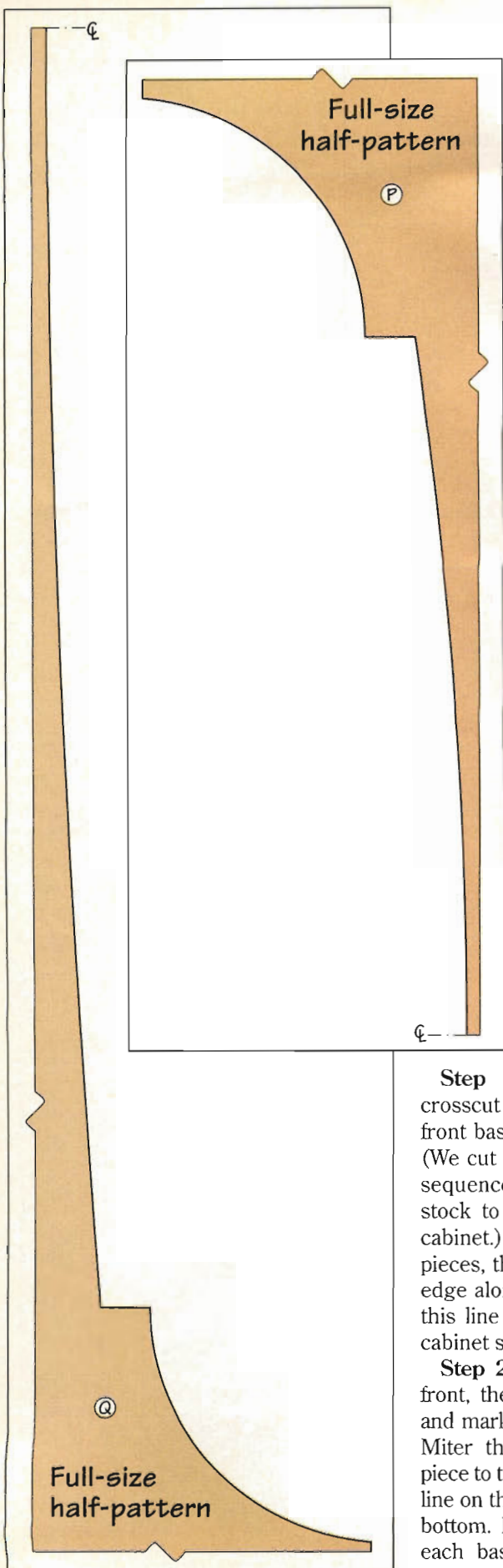
Step 3. Center, glue, and clamp the back to the assembled cabinet, aligning the top rail with the top rails of the sides. Note: The back will be wider than the cabinet. When the glue has dried, trim the edges of the back stiles flush with the sides.

Step 4. To reinforce the carcass, cut ten 2"-long triangular glue blocks from scrap. Glue them to the sides and bottom and back and bottom where shown on the Exploded View.

Step 5. From $\frac{3}{4}$ "-thick oak stock, rip and crosscut two face frame stiles (M) that match the height of the cabinet. Using a table-mounted router, cut a stopped $\frac{3}{8}$ " chamfer on the four corners as dimensioned on the Exploded View.

Step 6. Glue and clamp the face-frame stiles to the cabinet front where shown on the Front View. Align their outside edges flush with the outside faces of the sides.





Step 7. Measure the actual distance between the face-frame stiles. From $\frac{3}{4}$ "-thick stock, cut two face frame rails (N) to rough length, then trim them to fit snugly between the stiles. Now, glue and clamp the rails to the front edge of the top frame and bottom panel.

Step 8. Cut the drawer rail (O) to width and rough length from $\frac{3}{4}$ "-thick stock. Trim it to fit snugly between the sides. Next, notch the front edge at both ends to fit snugly between (and flush with) the face-frame stiles. Lay out and drill two pocket holes into the underside of this rail at both ends.

Step 9. Glue and clamp the drawer rail to the face-frame stiles and cabinet sides where dimensioned on the Front View. Drive #6x1 $\frac{1}{4}$ " self-tapping face-frame screws through the pocket holes and into the side stiles. Check to make sure the rail is parallel to the top.

Prepare the Base and Trim, Then Attach the Top

Step 1. From $\frac{3}{4}$ " stock, rip and crosscut two base sides (P) and a front base (Q) to final length plus 1". (We cut these parts in side-front-side sequence from a single length of stock to wrap the grain around the cabinet.) Mark a top edge on all three pieces, then pencil a line 1" from this edge along the inside face. You'll use this line to position the base on the cabinet sides.

Step 2. Miter one end of the base front, then position it on the cabinet and mark the opposite end for length. Miter this end, then dry-clamp the piece to the cabinet, aligning the pencil line on the inside face with the cabinet bottom. Miter the appropriate end of each base side, then dry-clamp the

sides in position. Mark their back ends for length, then crosscut.

Step 3. Using the half-patterns shown at left, lay out and bandsaw the cutouts on the base parts, keeping the blade wide of the line. Sand to the line, then glue and clamp the base parts to the cabinet.

Note: While attaching the side base parts, you'll notice that the arc of the base cutout extends above the bottom edge of the cabinet sides. Trim the sides to match the arc of the cutout. (We used a handheld router and a pattern-cutting bit, which has the bearing mounted above the cutter.)

Step 4. To make the base molding (R), first prepare a $\frac{5}{8}$ x3x36" blank. Using a table-mounted router and $\frac{1}{2}$ " cove bit, rout both edges of this piece. Now, rip a $\frac{5}{8}$ "-wide strip of molding from each edge. (See the detail on the Exploded View.)

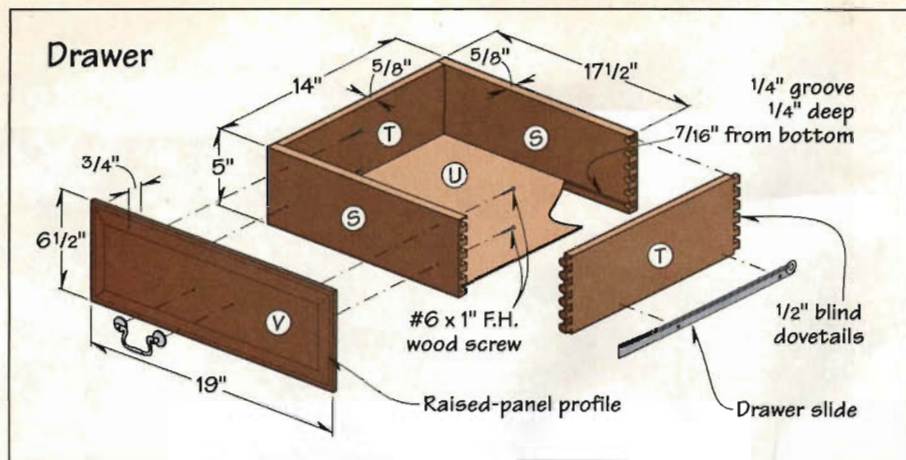
Step 5. Using the same procedure you followed to fit the base parts, miter and trim the three base molding pieces to sit on the top edge of the base. (See the Front and Side Views.) Note: The $\frac{5}{8}$ " height of the molding will leave a scant $\frac{1}{8}$ " reveal along the lower face frame rail (N).

Step 6. Drill eight $\frac{5}{32}$ " shank holes through the top frame where shown on the Exploded View. Drill a second hole next to each of these, then join them to form a slot. This will allow the screws to move as the top expands and contracts.

Build and Install The Drawer

Step 1. Measure the drawer opening of your cabinet to verify the drawer dimensions. (Our cabinet opening measured 6x18 $\frac{1}{2}$ ", so we made the drawer parts 5" wide. We sized the front and back 17 $\frac{1}{2}$ " long to allow $\frac{1}{2}$ " clearance on both sides for the drawer slides.)

Step 2. From $\frac{5}{8}$ "-thick stock, rip and crosscut the drawer front and back (S) and two drawer sides (T) to dimension. (Use the dimensions listed in the Bill of Materials and see the Drawer drawing *opposite* for additional information.) Note: We sized these parts to be joined by $\frac{1}{2}$ " blind dovetails. If you



elect to use different joinery, adjust part lengths accordingly.

Step 3. Rout the dovetails on the ends of the front, back, and sides following the instructions supplied with your dovetail jig.

Step 4. Measure the actual thickness of your $\frac{1}{4}$ " plywood. Then, cut a $\frac{1}{4}$ "-deep groove of this width near the bottom edge of the drawer parts (S, T) where shown on the Drawer drawing. To match the plywood thickness, use a $\frac{1}{8}$ " blade and move the fence to make a second pass.

Step 5. Carefully dry-assemble one drawer side to the back. From this assembly, determine the dimensions of the drawer bottom. Note: Allow $\frac{3}{16}$ " for the groove depth instead of a full $\frac{1}{4}$ " to make sure the panel doesn't bottom out in the grooves. Now, cut the bottom panel (U) to size from $\frac{1}{4}$ " oak plywood.

Step 6. Glue, assemble, and clamp the drawer, inserting the bottom panel in its groove. Check the assembly for square and flatness.

Step 7. From $\frac{3}{4}$ "-thick stock, rip and crosscut the false front (V) to dimension. Note: If you don't have stock this wide, edge-glue several widths of narrow stock, matching the grain and color carefully. Then, using a raised-panel bit, rout the front face of the panel in end-edge-end-edge sequence.

Step 8. Lay out and mount a drawer pull or knob on the false front. (We cen-

tered a brass pull side to side and top to bottom. To attach it, we drove screws from the back face, so we countersank the holes deep enough to prevent the screw heads from interfering when we joined the false front to the drawer. To mail-order the same pull, see Source at the end of the article.)

Step 9. Drill and countersink four $\frac{5}{16}$ " shank holes through the front face of the box where shown. Center the false front on the box front (side to side), allowing its top edge to overlap the drawer's top edge by 1". Clamp the parts in position. Using the shank holes as guides, drill pilot holes into the false front. Drive the screws part way, then remove them for now.

Step 10. Temporarily attach 14" slides to the drawer sides according to the manufacturer's instructions. (We aligned the leading edge of the slide flush with the drawer front. For mail-order information, see Source.)

Step 11. From $\frac{3}{4}$ "-thick hardwood, cut two spacers (W) to fit inside the cabinet where shown on the Exploded View. Square them to the cabinet, then screw them to the side stiles (front and back) using #6x1 $\frac{1}{4}$ " flat-head screws. Attach the drawer slides to the spacers as instructed by the manufacturer. (We positioned the front ends of the slides $\frac{1}{16}$ " from the cabinet face.) Insert the drawer slides in the rail slides, test the action, and adjust as necessary.

Apply the Finish, Then Reattach the Hardware

Step 1. Remove the drawer pull and slides. Finish-sand all parts that need it to 220-grit.

Step 2. Apply your choice of finish. (We wiped on Minwax golden oak stain, allowed it to penetrate for 10 minutes, then wiped off the excess and let it dry for two days. We then sprayed on two coats of satin polyurethane, sanding the first coat with 320-grit sandpaper and rubbing the second coat with an extra-fine abrasive pad.)

Step 3. Reattach the slides to the drawer. Mount the pull on the false front, then screw the false front to the box.

Step 4. Place the top upside down on a flat, padded surface. Center the cabinet on the top from side to side, aligning it flush with the back edge. Drill pilot holes in the top, centering them in the slotted shank holes you drilled in the top frame. Now, drive the screws. 

*Project design: Charles Hans
Project builder: Doug Forester
Photographs: StudioAlex
Written by Doug Cantwell*

SOURCE

Drawer Pull. Solid brass, bail style. Overall length 4 $\frac{3}{4}$ ". Screws included. Catalog no. 35402. Price: \$7.55 plus s/h.

Drawer Slides. Blum low-profile ($\frac{7}{8}$ "), epoxy-coated 14" steel slides with stay-shut feature. Catalog no. 34835. Price: \$4.95/pair plus s/h. Order either/both of the above from:

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CONTEMPORARY DINING CHAIR

by Douglas Stowe



About My Chair's Design

To match the chair visually to the table and sideboard, I kept its appearance simple and fairly austere. Although the back legs have an angle, they are not curved. I tapered them on the outside at the top to narrow the back and on the inside at the bottom to visually maintain a wide stance. Tapering the back face of the back legs at both ends also helps lighten the profile.

To form the trapezoidal seat frame, I angled the tenons on the

front and back frame parts (D, E) at 7° to the legs. The seat frame sides (C) and stretchers (I) remain square to the legs. The center stretcher (J), which parallels the front and back seat rails, likewise joins the side stretchers at a 7° angle. Because the assembled back legs (A) splay outward and thus converge slightly toward the top and bottom, the back rails (F, G) require compound-angled tenons.

Editor's Note
This chair matches Doug's dining table, which we featured in the March/April '97 issue, and completes the set we started in Jan./Feb. '97 with his angle-front sideboard. As projects go, chairs are complex and generally more difficult to make than most, but we think advanced woodworkers will find this one both challenging and fun.

I arrived at the dimensions listed in the Bill of Materials by first building a prototype from scrap. I suggest you also work through the construction this way to avoid problems during the production of your chairs. Once you've prepared the back legs, dimension and angle the other parts to fit as you go: first the front legs, then the seat frame, the back rails and slats, and finally the stretchers. This may sound complicated, but you'll find it's safer than relying on the cutting list.

Laminate the Back Legs

Start by laminating the back leg on a form using thirteen 1/8"-thick strips of cherry resawn from 1 7/8"x44" pieces of 4/4 stock. I've found it difficult to get a good glue joint at the ends of a lamination like this, so I cut the strips extra-long in order to have ample length to trim at the ends.

To make the laminating form, face-glue three 6x44" pieces of 3/4" plywood to build up a 2 1/4"-thick block. Lay out the angles of the back leg as dimensioned in *figure 1* on the form blank, then bandsaw the straight lines. I kept the blade wide of the line, then cleaned up the two bandsaw cuts on the jointer.

To connect these two surfaces, lay out an 18"-radius curve that the 1/8"-thick strips can easily be made to follow. I bandsawed the curve to rough shape, then smoothed it on the disc sander.

To form the laminations, I first laid down a dry strip of cherry (without glue). Next, working quickly, I applied glue to one face of the first laminate strip, then started building up the lamination, applying glue to both faces of the strips. After gluing the 13 strips, I added three more dry strips to protect the blank and to better distribute clamping pressure.

Wrap wide tape around the end of the shorter section to help keep the strips aligned from side to side, then position that end on the jig and clamp it in place (*photo A*). I clamped the short section first in order to gain leverage on the long

end. To pull the strips down tight all along the form, position and tighten each clamp in sequence before moving on to the next one.

After the laminations dry, joint one of the side faces of each blank, taking care to keep the front face of the leg square to the fence. Then, plane the opposite face to get the 1 5/8" finished width.



Photo A: To laminate the back legs, author placed one dry strip underneath and three on top of the bundle. He taped the bundle at the bottom end to minimize side-to-side slippage, then started clamping, tightening down each C-clamp before moving on to the next one.

BILL OF MATERIALS

CHAIR

PART	T	W	L	MTL. QTY.
A Legs—back* **	1 5/8"	1 5/8"	37 1/4"	C 2
B Legs—front*	1 5/8"	1 5/8"	17 1/2"	C 2
C Seat frame—sides*	3/4"	3"	15 3/8"	C 2
D Seat frame—front*	3/4"	3"	16 3/8"	C 1
E Seat frame—back*	3/4"	3"	12 11/16"	C 1
F Back rail—upper*	1"	1 5/8"	12"	C 1
G Back rail—lower*	1"	1 5/8"	12 13/16"	C 1
H Slats*	1/2"	1 1/4"	14 5/8"	C 3
I Stretchers—side*	3/4"	1 1/2"	16 5/8"	C 2
J Stretcher—center*	3/4"	1 1/4"	15 3/8"	C 1
K Cushion frame—front*	3/4"	1 3/4"	17 3/8"	P 1
L Cushion frame—sides*	3/4"	1 3/4"	15"	P 2
M Cushion frame—back*	3/4"	1 3/4"	13"	P 1

*Parts cut to final size during construction. Please read all instructions before cutting.

**Part laminated from thinner stock.

MATERIAL LIST

C—cherry
P—pine
(or any softwood)

SUPPLIES

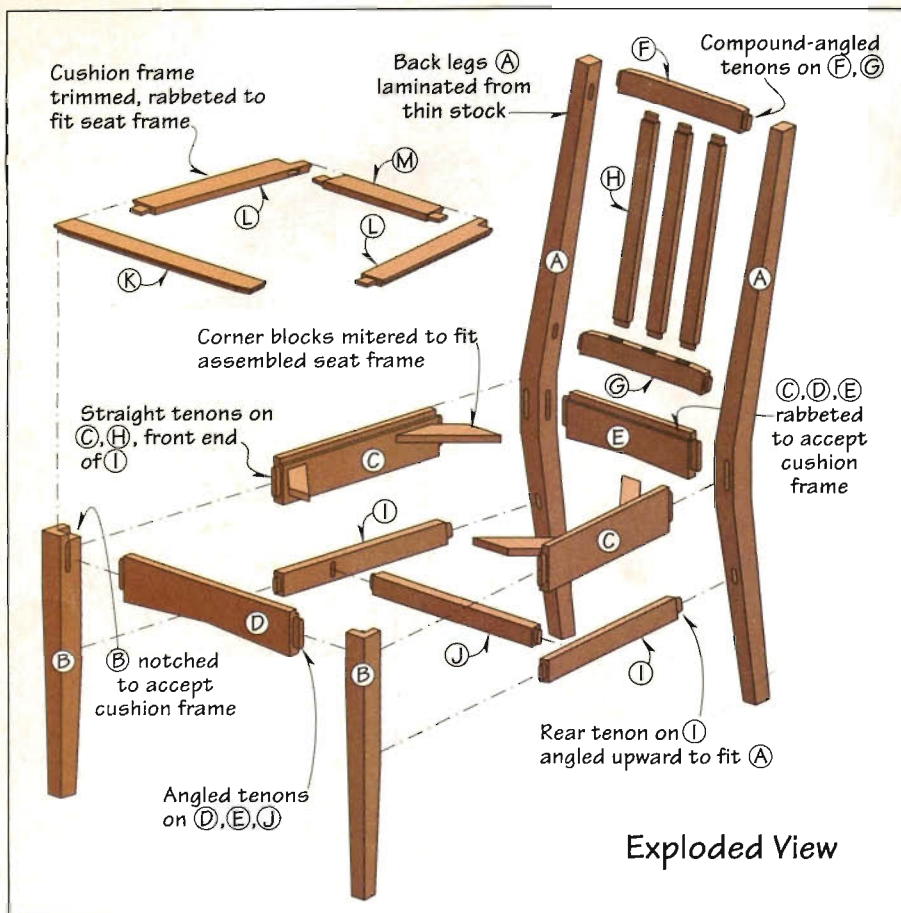
Upholstery webbing; 1" upholstery foam; upholstery fabric; upholstery staples; #8x1 1/2" flathead wood screws; hardening oil finish; 3/4"-dia. nylon glides (four per chair).

Shaping and Mortising the Front and Back Legs

To create a flat mortising surface on the front of the back leg, trace the contour of the leg's front face onto a piece of 1/2" plywood, then bandsaw it to form a contoured template. (See *figure 2*.) Using a straightedge as a guide, rout a flat surface on the template using a pattern bit. I clamped this template to each leg, then used the same bit to rout the flat on each back leg at the point of its bend.

On this same template, lay out the top and bottom ends of the leg and the mortise for the seat frame side (C), then transfer these to the back leg blanks. Next, cut the back legs to length, squaring the bottom end to the flat mortising surface and the top end of the leg to itself.

For the front legs, start with solid, 1 3/4"-square blanks 18" long. Joint two adjacent faces, then plane the two remaining faces to 1 5/8" square. Square one end, then trim the opposite end to finished length. To avoid confusion, I

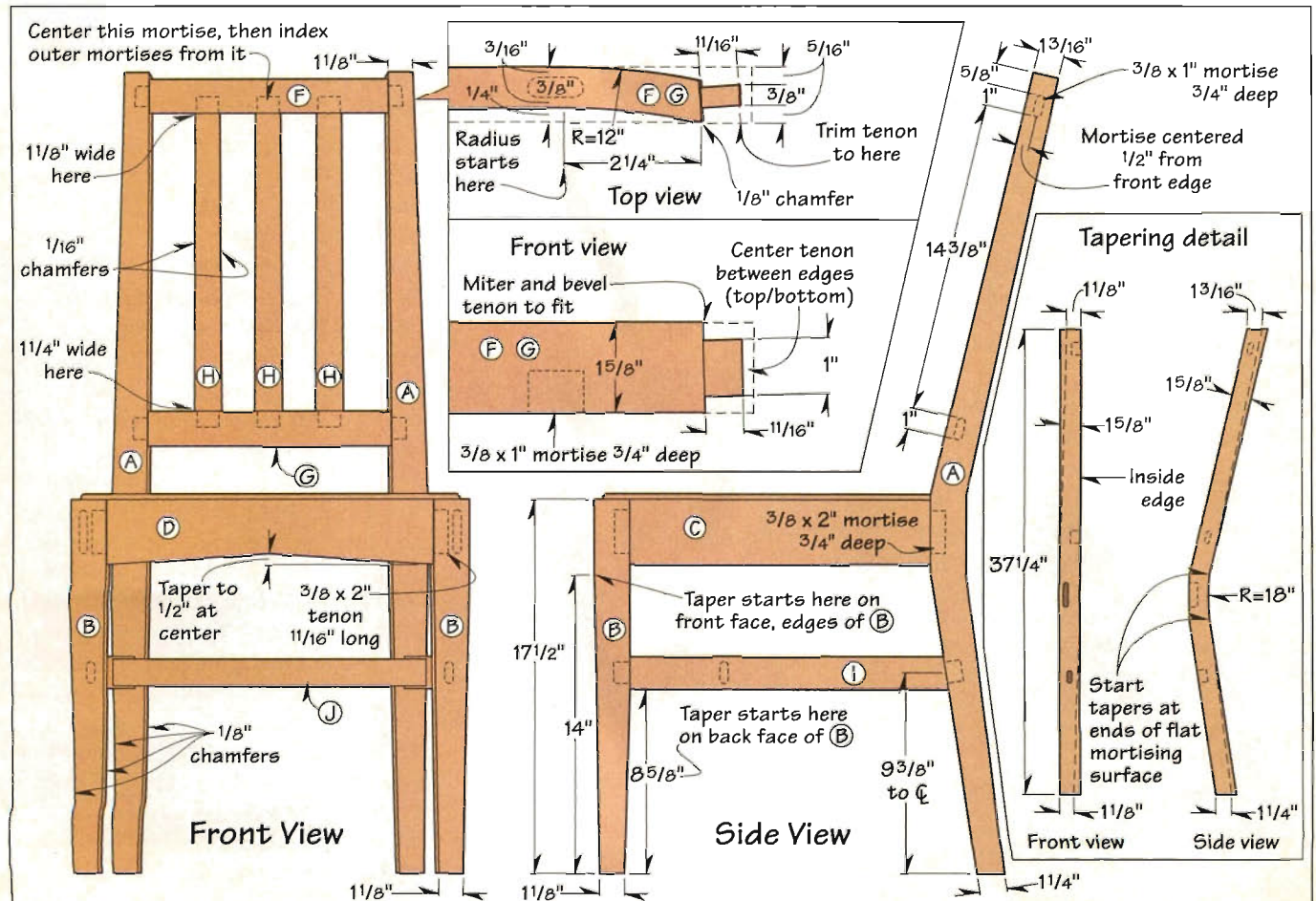


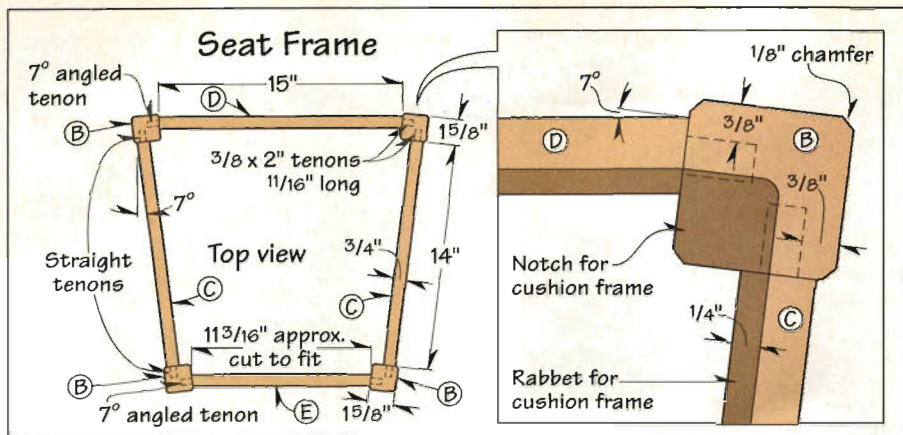
marked a bottom end, inside edge, and back face on each.

Align and clamp each front leg to the routed flat on its corresponding back leg, positioning the front leg's top end $\frac{1}{2}$ " above the top of the back leg mortise layout. Transfer the mortise layout to the inside edge of the front leg. (For location, see the Side View and Seat Frame drawings.)

Lay out the mortise for the side stretcher (I) on the same edge of the front leg, then transfer its centerline to the back leg using a try square. Note: From the centerline, lay out this mortise perpendicular to the back leg's front face. Unclamp, then transfer the seat frame mortise layouts to the appropriate faces of both legs. You should have mortise layouts for all seat frame parts (C, D, E). Lay out mortises on the inside edge of the upper back legs for the back rails (F, G) where dimensioned on the Side View.

Set your mortiser to cut $\frac{3}{4}$ " deep, then cut all mortises in the front and





back legs. If you don't own a mortiser, use a plunge router, edge guide, and a $\frac{3}{8}$ " spiral upcut bit. To limit the length of the seat frame mortises, use a mortising jig. For the remaining mortises, limit length with stop blocks.

Now, taper the back and outside leg faces above the mortised flat. Below the flat, taper the back and inside surfaces. I bandsawed the taper then belt-sanded them smooth, but you may prefer to make a jig and cut the tapers on the tablesaw. Cut the tapers on the front legs as dimensioned on the Side View drawing.

The Seat Frame Parts Come Next

Surface cherry stock for the frame parts to $\frac{3}{4}$ " thick and cut the frame sides (C) to finished dimensions. I cut the frame front (D) and back (E) 1" over length. (See the Seat Frame drawing above.)

As mentioned, the frame sides have square tenons, while those on the front and back are angled. To cut the angled tenons, tilt the tablesaw blade to 7° from perpendicular. Lay the piece flat, then cut the shoulders using a miter-gauge extension and stop block. Next, stand the piece on end, adjust the cutting depth (without changing the blade tilt), and cut the tenon cheeks to thickness using a tenoning jig. (See figure 3.) Note: Always keep the "finish" face against the jig to maintain accuracy in cutting both tenon cheeks.

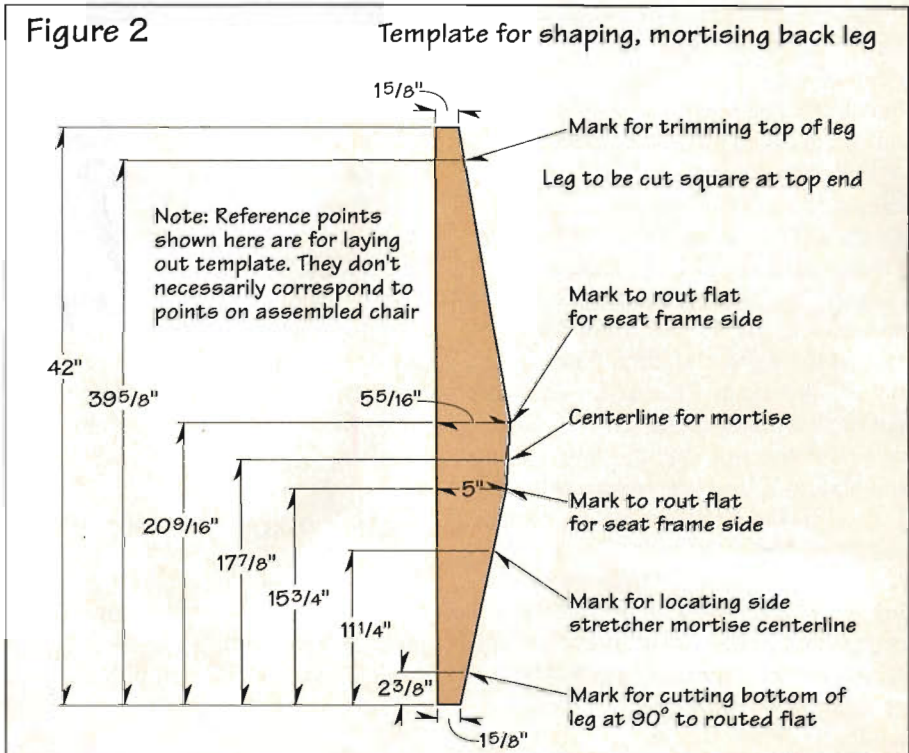
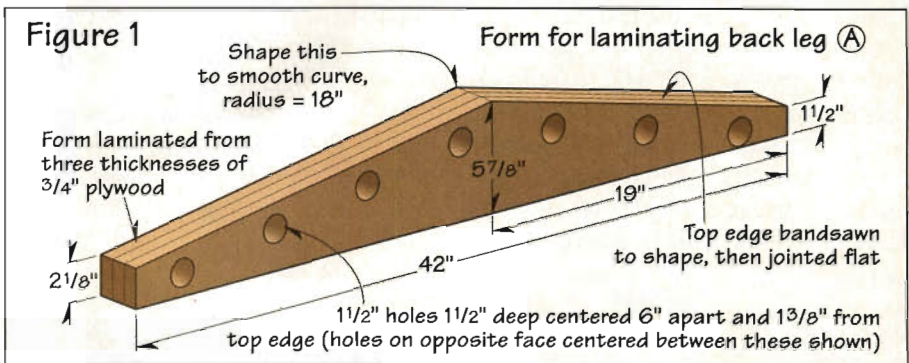
Without changing the 7° tilt, lay the frame front flat and trim the tenons to length, squaring them to the angled cheeks. Next, raise the blade to full height and set a sliding

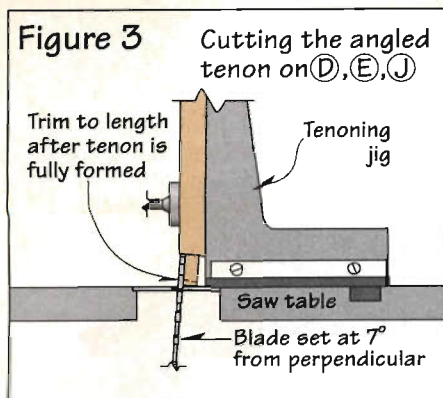
T-bevel to match the blade tilt. Use this setting to reset the blade later to the identical angle. Now, reset the blade to perpendicular and cut the tenons to width, standing them on edge to cut the shoulders, on end to cut the cheeks. If your mortises

have round ends, round the tenons to fit.

Cut the seat frame back to fit. To do this, I first located the two back-leg mortises that would accept the frame back tenons. Next, I laid out the $\frac{3}{4} \times 3$ " ends of the frame back on the legs so I'd know where the part would actually contact the legs.

Dry-assemble the other frame parts to the legs, then measure for the frame back's length (i.e., between the points where the front face of the part will contact the legs). I laid out this length on the frame back's front face. Note: The fit should require neither squeezing the back legs together nor forcing them apart. Reset the blade tilt using the sliding T-bevel you set earlier, then cut the angled tenons using the same procedure as before.





Cutting Compound-Angled Tenons On the Back Rails

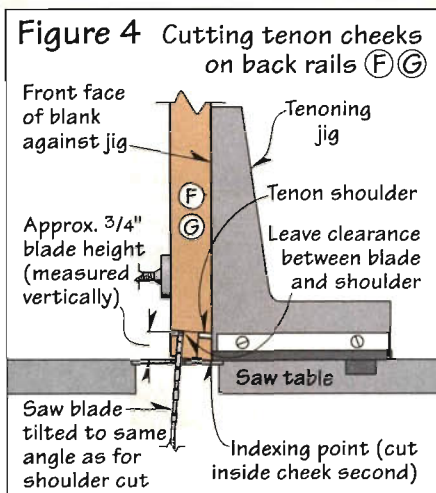
As you dry-assemble the chair at this point, notice that the splayed back legs converge slightly toward the top. This means that the back rails (F, G) will require compound-angled tenons and that these two rails will differ slightly both in length and tenon angle.

Surface 5/4 stock to 1" thick, then cut the two rail blanks to finished length plus 1". To fit the rails, use the same technique you used to measure for the frame back, but this time, you'll need to measure the top-to-bottom as well as the front-to-back angle. Measure the widest and also the narrowest distance each rail will have to span. (See the detail shown on the Front View drawing.)

Using these measurements, lay out the compound-angled tenons on the ends of the blanks. Using a sliding T-bevel, transfer the miter angle to your miter gauge and tilt the tablesaw blade to match the bevel.

I set the tilted blade to cut 5/16" deep, measured vertically from the tabletop. I then laid the rail blanks flat and bevel-mitered the tenon shoulders using a stop block. To do this, I cut the front face of the right end, then flipped each blank over, turned it end for end, and cut the back face of the left end. Next, I reversed the miter-gauge angle using the sliding T-bevel to ensure accuracy. I then cut the shoulder on the remaining faces of each blank.

Next, cut the tenons to length, squaring them to the shoulders. To do this, I repositioned the stop block on the miter-gauge extension. Then, without changing the blade tilt or miter-gauge angle, I elevated the blade and cut through the blank.



To cut the tenon cheeks to thickness, stand the rail blank on end with the front face against the tenon jig. I rested the mitered end (not its beveled surface) flat on the table. (See figure 4.) After clamping the blank in this position, cut the two cheeks, first the outside, then the inside (facing the fence).

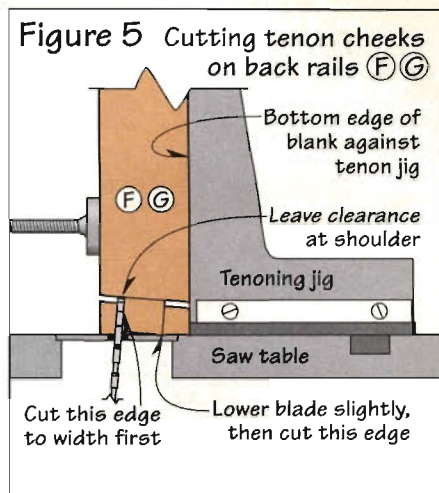
To cut the cheeks on the opposite end of the rail, turn the blank end over end, keeping the same (front) face against the jig. (The top of the blank will now angle toward the front of the jig.)

To cut the 1"-wide tenon to width, turn the blank so its edge rests against the jig. (See figure 5.) As before, rest the end of the angled tenon on the table, then clamp the blank to the jig. Adjust the blade height so the blade will connect with the shoulder kerf but not cut into the shoulder. Then, cut the outside edge of the tenon to width. Move the fence, lower the blade slightly, and cut the inside edge.

After rounding the tenon edges, I dry-assembled the back rails to the rest of the chair. At this time, I also measured the distance between the back rails to determine the length of the slats.

Mortising and Shaping The Back Rails

Lay out mortises for the three slats on the back rails. (See the dimensions on the Front View and accompanying detail.) To do this, I started with the middle mortise, centering it between the ends, then



indexed the two outer mortises from this one. I cut them using a plunge router, jig, and stop blocks.

On the bottom edge of each back rail, lay out the profile as dimensioned on the Front View detail. I first scribed a straight line 1/4" from the front face. Using a 12"-radius template, I drew a pair of arcs to establish the curvature at the ends of each rail.

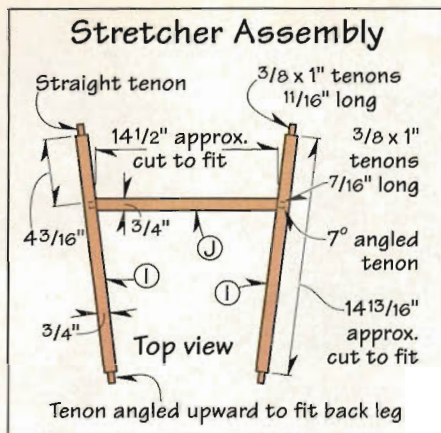
Stand each back rail on its top edge and bandsaw it to profile, keeping the blade just wide of the line. Note: The angled tenon shoulders make it difficult to enter and exit this cut cleanly so I avoided the ends with the bandsaw and sanded these areas to shape. Next, I sanded the bandsawn cuts to the line using an oscillating spindle sander on the front and a stationary disc sander on the back.

On the front ends of each rail, cut a 1/8" chamfer along the tenon shoulder. Note: There isn't a perpendicular surface for a bearing to ride against, so it's best to use the tablesaw with miter gauge, extension, and stop block. The extension serves as a backing board to prevent the corner from chipping out.

How I Prepared the Slats

From 1/2"-thick stock, cut the three slats (H), adding an extra 1 1/16" of length to both ends for the tenons. Cut straight tenons to fit the back rail mortises. Dry-assemble the slats to the rails to check for fit. (See the Front View drawing.)

Taper the slats in width from bottom to top (1 1/4" to 1 1/8") so they conform to the shape of the narrowing



back. To do this, set the jointer to remove $\frac{1}{16}$ " of stock, then clamp a stop to the infeed table that starts the taper $\frac{1}{16}$ " from the tenon shoulder. Lower the bottom end onto the outfeed table, bearing down on the infeed (top) end while applying only slight pressure to the outfeed end. This tapers the cut from zero at the bottom to $\frac{1}{16}$ " at the top.

Making the Side and Center Stretchers

From $\frac{3}{4}$ "-thick stock, cut the two side stretchers (I) and one center stretcher (J) 1" over length. Select and mark an inside face and front end on the side stretchers and a back face and bottom edge on the center stretcher. (See the Stretcher Assembly drawing above.)

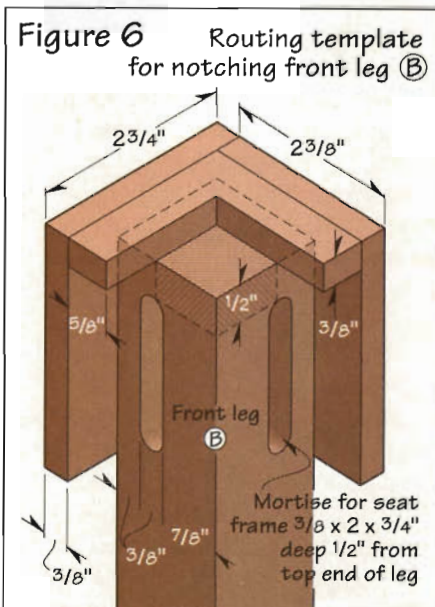
The front ends of the side stretchers require straight tenons, but the back-end tenons must be angled upward to fit the back-leg mortise. With the chair dry-assembled, I used the sliding T-bevel to mark these ends for length and angle and added an $\frac{1}{16}$ "-long tenon to both ends.

To cut the angled tenons, use the same procedure you used to angle (not bevel) the back-rail tenons. Then, add the side stretchers to the dry assembly to check for fit. When the fit looks good, lay out and cut a $\frac{1}{2}$ "-deep mortise for the center stretcher on the inside face of each side stretcher.

Turn the dry-assembled chair upside down, then position and clamp the center stretcher (J) across the top edges of the side stretchers, centering it over the mortises. Mark the edge of the center stretcher where it intersects the



Photo B: A stack of front leg assemblies with the top edge of the frame rabbeted to accept the cushion frame. Front legs have a matching notch, which the author routs using a simple shop-made template.



side stretchers. Remove the stretcher, then lay out a $\frac{7}{16}$ "-long angled tenon on both ends. I cut these tenons using the same procedure I used to tenon the seat frame front (D).

Preparing For Assembly

Cut a $\frac{1}{2}$ " rabbet $\frac{1}{4}$ " deep on the top inside edge of the seat frame parts (C, D, E) to accept the cushion frame. Also notch the top inside corner of the front legs to match the rabbet on the frame parts (*photo B*). To do this, I made a template that clamps to the top of the leg, then routed the notch using a $\frac{7}{16}$ " guide bushing and $\frac{1}{4}$ " straight bit. (See *figure 6*.)

Next, cut the profile along the bottom edge of the seat frame front and back as shown in Front View. I band-sawed the parts to rough shape first, then made a template for each part and routed them to final shape using a pattern-following bit.

Using a table-mounted router and a chamfer bit, rout the edges and ends of all chair parts: $\frac{1}{16}$ " on the slats and stretchers, $\frac{1}{8}$ " on the rest of the parts.

Now, Finish and Assemble The Chairs

Finish-sand all parts to 220-grit, taking care not to round the chamfers.

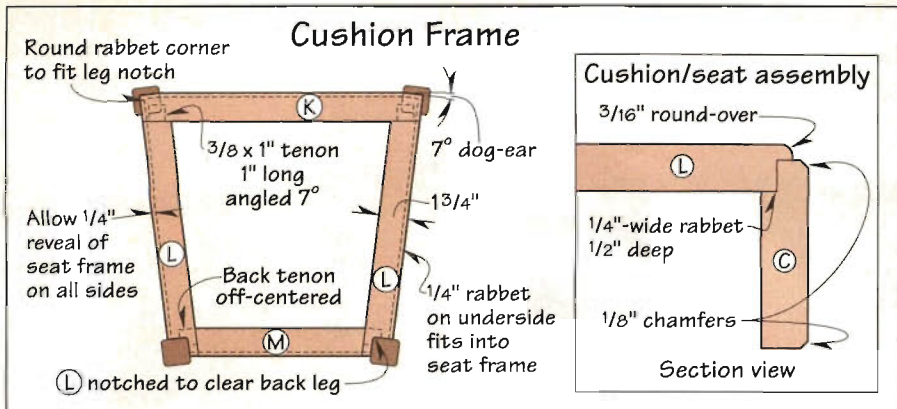
After masking the tenons and mortises, I applied three coats of Danish oil finish, rubbing each coat wet with 0000 synthetic wool and then wiping it dry. You may prefer an oil/polyurethane blend, depending on foreseeable wear.

After the finish cures, glue, assemble, and clamp each chair in the following order: first, the front legs to the frame front; next, the slats to the back rails; then, the back legs to the frame back and back rails. Next, I glued and assembled the center stretcher to the side stretchers, then immediately glued and clamped this assembly and the frame sides to the front and back leg assemblies to complete the chair.

To make corner blocks, prepare a 2x16" piece of $\frac{3}{4}$ "-thick stock. With the chair frame upside down, lay the stock across each corner, hold it firmly in place, then trace the corner angle onto the face. I used the T-bevel to transfer the angles to the miter saw.



Photo C: Miter-cut corner blocks to fit the odd-angled joints. The shank hole drilled through block is used to attach the cushion frame after upholstery. Also note the $\frac{1}{4}$ " chamfer on exposed ends and edges of parts.



Counterbore and drill the blocks, then position them in the seat frame corners. Drill pilot holes through the shank holes, then install the blocks (photo C). Now, drill pilot holes in the leg ends and attach $3/4$ "-diameter three-prong nylon glides.

Upholstering the Chair

To lay out the cushion frame parts (K, L, M), measure the outside dimensions of the seat frame. Subtract $1/2$ " from the width and length of this trapezoidal shape to allow a $1/4$ "-wide reveal of the cherry seat frame around the cushion perimeter. (See the Cushion Frame drawing above.)

Rip 6 linear feet of $3/4$ "-thick pine to $13/4$ " wide, then crosscut the cushion frame parts to 1" over length. Next, arrange the pieces to form the trapezoidal frame, overlapping the sides with the front and the back with the sides. Then, mark the ends of the

parts to the correct length and angle, allowing extra length for the tenons on the sides and back.

Lay out and cut matching mortises and tenons on the cushion-frame parts. Dry-assemble the parts. If everything fits, glue and clamp the frame. After the glue dries, cut a slight (7°) dog-ear at each end of the frame front to make it parallel to the front leg. Also, trim the back ends of the sides flush with the back (M).

Rout a rabbet around the bottom edge of the cushion frame to make it fit partially into the seat frame. (See the detail on the Cushion Frame drawing.) The rabbet should measure approximately $1/4 \times 1/2$ ", but remember to allow for the fabric thickness. Now, round the rabbet at the front corners to fit into the front-leg notches.

Notch the back corners of the cushion frame to clear the back legs.

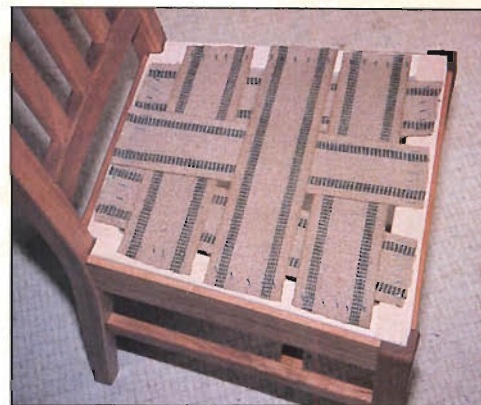


Photo D: Weave the strips of upholstery webbing, then staple one end of each to the cushion frame. Stretch each strip tight, then staple the opposite end to the frame.

Then, rout a $3/16$ " round-over around the frame's top edge to create a smooth edge for the upholstery.

Check the fit of the cushion frame, then cover the frame with upholstery webbing. To do this, I wove the pieces, stretched them tight across the frame, and stapled them to the cushion frame (photo D).

Next, cut 1"-thick foam to match the shape of the cushion frame. Stretch the fabric tightly over the foam and staple it to the back of the frame. To make sure you get the fabric tight and uniform, start stretching and stapling at the center of each side, working out to the corners. To install the upholstered cushion, I drove $\#8 \times 1 1/4$ " screws through each corner block and into the cushion frame. *WJ*

Photographs: By the author

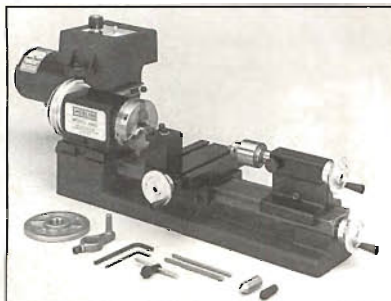
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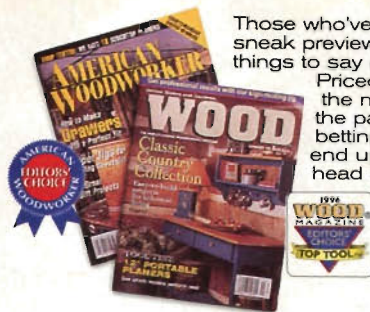
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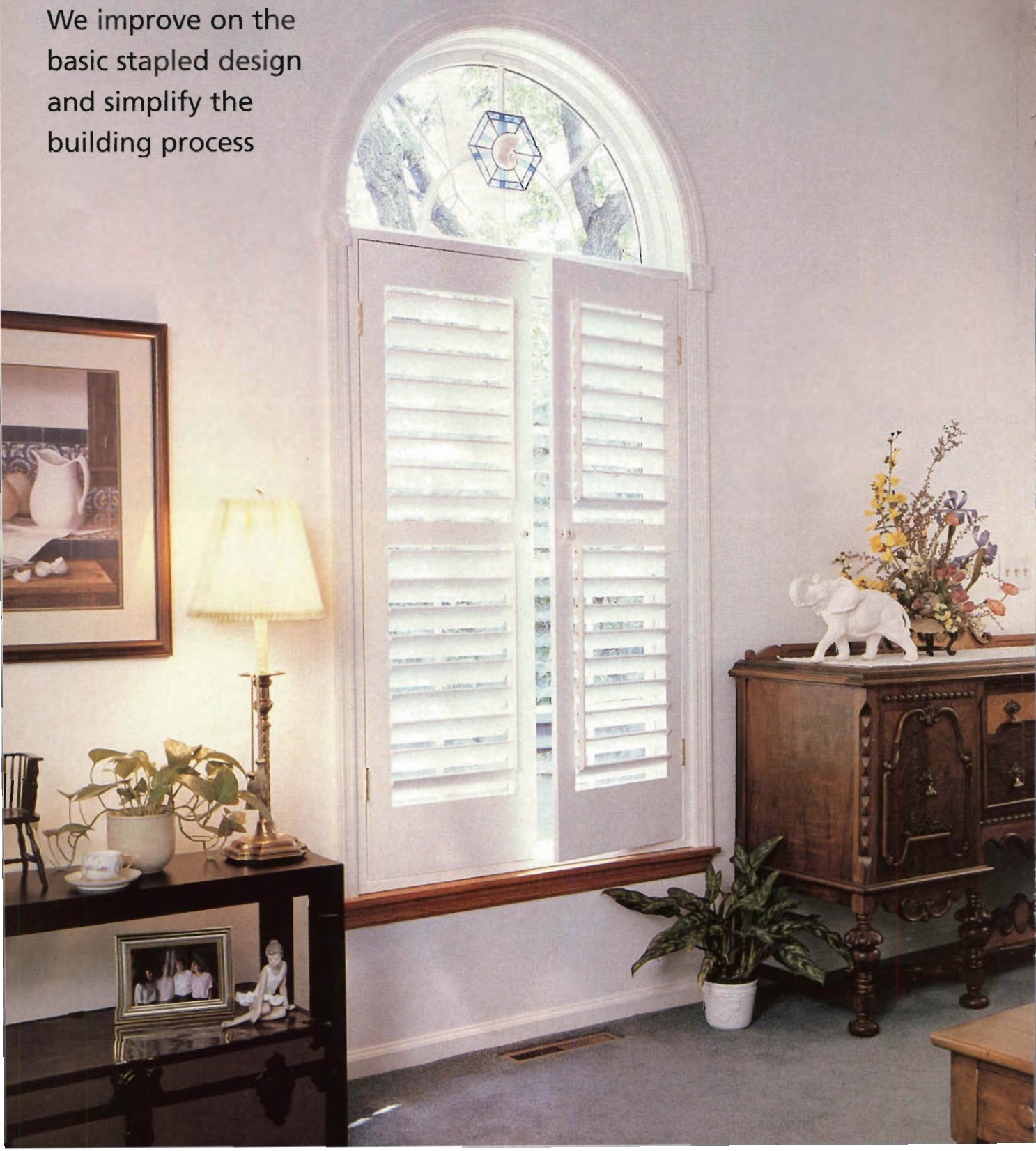


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BILL OF MATERIALS

SHUTTERS

PART	T	W	L	MTL.	QTY.
A Louvers*	½"	3"	14⅞"	P	34
B Stile—center**	1¼"	3"	60¼"	P	1
C Stiles	1¼"	2½"	60¼"	P	4
D Rails—bottom	1¼"	6 ²⁹ / ₃₂ "	13 ¹⁵ / ₁₆ "	P	2
E Rails—middle	1¼"	2 ⁵ / ₁₆ "	13 ¹⁵ / ₁₆ "	P	2
F Rails—top	1¼"	4"	13 ¹⁵ / ₁₆ "	P	2
G Openers—bottom	¼"	1⅞"	22 ¹³ / ₁₆ "	P	2
H Openers—top	¼"	1⅞"	20 ³ / ₃₂ "	P	2

*Parts cut to final size during construction. Please read all instructions before cutting.

**Overlapped center stile (B) cut ½" wider than overlapping stile (C) to maintain same apparent width when rabbeted.

MATERIAL LIST

P—poplar

SUPPLIES

#0, #20 biscuits; #4x¾" brass flathead wood screws; 4–3x1½" brass hinges; latex primer; semi-gloss latex enamel; brass or wood cabinet-type pull; roller catches; additional 6/4 stock for window frame.

Before You Start

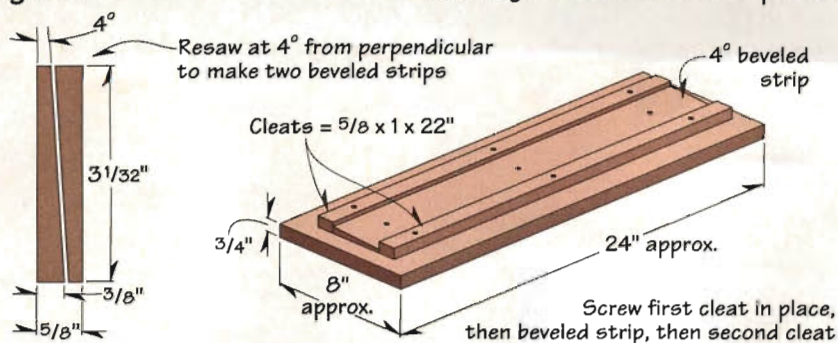
When we set out to work up our own version of these timeless favorites, our first criterion was "They have to surpass the kind you can buy ready-made at the home-supply center." To do that, we specified better stock, requested a cleaner, trimmer

look, designed a more positive means of opening the louvers than the center-mounted, staple-connected adjusting rod, and demanded construction procedures that didn't require unusual tools or complex jigs and fixtures.

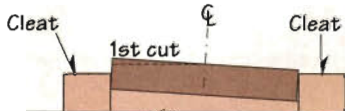
Now, check the product of our efforts in the photos at *left*. Note that we moved the center opener to one end of the louvers and attached it with small screws instead of staples. This innovative design change makes their operation very smooth and quiet, and cleaning of the louvers a breeze. You'll also find overlapping rabbets along the center stiles—they keep the center-stile gap light tight. You'll see the same feature where the shutters inset into the window frame. But probably the best part of all, you can make these shutters with a minimum of shop equipment (tablesaw, drill press, thickness planer, and biscuit joiner) and with basic woodworking techniques.

When it comes to shutters, we know that no one set of specifications would work for everybody. So, designer-craftsman Dick Coers wrote a procedure to help you design shutters to fit your particular set of windows. (See "How To Size Your Shutters" on *page 49*.)



Figure 1**Beveling fixture for surface planer****Figure 2****Beveling louver stock using surface-planer fixture**

Step 1 – Draw ϕ on faces of one workpiece. Gradually raise planer bed and plane up to ϕ

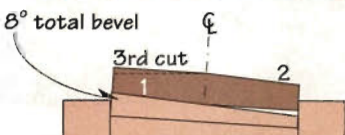


Step 2 – Flip stock over. Plane other side of opposite face at same height

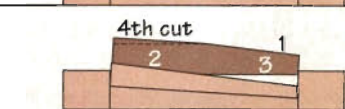


Attach second 4° bevel strip for 8° total bevel

Step 3 – Add second 4° bevel strip. Turn stock end for end. Again, plane up to ϕ



Step 4 – Flip stock over. Again, plane other side of opposite face at same height



Step 4. Lower the planer bed, and attach the second 4° beveled strip on top of the first one in the fixture to double the angle to 8°. (See figure 2, step

3.) Turn your piece of setup stock (with the penciled centerline) end for end, and place it in the fixture. As you did in the previous step, gradually adjust the

PRO TIP

Because the 4° bevel angle is so shallow, it can be tough determining which louver surfaces have been planed and which haven't. To solve the problem, make pencil marks across both faces of the louver blanks before you start. These marks will be planed away as you machine each of the four bevels, making it obvious which surfaces still need to be beveled.

planer bed until you plane away all but the centerline. (This will be cut three.)

Step 5. Flip the stock over, and plane the other side of the opposite face for the fourth and final cut. Now, make the third and fourth cuts on all of your louver stock.

Complete the Louvers

Step 1. Mount a $\frac{3}{16}$ " round-over bit in your table-mounted router. Set the bit to cut a partial radius, leaving a small flat on the louver edge to ensure accuracy when you cut the tenons later. (See figure 3.) Set a notched fence flush with the forward edge of the bit's bearing. Then, rout all four edges on all pieces of louver stock.

Step 2. Crosscut the louvers (A) to finished length ($14\frac{9}{16}$ "), using a miter-gauge extension and stop block.

HOW TO SIZE YOUR SHUTTERS

You'll need to consider three variables when sizing your own window shutters: louver width, louver overlap, and width of the frame rails. It helps to have some general numbers in mind before you start calculating the specifics. For example, I wanted the louvers to measure about 3" wide with a $\frac{1}{4}$ " overlap. I also wanted the top and bottom rails to be roughly 4" and 7" wide respectively. Actually, the only solid dimension I started with was a $\frac{1}{16}$ " clearance at the top and bottom of each section between the louver and rail.

The window I designed this set of shutters for required a 60 $\frac{1}{4}$ "-tall shutter. From this dimension, I tentatively subtracted a 4" top rail and 7" bottom rail to get 49 $\frac{1}{4}$ ". Then, I took off another $\frac{1}{8}$ " for the $\frac{1}{16}$ " clearance at top and bottom, which left 49 $\frac{1}{8}$ ". I figured each louver's net width at 2 $\frac{3}{4}$ " (3" minus $\frac{1}{4}$ " for overlap) and divided this number into 49 $\frac{1}{8}$ ", which came out to 17.86 louvers. So, I decided on 18 louvers.

At this point I knew that a 3"-wide louver would work. The top and bottom louvers in the opening would each measure a net 1 $\frac{1}{16}$ " to the centerline (1 $\frac{1}{2}$ " plus $\frac{1}{16}$ " clearance), which totaled 3 $\frac{1}{8}$ ". I subtracted this total from the 49 $\frac{1}{4}$ " height of the opening, which left 46 $\frac{1}{8}$ ". I divided this net height by the 17

spaces (between the top and bottom louver centers) and got 2.713". This number rounded to 2 $\frac{23}{32}$ "—very close to the net 2 $\frac{1}{4}$ " width of the 3"-wide louver I started with.

Next, I multiplied this rounded center-to-center spacing (2 $\frac{23}{32}$ ") by 17 and got 46 $\frac{7}{32}$ ". I added a 4"-wide top rail and the two 1 $\frac{1}{16}$ " top and bottom spaces, which totaled 53 $\frac{1}{32}$ ". To find the width of the bottom rail, I subtracted this total from the 60 $\frac{1}{4}$ " overall height. This calculated out to 6 $\frac{29}{32}$ "—just a bit shy of the 7" width I originally had in mind.

Because of the height, I decided to add a middle rail, dividing the shutter into 8- and 9-louver sections. To calculate this rail's width, I added the rounded width of two net louver spaces (2 $\frac{23}{32}$ "), which totaled 5 $\frac{7}{16}$ ". From this, I subtracted one louver's actual width (3") plus a $\frac{1}{16}$ " clearance along both rail edges ($\frac{1}{8}$ "). This yielded a 2 $\frac{9}{16}$ "-wide middle rail.

Good luck, and remember to double-check your calculations.

Dick Coers

Designer/Craftsman



Photo A: Fixture used to bevel the four faces on each louver. Note the 4° bevel on the bottom slide strip attached to the auxiliary base.



Photo B: Forming the tenon on the ends of the louvers on the tablesaw. Note dado head partially buried in the auxiliary wooden rip fence.



Photo C: Tablesaw set up to square-cut the $\frac{5}{16}$ " tenons. Note 4° bevel strip again being used to support the beveled louver.

PRO TIP

The louvers must appear level and uniformly spaced, so lay out the tenon holes accurately. To avoid errors, start at the top of the stile, use a fractional calculator to add dimensions, and don't move your tape or rule. Mark the lines with a sharp drafting pencil or other fine-point marker. Before you transfer the layout from your master to the remaining three stiles, make sure you have all stiles perfectly aligned and clamped tightly.

Figure 3 Routing round-over on louver edges

Note: Louver rides against fence, not bearing

Cut partial-radius with $\frac{3}{16}$ " round-over bit

Leave $\frac{3}{32}$ " flat here



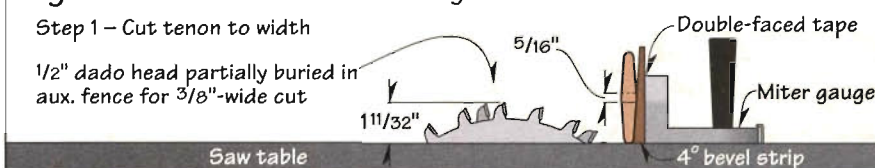
Step 3. To cut the louver tenons, mount a $\frac{1}{2}$ " dado head on your table saw. Attach an auxiliary wooden fence to the rip fence. Next, elevate the dado to $1\frac{1}{32}$ ", partially burying it in the fence but leaving $\frac{3}{8}$ " of cutter exposed. Remove one of the 4° beveled strips from the planer fixture, stand it on its thick edge, and screw it to the miter gauge. Leave a slight clearance between its end and the auxiliary rip fence, but put it close enough to back up the cut to minimize splintering.

Figure 4

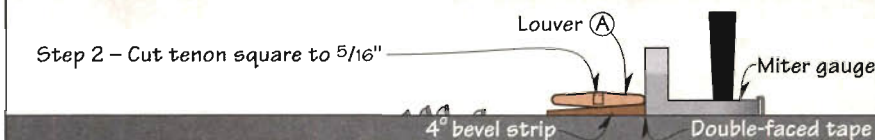
Cutting tenons

Step 1 – Cut tenon to width

$\frac{1}{2}$ " dado head partially buried in aux. fence for $\frac{3}{8}$ "-wide cut



Step 2 – Cut tenon square to $\frac{5}{16}$ "



Step 3 – Cut spacer tenon on one end of louver

Reset aux. fence $\frac{9}{32}$ " to right of first position

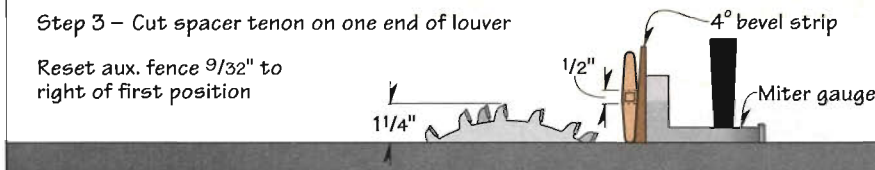
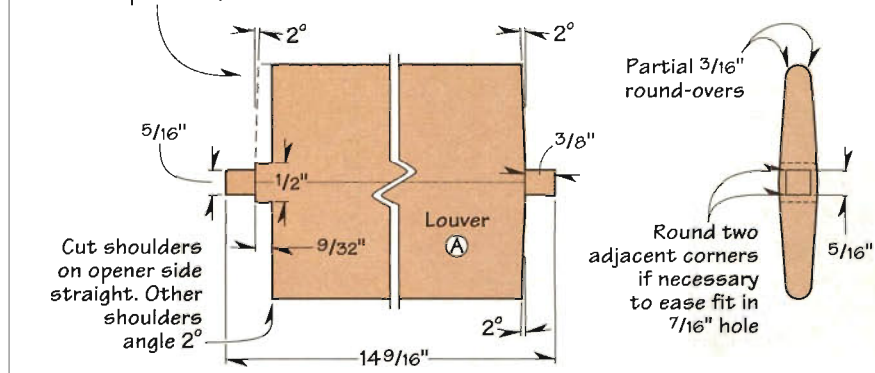


Figure 5

Completed louver

On four top louvers, leave this shoulder intact and cut at 2°



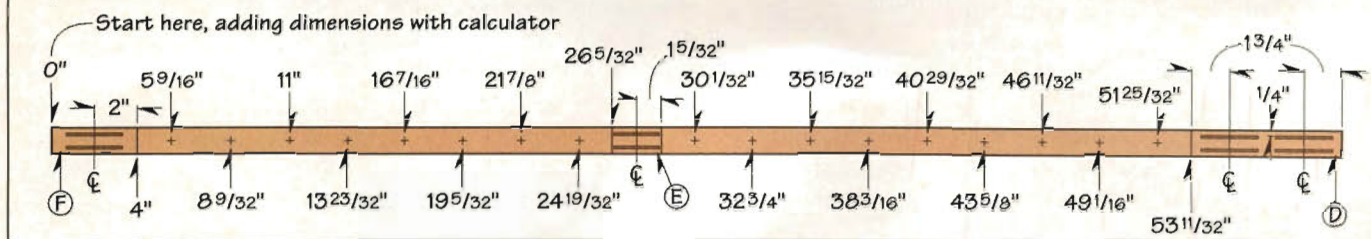
Step 4. One by one, stand each louver on edge against the beveled miter-gauge extension and hold it on edge as shown in step 1 of figure 4 and photo B. Then, using the auxiliary rip fence as a

stop, make four passes over the $\frac{3}{8}$ " dado head to form a $\frac{3}{16}$ "-wide tenon on both ends of all louvers.

Step 5. Remove the beveled strip, lay it flat on the saw table, and adhere

Figure 6

Layout for louver holes and biscuit slots



its thick edge to the miter gauge with double-faced tape. (See figure 4, step 2.) Reset the cutting height to square the tenons to $\frac{5}{16}$ ". Hold each louver horizontally on the beveled strip and make four more passes over the dado head. (See photo C.)

Step 6. Cut an additional $\frac{1}{2}$ "-square spacer on one end of all but four louvers to create clearance for the opener. (See figure 4, step 3.) On the remaining four louvers, cut away only one shoulder (or half of the spacer) as shown in figure 5. To cut this spacer tenon, back the auxiliary fence off the dado head, reset it $\frac{3}{32}$ " from its original position, and set the dado head to cut $1\frac{1}{4}$ " deep. Reattach the beveled strip to the miter gauge as in step 1 of figure 4 to hold the louver vertically. Again, use the auxiliary fence for a stop.

Note: On the ends of the louvers that have only the $\frac{5}{16}$ " tenon, angle-cut both shoulders at 2° from perpendicular where shown in figure 5. This will keep the louvers from rubbing and abrading the paint on the stiles.

Step 7. To make these shoulder cuts, mount a $\frac{1}{8}$ "-thick crosscut blade and tilt it 2° . Elevate the blade to just shy of the $\frac{5}{16}$ " tenon. Set the fence as a stop, allowing the blade to cut away a bit of the shoulder without lengthening the tenon. Again, hold the louvers in the vertical position using the miter gauge and bevel strip.

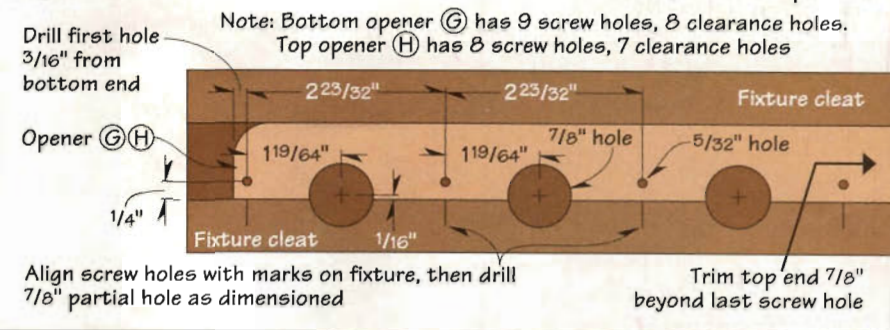
Prepare the Frame Parts

Step 1. Surface stock for the stiles and rails (B, C, D, E, F) to $1\frac{1}{4}$ " thick. Next, rip and crosscut these parts to finished dimension. Note: Use the straightest-grained material for the stiles. If the stock has any slight bow, cut and mark the parts to ensure that the mating stiles will bow uniformly in the assembled frames.

Step 2. Lay out and cut biscuit slots in the rail ends and mating stile edges

Figure 7

Layout for openers



as dimensioned in figure 6. Biscuit the frames together without glue to check for fit, then disassemble. (We prefer to use biscuits for this because they add strength to the joints and help align parts when assembling the shutters.)

Step 3. Using your own dimensions or those shown in figure 6, lay out hole centerpoints for the louver tenons on the inside edge of one stile. (Before you start, see the Pro Tip opposite.) Note: Remember to locate the top hole in each section $1\frac{1}{16}$ " from the rail to allow $\frac{1}{16}$ " of clearance for the louver. Double-check your measurements, then transfer them to the other three stiles.

Step 4. To drill the tenon holes, chuck a $\frac{7}{16}$ " brad-point bit into your drill press. Set a fence $\frac{5}{8}$ " from the bit's center. Mark the front face of all stiles, then keep that face against the fence during drilling to index the holes uniformly. Center the bit exactly on the line for each hole. Drill each hole $\frac{7}{16}$ " deep in all four stiles.

Step 5. Dry-assemble all parts using biscuits. Check for proper fit and clearance, and adjust as necessary. The louvers should clear the rails by $\frac{1}{16}$ " at the top and bottom of each section. The tenons should rattle slightly in the holes. If they're snug, use a file to lightly round two of the corners, but work cautiously—removing just a little material makes a big difference.



Photo D: Boring the partial holes in the openers. Note fence along back edge to position workpiece. Front cleat ensures a clean-cut hole every time.

Machine the Louver Openers

Step 1. To make the four openers, prepare two $\frac{3}{4} \times 1\frac{1}{16}$ " blanks: a 24"-long one for the two bottom openers (G) and a 21"-long one for the two top openers (H).

Step 2. Lay out screw holes on $2\frac{23}{32}$ " centers, the same interval you used for the tenon holes, on one face of each opener blank. (See figure 7.) Center the first hole $\frac{3}{16}$ " from one end of the blank. Note: Plot nine holes on the longer blank, eight on the shorter one.

Step 3. Drill the screw holes in the two blanks. To do this, chuck a $\frac{5}{32}$ "

brad-point bit into your drill press, and set a fence $\frac{1}{4}$ " from the bit's center. After drilling the 17 holes in the two blanks, countersink them on both faces enough to slightly recess the head of a #4 flathead screw.

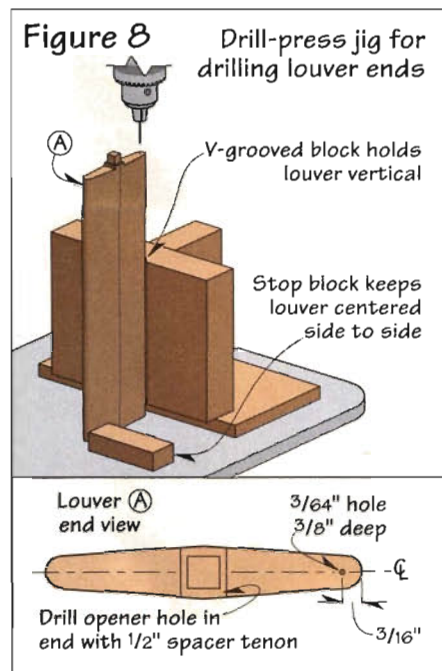
Step 4. You can save lay-out work and improve accuracy by using the screw holes already drilled in the openers to index the $\frac{7}{8}$ " partial holes. To do this, plot the center point of the first $\frac{7}{8}$ " hole on one opener (figure 7). Next, build a fixture to hold an opener between two cleats with a snug sliding fit. (We used a 6x12" piece of $\frac{3}{4}$ " plywood for the base and two $\frac{3}{4}$ "-thick strips for the cleats.)

Step 5. Chuck a $\frac{7}{8}$ " Forstner bit in your drill press. Place an opener in the fixture, position the fixture on the drill-press table, align the centerpoint of the $\frac{7}{8}$ " partial hole under the bit, then clamp the fixture to the table. Using a try square, transfer the centerlines of the two screw holes adjacent to the partial hole onto the bottom cleat as shown in figure 7 and photo D. You'll use them as indexing marks. Now, bore the first $\frac{7}{8}$ " hole. To bore each successive hole, advance the opener until the centerline of the next screw hole aligns with the indexing marks on the cleat.

Step 6. Trim the waste end of each blank $\frac{7}{8}$ " beyond the last screw-hole centerpoint. On the edge opposite the partial holes, lay out and sand a $\frac{1}{2}$ " radius on both ends. Now, resaw a $\frac{1}{4}$ "-thick opener from each face of both blanks for a total of four openers.

Step 7. To attach the openers, drill a $\frac{3}{64}$ " pilot hole $\frac{3}{8}$ " deep in the end of

each louver that has the $\frac{1}{2}$ " spacer tenon. (For location, see figure 8.) To do this, make a jig like the one shown in the figure and use a stop block. This jig has a perpendicular V-grooved block to hold the louver upright, and the stop block orients it from side to side. Note: A bit this small tends to flex and follow the end grain, so feed it very slowly until the hole is at least $\frac{1}{8}$ " deep, then proceed at normal speed.



Assemble the Shutters

Step 1. Dry-assemble the complete shutters using biscuits. To do this, first clamp one stile to your bench. Add the biscuits and the three rails. Next, install the louvers with the $\frac{1}{2}$ " spacer tenons all positioned at the same end and the opener holes at the bottom edge. To add the second stile, start at the bottom end. Insert the biscuits, then start lining up the louvers, bottom one first. Make sure the tenons of all louvers are aligned inside the stile, then engage them one by one with the second stile, working toward the top end. Clamp the assembly, check all clearances, and adjust as necessary.

Step 2. With the assembly still clamped, attach the openers to each set of louvers using #4x $\frac{3}{4}$ " brass flathead screws. Note: The louvers should rattle at this point because the primer and paint will reduce clearances. Check for

PRO TIP

To rout the hinge gains on the shutters, first make a $\frac{3}{4}$ "-thick plywood template 4" wide and long enough to fit inside the window frame ($60\frac{7}{16}$ " on our frame). With a dado head on the tablesaw, cut slots $\frac{3}{16}$ " deep and 3" wide.

Center this fixture on the hinge side of one of the shutters and flush with the front. Chuck a short pattern bit ($\frac{1}{4}$ " long) in a handheld router. To set depth, measure over the leaves of the hinge (with the leaves parallel). Subtract the gap desired between the stile and mounting frame. Divide this by two to get the gain depth needed. Rout the four gains in the two shutters.

Rip the fixture down to $1\frac{3}{16}$ " wide. Place it in the mounting frame flush with the front. You will probably need extra clamps because the plywood is rather flexible. Rout all four gains in the frame. Now, square out the corners of all gains, then attach the hinges.

squareness and smooth opening/closing action, then disassemble the frames.

Step 3. Final-sand the louvers and openers to 150-grit and break the sharp corners. Then, prime these parts. After the primer has dried, sand lightly, and then apply paint. (We sprayed on latex primer and a white latex semi-gloss enamel.) Mask off the joint areas on the stiles and rails, then prime and paint the inside edges.

Step 4. After the paint has dried, assemble the shutters as you did earlier but this time using glue on the biscuit joints. Clamp the frames and check them for square.

Step 5. After the glue has dried, unclamp the shutters, then scrape and sand all joints flush. Check the shutters' outside dimensions and trim if necessary. Next, cut half-lapping rabbets along the inside edges as dimensioned on the Exploded View detail. Note: Make the narrower stile (C) overlap the wider center stile (B) so the two parts will appear identical in width when closed.



Photo E: Shutter openers are attached with screws for more durable construction and mounted to the side for a cleaner look.

Build a Frame, Then Hang the Shutters

Step 1. Surface 1 1/4"-thick stock for the window frame. Machine the stock to the profile shown on the Exploded View detail. Arrange the shutters as they'll hang in the frame, then measure their overall height and width, adding 3/32" clearance on all sides. Now, miter the frame parts to these dimensions. Slot the mitered ends for #0 biscuits, allowing the slots to break out along the back face.

Step 2. Lay out and cut gains for 3x1 1/2" brass hinges on the outside shutter edges where dimensioned on the Exploded View. (We used 3" narrow brass utility hinges, Stanley number 80-2040.) For help in cutting the hinge gains, see the Pro Tip at left. Center the frame stiles along the outside shutter edges and transfer the gain locations. Cut the gains in the frame stiles.

Step 3. Glue, biscuit, and clamp the frame. Check for square. After the glue has dried, trim and sand the broken-out biscuits flush with the back face of the frame. Fill if necessary. Mount the hinges on the shutters, then attach them to the frame. Check the fit and action, then disassemble.

Step 4. Finish-sand the shutter frames and window frame to 150-grit. Break all sharp corners. Mask off the louver sections, then prime and paint the shutters and frame.

Step 5. Install the frame in the window enclosure using finish nails or trim screws. Shim if necessary to square the frame. Next, mount a pull on each shutter stile (we used 1 3/16"-diameter Amerock white/brass knobs number AM 76268-WH3), centering them in both directions. Install two roller catches (Amerock number BP9823-2G) and strikeplates on the lapping surfaces. (For position, see the detail on the Exploded View.) Now, reattach the hinges and then hang the shutters in the window frame. **Wj**

*Photographs: Studio Alex, Kevin May
Project design: Dick Coers
Written by Doug Cantwell*

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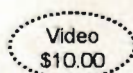
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CRAFTSMAN-STYLE ROUND TABLE

You may recognize the distinctive nail-shaped cutout on the legs of this table. Dick Coers designed it as a companion piece for the Stickley-inspired Privacy Screen in our Jan./Feb. '97 issue, which carries the same "signature" on its slats. To make the table feasible as a weekend project, Dick applied some modern technology, joining the frame parts with pocket screws.



Before You Start

We chose quartersawn white oak for authenticity's sake and also to minimize stability problems in the tabletop and shelf. To reproduce Stickley's ammonia-fumed look as much as possible (without risking our health), we applied a walnut-colored oil finish.

To cut and shape the round tabletop, we used the circle jig attachment on our plunge router as shown on the magazine's cover. (See Sources at the end of the article.) Also, if you haven't yet tried pocket-hole joinery, you can order the necessary tools and instructions from one of the mail-order suppliers listed under Sources.

Start With the Tabletop And Shelf

Step 1. To make the tabletop (A), surface 5/4 stock to 1" thick. Joint the edges. Then, edge-glue and clamp the pieces to form a blank at least 20 1/2" square.

Step 2. For the shelf (B), surface 4/4 stock to 3/4" thick. Edge-glue and clamp a blank at least 13 1/2" square. Plane the blank to 3/4"-final thickness. Note: If you don't have this planing capacity, surface your stock to a heavy 3/4" before edge-gluing, then handplane or belt-sand the blank to final thickness.

Step 3. Mark the centerpoint, then rough-cut a 20"-diameter disc from the top blank. (We rough-cut the blank to

round on our bandsaw using a circle-cutting jig. See *photo A*.)

Step 4. Rout the top to final diameter using a router, trammel base, and a flush-trim bit. (We used a plunge router and the Micro Fence adjustable circle jig attachment shown on this magazine's cover because it allowed us to easily and precisely adjust the jig and rout to final-cutting diameter.)

Step 5. Using a large compass or trammel points, draw concentric 13" and 12 5/8"-diameter circles on the shelf blank. Next, cut a flat on each quadrant of the blank tangent to the circle. (See the Top View drawing *page 57*.) Note: The objective is to form four 3 1/8"-wide flats to fit squarely into the leg dados. (To do this, we adhered the blank to a slightly larger, squared piece of scrap plywood using double-faced tape. See *figure 1*.)

Note: Position the blank so its grain runs perpendicular to two edges of the carrier board. To crosscut the first flat, place one of these edges against the rip fence, then sneak up on the 12 5/8"-diameter line by making several small cuts.

Step 6. Remove your tablesaw's rip fence. Rotate the carrier board 90°, placing the flat you just cut against a miter gauge with extension. (See *figure 1*, step 2.) Cut the second flat, again sneaking up on the 12 5/8" line. Next, remove the miter gauge, and set the rip fence 12 5/8" from the blade. Cut the third and fourth flats by running the first and second flats against the fence. Now, finish-sand the shelf to 220-grit.

BILL OF MATERIALS

PART	T	W	L	MTL. QTY.
TABLE A Top*	1"	20" dia.	Ø	1
B Shelf*	3/4"	13" dia.	Ø	1
C Legs	5/8"	3"	21"	Ø 4
D Top supports	5/8"	3"	12 5/8"	Ø 2
E Feet	1"	1 1/2"	5 1/2"	Ø 4

*Part edge-glued from narrow stock. Please read all instructions before cutting.

MATERIAL LIST

O—white oak (quartersawn)

SUPPLIES

#6x1 1/4" face-frame screws; #8x1 1/4" flathead wood screws; stain; hardening oil finish.

Prepare the Legs and Top Supports

Step 1. Surface stock to 5/8" thick for the four legs (C) and two top supports (D). Rip and crosscut the legs to finished dimensions. Measure the actual distance between the flats on the shelf and cut the top supports to this length.

Step 2. To rout the design into the legs, first make the template and fixture described on *page 58*. Note: If you made the Craftsman-style privacy screen that appears in our Jan./Feb. '97 issue, you can use the template you made for that project. However, you will need to add a stop block in order to shorten the tip of the "nail" cutout.

Step 3. Fit your plunge router with a 1/4" straight bit and a 7/16"-o.d. guide bushing. Clamp a leg in the fixture. Starting near the tip (bottom end), plunge the bit to depth as you move toward the tip. Note: Because of the white oak's toughness, make three passes to cut through the 5/8"-thick material, routing around the template in a clockwise direction. After completing the cutout, remove the waste piece and dust. Repeat the clockwise cut in case dust buildup prevented the bit from cutting a full profile on the first pass.

Step 4. Mount a 3/4" dado head on your tablesaw and set it to cut 1/8" deep. Using a miter-gauge extension and stop block, cut the shelf dado on the inside face of each leg where dimensioned on the Side View.

Step 5. Fit your tablesaw rip fence with an auxiliary wooden fence.

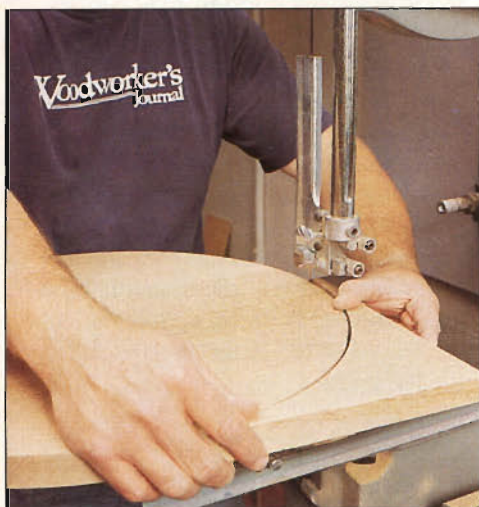
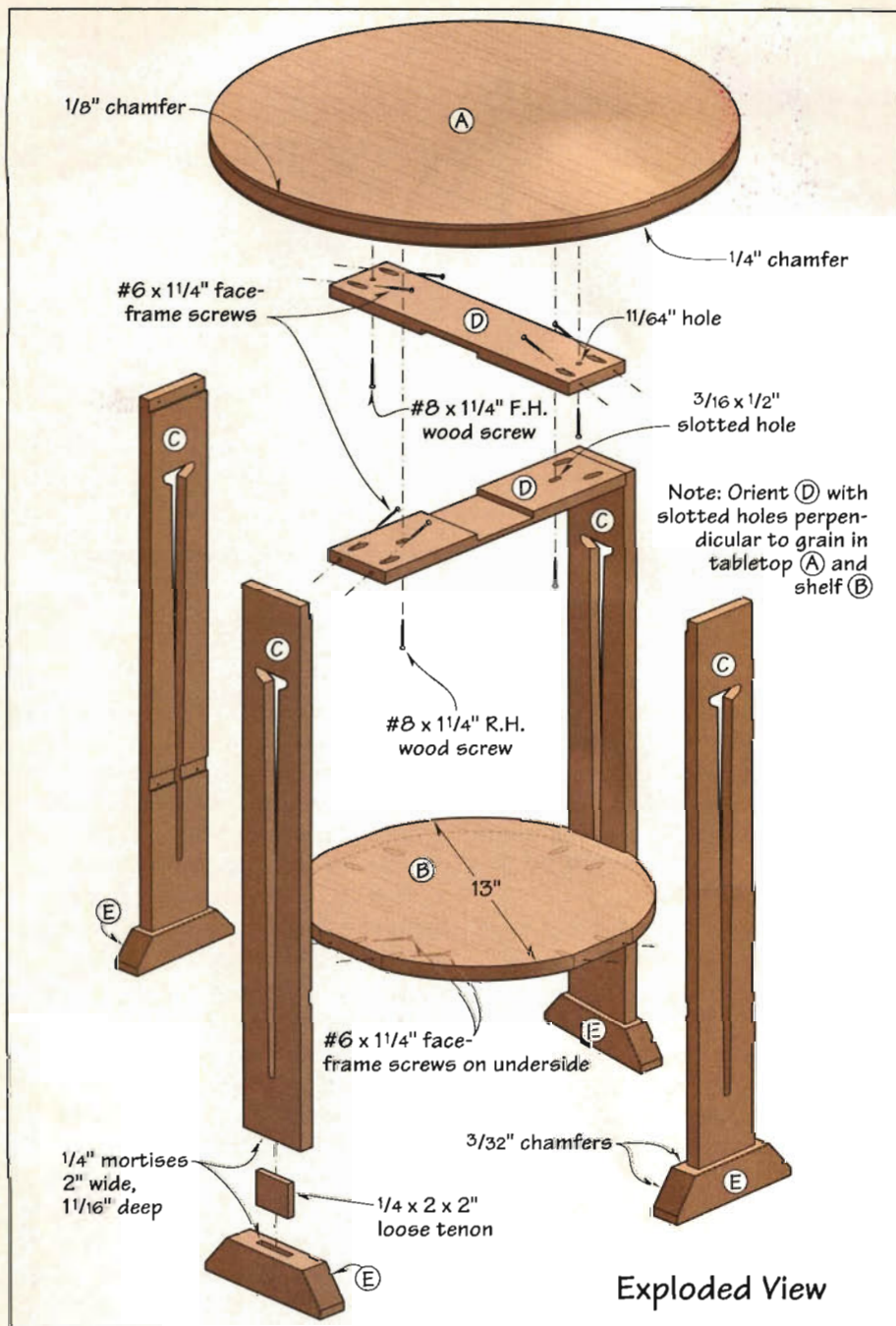


Photo A: The tabletop can be rough-cut on the bandsaw or with a handheld jigsaw. We trimmed our top to final size using the router and adjustable circle jig shown on the cover.



Partially bury the $\frac{3}{4}$ " dado head in it, leaving $\frac{5}{8}$ " of cutting width exposed. Using the fence as a stop and a miter gauge with an extension, cut a $\frac{1}{8}$ "-deep rabbet at the top end of each leg to accept the top support.

Step 6. To cut the half-lap in the top supports, first measure the actual length and width of the supports. Divide the length by two, then subtract half the width from it. (Ours was $4\frac{13}{16}$ ".) Set a stop on your miter-gauge extension this distance from the dado head. Next, measure the actual thickness of the supports, and set the dado to cut half that thickness. (We tested our setup using same-thickness scrap.) Place each support against the stop and make one pass over the dado head. Now, make additional passes, sneaking up to the line, checking the fit after each cut.

Machine the Feet, Then Join Them To the Legs

Step 1. From 1"-thick stock, cut the four feet (E) to dimension. (We used the waste from the tabletop blank.) Cut a centered mortise in the top edge of each as dimensioned on the Exploded View.

Step 2. Cut a matching mortise in the bottom end of each leg for a loose tenon. (After mortising the 1"-thick feet, we added a $\frac{3}{16}$ "-thick spacer to center the mortise in the $\frac{5}{8}$ "-thick leg without changing the mortiser setup.)

Step 3. Surface scrap hardwood stock to $\frac{1}{4}$ " thick. From this, cut four 2"-square tenons.

Step 4. Bevel-cut the ends of each foot as dimensioned on the Side View. Next, using a 45° chamfer bit and table-mounted router, cut a $\frac{3}{32}$ " chamfer along the top edges and ends of each foot.

Step 5. Final-sand the legs and feet to 220-grit. Then, glue, tenon, and clamp the feet to the legs. Note: Orient the tenons so the grain runs parallel to the leg grain.

Assemble the Frame Using Pocket Screws

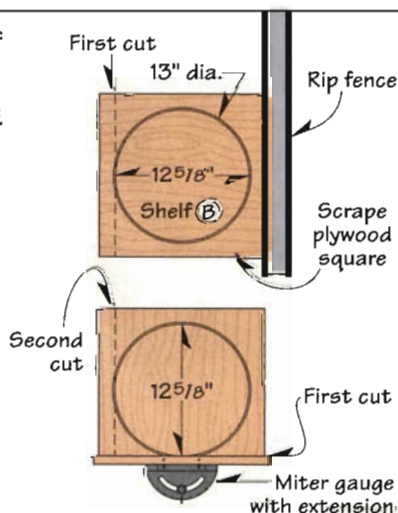
Step 1. Dry-assemble the half-lapping top supports, then mark a top face on the two parts. Lay out and drill pocket holes in this face where dimen-

Figure 1 Cutting flats on shelf

Step 1— Draw concentric $12\frac{5}{8}$ " circle on 13"-dia. shelf. Adhere shelf to squared carrier board with grain running perpendicular to edge. Make several trim cuts to sneak up on $12\frac{5}{8}$ " line

Step 2— Remove rip fence and add miter gauge with extension, turn carrier board 90° , placing first cut against miter gauge. Make trim cuts to sneak up on second $12\frac{5}{8}$ " line

Step 3— Remove miter gauge, add rip fence, set it $12\frac{5}{8}$ " from blade. Place first cut against fence to make third cut. Place second cut against fence to make fourth cut



sioned in *figure 2*. After drilling the holes, enlarge the shank hole in each pocket using a $\frac{5}{32}$ " bit so you won't have to drive the self-tapping face-frame screws through any more white oak than necessary.

Caution: Normally you have more material thickness to screw into so check drilling depth in scrap first to be certain the screw only protrudes $\frac{3}{8}$ ".

(To mail-order pocket-drilling tools and instructions, see Sources. For an introduction to pocket-hole joinery, see

the Contemporary Hall Mirror, pages 34-38 in our Sept./Oct. '96 issue.)

Note: If you don't want to use the pocket-hole technique, you can face screw the legs to the shelf and cross supports using #6 x $1\frac{1}{4}$ " flathead wood screws. To cover the counter-sink holes, use face-grain plugs or chisel the holes square and insert a darker colored wood as a decorative plug.

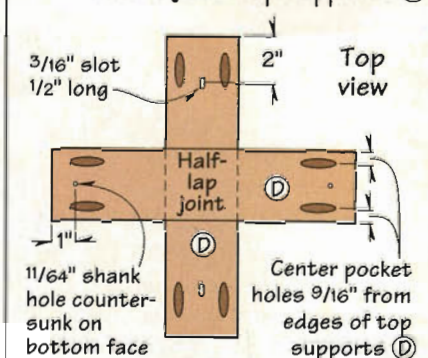
Step 2. To attach the tabletop later, lay out and drill shank holes and slots through the top supports where shown in *figure 2*. **Note:** The

$\frac{3}{16}$ x $\frac{1}{2}$ "-long slots in one support allow cross-grain expansion/contraction in the top; the $\frac{1}{64}$ " shank holes in the other support secure the top in the long-grain direction. Countersink the holes and slots on the bottom faces. Now, glue and clamp the half-lapping supports.

Step 3. Lay out and drill pocket holes in the bottom face of the shelf. (See *figure 3*.) Enlarge the shank holes to $\frac{5}{32}$ " as you did on the top supports.

Step 4. Center a leg on one of the shelf flats. Then pocket-screw and glue the shelf to the leg using #6 x $1\frac{1}{4}$ " face-frame screws. (See *photo*

Figure 2 Pocket hole and screw hole layout-top supports (D)



Note: Slotted holes allow cross-grain expansion/contraction in tabletop

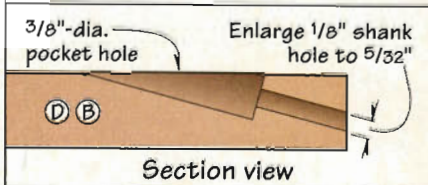
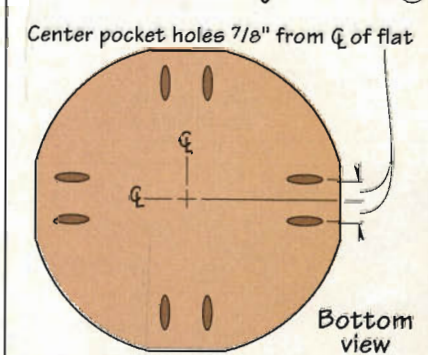


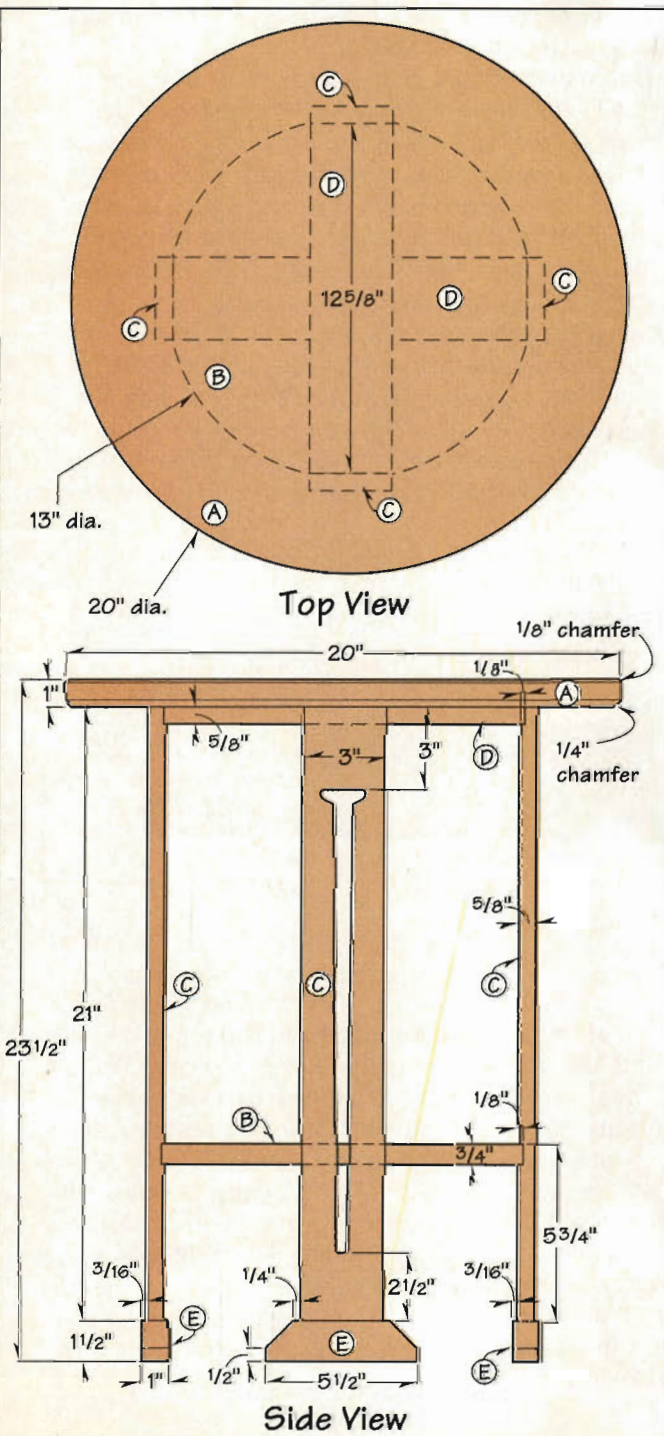
Figure 3 Pocket hole layout-shelf (B)



B.) Note: Apply glue sparingly to make sure it doesn't squeeze out into the leg cutout. Also, do not overtighten the screws. You have only $\frac{1}{2}$ " of leg



Photo B: Using a pocket-hole jig to predrill the screw holes makes assembling the legs and frame easy. Note half-lap top supports and rabbeted legs.

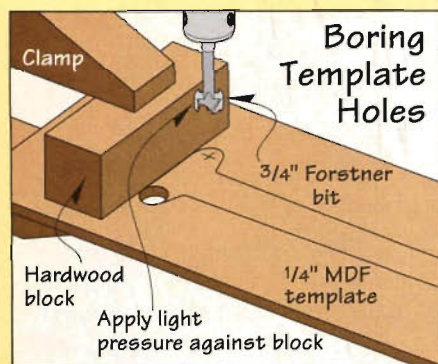
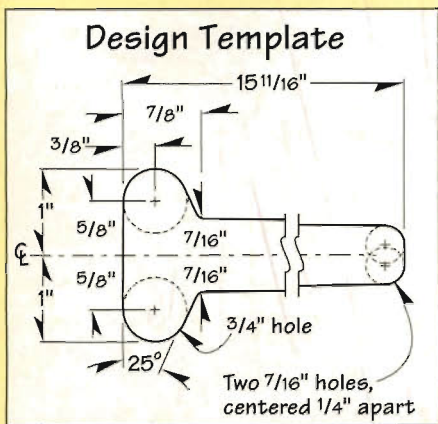


MAKING THE ROUTING TEMPLATE AND FIXTURE

Note: We designed this template for use with a 1/4" straight bit and 7/16"-o.d. guide bushing. To do this, we've oversized the template by 3/32" in all directions. If you use a different setup, calculate the amount of clearance you need to allow by subtracting the bit diameter from the bushing o.d. and dividing by two.

Now, cut an 8x25" piece of 1/4" MDF. Mark a lengthwise centerline, then a perpendicular line across the piece 4" from one end to locate the top end of the template cutout. Measure 15 1/16" from that line, and mark a second line for the opposite end. Lay out centerpoints for two 3/4" holes to form the head of the "nail" and two overlapping 7/16" holes to form the tip. (See the drawing *below*.)

Before drilling the $\frac{3}{4}$ " holes, clamp a scrap hardwood block to the template to serve as a stop. Align the block with the first line you scribed earlier as shown *below*. Use a Forstner bit to drill the holes, applying a slight pressure against the bit with the block to keep it aligned. At the opposite end, use a brad-point bit, centering the two holes $\frac{1}{4}$ " from the centerline.



thickness to work with, and the white oak is so hard that the screws will hold without much penetration.

Step 5. Use a framing square to align a second leg with the first one on the opposite flat. Attach it the same way. Repeat the steps to attach the third and fourth legs to the shelf.

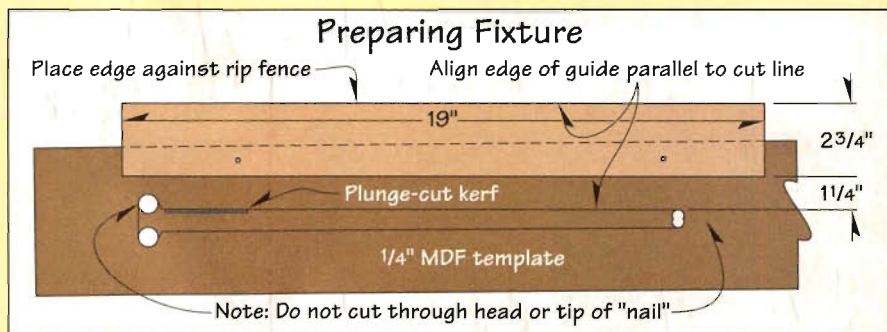
Step 6. Orient the top supports so that the slotted support runs perpendicular to the shelf grain. Then, glue and pocket-screw the supports to the rabbeted top ends of the legs. Finish-sand any surfaces on the shelf/frame assembly that still need it and lightly break all edges.

Using these four holes, lay out the remainder of the template. Scrollsaw the nail's head to rough shape, then carefully file to the line. To cut the long tapers that connect the head with the tip, tack a 2 $\frac{3}{4}$ x 19" straightedge guide parallel to one of the tapering lines. (See the drawing *below*.) Lower your tablesaw blade, then place this guide against the rip fence. Slowly elevate the blade to plunge-cut along the line. Take care that you don't cut through the head or tip of the nail.

Remove the guide, then tack it along the opposite edge to cut the other taper. If the cutout doesn't center perfectly on the template, adjust the rip fence. Cut the second taper, then file the areas you couldn't reach with the plunge cuts and clean up any rough edges.

To complete the fixture, plane a 3x20" piece of scrap hardwood to the same thickness as the table legs. From this piece, rip two 1 1/4"-wide cleats. Cut a 6x24" base for the fixture from scrap 3/4" plywood. Align a cleat with one edge and end of the base, and tack it in place. Using a leg as a spacer, position and tack the second cleat near the opposite edge of the base. Note: The cleats should grip the leg just loosely enough to permit sliding removal of it.

Attach a stop along the end of the base, aligning it with the cleat ends. Position the template on the cleats with the top of the cutout (head of the nail) located $2^{29/32}$ " from the end stop. Center the cutout between the cleats, then screw the template in place. Clamp one end of the fixture to your bench. Use another clamp to secure the leg to the fixture and bench.



Apply Finish, Then Attach the Top

Step 1. Using a 45° chamfer bit, rout a 1/8" chamfer along the top edge of the tabletop. Rout a 1/4" chamfer along the bottom edge. Finish-sand the top faces and edge to 220-grit.

Step 2. Lay the tabletop upside down on a flat, padded surface. Center the frame assembly on the underside, orienting the slotted support perpendicular to the grain. Drill 1/2"-deep pilot holes into the top, using the shank holes and slots

as guides. Note: Center the pilot holes lengthwise in the slots.

Step 3. Apply finish to the frame and both faces of the top and shelf. (We applied Watco Dark Walnut Danish Oil Finish as a stain, allowed it to penetrate for 15 minutes, then wiped it dry. After 24 hours, we applied Watco Natural, wet-scrubbing it with a fine flexible abrasive pad to remove some of the stain from the surface. We wiped the finish dry, then applied a second coat of Natural after 24 hours. This time, we wet-sanded with 320-grit sandpaper, wiped the parts clean, then

allowed them to dry. After the finish dried, we applied a Watco satin wax and buffed it to a low sheen.)

Step 4. Attach the top to the frame using #8x1 1/4" flathead screws but no glue. *WJ*

Photographs: StudioAlex, Kevin May

Project design: Dick Coers

Written by Doug Cantwell

Lamp Courtesy of Stained Glass and Antiques of Peoria

SOURCES

Circle Jig Attachment.

Micrometer-adjusting router fence system. Specify brand and model of router for correct fit. Circle Jig complete (CJC), \$125; Circle Jig attachment (CJA), \$98; Circle Jig and Micro Fence edge guide (MFT), \$219. Order from:

MICRO FENCE
800/480-6427

Kreg Jig Pocket Hole System.

Jig includes toggle clamp, hardened steel inserts, HSS 3/8" step drill bit, adjustable stop collar. Kit no. K2. Price: \$119.95 plus s/h. Order from:

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Pocket Hole Drill Guide

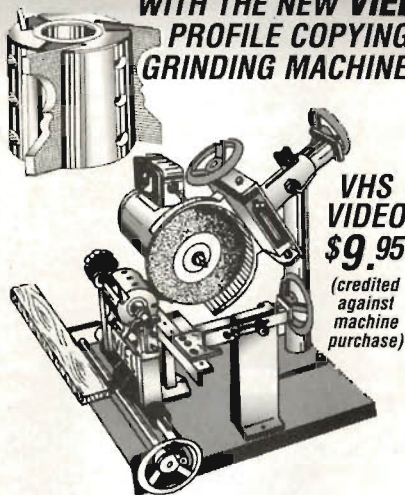
System. Machined aluminum drill guide, carbide-tipped step bit, adjustable stop collar, allen wrench, Phillips bit, 100 screws, and instructions. Catalog no. 03W65. Price: \$44.99 plus s/h. Drill guide (03W62), step bit (03W63) also available separately. Order from:

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Artist's Easel

**A professional, adjustable-height design
that folds to 5" thick**

by Jeanne Minnich

I like to consider myself an artist—in wood, however, not oils. My friend Mikel, who prefers to express himself with paint, asked if I'd make an easel for him. I consented, naively, figuring he had in mind some sort of tripod with a crossbar attached. How difficult could that be? As it turned out, Mikel had something more elaborate in mind. After he showed me the well-worn professional easel he'd been using, I set out to see just how closely I could reproduce it in wood. The results of my exercise you see here.



Before You Begin

Mikel's old easel adjusted three ways using a metal track. I couldn't find suitable hardware, so I devised a slotted system with carriage bolts and knobs that operates about the same way. A trip to the local hardware store yielded those parts and the necessary hinges. The finished product looked good to me and adjusted smoothly, but I wasn't sure that I'd succeeded until Mikel—who was pretty picky about the whole thing—actually used it to paint a picture.

I chose maple for strength and durability, but any sturdy hardwood that doesn't split easily should work. To economize a bit, you can glue up thinner stock to make the 1 3/4"-thick foot and foot brace. I planed the stock oversized initially, then surfaced it to final thickness after completing the joinery.

To keep construction simple, I formed the slotted parts by sandwicing thin spacers between two strips of stock. This eliminated the tedium of cutting long slots. Where frame members join, I cut simple, tight-fitting half-laps and notches, then reinforced the glued joints with screws to prevent racking.

For appearance, I counterbored the visible screw holes and plugged them with contrasting walnut plugs. If you don't want the contrast, use matching plugs. For a more utilitarian piece, you can simply countersink the screws and omit the plugs.

You should be able to find the inexpensive hardware—hinges, carriage bolts, and plastic knobs—at any well-stocked hardware store or building-supply center.

Make the Center And Side Posts

Step 1. From 5/4 stock, rip and crosscut a piece to 3 1/4"x86" (rough size) for the center post (A). Square one edge on the jointer. Next, using a combination square and starting 3" from one end, lightly pencil lines across the face of the board to mark the ends of the slotted areas where dimensioned on the Front View drawing on page 63. Note: Marking the locations of the slots on the stock will

EASEL

BILL OF MATERIALS

PART	T	W	L	MTL.	QTY.
A Center post*	7/8"	2 3/4"	83"	M	1
B Side posts	7/8"	1 3/4"	83"	M	2
C Spreader	7/8"	2 3/4"	26"	M	1
D Crossbar	7/8"	2 3/4"	28"	M	1
E Foot	1 3/4"	2 3/4"	34"	M	1
F Foot brace	1 3/4"	2 3/4"	23"	M	1
G Top brace	7/8"	1 3/4"	27"	M	1
H Lower brace*	7/8"	1 3/4"	36"	M	1
I Tray back**	7/8"	1 3/4"	28"	M	1
J Tray bottom**	1/2"	2"	28"	M	1
K Tray lip**	3/16"	1"	28"	M	1
L Spacer	7/8"	2"	4"	M	1

*Parts edge-joined from narrower stock. Please read all instructions before cutting.

**Parts cut to dimension during construction.

MATERIAL LIST

M—maple

SUPPLIES

One 3" light tee hinge; two 4" light strap hinges; three 1/4"-20 plastic knobs; three 1/4" flat washers; three 1/4"x2" carriage bolts; #8x1 1/4" flathead wood screws; walnut for plugs; finish.

help you realign the grain when you edge-glue the strips back together.

Step 2. From this 3 1/4"-wide board, rip a 1 15/64"-wide strip, then a 9/32"-wide strip, then a second 1 15/64" width. Crosscut the 9/32" strip at the pencil lines to form the 2", 6", and 12"-long inserts.

Step 3. Assemble, glue, and clamp the two 1 15/64"-wide strips with the three 9/32"-wide pieces sand-

wiched between them, keeping the pieces oriented as they were originally. Note: Align these spacer strips with the pencil lines on the wider pieces so the grain looks unbroken. Allow the glue to dry.

Step 4. Surface and then cut a 1 5/16"x4"x86" piece of stock. From this, rip two 1 3/4"-wide strips for the side posts (B).

Step 5. Plane and finish-sand the assembled center post and the two side posts to 7/8" thick. Trim the three parts to final length as dimensioned on the Front View.

Prepare the Spreader, Foot, Crossbar, and Braces

Step 1. From 5/4 stock, rip and crosscut the spreader (C) and the crossbar (D) as dimensioned in the Bill of Materials. Plane and finish-sand both parts to final thickness.

Step 2. From 5/4 stock, rip and crosscut two pieces to 3x36" and two pieces to 3x25". Face-glue the two pairs of parts. After the glue has dried, plane and sand both lamina-



You can retain the attractive grain of the center post wood by using the cutting and assembly technique described in the text at left and above.

tions to $1\frac{3}{4} \times 2\frac{3}{4}$ ", removing equal amounts of stock from both faces. Trim the longer piece to 34" long for the foot (E), the shorter to 23" long for the foot brace (F).

Step 3. From $5/4$ stock, rip and crosscut the top brace (G) as dimensioned in the Bill of Materials.

Step 4. To form the slotted lower brace (H), first prepare a $1\frac{3}{16} \times 3 \times 38$ " piece of stock. Using the dimensions shown on the Exploded View, rip and then reassemble the piece using the

same procedure you followed to make the center post. Plane, sand, and trim the brace to final dimensions.

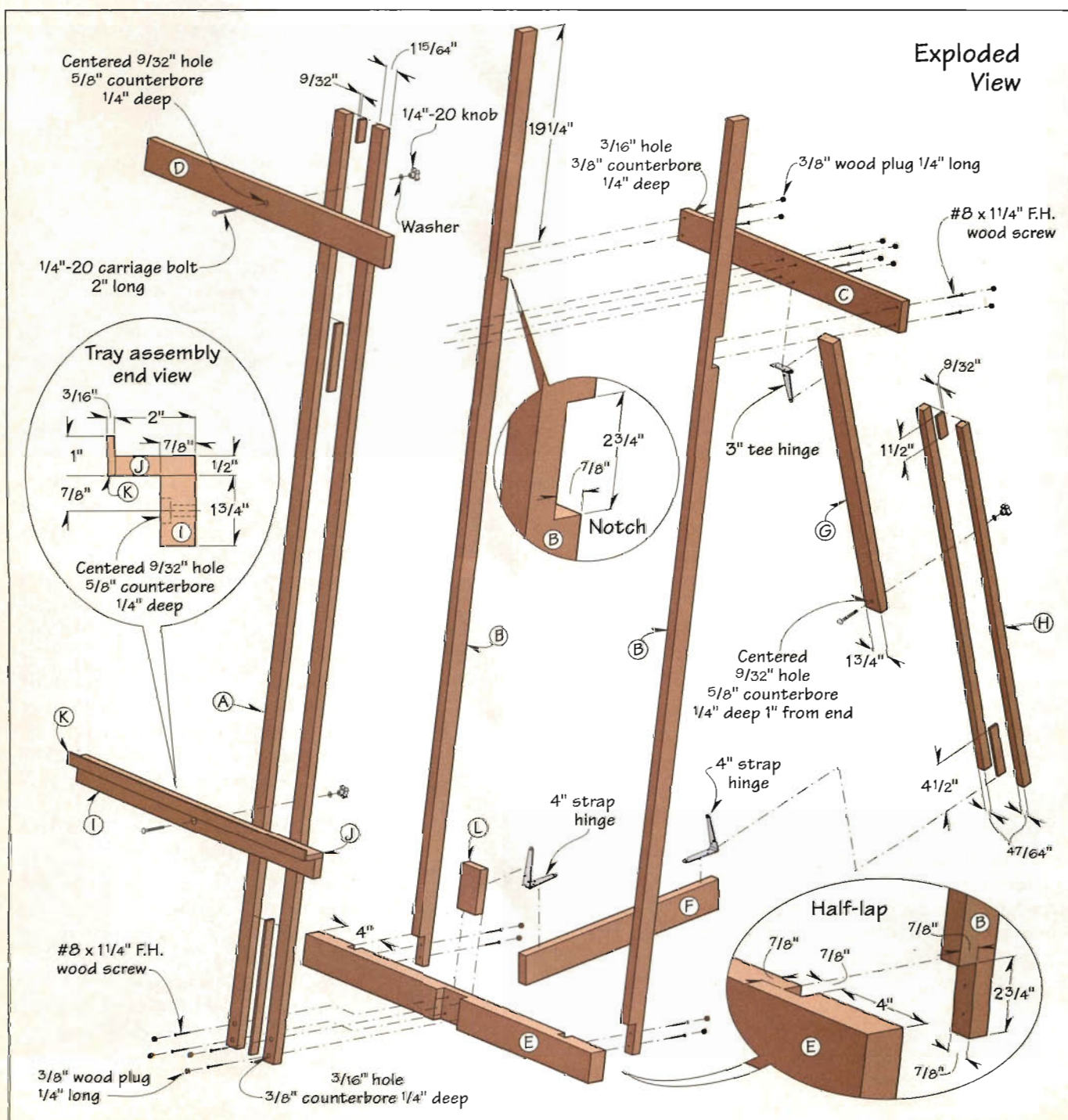
Assemble the Frame

Step 1. Arrange the frame members (foot, center post, side posts, and spreader) on a flat surface as dimensioned on the Front View drawing. Square the vertical parts to the horizontal members. Lay out the half-laps where the side posts join the foot. (To mark the half-lap loca-

tions, I stacked the two pieces. Then, using a sharp knife, I carefully scribed the width of each piece on the part it joins.)

Step 2. Lay out the notch on the side posts for the spreader and the notch in the front face of the foot for the center post. (To locate the notches, I measured to one edge, then used the actual piece to plot the second line.)

Step 3. Using your tablesaw and miter gauge with an extension, cut the half-laps and notches where



marked. Note: Cut the half-laps in the foot and side posts to a depth equal to one-half the width of the parts. (See the detail shown on the Exploded View.) Cut the notches to the same thickness as the embedded frame member ($\frac{7}{8}$ "). To ensure tight-fitting notches and half-laps, I started cutting at one line, made multiple passes, but stopped short of the second line. I then snuck up to the final width using the actual piece for a sizing gauge.

Step 4. Dry-assemble the frame parts to check for fit. Make adjustments as necessary. Square the parts, clamp them in position, then drill the shank and pilot holes. Counterbore the shank holes $\frac{1}{4}$ " deep to accept $\frac{3}{8}$ " plugs.

Step 5. Glue, assemble, and clamp the frame parts. Drive the screws. Cut

$\frac{3}{8}$ " plugs and glue them into the counterbores. Allow the glue to dry before moving the frame. Then, trim and sand the plugs flush with the surface.

Now, Make the Tray

Note: To simplify assembly of the tray, I initially cut the three parts 1" over length. Then, I trimmed the tray to final length after assembly.

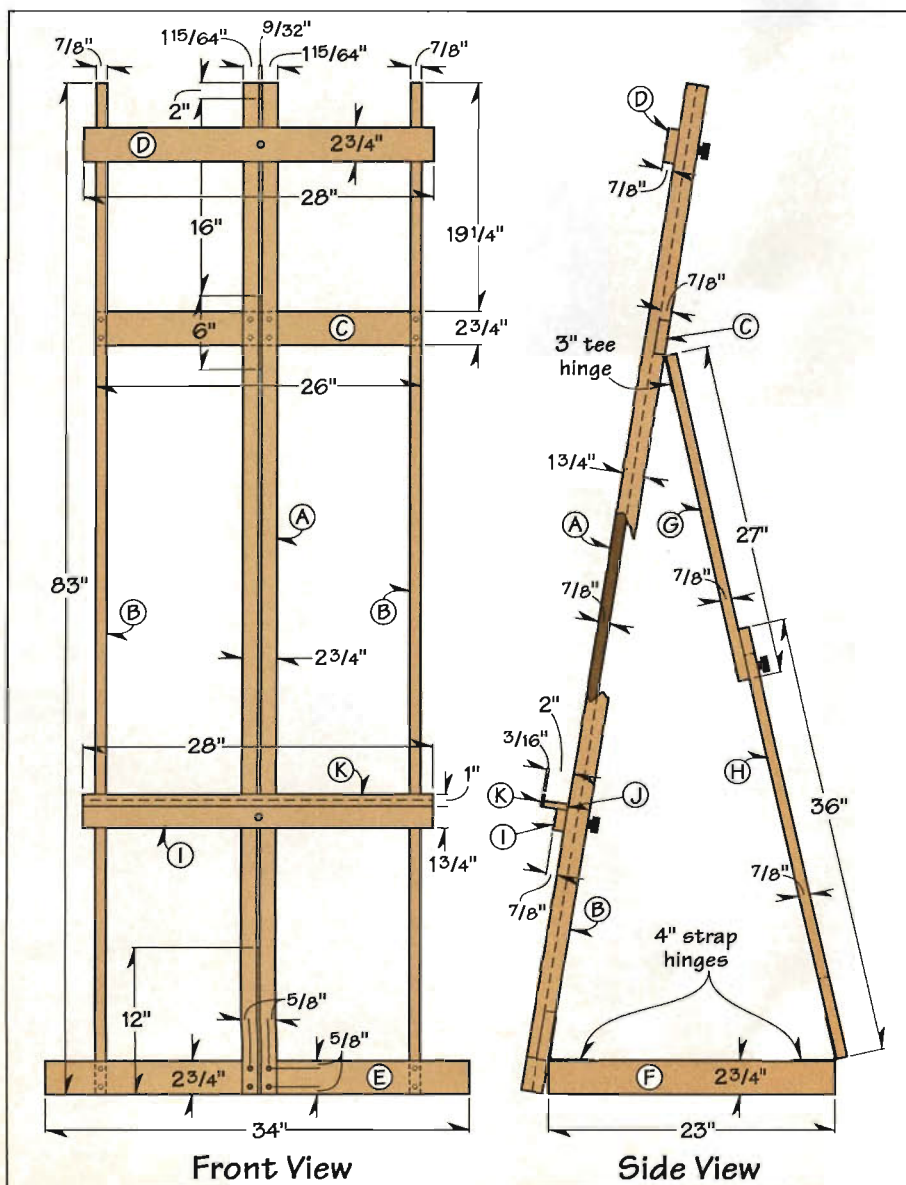
Step 1. From $5/4$ stock, rip, cross-cut, and plane the tray back (I) to dimension plus 1" extra length. Resaw or plane stock for the tray bottom (J) and tray lip (K), then cut these parts to the same length. Finish-sand the three parts.

Step 2. Glue, assemble, and clamp the tray as shown on the detail that accompanies the Exploded View. After the glue has dried, remove the



Meet the Designer/Author

Jeanne Minnich lives and works wood in Austin, Texas, where she's employed as a copy and design editor. Jeanne got her start in woodworking as an antique restorer, then eventually ran her own furniture-making shop in Orlando. She now concentrates her efforts on small jewelry boxes, display cases, intarsia, and commission work.



clamps and trim the tray assembly to final length.

Step 3. Lay out the centerpoints for the holes in the crossbar, top brace, and tray back where dimensioned on the Exploded View. Drill and counterbore the $\frac{3}{32}$ " holes.

Step 4. From maple scrap, cut the spacer (L) to dimension. Glue it to the back face of the center post where shown on the Exploded View.

Apply Finish, Attach Hinges, And Complete Assembly

Step 1. Sand all parts to break the hard edges, then vacuum them to remove the dust. Next, apply your choice of finish. (I used Amity natural stain #91700A to bring out the curly highlights in the maple, then sprayed on two coats of clear satin lacquer, sanding with 320-grit sandpaper after each coat had dried.)

Step 2. Attach the 3" tee hinge (Stanley #14-2460) to the spreader where shown, then to the top brace. Next, attach the 4" strap hinges (Stanley #14-0460). Insert the three $\frac{1}{4}$ "-20 carriage bolts through the holes in the parts where shown on the Exploded View, then complete the assembly. 

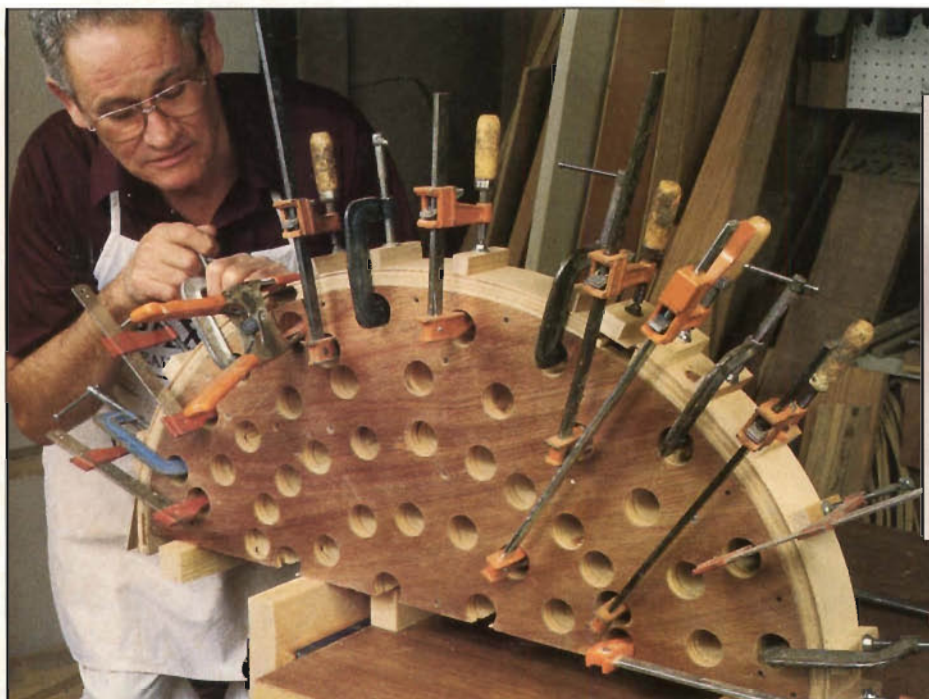
Photographs: StudioAlex, author



Making a Laminated Apron

—And, While You're At It, A Demi-Lune Table

by Sven Hanson



To laminate a curved table apron, use many clamps but light pressure. Here, author's colleague adjusts clamps on the laminated apron for the demi-lune table shown in photo at right.



Author previously described how he makes tapered legs on the jointer for this classic demi-lune table. See pages 30-34 of the Jan./Feb. '97 *Woodworker's Journal*.

Curved Parts: A Great Leap Forward

Adding curved elements to a furniture project can make a striking difference in its appearance. While large curves contribute to good looks, they also increase your workload. At every working step, they demand more time, effort, and skill.

The demi-lune or half-moon table you see in the inset photo has become one of my favorite projects to build. Whether you shape it elliptically (the hardest way) or make as a simple semi-circle, such tables need a curved apron that concentrically matches the top.

Four different methods will produce curved parts: kerfing, steam-bending, bricklaying, and laminating. I've tried all four on various types of projects and prefer laminating for furniture. I like the technique I'll be describing here because it produces

strong, stable parts with a predictable shape. The outside layers have straight grain that has not been tortured by steam or sullied by excess adhesive, so they sand and finish easily. I feel the superior results justify the extra time and material required to make the forms and slice the thin layers of laminating stock.

Begin With a Full-Size Template

This table looks fine as a 16"-to 18"-radius half-circle, but it looks even more elegant as a 16x36" ellipse. To draw the half-circle, you need a large compass or trammel. Drawing an ellipse gets slightly more complicated. For this, I use the simple shop-built device that is described in "Making an Ellipse Machine" on page 67. With

either shape, I add an extra 2½" of depth to the back of the curve when making the template.

To make the template, I draw the three concentric ellipses in full scale on a piece of ¼" plywood, then add the extra depth (*photo A*). I cut along

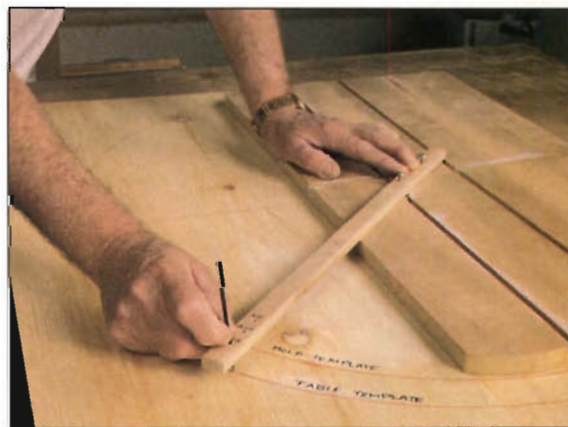
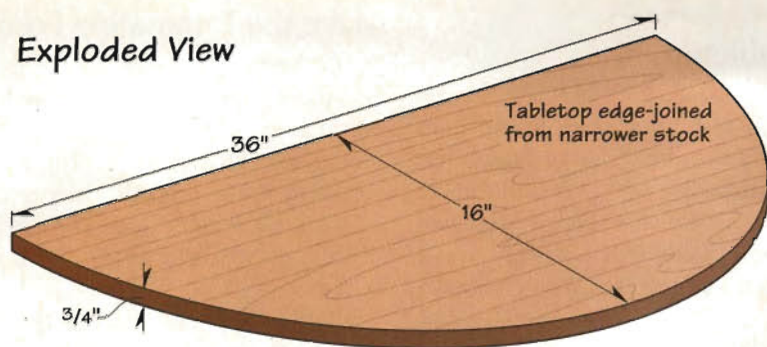


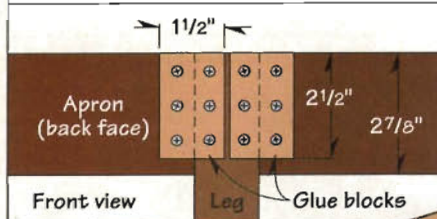
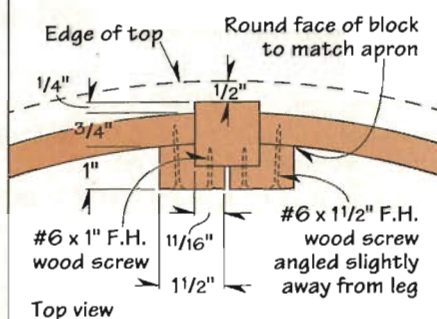
Photo A: Using a simple shop-made ellipse machine, author draws two ellipses on template, one for the tabletop edge, one for the laminating form (back face of apron).

Exploded View

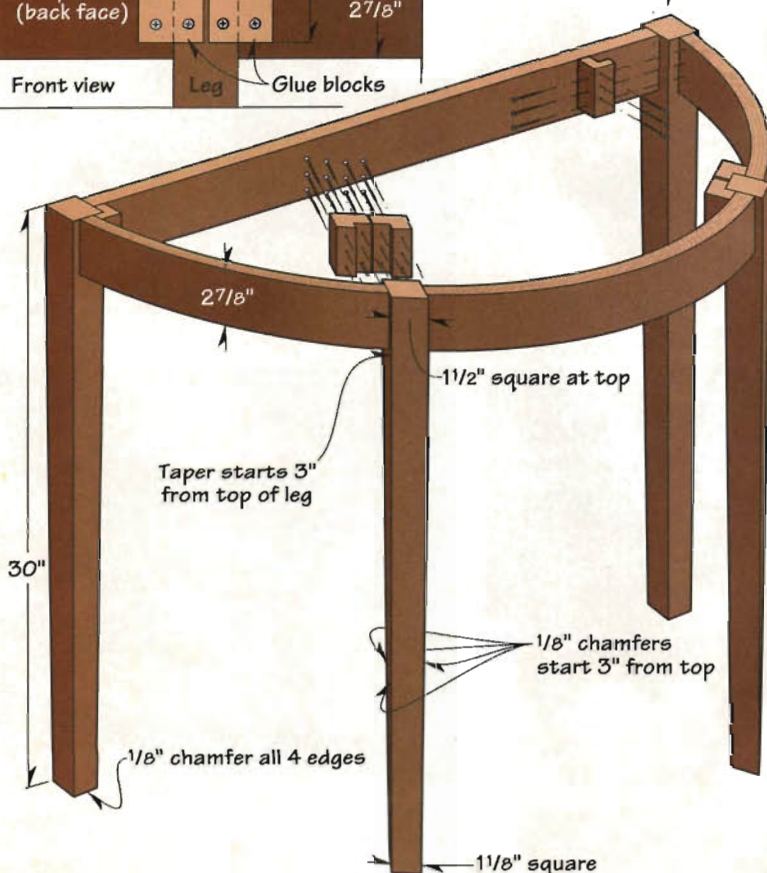
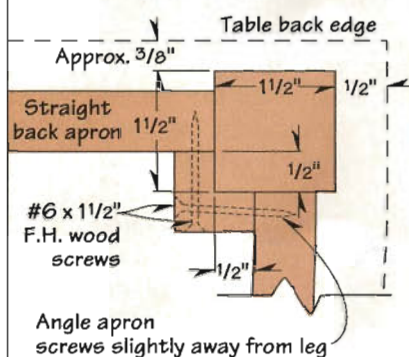


Middle Leg Corner Blocks

Attaching aprons to legs with glue blocks



Back Leg Corner Block



the outside line. Using a large compass, I divide the outside apron profile into three roughly equal arcs. Note: The left and right sections must measure exactly the same, although these two needn't be identical to the middle arc. I also pencil in the 1 1/2"-square profiles of the two middle legs. To make the faces of the legs tangent to the apron curve, I use the procedure shown in figure 1.

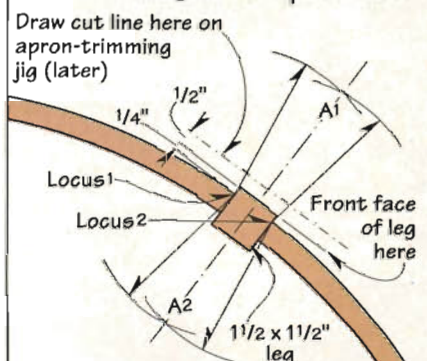
I position the legs so they protrude 1/4" beyond the apron's front face. This slight offset keeps the legs well back from the tabletop edge but still provides enough reveal that any small variation caused by irregularities in the apron will go unnoticed.

Make a Crisp Template Edge

Using a trammel-guided router to shape the curved edge of a template may seem like the best approach. However, the router must cut against the grain along much of the edge, which can do more harm than good. Instead, I rely on three techniques to make a curved template smooth and accurate.

First, I use a fine-tip pen or drafting pencil that makes a sharp cut line

Figure 1 Making middle leg tangent to apron curve



1. Establish location of middle legs with compass by stepping off locus1 equal distance from both ends of ellipse
2. Set compass points at 1 1/2", step off this distance from locus1 to locate other edge of leg (locus2)
3. Draw two arcs each from both loci to form two intersections (A1, A2). Connect A1 and A2 with straight line to establish leg centerline
4. Draw line perpendicular to C 1/4" from loci 1 and 2 to position front face of leg

(unlike the thick lines shown for visibility's sake in the photos).

Next, I bandsaw carefully outside the line, leaving the intact line plus $\frac{1}{32}$ " of unmarked wood. After knocking down the high spots with the belt sander, I sand the edge with a shopmade bow sander (*photo B*). I make this tool by fitting a $3 \times 12 \frac{1}{4}$ " scrap of $\frac{1}{8}$ "-thick Lexan plastic inside a 3×24 " 60-grit sander belt. The Lexan, being slightly longer than the flattened belt, bows and pulls the belt taut like a bowstring.



Photo B: To sand a near-perfect curve on the template and tabletop, author uses a simple bow sander made from a scrap piece of $\frac{1}{8}$ " Lexan that is slightly longer than a flattened sanding belt.



Photo C: Author cuts boards for tabletop to rough shape before edge-joining, then clamps using outside offcut as a clamping caul.



Photo D: To sand a tabletop edge square with its face, author clamps belt sander to the bench, partially burying the bottom edge of the sander in a scrap base piece.

Lay Out and Cut The Tabletop

For the tabletop, select the boards for grain and color, then mark them so you'll know how they go together. Rip them to the width you intend to use, except for the board that will form the outside of the curve—leave it wide so you can use the offcut as a clamping caul. Joint the mating edges, then dry-assemble the boards. Using the template, draw the tabletop on the unglued boards. Then, bandsaw them to rough shape, this time keeping the blade $\frac{1}{8}$ " outside the cut line.

Edge-glue the boards using the waste piece from the outside board as a clamping caul (*photo C*). After the glue-up, I level and smooth both faces, then fair the edge using a belt sander clamped to my bench (*photo D*). When I get down near the line, I smooth the edge to 180-grit using my bow sander and lightly break the edges.

Make the Laminating Form

After laying out the tabletop, I cut and fair the template down to the inside apron line, which also gives me the laminating form profile. I draw the resulting shape onto two pieces of flat $\frac{3}{4}$ "-thick plywood. Note: The plywood needn't be anything fancy, but it must lie flat.

After cutting and fairing the form parts, I assemble them around a core of 2×4 scraps. (See *figure 2*.) I've prepared these scraps in advance by arranging them to cover the entire form, then cutting them to a $\frac{1}{2}$ " smaller radius. I use a square to align the two halves of the form, then glue and screw the three layers together (*photo E*). If the halves end up slightly misaligned, I bring them into alignment after the glue-up using a router and long flush-trim bit.

After the glue has dried, I "ventilate" the form with $\frac{1}{4}$ "-diameter holes to provide footing for the clamps. (See the lead photo *page 64*.) By drilling large holes near the edge and far into the

Figure 2

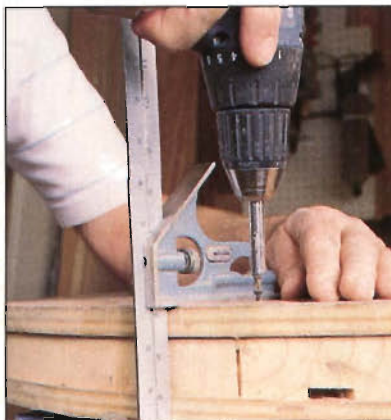
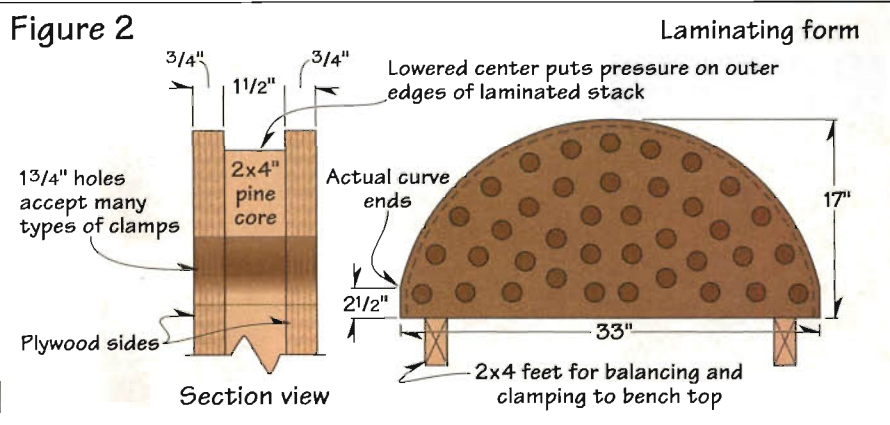


Photo E: Check sides of laminating form for alignment during glue-up. If sides end up misaligned, correct the problem using a router and long flush-trim bit.



Photo F: Author resaws $\frac{3}{32}$ "-thick cherry veneer strips from $\frac{1}{4}$ "-thick stock. For safety, he cuts only one thickness from each piece and inserts scrap in the kerf to prevent binding during the second cut.

center, you can use a variety of clamps. A layer of masking tape along the edges and a coat of paraffin on the curved surfaces keeps the apron from sticking to the form.

Prepare the Laminates

I start by cutting, face-jointing, and planing a 3x60" piece of 4/4 cherry stock. I select the better face of this piece, marking each third for grain sequence, then crosscut the stock into three 20" lengths. For the inner plies, I cut fifteen 3x20" strips of standard three-ply 1/4" birch plywood. Note: Five- or seven-ply material may not flex enough.

To resaw the face veneers, I mount my sharpest rip blade on the tablesaw, elevate it to 1 5/8", and set the rip fence to

cut a 3/32" thickness. I set a feather board that applies pressure at the center of the workpiece and place the better face against the fence. Then, I feed the cherry fast enough to avoid burning, using an icepick to start the cut and a push block to finish. I also insert a thin strip of stock into this first kerf to keep it from binding the blade, then flip the board over and saw through the opposite edge to complete the cut (*photo F*).

A word of caution: I play it safe and take one slice from each of the three boards. I used to make one board yield three veneers, but had too many close calls at the tail end of the third cut. Besides, you can always use the 1/2"-thick left-over pieces on other projects. Because the plywood I use for the core has at least one decent-looking face, I

turn that face inward and let it suffice for the inside face of the apron. This way, I need to cut a veneer strip for only the outside face.

I don't laminate solid cherry for the apron core. Resawing solid stock thin enough to bend would use up about three times as much stock as the thickness of the final lamination—one-third becomes laminate, two-thirds becomes sawdust. Also, cutting that last thickness from a perilously thin workpiece thins my hair.

At first, I tried substituting softer, cheaper wood for the core layers. I then tried 1/4" ply but found it too stiff and the outside layer often broke. To remedy this, I tried planing away the veneer on one face, and voila!—the pieces became flexible in both directions. I had reinvented "bender board." (See *figure 3*.)

A planer with sharp knives can skin the veneer off one face with just one or two light cuts. Many planers will thickness stock only to 1/4", so I use an auxiliary table made of 3/4" melamine-faced particleboard that lifts the work up to the planer knives (*photo G*). In 15 minutes, I'll have 15 pieces—four to

MAKING AN ELLIPSE MACHINE

Of the three or more ways of drawing an ellipse, I prefer the ellipse machine. (See the drawing *below*.) It holds a ballpoint-pen refill very steady, so you can draw and redraw the shape with consistency. To add a concentric line, you need only drill another hole for the pen at some point along the trammel arm.

To make the machine, start with a 14x30" panel. I glued up mine from scrap 4/4 poplar. I scraped and belt-sanded it flat, then laid out the three T-slots where dimensioned on the drawing. Actually, you need only one slot on each axis, but the second slot lets me work closer to the edge.

Form the slots using a keyhole-slot bit and router. Rout the slots to the depth detailed on the drawing. My keyhole bit cuts a wide enough but not deep

enough slot. So, I make several passes to deepen the slot until a 3/8" dowel, waxed with paraffin, fits snugly but slides smoothly. Note: because this is a lot of material for the keyhole bit to remove, you may elect to make the first passes with a straight bit of the same diameter as the neck on your keyhole bit.

For the two slides, cut 2" lengths of 3/8" dowel. Mark a lengthwise centerpoint on each, then drill a 1/8" hole 1/4"-deep at each centerpoint for a #10-32 machine screw.

For the trammel arm, cut a 1x24" piece of 1/4"-thick maple. Lay out and drill a series of three 1/8" holes on 3/4" centers through the arm near one end as dimensioned in the drawing: one for the tabletop outside edge, another for the apron outside or front; and a third for the apron back (which also serves for the laminating form).

From the outermost hole, measure down the arm 16" and 18" respectively and mark pivotpoints for the short and long axes pivots. Drill 5/64" holes at these points.

Insert the waxed dowels into their slots. Assemble the arm and dowels using 5/8"-long #10-32 machine screws.

Figure 3 The laminate stack

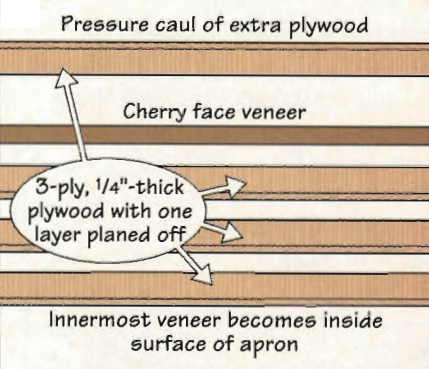


Photo G: To make "bender board" for laminating core layers, plane veneer off one face of 1/4" three-ply birch plywood. Use auxiliary table as shown if your planer won't cut material that thin.

Ellipse Machine

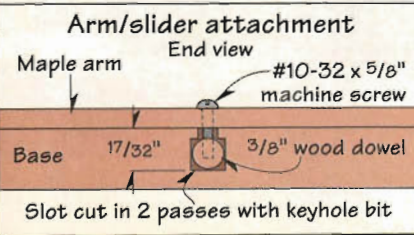
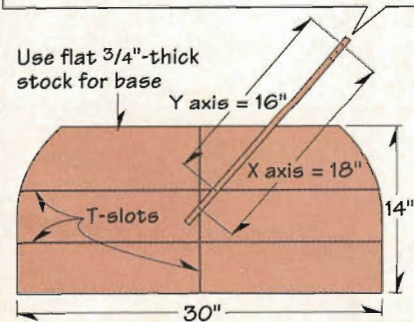
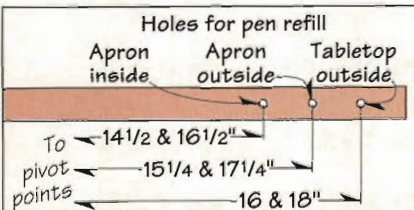




Photo H: For error-free laminating, author dry-stacks and clamps laminates before gluing, then and trims layers to rough length.



Photo I: Author dampens face of laminates with mist (to activate adhesive), then applies polyurethane glue to laminate faces, spreading it evenly using an artist's roller.

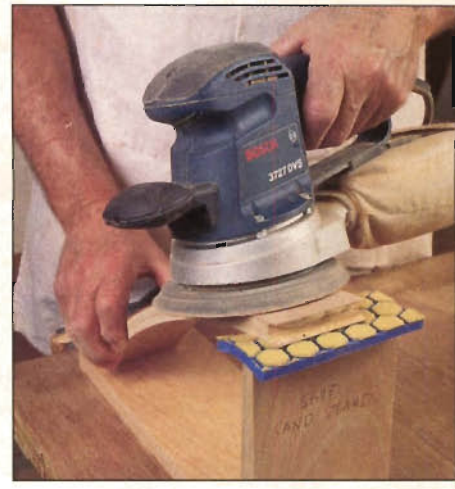


Photo J: After glue has fully cured, author removes apron segments from form and sands cherry faces to 220-grit before assembly.

fill the core of each apron segment plus three to serve as pressure cauls during clamping.

Laminate the Middle Apron

Mark a widthwise centerline on the edges of the core and veneer pieces, then press them over the form. The four $\frac{3}{16}$ "-thick plywood layers each have their (intact) veneer face turned toward the mold, with the best veneer of the four positioned on the inside to become the apron's back face.

Dry-stack the layers, aligning their centers, and center each stack over the centerline marked on the form for that segment. The extra (dry) layer of planed plywood goes on top as a pressure caul. I lay 1x1x3" blocks across the stack to apply even pressure, and then

clamp from the middle, working alternately toward both ends (*photo H*). If necessary, I'll clamp the stack edges to minimize sidewise skating.

The layers should extend to the center of the leg position at both ends. If they extend beyond the center, I saw the stack off at the approximate mid-point using a fine-tooth saw. Note: This preliminary trim ensures that the three apron segments will fit on the form; I don't even think about trimming the aprons to finished length until after the glue-up.

Lift the stack off the form and arrange the plywood pieces with their cross-grain (planed) faces up, the solid cherry veneer with its good face down. I lightly dampen the veneered faces of the plywood and

the back face of the cherry with water from a plant mister, except the face that will contact the form. The moisture will help activate the polyurethane glue.

Apply beads of the polyurethane glue to the cross-grain surfaces and spread it evenly. I use a wood roller from the art-supply store (*photo I*). Next, place the (undampened) birch veneer face on the form, then stack and center the other core pieces on top, followed by the dampened face of the veneer. Place the first clamp on the centerline, then apply clamps alternately, moving toward the ends.

Laminate the Side Aprons

The side apron glue-up proceeds in the same way, except that I align the



Photo K: Joint apron edges to $2\frac{1}{8}$ " final width. Hold the workpiece firmly against fence over cutter head to ensure uniform jointing over its entire length.



Photo L: To trim aprons square to tangent line for middle legs, use a shopmade jig and sliding crosscut table. Note backing board beneath workpiece used to minimize veneer tearout.

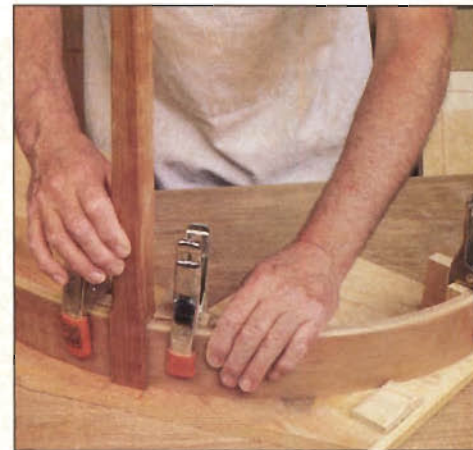


Photo M: Start apron cuts inside marked leg position, then sneak up on final width, test-fitting each leg as you work.

ends of each stack with the center of the middle leg position, and start clamping from that end, working toward the corner of the form. This ensures adequate glue and uniform clamp pressure over the part of the lamination that, once trimmed, will butt against the leg. It also ensures a fair curve and consistent thickness in the apron segments.

It's critical that you clamp all the way to the corners of the form, even though you'll trim away the last 1 3/4" of each apron. Gluing and clamping past the final cut makes stronger, true-shaped parts.

If a minor gap appears between the layers during glue-up, place a clamp over it to help spread the gap out. This won't make it disappear entirely, but the urethane glue will expand, filling at least some of the gap.

Let the glue cure overnight, then remove the three laminated segments from the form. Sand the cherry veneer face of each to 220-grit using a random-orbit sander (*photo J*). Next, joint both edges, removing 1/32" per pass, or joint one edge and rip the second to a final 2 7/8" width. Note: As you work, hold each apron firmly against the fence over the cutter head (*photo K*).

Trim the Aprons To Fit

On these small, light-duty tables I join the apron to the legs with butt joints and reinforce them with corner blocks along the back face. The legs, which I taper on the jointer, measure 1 1/2" square by 30" long, tapering to 1 1/8" square at the bottom. The taper starts 3" from the top. (To make these legs, see my article "Tapering Legs On the Jointer," pages 30-34 in the Jan./Feb. '97 *Woodworker's Journal*.)

For snug-fitting butt joints, trim the ends of each apron square to the adjoining legs. To do this, I use the shopmade jig shown in *figure 4*, which holds the curved parts in their assembled configuration for precise trimming.

I edge-join three pieces of flat 3/4"-thick scrap material to make up the jig base. Using the ellipse machine, I draw the inside and outside lines of the apron, then add the leg positions where marked on the template. I then trim the jig ends to square them and also to center the apron layout. Next, I draw diagonals to locate the center of each leg, then lay out and cut the angles along the front edge of the jig.

Make up nine 3x3" clamping brackets, then glue and screw them to the jig at the approximate points where the aprons join the legs. I also centered one bracket between the leg locations along the curve. Note: Align the two front corners of each bracket with the inside apron line.

To trim the aprons, position and spring-clamp them to the jig brackets.



Photo N: To trim apron for back leg, stand jig on end on crosscut table, then cut apron square to 90° jig end.

Resting the jig on one of its angle-cut front edges, clamp it to a sliding crosscut table. To trim for the middle legs, cut one apron end slightly inside the leg location mark (*photo L*). Then, slide the jig over, reclamp it, and cut the end of the adjoining apron just inside the other leg location mark.

Next, hold the leg against the undersized gap for comparison. I "sneak up" on the final fit by making small trim cuts (*photo M*). To minimize tearout, support the veneered edge with tapered backing blocks that fit between the apron face and the crosscut table. (As an alternative means of avoiding tearout, start with a 1/16"-deep scoring cut, then raise the blade to complete the cut.)

To trim for the other middle leg, rest the jig on its other angle-cut edge. Then, trim for the back legs by turning the jig on end (*photo N*). Note that I use a flat backing block for this operation.

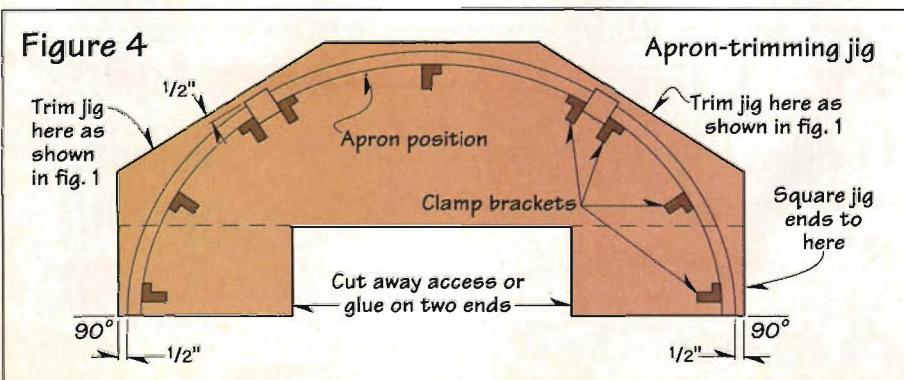
Make the Corner Blocks

Building multiple editions of a project gives you a chance to try different methods at each step, including the joinery. I've found that the butt joint, reinforced with corner blocks, makes a good compromise. What it lacks in tradition and elegance, it makes up for in strength and ease of construction.

For strength, orient the grain of these corner blocks horizontally. (See the details that accompany the Exploded View.) To make the six blocks, I started with a 5 1/8"x12" scrap of 1"-thick cherry. I cut an 1/16"-wide rabbet 1/2" deep on both ends, cut a 5 1/8"x1 1/2" strip from both ends, then cut each strip in half to get four 1x1 1/2"x2 1/2" blocks—two for each middle leg.

For the back leg blocks, I cut a 1/2"x1 1/2" rabbet across one end of my remaining 5 1/8"-wide stock, then crosscut a 5 1/8"x1" strip from this end. I cut the strip in two to get two 1x1 1/2"x2 1/2" blocks one for each back leg.

Lay out, drill, and countersink the six blocks for the #6 screws where shown. Note: In the section of each block that connects to the apron, angle the holes away from the leg as shown. The screws will pull the leg-apron joint tight when you install them.



With the legs dry-assembled to the apron (which is still clamped to the jig), trial-fit the blocks. I use a stationary belt sander to round the face of each block slightly to match the apron's curve. Then, using the block holes as guides, I drill pilot holes into the legs and aprons.

Join the Legs To the Apron

Without glue, screw the two middle legs to the middle apron segment, then attach the two side aprons to the legs. Note: If the assembly doesn't line up with the drawing, I sand the blocks a bit more as necessary.

Now, disassemble the parts and glue and screw the blocks to the legs. For this operation, yellow glue grabs well and dries quickly with little mess. Next, apply the same adhesive to the apron ends and block faces, then press the aprons into place and drive the apron screws.

Install the Back Apron

You can make the straight back apron from solid stock or plywood. (Stresses from cross-grain wood movement in this part don't amount to much, and I've never had a problem using solid cherry.) First, measure the distance between the back legs on the assembled apron. I cut the back apron to fit or a bit longer—up to $\frac{1}{8}$ ". This extra length compresses the front joints just enough to perfect the appearance.

Glue and clamp the back apron in place, then drill pilot holes and drive the screws. The clamp keeps errant screws from pushing the joints open. If you find working from the inside too complicated, you can counterbore and plug the screws from the outside.

Because the long legs make such good levers for stressing the joints, I let

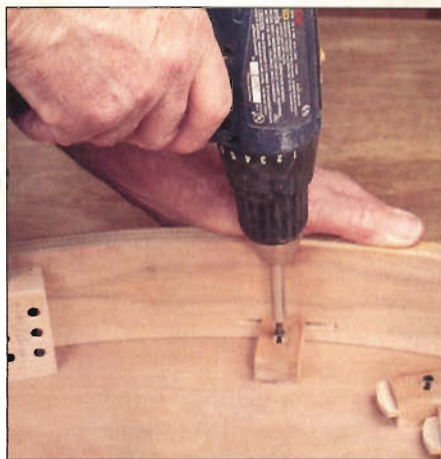


Photo O: Cut biscuit slots along top edge of aprons, then attach tabletop using specially made wooden buttons.



Photo P: To remove sanding "fuzz" that causes water rings to form beneath finish surface, dampen sanded tabletop with sponge. Blow-dry to raise fibers, then resand lightly.

the whole assembly cure overnight. Place sheets of waxed paper under the joints to prevent them from sticking to the work surface.

Make the Buttons

I attach the top to the apron with my own shop-made wooden buttons. To do this, I first stand the

table base upright on the floor and cut five equally spaced biscuit slots in the inside face of the apron. Note: Use the tool's normal setting for biscuiting $\frac{3}{4}$ "-thick boards for a #20 biscuit.

To make the buttons, measure the distance between the top of the apron and the biscuit slots you just cut. Machine a $\frac{1}{8}$ "-thick tenon on the end of a $\frac{3}{4}$ "-thick board, leaving a bit less clearance than the distance you just measured. (This will pull the tabletop tight as you screw in the buttons.) Crosscut a 2"-long strip from this end, then rip it into 1"-wide strips. Using the stationary disc sander, round each tenon to fit in the bottom of the biscuit slot.

In the center of each button, drill a countersunk pilot hole for a #6x1 $\frac{1}{4}$ " screw. Fit the buttons into the slots, then screw them to the top (*photo O*).

Apply Finish, Then Attach the Top

After trimming and sanding the top, I wipe it with a damp sponge, blow-dry it, and then give it a final light sanding (*photo P*). This procedure raises and removes the looser grain that tends to make water rings beneath the finished surface.

I then wipe on three or four coats of Waterlox Oil Finish, allowing each coat to penetrate for 10 minutes, before wiping it off. This protects the surface without building to a plastic look. I wait two days to install the top, then wax and buff the table. I'll wait at least another week before placing the table into service. *WJ*

Photographs: By the author

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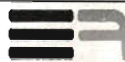
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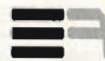
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TOOL BASICS

A ROUTER BIT IN THE MAKING

by Charles Sommers

During the past few years, I've had a chance to visit the manufacturing plants of several tool makers. Each tour has been interesting and informative. When CMT (name changed to Jesada Tools as of June 1) invited me to look around its new facilities at Oldsmar, Florida, I gladly accepted.

I appreciate well-designed, precisely balanced, and finely finished router bits, but I'd never given much thought to how they're made as long as they were sharp and worked well. An up-close look at their manufacturing steps showed me what I had ignored.

Most bits we buy are either made by casting or turning. Jesada turns or machines its products from round

steel bars. This method lends itself to considerable automation, and computers controlled many of the turning operations I saw. The stages of completion you see in the photo at right show how a length of steel bar evolves into a finished cove bit.

It Starts As a Drawing

As with most tools, production begins in the design department, where engineers draw each bit on their computer screens. After creating the desired profile,



▲ As of June 1st, bits made by Jesada Tools (formerly CMT Tools) are being coated with white-colored Teflon.

▶ Router bit manufacturing sequence, bottom to top: rough-turned body drilled and tapped; body with milled gullets; bit with carbide tips brazed to body; coated bit after baking at 500°F; finished bit with ground carbide tips and bearing attached.

they call up highly sophisticated software that plots the precise lathe movements and cutting sequences that will remove the waste steel from the bar. The computer then converts this

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information into codes that will control the programmed lathe.

During manufacture, a steel blank passes through the following processes that transform a length of rough steel bar into a ready-to-use bit.

Rough turning. During this first machining step, a length of steel bar is fed automatically into the lathe. This machine turns a bar to what engineers consider "rough" shape—a tolerance of .0002" (two ten-thousandths of an inch). At the same time, any required holes are drilled and tapped. Depending on the bit, this entire process takes a couple of minutes. At the completion of this step you see a shaped bit body that looks like the one at the bottom in our photo lineup.

Milling. From the lathe, the rough turning moves to the milling center. Here, another computer-controlled machine cuts precise gullets or grooves into the body at the points where rough-shaped carbide blanks for the cutting edges will eventually be brazed. At this stage, the emerging bit looks like the second rough in the photo.

Wash. After milling, all bits are washed in a 160°F bath of distilled water blended with an alkaline solution. This removes any remaining oil or coolant residue left from the milling operation that could interfere with the brazing process.

Carbide brazing. To braze the carbide tips, technicians first clamp the bit body in a special vise, then heat it by means of electrical induction until it turns a dull red color. This typically takes just a few seconds. During this time the brazer positions the carbide

blanks on the bit, then adds a silver alloy brazing.

When brazing is completed and passes the operator's inspection, the bit gets buried in a tray of silica sand for slow cooling. When cool, the bit moves to the sandblaster for cleaning away any brazing residue and to prepare it for inspection and coating. The bit now looks like the middle body in the photo lineup.

Coating. After technicians inspect and okay the brazing, the bit moves on for coating. Jeseda Tools now applies a white, non-stick PTFE (Teflon™) coating (see photo) electrostatically—that is, the bit is given an electrical charge to attract the coating particles.

Once coated, the bit goes into an oven where it's heated to 500°F to cure and harden the coating. Except for the color (white now instead of orange), the bit looks like the sample second from the top.)

Grinding. In this final machining step, a sophisticated computer-programmed grinder polishes the shank to a tolerance of .0004", then grinds and polishes the cutting edges on the carbide tips to proper profile.

Inspection and assembly. The bit now goes to an optical comparator. This machine magnifies the bits 10 times and enable the inspector to compare its profile against a master mask. If the bit passes this inspection, it moves on for final processing where an ID number will be laser-etched on its shank, and the bearing, if required, attached. (See top bit in photo.) Following a final inspection, the bit is packaged for shipment. 

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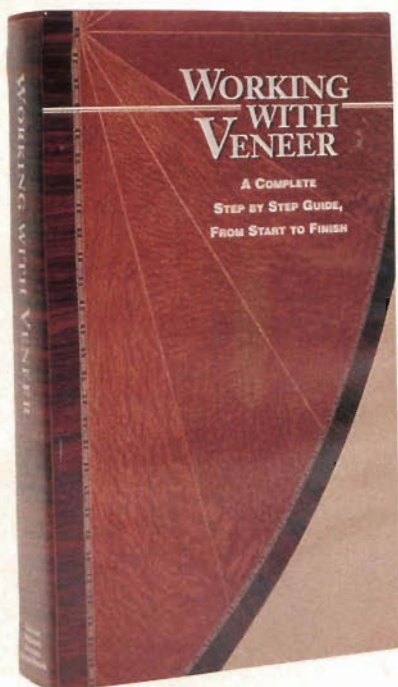


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Over the last few issues of *Woodworker's Journal*, you may have noticed our enthusiasm for veneering techniques, particularly vacuum veneering. A good bit of our inspiration has come from a video entitled "*Working With Veneer, A Complete Step by Step Guide from Start To Finish.*"

Veneering Video Can Add A New Dimension To Your Woodworking

The author of the video, Darryl Keil, runs Vacuum Pressing Systems, a company that sells vacuum veneering equipment, but the video is devoid of sales pitches. The strong suit of this video really is the number of options presented and the thoroughness of the information.

Keil starts by explaining the reasons for using veneer and shows a selection of stunningly beautiful examples of veneered work. Next he discusses types of veneer, substrate choices, and layout and arrangement of pieces. You also get several good tips on ordering, handling, and storing veneer. The author's formula for flattening wrinkled veneers will be of particular interest to anyone who wants to work with burl-figured veneers but doesn't have a way to tame this material's wildly irregular surface.

Several methods of cutting and trimming veneers were presented:

with a knife, a veneer saw, tablesaw, jointer, and a router. Keil favors a router for trimming edges and shows a fixture you can build to expedite the process. The video proceeds with a good discussion of veneer tape, the glue choices, and how to build protective cauls.

As for the all-important process of pressing or clamping veneer, Keil discusses the basics of vacuum pressing, but also references printed material you can get to build traditional veneer presses. He also discusses hammer veneering and "hot-iron" veneering, albeit briefly. Keil ends with a tip about edging and some sanding and scraping considerations.

I've been researching veneering for years and was always miffed that so many informational sources left out some critical details about the process. Keil's video covers every aspect of the process thoroughly. The information is presented clearly enough for a beginning woodworker to understand the process, yet there's also enough detail to advance the skills of many professional cabinetmakers.

Like it or not, the logs containing the finest wood in the world go to veneering mills. If you want to work this beautiful wood into your projects, I recommend you get this video. 

Reviewed by Tom Jackson

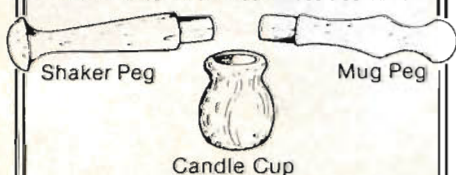
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PRO TIP

The width of profile cut by your panel-raising bit determines the final size of the crown. To calculate the crown's width and length, up the bit to route the profile. Make a test cut on scrap. Measure the width of the crown. To calculate the crown's length, measure the length of the (rail plus stiles), then the width of the bit's (to allow for a 1/4" reveal ends). To calculate the width, add the width cut, then add 1/4" for the reveal.

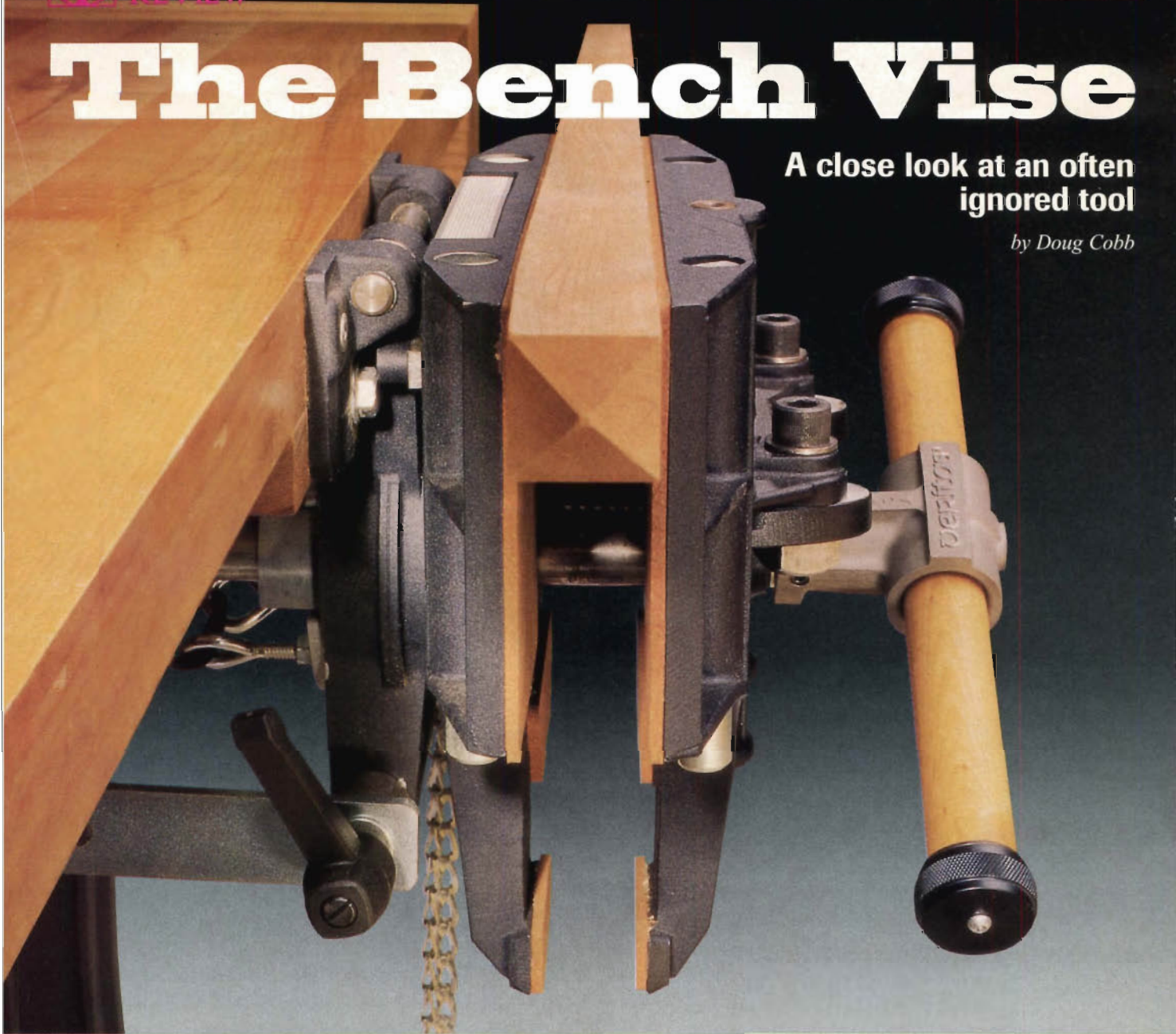
When working with narrow pieces, you start with a piece wider for safer handling during routing operation, then rip it to final width later.



The Bench Vise

A close look at an often ignored tool

by Doug Cobb



An ocean of ink has been spilled reviewing tools that cut wood: saws, routers, lathes, and planers. But the bench vise—a tool we use with almost every project we build—rarely gets any press.

Yet without the bench vise, woodworking as we know it would never have developed. By securing the wood against the force of chisels and hand planes, this centuries-old contrivance made it possible for early woodworkers to produce straight edges and flat, dimensioned stock. If not for the vise, we might still be hacking away with axes and adzes.

On early vises, wooden screws opened and closed the jaws. This design prevailed until the early nineteenth century, when steel screws began to replace the wooden variety. The evolution of the bench vise reached its zenith in the first

half of this century with the development of the patternmaker's vise. High-tech manufacturing innovations have thinned the ranks of patternmakers, but two examples of this versatile tool are still sold today, so we've included them in our review.

Editor's Note:

This article is the first in a three-part series on the design and components of a woodworker's bench. In our second installment, we'll look at the accessories used with a bench. And in the third article, we'll offer a pair of novel bench designs for you to build.

Patternmaker's Vises: They tilt, turn, and hold almost anything

Until the late 1970s, the world relied on patternmakers to fabricate the wooden parts used to make molds for castings. This highly skilled work prompted the development of the versatile patternmaker's vise. The largest manufacturer of these vises, the Emmert Company, went out of business years ago, but you can occasionally find used Emmert universal patternmaker's vises. Prices for these vises, however, can run in the thousands of dollars. Fortunately, AMT and Veritas still make similar vises. (See our reviews starting *below*.)

A patternmaker's vise has the unique capability of rotating 360° in the vertical plane parallel with the front edge of the bench. This lets you stop at 90° (or 270°) and use the long edges of the jaws to hold tall narrow pieces (*photo A*). Or, you can stop at 180° and use the metalworking jaw ends for clamping small objects (*photo B*). The jaws also tilt upward, allowing you to crank the front jaw straight down and squeeze pieces vertically (*photo C*). The front jaw on a patternmaker's vise can also be canted to clamp tapered workpieces.

The patternmaker's vise also employs a double pair of dogs—two on the front jaw and two on the rear jaw. These enable you to clamp objects between the dogs and above the jaws (*photo D*). This combination of rotation and tilt, angling jaws, and paired dogs makes it possible to hold almost any irregularly shaped object in a workable position.

Photo A: Patternmaker's vise turned 90° for edge clamping workpieces vertically.

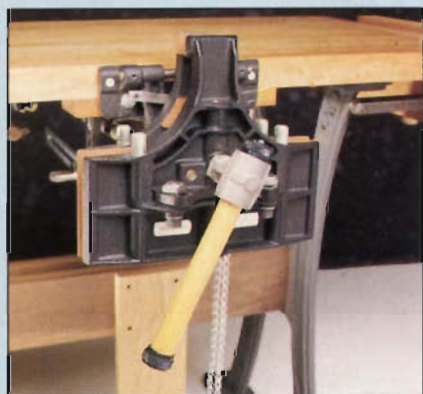


Photo B: Patternmaker's vise turned 180° can clamp small objects in the metalworking jaws.



Photo C: Rotate a patternmaker's vise upward to clamp objects on top and bottom.



Photo D: Two dogs on each jaw face easily clamp round or irregular objects.

AMT Patternmaker's Vise

The AMT vise (*photo E*) arrived with a thick coating of cosmoline on most of its components. I used brake cleaner and hand soap to clean it up. The vise is massive and sturdily put together but a little rough in spots. A few strokes with a file were needed to deburr some of the edges.

All of the required mounting hardware came in the box. The manual and instructions were clear and detailed and included helpful drawings. The manual provides a drilling template to help you position the mounting holes accurately on your bench. I could've used an additional template to locate holes for the tilt bracket, which proved to be a tricky operation.

You'll need a router and several hours to mount the AMT vise. It helps if you can flip your benchtop over to rout the clearance area for the tilt bar on the underside. You'll also have to rout a $\frac{3}{8}$ "-deep recess in the top of the bench for the steel mounting flange. So, plan your layout well: you won't want to move the vise once you've done all the routing.

To angle the front jaw, you rotate a cam lever centered on the front jaw. This jaw doesn't pivot freely to conform to the angle of the workpiece; you have to lock in the angle, then clamp the workpiece. But it will open up to 5° in either direction. The vise also includes a smaller auxiliary jaw that fits

inside the right side of the main fixed jaw and pivots perpendicular to the main jaws (*photo F*).



Photo E: AMT Patternmaker's Vise, model C334

This vise has no guide rods. A center beam encloses the screw and protects it from dust and debris. Without the guide rods, the jaws rack slightly when a workpiece is clamped in one end. The steel dogs are rectangular in cross section and beveled at the top ends.

The AMT has keyhole-shaped slots in the jaws, which I found very helpful. These let you quickly mount and remove auxiliary jaws of your own making—jaw liners with leather and cork facings, for instance, or with V-grooves and assorted slots for dowels and other hard-to-hold objects. The firm also offers an optional set of rubber-faced liners with magnetic tape backing. (The aluminum ribbing on the liners, however, stands slightly proud of the magnetic surface, which impairs their ability to hold to the cast-iron jaws.)



Photo F: These auxiliary tapered jaws fit inside the main jaws of the AMT enabling it to clamp tapered objects vertically.

My least favorite feature of the AMT is the 2 5/8 x 6 1/8" steel mounting plate that sits flush on top of your bench. If you're careful it won't cause a problem, but I worry that sooner or later I'll nick a well-sharpened chisel on this plate. Otherwise, I found the AMT to be a

rugged, versatile workhorse of a vise that sells at a reasonable price given its size and flexibility.

AMT Patternmaker's Vise, Model C334

Jaw opening	14"
Top jaw length	13 3/4"
Top jaw depth	2 1/4"
Small jaw length	2"
Small jaw depth	3 3/8"
Side Jaw length	5 3/4"
Side jaw depth	4 1/2"
Jaw advance	1/4" per revolution
Weight	55 lbs.
Price	\$249

American Machine & Tool Company,
400 Spring St., Royersford, PA 19468-2519. Telephone: 800/435-8665.

The Tucker Vise

Like many of the products sold by Veritas, the Tucker vise (*photo G*, and photos A–D) offers precision and quality. The design features a handsome blend of materials—cast iron, steel, wood, and aluminum—and all machining was smooth and well-finished. I found the castings to be strong and solid but not bulky, which gave them an elegant appearance (to an engineer's eye, anyway). Before installing the vise, I had only to wipe off a very light oil with a cloth.

The mounting instructions were clear, detailed, and accurate. They include a schematic showing hole locations and dimensions. All the necessary hardware

came in the box, including square-drive bits and allen wrenches.

To install the Tucker vise, you must first build up the thickness of your benchtop to between 2 1/2" and 2 3/4". Next, you rout a 1/4" groove in the front edge of the bench for the mounting-plate tongue and then rout the bottom of the bench to create clearance for the yoke hub. Insert the mounting plate tongue in its groove, then drill pilot holes and drive two lag screws and two wood screws to secure the vise.

I appreciated the Tucker's unique quick-release mechanism. To engage it, you either press a bar on the top edge of the fixed jaw or step on a foot pedal. Elastic cords "pop" the jaws open, so you don't have to pull back on the handle to release the workpiece. The foot pedal may get in the way in some situations, but if you need to turn and reposition a workpiece frequently, the pedal will be a big help.

The front jaw on the Tucker pivots to secure angled workpieces. You can keep the pivot mechanism loose, so the jaw centers itself, or lock it into a pre-determined angle of up to 5° or so. When you're clamping at one end of the vise, two guide rods on either side of the lead screw help prevent racking. The rods are not situated as far apart as those on a conventional vise, but I

had to bear down pretty hard to rack the jaws enough to cause a problem.

The built-in dogs have both round and flat faces and can rotate in their holes. This makes it easy to accommodate round or irregular objects. The Tucker's jaws are lined with cork to protect workpieces, but they offer no means of securing auxiliary jaws. The firm sells replacement liners, but you have to scrape the old cork from the jaws before gluing on new ones.

Aside from this minor limitation, the Tucker vise struck me as an excellent tool in every way. All parts fit well and worked with effortless precision. Some woodworkers may find it hard to justify the cost of the Tucker, but those who make the investment will have no qualms about the product's quality or performance.

Tucker Vise

Jaw opening	12"
Top jaw length	13"
Top jaw depth	4"
Small jaw length	2 3/4"
Small jaw depth	6"
Side jaw length	5 1/4"
Side jaw depth	4 1/2"
Guide rod dia.	7/8"
Jaw advance	1/5" per revolution
Weight	50 lbs.
Price	\$495

Veritas/Lee Valley Tools, 12 E. River St.,
Ogdensburg, NY 13669.
Telephone: 800/871-8158.



Photo G: The Tucker Vise

Conventional Bench Vises:

Three basic models offer different features

Jorgensen Rapid-Acting Woodworker's Vise

The Jorgensen vise (*photo H*) ships with a light oil coating that wiped off easily. The jaw faces were well-machined. The front jaw has countersunk screw holes that let you add your own auxiliary jaws. The rear jaw has tapped holes, so you can attach facings to it with machine screws. Jorgensen also offers magnetic-backed felt jaw liners as an option.

I found the installation instructions clear and easy to follow. Drilling templates were not provided, but the procedure was easy enough without them. You need to build up the benchtop thickness to 3". The lag screws supplied with the vise, however, were too short to penetrate the full thickness of the shim and still get a good bite in the bench itself.



Photo H: Jorgensen Rapid-Acting Woodworker's Vise

The vise attaches to the bench using two lag screws through the mounting flange and two wood screws through the rear jaw. The flange has holes instead of slots, so you don't have much leeway to position the vise before driving the rear-jaw screws. Once I'd tightened everything down, however, the mounting seemed substantial enough.

The Jorgensen includes a center-mounted dog in the front jaw that elevates 1" above the top edge at full extension and retracts to just below the top when you don't need it. Friction holds the dog in place.

Jorgensen Rapid-Acting Woodworker's Vise, Model #41012

Jaw opening	12 1/2"
Jaw length	10"
Jaw depth	4"
Guide rod dia.	7/8"
Jaw advance	1/2" per revolution
Weight	32 lbs.
Price	\$114

Adjustable Clamp Co., 417 N. Ashland Ave., Chicago, IL 60622.
Telephone: 312/666-0640.

To operate the quick-release mechanism, you turn the handle from one-half to one full rotation counterclockwise, which disengages the brass sector nut on the lead screw. On my first few tries, the quick-release didn't work consistently, but after a bit of breaking-in time, it worked just fine.

As with the other bench vises, the Jorgensen's jaws are designed to give you a bit of "toe-in." On a vertically held workpiece, the tops of the jaws contact the stock first. Apply more pressure and the full width of each jaw presses in on the workpiece. The Jorgensen delivered full jaw contact with less pressure than the other vises required.

The guide rods sit 1/4" above the lead screw, so your work never touches the screw. The rods, although not as polished as those on the Record, did a good job of keeping the jaws parallel when I clamped material in one end of the vise.

Overall, this vise proved to be solid and dependable. The finish was a bit rough and I'd have preferred an easier mounting arrangement, but once I had it broken in, it performed without a hitch. Jorgensen also makes a smaller version of this vise, model 40709, which has 4 x 7" jaws that open to 9" and sells for about \$100.

Record Large Cabinetmaker's Vise

Right out of the box, the Record vise (*photo I*) showed evidence of quality workmanship: clean, well-finished castings, finely ground and polished guide rods, and an excellent paint job. The jaw faces were not ground, but this makes little difference if you install your own wooden faces. A light coat of oil protected the unpainted parts from rust.

The easy-to-follow instructions described four different mounting options. You'll appreciate the recessed mounting option if you want to limit the distance the vise protrudes from the bench.

To mount the Record, build up your benchtop thickness to at least 3 1/2". The

manufacturer doesn't provide mounting hardware, so you'll need to buy 3/8" lag screws and supply the wood screws to mount wooden jaw liners. There's no drilling template for the vise, either, but it too mounts easily enough without one. Simply start the rear lag screws, slide the mounting-flange slots under the heads of these lag screws, install the front lag screws through the holes, and then tighten the rear lags screws to complete its mounting.

The holes for attaching the rear jaw liner are neither countersunk for a wood screw nor tapped for a machine screw. So, I counterbored two small "dimples" in the edge of my bench to

create clearance for the screw heads.

The vise's center-mounted dog has a thumbscrew that locks it in position. The dog protrudes 1 1/4" above the

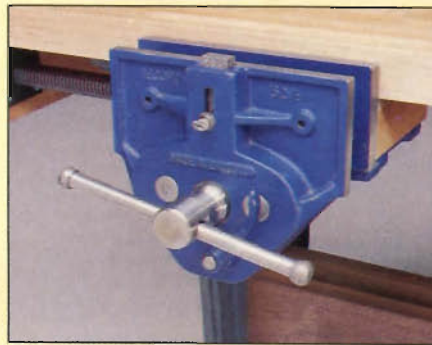


Photo I: Record Large Cabinetmaker's Vise

bench at full height but still sticks up about $\frac{1}{4}$ " above the top of the jaw when retracted. Although this puts it below the top of the bench, you can still scrape a knuckle if you're planing or sanding stock secured in the vise. You can remove the dog to spare your knuckles, but then you have to keep track of it.

To engage the Record's quick-release mechanism, you flip a lever on the front jaw face (instead of cranking the handle backwards as on most vises). I found the lever-system to be fast, positive, and easier to use than a handle.

The toe-in on the metal jaws works well for clamping pieces horizontally.

With vertical pieces, however, I had to exert considerable pressure to close the jaws all the way to their bottom edges.

I found the Record very pleasant to use. The highly polished finish and the precise tolerances of the guide rods provide very smooth opening and closing action with no appreciable racking. And the quick-release mechanism improves your working speed and efficiency. Record makes two other versions of this vise: the #53E Extra Large cabinetmaker's vise, which has $3\frac{1}{2} \times 10$ " jaws that open to 15", and the #52ED Standard cabinetmaker's vise, with $2\frac{3}{8} \times 7$ " jaws that open to 8".

Record Large Cabinetmaker's Vise, Model 52 1/2 ED

Jaw opening	13"
Jaw length	9"
Jaw depth	4"
Guide rod dia.	1"
Jaw advance	$\frac{1}{4}$ " per revolution
Weight	36 lbs.
Price	\$130

Record Tool Co., 1915 Clements Rd. #1, Pickering, Ontario L1W 3V1.
Telephone: 905/428-1077.

Wilton Pivot Jaw Vise

Although the Wilton Corporation has been around for years, it has only recently released the model #78A vise (*photo J*), which features a unique pivoting angle attachment. The surfaces of this vise, including the jaw faces, are finished in a pebble-texture paint. I found the castings a bit rough and had to deburr a few edges and also flatten some high spots on the jaw faces.

The jaws require some sort of facing, but no mounting holes have been drilled. You either have to drill your own holes or buy the optional set of maple jaw liners, which are backed with magnetic tape.

The angle attachment on the Wilton consists of a triangular steel block with a pivoting rod at its apex (*photo K*). Since the rod rotates freely, the attachment centers itself, providing even clamping pressure across the face of tapered or straight stock. The angle

jaw also serves as a full-length dog for the vise. To use it this way, you raise it above the jaws and lock it at the appropriate height. For vertical clamping, simply pull the locking pin and remove the angle jaw from the vise.

The clear, simple mounting instructions include a hole-drilling template. Before mounting, you need to build up the bench thickness above the vise to 3". Like the Record, this vise mounts easily using four lag screws that anchor the flange to the underside of the benchtop. However, you'll have to supply your own screws.

With its single guide beam, the Wilton doesn't edge-clamp as well as the twin-rod vises. But the beam does help keep sawdust off the lead screw and also prevents oil on the screw from contaminating your work. Like the other vises, the Wilton has a little toe-in at the top, but I had to exert a lot of pressure to close the jaws flush on vertically held workpieces. Without wooden liners, this would cause dents in most workpieces.

If you have large hands, the narrow clearance between the handle and the front jaw face makes it easy

to bark a knuckle on the locking pin. Otherwise, I found a lot to like about the Wilton. It has a compact profile and exerts a tremendous amount of clamping force. And for those woodworkers who need it, the angle jaw operates simply and efficiently.

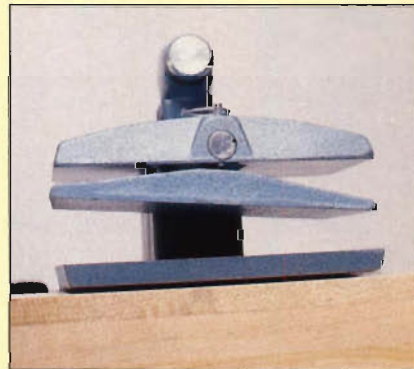


Photo K: A bird's-eye view reveals the unique pivoting jaw on the Wilton vise.

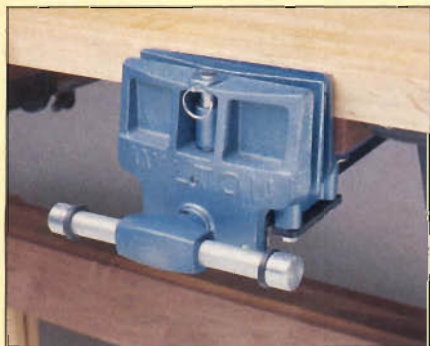


Photo J: Wilton Pivot Jaw Woodworking Vise

Wilton Pivot Jaw Woodworking Vise, Model #78A

Jaw opening	10 $\frac{3}{4}$ " w/o angle jaw, 9 $\frac{3}{4}$ " with
Jaw length	7"
Jaw depth	4"
Jaw advance	$\frac{1}{4}$ " per revolution
Weight	30 lbs.
Price	\$130

Wilton Corporation Tool Division, 300 Hicks Rd., Palatine, IL 60067. Telephone: 874/934-6000.
Web site: www.wiltoncorp.com.

Veritas Twin-Screw

A Traditional Vise With a New Twist

Unlike most vises, which span 10" or 12" in length, the Veritas Twin-Screw (*photo L*) lets you position a pair of screws up to 16" apart and build jaw faces as long as your bench is wide. When you order this vise, you actually get a hardware kit. However, the parts are all machined and finished to Veritas's usual high standards.

The first sentence of the instructions says a lot: "If you are the kind of person who really looks at instruction sheets after something goes wrong, this is one product where you should mend your ways." One paragraph later, the manual reiterates this warning by listing the four easiest ways to make a mistake.

That may sound intimidating, but Veritas did an excellent job with its eight-page manual. Even so, it still took me about a day and a half to machine my own jaw faces and install the vise. Accuracy is critical,

and you'll need a good tablesaw, drill press, and thickness planer.

A few small shortcomings made installation more tedious than it needed to be. It would've helped to have a longer chain to connect the screw drives. Stretched to its full length, the chain allows you to position the screws 16" apart, which puts them 4" from the edges of a 24"-wide bench. This is fine, but on wider benches, the screws get proportionally farther from the edges. You can buy extra links, but my source sells this chain only in 10' lengths.

A second problem: Although Veritas supplies bolts and barrel nuts to attach the rear jaw face to your bench, the barrel nuts don't have the usual screwdriver slot in the bottom end. Because of this, I had considerable trouble getting them lined up to receive the bolts.

Once assembled, the Veritas offers a lot. The widely spaced, twin-screw system eliminates racking problems when you clamp a workpiece vertically in one end of the vise. Since the vise doesn't have a

center screw, however, you might as well clamp boards vertically between the screws.

Although the vise has no quick-release mechanism, the chain drives the two screws in tandem, so you need only turn one handle to move the front jaw. The company supplies a speed knob to make cranking easier. This vise isn't designed to clamp tapered workpieces, but you can skew the jaws about 1/4" out of parallel to bring the dogs in tight on a large object.

The Veritas Twin-Screw performs the basic chores as well as any vise, and it also excels at clamping large panels flat using dogs in the bench and front jaws. Having all-wood jaws enables you to plane them along with the benchtop to maintain uniform flatness. Since you build your own jaws, you can also position dog holes anywhere you like to suit your needs. *WJ*

Photographs: Kevin May, StudioAlex

Veritas Twin-Screw Vise

Jaw opening	12" (with 2"-thick jaws)
Jaw length	Determined by user, usually the width of bench
Jaw depth	2 3/4"
Jaw advance	1/8" per revolution
Weight	19 lbs. (without wooden jaws)
Price	\$145

Veritas/Lee Valley Tools, 12 E. River St., Ogdensburg, NY 13669.
Telephone: 800/871-8158.



Photo L: Veritas Twin-Screw Vise

Meet Our Bench Vise Tester

When we started looking for a woodworker with a strong technical background to help us with product testing, it didn't take long to settle on Doug Cobb. A third-generation home woodworker whose father owned the "first tablesaw in the neighborhood," Doug belongs to the Mid-West Tool Collector's Association and is a charter member of the Peoria Area Woodworker's Club.

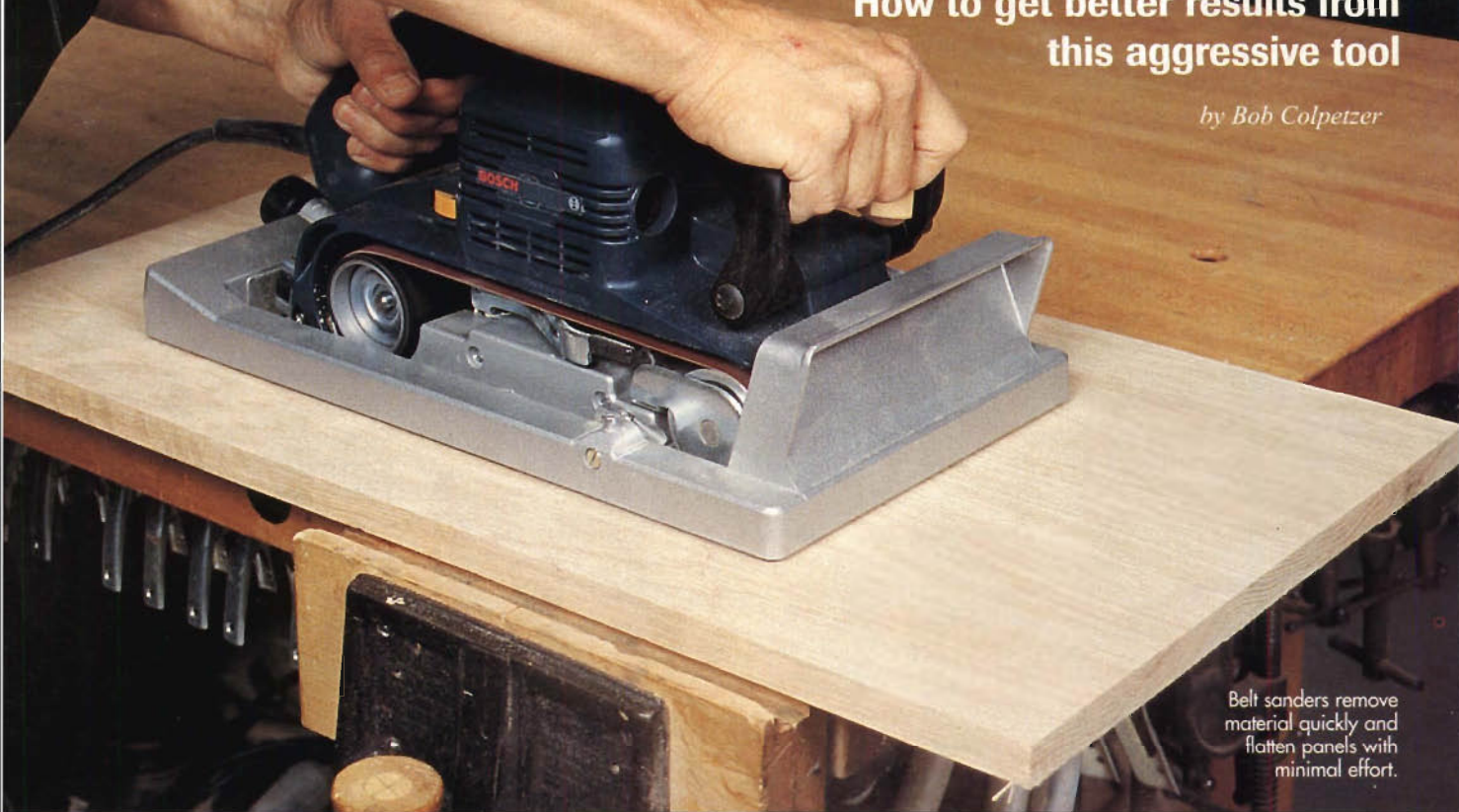
When he's not working wood, Doug works with some truly big machines. An 18-year veteran at Caterpillar, Inc., Doug is a senior project engineer in engine structures testing at the firm's technical center in Mossville, Ill. Doug holds a B. S. degree in mechanical engineering from the University of Illinois and received his Professional Engineer registration in 1984.



The Portable Belt Sander

How to get better results from
this aggressive tool

by Bob Colpetzer



Belt sanders remove material quickly and flatten panels with minimal effort.

The portable belt sander has gotten a bad rap and fallen from favor with many woodworkers. The tool's major asset—its ability to remove stock from all kinds of surfaces quickly—has sent a disproportionate share of project parts to the scrap boxes of inexperienced users. Its aggressive action strikes fear even into the hearts of some seasoned veterans. One slip or tilt of the tool can spell disaster.

That's probably not too surprising. Early models were heavy, poorly balanced, and often hard to control. Then along came the new, lighter-weight, easier-to-handle random-orbit sanders. They quickly took over many of the sanding chores formerly entrusted to the belt sander.

However, for home woodworkers and production shops with tight budgets, the belt sander remains a viable and

economical solution. It can swiftly and successfully flatten and smooth surfaces with a minimal amount of physical effort, provided you understand and apply a few basic skills.

I hope the techniques I offer here will help restore your confidence in belt sanding for the applications it excels at. As I present them, I'll also fill you in on some of the recent advances and latest accessories to help you get the most out of this tool's features and capabilities.

How To Choose a Belt Sander

For starters, make sure you choose a tool that feels comfortable in your hands and that's well-matched to the tasks you want it to do. You'll find today's belt sanders much more user-friendly and endowed with a wider range of features than their predecessors.

Besides the various belt sizes (see *photo A*), you can select variable-speed capability that lets you adjust sanding speed to fit the job, easy belt-tracking adjustment, and fast belt-changing. Some units also offer sanding frames and dust-collection bags as accessories. These choices, along with the improved balance you get in the newer machines, should make it easy to find at least one that fits your needs.

The overall size and weight of a belt sander varies primarily with belt size: the bigger the belt, the larger and heavier the machine. On today's sanders, belt sizes range from 3x18" to 4x24". Those with wider and/or longer belts tend to have larger motors and frames, so they weigh more than smaller units. Their larger sanding surfaces also enable you to do more work with them in a given amount of time.



Photo A: Today's belt sanders come in different sizes. The DeWalt 3x21" unit has variable speed control and a dust-collection bag. The 4x24" Bosch has the same features. Both offer accessory sanding frames.



Photo B: The motor-mounting configuration determines the shape, size, and feel of a belt sander. On the Bosch, the motor is mounted crosswise. The Rockwell worm-drive model has its motor mounted in line with the belt.

Base your choice of belt size on what you need. If most of your work involves flattening and smoothing large panels, and you want to get it done quickly, then go with one of the wider- and longer-belt models. If you're more likely to sand smaller panels, level cabinet frames, or belt-sand vertical surfaces, you'll find a smaller, lighter-weight unit easier to control. Sanders with 4x24" belts tip the scales at 12 to 15 pounds, whereas 3x21" and 3x24" models usually weigh between seven and 10 pounds.

The style of motor mount has a lot to do with the sander's overall design. On some machines, the motor is mounted across the width of the belt. This allows good placement of adjustment controls and usually ensures a more comfortable handle. Unfortunately, this design produces a taller, wider unit (*photo*

B). These sanders tend to be more prone to tilting. Sanders with inline-mounted motors typically have a lower center of gravity, which makes the unit a bit less apt to tilt during use. I recommend trying both designs before making a choice.

Other Features to Consider

If you're thinking of buying a belt sander, by all means consider a variable-speed model (*photo C*). Although you'll probably do most of your belt-sanding at full speed, some applications call for a slower speed which removes material less aggressively. For example, I like to reduce belt speed on thin-veneered plywoods. Slower speeds also work better with fine-grit belts so they'll generate less heat and be less likely to glaze the belt and burn the stock.

If I were buying a belt sander, I'd also look for one that can be outfitted with a sanding frame (*photo D*). This device attaches to the bottom of the unit, broadening its base and making it difficult (if not impossible) to tilt the sander and gouge the workpiece. In effect, a sanding frame serves as "training wheels" for a belt sander. It also lets you raise or lower the sanding belt within the frame, thereby adjusting the sanding action.

Unless you have a down-draft sanding table, it makes good sense to buy a machine with dust-collecting capabilities. Belt sanders generate massive amounts of fine dust that can quickly fill a shop (and your lungs). On most sanders you'll find the pickup bag positioned so as to be unobtrusive. It's also possible to rig a belt sander for attaching to a shop vacuum.



Photo C: With variable speed control, you set the belt speed. On this unit, you can select belt speeds from 1150 to 1550 SFPM.



Photo D: A sanding frame attached to the bottom broadens the sander's base to improve its stability and controls abrasive contact with the workpiece.



Photo E: Inspect the platen, pad, and wear plate when you change belts. Replace any damaged or worn parts.



Photo F: A used but properly dressed (cleaned) belt left; a loaded and worn belt center; a new, unused belt right.

How To Tune a Sander

Good sanding depends on the condition of the unit's platen assembly, on proper belt tracking, and on the belt.

A sander's platen presents the abrasive to the workpiece. Any defect caused by wear or damage telegraphs directly to the sanded surface. To avoid any unpleasant surprises, inspect the platen, pad, and wear plate each time you change belts (*photo E*). Replace worn or damaged parts and remove any dust buildup. Despite whatever advice you've received to the contrary, never alter these parts to produce anything other than a flat surface.

It may seem obvious, but make certain you install the belt so that it runs in the proper direction. Most belts have arrows on the inside surface that indi-

cate correct rotation direction. If you can't find a marking, examine the belt's splice and install the belt so that the sanding action doesn't lift and tear apart the joint.

A belt with loaded or broken-down abrasive will burn or glaze the wood surface rather than abrade the fibers cleanly and evenly (*photo F*). By the same token, making a worn coarse-grit belt serve as a fine-grit belt is a poor way to economize. To prolong the life of a belt, clean it with a rubberized belt stick whenever it starts to load up. To choose the correct grit for the job, use the Grit Selection Chart on *page 88*, changing grits as needed.

Mount the belt, then run the sander and adjust the tracking so the belt tracks straight and covers the entire wear plate. An improperly tracking belt

wears the plate unevenly, eventually requiring its replacement. Check the tracking periodically as you sand, especially with new belts. Some belts will stretch as they run in. Continue to fine-tune the tracking as necessary until the belt settles into its permanent shape.

Best Way To Sand Flat Panels

The technique you use for sanding a flat panel depends on the type and condition of the workpiece. I usually divide sanding jobs into three groups and use a slightly different technique for each.

To flatten and smooth a rough, uneven, or glued-up panel, I first locate and mark the high and low spots. A straightedge laid across the width of the panel will show clearly where these are. I move the straightedge from one end of the panel to the other,

Continued on page 86

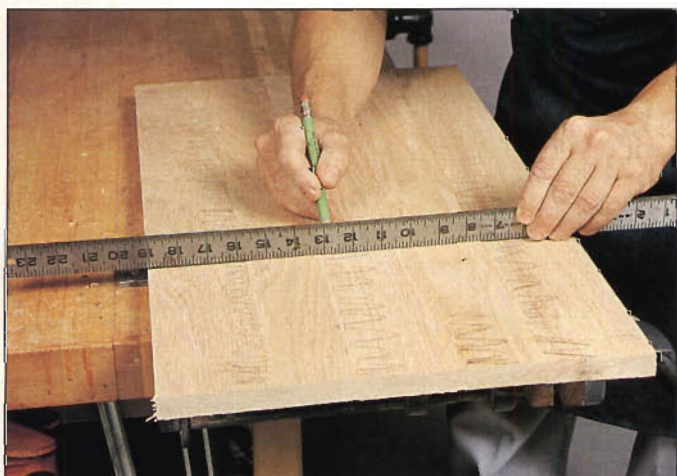


Photo G: Author locates low spots on a panel using a straightedge, then marks them with a soft #1 or #2 pencil.



Photo H: Sand high spots down quickly by moving the sander across the grain at a slight (30°) angle.



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DW744 10" Portable Table Saw

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DW7880	Stand	\$89.95
DW7881	Light	39.95

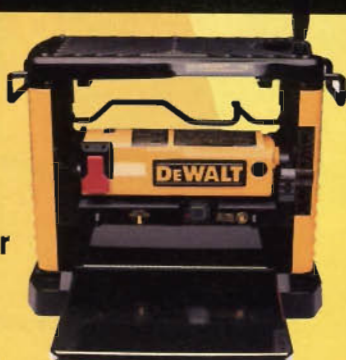


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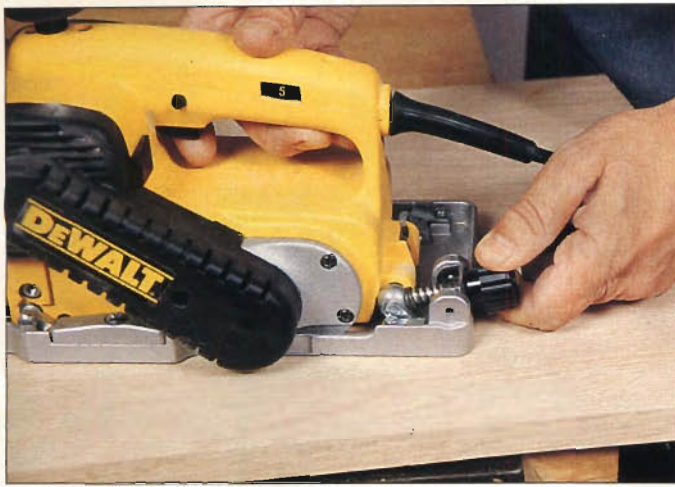


Photo I: Adjust the sanding rate by raising or lowering the position of the sander in the sanding frame.

Continued from page 84

marking the low spots as I go with a pencil or, on dark woods, a piece of chalk (*photo G*). Note: If you're working with a glued-up panel, remove any glue squeeze-out before you start sanding. Most white and yellow glues melt if sanded at high speed, quickly loading the abrasive belt.

Select, install, and track a belt of the appropriate grit for the task at hand. For glue-ups with uneven boards that require considerable stock removal, I'll start with a 60-grit belt. For very rough boards or panels, an even coarser belt might be my initial choice.

First, sand the high spots. Do not apply downward pressure on the sander—let the sander's weight do the work. I usually work at a cross-grain angle (about 30°) in both directions on these high spots (*photo H*). Keep the sander moving constantly over these high spots until they begin to approach the lower areas. Stop when you start to make contact with the low areas. Recheck the panel with the straight-edge and work any high areas that need more sanding. Note: I don't use the sanding frame when sanding the high spots.

Using a Sanding Frame

Using a soft #1 or #2 lead pencil, scribble light lines across the panel, spacing them 2" to 3" apart. If you have a sanding frame, here's a good time to use it. To fine-tune the sander and frame, slowly lower the sander in the frame until the abrasive belt just starts to make contact with the stock surface

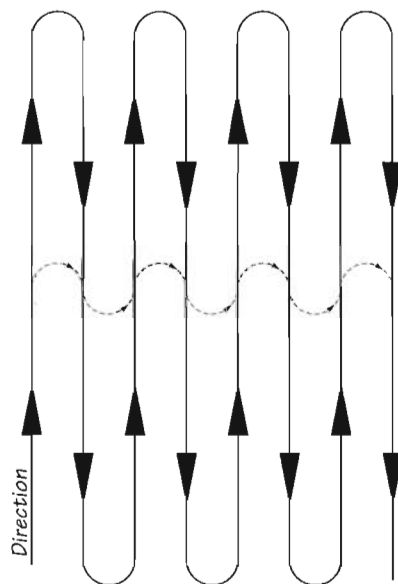
(*photo I*). Using the same belt, sand with the grain to remove the pencil lines and any cross-grain scratches.

Although you'll get conflicting advice on the best sanding pattern to use, I prefer to make long strokes in an overlapping pattern. (See *figure 1*.) Sand cautiously near the edges and ends of panels. Remember, flat sanding occurs only directly under the platen assembly. To sand to the ends of a panel completely and evenly, you should extend part of the platen over the panel's end on each stroke. Just be careful not to extend it so far that the sander tips over the end (*photo J*).



Photo J: Author points out front and back edges of platen which should extend about one fourth of its length over the edge of the stock.

Figure 1 When sanding large panels, use long strokes in an overlapping pattern



Once you've removed the pencil marks, check the panel again for flatness. Sand any remaining uneven areas before changing belts.

Install an 80- or 100-grit belt, then sand the panel to remove the scratches left by the 60-grit. To do this, I use the same procedure: scribble fine lines across the panel, then sand until they're gone. Once they're gone, I know that the scratches from the previous belt have been removed as well. Repeat this procedure, using increasingly finer belt grits, until you achieve the desired smoothness.

Smoother Flat Stock

A belt sander can also make short work of preparing already flat solid wood panels. Typically, these panels will have been planed to finished thickness and you simply want to remove the machine marks and sand them smooth.

I use the sanding frame for this operation, starting with an 80- or 100-grit belt depending on the type and hardness of the stock. Again, I scribble pencil lines across the panel and sand until the mill marks and lines have disappeared. I then switch to a finer-grit belt and repeat the process. To keep the panel flat, avoid oversanding any one area. As before, use a progression of finer grits until you reach the desired finish.

Hardwood plywood panels present a special challenge. Because the veneers are usually so thin, you can sand through them in a flash

Continued on page 88

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Photo K: To sand a hardwood edging flush with the surface of a plywood panel, scribble pencil lines on the plywood against the edging. Sand the edging, then attach the frame and sand both plywood and edging.

Continued from page 86

simply by starting with too coarse a grit, by sanding a bit too long in one spot, or by tilting the sander.

To avoid these pitfalls, I use a sanding frame and adjust it to restrict the belt's contact with the veneer's surface. I also slow the belt speed. This removes material more slowly, and also helps prevent finer abrasives from glazing or burning the wood. If your sander doesn't have built-in speed control, use an auxiliary speed control, which you can buy from tool dealers and mail-order suppliers. Note: Select a control that can handle the amperage of your sander.

When sanding veneered plywoods. I usually want to smooth the face without removing much material. I'll scribble lines across the panel in sev-

eral places so I can keep track of where and how much I've sanded. I start with 150- or 180-grit abrasive, changing to progressively finer grits until the surface matches the smoothness of the other parts.

Leveling a hardwood edging you've attached to a plywood panel also presents a challenge. For this task, I don't use the sanding frame immediately. Instead, I scribble pencil lines on the plywood right up to the edging (*photo K*). Starting at extra-slow speed with a 100-grit belt, I sand only the hard-

wood edge, stopping as soon as the sanding belt makes contact with the pencil lines. I then switch to a 150- or 180-grit belt, attach the sanding frame, and sand the entire panel as if it were plain, unadorned plywood. *WJ*

Photos: By the author

BELT-SANDING SPEED TABLE

Belt Speed	Application
Slow	Delicate surfaces, veneers, and (with sanding frame) light surface finishing
Medium	Surfaces where belt loading, heat buildup is a problem, or to limit stock removal to a more manageable rate
Fast	General service on solid wood, fast stock removal, and coarse sanding on rough surfaces

BELT-SANDING GRIT SELECTION TABLE

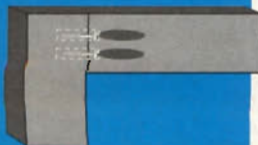
Abrasive Belt	Application
30- to 60-grit Open Coat	Rough or fast stock removal
60- to 100-grit Open Coat	Intermediate sanding
120- to 180-grit Open or Closed Coat	Fine finish-sanding
200-grit or finer Open or Closed Coat	Extra-fine finish-sanding

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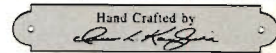
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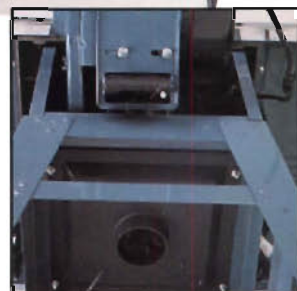
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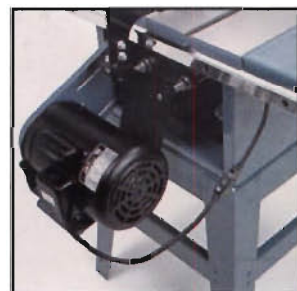
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