Fine WoodWorking

March/April 1989, No. 75, $4.50

Building Pool Tables

Oil Finishes

Tambour Jewelry Box

Pattern Routing

Bandsaw Tune-up

Building a Blanket Chest

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Fine WoodWorking

March/April 1989

A pool table is a large project, but not beyond the reach of the average woodworker. Paul Bowman tells how on p. 38. Cover: John Dunham waxes his blanket chest, which has dovetailed sides and a wooden hinge (see article on p. 48).

Fine Woodworking is a reader-written magazine. We welcome proposals, manuscripts, photographs and ideas from our readers, amateur or professional. We'll acknowledge all submissions and return within six weeks those we can't publish. Send your contributions to *Fine Woodworking*, Box 355, Newtown, Conn. 06470.

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DEPARTMENTS

ARTICLES

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Turner responds to safety concerns—As the "guy with his head almost in the center of a spinning tree trunk" in the article on turning large bowls (*FWW* #72), I feel I must respond to J. Osicek's letter in the following issue. First, let me assure him and any other concerned reader that my face shield is certainly used where appropriate. Secondly, if his concern is about shavings from the bowl flying out, he will be greatly relieved to know that the shavings come off the tip of the tool perpendicular to the axis of the tool, impinge on the wall of the bowl and are captured there by centrifugal force. And because these shavings don't fly into my face, I don't wear a face shield. Lastly, although unclear from his letter, if his concern is about the bowl flying loose from the faceplate and engulfing my head like some carnivorous creature, a face shield would be of little use in such an event. This has never happened, needless to say, or I would be writing about needlepoint, not woodturning.

The whole point of the article was to show that large turnings can be tackled safely and successfully. Although it doesn't show in the photo, I am sitting there, with my legs crossed, hollowing the bottom of a 27-in.-deep bowl. If I weren't comfortable with the situation, I would certainly change it. And that most emphatically includes eye protection. —*James R. Johnson, Bastrop, Tex.*

A PNG resident's view of deforestation—I'd like to respond to comments on tropical deforestation made by Lucinda Leech in *FWW* #70, particularly with respect to the logging operations in Papua New Guinea (PNG), where I live. Leech states that the developing countries she visited cannot simply leave their forests alone; they need the income from their timber exports.

There are several fallacies in this argument, and please remember, I speak only of PNG, having no direct knowledge of practices in other tropical countries.

Virtually all logging companies are foreign owned, with the Japanese being the largest group of investors. Apart from the relatively low levels of funds paid out in local wages, almost no real income is derived by PNG from these foreign logging operations. Gross dishonesty is legion. Should the Ministry of Forests stipulate minimum selling prices for various species, the companies apparently falsify the documents. I've heard of cases, for example, where companies call the exotics, such as walnut and black bean, some lower grade and sell at that figure. As far as I can tell, lumber dealers all have short rulers, too. It is generally believed that the real measurement of logs exported is double the submitted figures. Invoices for shipping charges, machinery imports, head-office charges, consultancy fees and a maze of other costs can be similarly distorted to ensure little or no profit is made in PNG.

Reforestation is an equally sick joke. Token stands are planted in visible areas where the politicians may visit occasionally, but there is no wide-spread program in effect. Natural regrowth is also not often successful. The massive damage done during the initial logging operation normally leaves only undesirable saplings. These can quickly dominate, and valuable species are simply beaten by the competition. Selective hand-thinning can greatly aid the regeneration of a natural forest, but it is not generally carried out.

The real question is what does PNG gain? Is logging necessary for its economy? The answer, in my opinion, is a definite no—certainly not in its present form. In fact, it's probably negative: There is no significant income, and its forests are being destroyed. Apart from intelligent and controlled logging *and processing* on a much smaller scale, leave the trees there. Every day they are worth more. When the world is prepared to pay the real price and the benefits flow to the country and not to foreign exploiters, then the trees can be farmed intelligently.

—*M. F. Henderson, Rabaul, Papua New Guinea*

Castle piano hits sour note—As soon as I saw the November 1988 *Smithsonian* magazine article on the Steinway piano by Wendell Castle, I knew it would be on the back cover of *FWW*'s next issue. Fortunately, *Smithsonian* writer Edward Rothstein, a music critic, kept his head while the *FWW* editors were going "Yeah, Yeah, Yeah!"

Rothstein is not one of those many who are infatuated with Castle's work. According to him, the piano body was "artificially 'streamlined'—strikingly angular, with sloped side arms bracketing the keys. It almost looked electronic. And when, past midnight, a 10-year-old prodigy sat down and played it, the sound was brittle and unsubstantial."

Imagine! Castle (and the current Steinway management, for that matter) thinking that he could improve on the design of a musical instrument. Give us a break. The whole incident just goes to show that when shallow, flashy, narcissistic, pop-art "designers" come up against a test of true craftsmanship, they fail miserably every time. —*William W. Thomas, Hillsboro, N.H.*

RBI disputes scroll-saw test—In reading the article "Testing Scroll Saws" (*FWW* #74), I found what I consider several errors and discrepancies concerning our machine, the RBI Hawk, that I would like to clarify for your readers.

The testing facility could not have read the owner's manual, because the specifications in the information table on p. 53 do not match reality or the information in the owner's manual. The motor speed (SPM) for the Hawk 220 is 700/1,300 and has been for the last four years; the table tilts 45° both left and right. The Hawk 220 now has three speeds of 375/750/1,550 SPM, incorporating a dual-step pulley system that allows the owner to change speeds in five seconds. The testing facility also neglected to install the rubber glides for the Hawk 220 saw, as is shown in the photo on p. 50. The set-up instructions clearly state to mount the glides to the feet to level the saw. The end result is similar to driving your car without tires on it: The car moves, but the ride is rough and you get vibration.

Another misconception is the stability of the three-legged stand. The article states that the three-legged stand is better than a four-legged stand. We feel this contradicts basic physical laws. How can a three-legged stand with 14 in. to a side be more stable than a four-legged stand that measures 20 in. by 33 in.? It cannot be. Try tipping over a three-legged stool with a small base; then try tipping over a card table with four legs and a larger base. You will find it much harder to tip over the four-legged, larger base.

The biggest omission is the lack of testing of the scroll saws

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...by fellow enthusiasts

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for ease and speed in doing an intricate inside cut—something only a scroll saw can do. It was a disservice for the writers to omit this, because most scroll saws are bought to do inside cuts.

Heavy does not equal quality, as the writers seem to think. Weight is an easy way to eliminate vibration, because you are increasing the mass. But, which would you rather take to a craft show or move around your shop: a Hawk 220 (89 lbs.) or the Delta Electronic (230 lbs.)? It is easy to add weight to lower vibration, but why not engineer the vibration out of the machine and keep the weight low?

Another point of contention is that the article speaks of testing all the Hegner saws, but why weren't all the manufacturers able to send their entire scroll-saw product line? RBI makes six different models of scroll saws—the most-extensive precision scroll-saw line in the world.

I think the best way for your readers to make an informed decision about purchasing their scroll saw is to compare all the makes and models with their own hands-on experience; then draw their own conclusions about which scroll saw is best for them.

—Kris L. Rice, President, RBIndustries, Inc., Harrisonville, Mo.

Vibration problems in scroll saws—I found the scroll-saw test results very interesting, but I would like to add some of my own observations. I've owned a Hegner MultiMax for about three years. Two saws in the test run in the same speed range as the Hegner: The Superscroll 18 and the Super 15 run at 1,650 SPM; the Hegner runs at 1,660. You mention vibration in the first two saws, but you don't mention vibration in the Hegner.

I consider vibration the greatest fault in the Hegner. My saw will walk across the floor. Because I have a concrete slab floor and don't want to fasten the saw down in one spot, I put a 2x4 laminated wood base on it, but it still moves when running. I've had people tell me the arms can be tuned to stop vibration, but I haven't been able to do it. Even the owner's manual says there will be a certain amount of harmonic vibration. This driving vibration for long periods of time can drive you up the wall. I think the Hegner runs too fast.

I tested the Delta and agree that the electronic control is kind of gimmicky, but at least you can set the saw at a speed where you feel it is cutting its best. I also tried the Lancaster Pro 20. As you said, it seems to be running too slow, but it is one of the quietest tools I've encountered. This all leads me to believe the ideal SPM would be in the 1,200 to 1,500 range. You can get there with the Delta. *—Bob Killian, Lubbock, Tex.*

Speed control not a gimmick—As an owner of a Delta 18-in. electronic scroll saw, I would like to take exception to the statement in the scroll-saw review (*FWW* #74) that the Delta electronic speed control was "more a gimmick than a bonus." I have found the speed control very useful. By slowing the speed, the occasional user, or a new user, can reduce the chance of making a cutting error. While I consider myself an experienced user, I will still slow down the speed with a new design or a more intricate design. The speed control allows me also to cut a wide variety of materials. Plastic is especially susceptible to the heat generated by higher speeds. As for lower speeds affecting the smoothness of the cut, I haven't noticed this to be the case.

One comment on quality control: My saw was accompanied by a "Quality Assurance Standard Practice" card, indicating it had been thoroughly checked before leaving the factory. I have my doubts. When the box was unpacked, the table was not attached to the saw. When attached properly, the table is quite secure, but I suppose it could have worked loose during shipping. The other problem was that the spring-steel tension pin that secures the blade-tensioning bracket was not pushed all the way into the bracket. Once the tension pin was inserted properly, the saw ran as advertised. *—Bill Endress, Orlando, Fla.*

Claims against Tools-to-Go—Other readers might like to know what I turned up while tracing my order to Tools-to-Go, which is no longer in business. The matter is now in the hands of the post office and is being handled by Inspector Mike Bollie. You can contact him by writing to Box 520772, Miami, Fla. 33152. Those who bought tools on credit cards should contact their banks as soon as possible. You may be able to receive credit on your purchase. *—Bill Toth, Yuma, Ariz.*

Praise for Boomer sculpture—I really enjoyed the article in *FWW* #73 on John Boomer's sculpture. Not only was the work beautiful, but the artist expressed his feelings and motivations in creating the work very well. There may not be a lot of us out there who deal in such nonpractical stuff as sculpture, but it sure is nice to see an article on the subject once in a while. No technical or how-to information is needed—we get plenty of that in the other articles. Hopefully you can continue to give exposure to the artistic side of woodworking. *—John Taye, Boise, Idaho*

No ripping on radial arm—As a radial-arm saw user for 30 years, I read with interest the articles on radial-arm saws in *FWW* #73. I agree with those who don't like radial-arm saws for ripping. My complaint is that the carriage will creep if one rips a long or heavy piece; the carriage lock simply isn't good enough. This weakness finally impelled me to purchase a tablesaw with sufficient power.

Keeping the radial-arm saw properly aligned is a chore, as Mark Duginske wrote on p. 66. Also, I found it impossible to establish sufficiently accurate parallelism between the table and the blade path. Perhaps this is because of distortion of the table supports on my saw, but it does limit the uniformity of depth of dado or rabbet cuts.

Nonetheless, even with its faults, the radial-arm saw is a useful tool, especially as an adjunct to a tablesaw. With a Jacobs chuck, it can do horizontal boring when the arbor speed can be reduced below the usual 3,450 RPM. A similar comment applies to drum sanding and other operations.

—N. Leonard Wener, San Diego, Calif.

Check out the radial saw table, too—Thanks for the comparison of nonindustrial radial-arm saws (*FWW* #73). However, there is one underlying issue that might deserve more attention than this study gave it. Over a few weeks testing, of course, you won't see an inadequate table surface buckle or sag; in a year, easily, you will. And careful adjustment of the blade becomes, in this circumstance, next to impossible. Thus, some comparison of the quality and thickness of the table and spacer boards would be very helpful, as well as a look at the size of the support structure and any compensators built into it.

This is an interesting problem in that an often-recommended procedure for "protecting" your table boards usually makes them worse. My Sears radial, purchased a year ago, came with 1-in. particleboard surfaces. The manual suggests tacking or screwing ¼-in. plywood over these to take up the kerf cuts and prolong table life. But, you must drill ¾-in. holes through the cover to access the leveling and adjusting hardware. And the truth is, sawdust works its way very quickly between the "protection" and the table, causing it to buckle. Sawdust also comes through these holes and along the edges, especially near the fence. In combination with deeper kerfs (to prevent splintering in plywood, for example, or on high-bevel cuts), the surface has sagged off out beyond the edges of the support structure and has hills and valleys around kerfs and mounting holes.

A friend of mine suggested covering the new table with ½-in. plywood. This, perhaps with a little sealer over the seam edges, would certainly help prevent the sawdust-induced buckling. But, because it is tacked on, the extra beef in this covering will not

help sagging around the table edges. It would have to be glued to do this. And why glue up a 1¼-in.-thick top when you can buy one? My own solution would be to simply make a new table out of 1¼-in. or even 1½-in. particleboard. When it goes, it goes, and that's simply the price of square ends, level dadoes and the like on these machines. Remember, once the flatness of the table goes, you cannot really adjust the blade.

—Michael Reddy, City Island, N.Y.

Poor quality is the real radial-saw problem—The criticisms of the radial are not unreasonable, but the most significant point was omitted. Having used radial and table saws over a span of 40 years, it is my judgment that the radial is far superior if you must choose one or the other. The problem is that manufacturers have cheapened their quality to remain reasonably competitive. If you put all controls, height, miter, etc., up front for convenience, you introduce linkages or belts that aggravate adjustments, ultimately introducing errors.

I have a DeWalt 925, bought in 1961, that is a jewel. Its controls are on the column for height and miter, and on the carriage for other adjustments. The switch is on the side of the arm. I have made furniture for every room in several houses, including extensive molding and shaping. Alignment is relatively easy and seldom needed, if the saw is not abused. The carriage rolls very easily on the arm if adjusted properly. Considering the time one spends changing settings and cuts, I prefer precision and quality to small inconveniences. *—James C. Mingee, Englewood, Colo.*

Consistency in Chinese furniture—I enjoyed Allan Smith's overview of Chinese furniture (*FWW* #73) and would like to add one point relating to the stylistic continuity Smith mentions. I believe this consistency exists because of the nature of a Confucian society, where elders and that which has gone before is revered. An apprentice would not presume to improve upon the sublime efforts of his forebears. In our Western society, previous design is regarded as a thing to be studied and then made better. Originality is the goal. Consequently, our taste in design may change quite rapidly.

The exposure to both Oriental and Occidental design has made my own fascination with building Chinese furniture more enjoyable. Two museums that house good collections are the Philadelphia, Penn., Museum of Art and the Nelson Gallery, Kansas City, Mo. *—Peter C. Christine, Alna, Maine*

For further reading—In reference to the article on "Learning from the Chinese" (*FWW* #73), Allan Smith's bibliography overlooked a valuable book by Wang Shizaing, China's leading scholar in this field: *Classic Chinese Furniture* (1986), China Books and Periodicals, Inc., 2929 24th St., San Francisco, Calif. 94110.

—Alan Bauer, Honolulu, Hawaii

Tapping threads into wood—I read about the marking-gauge locking device in "Methods of Work," *FWW* #73. I, too, find that the reassuring creak of a wooden screw is a luxury I must deny myself in things I make. I found Blandford's alternative—the captured nut—an ingenious solution. There are commercial alternatives, T-nuts being the most readily available, but why not simply tap the wood, which I've been doing for half a century? One has to do a little experimenting with tap-drill sizes and tapping techniques. If strength or long life are important, then here's a trick. After tapping the hole, put a drop or two of cyanoacrylate adhesive on the threads: It fills the pores and hardens the surface. Retapping is sometimes necessary, but infrequently.

—Robert B. Meuser, Oakland, Calif.

Disassembling old machines—I'd like to comment on Roger Apted's letter (*FWW* #73) on restoring industrial woodworking equipment. As an owner of three pieces of Oliver machinery from the 1940s, I suspect that Apted has never tried to disassemble machines like mine or convert them to single-phase motors. The smallest piece of equipment I own would still weigh 800 lbs. stripped, and it'd take a week to put it back together. The motors are all direct drive and impossible to convert without a lot of needless additional shafts and pulleys. And finally, a three-phase converter is easy and cheap to assemble from a large old motor, some starting capacitors and a switching system. Mine cost $100 and has worked flawlessly for three years.

—Ron Lira, Oklahoma City, Okla.

Tiny bits for cordless drills—I wonder why Mark White in his article on cordless drills (*FWW* #72) made such a point regarding minimum chuck capacities of these machines, citing sizes such as ¹⁄₃₂ in. and ¹⁄₆₄ in. Would anyone use such small bits in any electric drill—cordless or conventional? I personally would not use such drills for fragile bits. A better, low-tech solution would be to use the traditional "eggbeater" hand drills.

—Tom Seward, London, England

Building in fire protection—Gary Boudreaux's letter presenting the idea of protecting investments with a fire resistive room (*FWW* #73) is excellent. I have some concern, however, with the thought that just an extra sheet of sheetrock and a solid-core door is all that's required. Fire pays no attention to what we "think" will stop it, and it simply is not a wise move to build without being positive about fire resistance.

For a true enclosure that is fire resistant for one hour, you must provide protection on three fronts:

1) The walls—These must have one layer of ⅝-in. type "X" gypsum board on both sides, with the seams taped;

2) The ceiling—If your room is 8 ft. high in a 14-ft. shop, you must either extend the ⅝-in. gypsum board walls to the roof or build a fire-rated ceiling assembly. This requires one layer of ⅝-in. type "X" gypsum board screwed to a hat-shape, metal furring channel, which is, in turn, attached to the bottom of the joists. On top of the joints, ¾-in. tongue-and-groove plywood should be used;

3) The entry—A concrete vault won't stop a fire if in the rush to run out, you forget to shut the door. A door rated fire resistant for 45 minutes and an automatic door closer are a must. Try to resist blocking the door open, too, or you will have thrown your money away.

For those in rural settings who need an enclosure that can resist fire for two hours, two layers of ⅝-in. type "X" gypsum board on each side of the walls and a "B" label door with closer is required. A two-hour ceiling is difficult to get, and it would probably be cheaper to continue the two-hour walls to the roof.

Please note that these assemblies will stop fire for as long as the ratings claim; they also are accepted by code where I live. If you are required by your insurance company or a building official to meet your local code, call your local building inspector for requirements in your area. *—Jeff Overright, Bloomington, Ill.*

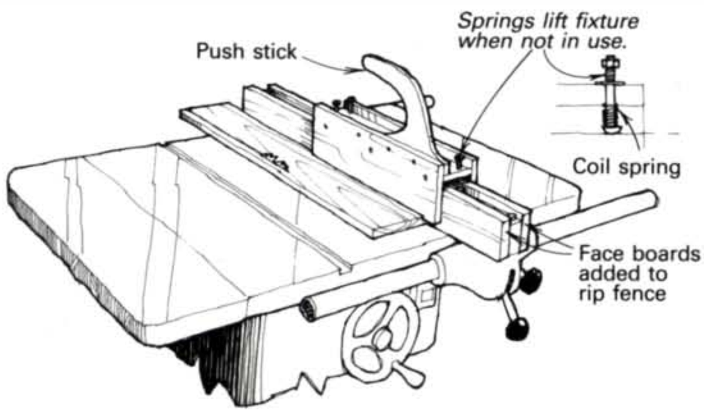
About your safety:

Working wood is inherently dangerous. Using hand or power tools improperly or neglecting standard safety practices can lead to permanent injury or death. So don't try to perform operations you learn about here (or elsewhere) *until you're certain that they are safe for you and your shop situation.* We want you to enjoy your craft and to find satisfaction in the doing, as well as in the finished work. So please keep safety foremost in your mind whenever you're in the shop.

—John Lively, associate publisher

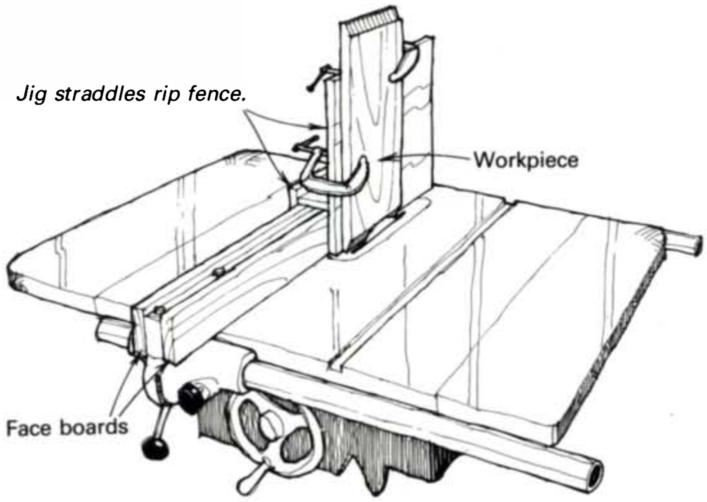
edited and drawn by Jim Richey

Two rip-fence straddling jigs



This fence-straddling push stick was originally designed to fit a Biesemeyer fence, but it could be adapted to practically any fence fitted with auxiliary face boards, as shown in the sketch. For added convenience, I installed plungers made from coil springs and bolts to raise the push stick when not in use.

–Bill Hatch, Greensboro, N.C.



This jig, above, is designed specifically for making those steep angled cuts on the edges of long workpieces, as in making fielded panel doors. If you've tried sliding a wobbling workpiece vertically along the fence, while watching to make sure the tapered end doesn't fall through the space in the saw insert, you'll immediately recognize the advantages of this jig. With it, you can make a smooth, controlled, burn-free cut.

Dimensions aren't critical, just make sure the jig slides smoothly on the rip fence. The face of the jig can be large or small depending on the size of the workpiece. It can be fitted with a vertical fence if needed. Just C-clamp the workpiece to the face of the jig, then slide the jig past the blade.

–Alfred W. Swett, Portland, Maine

Quick tip: If your screwdriver tip won't grip the slot of a hard-to-remove screw, put a little valve-grinding compound in the screw slot. *–Steve Daechsel, Abbotsford, B.C., Canada*

Hot-melt adhesive by the sheet

When I couldn't find sheets of hot-melt adhesive for my veneering project at the store where I bought the veneer, I went looking elsewhere and found it at a fabric shop. The sheet adhesive comes in two forms: fusible web and transfer web. Fusible web is simply a sheet of hot-melt adhesive that you cut to size, place between the parts and press with a hot iron to fuse. With this type, there may be a bit of squeeze-out around the edges of the veneer.

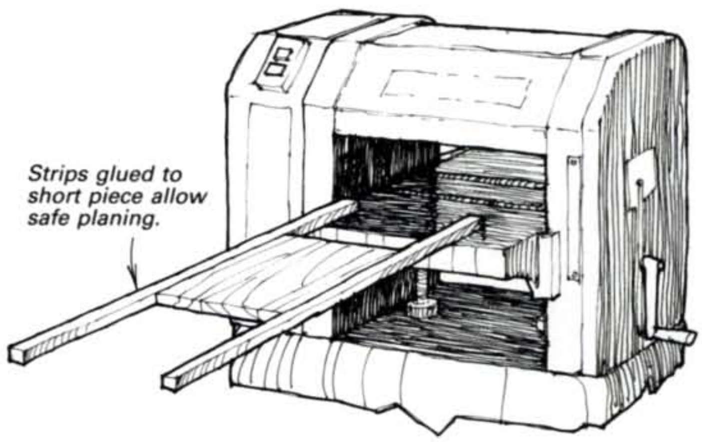
By contrast, the transfer-web adhesive is applied by first melting the adhesive to the back of the veneer. Then you peel off the backing paper, cut the veneer to size and fuse the veneer to the ground with a hot iron. This approach seems to result in a neater glue job. To avoid ironing dirt into the wood, place a clean sheet of paper between the iron and the veneer. A sandbag will apply the small amount of pressure needed to hold the veneer in place while the glue sets.

The fabric-store adhesive works just fine, and at $1.70 per yard, I certainly can't complain about the price.

–Gerald W. Edgar, Renton, Wash.

Quick tip: During the summer, I wear shorts while turning, and that lets the sawdust fall annoyingly into my shoes. To prevent this, I bought a pair of hiking gaiters at the local sporting-goods shop. *–Helga Wink, Nashville, Tenn.*

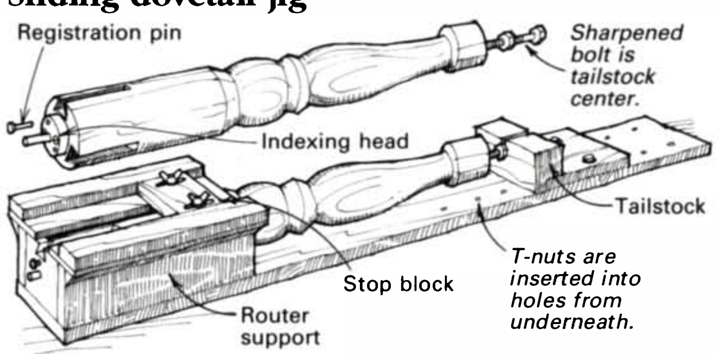
Thickness-planing short pieces



Because feeding short boards through the planer may result in snipes and even kickbacks, the operation should be avoided. But when the job is necessary, here's a way to make it less risky. Glue two scrap outriggers to the edges of the piece to be planed, as shown in the sketch. These scraps, because they extend several inches beyond the ends, will stabilize the short board as it enters and leaves the planer, thus reducing the chance of sniping. When the desired thickness is reached, saw off the scrap outriggers and run the board's edges over the jointer to clean them up. *–Bill Clark, Bakersfield, Calif.*

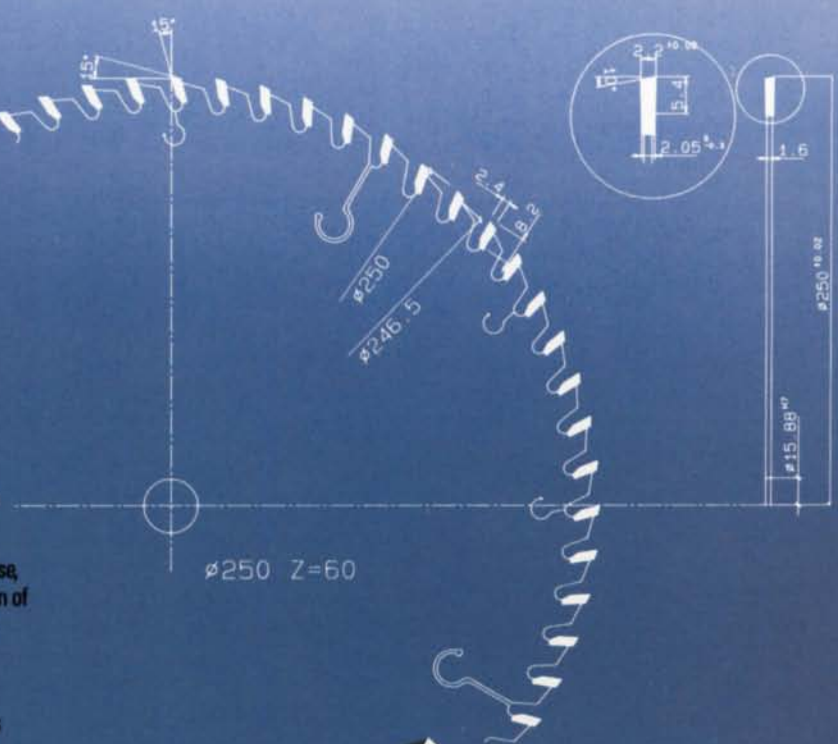
Quick tip: If you run into burning problems when drilling hardwoods, try lubricating the hot bit by letting a little beeswax melt on it. *–John Wiznak, Victoria, B.C., Canada*

Sliding dovetail jig



I use this jig for routing the sliding dovetail housings for the legs of small pedestal tables and stands: It's fast to set up and very accurate. I made the jig's index head from a ½-in.-thick aluminum plate bandsawn into a circle, but you can make it as easily out of a thick piece of hard maple. I tapped the center of

Thin Kerf. Advanced Design.



The Freud Difference

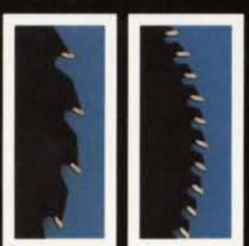
Superior Carbide. Some of the physical properties of carbide, elasticity, hardness and resistance to chemicals, can be changed to meet cutting requirements.

To ensure the blade you buy has the best carbide qualities for its purpose, Freud produces special blends at its own factory. Through a combination of robotic and computer monitoring, each batch is checked to assure purity and quality.

Advanced CAD System. The Computer-Aided Design System simulates actual cutting conditions in three dimensions and records the blade performance. This allows Freud engineers to electronically vary the material being cut and the blade's physical characteristics to develop saw blades that provide optimum cutting performance.

Laser Technology. A computer-controlled, 500-watt laser is used in the production of Freud cutting tools. The concentrated beam of light creates a perfectly round blade, produces shoulders identical in shape and size and precisely centers the arbor hole. In addition, expansion slots are strategically placed to allow for heat dissipation during brazing and blade body expansion during actual use.

Thin kerf blade compared to standard kerf blade



Freud thin kerf blades Rip (left), Crosscut (right)

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Stock Number	Thin Kerf Rip	Kerf	Suggested Retail
LU87M008	8" x 22 x 5/8"	.086 inch	$49.00
LU87M009	9" x 22 x 5/8"	.094 inch	$54.00
LU87M010	10" x 24 x 5/8"	.094 inch	$56.90
Stock Number	**Thin Kerf Crosscut**	**Kerf**	**Suggested Retail**
LU88M008	8" x 48 x 5/8"	.082 inch	$59.90
LU88M009	9" x 54 x 5/8"	.090 inch	$63.90
LU88M010	10" x 60 x 5/8"	.090 inch	$69.90

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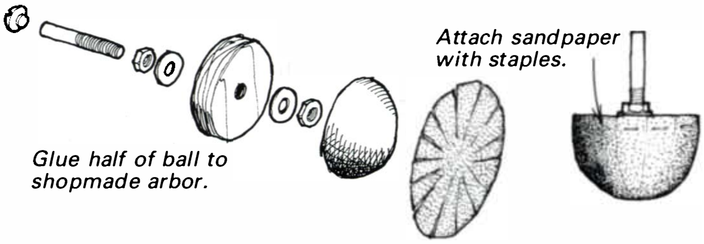
the index head to receive a short length of ½-in.-dia. aluminum rod with one end protruding slightly and pointed to act as a center. Three indexing holes are bored through the head to correspond with the dovetail housings to be cut in the pedestal. A registration pin pushed through the face of the router support seats in one of these holes, positioning the pedestal for routing.

I use a ¾-in. dovetail cutter in my router to cut the housings and install an adjustable stop block on the router support to keep the housings the same length. *—Eric Schramm, Los Gatos, Calif.*

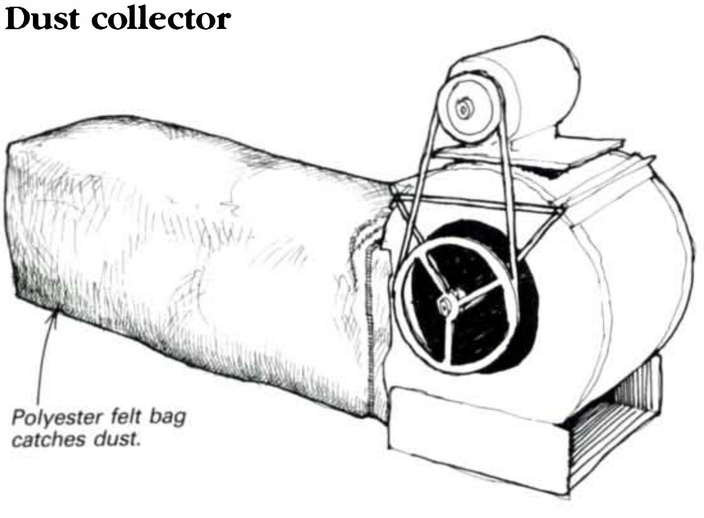
Hemispherical sander



This little device, which works especially well for sanding concave interior surfaces, can be easily produced in the workshop. Start with a sponge-rubber ball, the kind available at toy stores in various diameters from 1 in. to 3 in., and carefully cut the ball in half. Now saw the head off a ⅜-in. carriage bolt. Using jam nuts, screw the bolt to a plywood disc the same diameter as the sponge-rubber hemisphere. Hollow the hemisphere to accept the jam nut and attach it to the plywood disc with hot-melt glue or silicone adhesive. Prepare an abrasive disc to conform to the hemisphere by cutting several radial slots at equal distances, as shown. Staple the abrasive paper to the wooden disc or hold the paper in place with a hose clamp. *—Donald F. Kinnaman, Phoenix, Ariz.*

Quick tip: Cardboard tubes from the centers of newspaper rolls make good drums for lathe-mounted thickness sanders. Just turn end plugs and epoxy in place. My drum is 6 in. in dia. and 3 ft. long, with 1-in.-thick walls. Newspapers give them away for the asking. *—J. Mark Fineout, Terrell, Tex.*

Dust collector

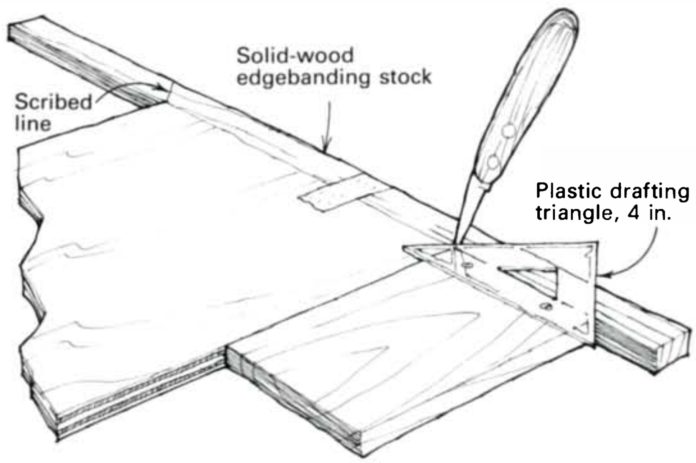


When I went shopping for a shop vacuum system, the culmination of the salesman's pitch concerned the unit's large blower that sucked the dust out of the entire shop. I realized then that I did not need another vacuum in the shop, simply a dust eliminator. Turning to an article by Mac Campbell in *FWW on The Small Workshop*, I found the key: a bag made from polyester felt. The material, available from most large retail fabric outlets, allows air to flow through, but it catches dust, similar to the way a filter bag works in a vacuum cleaner. I combined a homesewn bag with a discarded squirrel-cage blower, and the rest is history. You would not believe the dust this thing sucks up. I keep the unit on the floor and direct my sweepings toward the inlet; when I'm sanding, I stay close to the blower. All the dust that normally stays in the air for minutes and powders every inch of the shop is sucked up instantly.

—Thomas C. Turner, St. John's, Newfoundland, Canada

Quick tip: To prevent your oilstone box from sliding around the bench while you sharpen tools, drive a small finish nail near each corner. Clip each brad short and sharpen it to a point so it will grip. *—P.W. Blandford, Stratford-on-Avon, England*

Miter gauge for plywood edgebanding



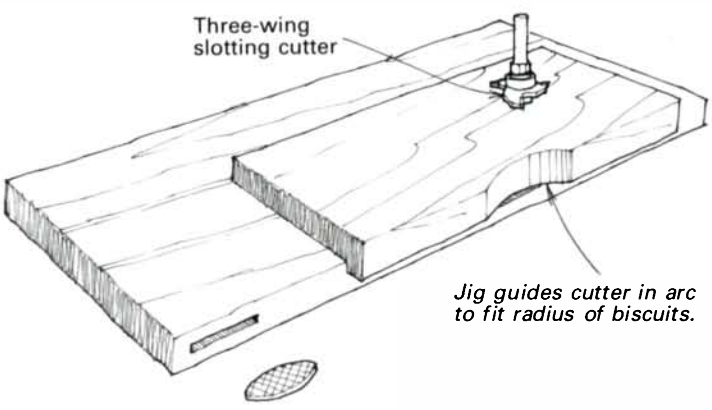
Solid-wood edgebanding is often used around plywood doors and tabletops to cover the edge laminations. But measuring, aligning and scribing the eight 45° miters on the banding is a tedious job, because the banding's length and the miters' angles must be perfect for everything to fit. This little gauge eliminates the measuring and allows you to mark the miters right from the workpiece.

To use the jig, first tape the banding stock in place on the edge. Slide the jig into the corner where the work and the banding stock meet, and scribe the 45° miter with a sharp knife. Move to the other end and repeat. If the jig has been accurately made, you'll have perfect scribe lines for cutting miters on the banding.

To cut the miters, I use a standard plywood jig with rails on the bottom that run in the miter-gauge slots on my tablesaw.

—L.A.D. Colvin, Satellite Beach, Fla.

Plate joinery on a budget



When my hankering to take advantage of quick biscuit-joint systems ran up against the high cost of the required machinery, I looked for a cheaper approach. My solution was to use a wing slotting cutter in a router to make the kerfs for the standard biscuits. An Amana three-wing slotting cutter (available from W.S.

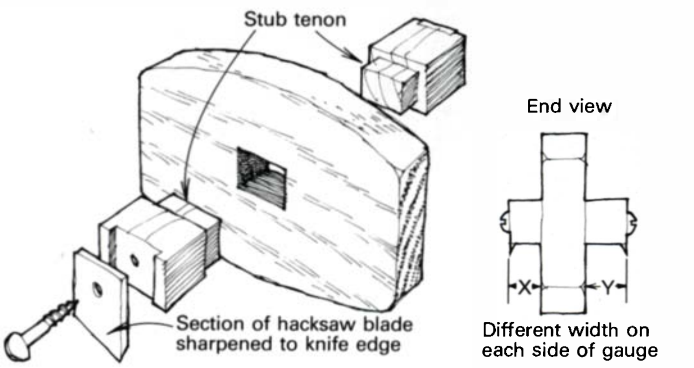
Jenks & Sons, 1933 Montana Ave., N.E., Washington, D.C. 20002 for about $15) can cut a 5⁄32-in.-wide, ½-in.-deep slot the same as any biscuit joiner.

The only problem is that the three-wing cutter's radius is just under 1 in., while the radius of the biscuit joiner's sawblade is 2 in. Because of the smaller radius, the profile of the routed slot will not mate perfectly with the semi-circular edge of the biscuit. Although this mismatch will not affect the assembly or strength of the joints, it can be eliminated by constructing a simple jig, as shown in the sketch. The jig guides the cutter through a 2-in. arc and also sets the depth of cut.

—Richard Fryklund, Arlington, Va.

Quick tip: Arm & Hammer washing soda cleans pitch and gum from sawblades. Dissolve about half a cup in a shallow pan of hot water large enough to hold the blades, and let them soak a few minutes. Rinse with hot water and dry. This will not harm the blade or your hands, and as a bonus, it will also help keep the drainpipes clean. *—Gerald Szeflinski, Greendale, Wisc.*

Fixed-position marking gauges

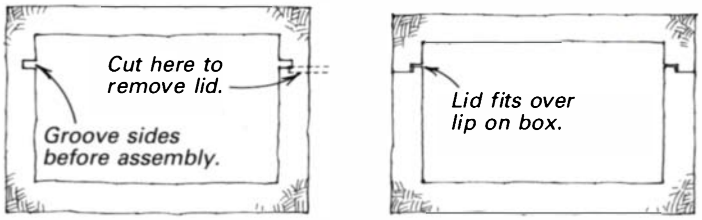


Using fixed-position marking gauges saves me time and tedium while laying out. Here's how I make them: Cut several short pieces from a hacksaw blade. Drill a hole through each blade section and bevel and sharpen one end to a knife edge. The body of the gauge is a 3-in. by 5-in. block with a mortise in its center. Cut stub tenons on the ends of two pieces of ¾-in. by 1-in. hardwood so they each can be glued into the mortise from opposite sides of the body. Cut each of these two pieces to length so that when a section of hacksaw blade is screwed into a notch in the end, the knife edge will be the desired distance from the body of the gauge. Mount the blade with the bevel facing the block. This way the blade will pull the block into the work and stay on track. When finished, mark the gauge's measurements so you can quickly find the size you're looking for.

—Dennis R. Mitton, Gig Harbour, Wash.

Quick tip: If your sandpaper tends to clog quickly because of gum or glue, a quick pass with a file card or wire brush will extend its life. *—Chris Dallsmore, Salt Lake City, Utah*

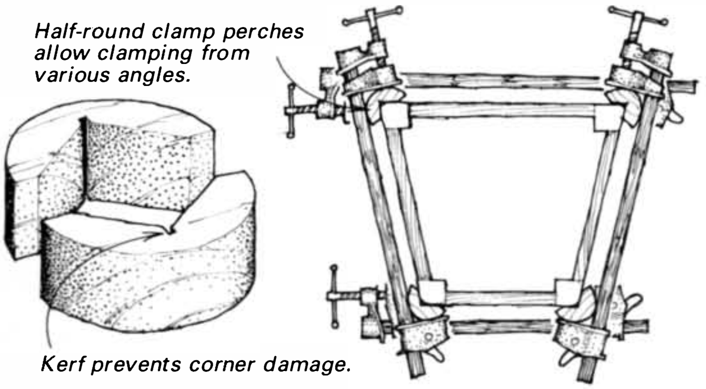
Box-lid trick



When I make small boxes, I assemble them in one piece, including the lid. Then when I cut the lid off, it will match the box exactly. When I want an undercut on the lid to fit over a lip on the box, I use a variation of the one-piece technique. First, before assembly, I cut a ⅛-in.-wide groove in the inside face of each of the box's sides where the top of the lip is to be. After the box has been assembled, I use a narrower blade to cut off the lid. I offset the second lid-removal cut from the inside groove, as shown, to produce a lip that nests into the lid.

—F.B. Woestemeyer, West Chester, Penn.

Clamping perch for irregular shapes

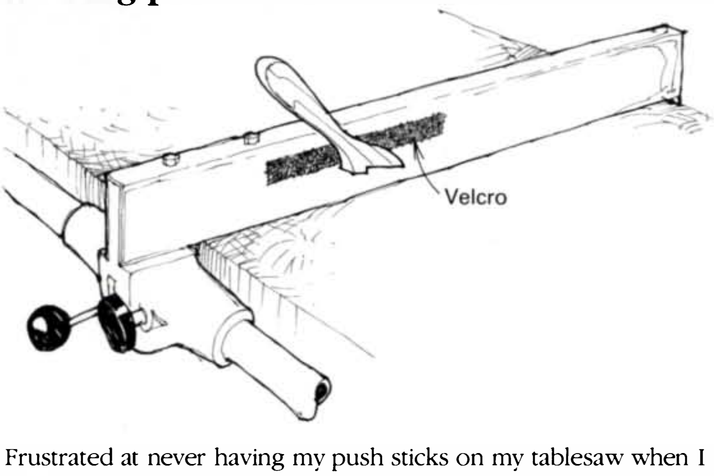


To clamp up chair frames and other irregular shapes, I use semi-circular clamping perches like the ones shown in the sketch. To make the perch, cut a 3-in.-dia. circle from a 2x4 with a large hole saw or fly-cutter. On the bandsaw, halve the circle with the grain and make a V-cut in the flat side to match the angle of the corner of the piece being glued. An extra kerf at the apex will prevent the block from crushing any sharp edges or from being glued to a mitered corner. The round surface will accept clamping from any angle, even crossclamping.

—John M. Gray, Syracuse, N.Y.

Quick tip: Smoothly planed wood can be slippery to get a grip on when feeding a machine. Licking your fingertips greatly increases the control. *—E.C. Kimball, McCall, Idaho*

Holding push sticks with Velcro



Frustrated at never having my push sticks on my tablesaw when I need them, I glued a strip of Velcro on the right side of my rip fence and the mating Velcro material on the sides of my push sticks. The push sticks now stand at attention on the rip fence, ready to be grabbed when needed. Most Velcro now comes with a peel-off sticky back that should fasten the material well enough. This tip could be used for many accessories and tools around the shop. *—David Crawford, Brownsboro, Tex.*

Methods of Work buys readers' tips, jigs and tricks. Send details, sketches (we'll redraw them) and photos to Methods, Fine Woodworking, *Box 355, Newtown, Conn. 06470. We'll return only those contributions that include an SASE.*

Truing a jointer-plane sole

How do you true up the sole of jointer planes—both wood and metal? It seems that if a plane's sole is absolutely flat, the protrusion of the blade would cause the plane to rock. There must be a way to compensate for this.

—John Latta, Anchorage, Alaska

Rich Preiss replies: Truing the sole of any handplane, be it metal or wood, is essential if you are to obtain flawless performance. Longer planes, such as jointer planes, require special care because of their size and because they are used mostly to shoot edges prior to glue-up, an operation that demands accuracy. The process for truing wood and metal planes is similar; the required tools are a large mill file, some large sheets of cloth-backed emery or silicon-carbide abrasive and a flat reference surface, such as a ground metal plate or a pane of ¼-in.-thick glass (preferably tempered).

I start by backing the plane iron out of cutting range and clamping the plane upside down in my bench vise. Do not clamp the cheeks of the plane, but rather clamp the plane by its handle, with the front knob resting on top of the bench. Any compression on the plane's side walls during flattening will cause the sole to deform and become unflat when the plane is unclamped. Using a good metal straightedge, or the rule from a combination square, carefully gauge the condition of the bottom of your plane. Check across the sole starting at the nose, work your way back to the heel and then check lengthwise. More often than not, you will find a hollow in the center and also a low spot around the mouth of the sole—a result of wear.

Depending on how far out of true the sole is, you'll have to perform one or two operations: The coarser step is filing or grinding away the high spots; the finer step is lapping the bottom smooth. If the irregularities are slight, you are fortunate and can proceed right to the lapping step. Remove the plane from your bench. Tape your abrasive by the edges to your reference surface and carefully, one stroke at a time, move the plane over the surface until the entire sole is uniformly polished. Start with a 320-grit paper and proceed to 400 grit, or finer if you choose. The finer the polish, the slicker the plane's ultimate performance. Avoid the tendency to rock the plane as you go back and forth: This will round the sole. Be sure to press squarely over the plane's entire body; to ensure accuracy, occasionally reverse the plane and push it heel-first.

If the straightedge reveals the sole is very uneven, carefully file it flat, one stroke at a time, until it comes within lapping range. Work the file in one direction until the high spots are just about flush with the majority of the surface and then proceed to the lapping. Do the filing with the plane upside down in your vise as before. Keep your file clean, and check your progress often with the straightedge and a set of winding sticks. Winding sticks are two straight strips of wood that are laid on the sole parallel to each other and perpendicular to the length of the plane. By sighting the top edges of the two sticks, you can see if there is any twist or "wind" in the sole.

Once the sole is flat, you should check if the mouth of the plane is a straight and square opening. This is important, because the mouth allows the chips to escape between the sole and the blade. If the opening is not square, scribe a fine line at the leading edge of the mouth, perpendicular to the long edge of the sole; using a small mill file, carefully remove just enough material to true the opening.

Wood planes require more frequent flattening, because they are more susceptible to climatic changes. However, if you do a little bit of truing regularly, you will never have to face severe modifications. Many contemporary wood planes have adjustable throat inserts that should be reset after any major retruing of the plane sole, to make the size of the mouth the same as it was.

On a properly flattened jointer plane, the iron should project only enough to take a fine shaving, and that small amount should never cause the plane to "rock," as you mentioned. There's no need to do any special truing to account for the blade's projection.

[Rich Preiss is head of the woodworking program at the University of North Carolina at Charlotte and a consulting editor to *FWW*.]

Wormy maple

I recently ran across some wormy maple at a local lumber dealer. Although I understand that wormy wood is fairly common, I wonder if such lumber is usually available commercially. Also, do they cut wood that's already been attacked by worms, or do the worms only attack sawn lumber?

—Marilyn MacEwen, Fairview, N.C.

Jon Arno replies: Wormy maple is quite common, as is wormy ash, butternut, chestnut and oak. Although some species are resistant, most woods will become wormy if attacked by the larvae of certain beetles. One of the primary culprits is the powder-post beetle, which has a special fondness for ash but will attack other species.

Although wormy wood can be attractive in paneling, picture frames and rustic furniture, the lumber trade views "worminess" as a degraded condition, because it structurally weakens the wood. For this reason, sawyers avoid processing wormy wood at the mill, and most lumber dealers don't stock any, except for wormy wood that's been milled for paneling and thoroughly kiln dried to kill the eggs and larvae.

The best way to track down a supply of wormy maple is to contact some of the smaller sawmills in your area and ask the operators to call you if they receive any wormy logs. You'll have to act quickly, because wormy wood is usually discarded or sold as firewood right away, as sawyers don't like to keep wormy logs around for fear the worms will infect their inventory of sound logs and lumber. For this reason, wormy wood is usually a little hard to find, but not necessarily expensive. If you get some wormy maple, it is important to have it kiln dried before you use it, to kill the worms.

[Jon Arno is a woodworker and amateur wood technologist in Schaumburg, Ill.]

Horsepower ratings and reality

Volts X amps/746 watts = horsepower, right? If so, why are so many motorized tools advertised as having higher-than-possible horsepower? Also, what is developed horsepower?

—Ed Good, Nordland, Wash.

Ed Cowern replies: Much of the confusion about electric-motor horsepower is due to the fact that manufacturers use different methods to rate the power of different kinds of motors. Standard induction motors that are used on most stationary power tools, like tablesaws and planers, are rated according to the motor's continuous running capability. Although not stated on the motor's nameplate, these motors can normally produce 200% to 300% of the specified horsepower rating for short bursts of time. When producing the higher horsepower, they draw more amps than the nameplate indicates, but as long as the overload periods are short (typically several seconds), the motor will not be damaged. If you use the standard horsepower formula you stated and figure in the amperage printed on the nameplate, you'll come up with a horsepower rating very close to the motor's continuous power output.

Portable tools, such as electric drills, routers and jigsaws, have universal motors. Compared to induction motors, universal motors are smaller, lighter, capable of variable speeds and run on either AC or DC power. Unfortunately, the rated output of universal motors isn't clearly a product of the standard horsepower formula: These motors are typically rated in terms of their "maximum developed" or "peak" horsepower output. Just as the power generated by an induction motor in a short burst can far exceed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its continuous power rating, a universal motor can produce its maximum or "peak" horsepower for very short periods before burning out. During the overload or peak period, universal motors draw much higher amperage than what's stated on the motor's nameplate. When manufacturers calculate horsepower, they factor in this peak amperage figure, rather than the amperage on the nameplate. This gives a rating higher than seems possible by the standard formula. For more information about calculating horsepower, see my article in *FWW* 64, p. 57.
[Ed Cowern is an electrical engineer and president of a company that distributes electric motors. He lives in North Haven, Conn.]

Making a wax mixture

I understand you can mix beeswax with paraffin wax to make a furniture polish, but I don't know the proportions for the mixture. Also, what is the procedure for combining them?
—William H. Crist, Charleston, W. Va.

Bob Flexner replies: Beeswax has been used on furniture for centuries, both as a primary finish and as a polish. Paraffin wax is a soft wax that's a petroleum derivative usually combined with hard waxes, such as carnauba or candelilla, to make them easier to spread. When combined with beeswax, its purpose is usually to reduce the cost of wax, not improve the quality. Rather than using paraffin, I'd experiment with mixtures of beeswax and the harder carnauba or candelilla (see my article "Demystifying Wax," *FWW* #70, p. 66).

Any wax can be made into a paste by mixing the wax with a solvent, such as turpentine or mineral spirits, and heating it in a double boiler. However, if done on a stove top, this is a highly dangerous operation that can easily result in a fire or explosion, so I don't advocate amateurs doing it. Fortunately, there is another method that is quite a bit slower than the heating method but far safer. First, shred the wax into a lidded glass or metal container. Add about ½ pint of solvent to 1 lb. of wax and stir the solution to an even consistency. Then, simply shake or stir the mixture from time to time for several days until all the wax is dissolved. If you want the paste to be thicker or thinner, either add a little more wax or more solvent. Rottenstone, oil-based pigments or dark-color dyes can be added to create different antique and scratch-covering effects.
[Bob Flexner is a professional finisher and restorer. He lives in Norman, Okla.]

Tenoning with a retoothed backsaw

I enjoy cutting tenons by hand. However, when cutting the tenon cheeks, I'm ripping with crosscut teeth. Is it possible to refile the teeth of a backsaw to work faster or cleaner when cutting with the grain? —Paul J. Pieper Jr., Abington, Penn.

Michael Podmaniczky replies: Although it may not appear to be so, backsaws and dovetail saws are already designed for cutting both with and across the grain. True, the teeth are more like crosscut teeth than rip teeth, but there's a reason: A crosscut saw used to rip will merely take longer to use, but a ripsaw used against the grain will grab, drag and tear. Try a few crosscuts with even the finest-toothed ripsaw, and you will understand why manufacturers have come up with "combination" tooth designs for saws that are meant to do a multitude of sawing tasks.

However, if you cut a lot of tenons by hand, the ideal situation is to have two different saws, one for each tenoning job: a crosscut saw for the shoulders and a ripsaw for the cheeks. As I said before, you will find that most backsaws already come sharpened to crosscut. To modify a backsaw for ripping, old-time craftsmen often would grind or file off the fine teeth and cut new ones, reducing the number of teeth per inch at a ratio of six new rip teeth for each eight old crosscut teeth. The new teeth should be filed straight across, with no bevel, and the face of each tooth should be square to the axis of the blade. Rip teeth should also have less set than crosscut teeth. Unless you file saws on a regular basis, it is unreasonable to attempt this task: Pay a local saw-sharpening shop to do the job for you.
[Michael Podmaniczky is a contributing editor to *FWW* and a furniture conservator at The Winterthur Museum in Winterthur, Del.]

Acidic wood and carbide

I have read that woods with high-acid content destroy carbide, so these woods should only be cut with steel or stellite. If this is true, which woods should I avoid cutting with carbide blades? —Stuart Grimstad, Amherst Junction, Wis.

David Snook replies: Phenolic acid in wood does affect tungsten-carbide teeth cutting green or wet wood. The acid eats the cobalt binder that holds the grains of tungsten together, causing the teeth to deteriorate. This effect, coupled with the high temperatures generated during cutting, also causes the teeth to dull much faster than normal.

Cedar is a real problem, because it has one of the highest phenolic-acid contents of any commercial wood and is naturally very abrasive. Conifers and most other softwoods are also high in acid content. Oak and other hardwoods have a very low acid content. Fortunately, the phenolic-acid content in dried woods is low, so it's not a concern.

Steel and stellite tooth blades are not affected by phenolic acid and are therefore good substitutes for tungsten carbide when working with green woods. Special grades of carbide with a nickel binder rather than cobalt are also available. The acid doesn't affect nickel, thus eliminating the problem, and nickel carbide stays sharp longer than steel or stellite, because it is much more resistant to abrasion in green woods.
[Dave Snook is a custom sawblade maker and owner of Snook's Saw Shop in Salem, Oreg.]

Drying turnings in the microwave

I cut logs from red cedar, cherry and oak for woodturning. I rough-turn the green stock, dry the wood and then do my final cuts and sanding on the lathe. I've tried to expedite the drying by using a microwave oven, but I don't get consistent results. What's the proper way to do this?
—W.L. Peterson, Princeton, Wis.

Alan Stirt replies: From your letter, it's not clear to me which way the grain runs in your bowls. I suspect you're turning the endgrain, with the tree's center as the center of the bowl. In this case, no matter how you dry the bowls, you're going to have a higher loss rate and less consistent results than you would if you turned bowls into side grain and eliminated the tree's pith center.

To aid in drying, no matter what the grain orientation, the thinner you turn the green-wood bowl (while making sure there's enough wood to finish), the less chance of cracking. It's also very important to turn the bowl with an even thickness throughout. Thicker areas will have a greater tendency to crack. When air-drying, coating the bowl with a wax or other sealer to slow and even out the drying also reduces cracking. The portions of a bowl with the most endgrain showing dry much faster than the side-grain portions. You can use paste wax, white glue diluted with water, commercial end coating (wax-emulsion type) diluted with water or anything that provides a moderate water-vapor barrier. Too heavy a sealer can be counterproductive: The idea is to slow down, not stop the drying process.

I've found that the moisture content of the wood probably has the greatest effect on how the bowl will dry in the microwave. If the wood is too wet (above 22%), it will not dry evenly and cracking will occur. I have found this to be true even with butternut and other woods that can be dried by more conventional methods with little fear of cracking. If necessary, I air-dry my

bowls to get their moisture below the about 22% before drying them in the microwave. I measure the moisture content with a moisture meter. If you don't have a meter, you can experiment by varying the amount of time you leave the bowls to air-dry before microwave drying. If you leave the bowls for a few weeks and they microwave crack-free, you can speed things up by gradually shortening the air-drying periods until you determine the minimum air-drying time needed in your local climate.

I prefer to treat the wood with several short microwave treatments rather than fewer longer ones. I set the microwave on the defrost cycle and place the bowl on a carousel inside. This rotates the bowl slowly so it will dry more evenly. For a 6-in.-dia. bowl that starts just under 22% moisture content, I'll use three or four 10-minute treatments, allowing the wood to cool off in between. The exact timing is dependent on the wood's mass, moisture content, grain orientation and species. The more mass (both size, thickness and weight), the longer it has to be zapped in the microwave to dry. Some woods are much harder to dry than others: Bowls with crotch figure or burls with large irregular areas of endgrain must be treated on a more gentle schedule. Very dense woods, such as ebony and lignum vitae, also need this gentler treatment. Burls with a heavy bird's-eye figure, such as big-leaf maple burl, can be dried on a faster schedule than normal wood. The amorphous structure of these burls seems to prevent any cracks that form from spreading too far.

Because the moisture loss in the microwave is caused by heating the wood, temperature is an important factor. In general, especially during the earlier stages of drying, don't let the bowls get any hotter than you can hold in your hand. Getting the wood too hot causes internal cracking (honeycombing) and can adversely affect the wood's color and working qualities.

[Alan Stirt is a woodturner in Enosburg Falls, Vt.]

White dots in a mahogany finish

About six months ago, I finished a mahogany dining-room table with a high-gloss lacquer. After applying a paste wood filler, I let it dry for days before sealing it; the buffed-out surface looked perfect. Several months later, random patches of white appeared in the finish, as if it had blushed. In addition, there were countless tiny white dots at the base of the finish, down at the wood level. What happened?

—Phil Hostetter, New York, N.Y.

Michael Dresdner replies: Apparently, oil from the filler mixture was absorbed into the pores of the mahogany, held there and later released back into the filler after the finish had dried. The oil reacting with the filler forms a tiny white dot at the mouth of each pore. For some reason, this only occurs in mahogany, not walnut or any other wood with similar pores; even then, it happens only occasionally.

Unfortunately, there is no way to remove the dots, short of refinishing. My suggestion for avoiding it in the future is to lightly seal the mahogany before filling, thus preventing excess oil absorption. This is done by applying one very thin coat of vinyl sealer on the wood prior to filling, but after it has been stained. (This vinyl sealer is available at professional paint stores. Don't use regular lacquer sanding sealer.) Applying the vinyl sealer will also make the excess filler a bit easier to remove, and if the filler is pigmented, will prevent it from coloring any of the wood except for the pores themselves. After the filler has been wiped off, left to dry and lightly scuffed to remove any surface residue, the piece can be resealed with another coat of vinyl before moving on to the lacquer topcoats. In this way, you have essentially created a vinyl "envelope" that isolates the pocket of filler in each pore from the mahogany itself.

[Michael Dresdner is a contributing editor for *FWW* and an instrumentmaker and finishing specialist in Zionhill, Penn.]

Antiquing cherry with lye

I have been attempting to achieve an antique look on cherry using a dilute lye solution. The results have been less than excellent: The wood does turn a beautiful color, but it also becomes splotchy. I have had a similar problem when staining with an aniline dye. Is there any way to obtain a more uniform result? ***—Robert W. Hendrich, Williamsburg, Va.***

Tom Dewey replies: Your letter does not say whether or not you followed on through and topcoated the treated wood with a finish. My experience with the process has been quite similar: I was apprehensive the first few times I used lye, because I, too, experienced uneven and splotchy coloration. However, upon following through and finish-sanding and applying a good topcoat of varnish, oil or lacquer, the condition was eliminated.

I suspect that it has something to do with the wood itself rather than uneven concentrations of the lye (although you should make every effort to thoroughly mix and evenly apply the lye and warm, not cold, water). Perhaps cherry naturally contains soft and hard (dense and less-dense) areas of grain. Keep in mind that regardless of the initial results, in time, the entire coloration tends to "mellow," that is, lighten up a bit.

As a further check, I have just examined a 100-year-old dropleaf table, and sure enough, there is a color variation (though not especially pronounced) from one spot to another. So perhaps the lye merely accentuates what is already there. Bottom-line advice: Don't fret too much. Old furniture in the 100-plus-years category isn't perfectly uniform anyway.

[Tom Dewey designs and builds furniture in Coudersport, Penn.]

Keeping fumes out of your eyes

Dr. Paul Vinger's article on eye safety in FWW ***#72 gives a nice overview of appropriate measures for protecting the eyes against solids and liquids, but it doesn't deal with gaseous irritants. We know to wear a respirator when spraying finishes to keep from inhaling harmful vapors, but what effect do these vapors have on the eyes?*** ***—Clark Jenkins, Harrison, Ariz.***

Dr. Paul Vinger replies: There are three main routes through which chemicals can enter the body: the respiratory system, the skin and the gastrointestinal tract. Gases, vapors, mists and airborne particles are mainly inhaled; therefore, a respirator is your most important defense against harmful substances. However, some vapors and gases, such as strong alkalies and acids, can cause severe, potentially blinding burns to the eye. Further, some solvents, such as lacquer thinner, can cause surface irritation on the eye by dissolving the fatty bonds that attach the thin skin (epithelium) to the underlying cornea.

The most efficient means of protection is to reduce the concentration of gases, vapors or mists in your work area with an adequate ventilation system. Goggles that meet American National Standards Institute (ANSI) standards #Z87 for chemical use will give some eye protection from low to moderate air-toxin levels, but they're mainly designed to protect from liquid chemical splash and are not a substitute for good air-quality control in your spray room. Contact lenses are not advised where there is exposure to eye-toxic chemicals in either the liquid or gaseous state, because the lens could make irrigation of the eye ineffective. More detailed information may be found in *Occupational Health: Recognizing and preventing work-related disease*, edited by B.S. Levy and D.H. Wegman, Little, Brown and Co., 200 West St., Waltham, Mass., 02254; (800) 343-9204 or (617) 890-0250 in Massachusetts.

[Dr. Paul Vinger is a woodworker and ophthalmologist. He lives in Lexington, Mass.]

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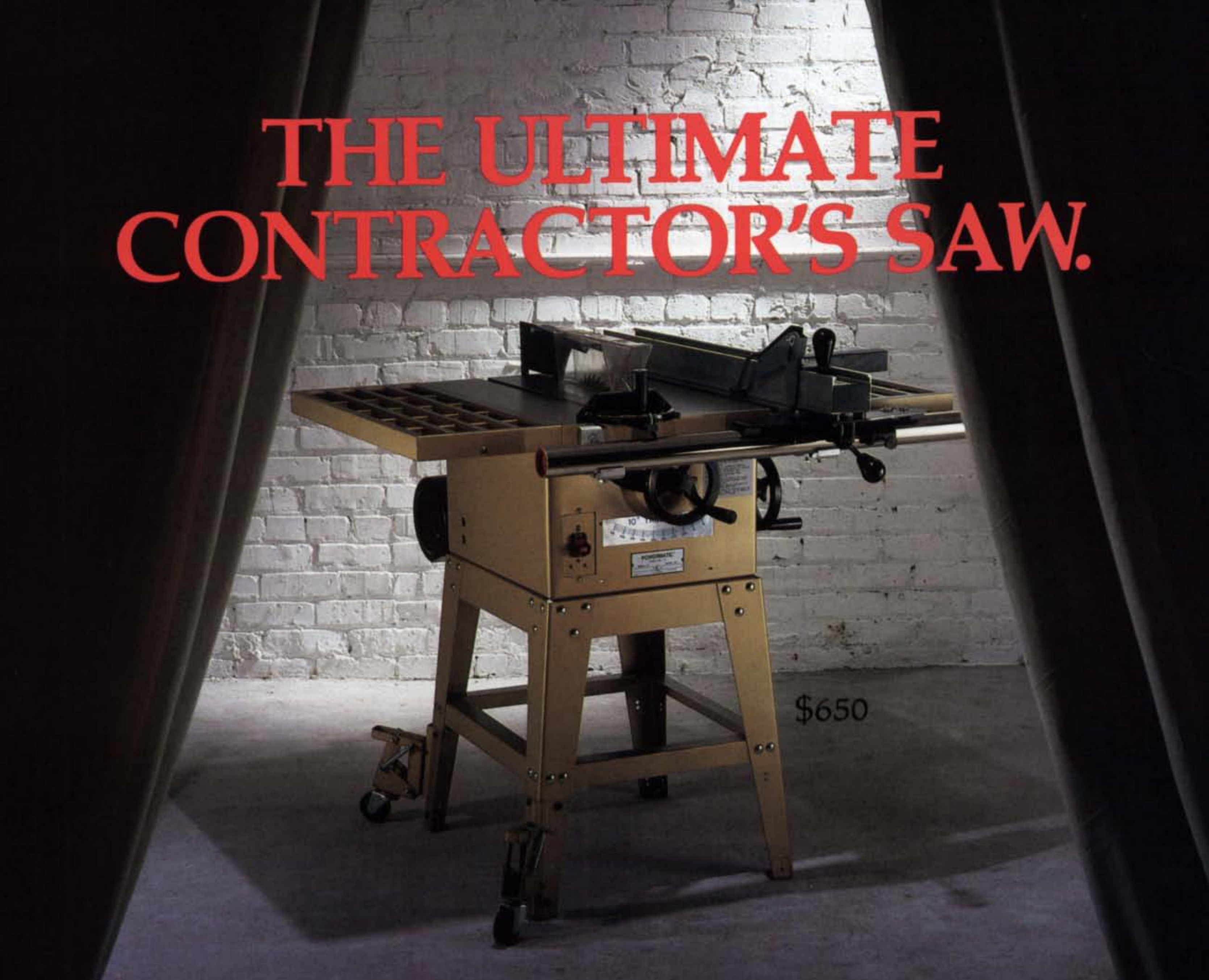
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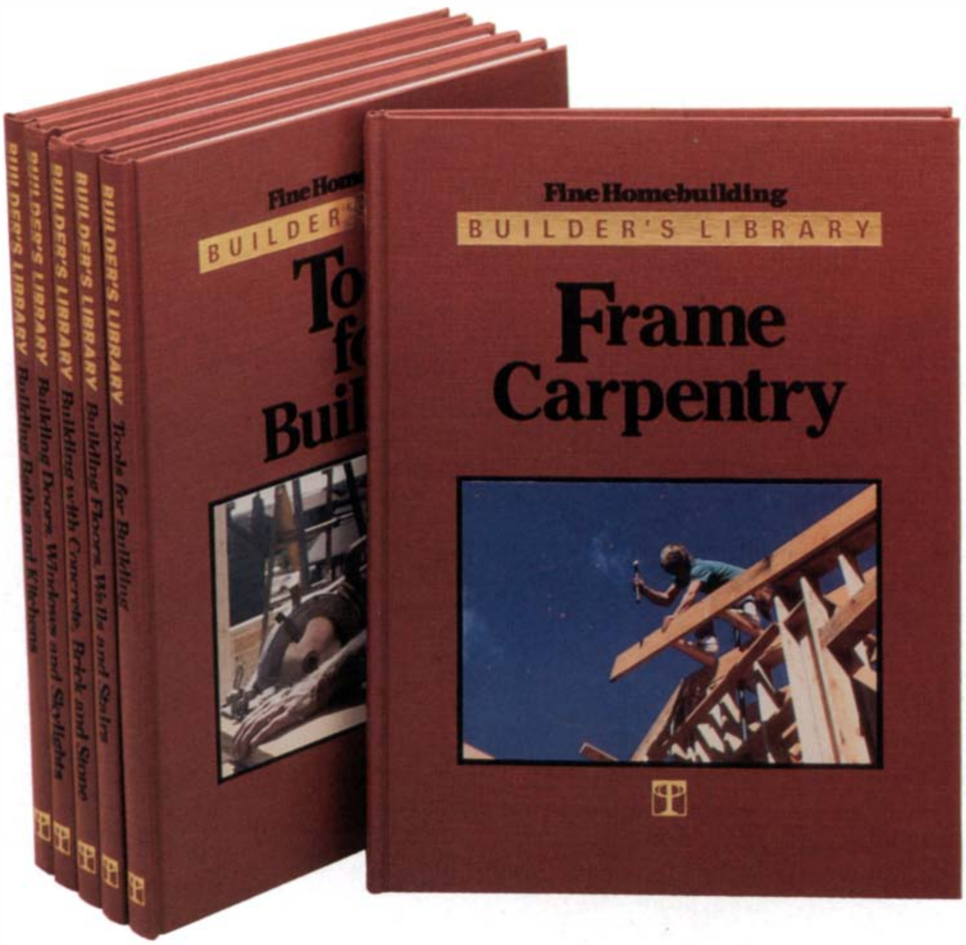

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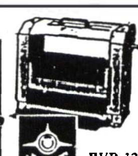

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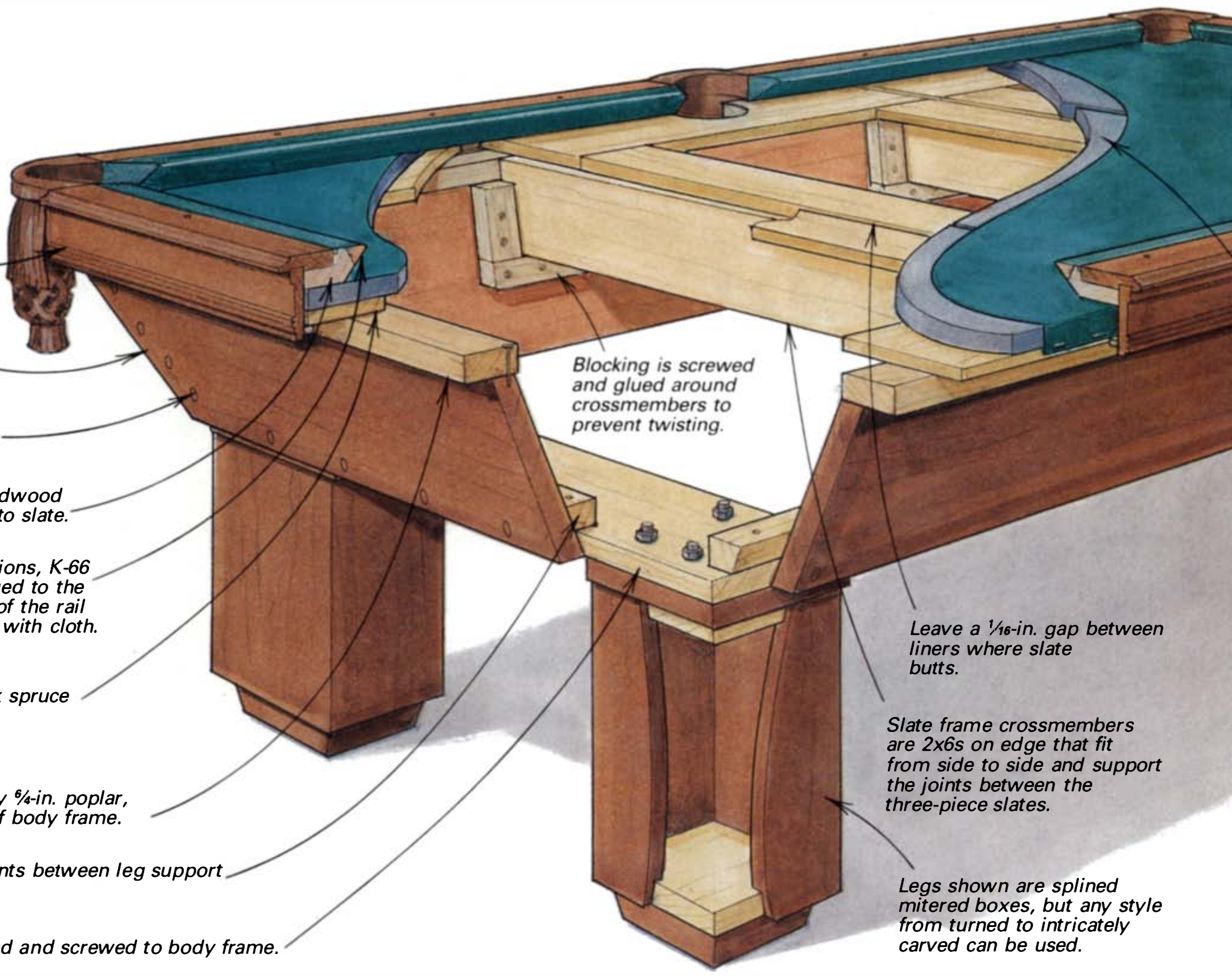
Building a Pool Table

Starting from scratch with nuts-and-bolts joinery

by Paul M. Bowman

Fig. 1: Pool table

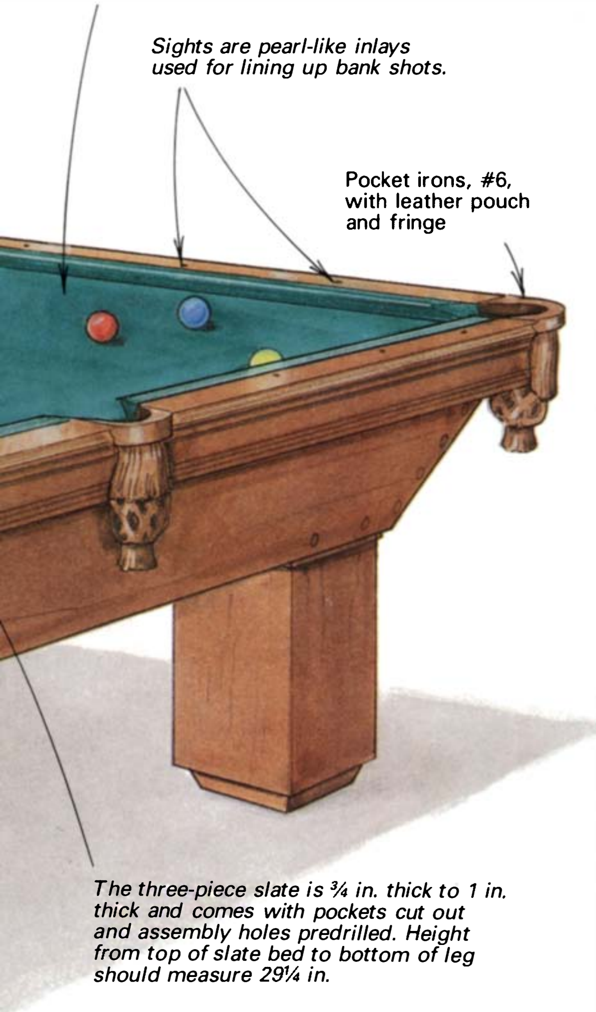


The distinctive crack of the break, brightly colored balls rolling across the expanse of green and the "plop" of the ball dropping into the pocket–these are the sights and sounds of satisfaction to pool afficionados. But, few of them have the satisfaction of sinking balls into pockets on a table they've built themselves.

Building a pool table is somewhat intimidating, because of the size of the table and the weight it must support. In addition to the 400-lb. slate playing surface, a pool table must be able to support a person sitting on the edge while attempting a behind-the-back shot. On the other hand, aside from the compound angles, building a pool table doesn't involve anything that's beyond a competent weekend woodworker with the gumption to take on a large project.

The table described here is constructed much like many high-end commercial pool tables (see figure 1, above). Each section of the three-piece slate is glued to a wood liner and then screwed, but not glued, to the main table body, a box whose sides incline down and in at 15°. A 2x8 leg support is screwed and glued between the sides at each end of the box. The four legs are attached to these supports with lag screws or hanger bolts. Bolted on top of the slate are six rails, which support the cushions and pockets. An apron, or blind as it's called on pool tables, surrounds the rails and covers the edge of the slate assembly.

The choice of wood, the carving or other decoration on the table and the style of legs can be custom designed to suit an individual's tastes. But one thing is certain: The table must fit the slate, so buy the slate before you begin working. The slate comes from Italy or Spain, where it is cut to size and the pocket cutouts and holes are drilled for assembly hardware. The chart on the facing page lists common slate sizes, weights and playing areas. Unless you're buying 100 or more sets, you'll need to locate a local pool-table dealer in your area who is willing to sell you a single set. Don't buy slate that is not predrilled. You'll also need a set of #6 leather-covered pocket irons, type K-66 rubber cushions and facings, plastic sights for the "dots" in the rails and various hardware. After the table's built, you'll need cloth to cover the slate, balls, a triangle,



This walnut pool table, built by the author, has sloping sides and leather-and-fringe pockets, which are indicative of an antique-style table. The legs were purchased from a company that specializes in carving pool-table legs, and the relief-carved blinds are from a millwork-supply house. Once you've located the slates and accessories, there's nothing about building a pool table that's beyond the abilities of a competent weekend woodworker.

Figuring rail lengths

3-piece slate				Rail lengths (in.)	
Size	**Weight (lbs.)**	**Slate description**	**Playing area between cushions**	**Side rails (4)**	**End rails (2)**
1x45x85	398	Oversize 7 ft.	40x80	36½	37⅞
⅞x51x95	422	Oversize 8 ft.	44x88, std. 8 ft.*	40½	41⅞
1x51x95	484	Oversize 8 ft.	44x88, std. 8 ft.	40½	41⅞
1x53x99	528	Oversize 8½ ft.	46x92, oversize 8 ft.	52½	43⅞
1x57x107	612	Oversize 9 ft.	50x100, oversize 9 ft.	46½	47⅞

* The description of the slate size sometimes differs from the description of the playing area.

To determine if your room is large enough, take the desired playing area and add 57 in., the length of a standard cue, to all four sides. In tight spots, you can always use a shorter cue.

Formula for calculating rail length:

$$\text{Side} = \frac{\text{Playing length - side pockets (5 in.) - 2⅛ in.}}{2}$$

End = Playing width - 2⅛ in.

cues and a bridge. The retail price of the slate and other supplies will come to about $800. Methods for covering the table and rails with the cloth are explained in the sidebar on p. 43.

Slate liner–The slate liner reinforces the brittle slate, anchors the staples holding the cloth and distributes the effects of the shims used to level the slate. You should use spruce or poplar 1x8 liners on the long sides of the table so there will be enough stock to accommodate the pocket cutouts. The rest of the liner can be from 1x4s. Be sure all the liner material is planed to the same thickness, or you'll be adjusting for the difference later. Butt the pieces together and glue the liner to the underside of the slate with Titebond glue or contact cement, as shown in the top, left photo on the next page. Hold the liner back about 1⁄16 in. from the edges where the slates butt so they can be pushed tightly together. Cut out the pockets in the liner by running a sabersaw blade along the slate cutouts. The ⅞-in.- or 1-in.-dia. holes along the slate's edge are for the bolts that will be used to attach the rails. These holes should be drilled through the liner, along with the smaller countersunk holes for screws to hold the slate to the body.

Legs–There's no end to the design possibilities for pool-table legs: They can be square, tapered, turned or carved. The only limitation is that you leave a way to bolt or screw them to the table. The legs on the table in the photo above were purchased from a dealer who specializes in duplicating intricate carvings (see sources of supply, p. 43). The cross section in figure 1 shows the basic construction of simple, square legs. An official pool table should measure 29¼ in. from the bottom of the leg to the top of the slate. For the table described here, the legs should be about 15½ in. tall.

Body frame–The body sides are made from 11¼-in.-wide 6/4 flat and straight hardwood lumber. If you need to plane the pieces to flatten them, leave them as thick as possible. To determine the frame's dimensions, measure the slate's overall size and subtract 7 in. from each dimension, so the slate will overhang the body by 3½ in.

Drawings: Kathleen Creston

The ¾-in.-thick poplar slate liner is glued with Titebond glue and clamped to the underside of the slate. The slate's sides are lined with 1x8s to overlap the pocket cutouts, then 1x4 crosspieces are butted between them and held back 1/16 in. from the slate edges that will butt together.

To complete the body, the slate frame is screwed to the top edge of the body frame, and the crossmembers are installed to support the joints in the slates. Glue blocks, screwed below the crossmembers, add support. The slate frame stops short of the corners to allow pocket clearance, and a ¾-in. block ties the corner together.

all around. The incline of the sides is common, especially on antique tables. Joining these angled pieces, however, requires compound miters, so I initially crosscut the parts a couple inches longer than the final size to allow a little leeway for cutting these miters.

I prefer to cut the compound miters with a sliding tablesaw. However, a radial-arm saw will do. The arm of the saw should be swung 17° to the right of its normal, square position, and the blade should be tilted to 43¼°. Because the blade may wander in bevel cuts, I cut each end twice: I first cut about ¼ in. past my mark, then slowly trim to the line. You can cut the compound angle on both ends of each piece without changing the saw-arm setting. First, place the board to the left of the blade, with its bottom edge against the fence and its outside face down on the saw table. After cutting this end, roll the board over and slide it to the right of the blade. Measure and mark the long, top edge of the board and cut to length. After the angles are cut, rip the edges of all four box pieces at a 15° angle so the edges will be parallel to the floor when the slope-sided box is assembled. If you're using a scalloped bottom edge, shown in the photo on the previous page, saw the pattern now; be sure to leave the first 10 in. from each end square for the legs.

Assembling the body frame–Many commercial pool-table builders join the parts with nails, which are set and hidden with wood filler or molding. I prefer the additional strength provided by screws; the wood plugs covering the screws also add a nice detail. I drill plug holes for the screws that secure the corners and leg supports at the locations shown in figure 1. Then, I drill pilot holes through for the screws. I sand to 120 grit with a belt or stroke sander and use a vibrating sander after assembly for finer sanding.

I assemble the body frame on custom-made 20-in.-high sawhorses with 2x8x48-in. tops that can support the weight of the table and slate. The wide tops make it easy to assemble the sides, and the low height makes it easier to lift the heavy pieces of slate onto the completed body. Set the sawhorses where the body will be assembled, and level them in place, shimming beneath their legs, if necessary, to ensure that the body can be assembled square and true.

To assemble the four sides, I place the parts upside down on the sawhorses and brush a liberal amount of glue on the miters of two adjacent ends. Then, I carefully hold the corner in alignment and use a power screwdriver to run a 1½-in. #10 screw into one hole in the side and one in the end. I draw the corner tightly together with the rest of the screws, being careful not to strip out the end-grain holes. Repeat this process until the body is complete.

The next step is to cut and install a kiln-dried 2x8 leg support at each end of the body. Crosscut the ends with opposite 15° bevels so the supports fit snugly side to side. Then rip one edge of each at 15° to fit against the ends of the body. If you scalloped the bottom edge of the body, bandsaw the leg support back away from the scalloped portion of the end so the support doesn't show. Screw and glue the supports in place, running 2¼-in.-long screws through the predrilled holes in the body frame and into the leg supports. Glue wooden plugs in all the screw holes, and sand them flush.

To drill for the lag screws or hanger bolts that attach the legs, make a plywood template the same size as the top of the legs and drill four evenly spaced 5/16-in.-dia. holes. Place the template in the corners of the leg supports and drill through the template and the support. Use the same template when drilling the tops of the legs. Before I turn the table over, I round over the bottom, outside edge of the body and the four outside corners with a ⅜-in.-radius piloted router bit. With a helper, I turn the body over and reinforce the leg supports by gluing and screwing in hardwood glue blocks cut from scraps from the table sides (see figure 1).

A frame to support the slate completes the table's body. It's made from 3-in.-wide 6/4 stock and should overhang the body frame by 1¼ in. all around. Cut off the corners of the end pieces at 45° for pocket clearance, or let the parts come up short of the corner, as shown in the photo above, right. Screw and glue this frame to the top of the body. Install two crossmembers to support the joints in the slate. The crossmembers should be at least 1½ in. by 5½ in. (a standard 2x6) and cut to fit on edge from side to side. Glue them to the frame, and run a long screw into each of their ends from the outside of the frame. Screw and glue a block under the ends of each 2x6 crossmember for support. I usually also glue in side blocks to prevent twisting. With a sabersaw, cut out 6-in.-dia. arcs tangent with the body for the side pockets. Finally, round over the inside edges on the top of the frame so it's easier to insert wedges between this frame and the slate liner when leveling the slate. Now, set the slates on the body and slide them around until they're tightly together and centered on the frame.

The rails–The rails, more than anything else, make a slate-top table into a pool table. They can be made from a single piece of clear, straight hardwood, but hardwood and softwood laminated rails, shown in figure 2 on the facing page, reduce the possibility of warping and provide softwood for stapling on the cloth.

The most critical rail dimension is the cushion height. According to the Billiard Congress of America, the point of the cushion should be 1 13/32 in. from the bed of the slate on a standard table with 2¼-in.-dia. balls. The balls tend to climb a lower rail and be forced down under a higher rail. This height is determined by the 1¾-in. thickness of the rail in conjunction with the 15° angle of its face. If you vary the thickness of the rail, you must adjust the face angle to provide the proper cushion height, as shown in figure 2.

To make the laminated rails, you'll need six 1¾x3¼x48-in.

softwood boards (I prefer poplar because of its stability) and six ¾x3½x48-in. hardwood boards. Mill enough for one extra rail for tool setup and test cuts. Saw out a 2¼-in. by 11/16-in. rabbet in each piece of the softwood by making two cuts on the tablesaw. Glue the hardwood segments into this rabbet, and when dry, plane the hardwood flush with the softwood. Begin shaping the rail by ripping the 15° and 45° angles along the length of each rail's cushion face. On its top, cut a ¼-in. by 5/16-in. groove about 7/16 in. back from the 15° angled face. This groove is for the feather strip, which secures the cloth to the top of the rail. On the bottom of the rail, saw a shallow ½-in. by 1/32-in. rabbet where the rail cloth will be stapled. Finally, set the dado blade to just skim the back edge of the softwood as you cut a ¼-in.-deep dado for the blind into the hardwood. Mold the top edge of the hardwood with a router or shaper to add a detail and break the sharp corner.

Use the chart on p. 39 to determine rail lengths for your playing area, and crosscut the rails to length. These lengths are figured for #6 pocket irons, so be sure that's what you use. Bore ¾-in.-dia. holes in the rail ends; 2 in. should be deep enough for the pocket "ears" (see the left photo on p. 42). Center the hole 2½ in. back from the point created by the 15° and 45° angles of the angled face and ¾ in. down from the top of the rail. I drill the holes with a spade bit in an electric hand drill, using the bit's long shaft to align the hole.

Assemble the rails and pockets on the slate to check your playing area. Be sure the pockets are tight in the ear holes, and check the whole assembly for squareness. Tape pieces of cushion rubber onto rails across from each other, using double-faced tape, and measure the distance between their "noses." The measurements should be your desired playing area. If your measurements are long, you can trim the ends of the rails to leave the proper playing area.

Now you can cut the pocket angles on the rail ends with the radial-arm saw. The angles and sizes for the pocket openings are shown in figure 3 on the next page. The ends of the rails that border the corner pockets are cut with the blade tilted to 10° and the arm set at 52°. For the side pockets, the arm is reset to 15°. The angle in the rail's horizontal plane creates the correct-size opening for the pockets. The angle in the vertical plane serves to extend the cushion's nose around the ends of the cushions.

Cutting the pocket angles is much like cutting the opposite compound miters for the body: Cut one end, roll the board, move it to the other side of the blade and cut the other end. However, all the pocket-angle cuts should begin at the back of the feather-strip groove. So, cut the first rail to the right of the blade, with it's outside edge against the saw fence and its top side up so you can see where to begin the cut. The opposite cuts are made to the left of the saw blade with the top side of the rail face down. This makes it difficult to line the cut up with the feather-strip groove, so line up the first rail you cut with the other rails, bottom to bottom, to mark the location of the top-side-down cuts. The end rails get the 52° corner-pocket angle cut at both ends (in opposite directions), while the four side rails have one of their ends cut at 52° and the others cut with the saw arm reset to 15° for the side pockets. After the angles are cut, use a router to extend the shallow rabbet on the bottom of the rails, along the angled ends, for stapling the cloth.

The cast pocket irons are anchored in the ear holes with 5/16-in. by 1-in. bolts run up through the rail. Drill 1-in.-dia. holes, deep enough to countersink the bolt heads and washers, directly below the threaded holes in the pocket ears. Then, drill a ½-in.-dia. hole through to the ear hole. The bolt should screw into the ears when the pocket is snug to the rail, and it should have enough play for minor adjustments during final assembly.

Attaching the rails—There are several different ways to attach the rails to the table: lag screws, mortised nuts, threaded inserts and threaded discs. Threaded discs, often referred to as metal rail plates in billiard-supply catalogs, are used most often, but they may be hard to find. I'll describe how to use them, but the same basic procedures apply for the other methods as well.

To locate the threaded discs, assemble the rails and pockets tightly together on the slate. Center the assembly by lining the

Fig. 2: Rails and blinds

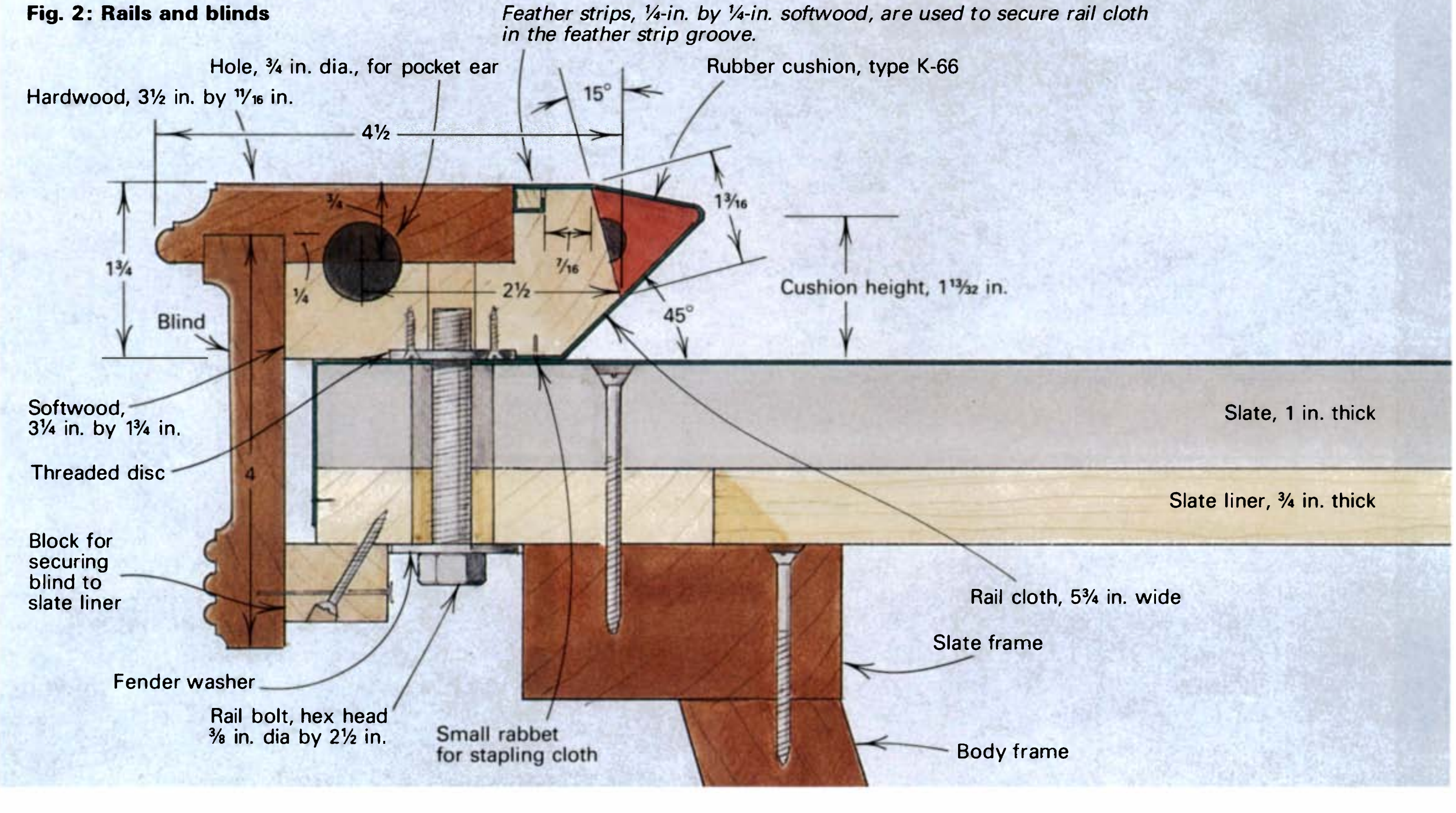
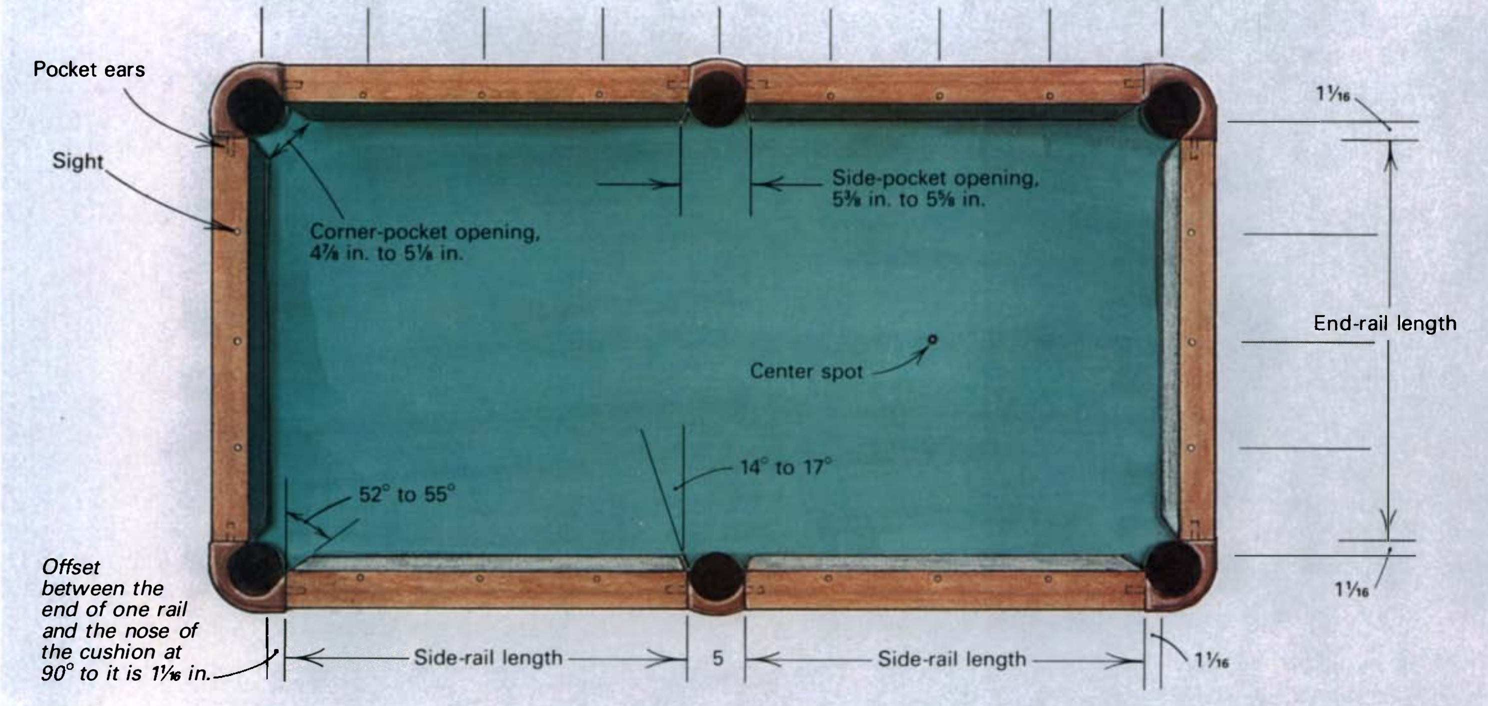


Fig. 3: Bed-and-rail assembly



Above, left: The pocket 'ear' is inserted into the hole in the rail's end, and a bolt is then run up from the bottom of the rail into the ear's threaded hole. The rails and pocket are upside down in the photo above, right. The ⁵⁄₁₆-in. by 1-in. bolt anchors the pocket ear in the rail, and the ⅜-in. by 2½-in. rail-bolts screw into the threaded discs under the rails to secure the rails to the slate. The cloth is stapled and trimmed closely behind the pocket angle for a tight fit between the rail end and the pocket leather.

side pockets up with the slate cutouts and measuring the rail assembly's overhang all around the slate. Eye the side rails to see that they are straight, and double-check the whole assembly for square. Then, reach under the slate liner, and with a pencil, trace the holes in the slate onto the bottom of the six rails. Disassemble the rails, turn them over and mark the centers of the holes. The side rails, as well as the end rails, should be interchangeable with their counterparts.

Drilling for the threaded discs is done with a fence clamped to the drill-press table set for the holes' front-to-back alignment. First, countersink for the discs by drilling a shallow hole the disc's diameter. Then, change to a ⁷⁄₁₆-in.-dia. bit and drill 1 in. deep in the center of each countersink for the shaft of the rail bolt. Use one of the discs, its flat side facing and parallel with the cushion side of the rail, to locate the pilot holes for the discs' attachment screws. Then, screw the discs in place (see right photo this page).

Inserting the sights—The last step in preparing the rails is locating the sights used to line up bank shots. Figure 3, above, shows their placement. Divide the playing area's width by four, or its length by eight, to get the distance between the three sights on each rail. The end rail has one sight in the center and one, the calculated distance, on each side of the center. Place them halfway between the feather-strip groove and the back of the rail. The center of the side rails falls in the middle of the side pockets, so measure from that point.

Sights come in various sizes, shapes and materials. The round, plastic ones are the easiest to use. Just drill a hole the proper diameter and deep enough that the sight will stand just proud of the rail. Then, brush in a little glue and drive them in with a hammer and a wood block, to protect the sight. Once the glue is set, sand the sights flush using 120 grit on a belt sander.

The blinds—The blinds, or aprons, trim the rails and hide the edge of the slate assembly. They're about 4 in. wide and the same length as the rail they'll be attached to. If you bandsaw the ends with the curve shown in figure 2, they blend nicely into the pocket fringe, but you'll have to cut them long to allow for this curve. The blinds fit into the dado in the bottom of the rail and are held in place with blocking, which is glued to the backside of the blind and screwed to the underside of the slate liner. Glue two blocks to the back of each rail, making sure they won't be in the way when tightening the rail bolts. Drill an angled pilot hole in each one to screw the block to the liner. This makes for easy disassembly of the blinds when the rails are recovered.

Assembling the table—After the table parts have been stained and finished and the cushions have been glued to the rails and covered with cloth (see the sidebar on the facing page), you can set up the table. Place the table body upside down on the floor of the billiard room. Bolt the legs in place and then turn the table over. Level the table by using a carpenter's level and placing ⅛-in. plywood and plastic-laminate shims under the legs. Next, set the pieces of slate in place and screw them tightly to the body frame. A screw-driver bit in a hand brace simplifies this process. It's not a good idea to screw down the center of the slates along the joints unless you need to pull down a bowed slate, which is very uncommon.

Run your fingers across the four points where the slate joints meet the edge of the table to detect any difference in height. If there's a difference, loosen the screws in the lower slate and raise it by inserting a playing card or folded paper shim between the liner and body. Repeat this until the three slates are even at the table's edge. If your body frame is straight and true, the slates should be too. To double-check this, stretch a taut string from end to end, near the edge of the table, anchored to nails in the slate liner. Slip a coin or poker chip beneath the string at each end and use another chip as a gauge to test for equal clearance along the length of the slate. Next, the joints are felt their whole length. If one piece is lower, drive a 1½-in. by 6-in. softwood wedge, tapering up to ¼ in., between the slate liner and crossmember. One person can tap the wedge in place while a helper feels for the moment when the two pieces of slate are even. When the three pieces of slate are as even as possible, putty the joints with "Durham's Rock Hard" (available from local hardware stores) and a wide putty knife. Any gouges, scratches or screw holes in the playing area should also be puttied and sanded smooth. After the putty has hardened, use 120-grit sandpaper on a block to gently sand off any excess. Putty and sand again if necessary, then brush the table clean.

The bed of the table can now be covered with the cloth, as described in the sidebar below. Then, the rails and pockets are assembled on the covered bed, as shown in the photo (right) on the facing page. The rail bolts and washers are inserted through the slate liner and slate and finger-tightened in the threaded discs. Then the pocket-and-rail assembly is centered on the slate, and the end rail bolts are tightened with a socket wrench. Sight down the side rails and adjust them until they are straight, then tighten them down. To test their alignment, roll a pool ball down the side rails. The ball should pass the side pockets without catching a point of the cushion. Nail or screw the loose ends of the woven leather pockets to the underside of the slate liner, making sure that the balls will not escape through this opening. Lastly, slip the blinds up into the dado in the rails, and screw through the glue blocks into the slate liner.

Fine-tuning the table—To check the table for final leveling, hold a pool ball between your thumb and first finger about 12 in. above one of the rails. The line from your thumb to your finger should be perpendicular to the front of the cushion rubber. Drop the ball so it will strike the slate and the front of the cushion simultaneously. It should travel across the table at 90° to the cushion; if the table is the slightest bit out of level, it will roll toward the low point. As an alternate technique, grab a cue and shoot a ball slowly the length of the table, about 6 in. from the side rail. As the ball slows and stops, it will veer toward the low point, if the table's out of level.

The severity of the ball's drift, using either method, will help estimate the thickness of the shim needed under the leg toward the low point. Lift the table from the end so both legs are off the floor, and have your partner place the shims under the proper leg. If you pick up only the low corner, the torque is sure to break the puttied joints between the slates. Repeat this procedure around the table until the balls show no drift. □

Paul Bowman is a freelance writer and builds pool tables on special order in Vancouver, British Columbia, Canada. For an article on turning a pool cue, consult FWW *#59, pp. 66-69.*

Sources of supply

Wholesale billiard-supply houses usually won't sell to individuals, so find a local dealer or pool-table manufacturer who will sell you the slates and accessories. If that fails, you can order everything you'll need, including slates, from the following supplier:

Tucker's Billiards, 3381 Ashley Phosphate Road, North Charleston, S.C. 29406

For machine-carved legs and decorative blinds:

Adams Wood Products Inc., 974 Forest Drive, Dept. I-3, Morristown, Tenn. 37814

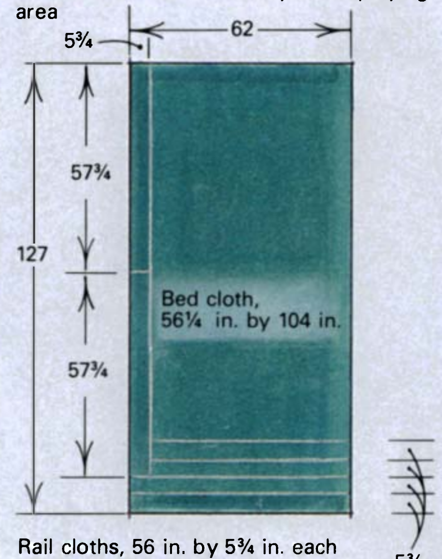
Covering the rails and slate bed

by Eldridge Tucker

Experience has convinced me that the best cloth for pool tables is a blend of 75% wool to 25% nylon, with a weight of 22 oz. per linear yard. A purist might prefer all wool, but the nylon adds durability, and the heavy weight is well worth an extra couple dollars per yard. It comes 62 in. wide; you'll need around 3½ linear yards. Figure 4 at right shows how to cut the cloth for an 8-ft. table with a playing area of 44 in. by 88 in. Adapt this layout to the size of your slate.

Fig. 4: Cloth layout

For 8-ft. table with 44-in. by 88-in. playing area



Rail cloths, 56 in. by 5¾ in. each (six needed)

Attaching the cushions: After the finish on the rails is dry, the cushions are glued to the angled face with either contact cement or yellow glue. The top edge of the rubber should be flush with the top of the rail. If you use yellow glue, use masking tape to hold the rubber in place until the glue dries.

After the glue has set, trim the rubber to length. Hold the rail so the cushion nose is down against a board or workbench, align a knife blade with the pocket angles and slice through the rubber from base to nose to extend the angle. Dip the knife blade in water for a smoother cut.

The cushion facings, made of laminated rubber and canvas, reinforce the cushion ends and cut down on the springiness of the cushion so the ball is not deflected too easily out of the pocket opening. Contact-cement them to the angled ends of the cushions and rails, flush with the beginning of the pocket angle and the top of the rail and cushion. Trim the facing's other edges to the contour of the rail with scissors or a knife. Break the top and front edges of the facing with sandpaper, as shown in the top, left photo on the next page, so a corner won't tear the cloth.

Covering the cushions: You'll need six ¼-in. by ¼-in. softwood feather strips to secure the cloth to the rails. Lay a feather strip in the groove on each of the rails so it's flush at one end, and mark the other end for length. Before removing the strip, make a line near its center, extending onto the rail and cushion, as a reference for lining up the strip when the cloth is being secured, as shown in the top, right photo on the next page. Remove the strip and cut it to length with a saw or chisel. Then, lay one of the precut rail cloths so its edge lines up on the joint between the wood and the rubber. Place the feather strip on the cloth above the groove, align the centerlines and tap the center of the strip partway into the groove. Work toward one end, tapping the strip partway in and pulling a little tension on the cloth in the direction you're working. Continue to the side-pocket ends, but stop about 6 in. back from the corner-pocket ends. While holding the feather strip down in the groove, pull about 2 in. of cloth through the groove below the strip, as shown in the right photo this page, to create a "pucker" so you can stretch the cloth around the angled cushion. Drive the last 6 in. most of the way into the groove to secure the cloth.

With a wood block, tap the length of the strip into the groove so it's just proud of the rail's surface. Trim the excess cloth by slicing with a knife against the cushion side of the protruding strip. Flip the cloth over the feather strip and cushion, and with a cloth-wrapped block, tap the strip flush with the rail's surface. Stretch the cloth tightly over the corner-pocket angle, and staple it to the rail right behind the facing and on the rail's bottom near the edge. The photo (right) on p. 42 shows where to staple. On the side-pocket ends, fold and tuck the cloth like you would wrap a gift, with the open part of the fold on the lower edge of the cushion. Pull the cloth tight and staple like you did on the other ends. Starting at the middle of the rail, stretch the cloth tightly over the cushion and staple it every 2 in. in the shallow rabbet on the rail's bottom. Trim the excess along this rabbet and close to the staples on the ends.

The cushion facing is contact-cemented to the angled rail end and cushion, then trimmed with scissors or a knife. The facing's sharp edge is eased with a sandpaper block so it won't tear the cloth when stretched tightly over the pocket angle.

The feather strip is driven into the groove to within 6 in. of the corner-pocket ends. Here, about 2 in. of the cloth is pulled through the groove to create a wrinkle or 'pucker,' which helps stretch the cloth over the corner-pocket angle.

Covering the slate bed: After the slate's joints have been puttied, you can cover the slate bed. Start by lining the pocket cutouts with 1½-in. by 12-in. strips of cloth contact-cemented to the edges of the slate and liner. Brush the slate clean of any small particles left from sanding the putty, and lay the cloth down so it overhangs the slate evenly.

Figure 5, below, shows the steps for stretching the cloth over the slate bed. Always begin at the center of a side and staple the cloth every 3 in. into the edge of the slate liner. Work toward the corner pockets, pulling the cloth slightly in the direction you're working. Staple to within 2 in. of the pockets, to leave some play for stretching the cloth over the pocket cutouts.

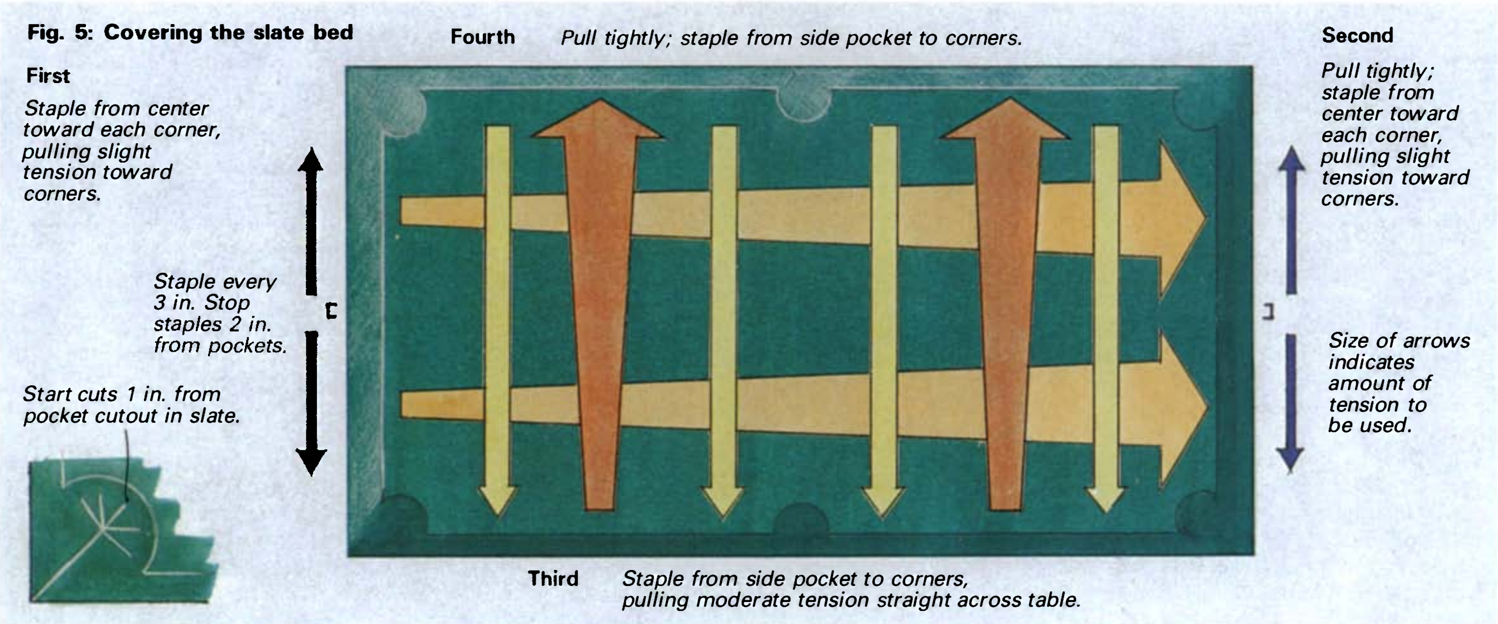
Pocket cutouts: To stretch the cloth smoothly over the pocket cutouts, you'll need to make radial cuts in the cloth within the pocket areas, as shown below. Grasp the cloth at the pocket and pull it down gently to reveal the outline of the pocket cutout. With a razor knife, cut in the center first and then once or twice on either side to create triangular tabs. Always cut toward the cloth's edge. Again starting at the center, pull down firmly on the tabs and staple them in a neat line near the slate liner's bottom edge. Trim the cloth as close to the staples as possible, to avoid a loose flap that a hand may catch when retrieving the balls from the pocket.

Trim the overhanging cloth around the table if it's long; if there's not too much excess, the blinds will hide it. Finally, cut circles out of the cloth with a knife for all the rail-bolt holes. If you just make an X-cut, the cloth will get caught in the bolt's threads. Now assemble the rails and pockets, and bolt them in place on the slate bed as described in the main article.

All that's left is to place the center spot for locating the rack of balls for the break. I run a string between the middle sights on two opposite side rails, at the end where the balls will be racked, and one between the middle sights on the end rails. Holding a level alongside the strings, I mark on the cloth the point where the two strings intersect and place the self-adhesive spot. Now you're ready. Rack 'em up. □

Eldridge Tucker has been in the pool-table business for 30 years. His shop, Tucker Billiards, is in North Charleston, S.C.

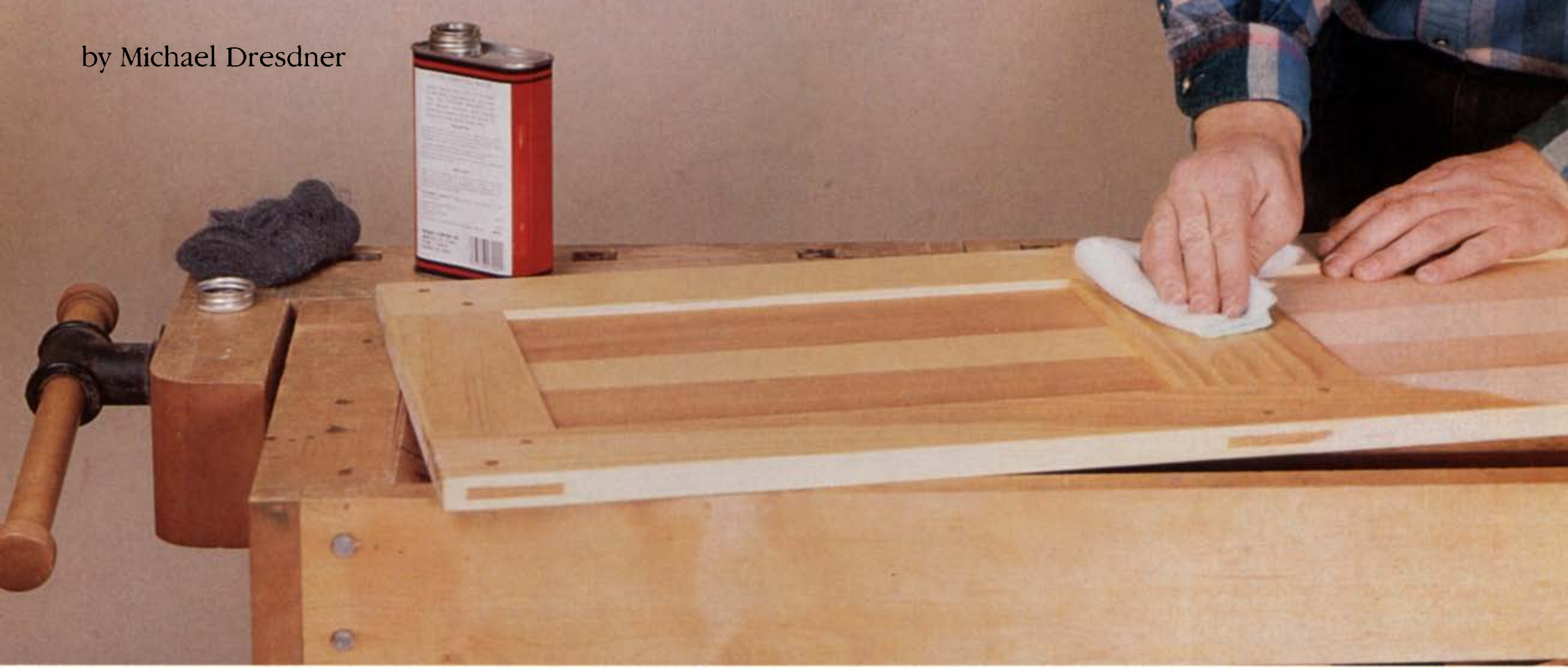
Fig. 5: Covering the slate bed



Finishing with Oil

Modern products for an age-old process

by Michael Dresdner



An oil finish's beauty, as well as its easy and forgiving application qualities, make it an ideal finish for woodworkers who have little finishing experience or who don't want to invest in spray systems or other specialized equipment.

The expression "hand-rubbed oil finish" conjures an image of the venerable craftsman practicing an ancient craft to bring beauty to a fine piece of woodworking. Oil finishes trace their lineage to "China wood oil," an Oriental tung-oil mixture reputed to go back 800 years. Although they are still widely used today, oil finishes must compete for space on the paint-store shelves with the most advanced chemical soups and coatings that the wizards of technology dish up.

Without question, oil's long suit is its simplicity, both in terms of its subtle appearance and its ease of application. Oil is generally the first finish a fledgling woodworker will attempt, because it requires virtually no equipment and will yield excellent results to the most inexperienced hand. Many consider a basic oil finish to be the only finish that allows wood to look "natural," imparting the rich color characteristic of freshly surfaced wood, while leaving the pores open and the surface feeling uncoated. And for those who view finishing as a necessary evil, the wipe-on, wipe-off modern oil finish is perhaps as close as you can get to not finishing at all.

Oil finishes have come a long way since the old days, when applying an oil finish was an involved process, requiring hours of arduous labor. The old-timers who taught me about woodfinishing had been trained to rub boiled linseed oil into the wood with their bare hands, following the "rule of two:" twice a day for a week, twice a week for a month, twice a month for a year, and twice a year for life. Unquestionably, this process still will produce an excellent finish, but few woodworkers, and fewer customers, are willing to agree to the sustained effort needed. As a result, the "modern" oil finish, one buffered with resins and prepolymerized oils, has taken its place. But just as few old-timers understood what boiling had to do with linseed oil, most craftsmen today have a dim understanding of what modern oil finishes are all about. I recently investigated about a dozen oil products and talked to several manufacturers, and I'd like to share what I learned about oil finishes: what they're made of, how they cure, how to go about applying them and how to use them when repairing and refinishing.

Oil mixtures—In spite of what manufacturers claim in their advertising and literature, various brands of oil finishes are more alike than they are different. Most commercial products, including "Danish-oil" finishes by Minwax, Watco, Waterlox and Deft, are mixtures of oil, resin, driers and a solvent. The natural oils most commonly used are linseed oil, pressed from flaxseed, or tung oil, from the nut of the tung (Montana) tree. The oil finishes made by Minwax and Watco, two of the best-known brands in the field, are of a linseed-oil base, while Deft Danish oil and Waterlox's "Transparent" are based on tung oil. Although there are many other natural oils, linseed and tung are inexpensive and readily available.

Resins added to oil mixtures may be natural or synthetic. The most common are modified alkyds, which are often added to linseed oil, and phenolic resin, which is used with tung oil. These resins are solids—in many cases the same solids used in varnishes and lacquers—and add bulk to the oil mixture. They result in a harder finish, one that builds film thickness quickly, because the solids fill the pores of the wood more readily than oils alone. The solvent dissolves all the components of the mixture and reduces its viscosity, which makes the finish easier to apply and increases its ability to penetrate the wood. The most common solvent used in commercial products is mineral spirits, though some products use turpentine.

Curing—Most oil mixtures include driers, heavy-metal salts that speed up the drying process. Although both natural linseed and tung oil will dry by themselves when exposed to air—a reminder to keep oils in closed containers with little airspace—raw oils may take weeks or even months to dry. By adding driers, this time is reduced to a matter of hours. The driers, sometimes referred to as "Japan driers," include zinc, cobalt, magnesium, manganese and lead. Some of these work as "top driers," causing the oil to form a "skin;" others act as "through driers," causing the oil to dry evenly throughout.

Linseed oil, as well as tung oil, can be purchased as raw oil, without driers in it. Linseed oil also comes boiled, with driers added. In spite of its name, boiled linseed oil is not actually boiled: The metal salts are added with the help of a chemical catalyst. The reference to boiled is probably a throwback to an early process in which oils were heated to help dissolve the metal salts. Used alone, boiled linseed oil makes a credible finish, and there are some purists who will use nothing else to finish their woodwork (see the sidebar on the facing page). Another method manufacturers use to shorten oil's drying time is polymerization. In fact, most commercial tung-oil products are partially polymerized. The process involves heating the oil, causing a percentage of its molecules to bond, which increases the oil's viscosity and shortens its drying time.

Application—The first thing most proponents of oil finishes rave about is oil's most alluring feature: It is easy to apply. You simply wipe it on, and after a short time to allow for penetration and solvent evaporation, you wipe off the excess. The time this takes may vary, so it's best to go by the manufacturer's recommendations on the label. It is almost impossible to get bad results; the amount of oil applied and the speed, pattern and method of application have virtually no effect on the result. You don't even need special equipment or a dust-free room to get excellent results.

However, because oil finishes don't hide surface imperfections very well, you must sand to a finer grit than necessary for surface-coating finishes, such as lacquer or varnish. Final sanding should be to at least 220 grit, but it may need to be 400 grit or 600 grit with fine-grain woods, such as rosewood or ebony.

The first and second coats of oil tend to be completely absorbed into the wood's surface and act as a sealer. Once the wood is saturated with cured oil, successive coats will start to form a film on the surface. You can get an effect that ranges from a barely perceptible finish in a single sealer coat to a glossy film, which can take from two to five coats. Because oil is a reactive finish (once it dries, subsequent coats will not redissolve it), a dried oiled surface can be recoated by wiping, brushing or even dipping, without fear of disturbing the dried layer. Some woodworkers prefer to do fine sanding while the surface is drenched with oil, which helps to build the finish quicker, because the wood's pores get filled with a slurry of wood dust and oil. I don't care for this approach though, because it puts sanding dust and grit into the pores and spoils the clean look I like my oil finishes to have.

About the only major mistake you can make with oils is neglecting to wipe off the excess before the oil dries. This will result in a sticky mess, which must be scrubbed off with steel wool. Although acetone or lacquer thinner might help lubricate this abrading process, neither is a true solvent for cured oil. If you need to remove an oil finish by redissolving the film, about the only thing that will work is methylene chloride, the active ingredient commonly found in paint and varnish removers.

The one common glitch that users of oil finishes often run into is "bleeding." On large-pore woods, such as oak, there is a tendency for the extra oil trapped in the pores to leach out and form shiny spots on the wood's surface. This generally occurs only on the first coat or two, until the cured oil seals the pores. Bleeding can often be avoided by applying the oil early in the day and rewiping the surface every hour or so until the leaching stops. Once the spots are left to harden, there is no way to remove them except by sanding the surface with fine paper (400 grit) or by stripping the finish entirely.

While oil's simple nature is its advantage, it also contributes to its downside. An oil finish is an inherently weak finish, which wears off easily and has a very low moisture-vapor resistance. Because oil is largely absorbed into the wood rather than becoming a film over it, the wood surface is given little protection from abrasion or staining. Although some people contend that an oil finish can case-harden the wood surface, evidence suggests that the effect is due to resins added to the mixture and not the oil itself. Because of its low moisture-vapor resistance, water molecules can penetrate easily, and oil also offers little protection against alcohol and other liquids. This makes oil a poor choice for furniture, cabinets, tabletops, counters or other wooden objects used in wet or humid conditions. Due to oil's poor performance as a vapor barrier, it also offers little protection from changes in humidity—one of the most important functions of any wood finish. Therefore, designing with regard to expansion and contraction is essential for work that's to be oil-finished.

Despite the easygoing attitude finishers have toward oil finishes, there is one very serious warning: *Oil-soaked rags or paper towels are ready prey to spontaneous combustion; if left in a pile, they can heat up and burst into flames on their own accord.* Therefore, any oily rags or paper should be disposed of quickly and carefully by incineration or by being completely immersed in water. If you can't do this immediately after oiling, hang the single-thickness rag up to dry until it can be disposed of properly. Although oil fumes are not as hazardous or offensive as those produced by most lacquers, you should work in a well-ventilated area, wear a vapor respirator and rubber or neoprene gloves when handling or applying oil mixtures. Also, many commercial oils are toxic, and unless otherwise indicated on the label, they shouldn't be used for wooden eating utensils or children's toys that are likely to be chewed, such as baby blocks or rattles.

Repairing and refinishing—Oil's reactive drying properties and forgiving application qualities make it a finish that's extremely repairable. A white water ring or a damaged spot can be lightly sanded or steel wooled, and new oil can be applied. Due to its inability to redissolve itself, the newly applied oil will not affect the undamaged finish in the surrounding area and will blend the spot almost invisibly, even if the finish is many years old. With oil's repairability comes a responsibility for maintenance. Ideally, an oil finish should be rejuvenated with a new coat every year or so, depending on the amount of wear it's subjected to.

While oil may be the ideal solution for a new project, it is often a poor choice when refinishing. Bob Flexner of Norman, Okla., an expert in antique conservation and repair, points out that the original finish on most old pieces was seldom oil. He considers oil an inappropriate replacement finish for most commercial and even pre-industrial revolution handmade furniture. Few commercial furniture producers today use oil finishes on their furniture (see the sidebar at right for some exceptions). Even woodwork that is commonly believed to be finished in oil, like Swedish and Danish-Modern furnishings, is more often than not finished with a thin film of catalyzed lacquer. In spite of oil's low cost, ease of application and moderately innocuous fumes, it remains the province of the individual craftsman. There, an oil finish's subtle good looks continue to be the earmark of handmade furniture. □

Michael Dresdner is an instrumentmaker and woodfinishing specialist in Zionhill, Penn., and a contributing editor at FWW. *He will conduct a seminar entitled "Understanding Finishing" the week of August 7th at Anderson Ranch Arts Center, Box 5598, Snowmass Village, Colo. 81615; (303) 923-3181.*

Using oil finishes: two approaches

While oils are often the finish of choice for beginning woodworkers, there are many professionals who prefer to use them as well. I recently discussed oil-finishing methods with two woodworkers who represent completely different-size shops: woodturner David Ellsworth, who works alone, and Tom Moser, founder of Thos. Moser Inc., a 90-person furniture- and cabinet-building company.

Ellsworth, one of the most prominent turners in the world, produces a variety of work, including the hollow forms that are his hallmark. Woodturners are a strong bastion of allegiance to oil finishes, and like many of his peers, Ellsworth finishes his pieces with a tung-oil product, specifically Waterlox Transparent.

After power-sanding with 320-grit paper on a foam-back disc, a process Ellsworth claims is equivalent to hand-sanding with 600 grit, he soaks the outside of the piece with Waterlox, spreading it on evenly but not wiping it off. Because he generally turns wood while it is still green, the oil is being applied to the outside of a relatively wet turning even before the inside has been turned. Ellsworth leaves the inside of his pieces unfinished.

As the turning dries, more coats of oil are added, the exact number depending on the wood's porosity. When both the oil and wood are thoroughly dry, he buffs off the oil residue using tripoli or white-diamond compound applied to a 6-in. stitched-cotton buffing wheel spinning at 3,500 RPM. This is followed by further polishing with a clean buff. The process removes all of the surface oil, leaving only finish that has been absorbed by the wood. The turning's exterior looks as if the wood has no finish on it at all. The ability to get what Ellsworth calls a "natural" appearance is what led him to choose oils over other finishes he had tried. While his application methods may be unorthodox, the results are excellent, as witnessed by this oil-finished vessel at right (above).

A notable exception to the fact that most commercial furniture companies don't use oil finishes is Moser. His company grosses millions of dollars yearly building Windsor and Shaker-style chairs, such as the one pictured at right (below), tables and case goods that are finished in linseed oil.

Flying in the face of the furniture industry's conventional wisdom, Moser proudly points to the beauty and durability of the boiled linseed-oil finishes on thousands of his tables and chairs. The soft, natural appearance gives each brand-new piece the feel of a vintage classic; in fact, Moser says that chairs that are 10 or 15 years old look better than the new ones. This is especially true on the arms and back, which are enhanced by repeated contact with human skin and the subaceous oil it secretes.

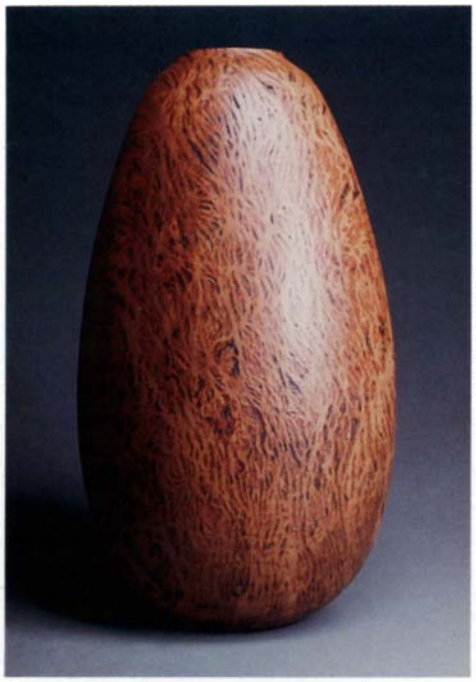


Photo: David Ellsworth, from collection of Arthur and Jane Mason

After turning this 24-in.-tall, 13-in.-dia. vessel from redwood-pitch burl, Ellsworth applied tung oil to give it a soft, rich finish. The inside is left unfinished.

Photo: Brian Vanden Brink

A simple finish of boiled linseed oil on top of a polished surface of cherry wood sanded to 400 grit gives Moser's 'reader's side chair' a soft appearance that ages gracefully.

Moser admits that offering only oil-finished furniture was a sales obstacle at first, because potential customers were used to seeing lacquer and varnish finishes in the furniture stores. With time, however, his buying public came to associate his style of furniture with what he calls "an extremely low-tech finish." But after trying dozens of finishes, including lacquers, polyurethanes and oils other than linseed, Moser settled on the finishing procedure he still uses today.

Preparing a wood surface for an oil finish is considerably more time-consuming than for any other kind of finish. A full one-third of his shop's production hours are spent sanding the pieces up to 3M's 40-micron Imperial Microfinishing Film paper, a polyester film-backed sanding material that 3M says is equivalent to 300-grit paper. (The product comes in sheets and self-stick 5-in. and 6-in. discs, ranging in grits from 9 microns [1,200 grit] to 100 microns [150 grit]. It is available from 3M, Box 33053, St. Paul, Minn. 55133-3053.) Moser's wood surfaces are indeed smooth and feel finished even before the oil is applied.

To increase penetration, Moser's finishers heat the boiled linseed oil to 120°F before applying it to wood. The oil is applied with fine Scotch-Brite pads and allowed to dry for about four hours before it is wiped off with special industrial-quality paper towels. To avoid the danger of spontaneous combustion, the oil-impregnated towels are burned after use. After the first coat, the wood is resanded with 400-grit paper, then a second coat is applied, and if needed, a third coat. When the oil is dry, two coats of Butcher's Wax are applied and rubbed down with 0000 steel wool. The wax gives the surface its characteristic sheen, and incidentally, helps repel water slightly. Moser's customers receive a furniture-care kit consisting of sandpaper, steel wool and a small jar of wax.

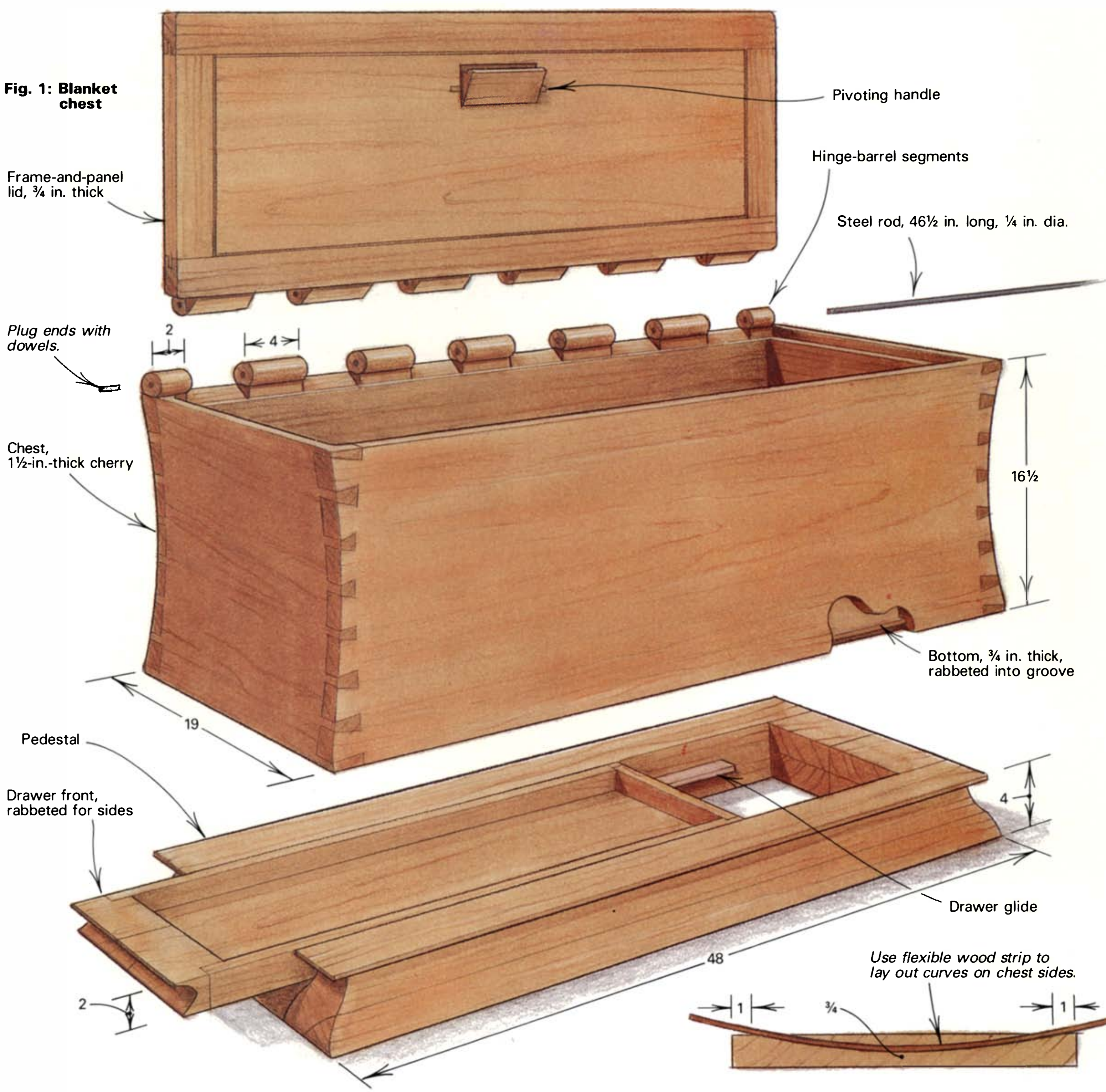
How does Moser deal with oil's poor moisture-vapor protection and low abrasion resistance? Wood movement is accommodated for in case goods by making a different fit for drawers and doors in winter than in summer—"a nickel fit versus a dime fit," as Moser puts it. As for abrasion resistance, Moser sees the marks of wear that furniture accumulates as part of its overall charm. He tells of a table in his house that bears the imprint of a Spirograph drawing his son did as a 6-year-old child. "It is a beautiful signature on that table," Moser remarks, "and that's priceless." —*M.D.*

Blanket Chest

Dovetails and wooden hinge are easier than they look

by John Dunham

Fig. 1: Blanket chest



When people see my blanket chest, the first thing they notice is the curved sides, which appear to require some especially complicated dovetails. Next they notice the hinge and wonder if a metal hinge can really be replaced by wood. When they try to test it, they can't find the handle. If they're bold, they reach for the rectangular cutout in the lid and are startled when a handle pops up at the touch of a finger. They are usually so caught up in these obvious details that they miss what I think is the real surprise: the drawer hidden in the base.

I designed the chest pictured at right nearly 20 years ago when I was a graduate student in furniture design at Virginia Commonwealth University in Richmond. It remained one of a kind for a long time, but in the last few years, I've built several on commission. In the process, I've worked out a way to rough out the curves on the sides quickly by running them perpendicularly across a tablesaw molding head. And, I've learned to cut the dovetails after the curves are roughed out, to avoid chipping them out when I cut cross-grain with the molding head. By reproducing the chest, I've been able to streamline the hinge construction so it is simple and straightforward.

I've seen a lot of wooden hinges, both at craft shows and in the pages of *Fine Woodworking*. Most of them, although clever, are difficult to make, requiring intricate router jigs; or, they are bulky, somewhat fragile fittings out of scale with the box or piece of furniture they're attached to. This wooden version of a piano hinge, however, is strong, easy to build and designed as an integral part of the chest. The 13 turned hinge segments are alternately glued onto the back frame piece of the frame-and-panel lid and the back edge of the chest after these two overlapping parts have been notched to mesh with each other. I use a ¼-in.-dia. steel rod for a hinge pin instead of a long dowel, to eliminate the squeak of wood against wood.

It's the combination of these features that challenge the builder and ultimately please the owner of this blanket chest. If you decide to tackle this project, you'll need about 52 bd. ft. of 8/4 cherry for the chest, base and hinge, and 8 bd. ft. of ¾-in. stock for the lid.

The chest—Begin by gluing up about 36 bd. ft. of the 8/4 cherry for the front, back and sides, then plane these parts to 1½ in. thick. The front and back will finish up 48 in. by 16½ in.; the two sides, 19 in. by 16½ in. To lay out the curves on the outside surfaces, draw a symmetrical arch on the endgrain of one of the side pieces by bending a thin strip of wood across it and drawing along its arch, as shown in figure 1 on the facing page. The curve should begin about 1 in. from each edge and peak in the middle at just under ¾ in. The 1 in. at the ends allows room for final shaping to achieve a continuous curve from top to bottom.

You could cove the sides by running them diagonally across a regular sawblade, taking small cuts and raising the blade until you've removed most of the waste. However, my molding-head method, shown in the lower photo this page, speeds up the process considerably. To make the cove cut, I clamp a wooden fence to the saw table 8¼ in. from the center of the arbor and perpendicular to the blade. I replace the blade with a three-cutter molding head with ½-in.-radius cutters and set the blade to take only a ¼-in.-deep cut. I run an edge of each of the pieces against the fence so they go over the spinning cutterhead perpendicular to it. Then I flip the pieces around and run them through again, with the opposite edge on the fence. I raise the cutter and repeat the process until I've cut an arch within 1/32 in. of the line. I move the fence about ½ in. farther from the cutter, lower the cutter so it takes only a ¼-in.-deep cut and repeat the process at the new fence setting. I keep moving the fence and adjusting the cutter until the curve is roughed out. The rotation of the molding head helps keep the work against the clamped fence, and the sharpened arch of the cutters allows easy crossfeeding. As with any power-tool operation, *think safety*. Make sure your hands are well away from the cutter, and don't force too deep a cut in a single pass: I recommend a maximum ¼ in. per pass. I smooth the slightly fluted surface of the roughed-out curves with a round-bottom plane before assembling the chest.

Photo: Anthony Cosentino

This cherry blanket chest features curved and dovetailed sides, a wood piano hinge, a pivoting flush handle and a drawer hidden in the deeply coved pedestal base.

Dunham speedily roughs out the curved sides by running the work perpendicularly across a molding head fitted with ½-in.-radius cutters. To remove the waste up to his layout line, he adjusts the cutter height and the clamped fence, and runs opposite edges of the piece against the fence.

The dovetails look tricky because of the curved sides. Actually they're regular dovetails, but they can only be laid out on the flat insides of the parts. First, lay out the pins on the inside surface of the ends. I use a 9° angle for the five pins with a half pin at each end. Saw them out with a handsaw or bandsaw as you normally would. To prevent chipping when chiseling out the waste, I back up the curved side with a soft woodblock bandsawn to match the curve. The tails are scribed from the pins onto the inside of the sides and cut in the same manner. When they've been fitted so all four sides pull tightly together, dry-clamp the chest and mark the pins and tails where they extend past the curves of the adjacent side. Take the chest apart and trim these ends on the bandsaw. At this time, dado each of the four carcase pieces for the bottom, ⅜ in. wide, ½ in. deep and ⅜ in. from the bottom edge, with a router or tablesaw. Stop the dadoes about ¾ in. from each end, or they'll show on the outside of the completed chest. The ¾-in. plywood bottom is rabbeted all around its bottom surface so it fits into the dado. Then the chest is glued up.

Because the lid is a flush fit, you'll need to cut a ¾-in.-deep rabbet around the inside of the chest's top edge. The rabbet is ¾ in.

Drawings: Kathleen Creston

Fig. 2: Pivoting handle

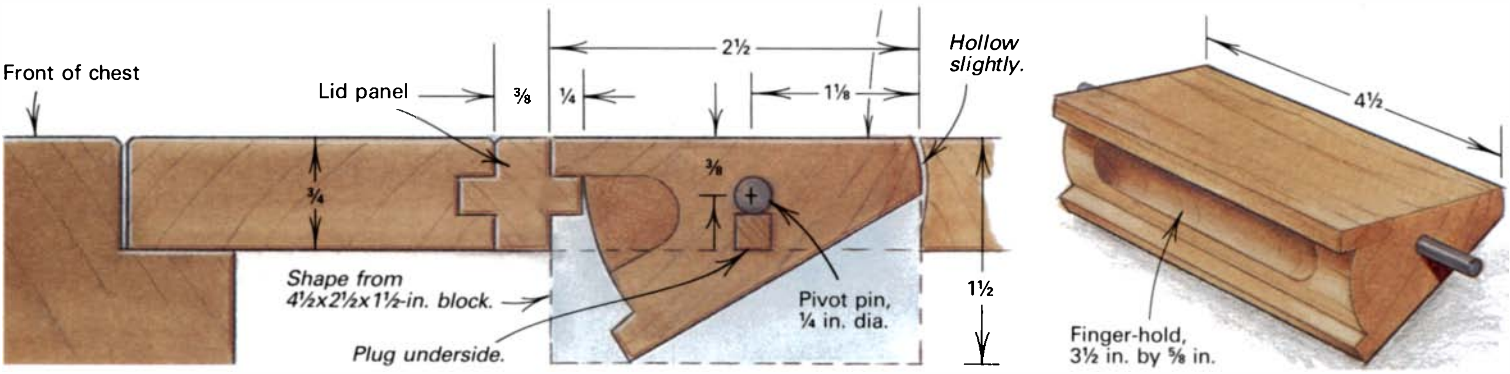
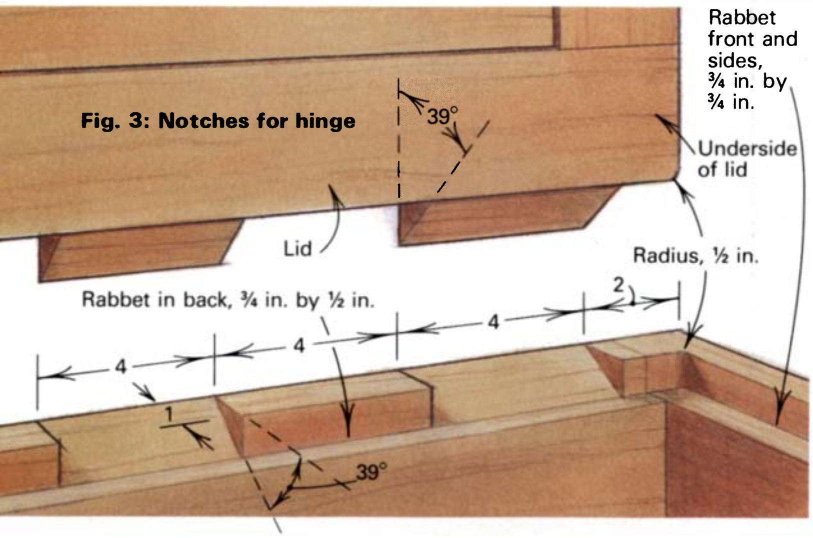


Fig. 3: Notches for hinge



by ¾ in. on the front and ends, but it's only ½ in. wide along the back, to accommodate the hinge. I cut the rabbet in several passes with a ½-in.-dia. straight, carbide router bit and a fence clamped to the base of the router that runs along the outside of the chest. I stop the rabbet when I get close to the corners. After all the straight runs are done, I take the fence off the base and remove most of the waste left in the corners freehand with the router. I use a gouge to clean out these corners to a smooth ½-in. radius. Sanding completes the chest. I prefer to sand by hand: It's quieter, and besides, these curved surfaces don't match platens of any electric sanders I know of. I begin with 60-grit sandpaper that has a heavy-duty cloth backing and sand to 120 grit. Later, when I apply the oil finish, I wet-sand with 220 grit.

The chest's frame-and-panel lid is made from ¾-in.-thick solid stock. The frame parts are 2½ in. wide, joined with mortises and ¾-in.-long tenons that I cut on the tablesaw. The ¾-in.-thick solid panel is rabbeted from both sides on the tablesaw to leave a tongue that fits into grooves in the frame. Because the back frame piece gets notched to become part of the hinge, it and the front piece run full length, with the side pieces fitting between them. Size the parts so the assembled lid will fit into the rabbet in the top of the carcase, with its back edge extending flush with the *outside* of the carcase back. However, don't glue the lid together until the hinge is completed, because the hinge work is so much easier when the frame is apart. Round the front corners of the frame to fit into the ½-in. radius of the chest's rabbet, then dry-clamp the lid together and check its fit on the chest. Take the lid apart to install the handle in the panel and to do the hinge work.

Figure 2, above, shows how the wedge-shape, pivoting handle fits into the cutout in the lid's panel. It's best to make the cutout first and fit the handle to it. Begin by drawing a 2¼-in. by 4½-in. rectangle, centered lengthwise and ⅝ in. from the panel's front edge. Drill a hole in one corner of this rectangle and insert a saber or coping sawblade to saw the rectangle out. With a block clamped to your router base as a fence, cut a ¼-in. by ¼-in. rabbet along the front edge of the cutout on both sides of the panel to create a lip that acts as a stop for the handle in both its open and closed positions. Hollow out the back surface of the rectangular cutout with a gouge to allow clearance for the handle to pivot.

The handle is made as shown in figure 2. Cut out the basic wedge shape on the tablesaw, but leave the piece long so it's easier and safer to handle when making the finger hole. Hollow out the finger hole ⅝ in. deep by drilling a series of holes with a ⅝-in.-dia. Forstner bit and cleaning up the bottom with a gouge or on a router table with a ⅝-in.-dia. core-box bit. Crosscut the handle to length, and drill through the handle for a ¼-in.-dia. steel pivot pin. Chisel two slots, ½ in. by ¼ in., in the bottom of the lid panel to receive the pin. Sand the handle until it fits snugly but pivots easily, then set it aside. The handle isn't installed until after the lid is glued up and both the handle and the lid are finish-sanded. Then, you'll plug the pivot slots by gluing in wooden blocks trimmed for a snug fit.

The hinge—Now you're ready to bevel and notch the chest's back edge and the lid's back frame piece so they will mesh and swing past each other, making the hinge. On the top back edge of the carcase, lay out for the 4-in. hinge segments, starting and ending with 2-in. lengths. Draw a line with a combination square across the top edge and down to the bottom of the rabbet. Saw and chisel out every other segment, beginning with the first 4-in. segment on each end, to leave a flat angled surface from the top outside edge to the bottom of the rabbet (see figure 3, this page). Make the initial cuts with a dovetail saw on the waste side of the lines, stopping short of sawing into the rabbet's base or into the chest's outside surface. Then, chisel out the waste between the sawcuts.

Next, you will notch the back frame piece to mesh with the notches you just cut in the chest. First, measure in 1 in. from the bottom back edge of the frame piece, and mark this point on one end. Draw an angled line on this end from the 1-in. mark to the top, back corner. The angle will be about 39°, the same as you chiseled on the back edge of the chest. Tilt the tablesaw blade to cut this angle. Because most tablesaws don't tilt past 45°, set the tilt angle at 39° from the vertical and run the frame piece edge down and with its surface flat against the fence. Rip this angle the length of the piece, then hold the frame piece against the notched back edge of the chest and mark it for the coinciding notches. Extend the marks across the angled surface with a square, and saw out alternate segments. I crosscut to the lines with the tablesaw blade set to cut 1 in. deep by holding the frame piece on edge and running it over the blade using the miter gauge. Then, I bandsaw out the notches and pare them clean with a chisel. After you round the frame piece's notched ends to match the radius of the rabbet's corners, it should drop into the rabbet, flush with the chest's top, its notches meshing with those on the chest back, as shown in figure 3.

To make the barrel of the hinge, begin with 13 1¾-in. by 1¾-in. blocks that are slightly less than 4 in. long. Crosscut two of the blocks 2 in. long for the ends. Make sure all end cuts are square, and use a stop block to ensure uniform length. Mark the center on one end of each block, and after checking your drill-press table to be sure it's square with the bit, bore a ¼-in.-dia. hole through each block. To mount the blocks on the lathe, I replace the point of the spur center with a short piece of ¼-in.-dia. metal rod, which fits into the hole in the blocks, and use a cone-bearing center in the tailstock, which centers itself in the holes. The blocks are turned to 1½-in.-dia. cylinders. Lock your calipers at 1½ in. and make sizing cuts with a parting tool at both ends and at the center of each block. Then remove the waste between these cuts with a large gouge. After turning, the holes in the blocks are reamed out to 9⁄32 in. and the cylinders are strung on a ¼-in.-dia. steel rod that is approximately 50 in. long with threaded ends. Arrange the cylinders in the order you want them on the chest, with a 2-in. segment at each end, and clamp them with a washer and nut on each end. I line up the segments as closely as possible and sand the whole hinge barrel smooth. This segmented dowel can now be run across the joiner as if it were one piece of wood until you've got a flat area 1 in. wide. I number the cylinders on this flat side before I remove them from the rod so I can reassemble them on the chest in the same order.

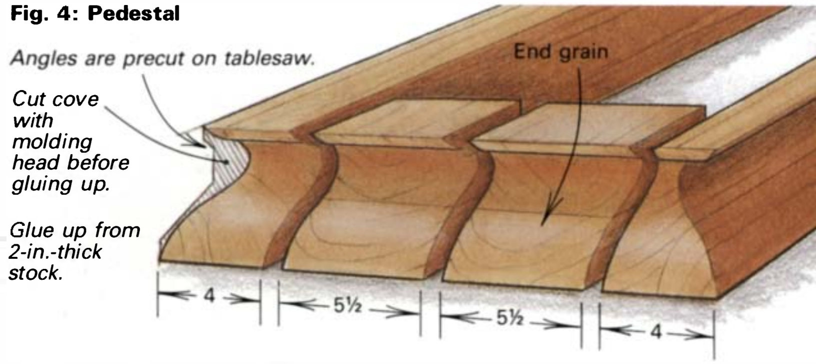
Now you're ready to glue the hinge-barrel segments to the lid frame. To aid in clamping these segments, clamp a 1-in. by 4-in. board to the underside of the frame piece so it extends out over the 39° angle, as shown in the photo this page. Then dry-clamp one of the 2-in. segments at one end. Start at the other end and glue and clamp the numbered hinge segments to the frame piece. Line them up with the frame's back edge, and align them by sighting through their holes. Use the sequentially numbered segments to test for the proper spacing between the segments you are gluing. When you reach the end, unclamp the dry-clamped 2-in. segment and glue it in place. You can test the alignment by running the rod through the segments, but I've found the eyeball method works every time.

After the glue for the hinge segments dries, glue up the frame-and-panel lid. Clamp to the flat, notched areas, not to the hinge segments. When the lid is unclamped, position it on the chest, and once again, sight through the holes as you glue the remaining hinge segments to the chest. Clamp these hinge segments to the back of the chest with pipe clamps. Remove the lid while the glue dries, and chip off any glue squeeze-out between the segments. When the glue has thoroughly dried, replace the lid and slide a 46½-in.-long, ¼-in.-dia. steel rod through the hinge barrel. The first time you operate the assembled hinge, do so cautiously. Minor adjustments to the angled notches are usually necessary. Note anywhere that they don't swing smoothly past each other; remove the hinge pin and file or sand the offending parts. When the hinge operates smoothly, open and close it a few times. If any of the hinge segments are rubbing end to end, you will see a polished area on their endgrain when you take the hinge apart again. Fix these with a sanding block. When these adjustments have been made, trap the metal hinge pin by gluing short sections of doweling in each end.

The base—I laminate the pedestal from 2-in.-thick stock. The long sides are each glued up from two pieces of 2x4x48-in. stock, and the end pieces are glued up between the sides so the endgrain continues across the whole end of the base. One of the ends is split horizontally for the front of the hidden drawer. Before laminating the long sides, preshape the profile as much as possible on the tablesaw, as shown in figure 4, above. For the end without the drawer front, glue up two blocks 5½ in. long by 4 in. wide. These two blocks get glued together side to side when the whole base is assembled, but first I mark the profile of the cove on their ends and saw this curve out on the bandsaw. The end with the drawer front is made up of four pieces of 2-in.-thick stock: two 5½ in. wide by 4 in. long for the drawer front and two 5½ in. wide by 5 in. long for the base. These four pieces are bandsawn to the cove's profile, and the drawer-front parts are glued together. Before gluing up the base parts, plow a ⅜-in. by ⅜-in. dado on the inside of the two long pieces, as shown in figure 4, to insert glides for the hidden drawer.


The author aligns the hinge segments by sighting through their holes while gluing them to the lid frame. The 1x4 clamped to the frame piece extends over the notched and angled edge to aid in clamping the hinge segments.

Fig. 4: Pedestal



Bandsaw end blocks to profile before glue-up.

The pedestal can now be glued up and the ⅜-in. by 1-in. drawer glides glued in. To be sure the base is flat, I clamp the long pieces to my tablesaw while gluing the base together. I do as much cleanup as possible on the cove with curved-bottom molding planes, then I scrape and hand-sand to 120 grit. The carcase is secured to the base with screws from the inside of the carcase bottom.

The drawer front is rabbeted so the drawer sides can be glued on flush to its sides (see figure 1 on p. 48). Rabbet or dado the drawer back into the sides, and groove the drawer parts for the ¼-in. plywood bottom. Finally, carve a finger grip in the underside of the curve in the drawer front and slide the drawer into the base. All that's left is to install the pivoting handle in the chest's lid, plug the pivot pin slots and sand the plugs flush.

The chest is now ready for finishing. I use a minimum of three coats of Watco Danish oil, wet-sanding the first coat with 220-grit wet-or-dry sandpaper. I often leave the inside unfinished to avoid trapping the smell of the oil. You could also line the inside of the chest with thin, aromatic cedar paneling—adding one more surprise. □

John Dunham builds custom furniture in Glens Falls, N.Y.

Sandpaper

A wide variety of gritty choices

by Robert Erickson and Jerry Tecklin

In our furniture shop, more than 50% of our time is spent shaping and smoothing wood with abrasives, usually some type of sandpaper. The labor involved and the cost of the abrasives make these operations very expensive, so we began a detailed study of the bewildering array of abrasive products on the market to determine which products would increase the productivity of our belt, orbital and drum sanders. We found that the vast technological changes that have occurred in recent years offer woodworkers more options than ever, but you need a basic understanding of abrasives to take advantage of these new products. Even in non-production situations, we think the following information can make sanding a less tedious chore for the individual woodworker.

A little history—Early woodworkers made their own sandpaper by using hide glues to attach flint, quartz, brick dust or fine volcanic powders like pumice to parchment. Even in ancient times, the term "coated abrasive" was valid; all it means is some type of backing coated with an adhesive that holds the actual abrasive particles. American inventors revolutionized the abrasives industry in the late 19th century when they synthesized aluminum oxide and silicon carbide, which are harder, tougher and sharper than any of the naturally occurring abrasives. The variety of abrasives continued to increase as manufacturers experimented with both natural and man-made abrasives bonded to paper, cloth, fiber or polyester-film backings. We concluded that the backings play a major role in the performance and life expectancy of an abrasive.

Shaping and smoothing—In our shop, we break the abrading or sanding process into three stages: shaping, smoothing and finishing. Traditionally, thickness planers and handplanes were used to shape or change the dimensions of the stock, but many production shops, like ours, now rely more on various belt and drum sanders for rough-milling operations. Both flat and curved surfaces can be worked. In cases of highly figured woods, abrasive tools are actually far more effective than planers and other cutters, which can tear the wood. We do most of our shaping with 40-grit abrasives, which can remove material quickly without clogging up or burning the wood.

Smoothing involves refining the form, polishing the piece and removing any tool marks, glue residues and coarse grit scratches. Smoothing, like shaping, is done mainly using belt, drum and orbital sanders, but hand-sanding also is often necessary. To get a well-sanded surface with a minimum of effort, use abrasives in a progression of grits, starting with the coarsest and progressing to the finest (the higher the number, the finer the grit). Each grit size

There are coated abrasives available today to satisfy any woodworker's shaping, smoothing or finish-sanding needs. The cornucopia of products comes in a wide variety of grits, backings and formats, as is evident in this photo. A basic understanding of abrasives is needed to choose the right material for your application.

will leave a characteristic pattern of scratches in the wood's surface. The goal with each grit size is to effectively (and efficiently) remove scratches made by the previous grit, producing an ever-increasing scratch density but decreasing scratch depth. When the scratch pattern is uniform, you're ready to change to the next finer grit. Sometimes, skipping a grit in the progression will only make the work harder and take more time. For the coarser grits, you will be able to tell by feel (or by eye) when it's time to change grits; for the finer grits, the best way to evaluate your progress is to use raking light to examine the scratch pattern with your eye. For most woods, even your eye won't be able to discern scratches made by 400-grit or finer papers, so instead, again using raked lighting, look for a diminished "foggy" or matte surface before changing grits.

For grits finer than 220, sanding might more aptly be called polishing. Here, the changes in surface are so subtle that a trained sense of touch rather than your eye can be a better indicator of how the work is going. These final polishing steps in preparation for applying finishes are critical, requiring care and patience to ensure that the finish will show off the wood grain and color to its maximum advantage. Most stains and oil finishes will magnify scratches to an embarrassing degree; stains applied to poorly prepared surfaces often appear blotchy or mottled, especially on softwoods. Don't neglect these final stages, because it's virtually impossible to remove scratches from finished surfaces without a good deal of work and mess. To ensure high-quality surfaces, we generally spend about 20% more time on smoothing and polishing than we do on shaping. The last grit used before applying a finish depends largely on the wood and the finish itself. On soft, open-pore woods, such as mahogany, 120 grit or 180 grit is sufficient, especially if a pore filler and lacquer finish is being used. For very hard woods, such as ebony, or when oil finishes or stains are used, 400 grit, and sometimes even 600 grit, is necessary to remove all visible scratches. On pieces to be painted or lacquered with opaque colors, 120 grit is usually sufficient. The role of abrasives in the finishing process itself is discussed in the sidebar on p. 55.

Manufacturing abrasives-The abrasives industry is highly competitive, so companies are reluctant to reveal their manufacturing processes. Basically, a continuous sheet of backing material runs under a spreading mechanism, which uniformly deposits the abrasive grit. The abrasive itself is screened to the desired size, which determines the cutting power of the final product. With more advanced electrostatic coating, the process most commonly used today, the backing is passed through an electrostatic field located above a conveyer carrying the abrasive. The negatively charged abrasive grains are attracted to the positively charged backing and become embedded with their sharp points facing outward. Because the points face outward and the grits are so uniformly dispersed, sanding efficiency is about 20% to 25% better than with abrasives made with the mechanically spread grain coating process. Once the abrasive is bonded to the backing, the gritty surface is reinforced with additional glue or resin and the material is formed into various belts and sheets. Manufacturers' product literature does not generally refer to how the abrasive was made; you must contact the manufacturer directly for this information.

Most abrasive products are classified as "closed coat" or "open coat." The backing on closed-coat abrasives is completely coated with abrasive; only about 40% to 70% of the backing is coated on open-coat abrasives. These uncoated areas mean the paper will be slower to clog or "load up" than closed-coat products. It makes sense to use open-coat products when working with soft or oily woods, painted surfaces and other substances that tend to gum up. Suppliers recommend closed-coat abrasives for hardwoods and for shaping applications where you want to quickly remove a lot of material. In our shop, however, we've found that the difference in cutting ability between open- and closed-coat papers is not that great. It's also easy to clean the cheaper, open-coat papers with the crepe blocks available from most woodworker suppliers. Just turn the sander on and press the block against the moving abrasive.

Most suppliers offer abrasives coated with a load-inhibiting substance, such as zinc stearate. Norton's "No-Fil" and 3M's "Fre-Cut" product lines are examples. The stearates are soft, powdery minerals that act as a lubricant to minimize heat buildup and prevent the sanding residue from sticking to the abrasive grains. While it's desirable to use the nonclogging, stearated papers on raw woods, particularly oily woods like teak, they're a necessity for scuffing off paste-filler residues and for sanding between coats of most finishes. Because these papers are "lubricated," they prevent the buildup of heat, which can soften some finishes. Papers greater than 400 grit are not available with stearates. Here, it's best to use wet-or-dry papers with naptha, mineral spirits or water as a lubricant.

Selecting an abrasive—Hardness isn't the only factor in selecting the proper abrasive. Equally important is toughness, the property that allows the abrasive grain to wear down slowly while maintaining sharp, cutting edges by fracturing along the definite cleavage planes. Woodworkers understand these qualities in a practical way and know the abrasive is worn out when the cutting action decreases and the paper begins to clog and heat up appreciably. Garnet rates lowest in terms of both hardness and toughness. Silicon carbide rates highest in hardness, but only above garnet in toughness. Zirconia alumina is tops in toughness and only above garnet in hardness. Aluminum oxide is surpassed only by silicon carbide for hardness and by zirconia alumina for toughness. This combination of hardness and toughness makes aluminum oxide a popular choice of both professionals and hobbyists.

The cutting abilities of abrasives vary dramatically, so it's important to match the abrasive to the task at hand. When we opened our shop 16 years ago, we only used garnet, which is a natural gemstone (described as an iron/aluminum/silicon amalgam). It is especially useful whenever sanding heat might burn the wood: for example, on the hard endgrain of oak and curly maple. Garnet doesn't heat up, because it fractures so easily that fresh, sharp surfaces are constantly exposed. This also means, however, that garnet wears out rapidly. Consequently, the much harder, synthetic grains have all but replaced it in our shop. Aluminum oxide and silicon carbide have become the real workhorses in our operation. Because they don't wear down rapidly or scratch deeply, they're ideal for shaping or finish-sanding. Scratches are well defined and wide rather than deep, and so are more easily removed, which is what it's all about. Silicon carbide, which is synthesized from silica sand and coke, is much harder than aluminum oxide and almost as hard as diamond. It has sharp-edge grains that shave rather than grind; the grains have a self-sharpening quality, splintering off as they work, presenting ever-fresh, sharp cutting surfaces. Instead of following our normal grit sequence of 100, 120, 180, 220, 400, we've found silicon carbide helpful in enabling us to use a 100-150-220-400 grit sequence. This is an immense time-saver for even a small production shop like ours.

Zirconia alumina (or alumina zirconia) is an alloy not quite as hard as silicon carbide or aluminum oxide, but very aggressive and tough. We've found its aggressive cutting action and long-wearing qualities useful in shaping, but for finish-sanding, its aggressiveness is easily misapplied. A little too much pressure sometimes causes deep scratches, requiring extra time and effort to remove.

One additional point on abrasives: Color is not a reliable prod-

Grit comparison between grading systems

Micron	U.S.A. CAM I Grade	European "P" Grade	Coarseness rating	Aught system	Applications
9 —	1000 —				
	600 —	—P1200	Extra Fine		
15 —					
	500 —	—P1000			
	400 —	—P800			
		—P600			Grits above this line are useful for finishing.
	360 —				
		—P500	Very Fine	10/0	
30 —					
	320 —	—P400		9/0	Grits in this area are useful for smoothing.
40 —	280 —	—P360			
		—P320			
	240 —	—P280		8/0	
		—P240	Fine	7/0	
60 —	220 —	—P220		6/0	
	180 —	—P180		5/0	Grits below this line are useful for shaping.
	150 —	—P150	Medium	4/0	
80 —					
	120 —	—P120		3/0	
100 —					
120 —	100 —	—P100	Coarse	2/0	
	80 —	—P80		1/0	
	60 —	—P60	Very Coarse	1/2	
		—P50		1	
	50 —				
	40 —	—P40		1 1/2	
	36 —	—P36		2	
	30 —	—P30		2 1/2	
	24 —	—P24		3	
	20 —	—P20	Extra Coarse	3 1/2	
	16 —	—P16		4	
	12 —	—P12		4 1/2	

Manufacturers' names for abrasive grains

Grain type	Norton	3M	Carborundum
Garnet	Garnet	3M Garnet	Garnet Fastcut
Aluminum oxide	Metalite Adalox No-Fil Adalox Resinall	3-M-ite Production Imperial Cut-Rite	Aluminum-Oxide Aloxite Fastcut
Silicon carbide	Durite	Tri-M-ite Wetordry	Dri-Lube Fastcut Sandscreen
Zirconia alumina	NorZon	Cubicut	
Ceramic aluminum oxide		Cubitron	

uct-recognition device. Aluminum oxide, for instance, appears in tans, pinks, blues, browns and grays. Suppliers may also identify products with trademark labels instead of more descriptive generic names, as shown in the chart at the bottom of this page. The trade name primarily identifies the kind of grit, but manufacturers often use the same label for products with different backings, bonding adhesives, open-coat, closed-coat and lubricated abrasives. Again, the best way to be certain you're getting what you want is to contact a sales representative or knowledgeable supplier (see sources of supply on the facing page).

Grit size—The coarseness or fineness of a particular sandpaper and the amount of material it will remove is determined by the size of the grain—its grit, in common parlance. Understanding the grading system for sandpaper is easy. Eighty-grit paper, for example, has grains that passed an 80-hole-per-inch screen but were trapped by the finer 100-hole-per-inch screen. The confusing part is that different manufacturers use several different grading systems, as shown on the chart at left.

Backings and bondings for abrasives—We use abrasives with paper, cloth and polyester-film backings. Generally, though, the nature of the backing and bonding material determines how well the product will hold up under heavy use.

Paper backings are designated by the letter A, C, D, E or F. As the letters progress, the papers get heavier and stiffer. For example, the lightest, most-flexible "A" paper weighs 40 lbs. per ream (480 sheets, each 24 in. by 34 in.); the heaviest and stiffest "F" paper weighs 170 lbs. The lightest-weight papers are prone to rip, so they are mainly used for fine hand- or light machine sanding. Their flexibility makes them ideal for smoothing contoured surfaces and for getting into tight corners and crevices. Our shop uses mainly A- and C-weight papers for orbital and hand-sanding, J- and X-weight cloth for beltsanding and polyester-film backings in both belt and sheet formats. Generally, light-weight papers are found with fine grits; the coarser grits need heavier papers to minimize tearing.

Cloth backings also are designated by letter and come in sheets and belts. J-weight cloth is light, flexible and strong; it is probably the most-used cloth backing. (We found Ekamant's Extraflex J-Cloth more durable than any other product we've tried on our Singley cylinder sanders.) X-weight is a heavier, drill cloth for medium- and heavy-duty applications. Other less-common cloth backings include cotton, rayon and polyester. Their weight classifications, from lightest to heaviest, are J, X, Y, T and M.

Paper and cloth backings are affected by climatic conditions. Sanding belts and drums should be stored away from heat or moisture sources and hung singly on large-radius (4 in. dia.) wall hangers to prevent creasing and cracking.

Polyester film backings offer both high strength and toughness. They have a subtle rigidity that helps get the high spots out of flat surfaces like tabletops. Their effectiveness makes us overlook the fact that the polyester sanding belts are more prone to tearing than cloth belts. The polyester backings are available with virtually every type and grade of grit, but the material's thickness consistency and high strength make it especially effective with the finest grits.

Heavy-backing materials combined with larger grit sizes are not very flexible, so some companies provide "preflexed" products for contour sanding. During manufacturing, the backing is flexed to crack the bond in one or more directions, usually 45° or 90° to the running direction. These products are especially handy for stroke and drum sanders, and for hand-sanding.

Manufacturers use animal-hide glues and urea or phenolic resins to bond abrasives to the backings. The adhesive is important. Unfortunately, manufacturer labels don't usually indicate which glue has been used. The highly flexible hide glues have low heat resistance and are not moisture proof. This isn't a problem for dry sanding or low-heat generating applications. But, with wet sanding or for belt-sanding, where heat buildup is a consideration, water- and heat-resistant resin bonding should be used. Fortunately, whether or not they're labeled, most products you buy for these hard applications will be resin bonded. The best way to determine if you're using the right stuff is to watch what's happening while you're sanding: If the bond fails or the backing wears out before the abrasive gets loaded with sanding residue, you should contact a knowledgeable dealer to order a resin adhesive and/or a stronger backing material.

Putting it all together—The industry is large and highly competitive, so you can get excellent assistance from sales representatives listed in the yellow pages under "abrasives." The major manufacturers maintain technical-assistance centers that will help you solve sanding problems. Keep in mind that the industry serves a much greater public than woodworkers. Consequently, there may be products out there that were never intended for woodshop use, but which might be very useful.

We don't want to leave the impression that technical knowledge of coated abrasives is a substitute for that most-elusive quality—the right touch, which all good finishers have. One of our finishers, Tove Killigrew, was both dazzled and amused by the knowledge we had acquired about coated abrasives. Her approach is to "just try things." And, her guiding principle is simple: "It doesn't serve your purpose to sand too fast." □

Robert Erickson and Jerry Tecklin make chairs and furniture in Nevada City, Calif.

Sources of supply

A variety of abrasive materials and technical help are available from the following companies:

Carborundum Abrasives Co., 6600 Walmore Road, Box 350, Niagara Falls, NY 14304; (716) 695-8120.

Ekamant, Uneeda Enterprises Inc., 640 Chestnut Ridge Road, Box 322, Spring Valley, NY 10977; (914) 426-2800.

Industrial Abrasives Co., Box 14955, Reading, PA 19612; (215) 378-1861.

Norton Co., Consumer Products, 1 New Bond St., Worcester, MA 01606; (800) 321-3316 (East Coast) or (800) 423-4621 (West Coast)

Standard Abrasives, 9351 Deering Ave., Chatsworth, CA 91311; (818) 718-7070.

3M, Home Products Division, Building 223-4S-01, 3M Center, St. Paul, MN 55144-1000; (refer to the yellow pages for a local 3M representative)

Abrasives in finishing

by Michael Dresdner

There are two major differences between sanding finishes and sanding bare wood: With finishes, finer grits are normally required and the abrasive must be lubricated. The basic sanding techniques are the same as with bare wood, but you usually must be a little gentler with finishes.

Sandpaper will gum up quickly when sanding finishes. When finishes are sanded between coats, the finish usually has not completely cured, so it is still soft and rubbery. The abraded finish will build up even on open-coat papers; the situation is further aggravated by the frictional heat generated even from hand-sanding. Finishers handle this problem in one of two ways: by using "self-lubricating" paper or by using waterproof paper with a lubricant (wet sanding).

Self-lubricating papers, or stearated abrasives, are mentioned in the main article. A good way to understand how they work is to think about what happens when a baker flours his hands before kneading dough: The flour sticks to the dough before the dough sticks to the baker's hands, so his hands remain relatively clean. Similarly, the lubricants in the paper prevent finish residue from building up, and the abrasive stays cleaner, cuts faster and lasts longer.

Stearated papers are not available in grits finer than 400, so it is not practical to use them with gloss finishes. For gloss finishes, it's best to use silicon carbide, double-resin bonded to waterproof backings. Here, a liquid lubricant does the job of the stearate to keep the surface cool, reduce friction and float off finish particles before they can gum up the paper. The lubricant can be any liquid that does not harm the finish, but I prefer naptha or mineral spirits. These materials evaporate quickly and leave no significant residue. Light oil, or water with a small amount of mild liquid detergent added, also works well, but any remaining film residues must be removed before applying additional finish.

Use plenty of lubricant. If the slurry of liquid, grit and finish particles becomes too dry, the sandpaper will be clogged. Sanding uniformity and efficiency are affected, but even worse, the clumps are often large and can cause deep, finish-destroying scratches. It's not possible to check sanding progress while the surface is flooded with slurry, so it's necessary to wipe or "squeegee" the area periodically.

Sanding finishes is one area many workers neglect, but it's very important. Sanding improves the surface quality by leveling brush marks and by eliminating orange peel, sag and overspray. It also roughens the surface to promote mechanical bonding between finish coats. Generally, a finish can only be as good as the surface to which it is applied. Fast-drying coatings, such as lacquer, shellac and spirit varnish, accurately replicate the surface on which they are applied. While this characteristic is advantageous in delineating fine carving detail or subtle grain, it also magnifies any surface imperfections in the base wood or in previous finish coats. For the final finish coats, usually applied in thinner layers, surface preparation is more critical, and increasingly finer grits, 400 and higher, are used.

Evaporative, or "solvent-release" systems, such as lacquer and shellac, dry by evaporation of the solvent. These finishes can be redissolved by the same solvent. To some degree, this is what happens with each successive finish coat that is applied. So, sanding between coats doesn't improve adhesion, but it can eliminate minor defects. As long as the quality of the surface is acceptable, there is no need to sand between each coat. This is one reason why lacquer is a cost-effective finish.

The mechanical bonding between layers only applies to "reactive" finishes, like oil-base or conversion varnishes and catalyzed lacquers. In addition to releasing their solvent, reactive finishes cure by a chemical reaction and are distinguished by the fact that, once cured, they cannot be redissolved by their own solvent. Hence, each successive layer is separate and distinct, adhering to the previous coat mainly by mechanical means. Sanding between coats roughens the surface to provide a good adhesive base for the subsequent finish layer.

Sanding during the finishing process, especially with sprayed evaporative finishes, is nowhere near as onerous a task as sanding raw wood. Once the wood's surface has been properly prepared, it's all downhill. □

Michael Dresdner is an instrumentmaker and woodfinishing specialist in Zionhill, Penn., and a contributing editor at FWW.

Tambour-Top Jewelry Box

Pull the drawer and the top rolls open

by Jamie Russell

Trick tambour boxes are functional objects with a surprise: Opening the dovetailed drawer reveals a compartment under the tambour top. The system works with two-drawer models and various shapes of tambours.

Customers at craft shows are always mystified but delighted by the way my boxes work: The tambour top automatically opens as the drawer is pulled out. When I first used this "trick tambour" to push out the writing surface on a desk I made, I thought I had an original idea. But, an acquaintance shattered my illusions when she showed me an old Japanese crayon box with a tambour attached to its drawer. It may be an old idea, but tambour-top boxes are fun to make.

In addition, small projects like these boxes offer a craftsman lots of design possibilities. You can afford to experiment with different ideas without risking much material or time, you don't need a lot of room or equipment and you can turn cutoffs from other projects into money-makers. It's also much easier to sell three pieces involving 40 hours of labor and $50 worth of material than it is to sell one piece requiring the same labor and $200 in materials. Personally, I find my optimum attention span for a given project is one week; after a week, my interest loses its fine edge and I get sloppy. It's simple to tailor a batch of jewelry boxes like the ones shown above to make a perfect week's work.

Even though I work in batches, this article will deal only with how to build one single-drawer jewelry box. You can come up with your own production techniques or design variations for drawer-and-tambour boxes, but the basic principle is simple: Any tambour needs a track to carry it out of sight when it's opened. I take advantage of this fact and screw the slat at the rear of the tambour to the drawer bottom and run the track groove under the drawer, as shown in figure 3 on p. 58. Because the tambour top is fairly light and the drawer is barely 8½ in. wide, the drawer easily pulls the tambour open. The tambour also acts as a drawer stop when it reaches the end of the track. The base and molded shelf-supports tenoned inside the box align the gable sides and keep the box square and rigid—important features for a smooth-running tambour.

Rough-milling stock—Because thick wood has a tendency to move after it is sliced into thin pieces, the first step is to resaw all the box components about a week before you want to build the boxes. This gives the wood time to stabilize before you work it. So far, my best sellers are boxes in oak and walnut. For stability and attractiveness, I prefer stock with a grain pattern somewhere between quartersawn and rift-sawn. Depending on the exact thickness of your stock and your bandsaw blade size, you should end up with three pieces about 5/8 in. thick, which will finish out after planing to either 7/16 in. or 1/2 in. thick, depending on how badly the wood cups. Because it's safer and easier to handle 12-in.- to 13-in.-long sections rather than individual pieces, I lay out both gables, or case sides, on a single board, as shown in figure 2 on the facing page, then bandsaw them out after cutting the tambour track and mortises for the shelf and bottom.

I also cut the 3/16x3/8x8½-in. tambour slats a week or so before I need them, to let them stabilize. The slats are glued to a canvas backing and their ends run in a groove routed in the inside of each gable. To help the vertical-opening tambour run smoothly, I also rabbet the slats slightly to create tongues on the ends. The front end of the tambour is a thicker piece dadoed to fit over the edge of both the slat and cloth, as shown in figure 3. Alphonse Mattia's article in *FWW* #12 (or *FWW Techniques 2*, p. 88) taught me most of what I know about making tambours; I recommend you study Mattia's method if you need more information on tambour construction.

Photo: Michele Russell Slavinsky

Designing router jigs–Jigs are essential for quick, accurate and safe work, and I don't think you should avoid them even if you decide to make just one box. To make router jigs for routing the box gables, I generally construct one template for the horizontal grooves (and vertical grooves used on some of the larger boxes), one template for the tambour track and one for the escape/entry slot that allows the tambour to slide in and out of the assembled case. As you can see in figure 2 below, the grooving template has a rim on three sides to index the board to the workpiece. It's easier to glue up the grooving template from separate plywood strips than it is to machine it from a single piece of plywood. I use screws to attach the templates to the workpieces during routing, and the screw holes in the grooving template are indexed to the two other templates so all three can be mounted in turn in exactly the same location on the stock. Thus, the grooves cut with one template will align perfectly with those cut with the other template. The screw holes are located so they'll be hidden by the drawer once the box is assembled.

I cut the horizontal grooves first, then the curved tambour track and finally the escape/entry slot. When routing the track, cut counterclockwise and push the router firmly toward the center to keep

Fig. 1: Gable layout

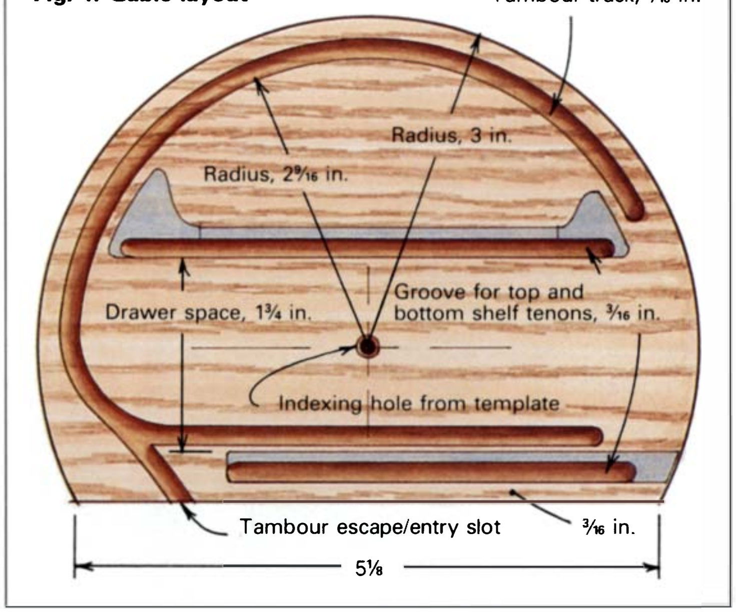
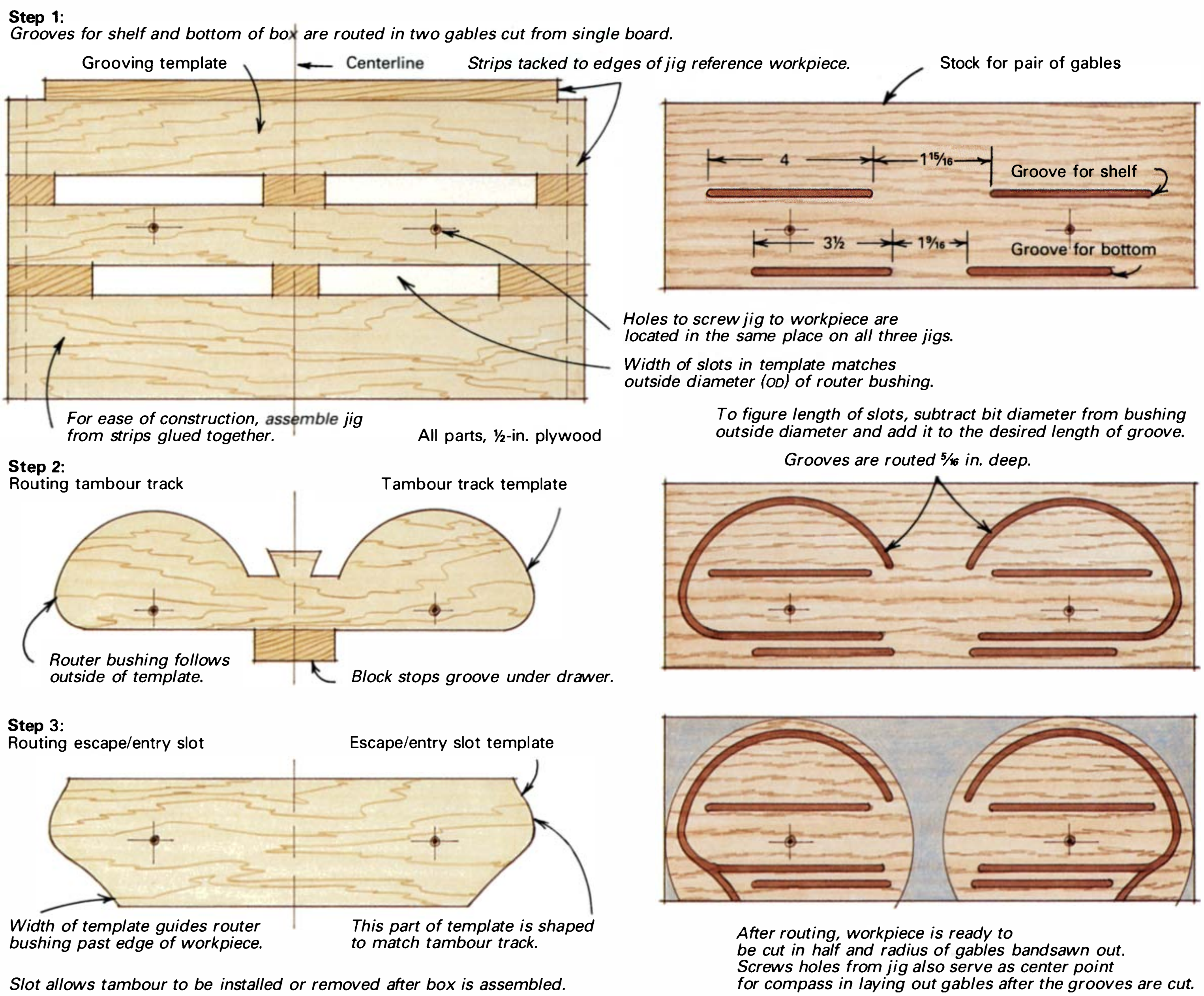
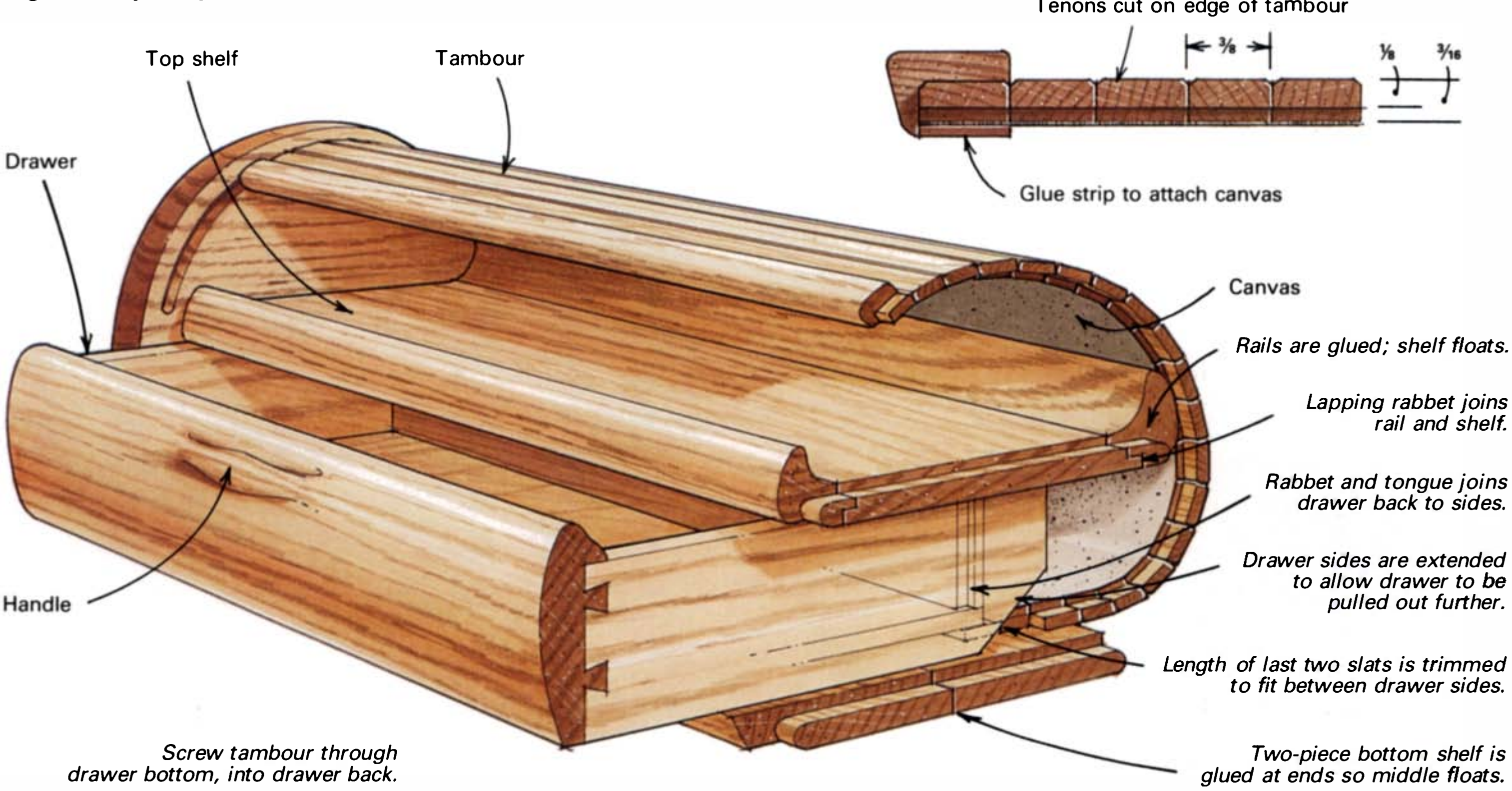


Fig. 2: Jigs for cutting grooves in gables



Drawings: Joel Katzowitz

Fig. 3: Box joinery



it from taking off for parts unknown. After roughing out each slot, I rotate my router 180° and make a final pass to compensate for any guide-bushing eccentricity.

Constructing the box interior—The next step is to cut all the shelves and rails to width and then to length, using a single tablesaw setup in each operation to ensure all the parts are identical. As shown in figure 3 above, cut tenons on the ends of the rails and on the two halves of the bottom shelf to fit the grooves routed in the gables. For accuracy in cutting the tenons, I set the saw fence so all the tenons will be the same length, then move the blade up and down to adjust for the various thicknesses of the rails and shelves. I cut the tenons with a few passes over a good carbide blade to avoid tearout, then glue up with WEST SYSTEM epoxy (available from Gougeon Brothers, Box X908, Bay City, Mich. 48707; 517-684-7286). Epoxy has excellent gap-filling qualities, in case the tenons aren't a perfect fit. The ridges left on the tenons by the multiple sawcuts help lock the joint; should you need to adjust the tenon for a tight fit, it's easy to pare the ridges with a chisel. I make pairs of rails from a single piece to keep my fingers farther from the cut and to give myself solid contact with my router fence and table when I cut the inside coves. For the convex edges of the rails, I rough out the curve by cutting a series of bevels on my tablesaw. Then, after I've ripped the rails apart, I round the bevels over on a 6-in. by 48-in. belt sander. Next, I cut the lapping rabbets on the shelves and rails and try them in their grooves for fit and tambour clearance. Scrape and sand the shelves and rails prior to assembly. I leave the front edge of the bottom shelf square and shape it to the gable's curve after assembly.

I clean up both sides of the gables with a cabinet scraper but only final-sand the inside. I final-sand the outside to 400 grit after assembly. Because these gables are part of a circle, I put the point of my compass in the screw hole left from mounting the template and draw the outside of the box. I rough-out the gables on the bandsaw, fair up the curves on my stationary sander and roundover and clean up the edges with a spokeshave and sandpaper. After dry-assembling the box to make sure everything fits, I glue up the box and leave it while I finish-sand the tambour.

Shaping drawer fronts—I build my drawers square, then shape the front curve after fitting them into the box's opening. This enables me to match the drawer front's curve to the gable's curve. You can build the drawer anyway you like, but I prefer drawer sides of contrasting wood and hand-cut dovetails. The graphics of the dovetails are classy, and I don't think there is enough wood or glue surface to cut a strong rabbet in a small drawer like this. And, after several days of machining and sanding, it's a pleasure to shut off the power tools, sharpen my chisels and be a hand-tool woodworker for awhile.

I also enjoy shaping the drawer front mostly with hand tools. I prefer to carve a pull directly into the drawer front, but you may choose to use a separate pull glued or screwed on the front, or even eliminate it entirely, as I did on the oak box shown in the photo on p. 56. With no pull, the tambour itself is slid back, pushing the drawer open in the process. Starting with a 4/4 piece of the same stock as the gables, I cut the drawer front into a rough curve with several beveled cuts on the tablesaw, running the back of the drawer against the saw fence. Then, I fair the curve and match it to the gables using rasps, planes, spokeshaves and sandpaper, leaving enough stock to shape the lip-like drawer pull with carving tools.

Fit the drawer into the box, slide the tambour into its track and attach it with a single screw to the bottom of the drawer back. Now you're ready for finishing. I use Watco oil mixed three to one with gloss alkyd urethane or varnish and a bit of Japan drier (available from paint and hardware stores)—about ¼ teaspoon to a pint. After the finish dries, try the tambour by pulling on the drawer. It should open smoothly; if it doesn't, you may have to detach the tambour and either adjust the fit of the drawer or lubricate the tambour ends and drawer bottoms with a bit of wax. □

Jamie Russell is a self-employed furnituremaker. He would like anyone who makes trick tambour-top boxes to write him at Box 43, Ruddell, Saskatchewan, Canada S0M 2S0.

Complementary Template Routing

Tight-fitting curved joints from a single pattern

by Patrick Warner

Template routing is one of the most powerful methods in the workshop. With homemade medium-density fiberboard (MDF) templates and a router with a bushing or ball-bearing piloted bit, you can quickly rout grooves, chop mortises, recess inlays and shape workpieces. Template routing is repeatable, accurate and capable of handling either straight or curved shapes with ease. You can encounter problems though, when you want to fit two workpieces along an irregular curve. For this jigsaw work, you usually must painstakingly make two templates that precisely match each other, a hassle that limits the usefulness of template routing.

To avoid this predicament, I developed a method I call complementary template routing. Its beauty is that only one master template must be shaped by hand—a router handles all the subsequent steps—and the final fit is perfect. I've used the method for all sorts of curved joinery and inlay. Some applications are shown at right. Best of all, aside from buying a few sealed ball bearings and perhaps a standard router bit or two, no expensive fixtures or custom cutters are needed.

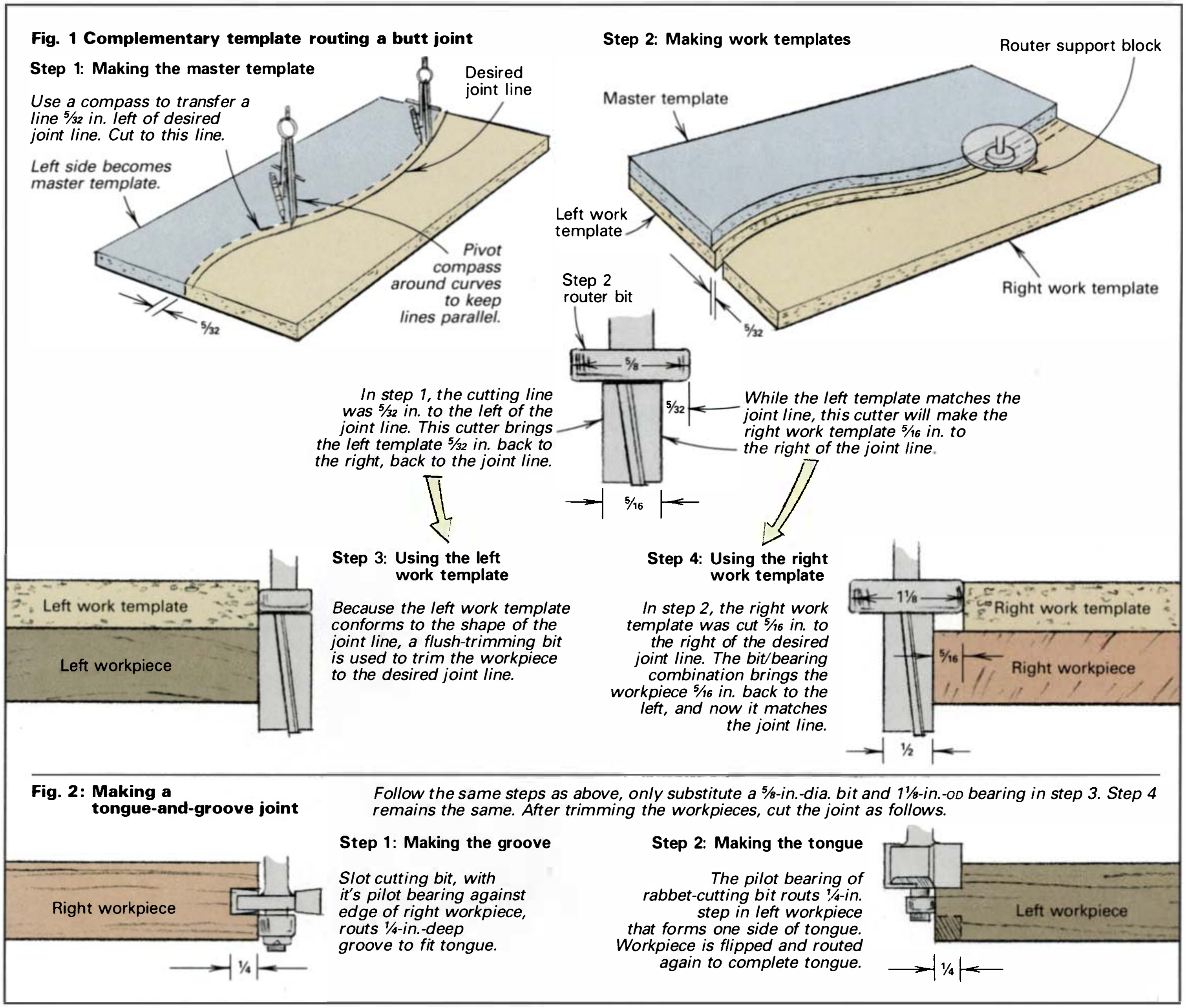
The template-routing process is straightforward: A master template guides a piloted straight bit that plows a path through a piece of particleboard, simultaneously creating complementary work templates. These templates guide the router as it shapes the right and left halves of the workpieces. The two work templates don't nest snugly together, because the bit used to cut the templates apart creates a kerf as wide as the bit. This is where the trick to my method comes in: In making and using the work templates, you must make offset cuts with the router, to shift the final joint line enough to compensate for the kerf and allow the workpieces to mate perfectly. Offset cuts are accomplished by piloting a router bit with a ball bearing that has an outside diameter (OD) larger than the cutting circle of the bit. Figure 1 on the next page shows how my method of template routing can be used to produce a butt joint. By varying the combination of bits and bearings used with the templates, as shown in the chart on p. 61, you can cut several other common joints. Note that in each case, only stock, off-the-shelf straight bits and sealed ball bearings are used. Once you get accustomed to making the offset cuts, you can also figure out bit/bearing combinations for making other joints, as described later in the article. But first, let's go through the steps of making a butt joint.

Complementary template routing allows a wide range of possible joinery and inlay designs that are quick to make and reproduce, and dead accurate. The author uses his router method to make decorative drawer fronts and panels, marquetry and structural joints for furniture.

Making the templates—Before you can make the master template, you must lay out the joint line along which two workpieces will meet, say the leg and the foot of a trestle table. For a butt joint, the pieces can meet along any straight or curvy line, because right and left workpieces can slide down over one another, much like interlocking jigsaw-puzzle pieces do. Sometimes the workpieces aren't clearly a "right-hand" piece and a "left-hand" piece, but I always designate one right and one left, for clarity. The only restriction on the joint line is that you cannot make curves so tight that the bearings of your piloted bits won't fit into them. In other words, a curved section can't be less in diameter than the outside diameter of the largest pilot bearing you'll use at any stage of the routing process.

Next, draw your joint line on the master-template stock. I use ½-in. "Medite" MDF, because it shapes easily, is dimensionally stable and holds screws well. But, any high-quality particleboard, other than underlayment grade, will do. Before cutting out the master, the joint line must be transferred 5/32 in. to the left to compensate for the offset created by the 5/16-in. bit and 5/8-in.-OD bearing combination used here to cut templates apart (see steps 1 and 2 in figure 1 on the next page). I do this by setting the legs of a compass 5/32 in. apart, and following the original joint line with the point, pivoting the compass around curves as necessary to keep the new line parallel. The left side of the particleboard will become the master template; therefore, saw on the new line with the blade on the right, or waste side, using a coping saw or bandsaw. Then, rasp, file and sand the work edge until it is smooth.

The master template can now be used to simultaneously cut the



two work templates, as shown in the top photo on the facing page. Start with a large piece of particleboard. You want the two work templates to end up at least 5 in. or 6 in. wide, to leave room for clamping the templates to the workpieces later. I clamp or screw the master template on top of the particleboard, then clamp the assembly over a piece of scrap plywood. The scrap is needed to protect the workbench, because you'll be cutting clear through the particleboard to make the work templates.

The work templates are cut with a 5⁄16-in.-dia. straight bit in a 5⁄8-in.-OD pilot bearing. This bit/bearing combination results in a cut that's offset by 5⁄32 in., the same offset used in drawing up the master template, as previously discussed. To bear on the template, the pilot bearings must be above the cutter instead of below it, as is more usual on piloted router bits. Therefore, I use sealed ball bearings that have a 1⁄4-in.-ID (inside diameter) that will slide right over the 1⁄4-in. shank of the bit (see step 2 in figure 1). These bearings, as well as the others mentioned in the article, are available from Valley Chain and Gear Inc., 1320 Grand Ave., San Marcos, Calif. 92069; (619) 744-4200. I stack two bearings on the bit's shank to ensure solid contact with the template and to prevent any gouging of the particleboard edge. A drop of Locktite (available from auto-supply stores) between the shank and the inner race of the bearings will keep them from riding up on the shank, if that becomes a problem. For the bit itself, use only carbide straight bits with a cutting length long enough to cut through the work-template stock. The bit's shank should be long enough to hold the bearings and still have at least 5⁄8 in. chucked in the router's collet.

With bit and bearing chucked in the router, I cut through the particleboard in one pass. Following the contour of the master, concentrate on keeping the router's base flat and the pilot bearing tight against the template's edge. To help keep the router from tipping, I screw a small, 1⁄2-in.-thick scrap (the same thickness as the master template) to my router base, to slide on the right work template as I cut. If the contours of the master are very curvaceous or convoluted, the router will want to pull away from the template as the cut changes directions. To prevent this, use the biggest router you have, to dampen the cutting forces. Try to keep full, even pressure at a right angle to the tangent of each curve you follow. Fortunately, even if the bearing loses contact and the cut deviates, the pair of work templates can still yield a tight joint, because the deviation is transferred to both templates equally and will be complementary in the final joint.

Drawing: Roland Wolf

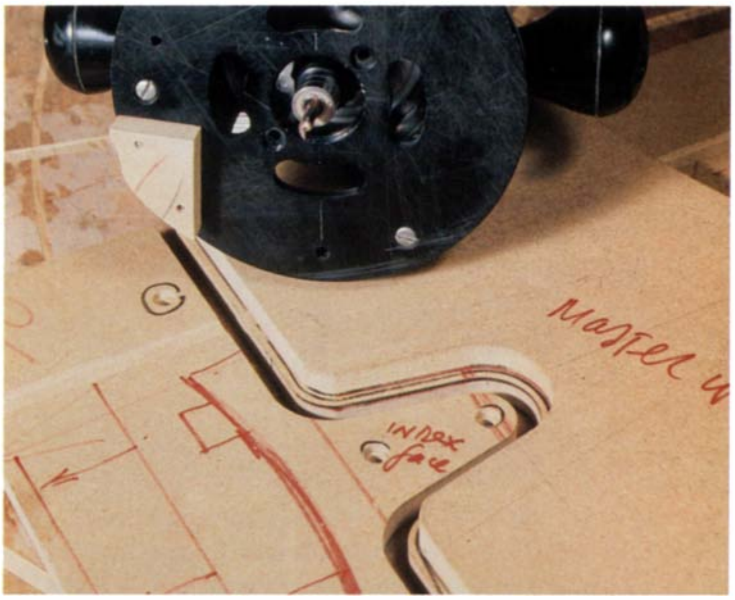
Routing the workpiece—Once the work templates are cut, you're ready to use them to shape the joint on the workpieces. Once again, a combination of straight bits and ball-bearing pilots provides offsetting cuts. If you follow the bit/bearing combinations in the chart, you'll see that for a butt joint, you'll need a bit/bearing combination that yields a ⁵⁄₁₆-in. offset for the right half of the joint and a flush trim bit (one that yields zero offset) for the left half. Like the bit/bearing combinations for making the work templates, use a carbide straight bit. The bearings you'll need are listed in the chart by their outside diameter; the inside diameter should be chosen to fit the shank of the bit you use—¼ in., ⅜ in. or ½ in.—depending on what your router will handle. The flush-trimming bit can be any diameter, as long as the pilot bearing's outside diameter matches the bit's cutting circle. I prefer to use larger-diameter ⅜-in. or ½-in. shank bits, like the ones shown in the lower photo at right, because they are less susceptible to flexing and chatter.

To cut the butt joint, follow steps 3 and 4 in figure 1 on the facing page. Trace the outline of the left work template on the left half of the joint and bandsaw away the waste to within ¹⁄₁₆ in. of the line. Clamp the left template and workpiece to the bench and shape with the flush-trimming bit. The procedure is the same for the right half, except shift the joint line you trace from the right work template ⁵⁄₁₆ in. to the left. Use the ⁵⁄₁₆-in.-offset bit combination to take the final trim cut; always keep the router base flat and the pilot bearings against the template. If you've routed carefully, the right and left workpieces should fit together with less than .003 in. to .005 in. of variation along the joint line.

Tongue-and-groove joint—A butt joint is adequate if the two pieces are glued together with mostly long-grain to long-grain contact. But, if the parts join cross-grain, or if the joint needs to be reinforced, say for curved joints where the seat rails join the rear legs of a chair, I prefer some sort of interlocking joint. Fortunately, the same work templates created for a butt joint can also be used to make interlocking joints: The chart lists the bit/bearing combinations necessary for making two different-size rabbet or tongue-and-groove joints. These joints strengthen the mechanical connection between the workpieces and provide a better glue surface, even if the pieces join entirely cross-grain to one another. Further, an interlocking joint helps to register the two pieces, to keep them from sliding during glue-up; if the ends of the joined pieces are visible, they provide a nice bit of visual detail.

To make a tongue-and-groove joint, prepare the master and work templates exactly as described above. When you're ready to trim the workpieces, trim the joint surfaces on the workpieces just as shown in steps 3 and 4, but substitute the bit/bearing combinations from the chart that are designed for a tongue and groove or rabbet, either ¼ in. deep or ³⁄₁₆ in. deep (see figure 2 on the facing page).

After trimming the joint, I rout the tongues and grooves using a rabbeting bit for the tongues and a slot-cutting bit to plow the grooves. Make the groove in the right workpiece first, taking care to center the piloted bit on the thickness of the workpiece. For the tongue, choose a piloted rabbeting bit that cuts a shoulder the same width as the amount of overlap: ¼ in. or ³⁄₁₆ in. Set the depth of cut so that after passes are taken from both sides of the left workpiece, the resulting tongue will fit snugly into the groove. The advantage to this method is that by making passes from both sides of the stock, the tongue will automatically be centered. Make a test piece from a scrap of stock the same thickness as the workpiece to test the fit. If your stock is thin enough, you can get by using the slot cutter as a rabbeting bit to cut the tongue as well as the groove. The joint-making process is the same for making a rabbet joint, but only a single rabbet cutter is needed to rout complementary lips on both workpieces.



Using a master template to guide a router fitted with a ball-bearing piloted straight bit, a piece of particleboard is cut into left- and right-hand subtemplates. These templates are used to rout both halves of a joint so two pieces can be fitted together accurately.

The author fits most of the router bits used for his complementary routing process with a ball-bearing or two slipped down on the shank, to serve as a pilot. Each bit/bearing combination is chosen to give a prescribed amount of offset, for snug-fitting joints.

Bit/bearing combinations for trimming workpieces

Type of Joint	Left workpiece		Right workpiece	
	Bit dia.	Bearing OD	Bit dia.	Bearing OD
Butt joint	Flush trim bit (same dia. bit and bearing)		½ in. ¾ in.	1⅛ in. 1⅜ in.
Tongue and groove or rabbet ³⁄₁₆ in. deep	½ in. ¾ in. 1 in.	⅞ in. 1⅛ 1⅜ in.	½ in. ¾ in.	1⅛ in. 1⅜ in.
Tongue and groove or rabbet ¼-in. deep	⅝ in. ⅞ in.	1⅛ in. ⅜ in.	½ in. ¾ in.	1⅛ in. 1⅜ in.

My complementary-template method isn't limited to the joints I've described: You can use other bit/bearing combinations to make more elaborate joints, like the glue-lock joint. You can do this by figuring out the bit-diameter/bearing-outside diameter combinations needed to give the proper amount of offset to make a joint with the bit you've chosen. The amount of offset is calculated by subtracting the cutting diameter of the bit from the outside diameter of the pilot bearing and dividing by two. □

Patrick Warner lives in Escondido, Calif. He teaches classes in router techniques and making jigs and fixtures.

Narrow-Belt Strip Sander

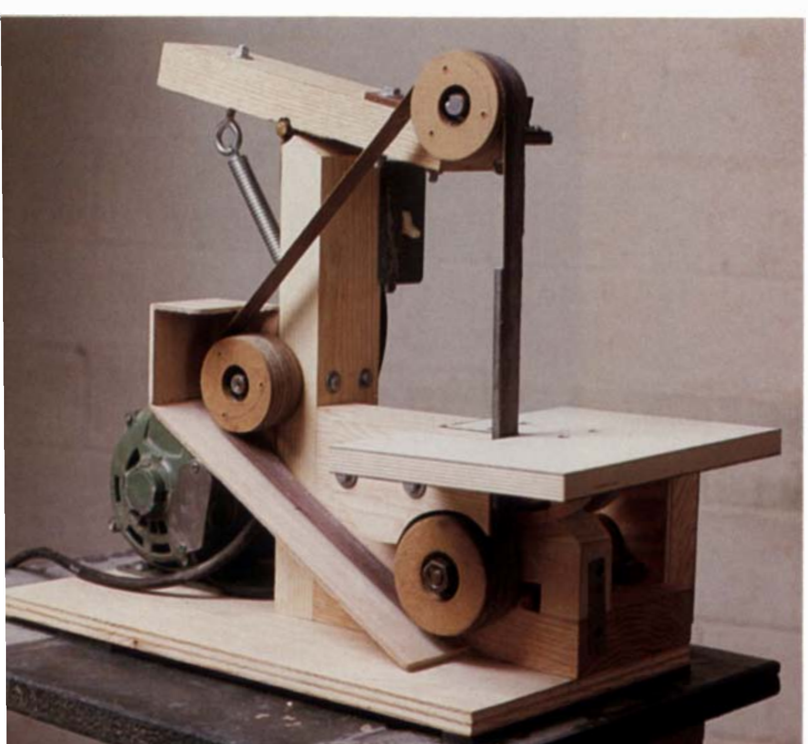
Shop-built workhorse for shaping, sharpening and smoothing

by Robert M. Vaughan

My narrow-belt strip sander is one of the handiest tools in my shop. It's great for easing or beveling edges, rounding corners, sharpening dowels, fudging miters for a perfect fit and smoothing the bandsawn edges of straight and curved surfaces. In addition to working wood safely and precisely, it's a metalworking tool, perfect for sharpening lathe tools and drill bits, deburring rough edges and shaping metal parts.

I built the sander shown below, because most of the $100-and-up store-bought models vibrated excessively and were too flimsy to be accurate. I wanted a sander that would be stable without being bolted to a bench, inexpensive and easy to build with normal workshop tools and readily available hardware (ideally, the odds and ends hanging around my shop).

My sander is nearly the same size and weight (about 48 lbs.) as many commercial models, but my hardwood-and-plywood frame absorbs vibration much more effectively than the plastic and sheet-metal commercial units. I used oak and ash for the frame on the sander shown below, but because these ring-porous woods deflect drill bits, they make it difficult to properly center a hole. I'd recommend using maple for the frame members. The frame supports a large, Formica-laminated work surface that can be tilted through 45°. Although the sander uses 1-in.- wide, 42-in.-long belts, available from Sears and several other companies, you can also use 1-in. strips ripped from 6-in. by 48-in. belts. The belt runs over three wood wheels. One of the two idler wheels attaches to a spring-loaded, pivoting upper arm, which tensions the belt. Belt tracking is controlled by adjusting this idler wheel with two counteracting thumbscrews.



Vaughan's narrow-belt sander, assembled from scraps of oak, plywood, fiberboard and assorted hardware, is stable, accurate and capable of performing a multitude of tasks.

A salvaged ⅓-HP, 1,750-RPM motor turns a 3½-in. pulley, which is V-belted to a 3-in. pulley on the mandrel. With a 3⅝-in. drive wheel, the belt moves at a rate of 1,900 surface feet per minute (SFM). Commercially available sanders usually run 3,000 SFM to 6,000 SFM and vibrate a whole lot more than mine does.

Figure 1 on the facing page shows the dimensions of the hardware and fittings on my sander. Your hardware may be different, especially if you scrounge your materials as I did, so collect the metal parts before you begin construction, and adjust the dimensions as needed. The mandrel is the heart of the sander, so look for one with ball bearings, a threaded shaft on one end for the drive wheel and a plain shaft on the other end for the pulley. Even if you follow the plan exactly, you'll want to trial-fit and fine-tune most of the parts before assembly. I clamped the parts together and did not drill any pilot holes or install any screws until I was sure of the fit.

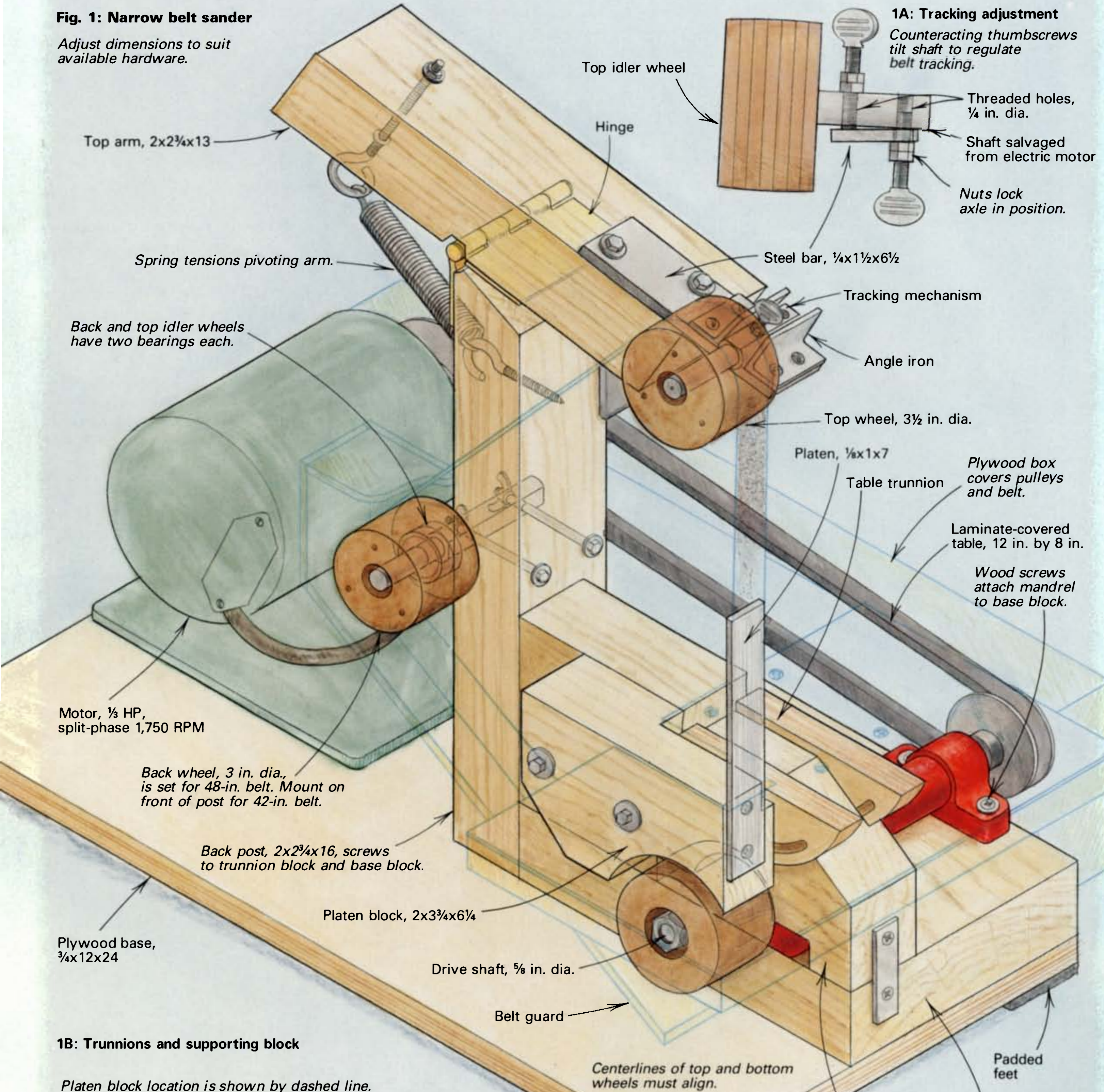
Building the base and frame—There are six basic wood parts in the frame, including the ¾-in.-thick plywood baseplate on which everything is mounted. The other components, all cut from 8/4 hardwood, are the base block supporting the mandrel, the trunnion block holding the table, the back post, the top arm and the platen block, which supports the sanding surface.

After cutting the plywood base, I run countersunk screws up through the plywood into the base block. The base block must be wide enough to support the drive-shaft mandrel and about 10½ in. long, as shown in figure 1. You will have to remove this base block later, so don't glue it down. Set the mandrel on the base block with its centerline about 3¾ in. back from the front edge; screw it down with the largest wood screws that fit the mandrel base holes. You can't accurately align the mandrel without the drive wheel, so the next step is to build that wheel and the other two for the sander.

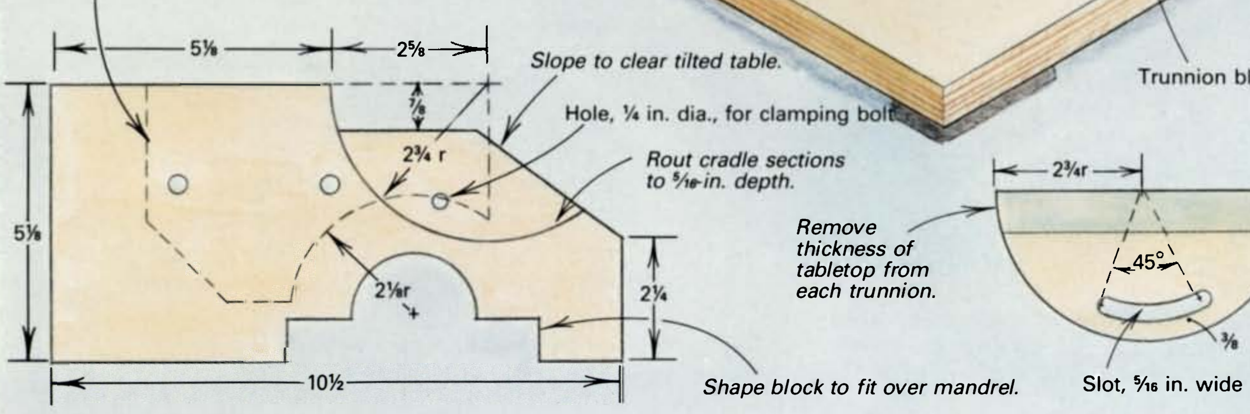
Wheels, shafts and bearings—The wheels are seven pieces of ¼-in.-thick tempered hardboard laminated together with Titebond glue. Hardboard, available from most large building-supply houses, has no voids or dense spots that could cause vibration or balance problems. The drive wheel, bored ⅝ in. for the mandrel's drive shaft, is 3⅝ in. in diameter, while the two idler wheels are 3¼ in. in diameter and bored out to accept two stan-

Fig. 1: Narrow belt sander

Adjust dimensions to suit available hardware.



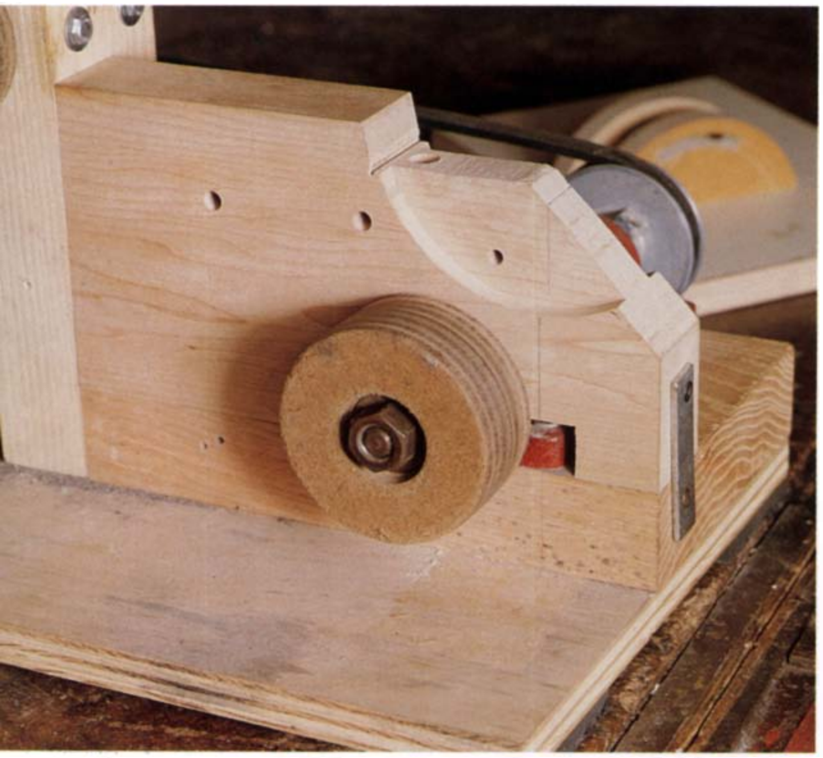
1B: Trunnions and supporting block



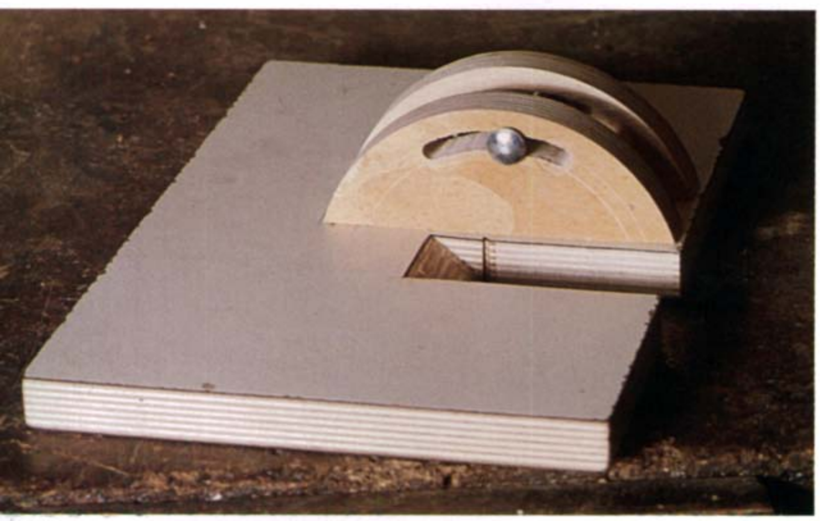
dard 40mm-dia. by 12mm-thick ball bearings. I bandsaw each wheel slightly oversize, mount it on a lathe faceplate and turn its outside diameter with a slight crown—about the thickness of a penny. Then, with a drill bit in a chuck mounted on the lathe tailstock, I bore a large starter hole in the wheel's center. The tip of an old file, ground like a regular lathe scraping tool, is used to enlarge the hole enough to slip-fit the bearings.

I use sealed ball bearings in both idler wheels, because they are durable and resist lateral movement of the wheels, which would lead to inaccurate tracking of the sanding belt. You can purchase the four ball bearings at most electric-motor repair shops and bearing distributors, or from W.W. Graingers (stock #1L050), 5959 W. Howard St., Chicago, Ill. 60648. These are the standard-size 203 sealed bearings used in almost all NEMA 56 frame-electric motors. The center shafts of old discarded motors (usually free of charge from motor-repair shops) are also a good source for the precision-ground stock needed to support the bearing. Many of these shafts have precision-ground bearing seats that will accommodate two bearings. Cut off this section. If the bearing seats are not long enough, see if the motor shop will press a couple of the shafts out of the rotors for you. To make dulling and mounting much easier, file, mill, sand or grind a flat on both sides of the portion of the shaft that will be resting on the machine. Don't flatten the actual seat.

Press the ball bearings on their shafts, coat the insides of the hardboard wheels with epoxy and insert the wheels over the bearings, being careful to leave them proud of the wheel. This will provide a surface for pressing the wheel on or off the shaft. Never put pressure against the hardboard wheels. Use sleeves to press against the inner edge of the bearings, if necessary, or you risk damaging the bearings. Let the wheels dry square and aligned with the shaft. Then, mount the drive wheel on the motor shaft and turn it true. If this wheel is ever removed, it may have to be turned true again.



The mandrel fits through the trunnion block and supports the laminated hardboard drive-shaft wheel. The trunnion block is routed and shaped to accept the trunnion cradle and worktable assembly.



The trunnion cradle is screwed to the table near the opening through which the belt runs. The bolt is needed to secure the cradle to the supporting trunnion block and to lock the table in place.

Trunnion assembly—The trunnion supporting the table is simply an arc of a circle that rocks in a round cradle around a common center point, as shown in the top photo at left. To ensure free and accurate movement, the center point of that circle should be right where the tabletop meets the front of the belt. The trunnion cradles are routed ⁵⁄₁₆ in. deep in both sides of a 5½-in.-wide 8/4 upright with a circular router template. Leave the trunnion block about 2 ft. long to allow room for clamping the router template and to provide stock for the platen block, which supports the sanding belt. A disc is then lathe-turned to match the 5½-in. diameter of the circle cut by the router template. The disc is cut so the two equal halves plus twice the thickness of the table equals the disc's original diameter. You can make the template any way that's comfortable for you, but don't forget to account for the diameter of the router bushing you'll use so you can accurately produce recesses with the 2¾-in. radius shown in the drawing on the previous page. The template is also needed to rout a circle in a piece of scrap large enough to hold the trunnion discs when they're crosscut on the tablesaw. Also, rout another circle to serve as a diameter gauge when you turn the trunnion disc.

After turning the plywood trunnion disc to size, leave the piece on the faceplate and score a ⁵⁄₁₆-in.-wide area ⅜ in. in from the outside rim. This area is used to lay out the slot that the trunnion clamping bolt runs in. It's a good idea to make extra circles in case you later want to make special grinding and sanding platforms for things such as lathe gouges and chisels. With your trunnion cut-off jig, cut the trunnion discs in equal parts, so when they are screwed on the bottom of the table, the tabletop will be at the center of the trunnion circle, as shown in the bottom photo at left.

Place the trunnion disc halves in their cradles so the tops of the trunnions are parallel to the top of the block; use a drill press to bore a ¼-in. hole through all three pieces. The hole should be positioned behind the center vertical line (about 1 in.) to give good clamping support. Take the trunnion halves out, mark where the bolt hole would be at the 45° setting, drill a hole through both pieces and cut out the slot on the jigsaw. Use a small rasp to do the final fitting, and elongate both ends of the slot slightly to allow for fine adjustments.

Now joint off about ¹⁄₁₆ in. from the top edge of the trunnion block so it will be slightly below the table's surface, and cut the block the same length as the base block. Bandsaw out an opening so the block will fit comfortably over the mandrel. Set a trunnion half in its cradle, pivot to the 45° setting, and mark and bandsaw a slope as shown on the front of the trunnion block to allow the table to drop.

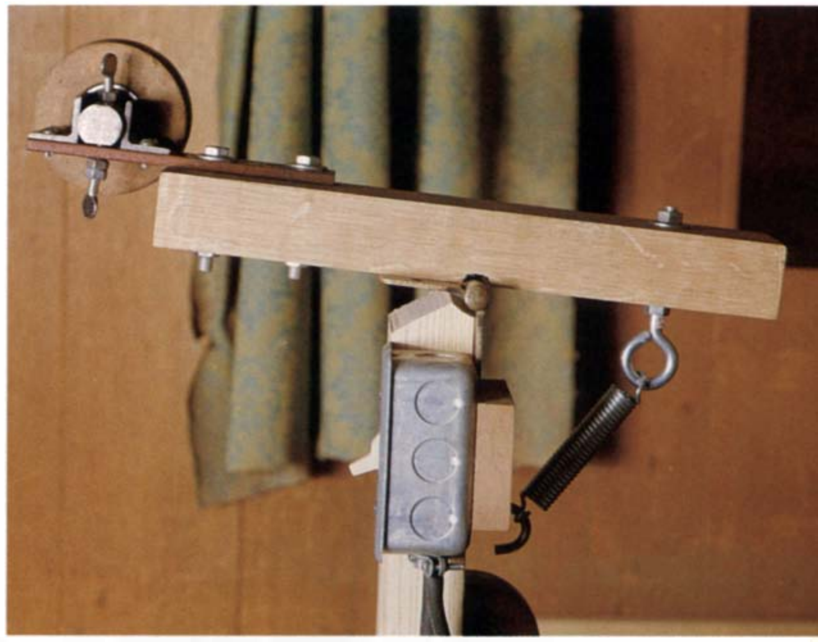
Making the back post and top arm—Clamp the trunnion block in place over the base block, then clamp on the back post. Hold the top arm where you think it should go, giving it about a 10° droop, and clamp it in place for later trimming. Now make the two axle assemblies and clamp them in place. The top-wheel adjustment assembly shown in the top photo at right, is made from a piece of ¼x1½x6½-in. steel and a couple pieces of 1¼-in.-long, 1-in. by 1-in. angle iron. Drill and tap four 10-24 thread holes to secure the opposing pieces of angle iron. Drill two 3⁄16-in. holes in each piece of angle iron, and slightly elongate the holes front to back for adjustment of the top-wheel shaft. Drill and tap the top-wheel axle with ¼-20 threads. The ⅝-in. diameter of the axle is a long way to thread, so a 9⁄64-in. hole could be drilled about halfway down and the remainder tapped. Clamp the shaft between the angle-iron sides, and mark and drill two ¼-in. holes in the 6½-in. steel plate to mount the assembly to the arm. For final seating of the shaft in the top brackets, pinch the shaft with the top edges of the angle iron, and then tighten the angle-iron screws. Because the distance between the angle-iron sides is wider at the top than at the bottom, the shaft will seat quite snugly as the bottom adjustment screw pulls it down into the recess. Tracking adjustments are made by tightening and loosening the opposing thumbscrews.

Now, clamp the two axle-and-wheel assemblies in place. The front edge of the top wheel should be directly over the front edge of the bottom drive wheel. Be sure there is enough overhang on the back of the top arm to fasten the spring eyebolt. The back wheel should be high enough on the back post so it can be bolted on the front or back of the post, depending on whether you want to use 42-in. or 48-in. belts. For now, clamp it on the back, loop a 48-in. sanding belt over the wheels and move the arm around until it fits properly and secures the belt. Note the location of the top arm, and trim the back post accordingly.

Now take your hinge and determine the allowances needed for the knuckle, then cut the parts as shown in figure 1. Mount the hinge, and if everything fits okay, mount the top-wheel assembly. Take off the top arm, adjust the front bevel as needed so the arm can move freely and mount the eyebolts and the spring. (The spring I used came from a local hardware store's "Select-A-Spring" display, spring #171, for about $3.) Also at this time, predrill the back post for the screws that go through it into both the trunnion block and the base block. If you're sure of the position, you can also mount the back axle. In both cases of axle mounting, drill a hole in the wood about 1⁄32 in. larger than the bolt used, to allow for some adjustment.

With the sanding-belt system set for a 42-in. belt, make a template of the platen block. Get the remainder of the stock you used for the trunnion block and route a trunnion cradle in one side, a little deeper and a little farther back than the actual trunnion, as shown in the bottom photo at right, to allow free movement of the trunnions after the platen block is installed. Cut the platen block to length, allowing for the ⅛-in.-thick steel platen, and bandsaw to the needed profile. Install the platen, clamp the assembly in place and test-run a belt. The platen should deflect the belt out of line about ⅛ in. Unclamp the base and trunnion blocks and drill for platen-block mounting bolts.

Table assembly—Clamp the trunnion block to the base and clamp on the trunnion halves. Position the table, then clamp it to the trunnions. I let the table's centerline go right over one of the trunnions. Mark where the trunnions go, remove the table and drill countersunk holes in the table so it can be screwed to the trunnions. Reclamp the table to the trunnions and drill pilot holes in the trunnion halves, using the screw holes as guides. Drive the screws home while everything is still clamped. Next, mount the platen block and determine how much the table must be notched to fit over it. Allow for an extra ¼-in. clearance to the left of the platen for slipping belts in and out. Turn the table upside down and bandsaw out the clearance for the platen and block. Once the table and belt run satisfactorily, take the table off, turn it upside down and chisel out the relief for the 45° tilt.



Two counteracting thumbscrews move the top-wheel shaft to control belt tracking. Belt tension is provided by the spring pulling against the hinged arm. A motor switch mounted on the same post is easy to reach from the front of the sander.

The platen block must be relieved so the trunnion cradles can be moved freely to adjust the angle of the sanding table.

Now unclamp everything and unscrew the base block from the plywood baseplate. Clamp the base and trunnion blocks in their proper position and install the screws through the back post into these two pieces, keeping everything as square as possible. Cut and bore a piece of flat strap steel, and screw it into the front of the trunnion block and into the base block. Reinstall the assembly on the plywood baseplate.

One point of caution: If a belt breaks, the top arm will flip upward about 4 in. in a sudden and unsettling manner. Keep away from the top wheel when sanding, to avoid a face full of sander. The spring does limit the upward movement of the top wheel, but a safety chain from the top arm to the front of the back post could easily be installed. You should also make hoods to cover the belts, pulley and wheels. A dust mask and eye protection are also recommended. □

Robert Vaughan is a professional woodworker and has his own shop in Roanoke, Va.

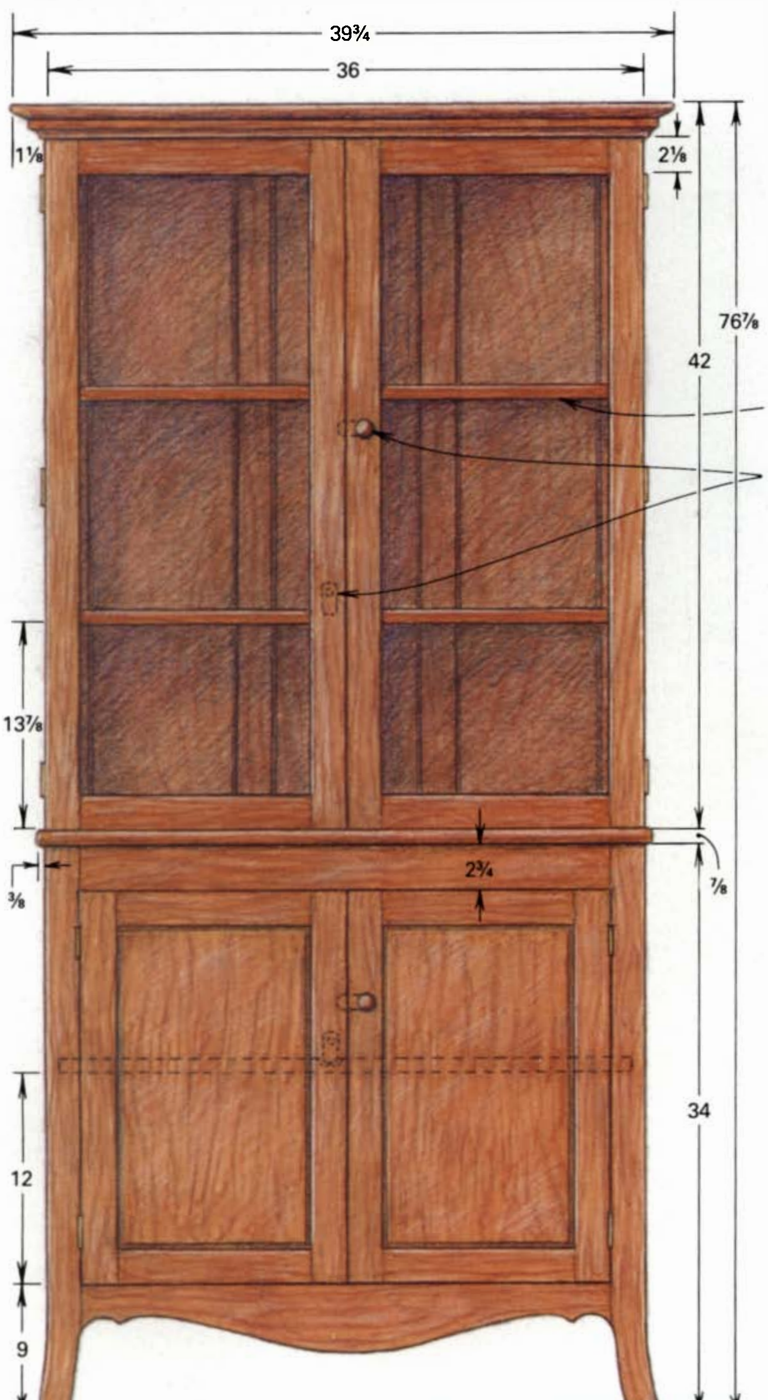
Kentucky Cupboard

Retaining the essence of the country style

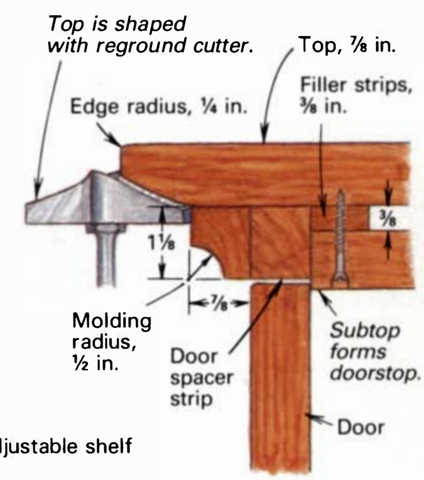
by Warren May

Fig. 1: Cupboard plans

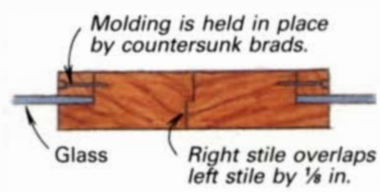
Rails and stiles for all doors are 2⅛ in. by ⅞ in.



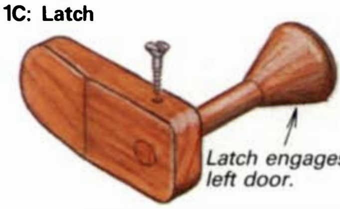
1A: Top corner molding detail



1B: Section through glass doors

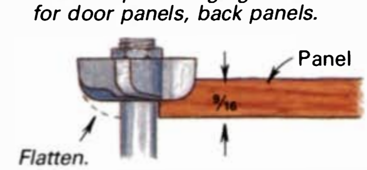


1C: Latch



1D: Panel cutter

Reground shaper cutter cuts tongue to fit standard groove; versatile panel edging is used for door panels, back panels.



In the early 1800s, lumber was so abundant that Kentucky became known as the hardwood capital of the world, and there were more than 30 cabinetmakers in the central Kentucky (Lexington) area alone. Even though these cabinetmakers were far from major cities and fashion centers of the day, prosperous rural landowners and prominent townspeople in the area wanted furniture of the trendy Chippendale, Sheraton, Hepplewhite and Federal styles popular in the East. Striving to meet the needs of their patrons, these local cabinetmakers made the fashionable pieces as best they could, but at the same time, developed their own "Kentucky style."

The Kentucky builders took advantage of the ready availability of local hardwoods, such as cherry, walnut and poplar, rather than depend on mahogany or veneers. And even though they often simplified construction procedures and didn't bother wth curved dovetails and other elaborate devices, their pieces were not plain. The furniture was often embellished with inlays that conveyed a strong folk quality and a sense of the individual builder. Various cabinetmaking schools in the area and individual craftsmen, in training their apprentices, solidified these characteristics into an identifiable and lasting style. I've always found the honest melding of function with design and the use of the marvelous local hardwoods in the furniture of this period to be particularly appealing, and I try to incorporate these characteristics into my own pieces, such as the cherry cupboard shown below.

The cupboard is tall, light and functional, with simple, clean lines commonly found on Kentucky-style pieces. The cabinet is made in two sections, which simplifies construction and assembly. I begin by building the legs, then the bottom and upper sections and finally the doors and back. All the rails and stiles are joined with mortises and tenons. The backs of each section are large frames fitted with floating panels.

The top, display section has two shelves: one adjustable, the other fixed. The framed glass doors overlay the sides of the cabinet and are rabbeted along their abutting edges so they "nest" together when the doors are closed. The molding crowning the upper section is formed by shaping the edge of the top and adding a simple underlying cove molding. This molding treatment is the display section's single decorative feature.

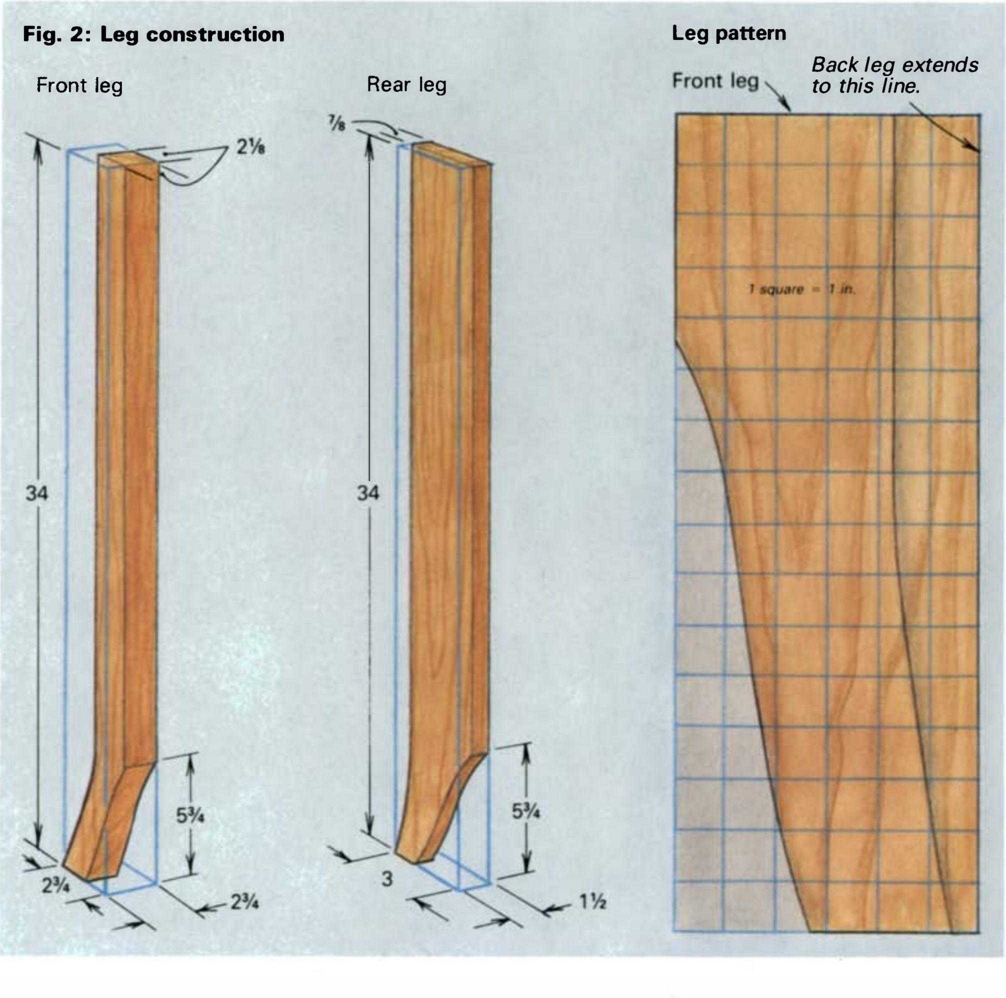
The base section has a single, fixed-position shelf. The paneled doors are flush-mounted. Flared, Kentucky-style legs are integral to the sides of the base and are reminiscent of the proud stance of pieces from the Federal period. Both the scalloped sides and bottom apron combine with the legs and top molding to provide a softening contrast to the otherwise straight-line features of the cupboard. To make the most of the wonderful grain of the cherry used throughout, the cabinet is finished with oil and then several coats of lacquer.

Feet first–Even after 20 years of furnituremaking, I still make a full-size "rough-out" to test any new leg design. A pine 2x4 prototype costs only a few dollars but will give you a good feel for how the drawing translates into three dimensions and help you visualize the proportions of the entire piece. The same curve pattern is used for both the front and back legs. I've flared the front legs sideways and forward; the back ones flare only sideways. For this reason, they are laid out and cut differently, as shown in figure 2 below.

I make each leg from a single piece of cherry, because the glue lines and interrupted grain patterns of a lamination would detract from the appearance. Square the stock for the front and back legs, cut the pieces to length and lay out the patterns. The front legs are interchangeable, but the back ones are not and should be marked "right" and "left" to avoid mistakes when the joints are cut. Carefully bandsaw the legs close to the line; later, after the legs are glued to

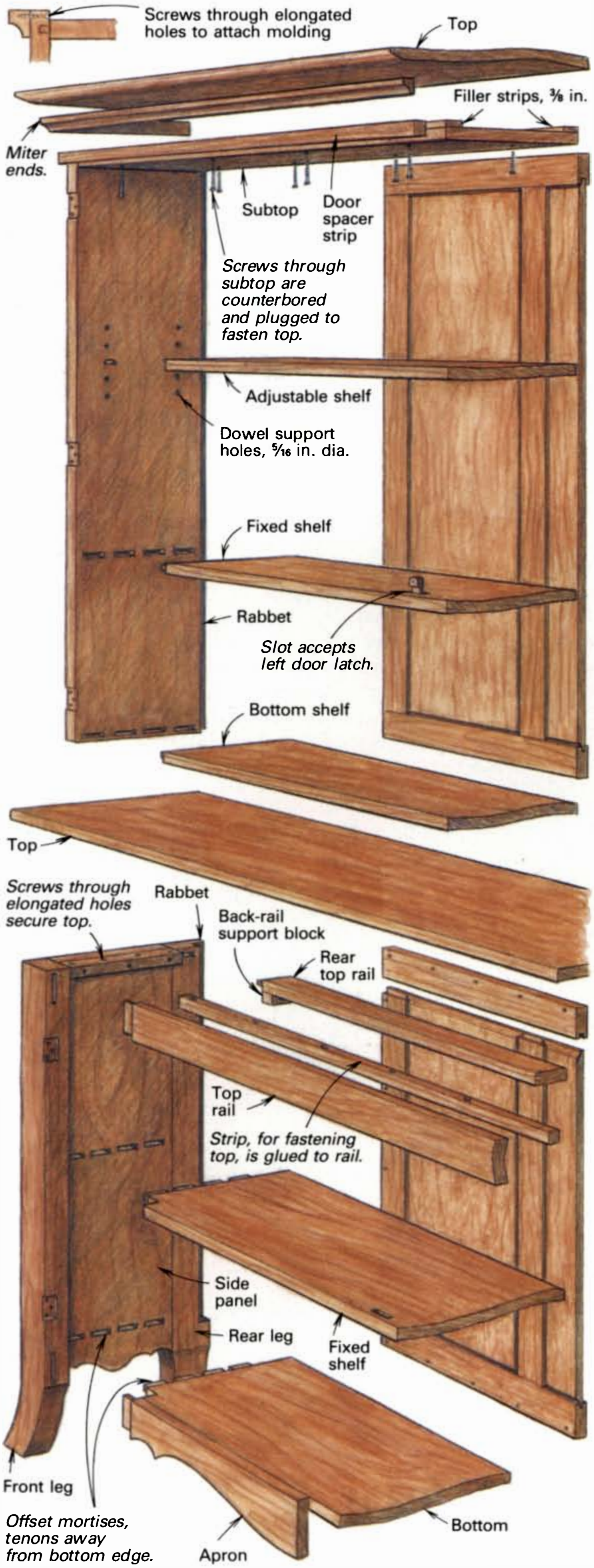
The author's cherry cupboard features flared legs, patterned front and side panel aprons and an unobtrusive top molding, identifying it as 'pure Kentucky.'

Fig. 2: Leg construction



Drawings: Lee Hov; photo: Warren E. Brunner

Fig. 3: Cupboard construction



the side panels, these bandsawn curves can be spokeshaved to blend gracefully into the side panel surface and smoothed with a scraper.

Making the base section–You can make each side panel shown in figure 3, left, from a single, wide board, or you can joint and edge-glue two or more narrow pieces to make the needed width. After jointing the mating edges, I apply Titebond yellow glue and simply clamp the pieces together. The long-grain joints are strong and do not require dowels or other reinforcement. I am quite fussy, however, about selecting wood for grain and color match. I also orient the grain for maximum visual effect. For example, placing denser, more intense grain patterns toward the bottom of the tall, narrow sides of the cupboard imparts a welcome sense of balance. I also like to use arching grain patterns on the horizontal rails, which seems to lighten and lift a piece visually.

After cutting the side panels to width, align each one with its front and back legs, then dry-clamp everything together. If you've been careful in your wood selection, the grain pattern along the edge joints between the legs and the side panel should match closely. Now you can mark the decorative bottom curve using the pattern shown in figure 4 on the facing page. I make sure the shape and grain pattern harmonize with the legs; if they don't, I substitute another piece.

The next step is to cut the mortises for the front and rear top rails and the shelves. I rout the mortises with a ⅜-in. spiral cutter, which makes a smoother cut than a straight bit and chatters less. I offset the mortises and tenons for all the rails away from the sidewalls of the legs to leave more wood to support the tenons and to help prevent side-grain breakout. I finish the job by slightly rounding the ends of the tenons with a hand chisel.

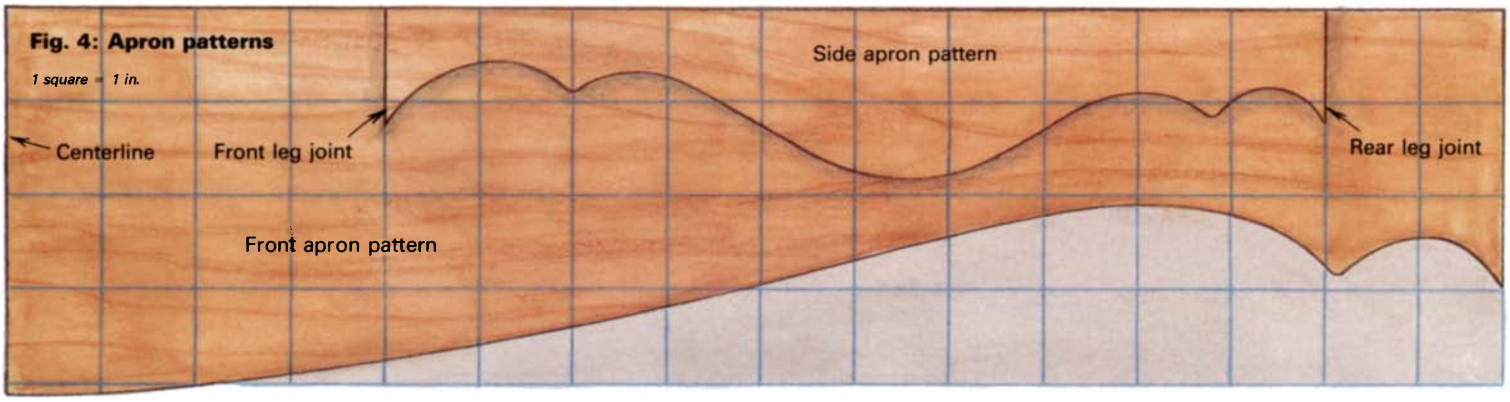
Next, I cut the stopped rabbet in the rear legs for the paneled back with a dado blade on my tablesaw. Once the corners, which are not reached by the blade, are squared up with a chisel, the side panels and legs are ready to be glued up. Use caul blocks to ensure uniform clamping pressure, and edge-glue each side panel to its front and back legs.

The front legs serve as stiles to frame the flush-mounted doors, so here you just need to cut the tenons on the rails and apron, and shape the apron. Bandsaw 1/16 in. or so proud of the apron curve so you can blend the apron into the curve of the front leg. A sharp knife or round-bottom spokeshave works well for this. For additional support, I screw a small block to the leg under the tenoned back rail.

Fitting the middle shelf and bottom to the base is a bit tricky and requires careful measurement. The bottom must be level with and butt against the bottom apron rail. The middle shelf must set back exactly the door thickness plus 1/32 in. for clearance so it can act as the doorstop. Notching around the front legs and marking out the tenons is critical here to ensure that the shelf and bottom fit snugly to all their mating surfaces. Finally, the shelf and bottom must be cut so the back-panel assembly can butt against them at final assembly. Carefully aligning the bottom shelf and gluing it to the apron rail at this point makes it easier to square up the carcase during assembly. Check all joints in a final dry run. Multiple tenons on the shelves should be an "easy fit," but even here, sturdy caul blocks across the sides should be used for clamping in the final glue-up.

The top of the lower cabinet is made with a ⅜-in. overhang on the sides and front. I soften the edges using a router with a stock ¼-in. cove bit. The top is held in place with screws driven up through strips fastened to the inside top edge of each side and front rail. Be sure to use elongated screw holes in the strips to allow for the seasonal expansion and contraction.

Building the top section–Mortise-and-tenon joints are also used for the frames and fixed-shelf top section of the cupboard. The



upper display shelf is adjustable, but the fixed lower shelf provides needed rigidity. The cabinet has a subtop that acts as a doorstop. The top, attached by screws driven up through the subtop, overhangs the sides and front, and with its shaped edge, forms the upper part of the top molding. The lower molding is a cove-shape strip installed under the overhang. The top molding works visually with the flared legs to give the cupboard a well-balanced appearance.

Construct the sides, shelves, bottom and subtop as shown in figure 3 on the facing page. Note that the subtop is set down from the top of the sides by ¼ in. This provides a space between the top and subtop, giving me room to screw through the sides to attach the cove molding. This space also means there is plenty of wood to support the joints, so there's no need to offset the mortises and tenons here. I do, however, offset the tenons on the bottom shelf to minimize the risk of tearout. Dado the rabbet for the back, rout mortises, cut tenons and dry-clamp the pieces together for a final check. Again, use sturdy caul blocks for applying even pressure during glue-up.

After assembly, I add ¼-in. filler strips to the subtop and glue on a spacer strip for attaching the molding above the door, as shown in figure 3. The molding is shaped with a stock ½-in.-radius cove bit. The front cove molding can be glued along its entire length. The end moldings are glued only at their mitered ends; they're screwed at the back ends, as described above. I shape the edge of the top in two steps, using first a ¼-in. cove bit to round the top edge and then a ½-in. roundover bit, which I've custom-shaped on my grinder (see figure 1A on p. 66), to extend the curve back from the edge. This bit allows me to emphasize the overhang and at the same time blend its curve smoothly into the underlying cove molding. The top is attached with countersunk screws run up through the subtop. These screws are hidden with wood plugs.

Doors and back panels–Again, I select my wood very carefully for grain pattern and straightness. I also rough-cut the lumber a few days before I need it, to identify pieces prone to warping. Second-choice pieces become the frames for the paneled back; really warped pieces are discarded. On the back, rather than cut mortises in rails for the stile tenons, I groove the entire rail. The groove accepts the tenoned ends of the four stiles as well as the routed edges of the floating panels. I modified this construction procedure slightly for the bottom doors. Here I grooved the stiles to accept the rail tenons and the panel edges. This makes for a strong door, and the tenon is only visible on the top edge. The door panels are resawn and finished to 9⁄16-in. thickness; the backs are ½ in. thick. I shape the edges of the floating panels using a cove bit with one edge ground flat, as shown in figure 1D on p. 66, which permits the panel edge to fit snugly in the frame's groove. The back assembly is then fitted to the routed opening in the back of the carcase and attached with countersunk brass flat-head screws. For the glass doors, I cut stopped grooves in the ends of the stiles to accept the tenoned ends of the rails. I use a ¼-in. dado blade to cut these and then square them up with a chisel. The rabbet for the glass is routed using a ¼-in. straight bit. Here again, I use a chisel to square the corners. The butting edges of the doors are rabbeted to allow the right door to overlap the left one by ⅛ in. when closed. After fitting the glass, I secure it with molding that's attached to the frame with countersunk nails. Note that the glass doors are designed to fit against the front of the upper section, while the lower, floating panel doors are flush-mounted. This visually ties the top and bottom sections of the cupboard together by allowing the full width of the leg line in the bottom section to extend through the full height of the cabinet. To mount the doors, I use extruded brass 1¼-in. by 1⅞-in. desk hinges (available from The Wise Co., Box 118, 6503 St. Claude, Arabi, La. 70032; 504-277-7551), because of their strength and ease of installation. These hinges also add to the appearance of the cupboard, because when installed flush, the gap between the door and the frame is smaller than is possible with conventional door hinges.

Early Kentucky pieces sometimes had wooden spools for pulls and buckles for catches, because these items could be designed to fit any application and were easily repaired or replaced. I prefer the knobs shown in figure 1C on p. 66. I turn the stems and rough out the knob ends on a lathe. The knobs are finish-shaped by hand-sanding. The stem extends through a hole drilled in the door and is secured to a wooden latch, which holds the stem in place and engages a catch when the knob is turned. The catch for the left door is a groove formed in the fixed shelf; for the right door, the back inside edge of the left door acts as the catch.

Finishing up–Most projects will bring rave reviews only if they are well finished. After all fitting, shaping and detailing is completed, I round all edges with sandpaper to about 1⁄32 in. radius. This gives the cupboard a soft look and pleasant feel. I sand first with 80 grit, then dampen the surfaces with water to locate glue residues and to raise the grain before finish-sanding with 120 grit. Planed surfaces, such as panels, need only be hand-scraped and sanded with 120 grit.

After 20 years of experimenting with different finishes, I've settled on an oil-and-lacquer finish I feel best complements the natural beauty of the cherry and walnut hardwoods I use. I apply several coats of my oil recipe (two part boiled linseed oil, two part high-gloss polyurethane, one part turpentine) until the wood is evenly sealed. After two to three days of drying time, I apply two coats of lacquer sanding sealer, sand with 240 grit and finish with two additional coats of high-gloss lacquer. After buffing the surfaces with 0000 steel wool, I apply a protective layer of Lemon Pledge spray wax. □

Warren May makes traditional Appalachian Mountain dulcimers and Kentucky-style furniture. He and his wife, Frankye, operate The Upstairs Gallery in Berea, Ky.

Reviving Period Hardware

Hints for restoring the gleam in the maker's eye

by Gregory Landrey and Helen Stetina

Brass hardware has been an important decorative and functional design element on American furniture since the early 1700s. Hardware catalogs of the day indicate the metal components were originally bright focal points on the furniture, not the heavily patinated antique brass sometimes envisioned today. Thus, keeping "brasses" bright, despite the effects of time, wear and pollutants, is a major concern among those working with period furniture. The 18th-century cabinetmakers and brass manufacturers used lacquer or other natural resin coatings to protect the brasses—a tradition that still is followed at The Winterthur Museum in Winterthur, Del., but with much improved materials. The Agateen 2-B cellulose-nitrate lacquer described here (available from Agate Lacquer Manufacturing Co. Inc., 11-13 43rd Road, Long Island City, N.Y. 11101), when properly applied, will help protect furniture hardware and enhance its visual qualities for at least 10 years, as long as the metal is not handled excessively.

Brass and its degradation—Most furniture brasses are alloys of copper and zinc, although they may also include lead, iron and other elements in varying mixtures. These variations are responsible for making the brass appear yellowish or reddish and also for the types and degrees of corrosion that arise, as shown in the top, left photo on the facing page.

Airborne contamination produces the familiar black tarnish on brass. "Stress corrosion cracking" (season cracking) can result when brass, stressed from being stamped out, is exposed to a mixture of water, air and ammonia (a major ingredient in most household brass polishes and perhaps hardware's greatest enemy). A green corrosion product, possibly a copper/salt mixture, is formed in this instance. Frequent polishing causes further degradation and the eventual loss of surface detail through wear. Also, in time, body salts and acids from skin appear on the hardware as etched fingerprints. Acetic acid, which is released by wood over a long period of time, is also a source of hardware deterioration.

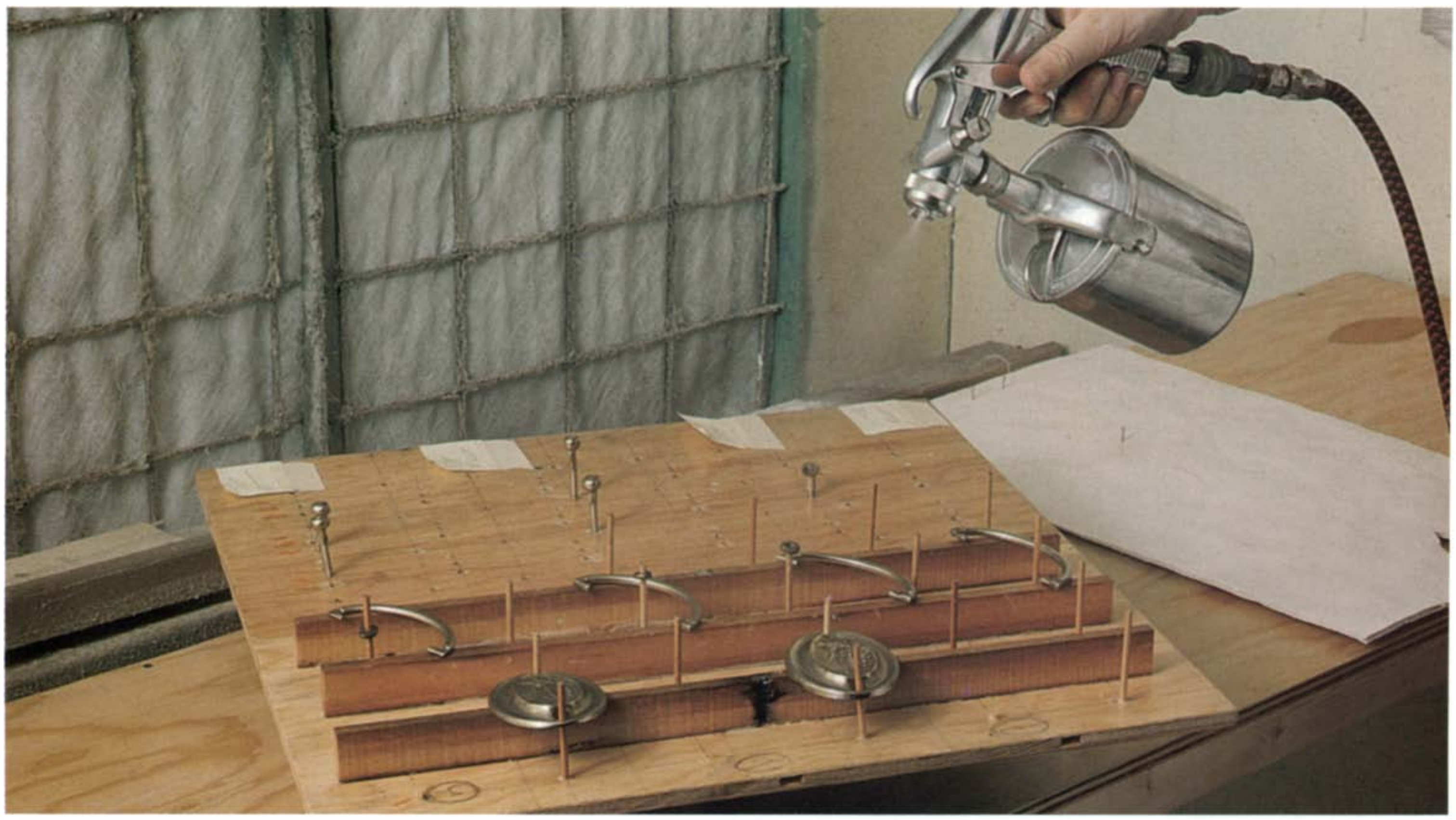
The look of 18th-century hardware—It is rare to find an early hardware coating intact. Lacquer deteriorates as it ages and was often abraded away by polishing. The brasses were occasionally recoated, but we still have a good idea of how the originals looked. One 18th-century English catalog referred to brass hardware as "a fine burnish'd gold colour" or "burnish'd and lacquer'd." In addition to preventing tarnishing, these high-luster coatings imparted a gold-like color to the metal. In fact, the 1804 edition of *The Royal Standard English Dictionary* (published by E. Merriam & Co., Brookfield, Mass.) defines "lacker" as "yellow varnish used in brass-work." Some traditional lacquer mixtures, of such things as spirits of wine, turmeric (*Curcuma longa*) or dragon's blood (*Daemonorops draco*), were described as making brass resemble "pale French brandy," as shown in the top, right photo on the facing page.

Removing old residues—Assuming that any existing coating on the brasses is not antique, it must be removed. Soaking and scrubbing the hardware with lacquer thinner (we use Agateen Thinner #1), followed by acetone rinses ensures complete removal in most cases and degreases the metal. More tenacious, waxy deposits can be treated by swabbing them with mineral spirits or petroleum benzine (available from chemical-supply houses). Very often, incrustations of old varnishes, shellacs and polishes will accumulate on the reverse sides of escutcheons and back plates, around the bases of posts and along the ends of bails. We remove these incrustations with a fine stream of glass beads from an air-abrasion unit, which acts as a miniature sandblaster. The glass beads leave a satiny, matte finish, so this process is not recommended for the highly polished, visible surfaces of hardware. Rinsing the metal with reagent alcohol (90% ethanol, 5% methanol, 5% isopropanol) removes any abrasive residue; denatured alcohol is not recommended, because it contains too much water.

Cleaning brass—The metal should be as clean as possible before recoating, to prevent further corrosion and to provide a good bonding surface for the lacquer. Heavily tarnished brasses should first be dipped in a thiourea and acid solution (available from Fisher Scientific Co., 50 Valley Stream Parkway, Great Valley Corporate Center, Malvern, Penn. 19355). At the museum, we use a mixture of 8% (by weight) thiourea crystals, 5% (by weight) sulfuric acid and 87% (by weight) distilled water that contains 0.5% (by volume) Photo-Flo 200 wetting agent (available in photo-supply stores). Commercial preparations used for removing tarnish from silver can be used if they contain the key ingredients—thiourea (also available from Fisher Scientific) and acid (sulfuric or hydrochloric). A thorough rinsing first with water and then pure acetone should follow the dipping. Take care when handling acids and other materials like thiourea, which is a suspected carcinogen and "slightly toxic" to the skin or when ingested or inhaled. Wear latex or polyethylene gloves; if thiourea crystals are used, wear a particle mask. If the brasses still have a green, copper corrosion in crevices and in the decorative relief, swab the areas repeatedly with 10% (by weight) formic acid solution (concentrated preparations are available through chemical-supply houses), followed by thorough rinsing in warm water and drying with acetone.

Polishing—To ensure that the brasses remain "chemically" clean, polish them with pure abrasive containing no ammonia, tarnish

Brasses on 18th-century furniture were bright and jewel-like, far from the heavily patinated pieces often associated with old work. That dull work, shown above left, is due more to age, wear and pollutants than to the maker's intent. However, cleaning and lacquering techniques can bring old metal back to its original state, as shown above right.



Brass hardware is sprayed on a platform equipped with various pegs and holes to accommodate the small, hard-to-handle pieces.

inhibitor or other chemicals. We apply a slurry of Buehler's (Union Carbide) 0.3u and 1.0u microaluminas (available from Buehler Ltd., 41 Waukegan Road, Lake Bluff, Ill. 60044) and reagent alcohol with soft, clean, additive-free, cotton flannel cloths or cotton diapers. Various sharpened sticks and dowels, dental picks, toothbrushes and strong, cotton thread can be used to scrape away more tenacious residues. After the alcohol in the slurry evaporates, the abrasive dust is blown away with compressed air. The brasses are then buffed to a high polish with either a soft flannel cloth or a chamois-like, 100%-cotton cloth called "Selvyt" (available through Allcraft Tool & Supply Co., 60 S. MacQuesten Parkway, Mount Vernon, N.Y. 10550). If the hardware can't be coated immediately, it's stored temporarily in polyethylene sandwich bags; avoid potentially corrosive cling-type plastic wraps that may contain polyvinylidene chlorides.

Applying lacquer—Agateen's 2-B cellulose nitrate lacquer is clear and durable, bonds well to the metal surface, dries within seconds and flows smoothly to minimize drips and runs. Its slight yellow tint makes the brass more mellow looking. We apply two coats of a 50/50 mixture of 2-B lacquer and #1 thinner with a spray gun at approximately 40 to 50 psi in a prefabricated industrial-size spray booth. The lacquer can be easily removed with the #1 thinner by soaking or swabbing. Don Heller, Winterthur's objects conservator, who researched and instituted this metal-coatings program, has designed special boards with various pegs and holes to accommodate small, difficult-to-handle pieces, as shown in the larger photo above. □

Gregory Landrey is furniture conservator and Helen Stetina is a former metal-coatings technician at the Henry Francis du Pont Winterthur Museum in Winterthur, Del.

Photos: Courtesy of The Winterthur Museum

Turning Boxes

A perfect fit for lids and inlays

by Kip Christensen

A challenge for even experienced turners, an inlaid box requires patience in preparing and drying the stock, precision in fitting the lid and inlays and artistry in shaping the form. The largest of these, only 3½ in. in diameter, is Macassar ebony with Indian ebony and spalted maple inlays; the smallest has inlays of tagua nut and spalted maple; the third is rosewood topped with holly and tulip.

The feel of a properly fitted lid on a turned box provides a fascination that some people find almost addictive. When the lid is lifted with a gentle twist, there's a touch of vacuum resistance, and as the lid is removed, the box catches a small breath of air. When the lid is replaced, the box vents a soft sigh of relief.

I was introduced to turned boxes seven or eight years ago. After trying to make one, I realized there was more to it than meets the eye: Both technical and aesthetic challenges must be met for a box to be successful. I've made boxes with shapes that looked nice but were unacceptable because the lid was not comfortable to grasp or easy to remove. A perfect grain match where the lid meets the base is another element of a quality box.

And then there's the fit between the lid and the base. There's a very fine distinction between a fit that is too tight, too loose or just right. The nature of wood complicates the matter of obtaining, and in particular, maintaining a perfect fit. Even the slightest expansion or contraction in the wood can be detected in the fit, resulting in a loose-tight-loose-tight feel as the lid is rotated. A box that is flawless in every other aspect but lacks that just-so fit is always somewhat of a disappointment. Wood movement, due to seasonal changes in the atmosphere, cannot be completely eliminated, but it can be significantly reduced by rough-turning the box to its basic shape and then patiently controlling the drying of the wood. After having made a few hundred turned boxes, I still find the process challenging and fun, and the end result rewarding.

The addition of an inlay to the top of a turned box can highlight a unique piece of wood or other material. I have experimented with inlays of metal, plastic, scrimshawed bone, tagua nut, stone and wood. The inlay, which is actually an insert, is a circular wafer about 3⁄16 in. thick fitted and glued into a recess in the top of the box. Figure 1 on the facing page shows a cross section of a box with two concentric inlays. However, the addition of an inlay is not always an improvement; it may even detract if the box is made from an exceptional piece of wood.

Making a turned, inlaid box can be broken down into three separate processes: preparing the box blank, preparing the inlay and finally, turning the box. The procedure may seem long and cumbersome, but in reality, each step (with the exception of drying the blank) can be accomplished rather quickly. Once you're comfortable with the process, the challenge comes in improving the efficiency of your cuts and reducing production time while still maintaining the fine distinctions that result in a quality box.

Preparing the box blank—Hardwoods with tight, close grain are most appropriate for turned boxes, because they turn more cleanly and generally present fewer wood-movement problems than ring-porous woods. The direction of the grain should run parallel to the lathe bed to make any wood movement less critical to the fit of the lid. Box blanks can be made from quartered log sections or from precut turning squares. If beginning with a log, I saw a bolt 12 in. to 15 in. long, quarter it with a chainsaw and remove the bark and sapwood. Sapwood is attractive in some species, but I generally remove it completely, because it's typically less stable than heartwood and therefore more susceptible to movement that may undermine the fit of the lid. When a 3-in.- to 4-in.-thick piece of wood is hollowed out, stresses are relieved and movement occurs, even with dry wood. So, whether beginning with green or dry wood, I rough-turn the box blanks inside and out, then set them aside to stabilize.

Photo this page: Michele Russell Slavinsky; drawing: Bob La Pointe

Begin by mounting a 3-in. to 4-in. turning square between centers, and with a large gouge, turn a cylinder of equal diameter its full length, then turn its ends clean and square with its sides. A cylinder 12 in. to 15 in. long will yield four to six box blanks. I lay out for the lids and bases by cutting ¼-in.-deep kerfs with a special narrow parting tool. I made the tool, shown in figure 2 at right, by grinding a ¼-in. by ¼-in. steel bar so it will cut a kerf less than 1/16 in. wide. Removing a minimum of wood here preserves the best possible grain match between the box and the lid. Mark the cylinder across the kerf lines with a magic marker to indicate pairs of lids and bases. Remove the cylinder from the lathe, and using the narrow kerfs to guide the bandsaw blade, saw it into lid and base blanks (see the photo this page).

To remove the bulk of the wood from the interior of the blanks, mount the bottom of the base blank on a waste block and faceplate or in a three-jaw chuck. If you're turning green wood, leave some extra thickness at the blank's base and screw a faceplate to the bottom, because the green wood will not glue well to a waste block. Hollow out the center, keeping in mind the desired shape of the box and leaving the wall approximately ½ in. thick. Hollow out the inside of the lid in the same manner. Now, take the parts into the house and lay them on their sides to allow air access to all surfaces. Allow three to six weeks if you begin with dry wood and 16 to 20 weeks for green wood. During the first three weeks, watch the blanks closely for initial surface checking. I've found that if I place the blanks in a double paper sack, it reduces checking by slowing down and evening out the drying process of the hollow blanks. When the moisture in the blanks has reached equilibrium with the new environment, they are ready to be finish-turned. You can measure this to some extent by weighing the pieces periodically. When they stop losing weight, they are at equilibrium.

Preparing the inlays—The recess in the lid must be sized to accept the inlay, so the inlay must be turned before you work on the box. First, bandsaw the inlay stock, which you've selected for exceptional color or figure, into 3/16-in.- to ¼-in.-thick wafers. The round or square wafers should be large enough so that when they're turned true, they'll yield the desired diameters. To mount an inlay wafer on the lathe, remove any accessories from the spindle and place double-faced tape on the end of the arbor shaft. Sand the bottom side of the inlay flat on a belt or disc sander, and center the sanded side of the wafer against the tape. Slide the tailstock up to the wafer and adjust the tailstock center so it exerts light pressure against the center of the wafer. Turn the inlay round, taking care to leave a 90° angle between the edge and the sanded bottom. Remove the inlay from the lathe and set it aside.

Turning the box—To mount the base during the turning process, I prefer a center-screw faceplate and waste block. I use a three-jaw chuck to hold the lid for turning, but you could also use another faceplate and waste block.

First, mount a 2-in.-thick waste block on the faceplate and turn it round and its face flat. Make the waste block's diameter about ⅛ in. larger than the diameter of the base blank you'll be turning. This makes it easy to center the blank by eye when gluing it to the waste block. The 2-in. thickness of the block holds the box far enough away from the faceplate to allow access for shaping the bottom. Sand the bottom of the box blank flat and glue it to the waste block. With a ⅜-in. spindle gouge, turn the blank just enough to bring it into round inside and out. To turn the lip that will receive the lid, I use a modified parting tool, as shown in the top photo on the next page, but a skew or normal parting tool will also work. I've designed this tool (see figure 2 this page) to cut

Fig. 1: Anatomy of a turned, inlaid box

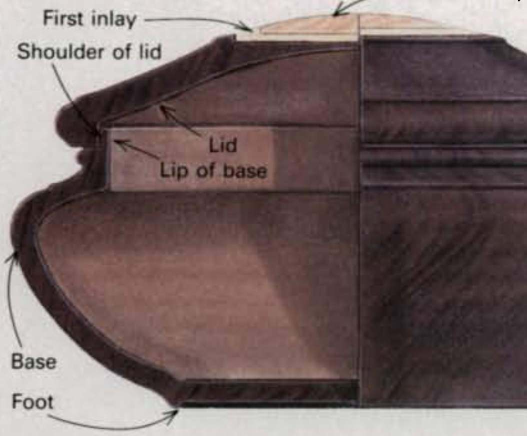
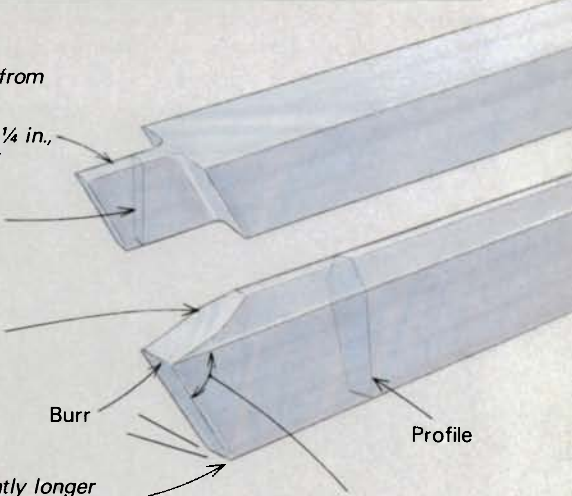


Fig. 2: Tools

Both tools are made from high-speed steel.



Christensen bandsaws the rough-turned cylinder into base and lid blanks. Thin kerfs, made with his narrow parting tool, are used to lay out the sections and guide the bandsaw blade. Marks across the kerfs identify lid and base sets and register the grain match.

With a modified parting tool, the author turns a lip on the base to receive the lid. The base is glued to the waste block, which is mounted on a center-screw faceplate. The 2-in.-thick block holds the work away from the faceplate to allow access for tools to shape the bottom of the box.

A shallow recess for a second inlay is cut into the first with a modified parting tool. The interiors of both the base and lid are turned to completion, and the lid is pressed onto the base to mount the inlays and shape the exterior of the box.

with a true scraping angle, which gives a much cleaner cut than the blunt angle on standard parting tools. (This tool is now available from Craft Supplies USA, 1287 E. 1120 S., Provo, Utah 84601.) Make the lip's sides parallel to the lathe bed or slightly undercut and about ⅛ in. to 3⁄16 in. long. The shorter the lip, the better the grain match between the lid and base. Now I use a gouge to shape the outside, then make the finish cuts on the inside with freshly sharpened scrapers, leaving the walls about 3⁄16 in. to ¼ in. thick. Don't sand the base until after the lid is turned to fit it, because heat from sanding can cause the base's shape to temporarily distort.

Remove the box and faceplate from the lathe and attach the three-jaw chuck. Mount the lid blank in the chuck, with the inside surface exposed, so you can fit the lid to the lip on the base. If you don't have a three-jaw chuck, mount the faceplate and waste block that's attached to the lid on the lathe. True the inside face of the lid and make a couple of concentric pencil lines on the lid's face, approximately the diameter of the base's lip. Hold the base up to the lid and use the concentric lines to visually determine where to cut the recess to mate with the lip on the base. Turn the recess to a depth matching or slightly exceeding the length of the lip on the base, with a diameter about 1⁄16 in. smaller than the lip. To fine-tune this fit, turn a small chamfer on the shoulder you just created on the lid. Try the base to the lid. When the base's lip fits inside the chamfer, you know you're close, and you can see just how much more needs to be removed for a perfect fit. Every small cut on one side of the circle is simultaneously coming off the other side, so proceed cautiously. When you make the final sizing cuts on the sides of the recess, they must be parallel to the lathe bed, not tapered in or out. The fit should be snug but not forced. Now finish shaping the inside of the lid, but remember, you'll be inserting an inlay in its top, so don't dish it out too much. The final cut should be as clean as possible to avoid excess sanding, so make sure your tools are sharp, and take a light cut. To avoid heating up and distorting the lid, use light pressure while sanding; if you feel the sandpaper warming up, take a break and let the work cool down.

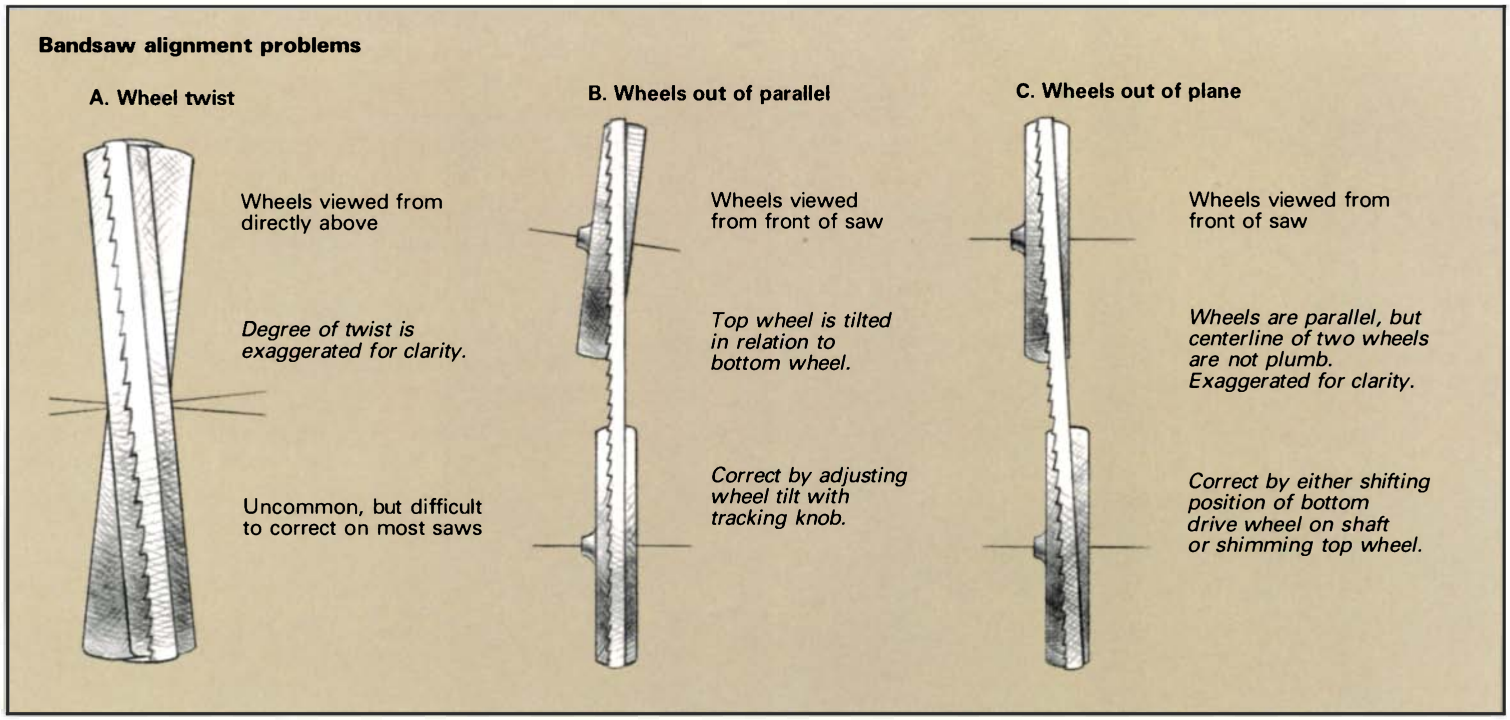
Finishing—The finish can now be applied to the inside of the lid. If a finish with a strong odor is used on the inside, the odor will likely become a permanent characteristic of the box. To avoid this, I use a light coat of mineral oil topped with a coat of odorless paste wax. Then, I remove the lid from the chuck and the chuck from the lathe. If you are using a faceplate, just part the lid off the waste block. Remount the faceplate and the base on the lathe, and press the lid onto the lip of the base with the grain lined up.

The recess for the inlay is cut at this time, before the final shaping of the lid. True the top of the lid with a gouge or a scraper, then working from the center out with a parting tool, cut a recess about ⅛ in. deep and the diameter of the inlay. Here again, I prefer my modified parting tool, and I use the concentric lines and the chamfer on the shoulder of the recess as I did when fitting the lid to the base. The bottom of the recess should be flat, and the sides should be parallel with the lathe bed. If glue is applied to the full bottom surface of the inlay, it may pull the lid out of shape as it dries. So, apply yellow glue only to the inlay's edge and the outer edge of its bottom, and tap it into the recess with a mallet. If a double inlay is desired, simply cut a slightly shallower recess into the first inlay, as shown in the bottom photo this page, and insert an inlay wafer with a smaller diameter. The inlays should fit so tightly that you don't need to wait for the glue to dry before cutting the recess for the second inlay.

With inlays in place, turn the total exterior shape of the box so the form flows continuously from top to bottom. When the shaping is completed, take the lid off and sand and apply finish to the inside of the base. Then, replace the lid and sand and finish the outside of the entire box. Because I turn tiny beads and sharply defined lines, I take special care to preserve them while sanding. I cut the sandpaper into ¼-in. strips so I can sand right up to the smallest beads without rounding them over. I sand the inside of my boxes to 400 or 600 grit and the outsides to 600 grit or 1,000 grit. On the exterior of most of my boxes, I use Super Rapid Pad by Mohawk Finishing Products, Inc., Route 30N, Amsterdam, N.Y. 12010. This is an extremely fast-drying finish that provides a good gloss without excessive buildup.

The box is completed now except for the bottom. Separate the base from the waste block with a parting tool. To hold the base on the lathe while turning the bottom, cut a shoulder on the waste block to fit the inside diameter of the base lip. If the fit isn't tight enough, use masking tape to build up the diameter of the shoulder for a pressure fit. Then shape, sand and apply finish to the bottom. I usually turn a small foot to add a touch of detail to the bottom (see figure 1 on the previous page). Take the base off the lathe, gently press the lid onto the base, and admire your latest creation. A well-made box will feel nice in the hand and provide an attractive haven for anything from paper clips to diamond rings. □

Kip Christensen is a woodturner and assistant professor of industrial education at Brigham Young University in Provo, Utah.



Adjusting Bandsaw Wheels

Small alignment changes improve performance

by Mark Duginske

The bandsaw can be one of the most useful tools in the shop: It can resaw thick stock or slice off thin veneer and cut curves, circles, tenons, dovetails and more. But don't expect it to do all these jobs well straight from the factory. For top performance, you must fine-tune the saw, paying special attention to wheel alignment. This takes no special tools, gadgets or miracle blades, just a little time and attention, and a shim or two.

In the course of my travels in the past 10 years, teaching classes and giving seminars on woodworking tools and techniques, I've adjusted at least 100 different bandsaws. Most of these were poorly tuned, and many were miserably out of adjustment. Unfortunately, when a bandsaw doesn't work correctly, people tend to blame the machine, the blade or themselves rather than alignment or any other adjustment. Some workers seem almost afraid to mess with the machine, but the method I'll describe here is simple and virtually foolproof, if you follow the steps properly. But before getting into the "how to," I'll explain a bit about the dynamics of a bandsaw and why misalignment can be such a complex problem.

Good alignment–For any blade to cut accurately, the wheels of the bandsaw must drive it smoothly and continuously. Proper wheel alignment is essential for this to happen, just as correct wheel alignment is necessary for a car to travel in a straight line without excessive vibration. For top performance, the wheels must line up with each other in three ways, as shown in the drawing above. The wheels must align in the vertical axis, be in the same plane and be parallel to each other. When the wheels are aligned all three ways, I refer to them as being "coplanar." With poor wheel alignment, the blade can hop around on the wheel, yielding an erratic cut. These undesireable movements will shorten the life of the blade and the thrust bearing, as well as wear the guides unevenly.

Because bandsaw wheels have no rims, the only thing that holds the blade on the tire covering the wheel is proper tracking. To adjust the tracking, you must alter the angle of the bandsaw's nondriven wheel while the blade is running. On most saws, this adjustment is made by screwing a knob in or out. This tilts the arbor supporting the top wheel, which in turn causes the blade to run or track on a different section of the tire. The goal is to keep the blade riding evenly on the wheel: A properly tracked blade will run without rubbing hard against the thrust bearing or coming off the wheel.

Blade tracking is also enhanced by the crowned wheels found on most small American and Taiwanese bandsaws, like the Delta, Sears and Grizzly. The wheels' convex profiles tend to automatically center the blade in the middle of the wheels, just as the crowned front roller on a belt sander tends to center the belt. This natural centering occurs because the blade wants to equalize the tension

Drawing: Bob La Pointe

With the table tilted out of the way, the author uses a strip of plywood with a straightedge jointed on it to check the wheels of a Delta 15-in. bandsaw for plane and parallel alignment.

on its inner and outer edges. Crowned wheels also buffer many wheel-alignment problems and even compensate for irregularities in the blade's thickness and width.

Variables of poor tracking–Despite the crowned wheels and tracking adjustment, there are several variables that constantly work against good tracking and often make even a high-quality bandsaw perform poorly. First, bandsaw blades are rarely perfect: Each blade has its own performance characteristics or "personality." If the weld joining the ends of the blade is uneven, the front and back edges of the blade won't be the same length, and the blade may track poorly and tend to hop around on the wheels. Blade straightness is also affected by the manufacturing process: When the front of the blade is heat-treated to harden the teeth, it often contracts, making the back of the blade longer than the front.

Other variables include wheels that are out of round, causing the blade to loosen and tighten on every revolution, or tires that are worn unevenly. Even the self-centering quality of crowned wheels can be a disadvantage with misaligned wheels: The two crowns compete for control of the blade, rocking the blade back and forth, producing a crooked cut. This is similar to what happens when you drive down a rutted dirt road: The car will jerk from side to side as the wheels slip into one rut, then the other.

Tension and tracking–Even though we can't always change the variables described above, we can cure the biggest cause of tracking problems: misalignment of the bandsaw wheels. If poor alignment isn't remedied, an excessive amount of wheel tilt, via the tracking adjustment, may be needed to keep the blade tracking properly. In extreme cases, it's nearly impossible to keep the blade on the wheel or to keep it from riding so hard against the thrust bearing that it prematurely wears the bearing and the blade.

If wheel alignment is so critical, why don't manufacturers take care of it? In fact, the wheels ***are*** aligned at the factory, but before a blade is installed. This presents yet another variable: blade tension. Wheels that are coplanar under no tension can be forced out of alignment when the blade is mounted and brought up to proper running tension. Also, a saw that is coplanar at normal tension can become misaligned under excessive tension. When a wide blade that runs at a higher tension than a narrow one is installed, the misalignment may become even greater. That is why a saw that runs fairly well with narrow blades can perform poorly with wide blades. For this reason, bandsaw wheels should be aligned while a wide blade is fully tensioned on the saw. This will ensure that the wheels are coplanar when the relationship is the most critical.

Some authors claim that many bandsaw problems can be cured by drastically increasing blade tension beyond the manufacturer's specifications (see *FWW* #63, pp. 62-69). This is something I am strongly against, because I think it reduces the quality of cut and can eventually damage the saw. Bandsaws, as well as bandsaw blades, are designed to work at specific tension settings; higher blade tensions unduly stress the saw and make the blade much more susceptible to harmonic flutter, a rhythmic vibration that results in poor cuts. In contrast, blades will run truer and last longer on a bandsaw with coplanar wheels, because there is no binding or twisting of the blade. You will notice more accuracy and power, with less vibration and less blade wander.

Checking wheel alignment–This simple procedure only takes about half an hour. As already mentioned, the alignment should be checked with a blade in place. Tension the widest blade you use on your saw according to the gauge on the saw. In my opinion, a ½-in. blade is the largest practical size for a consumer bandsaw. If your saw is old, or if you do not habitually release the tension after using the saw, the spring may be compressed and not give you a true tension reading. You can check this by raising the upper guide assembly for a 6-in. cut and pushing sideways on a ½-in. blade: The blade should only deflect about ¼ in. If it's a lot more, you should increase the tension until the deflection is right. If you're using a wide blade, you may need to increase the tension slightly past the highest mark, but not to the point where you're at the end of the adjustment screw. When the spring is compressed completely (you can see if it's squashed all the way down), it loses its ability to function as a shock absorber, which is its secondary purpose.

Use a straightedge, a board or a piece of plywood with a true edge on it to check if the wheels are parallel and in plane with each other. Hold the straightedge vertically and lay it across the middle of the wheels, as shown in the photo on this page, but avoid the hubs if they protrude. If the straightedge touches on the top and bottom rims of both wheels, the wheels are parallel and in the same plane. If this is the case, rest easy: The wheels are aligned and you're ready to check for twist, as described at the top of the next page.

If the wheels are out of alignment, the straightedge will touch at two or three points. In most cases, only the top wheel or only the bottom wheel will touch the straightedge. In either case, one of the wheels will have to be moved to make both wheels coplanar.

It is important to know exactly how far to shift the wheels. This eliminates a lot of trial and error in adding and subtracting washers from behind the wheel. The measurement is made at two points: at the top and bottom edge of the wheel not touching the straightedge. The distances between the straightedge and the two points should be exactly the same; if they're not, tilt the top wheel with the tracking adjuster until they are. This will make the top wheel parallel to the bottom wheel. The distance from the straightedge to the wheel is the amount the wheel must be shifted to be in the same plane.

Finally, you need to check the wheels for twist by laying the straightedge diagonally across the wheels, as shown in the lower photo at right. Check both diagonals. You may have to tilt or remove the saw table to accomplish this. The straightedge should contact each wheel on both rims; if it doesn't, the wheels are twisted. Don't worry if your saw doesn't have an adjustment for wheel twist; it is very uncommon and doesn't affect the saw's performance nearly as much as the other misalignments. Some old bandsaws and European saws have top wheels that tilt from side to side, allowing the blade to find its alignment in this vertical plane (twist).

All the above procedures can be done on a three-wheel bandsaw as well: Just check the relationship of the drive wheel to one nondriven wheel, then the other. Finally, check the two nondriven wheels to each other. One or two wheels may need to be shifted to get them into plane with each other.

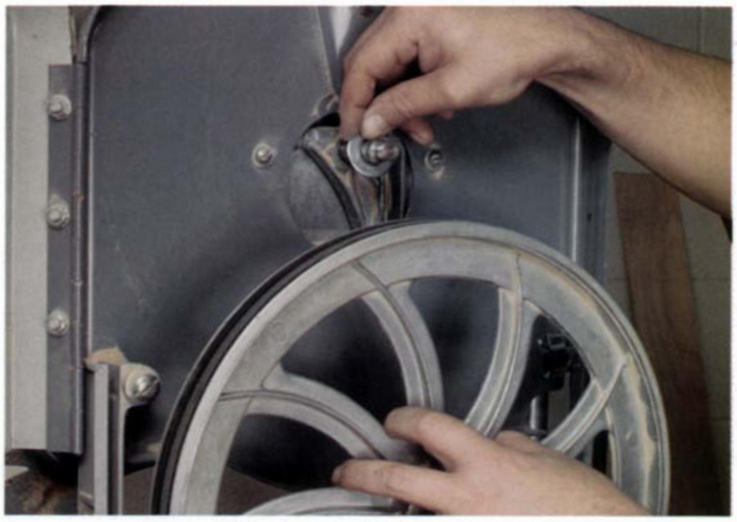
Shifting the wheels–Each bandsaw will require a slightly different method for shifting the wheels to get them coplanar. Some manufacturers, such as Sears and Inca, allow for an adjustment with a movable bottom wheel. This is the easiest kind of saw to adjust. The bottom wheel is mounted on a shaft with a keyway and locked in place with a setscrew. To adjust the wheel, loosen the screw and slide the wheel the desired amount, then tighten the screw.

Delta and some Taiwanese saws must be adjusted by shifting the top wheel, which is mounted on a threaded shaft and held secure with a nut. Unscrew the large nut and remove the wheel, as shown in the top photo at right. The wheel is shifted by either adding or subtracting the shims or washers on the axle behind the wheel. Some saws won't have any shims to remove, but it's almost always necessary to add shims, so this isn't a problem. The Delta bandsaw has a ⅝-in. axle that standard hardware-store washers will fit. If a smaller adjustment is necessary, you can make shims from sections of an aluminum can. Replace the wheel and tighten the nut snugly.

After you make adjustments, rotate the wheels several times to make sure the blade is tracking properly. On machines with crowned wheels, the blade will often find a new equilibrium that's not in the middle, so don't worry. Recheck the plane and parallel alignment one more time. It is a good idea to mark the original wheel positions relative to the straightedge so the reading won't be thrown off by an uneven section of the wheel's rim. Use a pencil or magic marker to mark the wheels.

Don't be afraid to realign your saw often–think of it as part of your regular maintenance. If you plan on doing much work with one blade, it's not a bad idea to align the saw for that blade. It is important to continually monitor the performance of your saw. New blades often stretch, and any blade will expand as it gets warm from sawing, and this may affect blade tracking. Remember, wheel alignment is the best adjustment. You can still use the top-wheel angle to fine-tune the running blade, but don't depend on it too much. After you align your saw a couple of times, it will become very quick and easy to do. The minute it takes to align the wheels is a small price to pay for good performance.

Final tricks–There are two more things you can do to make your bandsaw a pleasure to use. With the blade running, gently round the blade's back corners. This simple modification makes an enormous difference. I use a diamond hone, but you can use a fine sharpening stone or even 100-grit sandpaper on a block. A blade with rounded corners catches less at the back of the cut, especially in tight turns, and tends not to dig into the thrust bearing during curved cuts, preventing excess heat and wear. The second trick is to exchange your saw's stock guide blocks for a new type of block made from graphite-impregnated phenolic. The replacements, called "Cool Blocks," can be set tight to the blade, for more cutting control and accuracy, without heating up the blade or wearing down excessively fast. They're made to fit most popular bandsaws and are available from Garrett Wade Co., Inc., 161 Ave. of the Americas, New York, N.Y. 10013; (800) 221-2942 or (212) 807-1155 in New York. Custom block sets can also be ordered to fit practically any saw. □



Slipping a regular ⅝-in. hardware-store washer on the axle of the Delta bandsaw's top wheel shifts its position sideways to put it in plane with the lower wheel.

Laying a straightedge diagonally across the bandsaw's wheels allows the author to check the wheels for twist. This often requires the bandsaw table to be tilted out of the way.

Mark Duginske is a woodworker and author. He also teaches woodworking at his shop in Wausau, Wis. He has written a book on the bandsaw that's due to be out in the fall of this year (Sterling Publishing Co., Inc., 2 Park Ave., New York, N.Y. 10016).

Above left: Laurel Bernini gets ready to demonstrate the zigzag marble roll she built as a sixth grader in one of the author's classes. Above right: Topher Wilkins uses a gouge to make a marble channel in a piece of pine. When this section of track suits him, he'll glue it in place on the plywood backboard. Masking tape provides the clamping power for odd-shape pieces used for tracks or guardrails.

Making Marble Rolls

A crooked path to fun and physics

by Richard Starr

Ideas in my middle-school shop drift about like dandelion seeds looking for fertile soil. The seeds may stay aloft for years, but when they finally settle and take root, the blossoms abound. So it has been with marble rolls. Even in this age of radio-controlled cars, computer games and VCRs, kids still delight in making these simple structures, which use gravity to propel marbles in ingenious and amusing ways. In the process, they learn the value of patience and care, which results in pride of accomplishment as well as the ability to deal constructively with the frustration of things going wrong.

Building a marble roll is an enjoyable trial-and-error exercise in engineering and physics, a painless way to learn about motion, friction, gravity and momentum. The photos and drawings accompanying this article illustrate the basic constructions and some of the devices—I call them "events"—we've experimented with in class. If you build a marble roll, you should experiment with dimensions, making adjustments as you go along. Shapes and sizes aren't critical. The point of this project is not to follow a plan, but to boldly roll where none has rolled before.

Zigzags—The easiest-to-build marble roll is the traditional zigzag, like the one shown above, left. Sloping U-channel tracks made from thin strips of pine are glued and nailed at each end to L-shape uprights. A ¾-in.-dia. exit hole is drilled near the bottom end of each track section and sawed through to the end so the marble can drop through to the track below. The uprights support the tracks and redirect the rolling marbles onto the top end of the lower track segment. At the bottom of the zigzag, marbles are collected in a scrapwood corral. For additional support, the uprights are fastened to a flat base. To decide how many tracks, how high and how wide the roll will be, a child can sketch the project full-size and take measurements from the drawing. The actual construction is simple, requiring only hand tools, white glue and small brads.

A nifty variation is the double-track marble race shown in figure 2 on the facing page. Make your upright posts exactly as wide as two tracks side by side. Lay out the first set of tracks and then place the second set of tracks alongside the first, but tilted in the opposite direction so the tracks cross in the middle.

Automatic starter—You can add to the excitement and validity of the race with a simple mechanism for starting two marbles at the same time. This automatic starter is made from three ¾-in.-thick pine boards that fit between the uprights. Drill them as shown in figure 1 on the facing page so the holes in the top piece are the same distance apart but offset from those in the bottom and middle pieces. The top and bottom pieces fit between the uprights, with the middle piece, which is ¾ in. shorter, trapped between them. When the middle piece is slid side to side, its holes line up either with the top holes, letting a marble drop into and be trapped in the center section; or with the bottom holes, letting a trapped marble drop onto the track. Carve sloping channels on the top board, directed toward each hole, so several marbles can be lined up and fed to the tracks. It's amazing to see dozens of colored glittering balls clunk and zoom down the tracks on their way to the finish line.

Fig. 1: Automatic starter

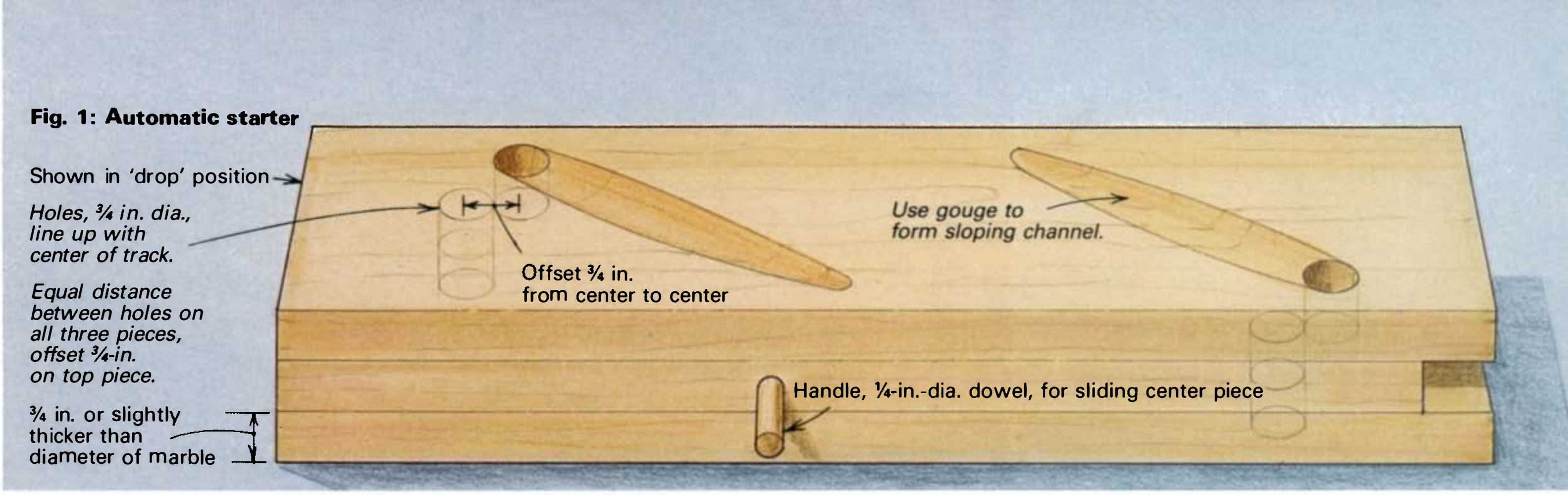


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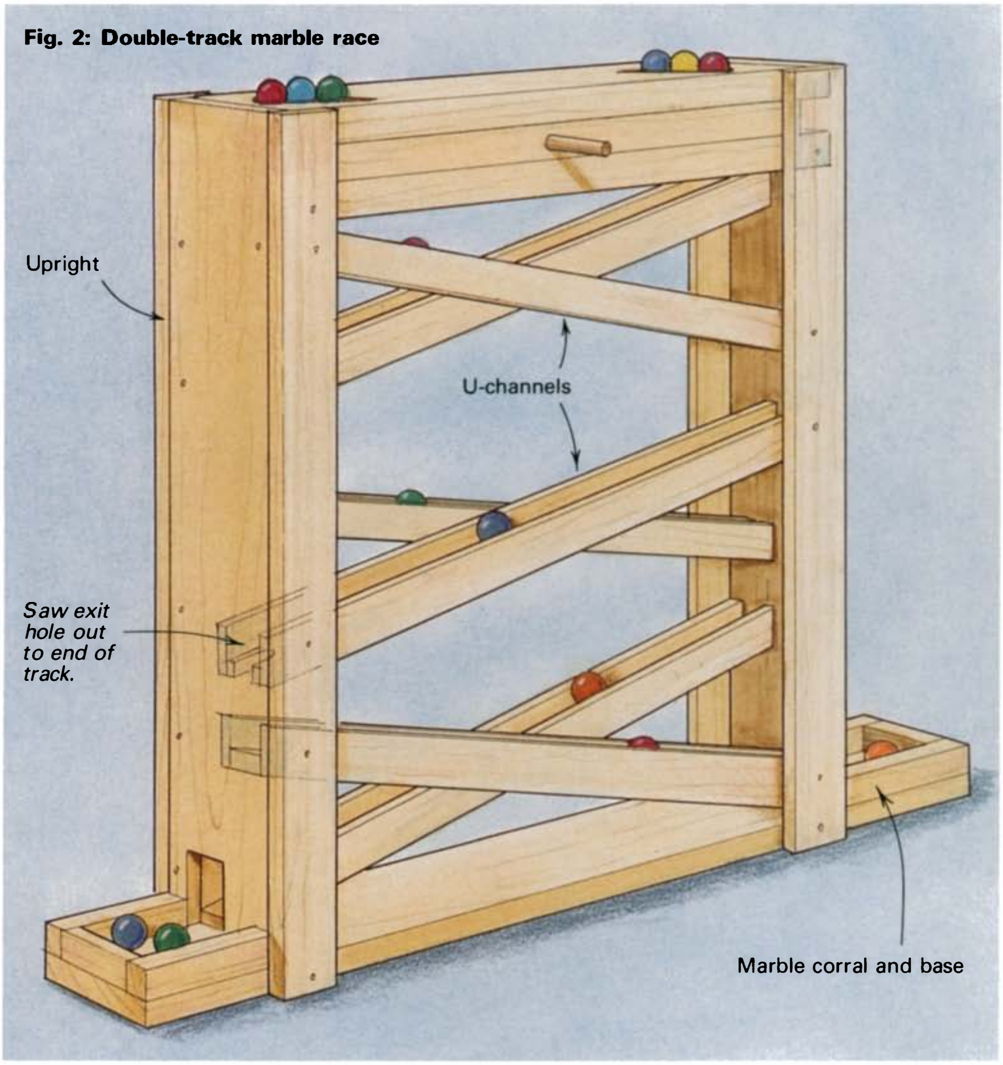
Fig. 2: Double-track marble race



The author built this three-dimensional marble roll to show his students what is possible when basic 'events' are combined within, on and around a simple framework. Rube Goldberg, eat your heart out!

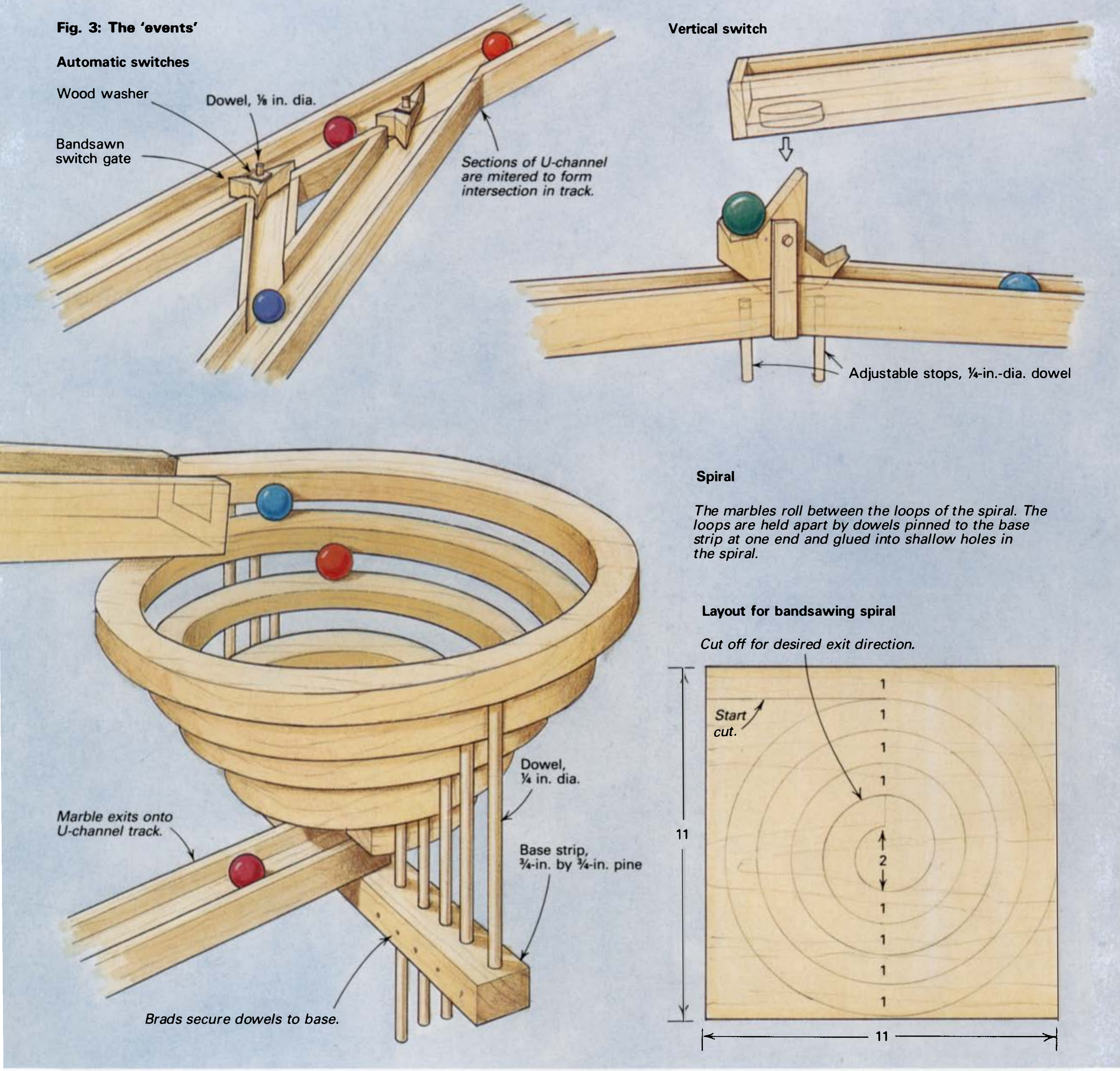
Chutes and ladders–After mastering the zigzags, many kids move on to building chutes-and-ladders marble rolls on a piece of plywood mounted vertically in a simple stand (see the top, right photo on the facing page). Although they begin as two-dimensional constructions, paths often run out from the board and sometimes bore through it. The backboard is a less restrictive structure than the uprights of the zigzags, offering more opportunity for experimentation. Sometimes we miter the U-channel track for the zigzag rolls into curves, steps and even spirals by gluing segments end to end and using masking tape to hold the pieces until the glue dries.

As imaginations run rampant, students raid the bandsaw scrap box for odd-shape pieces that can be glued to the backboard to alter the marble's path. A gouged path in a block of wood or a guardrail in just the right place keeps the marble on track. And a small wedge at the start will add to the marble's speed, enabling it to overcome obstacles farther down the line.

Three dimensionals–If building a backboard marble roll is like composing a quick and amusing scherzo, three-dimensional rolls are a symphony. There is less structure to fasten things to, but room for much more to happen. The framework is four upright ½-in.-dia. dowels glued in holes bored at the corners of an H-shape base. We use U-channel tracks mitered and glued into various shapes and doweled to the uprights. Begin at the top and work your way down. Think of strange things you can make the marble do. To encourage the kids, I built the marble roll shown in the photo above. It is 3 ft. high, with three separate paths. Several different events cause the marbles to accelerate, slow down, spin wildly, rumble or fall abruptly along the way. An automatic switch-

Drawings: Kathleen Creston

Fig. 3: The 'events'



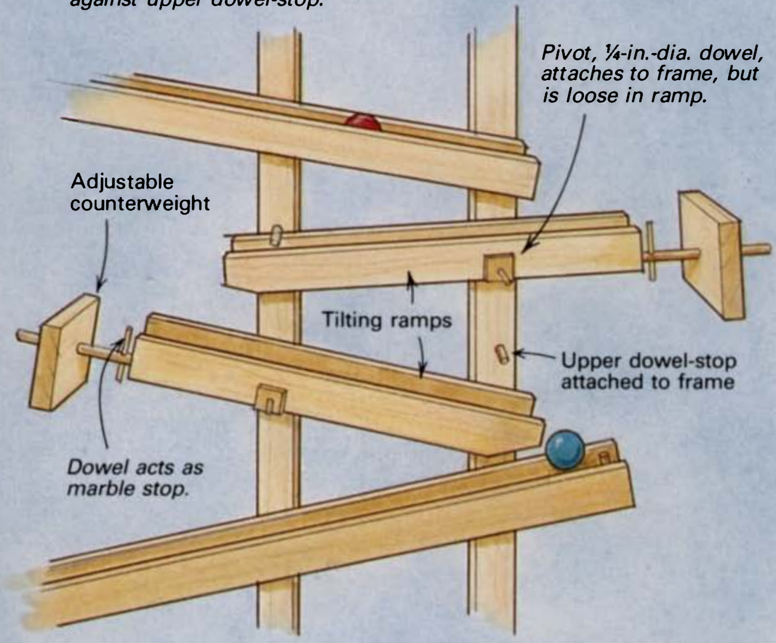
ing system feeds marbles to the various paths in sequence, and at the bottom, a marble pulls a lever that starts another at the top. The major events on this machine can be used together or alone on rolls as simple or complex as you care to build.

Switches–Any marble can be directed to a variety of paths by using intersections and automatic switches. Furthermore, several switches can be used together to introduce an element of surprise. A simple switch gate is shaped like a three-point star and swivels on a dowel inserted in the track floor where two tracks intersect, as shown in figure 3 above. The gate swivels until its long leg hits the sidewall, opening one path and closing the other. A marble rolling by the gate hits a short leg in the open path, causing the switch to swivel to its alternate position. Beveling the bottom edges of the gate will keep it from hanging up on the track surface. A small piece of scrapwood acts as a nut to hold the gate on the dowel.

The basic principle is the same for a vertical switch. When a marble drops onto a vertical switch through a hole in the track above, it is directed to one of two paths, and the position of the switch is simultaneously reversed. Dowels located in the floor of the track limit the gate's tilt. To ensure that the marble doesn't roll off the side of the switch, you can hollow out the edge of the switch slightly with a gouge and cup the lip where the marble exits. Or, you can make the switch with a narrow sidewall to contain the marble.

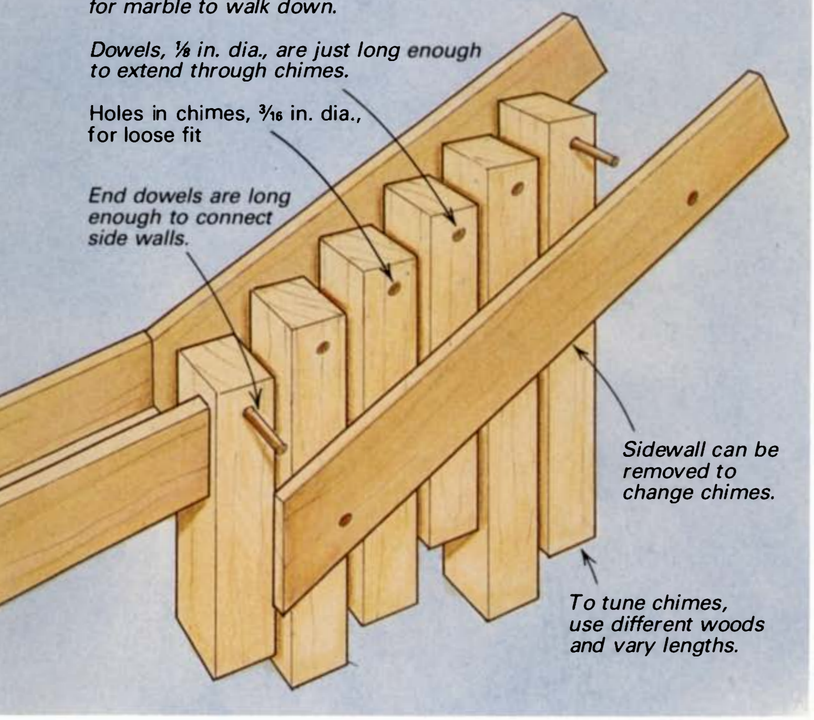
Tilting ramps

Weight of marble tilts ramp down until it hits ramp below. When marble rolls off end of ramp, the counterweight brings ramp back up against upper dowel-stop.



Musical steps

When mounted at an angle, the chimes become steps for marble to walk down.



Spiral—In this event, the marble should accelerate dramatically, making a whirring sound as it races down the spiral path. A spiral is an unusual shape for wood, but it's easy to make. Select an 11-in. square of ¾-in.-thick white pine with clear, straight and flat grain. Bandsaw this square by eye, with successive loops about 1 in. apart, leaving a straight tongue tangent to the circle and parallel with the grain as an entrance (see figure 3 on the facing page). Then decide which side will be up, thus determining whether it will be a left- or right-handed spiral when stretched open. On the bottom surface, draw a line perpendicular to the grain and drill ¼-in.-dia. holes, almost through the board, on the line at each turn of the spiral. Glue an 8-in.-long piece of ¼-in. dowel in each hole. On a ¾-in. by ¾-in. strip of pine, which will support the spiral, mark the position of each dowel and drill ¼-in.-dia. holes clear through. With this strip in a vise, use a hammer to gently tap the spiral above each dowel until each one is through the base strip.

To expand the spiral to its funnel shape, start at the center and drive the first pair of dowels through the base strip about ½ in. Moving outward, drive each successive pair of dowels through a little less than the previous set. Return to the center and repeat this process until a funnel shape is fully formed. The loops should be spaced so a marble is just barely retained by the next track up. You'll find the wood is stiffer near the bottom and can't be spread as far without breaking. As you approach full depth, test the track: Start a marble at the top with a little push so it'll cling to the rim. If it slows down anywhere along the path, drive that section of the spiral down slightly and try it again. When you're satisfied with the run, pin each dowel in the base strip with a small brad.

A spiral makes a fine beginning for any marble roll. If you install the spiral some distance from the starting point, you may need to use an entrance ramp to ensure the marble has enough speed to take the long, sweeping, ever-accelerating path, instead of walking down the funnel's steps.

Tilting ramp—The rhythmic, cascading motion provided by a series of tilting ramps contrasts nicely with the faster, swirling motion in a spiral. Short ramps give a rapid, herky-jerky motion; longer ones dip and rise more slowly in a less frantic way. Figure 3, left, shows how these tilting ramps are made. At the end of a section of U-channel, where the marble enters, a ¼-in. dowel is inserted to hold an adjustable wooden counterweight. Another small dowel is installed to prevent the marble from escaping. The bottom of the other end is beveled to increase the distance the ramp can tilt. The ramp pivots on a dowel about one-third the distance from the counterbalanced end. When a marble drops onto the inclined ramp, it rolls toward the exit end, tilting the ramp more as it rolls. When it falls off the ramp, the counterweight causes the ramp to snap back to its original position. I call the tilting ramps "click-clocks," because of the regular beat they produce as they dip, hit the underlying ramp and then rise and hit the upper dowel stop.

Musical steps—One of my favorite events is the musical steps shown at left. Marbles march down a set of stairs, creating an entertaining percussive sound. To make the steps, mark out and drill equally spaced holes (one for each step) in a ½-in. by 1-in. strip of wood, which will be one of the sidewalls. On the other sidewall, drill just the two end holes. Glue a ⅛-in. dowel in each hole on this sidewall. The dowels at each end should be long enough to run through and support the other sidewall. For the stairs, which will be the chimes, cut varying lengths of ¾-in.-thick pine, drill a hole near the end of each strip and hang one on each dowel. They should fit loosely. Drill two ⅛-in.-dia. holes in the other sidewall, and install it in place on the long end dowels from the first sidewall. Finally, hang the stairs on the framework of the marble roll at an angle that allows a marble to drop from step to step. Different kinds of wood give different tones. The chimes can be tuned by adjusting their lengths, and the scale can be changed by removing the sidewall and rearranging the chimes. □

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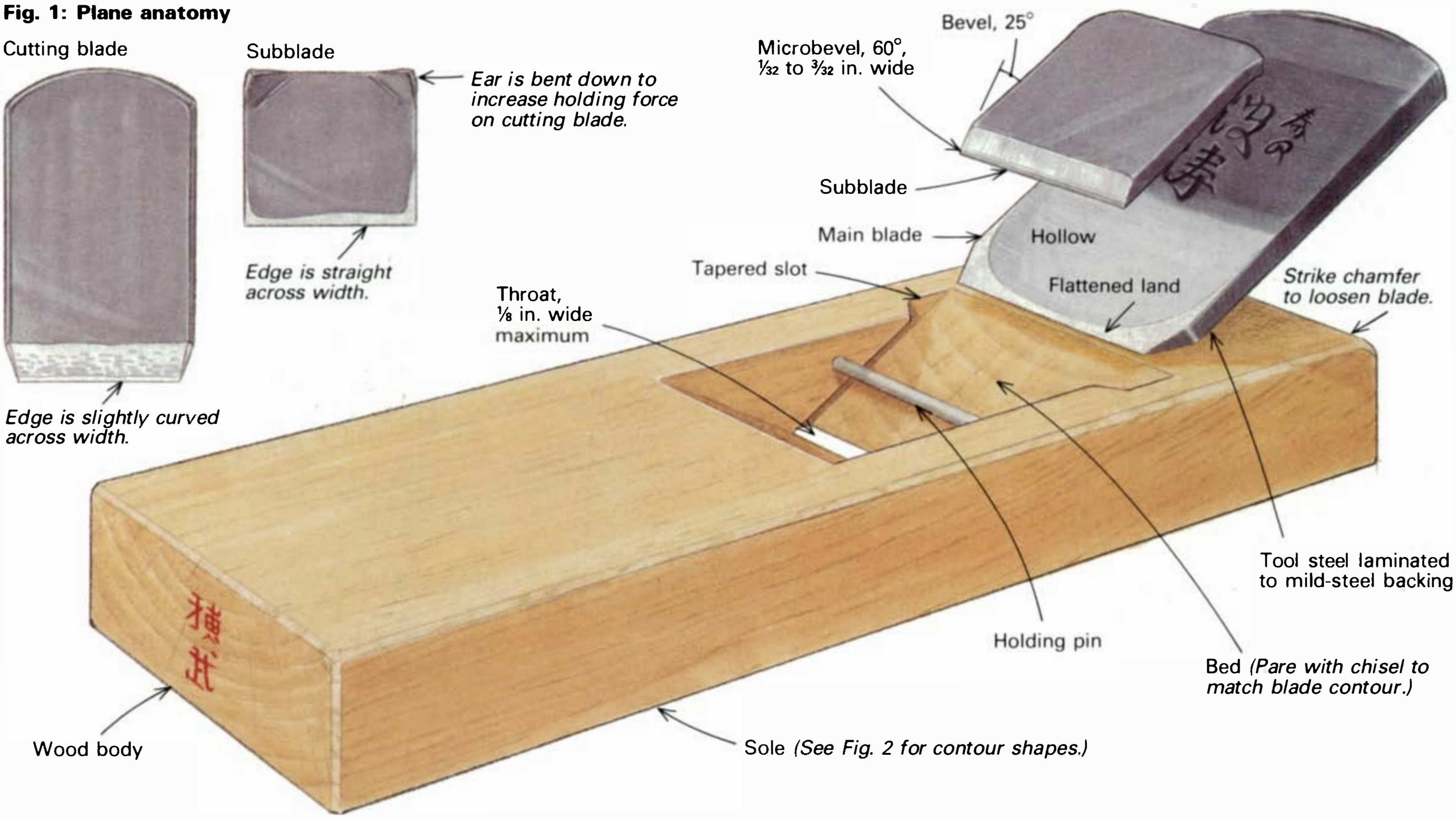
Tuning a Japanese Plane

Taking the tool to its full potential

by Robert Meadow

Fig. 1: Plane anatomy



Handplaning at its best is perhaps the most pleasurable of all woodworking surfacing techniques; at its worst, it's one of the most frustrating. The handplane can surface even the most figured woods, such as bird's-eye maple, to a mirror-like finish, producing far better surfaces than possible with a cabinet scraper or sander. As a musical instrumentmaker, I have conducted many tool demonstrations, and my students invariably are astonished at how my Japanese planes produce long ribbons of tissue-thin shavings with any wood. They sometimes think some magic or trickery is involved. There isn't. But to make these fine cuts, you need a well-designed, high-quality plane that has been meticulously fine-tuned. The planing itself requires a high degree of concentration and sensitivity. You must be aware of what is going on at the blade's edge as it moves through the wood, continually adjusting your plane and technique to achieve the best results.

A newly purchased Japanese plane possesses the potential for superior performance, but it won't work well right off the dealer's shelf: The wooden body may have dried out and shrunk since it left the moist Japanese climate. The blade and subblade also must be shaped, sharpened and fitted to the body. But before you make these adjustments, you need to understand a bit about the planes themselves.

I was introduced to Japanese planes by my friend Makoto Imai, who apprenticed as a temple builder in Japan and now works in California. Although I had been getting good results from Western planes for years, it wasn't long before I abandoned them in favor of the Japanese planes. Their heavy irons can be sharpened to an incredible edge, and their wood bodies can be customized to make fine cuts in any wood.

The Japanese plane appears primitive alongside a metal Western-style plane. It has few parts: a wood body with tapered slots that hold the cutting blade, also tapered, and a subblade wedged tightly behind a pin that spans the width of the plane. Figure 1, above, shows the plane's anatomy. There are no built-in adjusting mechanisms. The Japanese plane, unlike its Western counterpart, is normally pulled rather than pushed. One hand grasps the long

Drawings: Bob La Pointe

part of the plane's body in front of the blade to provide downward pressure and to pull the plane over the workpiece. The other hand, positioned behind the blade, guides the plane. At all times, one must be sensitive to the balance between the pressure of the two hands.

The blades used in Japanese planes are thicker than those used in today's Western planes and are laminated from two pieces: a thin, high-carbon steel layer that forms the cutting edge and a thicker, wrought-iron back. This thicker blade rigidly supports the cutting edge, and because the bulk of the blade is a fairly soft metal, its cutting edge and bevel can be shaped more easily. The key to superior performance, however, is in the steel itself. The Japanese use unalloyed high-carbon tool steels, which they call "white steel." Western tool steels have alloys added. High-carbon tool steel without alloys warps when it is quenched in hardening. This warpage can be controlled by laminating the tool steel to a thicker backing. One great advantage of white steel is that it can be worked over a wide range of temperatures, so the size and shape of the metal grains can be manipulated. The edges of these flattened crystals are hard yet still flexible. The round crystals of alloyed tool steels used in Western planes (and the so-called "blue steel" in some Japanese planes) lose flexibility as you increase hardness. The process of "tapping out," which will be discussed later, aligns the flat crystals of white steel so their hard edges form the cutting edge of the blade. This gives you a blade that wears evenly, rather than one that dulls or chips.

Because the bodies of Japanese planes are made from solid wood, they can be affected by changes in temperature and humidity. Fortunately, these effects are small, and in any event, correctable. As mentioned earlier, the cutting blade is held in position by the tapered slots in the wood body. The blade is sprung when it is held in the body, which helps it to resist deflection as the tool cuts. The range of elasticity of the wood body affects its ability to spring the blade without requiring excessive force to get the blade in and out. Metal has too little elasticity to work well in this way, and a soft wood doesn't have the stiffness to support the blade sufficiently. Japanese white oak, the wood commonly used for the best planes, has the best balance of these characteristics. Additionally, as will be discussed later, the plane's wood sole can be reshaped for the particular task at hand, whether it be roughing, trueing or finish-planing.

Conditioning the plane—You must understand what happens when you plane a piece of wood before you can grasp the rationale involved in conditioning a plane. As you pull the plane, the forces on the blade deflect the cutting edge down into the wood. When working with softwoods, such as pine, these forces are not great, so the blade easily resists deflection. The forces on the blade increase, however, when taking heavy cuts or when working with hardwoods. Eventually, these downward forces can exceed the stiffness of the blade, causing it to pull down into the wood abruptly. As the blade snaps back to its original, nondeflected position, the wood will tear out. We think of steel as being a hard, rigid substance, yet in reality, it is flexible and whippy. Students are amazed at how the blade's edge is easily deflected simply from fingernail pressure applied along the back of the blade near its cutting edge. No small wonder then that even a slight change in edge angle has a great effect on how the blade flexes and how it feels as it moves through the wood. The trick in getting a plane to work well is to adjust the body to provide maximum support for the blade as it's carried across the wood surface, and to shape and sharpen the blade to resist deflection. A well-conditioned plane shaves cleanly, is easy to use and control, and doesn't vibrate.

Shaping and sharpening the cutting blade—Begin by disassembling the plane. Remove the blade and subblade by sharply hitting the chamfered surface on the back end of the body with a hammer. Keep your thumb on the blade to keep it from popping out. Note how the hard, high-carbon steel side of the blade has a flat at the cutting edge, then a dish-shaped area. The hollow is formed as the blade cools when it is being hardened; the thin, high-carbon steel layer contracts more than the plane's thicker, mild-steel back. The flat area is an essential part of the cutting edge and must be maintained at all times.

The process for maintaining the flat, or land as it's often termed, is called tapping out, and it's the first step in the blade tune-up. In addition to aligning the metal crystals as previously discussed, this process gently curves the edge of the blade to provide metal for shaping the flat. Over time, the flat wears away, so it's a good idea to tap the blade out a little each time you resharpen it. Using a cross-peen hammer, I gently tap on the mild-steel portion of the bevel, as shown in the photo on the next page. The blade has to be supported directly under the hammer blows; I use the rounded spot on the corner of an anvil. Begin tapping at the heel of the bevel, moving the blade back and forth like a typewriter carriage, and progress down the bevel toward the weld line between the mild steel and the tool steel. Don't tap on the hard, tool-steel laminate, because you're liable to chip it.

Once you've finished tapping out, you can flatten the land along the edge and alongside the hollow. The land along the edge should be perfectly flat, but the blade is slightly concave along its length. To preserve this slight curvature, don't place the whole blade down flat on the sharpening stones. Instead, begin at the edge, supporting the weight of the rest of the blade, and move farther into the stone in a controlled manner. Coarse and medium stones are used to form the flat area; it'll be polished later. Check for flatness using white light (the reflection of your light source) to highlight any uneven areas. The photo below shows an example of a well-prepared flat, along with some examples of problems to be avoided.

The next step is to prepare the bevel on the other side of the blade. Steep bevels support the edge best, making it more resistant to deflection, but this configuration, because of its bluntness, also decreases the blade's slicing effectiveness. A shallower bevel cuts more effectively but is weaker and more prone to chipping. Optimally, hardwoods require a larger bevel angle than softwoods, but for Japanese planes, a 25° bevel is a practical compromise for most planing applications. The bevel itself should be perfectly flat, but as you shape the bevel, you want to form a slight convex curve

Photo: Michele Russell Slavinsky

The left blade has been tapped out correctly, and the flat land is well defined. The other blades need to be tapped out. The flat area on the middle blade extends too far back, forming a groove. The flat on the right blade has almost disappeared from repeated sharpenings.

The author uses a small cross-peen hammer to gently tap out the blade, which is supported on the rounded corner of an anvil. Only the mild-steel portion of the bevel is struck. In this way, the hard tool steel, which is laminated to the mild steel, can be gently curved.

across the width of the edge by applying more pressure when stoning the outside edges than in the center of the bevel. The deviation from straight should be about five times the thickness of the shaving you want to take. This allows for the angle and deflection of the blade by the body and prevents the corners of the blade from nicking the planed surface. I carefully remove the burr formed during sharpening with a slower-cutting medium stone (3,000 to 4,000 grit), working alternately on the back side of the blade and the bevel. The objective here is to cut the burr off cleanly without work-hardening the edge. If you bend the burr back and forth to remove it by causing the metal to fatigue,. the edge will work-harden, dull more quickly and be more prone to chipping.

Finally, finish the edge by polishing it on fine stones. As before, work alternately on the back side and the bevel. Again, as you proceed, use reflected white light to make sure that these surfaces are smooth, flat and free of imperfections. When the white light reflects uniformly off the bevel and no longer reflects off the edge of the blade itself, the job is done.

The subblade—The subblade directs shavings up and over the cutting blade and out of the plane, but its major function is to deflect the cutting blade so it resists being pulled down into the wood. As the cutting edge dulls, the planing forces will increase and the subblade's role becomes more important. For finish-planing, where the goal is to produce a smooth and shiny surface and not to remove a lot of wood, the planing forces are minimal, because extremely fine shavings are made. Here it's possible to use the plane without its subblade and produce gleaming, mirror-like surfaces, because the subblade is not changing the shaving's angle as it leaves the plane.

The subblade, like the cutting blade, is made by laminating tool steel to mild steel. It is conditioned in the same way as the cutter, with a couple of important differences. Because the subblade isn't used for cutting, the keenness of its edge is not critical. Its bevel should be formed accurately, but it doesn't need to be polished. To provide additional support at the subblade's edge, I blunt the end of the bevel by forming a 60° micro-bevel. The micro-bevel should be polished. For hardwoods, where the most support is required, I make the width of the micro-bevel about 3⁄32 in.; for softwoods, about 1⁄32 in. If you are working with a wide variety of hardwoods and softwoods, the hardwood width will do for all the work. This eliminates the need to keep two sets of planes with different blade angles for use with hardwood and softwood. The edge is made straight so that when the subblade is aligned with the cutting blade, this edge will sit back just far enough from the cutting blade's curved edge to prevent shavings from getting jammed.

Fitting the blades to the body—Changing the plane's white-oak body to compensate for climatic effects and to fit the blade and subblade is not very difficult. The purpose here is to adjust the body so the cutting blade and subblade conform to their mating wood surfaces. Once these initial adjustments are made, you shouldn't have to make any major adjustments, as long as you use and store the plane in a reasonably constant environment.

The width of the tapered slots and the cheeks, which support the subblade, need to be adjusted first. The blades should be centered in the body and fit snugly, not tightly, at the bottom. At the top, leave about 1⁄32 in. of play on each side of the blades to allow for lateral adjustment. Use a chisel to carefully pare the sides of the tapered slots and cheeks. Keep the shoulders of the tapered slots square and clean. If you have any question about the fit, you should err on the side of tightness; you can always loosen the fit later, if necessary.

The back of the cutting blade must lie firmly on the bed. Adjusting this area is a matter of "cut and try." Cover the back of the blade with lead from a soft pencil and gently tap the iron into the body. When you remove the blade, the lead marks left on the wood will highlight areas where the blade interferes with the bed. Because the blade and the bed have small curvatures, some of the marks can be misleading, thus not all the marked areas should be pared away. Instead, look for how the blade skews to one side or the other as you tap it in. First pare the high spots, where the blade hangs up, repeat the marking procedure and check the fit again. Repeat this process until the blade can be positioned smoothly, with the tightest fit near the throat in the center of the plane.

Once the blades fit the body properly, adjust the subblade to apply the desired amount of pressure on the underlying cutting blade. The subblade is tightly wedged between the holding pin and the cutting blade. Contact between the two blades is made by the beveled edge of the subblade and the "ears," the bent-over top corners of the subblade. The ears are formed by hammering over the top corners of the blade, using the tapping-out process described earlier. As before, the blade has to be supported on the rounded corner of the anvil when being struck. If the ears are unevenly bent, the subblade will rock, so check for this before trying out the plane. If the cutting blade digs in or tears the sur-

The author uses winding sticks to check the sole of this plane for twist in the plane's body. Using a single stick, Meadow will later check the sole for flatness.

Meadow is shown here adjusting the sole of a plane, flattening its surface and removing any twist with a scraper plane. The wooden sole should be checked frequently so any necessary adjustments to compensate for wear or changes in environmental conditions can be made.

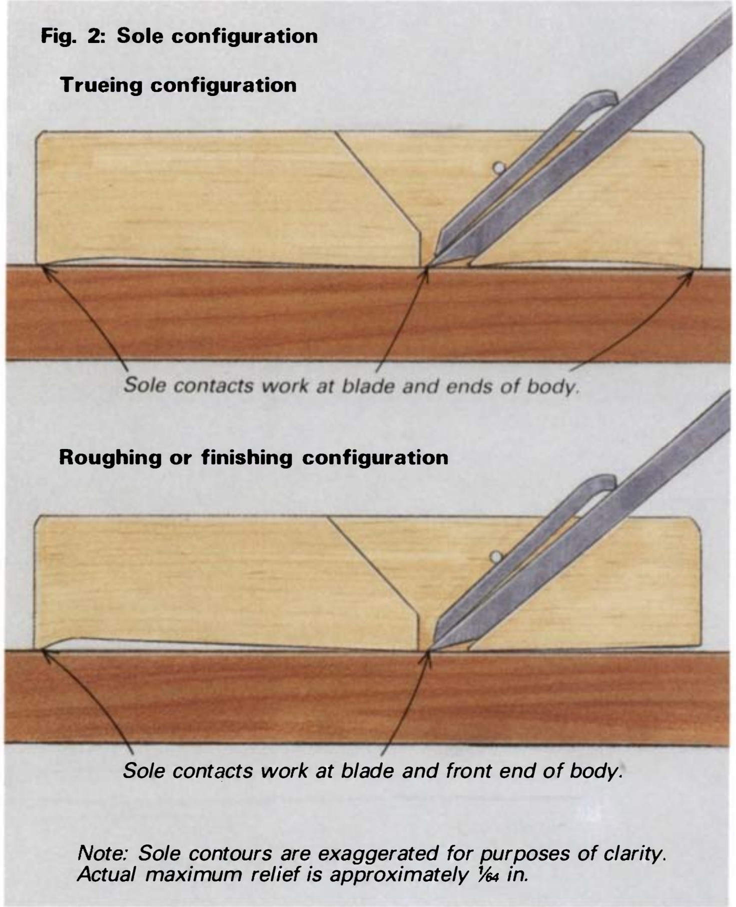
face, the blade is too loose and you'll need to bend the ears a bit more to increase the pressure on the blade. When working with hardwoods or when taking thick shavings, you may find it necessary to increase the pressure to resist the increased planing forces on the blade. The pressure is about right when you get shavings of the same thickness whether you plane with or against the grain.

Checking out the sole—Before using a wooden plane, you should carefully check the plane's sole. When a plane is not cutting smoothly, it almost always involves a problem with the bottom of the plane. Either the shape of the sole is not right for the job at hand, the body is twisted or the sole is not flat across the plane's width.

The first step is to check the body for twist with a pair of winding sticks, a matched pair of wooden parallel straightedges. Place one stick on the sole just in front of the plane's throat and the other at the front end, as shown in the photo above, left. Sight across the top edges of the sticks. If the end of one stick is higher than the other, the body is in winding—twisted. Use a scraper plane, working across the grain, to eliminate the high spots, as shown in the photo above, right. The scraper plane, because of its near-vertical blade, takes fine, dust-like shavings, so the adjustments can be made gradually.

When you're sure the sole is flat with no twist, you can modify its shape along its length. The shape of the sole depends on how you intend to use the plane. For trueing, the idea is to remove local high spots from the wood's surface and make it flat. To do this, the plane has to bridge the high spots, so the sole is supported at the far ends of the plane and near the blade. For rough-surfacing or finish-planing, the idea is to remove the wood uniformly. For finish-planing, the sole must conform to the trued, flat surface of the workpiece, so the plane is supported only at its front end and at the blade. For rough-planing, more relief is needed between the support points to allow the sole to conform to the more irregular surface of the wood. Figure 2 at right illustrates the ideal sole configurations for trueing and for roughing or finishing. Use the scraper plane again to contour the sole. Finally, you want to clean up the throat of the plane without enlargening it any more than necessary. The opening should be small, not larger than ⅛ in. Your aim is to make the plane as immune as possible to subtle changes in grain and wood hardness. The most critical point of support for the plane is at the throat opening: The closer this point is to the edge of the blade, the easier it will be to control the plane.

Fig. 2: Sole configuration



Now that you've worked your way through the tune-up procedures, it's time to see how well you've done. Try your plane out on a wood that's hard to surface, such as bird's-eye maple or quarter-sawn cherry. If you've tuned everything right, the plane should produce wide, uniform shavings. The plane should also feel good, be easy to handle and be free of vibration or chatter. And, it should be quiet: The only sound should be that of the blade slicing into the wood. If things are not quite right, you probably need to increase the pressure on the cutting blade or check the plane's sole configuration. □

Robert Meadow is an instrumentmaker. He and his wife, Bonnie Robiczek, who helped prepare this article, operate The Luthierie in Saugerties, N.Y.

Rudy Mihalicz's *walnut and birch lamp, left, has a stack-laminated base carved to form four helixes twinning around each other. The lamp's shade is made of thin slices of agate that are set into a multifaceted walnut frame.*

Jamie Russell's *ash armchair, right, is part of a six-piece set he made using laminated bending, spindle turning and router-joinery techniques.*

John Leach *made the tiny loon pictured below, left. It is less than 2½ in. long. Leach carved and painted the tupelo miniature in the same way he makes full-scale bird decoys.*

Stan Wychopen *did all the work on his ⅛th-scale model of a Wells-Fargo stagecoach, below right, including the fabrication of the rosewood, maple and ebony body parts and casting of the brass hardware and fittings. The coach's lamps and windows are glazed with beveled glass panes, and the interior is finished with leather upholstery and silk curtains.*

Staff

Woodworkers of Saskatchewan

A tour of talent on the Canadian prairie

by Sandor Nagyszalanczy

Before I visited the Canadian province of Saskatchewan, I had visions of furniture made from old barn wood and kitsch souvenirs carved from petrified bison horns. After all, the northern prairies are far from the pace and sophistication of the cultural trendsetters of New York and Toronto. What greeted me in Saskatchewan, however, was a surprise: Not only was the province's crafts community sophisticated and thoroughly cosmopolitan, but the local woodworking community had more than its share of what I'd call world-class craftsmen. In this article, I'll tell you a bit about Saskatchewan and the craftsmen I met in my travels.

My plans to visit the North country sprouted when I was asked to be one of three judges in the annual Saskatchewan Handcrafts Festival Juried Exhibition: Dimensions '88. The show, sponsored by the province's crafts council, included such diverse crafts as wheat weaving and glass blowing, ceramic sculpture and leather work, and papermaking and fine jewelry. Although woodworking represented only a small percentage of 45 pieces selected for the exhibit, the work was spirited and the quality was high throughout.

Some of my favorite pieces in the exhibit are shown on the facing page. The ash armchair by Jamie Russell of Ruddell features bent-laminated arms, rear legs and back, turned front legs and skillfully jigged router joinery throughout. Russell designed the chair for a client who commissioned a dining table and wanted a matching set of chairs. Because six chairs were needed, Russell designed a streamlined process that relied on an extensive array of router jigs to help him make identical parts without too much fuss. He was pleased enough with the design to make an extra chair for the exhibition. Like so many craftsmen in Saskatchewan who do all sorts of woodworking to pay the bills, Russell builds a wide range of pieces, from custom one-of-a-kind pieces to a line of limited-production tambour-top boxes (see how to build these boxes on pp. 56-58).

The lamp by Rudy Mihalicz of Regina is an unusual piece, both in design and materials. The lamp has a stack-laminated walnut and birch base and stem. For the shade, Mihalicz built a walnut frame reminiscent of a faceted gemstone and set it with 30 thin slabs of agate. The lamp sheds a soft, colorful light and brings out the veining and character of the translucent stone. Because Mihalicz works full-time in the family cabinet shop, he had to build the piece after hours. It seems only fitting that he built a lamp, considering all the midnight oil he burned.

John Leach of Saskatoon didn't have the largest piece of woodworking in the show, but it was certainly one of the best: a miniature loon. The loon, measuring only 2½ in. long, is carved from tupelo wood and realistically painted. The small details of the carving are done with such deftness that the piece, which won a special merit award, has what I call "the breath of life." At a critique following the jurying, Leach introduced himself and gave me a good laugh: His little bird is actually called a "liquor loon," because he carves them for his friends to float in their drinks. He had another sensitive piece of carving in progress: a martini mallard.

After jurying the show, I spent a week exploring the area surrounding Saskatoon, Saskatchewan's largest city, getting acquainted with the local woodworkers. Despite being far from the beaten path, the woodworkers of Saskatchewan are a well-connected and organized group. Their local association, the Saskatchewan Woodworkers Guild (SWG), has had a strong membership for more than 10 years. They also sponsor frequent woodworking conferences, which this year will feature instruction by Wendle Castle, Judy Kensley McKie, Gary Knox Bennett, Wendy Maruyama and Alan Peters.

Stan Wychopen—One of the first stops on my tour of local shops was in North Battleford, a frontier-like town west of Saskatoon, to see Wychopen. After working for years as a prison counselor, Wychopen decided to take up woodworking. He walked into a hardware store, asked what machines he would need and bought them on the spot. In much the same way, he taught himself metalworking and jewelry making as well. Not encumbered by the need to make a living from his crafts, Wychopen combined his talents with an interest in model making to come up with an impressive array of sculptural creations and replica-type models. His best model undoubtedly is his scaled-down Wells-Fargo stagecoach, shown on the facing page. The basic coach body is a frame-and-panel construction of Brazilian rosewood, maple and ebony. Hundreds of investment-cast brass parts (gold plated to prevent tarnishing) provide all the metal fittings, from the coach's brake lever to the working door locks. Other materials include leather, for upholstery and rigging, silk curtains and beveled-glass windows. Each coach is highly detailed: Just one of the side lanterns has more than 80 parts and features a working wick-raising mechanism.

Considering all the work involved in a single coach, Wychopen wisely decided to produce an edition of 20 coaches. He spent a year making all the parts in his spare time. To speed up the process, he invented dozens of ingenious jigs and construction methods. For instance, to make the dozens of tiny frames needed for each window, Wychopen miters and glues up a square tube, then slices off thin frames one at a time.

Despite his rural setting and lack of publicity, Wychopen's reputation as a master model maker has spread afar: His coaches are owned by distinguished clients, such as Prince Phillip and Conrad Hilton. He reluctantly put a $7,500 price tag on his first coach, which he sold more than five years ago, but now public demand for the limited edition has boosted the price to $50,000. There are bins and bins of coach parts awaiting assembly in Wychopen's meticulously kept shop, but he may not get around to building all the coaches for years. He was building an altar screen for a Greek Orthodox church when I visited him, and despite all the work, he acted as though he had all the time in the world.

Don Kondra—Kondra came to woodworking as a refugee from the corporate world. A manager at a meat-packing company, Kondra recently moved to the outskirts of Saskatoon to pursue a career making functional furniture. With the help of 13 friends, he built his modest-but-comfortable combination house/shop in only 30 days, and only cut down one tree in the process. As an indication of his priorities, Kondra's shop takes up more than half of his floor space. The shop is well equipped with Canadian-made General and homemade machinery, and it even has a well-insulated, heated finishing room—not a luxury in a land where the thermometers run short on mercury every winter.

Like many woodworkers struggling to learn their trade while making a living, Kondra has built everything from bread-and-butter plywood cabinets and wall units to custom pieces, including a corner aquarium and a Balans-style chair. As his skills have improved over the years, Kondra says his clients have been inspired to give him more challenging commissions. Kondra has also been working on developing production items, including turned-and-inlaid boxes made from local and exotic burls, a lacquered wood and spalted birch serving tray and some clean-line rosewood round-top tables.

Kondra, then chairman of the SWG, hosted a combination guild meeting/barbecue that I had the pleasure of attending. Working in relative isolation, local woodworkers relish the opportunity to get together to talk shop and discuss each other's latest creations. The annual Dimensions competition is the big event of the year, something Kondra considers to be his "yearly final exam: an opportunity to build something that displays my best abilities." Kondra's walnut

Photos: Grant Kernan, except where noted

***Don Kondra** uses frame-and-panel construction to make his walnut blanket chest (left) light, yet strong and free of wood-movement problems. He glued up the curved panels for the chest from thinner veneers, applying a burl-walnut face veneer for a beautiful contrast to the straight-grain walnut frame.*

***Leon Lacoursiere** built all the various parts of this maple, rosewood and brass balance scale, right, using turning, casting and sculpting techniques. The balance scale's maple-leaf finial is appropriate, because Lacoursiere is Canadian and because the scale was made for the Canadian Commonwealth Heads of Government.*

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blanket chest, above, scored well with the judges, though it might not have made the grade Kondra was hoping for: He won Premier's Prize in 1985 for a modern sofa table he built from Honduras rosewood, ebony and osage orange.

I was surprised to see so much work being done in Saskatchewan with exotic, hard-to-get woods, but once again, I underestimated prairie resourcefulness. Russell, who was my guide, took me to visit a lumberyard called Renaldo's Supply. After driving along dozens of miles of dusty roads, we came to the one-street town of Arelee, which was lined with faded and boarded-up storefronts. I met the owner of Renaldo's, Rick Dawson, who took me past a rank of old school buses used for wood storage to a couple of sheds filled with lumber. At first, I naively thought it was a good-size supply of lumber for such a barren area. Then Dawson took me for a tour of Renaldo's other lumber-storage rooms, which ended up including half the buildings in Arelee. As it turns out, Renaldo's ships orders all over the world and regularly stocks more than 100 species, including many exotics I have never heard of, such as guanacaste and kauvula.

Leon Lacoursiere—Like Wychopen, Lacoursiere is an accomplished craftsman in several fields, including woodworking, stone carving and jewelry making. I visited him in Delmas, a farming community a couple of hours northwest of Saskatoon. Lacoursiere had run the family farm until just a couple of years ago, when he opened a modest-size cabinetmaking shop. A shy man with a strong French-Canadian accent, Lacoursiere is so soft-spoken that it's a good thing his work speaks for itself. When I arrived, the shop was filled with ordinary-looking cabinet parts awaiting assembly. After we talked for a while and he became comfortable with my interest in his work, he brought out some boxes and unpacked enough of his "artistic" work to fill a display window. He showed me turnings, both of wood and alabaster, some of which were made with tools he had designed and made himself. He also had jewelry, spinning tops, a 7-in.-high ebony goblet with a hair-thin stem and the finely made balance scale shown above, right.

Why isn't a talented craftsman like Lacoursiere well known? Among his friends in the SWG, Lacoursiere is notorious for his modesty. At a turning seminar several years ago, he declined to demonstrate his talents in front of the class, but instead worked all night to complete an exquisite turned goblet before the next day's class. Not surprisingly, Lacoursiere hasn't done much to promote himself or his work outside of Saskatchewan. The one time he sent work, including the balance scale, to an exhibit at the Canadian Commonwealth Heads of Government Meeting in Vancouver, B.C., the card that accompanied his scale in the show was misprinted to read "Artist: Unknown."

Mike Hosaluk—As one of Canada's best-known wood craftsmen, Hosaluk has created wooden bowls and vessels that can be found in collections around the world, and his résumé reads like a list of the important woodturning events of the decade. But when he's not traveling around North America or elsewhere (he spent a month last summer in Australia), Hosaluk leads a modest lifestyle working in a simple, two-car-garage-size shop next to his house just outside Saskatoon. The day I visited, he was experimenting with a new vacuum chuck he had built for his lathe. But instead of turning a wood bowl or platter, Hosaluk used a body grinder to put a swirl pattern on a steel plow disc—the top to a playful steel table finished in gun blueing. Later in the day, he worked on a new stack-laminated vessel (see top, left photo on facing page) that combines a painted particleboard cone and intersecting rods with aluminum feet. The final result, shown in the top, right photo on the facing page, is more like an architectural construction than a bowl or vessel.

After seeing this modern, urban-inspired work, I wondered if the guy I was visiting was the same Mike Hosaluk who had done the more traditional woodturnings I was familiar with: natural-edge vessels adorned with porcupine quills (one of these won the "Best in Wood" award at Dimensions '88). As it turns out, like many of his compatriots, Hosaluk has explored many styles of work. After first being exposed to woodworking by his father, who made him a scroll saw from an old sewing machine, Hosaluk ran a leather-goods shop, then attended the Kelsey Institute of Applied Arts and Sciences in Saskatoon and focused his attention toward professional woodworking. Hosaluk's early turned work explored natural edges, but he quickly turned to lamination and began incorporating other materials, such as porcupine quills bravely plucked from road-kills. The quill-decorated work is an outgrowth of his fascination with Canadian Indian art and culture and also reveals his playful nature: "The whole trick to these vessels is to play on people's reactions to objects. They want to pick up the piece and admire the wood and touch it. Then, there's a whole other response when they see those hostile-looking quills." Hosaluk has also played tricks with other bowls that have unstable bases and rock when touched, scaring people who brush against them. This

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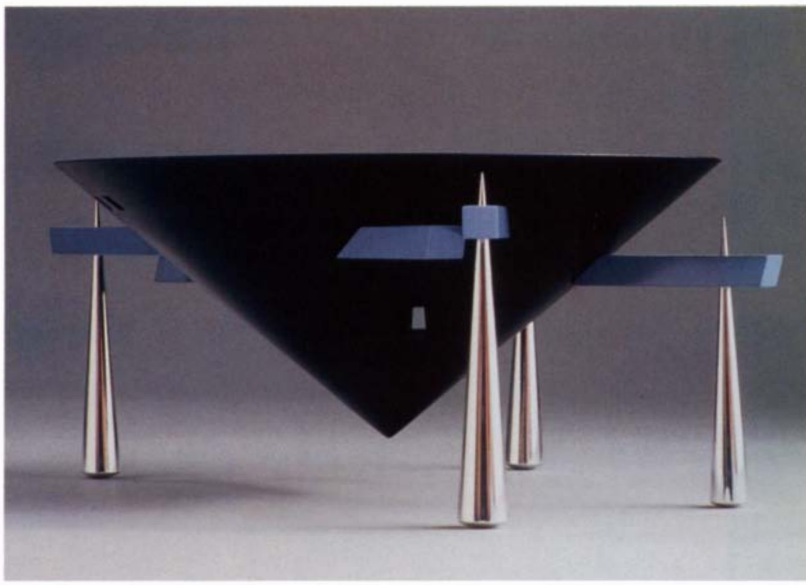
Mike Hosaluk, one of Canada's best-known woodworkers, is an inventive woodturner who's at home doing work in both traditional and contemporary styles. He applies a little filler to the surface of a turned vessel, left, to fill voids in the surface prior to final sanding and lacquering. Before Hosaluk glued up the cone-shape vessel from rings of particleboard, he cut out little windows designed to allow straight particleboard rods to pierce the sides and form a geometric pattern of intersecting parts. After experimenting with different piercing patterns, Hosaluk refined his design, right, and added three spike-shape aluminum feet that suspend the vessel in midair.



mischievousness, coupled with great technical skill, keeps Hosaluk's work fresh and his fans guessing.

Brian Gladwell—Although he's an accomplished cabinetmaker and a woodworker in residence at the Neil Balkwill Center, a community-arts center in Regina (Saskatchewan's capital), Gladwell's most innovative work isn't made from wood. It all started when Gladwell was trying to create an affordable furniture piece for sale at a local crafts show. In lieu of an expensive hardwood, he built the piece from cardboard, the same material he customarily used for maquettes of his wooden furniture.

The idea caught on so well that Gladwell developed a whole line of cardboard furniture, including tables, desks, shelves and cabinets. He employs many regular woodworking tools and techniques to build with inexpensive cardboard, mitering corners and joining edges with great precision. To make strong surfaces for tabletops and shelves, Gladwell glues up a kind of structural box by laminating precisely cut cardboard strips on edge between top and bottom cardboard skins, like a hollow-core door. The edges of the panels are usually left open so you can see the grid work of the inner core, a visual detail incidental to the construction process. He uses dowels for much of the joinery, pinning different sections or panels to each other. Gladwell also uses long dowels as a core for his cabinet and table legs. He wraps a long, triangular-shape strip of single-face cardboard around the dowel. The taper of the strip gives each leg a spiraling surface and a soft profile. For cabinets, such as the one shown at right, Gladwell mounts cardboard doors with regular brass hinges and gives each piece a final surface-hardening finish with colorful automotive lacquers. The pieces are water resistant and strong enough to sit on; Gladwell predicts they'll last five or 10 years.

Last fall, Gladwell showed collections of his cardboard creations in both Chicago, Ill., and England. Gladwell, as well as Hosaluk and Wychopen, have been successful at what many Saskatchewan craftsmen hope to do: develop markets for their work outside the province and carve out a profitable living on the Northern prairie. □

Sandor Nagyszalanczy is an associate editor at Fine Woodworking. *The Saskatchewan Woodworker's Guild is hosting "Contemporary Furniture Design and Technique 2" this summer. For more information, write to Saskatchewan Crafts Council, Box 7408, Saskatoon, Sask. S7K 4J3. For a wood and price list from Renaldo's Supply, write to Box 64, Arelee, Sask. S0K 0H0.*

Photo: Gary Robins

***Brian Gladwell** uses graceful lines and a colorful lacquer finish on this cabinet to disguise the fact that it's made of inexpensive cardboard. Gladwell uses many woodworking tools and methods to build his cardboard furnishings.*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Model		List	Sale
23-700	Wet/dry grinder	201	135
23-680	6" bench grinder ¼ H.P.	81	62
23-880	8" bench grinder ½ H.P.	136	99
23-980	10" bench grinder 1 H.P.	246	199
11-950	8" drill press	164	119
14-040	14" drill press	313	240
40-150	15" hobby scroll saw	178	125
28-160	10" hobby band saw	189	129
31-050	1" belt sander 2.0 amp.	93	69
31-460	4" belt/6" disc sander	178	125

DELTA STATIONARY

34-761	10" unisaw 1½ H.P.	1579	1179
22-651	13" planer 2 H.P.	1586	979
34-429	10" tilting arbor bench saw 1½ H.P.	1479	999
28-243F	14" band saw w/stand, no motor	621	419
33-990	10" radial arm saw	727	539
11-072	32" radial drill press	487	360
37-280	6" motorized jointer	440	319
50-179	¾ H.P. 2 stage dust collector	435	339
37-154	Deluxe DJ-15 6" jointer w/¾ H.P. motor	1288	979

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33-050 8¼" Sawbuck
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34-330 8¼" Table Saw 13 Amp
List Price 321 Special Sale 225!!

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PRICE BUSTERS		List	Sale
0224-1	⅜" drill 4.5A magnum	179	110
0234-1	½" drill 4.5A mag 0-850 rpm	189	105
0244-1	½" drill 4.5A mag 0-600 rpm	189	105
0222-1	⅜" drill 3.5A 0-1000 rpm	169	95
0228-1	⅜" drill 3.5A 0-1000 rpm	154	88
0375-1	⅜" close quarter drill	208	115
0379-1	½" close quarter drill	243	139
0212-1	⅜" cordless drill v/spd.	263	149
6539-1	Cordless screwdriver 190 rpm	108	62
6540-1	Cdlss. screwdriver w/bits & cse	137	89
6546-1	Cdlss.screwdriver 200&400 rpm	120	72
3102-1	Plmbrs rt angle drill kit	295	175
3002-1	Electricians rt angle drill	290	179
5399	½" D-hdle ham drill kit	299	169
1676-1	H.D. Hole Hawg w/cs	395	235
6511	2 sp SawZall w/cs	209	119
6405	8¼" circle saw	209	120
6750-1	Drywall gun 0-4000 4.5A	149	89
6798-1	Tek screwdriver	173	105
6226	2 sp bandsaw w/case	416	240
6234	TSC bandsaw w/case	427	279
6507	TSC SawZall w/case	219	129
6170	14" chop saw	430	295
6012	Orbital sander 3⅝"x7⅞"	179	100
6014	Orbital sander 4½"x9¼"	189	110
6305	6¼" cordless circle saw	284	155
6753-1	Drywall gun 0-4000 3.5A	129	77
8977	Var. temp heat gun	109	70
0214-1	⅜" v. spd. cordless drill	220	125
5397-1	⅜" v. spd. hammer drill kit	227	139
5371-1	½" v. spd. hammer drill kit	313	199
3107-1	½" v. spd. rt angle drill kit	305	180
6754-1	Drywall gun 0-4000 4.5A	179	115
6232	4¾" bandsaw w/case	432	275
6747-1	Drywall driver-0-2500	149	87
0230-1	⅜" drill 0-1700 rpm	169	99
3300-1	½" v spd magnum rt angle kit	289	179
5620	Router 1 H.P.—8 amp	289	169
5660	Router 1½ H.P.—10 amp	299	180
5680	Router 2 H.P.—12 amp	350	205
5455	⅞" polisher 1750 rpm	199	125
5535	7" polisher 2800 rmp	209	129
6215	16" chain saw	280	189
8975	Heat gun	85	55
6366	7¼" circular saw	198	112
6368	7¼" circular saw w/cse	226	125
0216-1	2 spd cordless drill Hi-torque	222	134
0235-1	½" drill keyless chuck mag	199	123
6016	¼ sheet pad sander	75	44
6145	4½" grinder 10,000 rpm	149	95
8950	8 gal wet/dry vac	205	139
8955	10 gal wet/dry vac	279	189
0239-1	½" drill keyless chuck	189	114
6749-1	Drywall gun 0-2500 4.5A	189	117
6377	7¼" worm drive saw	275	155

FREUD SAW BLADES

⅝" Bore—Industrial Grade
CARBIDE TIPPED SAW BLADES

Item No.	Description	Diam.	Teeth	List	Sale
LU72M010	Gen. Purp.A.T.B.	10"	40	77.49	34
LU81M010	Gen Purp. TrCh	10"	40	79.32	39
LU82M010	Cut-off	10"	60	98.89	42
LU84M011	Combination	10"	50	85.25	35
LU85M010	Super Cut-off	10"	80	126.90	59
LM72M010	Ripping	10"	24	74.22	30
LU73M010	Cut off	10"	60	91.15	37
LU87M010	Thin kerf	10"	24	56.90	36
LU88M010	Thin kerf	10"	60	69.90	43
PS203	Gen'l Purp.	7¼"	24	31.42	16
PS303	Plywood	7¼"	40	37.74	22
DS306	6" Dado - Carbide			168.13	95
DS308	8" Dado - Carbide			205.89	108
F0	1¾"x⅝" Biscuits 1000-Qty.				25
F10	2⅛"x¾" Biscuits 1000-Qty.				25
F20	2⅜"x1" Biscuits 1000-Qty.				25
FA	Assorts Biscuits 1000-Qty.				28
WC104	4 pce. chisel set w/cse ¼"-1"			39	27
WC106	6 pce. chisel set w/cse ¼"-1"			52	36
WC110	10 pce. chisel set w/cse ¼"-1½"			88	59
FB100	16 pce forstner bit set ¼"-2⅛"			262	152
94-100	5 pce router bit door system			260	159
JS100	Biscuit Jointer			285	154

MAKITA CORDLESS

Model		List	Sale
6070DW	⅜" var. spd. rev. 7.2v	123	65
6071DWK	⅜" var. spd. rev. w/removable batt. 7.2v	190	105
5090DW	3⅜" saw kit, 9.6v	243	125
5600DW	6¼" circular saw, 10.8v	317	167
6010DWK	⅜" cordless drill kit, 7.2v	155	89
6010SDW	⅜" cordless drill, 7.2v	103	58
DA3000DW	⅜" angle drill, 7.2v	238	130
4390DW	9.6 volt cdls. recip saw kit	218	122
6010DL	⅜" drill w/flashlight, 7.2v	198	113
6012HDW	2 spd. driver drill w/clutch & case*, 9.6v	224	110
6710DW	Cordless screwdvr kit, 7.2v	186	103
6092DW	V/spd. drill, kit complete	237	115
6093DW	V/spd. drill w/clutch—complete	248	119
6891DW	Drywall gun 0-1400, 9.6v	225	119
DK1001	6010 DWK drill kit comp. & 4071D vac. cleaner	178	115
632007-4	9.6 volt battery	49	29
632002-4	7.2 volt battery	42	27
5007NBA	7¼" saw w/elec. brake	228	125
5008NBA	8¼" saw w/elec. brake	276	145
804510	Sander	80	46
99008	3"x21" belt sander w/bag	254	139
9924DB	3"x24" belt sander w/bag	268	139
9035	⅓ sheet finish sander	106	58
90458	½ sheet finish sander	216	116
9045N	¼ sht fin. sand. w/bag	219	117
4200N	4⅜" circ. saw 7.5 amp	213	111
5201NA	10¼" circ. saw 12 amp	560	298
4301BV	Orb. v/sp jig saw 3.5 amp	274	146
JR3000WL	2 sp recip saw w/cse	220	122
JR3000V	Vs. recip saw w/case	224	125
LS1020	New 10" mitre saw	440	229
9820-2	Blade sharpener	354	199
410	Dust collection unit	480	269
3705	Offset trimmer	255	129
19008W	3¼" planer w/case	198	115
1100	3¼" planer w/case	381	185
9207SPC	7" sander-polisher	262	139
3601B	1⅜ H.P. router	242	125
37008	½ H.P. trimmer	180	92
95018	4" grinder	137	65
804530	6" round sander	95	57
804550	¼" sheet pad sander w/bag	85	46
DA3000R	⅜" angle drill	256	130
DP4700	½" v/sp w/rev. 4.8 amp	198	109
6300LR	½" angle drill w/rev	325	175
2708W	8¼" table saw	474	245
2711	10" table saw w/brake	800	460
GV5000	Disc sander 5"	109	59
6800DB	2500 rpm 3.5 amp	140	79
6800DBV	0-2500 rpm 3.5 amp	154	89
6801DB	4000 rpm 3.5 amp.	140	80
6801DBV	0-4000 rpm 3.5 amp	154	89
2030N	12" planer/jointer	2970	1575
2040	15⅝" planer	2470	1375
18058	6⅛" planer kit w/case	646	339
JV1600	var. speed jig saw	220	119
JV2000	var. speed orb. jig saw	242	127
5005BA	5½" circular saw	211	115
95038H	4½" sander-grinder	153	79
6404	⅜" drill 0-2100 rpm, 2 amp.	102	55
6510LVR	⅜" drill rev. 0-1050 rpm	137	72
6013BR	½" drill rev. 6 amp	240	125
5402A	16" circular saw - 12 amp	605	325
36128R	3 H.P. plunge router	376	185
9401	4"x24" belt sander w/bag	302	162
3620	1¼ H.P. plunge router w/cse	182	97
4302C	V/spd. orb. jig saw	287	145
50778	7¼" Hypoid saw	248	139
LS1430	14" Mitre saw	624	419
2414	14" cut-off saw AC/DC	350	195
5007NB	7¼" circ saw 13 amp	209	110
36128	3 HP plunge router sq/b	376	185

SKIL SIZZLERS

Model		List	Sale
5510	(551) 5½" circ saw	112	92
5625	(552) 6½" circ saw	175	110
5656	(553) 7¼" circ saw	132	103
5665	(554) 8¼" circ saw	204	118
5750	(807) 7¼" circ - drop foot	198	115
5765	(808) 8¼" circ - drop foot	216	130
5790	(810) 10¼" circ - drop foot	400	229
5825	(367) 6⅛" worm saw	229	139
5865	(825) 8¼" worm saw	250	149
4580	Vari - orbit jig saw w/cse.	144	82
3810	10" Mitre saw	263	189
595	3"x21" sander w/bag 5.5A	197	125
7565	¼" palm sander	52	34
7313	3x18 belt sander 4.5A	72	58
77	7¼" worm drive	230	132
5350	2⅓ HP circ. saw	80.99	69
5250	2¼ HP circ. saw	58.99	49

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2735-04	12v V.Spd. Cordless Drill comp. w/cse & 2 Batt.	210	118

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TR6	Trimmer	177	95
TR8	Plunge router, 1½ H.P.	219	119
TR12	Plunge router, 3 H.P.	354	169
C10FA	10" dlxe. mitre saw	490	265
C8FB	8½" slide compound saw	859	475
C15FB	15" mitre saw	745	389
FREUD LU85M015	15" Carb. Bld. 108 Tooth	181	115

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28-283F	14" Band Saw w/enclosed stand & ¾ H.P. motor	599.00
43-122	Lt. Duty Shaper w/stand & 1 H.P. motor	499.00
17-900	16½" Floor Drill Press	289.00
40-601	18" Scroll Saw w/stand and blades	679.00

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Model#	Diameter	#Teeth	List	Sale
73-756	6-1/2	36	28.96	16.30
73-717	7-1/4	18	13.14	7.10
73-737	7-1/4	24	16.36	9.00
73-757	7-1/4	40	29.72	16.35
73-758	8	40	42.04	24.15
73-759	8-1/4	40	42.86	24.60
73-739	9	30	31.48	17.85
73-769	9	60	66.58	38.95
73-740	10	32	32.98	14.00
73-770	10	60	67.02	25.00
73-715	5-1/2	16	13.00	7.30

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3203-HT	3"	5.22	3.00	67.50
3204-HT	4"	9.48	5.15	115.85

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#3/0	6"	3"	14.83	8.35	47.60
#2/0	7"	3½"	15.94	8.95	51.00
#0	8"	4½"	17.74	9.95	56.70
#1	10"	6"	20.29	11.40	64.95
#2	12"	8½"	23.29	13.00	74.00
#3	14"	10"	29.53	17.50	99.95
#4	16"	12"	38.38	23.00	139.95

STYLE 37 2½" Throat ¼"x¾" JORGENSEN

Item No.	Jaw Length	List	Sale	Box of 6
3706	6"	8.86	5.50	29.70
3712	12"	9.81	5.95	32.50
3718	18"	10.83	6.85	37.50
3724	24"	11.83	7.35	40.00
3730	30"	13.19	8.25	45.00
3736	36"	14.43	8.95	49.00

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Model		List	Sale	Lots of 12
50	¾" black pipe clamps	12.48	7.50	80
52	½" black pipe clamps	10.41	6.00	65

STYLE J. ADJUSTABLE HANDSCREW KITS

Model	Length Jaws	List	Sale
J04	4	7.10	3.75
J06	6	8.13	4.25
J08	8	9.12	4.80
J10	10	10.66	5.75
J12	12	13.21	6.90

BOSCH

Model		List	Sale
1581VS	Top hdle. jig saw	235	129
1582VS	Barrell grip jig saw	220	119
	Bosch metal case for above jig saws	34	26
	Bosch blade assortment for jig saws 30 of Bosch's best selling blades	23.99	
1942	Heat gun 650°-900°	99	69
1272D	3"x24" B.S. w/bag	299	172
1273D	4"x24" B.S. w/bag	315	179
11-212	Bulldog ¾" SDS rotary	339	189
1196VSRK	⅜" vs hammer drill	215	110
1198VSR	½" vs hammer drill	229	125
1608	5.6 amp lam trimmer	140	77
1608L	Same as above w/trimguide	145	84
1608T	5.6 amp tilt base trim	159	91
1609	5.6 amp offset base trim	205	122
1609K	Lam installers kit w/1609	295	165

Offset base, trimmer lilt base, trimguide, ¼" collet, collet nut, wrenches, hex keys and case

1601	1 H.P. Router 25,500 rpm	165	98
1602	1½ H.P. Router 25,000 rpm	199	110
1603	1½ H.P. D handle Router	223	120

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1606	1¾ H.P. D hdle. Router	243	135
3258	3¼" planer w/blade guard	210	121
3258K	3258 planer w/cse.	235	139
3270D	3"x21" belt sander w/bag 5A	225	131
1273DVS	Var spd. 4"x24" 6 speed range sander 10.5 amp.	339	189
1611	3 H.P. plunge router	349	202
1651	7¼ circ. saw drop foot	179	99
1654	7¼ circ. saw pivot base	179	99
1922K	Cdlss. jig saw w/cse.	239	169
921VSRK	⅜" cdlss. drill v/spd. w/clutch and case	235	137
1632VSRK	Recip. saw 8.4A orb. v/spd.	225	129

SENCO AIR NAILERS

SFN1	Finishing nailer 1" - 1¾"	349	265
SFN2	Finishing nailer 1½" - 2½"	529	395
SN2	General purpose 1⅞" - 2⅜"	525	415
M2	General purpose 1⅜" - 2"	440	345
SN4	General purpose 2" - 3"	635	475
LS2	Pinner ⅝" - 1"	325	258
SKS	Stapler	325	257

WORKMATES By Black & Decker

Model		List	Sale
79-029	#85, 18#	63.00	39.00
79-032	#200, 23#	103.00	65.00
79-033	#300, 28#	117.00	70.00
79-034	#400, 35#	152.00	98.00

Black & Decker Deals

1707	8½" crosscut mitre saw	813	469
2037	0-4000 5 amp drywall gun	160	92
1703	10" mitre saw w/73-770 blade	313	169
2660	0-4000 4.5 amp drywall gun	138	87
4015	½ sheet sander 3 amp	190	109
2600	⅜" 0-1200 4.5 amp drill	125	76
4018	½ sheet sander 2.3 amp	122	76
3051	7¼" worm drive 13 amp	246	142
3027-09	7¼ circ. saw 10.5 amp	170	75
3103	2 spd recip w/case	193	95
3028	7¼" circ w/18 tooth carb bld.	130	75
3047-09	7¼" super saw cat w/brake	282	164
3048-09	8¼" super saw cat w/brake	297	174
3157	Orb v/spd. jig saw	202	125
3153	V/spd. jig saw	195	121

RYOBI SPECIALS

Model		List	Sale
JP155	"NEW" portable 6" jointer/planer	545	335
R500	2¼ H.P. plunge router	326	159
TS251U	10" mitre saw	392	169
TS251US	10" mitre w/acc. kit & 60 tooth carbide blade	435	199
AP10	10" surface planer 13 amp.	820	358
TS380	14" mitre saw	773	339
W640	7¼" AC/DC dbl insul.	210	99
R150K	1 H.P. plunge router w/cse	206	95
E3810	0-2500 3.7A drywall gun	143	69
RJ102K	2 sp. 6A recip saw w/cse	218	89
W740C	8¼" AC/DC dbl insul circ saw	234	115
8E321	3"x21" v/spd. belt sdr.	259	119

PORTER CABLE

Model		List	Sale
630	1 H.P. router 6.8 amp	170	110
690	1½ H.P. router 8 amp	215	115
691	1½ H.P. router D hdle	235	129
536	1½ H.P. speedmatic router	310	195
518	3 H.P. 5 speed router	560	319
520	3 H.P. 15 amp router	510	298
309	3.8 amp lam trimmer	135	85
310	3.8 amp H.D. lam trimmer	190	114
312	Offset base lam trimmer	215	119
319	Tilt base lam trimmer	221	129
695	1½ H.P. router/shaper	299	190
696	H.D. shaper table	165	105
351	3"x21" belt sander w/o bag	215	119
352	3"x21" belt sander w/bag	225	122
360	3"x24" belt sander w/bag	310	175
361	3"x24" belt sander w/o bag	290	170
362	4"x24" belt sander w/bag	325	185
363	4"x24" belt sander w/o bag	310	180
7556	½" right angle drill	295	175
315-1	7¼" top hdle 13amp circ saw	195	105
9315-1	315-1 comp. w/cse. & carb. bld.	225	125
617	7¼" pushhandle 13 amp	195	105
9617	617 comp. w/cse. & carb. bld.	225	125
368-1	8¼" top handle 13 amp	205	129
314	4½" trim saw 4.5 amp	205	125
548	X HD bayonet saw	255	165
9548	X HD bayonet saw w/case	275	175
9629	Recip saw v/sp 8 amp	230	130
9627	Recip saw 2 speed 8 amp	220	125
666	⅜" H.D. vsp drill - Hdl	185	122
621	⅜" H.D. v spd. 0-1000 rpm	155	90
320	Abrasive plane 3 amp	150	98
126	Porta plane 7 amp	290	164
9118	Porta plane 7 amp kit	325	185
9652	Versa plane 10 amp kit	430	275
7545	0-2500 v spd. drywall gun 5.2 amp	169	100
7540	0-4000 5.2 amp gun	165	99
505	½ sheet pad sander	195	100
7511	⅜" v spd. drill 5.2 amp	185	105
7514	½" v spd. drill 0-750	195	114
303	Paint remover	230	150
304	7" disc sander 4000 rpm	195	125
305	7" disc polisher 2000 rpm	195	125
367	3¼" planer 6.5 amp	225	148
537	1½ H.P. D hdle router	325	205
7548	Top hdl jig saw 4.8 amp	215	119
7648	Barrel grip jig saw 4.8 amp	210	119
330	Speed block sander ¼ sht	97	54
555	Plate biscuit jointer 5A w/cse	280	159
345	6" saw boss 9 amp	160	95
5060	"Stair Ease" stair templet	194	125
5061	"Stair Ease" hard wood stair templet	204	135
659	0-4000 drywall gun 4 amp	130	74
100	⅞ H.P. router	160	94
59381	Door hanging kit	229	152
399	Drywall cutout unit	110	69
43218	Drywall cutout unit bit	6.75	5.50
5008	Dovetail template kit	99.50	69
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308	"NEW" laminate slitter	189	135
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9647	TIGER CUB recipro saw	185	115
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8500	Extra 12v battery	48	33

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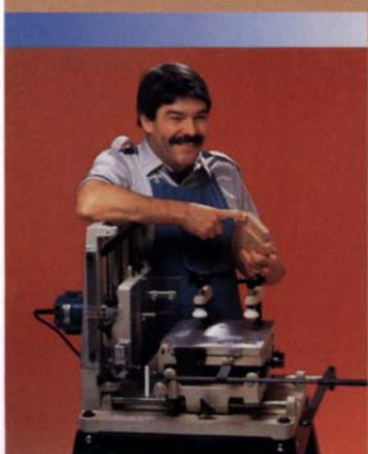

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3612B 3 hp router	195
3620 1¼ router	105
3700B Trim router	98
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They run cooler than conventional steel guides and are more "slippery". You can set them actually touching the blade, consequently giving more control and accuracy over the cut. They are sure to improve the performance of whatever bandsaw you use. 9 sizes are available to fit most bandsaws.

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33K09.01	"A" Delta 14"	$9.95
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33K09.03	"C" Inca 10½"	$9.95
33K09.04	"D" Shopsmith	$9.95
33K09.05	"E" Old Sears (¼" Rd.)	$9.95
33K09.06	"F" Jet 14" (fits most Delta-type copies)	$9.95
33K09.07	"G" Gilliom (5/15" Rd.)	$9.95
33K09.08	"H" Delta 16"	$9.95
33K09.09	"K" Sears 12" (Electron.)	$9.95

C / Garrett Wade Has Discovered Some Very Interesting Bandsaw Blades.

1/16" "Super Narrow" Blades

You may have never seen a blade like this 24 tpi. In a raker style, these give smooth cuts while making incredibly tight turns. We strongly recommend our "Cool Blocks" for these delicate blades, because they can be set closer to the blade without danger of overheating or destroying the teeth as normal metal guides can.

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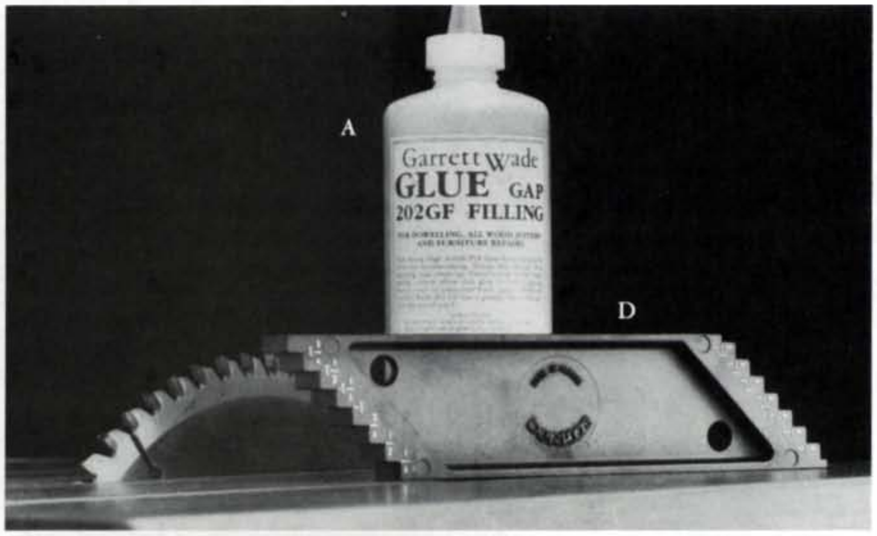

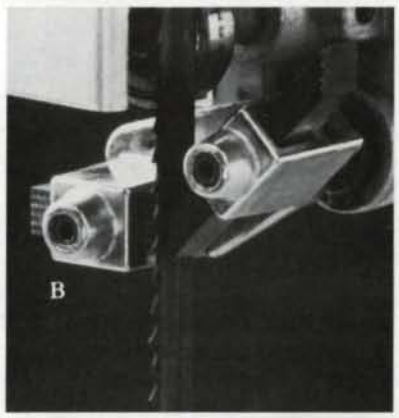

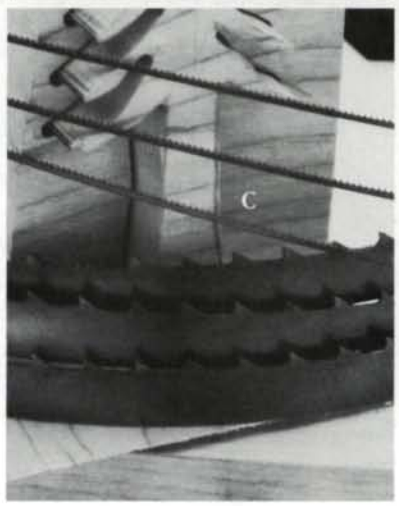

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33K12.02	¼" Cabinet.	$11.30
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72" Blades (Shopsmith)		
33K13.01	1/16" Scroll	$11.25
33K13.02	¼" Cabinet.	$10.20
33K13.03	½" Cabinet.	$10.50
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310.160	1/16" Scroll	$11.25
310.161	¼" Cabinet.	$10.20
310.162	½" Cabinet.	$10.50
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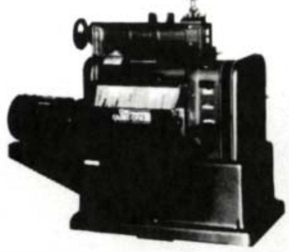

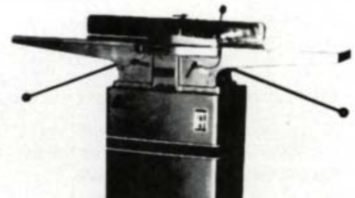

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LU84MO12 12"X60T COMB.	69
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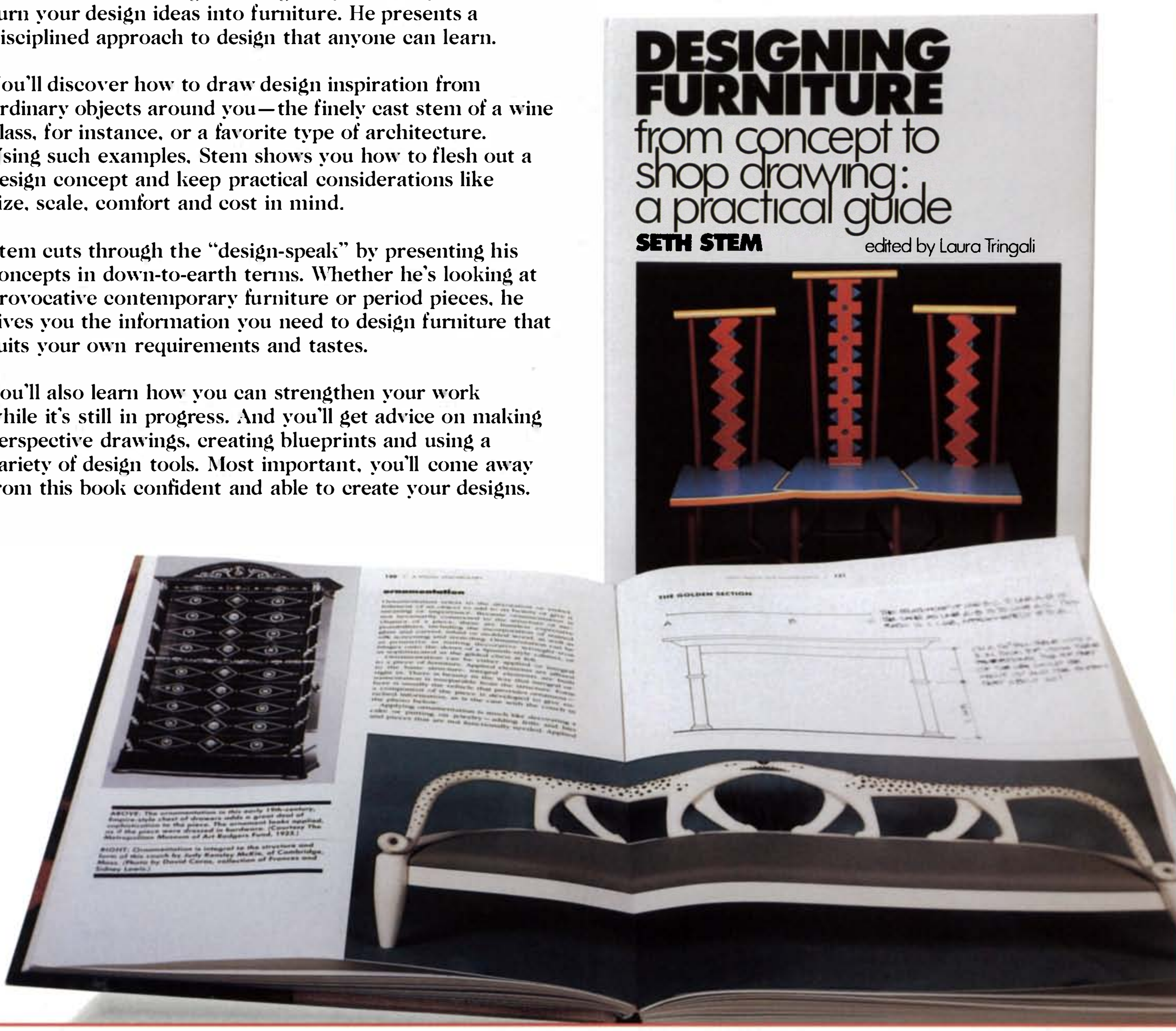

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Listings of gallery shows, major craft fairs, lectures, workshops and exhibitions are free, but restricted to happenings of direct interest to woodworkers. We'll list events (including entry deadlines for future juried shows) that are current with the months printed on the cover of the magazine, with a little overlap when space permits. We go to press two months before the issue date of the magazine and must be notified well in advance. For example, the deadline for events to be held in March or April is January 1; for July and August, it's May 1, and so on.

ALABAMA: **Juried exhibit**–"Magic City Art Connection," April 7–8. MCAC, Eileen Kunzman, 1128 Glen View Road, Birmingham, 35222; (205) 595-3563.

CALIFORNIA: **Exhibit**–"Four Traditions," the revitalization of the fine craft traditions within the larger arts community context, April 2–21. Southwestern College Art Gallery, 900 Otay Lakes Road, Chula Vista, 92010. Contact Joanne Peterson at (619) 421-0349, 421-6700, ext. 636 or 423-7405 (home); or Judith Nicolaidis at 421-0349, 421-6700, ext. 635 or 266-2605 (home).
Class–Building Sea Urchin, a traditional Nova Scotia rowing skiff, w/ Simon Watts, April 22–29. Contact Crissy Field, National Maritime Museum Assoc., Bldg. 275, San Francisco, CA 94129. (415) 929-0202.
Workshops–Traditional Japanese woodworking shoji screen, tansu chest, joinery & hand sharpening by Jay Van Arsdale. Contact Hida Tool Co., 1333 San Pablo Ave., Berkeley, 94702. (415) 524-3700.
Class–Building the Petaluma, a recreational rowing shell, w/ Simon Watts, April 8–15. Contact Ann Smith, 240 12th St., Arcata, 95221. (707) 826-1544.

COLORADO: **Classes**–Comprehensive carpentry and woodworking courses, day and evening. Red Rocks Community College, 12600 W. 6th Ave., Golden, 80401. For spring 1989 class information, call John Sperling at (303) 988-6160, ext. 211.

CONNECTICUT: **Workshops**–18th-century joinery techniques, w/ Eugene Landon, Mar. 4–5; surface design & techniques, w/ Robert Dodge, Mar. 11–12; woodfinishing techniques, w/ Gregory Johnson, Mar. 18–19. Contact Brookfield Craft Center, Box 122, Route 25, Brookfield, 06804. (203) 775-4526.
Exhibit–"Beautiful Soup," tureens and bowls, Mar. 22–May 6. The Elements Gallery, 14 Liberty Way, Greenwich, 06830. (203) 661-0014.

DISTRICT OF COLUMBIA: **Show**–1989 Washington Craft Show, April 20–23. Departmental Auditorium, 1301 Constitution Ave., N.W. For info., call (202) 357-2700.
Seminar–Smithsonian Institution meeting of ornamental turners, Mar. 30–April 1. Reception Suite, Nat'l Museum of American History. Contact Ted Crom, Route 2, Box 212, Hawthorne, FL 32640. (904) 475-1609 or 475-2291.

FLORIDA: **Workshop**–1-week "Ultralight" canoe building workshop with Thomas Hill, Mar. 6–12. Contact Wally Mason, Florida Gulf Coast Art Center, 222 Ponce de Leon Blvd., Belleair, 33516. (813) 584-8634.

ILLINOIS: **Expo**–5th annual American Craft Expo, Sept. 7–10. Application deadline: Mar. 1. Need duplicate slides of 5 works and nonrefundable $15 application fee. Contact Christine Robb, 530 Willow Road, Winnetka, 60093. (312) 441-7964.
Show–10th annual Fountain Square Arts Festival, June 24–25. Evanston. Application deadline: April 7. For application, contact FSAF, c/o Evanston Chamber of Commerce, 807 Davis St., Evanston, 60201. (312) 328-1500.
Show–Chicago Art Buyers Caravan Show, May 6–8. Expocenter, Chicago. Open to buyers from the trade only. Contact Paul Karel, ABC, 408 Olive St., St. Louis, MO 63102. (314) 421-5445.

INDIANA: **Workshops**–Sharpening techniques, tablesaw, router seminar, scroll-saw use. Free. Contact Edward B. Mueller Co. Inc., 3940 S. Keystone Ave., Indianapolis, 46227. (317) 783-2040.

IOWA: **Juried show**–19th annual "Art in the Park," May 20–21. Four Square Park, Main Ave., Clinton. Closing date: April 1. Clinton Art Assoc., Box 132, Clinton, 52732. (319) 259-8308 (Carol Glahn).
Exhibit–American Wildfowl Decoys, April 16–June 10. Shorebird and duck decoys carved between 1870–1960. Muscatine Art Center, Muscatin. Contact Susan Flamm, 444 Park Ave. S., New York, NY 10016. (212) 481-3080.

KANSAS: **Seminars**–13th annual wood technology seminar, Mar. 30–31; installation of architectural woodwork seminar, April 9–12; veneering procedures & applications, May 4–7. Nat'l Wood Technology Ctr., Pittsburg State Univ., Pittsburg, 66762. (316) 232-5500
Juried show–"Dimensions '89," Lenexa's 5th annual nat'l 3-dimensional art show, May 19–21. Sar-Ko-Par Park, 87th Street Parkway at Lackman Road, Lenexa. For more info. and entry forms, contact William H. Nicks Jr., show director, City of Lenexa, 13420 Oak, Lenexa, 66215; (913) 541-8592 or 492-8800.

KENTUCKY: **Workshop**–Greenwood chairmaking, techniques, technology & design, April 1–2. Instructors: John P. Alexander Jr., Drew Langsner, Brian Boggs; $110. Contact Brian Boggs, 114 Elms St., Berea, 40403. (606) 986-9188.

MAINE: **Lecture**–Chuck Paine will review recent developments in design and construction of yachts, Mar. 1. The Rockport Apprenticeshop, Box 539, Sea Street, Rockport, 04856. (207) 236-6071.
Classes–2-week design-&-build courses, Mar. 6–17, June 12–23, Nov. 6–17. Shelter Institute, 38 Centre St., Bath, 04530. (207) 442-7938.

MARYLAND: **Juried show**–Rocky Gap Music & Crafts Festival, Aug. 4–6. Rocky Gap State Park, Cumberland. Traditional and contemporary crafts (no kits). Deadline: April 1. Contact Lisa Land, Governor's Office of Art and Culture, 80 West St., Annapolis, 21401. (301) 974-5110.
Juried shows–14th annual Spring Arts & Crafts Fair, April 14–16. Montgomery County Fairground, Gaithersburg. 12th annual Spring Crafts Festival, April 28–30. Maryland State Fairgrounds, Timonium. For info. and application, send 3 stamps (75¢) for postage to Deann Verdier, Sugarloaf Mountain Works Inc., 20251 Century Blvd., Germantown, 20874. (301) 540-0900.

MASSACHUSETTS: **Class**–"Three Centuries of American Furniture," Thursdays, Mar. 16–May 25. Codman Carriage House, Codman Road, Lincoln. 7 P.M. to 9 P.M. Contact SPNEA, Harrison Gray Otis House, 141 Cambridge St., Boston, 02114. (617) 227-3956.
Show–7th annual Woodworking World Show, April 28–30. The Bayside Expo Center, Boston. Contact WANA, Box 706, Plymouth, NH 03264. (800) 521-7623 or (603) 536-3768 Mon. thru Thurs.
Exhibits–Ceramics, fiber, furniture, glass and metal works by students and faculty of Swain School of Design, Southern Mass. Univ., Mar. 11–22. Turned wood by Dan Kvitka, April 29–May 27. The Society of Arts and Crafts, 175 Newbury St., Boston, 02166. (617) 266-1810.
Workshops–Various weekend workshops. Contact Horizons, The New England Craft Program, 374 Montague Road, Amherst, 01002. (413) 549-4841.

MICHIGAN: **Meeting**–Annual meeting of Early American Industries Assoc., May 18–21. Ford Museum & Greenfield Village, Dearborn. Reservation deadline: April 10. Contact EAIA, Box 2128, Empire State Plaza Station, Albany, NY 12220-0128.
Class–Lofting and building the Herreschoff pram, w/ Simon Watts, May 6–13. Contact John Wilson, 500 E. Broadway Highway, Charlotte, 48813. (517) 543-5325.
Show–Woodturning show, April 28–May 20. Janis Wetsman 20th Century Decorative Art at Artpack Services, Inc., & A.I.R., 31505 Grand River, Door #10, Farmington, 48024. Call (313) 645-6212.

MINNESOTA: **Show**–ACC Craft Fair's American Craft Expo., Mar. 29–30 (trade) & Mar. 31–April 2 (public). St. Paul Civic Center, St. Paul. ACC Craft Fair, Box 10, 256 Main St., New Paltz, NY, 12561. (914) 255-0039. Contact Marylou Krajci at (212) 420-1140.

MISSOURI: **Show**–2nd annual Laumeier Contemporary Art and Craft Fair, May 12–14. Laumeier Sculpture Park, St. Louis. Applications due Mar. 3. Contact Ginny Herzog, art chairman, Laumeier CACF, 12580 Rott Road, St. Louis, 63127. (314) 821-1209 or 391-8201.

MONTANA: **Festival**–Western Montana College Industrial Arts Department's Annual Festival of Arts and Industry, April 28–29. Cabinetmaking, furniture restoration and woodturning. Contact Western Montana College, Dillon, 59725. (406) 683-7011.

NEW JERSEY: **Show**–Super Crafts Star Show, Mar. 31–April 2. Meadowlands Stadium Club, East Rutherford. Contact Creative Faires Ltd., Box 1688, Westhampton Beach, NY 11978. (516) 288-2004.
Auction–CRAFTS of NJ annual tool auction, April 1. Holiday Inn, Clinton. 10 A.M. For more info., write CRAFTS, 85 Brunswick Ave., Lebanon, 08833.
Exhibit–Spring Showcase, contemporary art, American crafts & jewelry, April 14–May 13. Will feature woodturned vessels by Michael Foster. Sheila Nussbaum Gallery, 358 Millburn Ave., Millburn, 07041. (201) 467-1720.

NEW YORK: **Workshops**–Hand-tool workshops by Robert Meadow. Mar. 11–12, April 15–16. Japanese tools, sharpening techniques, joinery, furnituremaking, instrumentmaking. The Luthierie, 2449 W. Saugerties Road, Saugerties, 12477. (914) 246-5207.
Juried show–3rd annual American Craft At The Armory exhibit and sale, May 4–7. 7th Regiment Armory, NYC. American Craft Enterprises, Box 10, New Paltz, 12561. (914) 255-0039.
Show–1st annual Woodworking World Show, April 7–9. Erie County Fairgrounds, Hamburg. Contact WANA, Box 706, Plymouth, NH 03264. (800) 521-7623 or (603) 536-3768 Mon. thru Thurs.
Show–5th Spring Fling Crafts Festival, April 28–30. Nassau Coliseum, Uniondale, Long Island. Contact Creative Faires Ltd., Box 1688, Westhampton Beach, 11978. (516) 288-2004.
Shows–Frame-O-Rama, April 14–16. Piers 90 & 92, New York Passenger Ship Terminal, NYC. Galeria, April 14–16. Pier 88. Open to buyers from the trade only. Contact Paul Karel, Art Buyers Caravan, 408 Olive St., St. Louis, MO 63102. (314) 421-5445.
Workshops–Weekend boatbuilding workshops, Jan. thru May (last weekend of each month). South Street Seaport Museum, NYC. For reservations, call (212) 669-9416.
Shows–Pratt Creative Arts Therapy Expo, Mar. 18. Spring Creative Arts Therapy Institute, Mar. 12–18. Pratt Institute 200 Willoughby Ave., Brooklyn, 11205. (718) 636-3600.

OHIO: **Conference**–Northcoast Woodturners Turning Conference, Mar. 30–April 1. Coventry High School, 3257 Cormany Road, Akron. Rude Osolnik, Dale Nish, Clead Christiansen & featured club members. Also, trade show and instant gallery. Contact Steve Geiger, 5834 Mallard Court, Mentor, 44060. (216) 257-0346.
Show–1st annual Woodworking World Show, April 14–16. Seagate Center, Toledo. Contact WANA, Box 706, Plymouth, NH 03264. (800) 521-7623 or (603) 536-3768.

OREGON: **Workshops**–"Art Furniture: Surface Treatments," by Beth Yoe, Mar. 5. Various workshops in woodworking for summer quarter, June 13–Aug. 22. Oregon School of Arts & Crafts, 8245 S.W. Barnes Road, Portland, 97225. Call (503) 297-5544 for a summer schedule.

PENNSYLVANIA: **Show**–1st Annual Graduate Apprentice Show, featuring woodworking of former apprentices of Jeffrey Greene, Mar. 4–April 14. Divergence Gallery, Ney Alley, New Hope. Contact Kay Lord at (215) 862-9620.
Juried show–7th annual PA Nat'l Arts & Crafts Show, Mar. 24–26. PA State Farm Show Complex, Harrisburg. PA. Nat'l Arts & Crafts Show, Box 11469, Harrisburg, 17108-1469. (717) 763-1254.
Workshop–Japanese woodworking, w/ Robert Meadows, April 29–30. PGC Craft Center, Tyler State Park, Richboro. $90. To register, contact the PA Guild of Craftsmen, Box 820, Richboro, 18954. (215) 860-0731.

TENNESSEE: **Exhibit**–Seeking exhibit proposals in sculpture, painting, drawing, metal, clay, wood, printmaking, glass, textiles & designs. Deadline: Mar. 15. Send proposals, 12 slides w/ dimension, resume and SASE to Trent Whittington, Exhibit Committee, Appalachian Center for Crafts, Route 3, Box 430, Smithville, 37166. (615) 597-6801.

TEXAS: **Juried show**–Annual Winedale Spring Festival & Texas Crafts Exhibit, April 1–2. Winedale Historical Center, Univ. of Texas at Austin. Contact Gloria Jaster, Box 11, Round Top, 78954. (409) 278-3530.

UTAH: **Workshop**–Annual Woodturning West Symposium, May 4–6. Brigham Young Univ. Richard Raffan, May 8–12. Craft Supplies USA. Contact Craft Supplies USA, 1287 E. 1120 S., Provo, 84601. (801) 373-0917.

VIRGINIA: **Exhibit**–Miles Carpenter Centennial Exhibit, April 28–June 23. Hand Workshop, 1812 W. Main St., Richmond, 23220. (804) 353-0094.
Seminar–"Maximizing Quality & Profit for Your Woodworking," April 29. Registration closes April 1. Contact Jack McClintock, 9901 Burke Lake Road, Burke, 22015. (703) 250-7122.

WASHINGTON: **Shows**–"Members' New Work," new pieces by gallery members, Mar. 2–26. "Elegant Simplicity," of furnituremaker Ross Day, April 6–30. Northwest Gallery, 202 1st Ave. S., Seattle, 98104. (206) 625-0542.
Workshop–Lapstrake construction by Simon Watts, Mar. 18–26. 8:30 A.M. to 5 P.M. The Center for Wooden Boats, 1010 Valley St., Seattle, 98109. (206) 382-BOAT.
Workshops–Planking, Mar. 4; sailmaking & repair, Mar. 18; interior joinery, April 8; flat-bottom skiff, April 29–30. Contact Northwest School of Wooden Boatbuilding, 251 Otto St., Port Townsend, 98368. (206) 385-4948.
Lecture/workshop–Woodworking joinery & design, w/ Tage Frid, April 14 (lecture), 15–16 (workshop). The Center for Wooden Boats, 1010 Valley St., Seattle, 98109. (206) 382-2628.

WEST VIRGINIA: **Workshops**–Wooden handplanes, w/ David Finck, Mar. 10–12; woodturning, w/ Alan Stirt, April 21–23; progressive Windsor chairmaking, w/ Randall Fields, April 24–29. Crafts Center, Cedar Lakes, Ripley, 25271. (304) 372-6263.

WISCONSIN: **Juried show**–17th annual Festival of the Arts, April 2. Fine Arts Bldg (interior courtyard), Univ. of Wisc.–Stevens Point. Contact John Morser, Festival of the Arts, Box 872, Stevens Point, 54481. (715) 341-4655.

CANADA: **Workshops**–Specialty lumber milling, w/ Will Malloff, author of "Chainsaw Lumbermaking," The Taunton Press, which is course prerequisite reading, April 22–28. Contact Don Gillingham at Selkirk Rosemont College, 2001 Silver King Road, Nelson, B.C., V1L 1C8. (604) 352-6601, ext. 232.

CHINA: **Study tour**–Visits to famous woodworking factories, Imperial Palace Museum, Shanghai Furniture Factory, Xian Raw Lacquer Research Institute, June 3–19. $3,505 includes air fare. Contact Eva Frank, 3504 Beneva Road, Sarasota, FL 34232. (813) 923-3377.

Designing and Building Colonial and Early American Furniture (with 47 projects) by Percy W. Blandford. *TAB Books, Inc., Blue Ridge Summit, Penn. 17294-0850; 1988. $12.95, paperback; 193 pp.*

This book covers virtually all the pieces one might need to furnish a well-appointed colonial-American home, but it's not just a projects book. In the first four chapters, the reader is eased into the subject with background information on furniture woods, tools and techniques, joints and special processes for duplicating time-honored styles with today's materials and equipment.

Blandford, both a woodworker and a journalist, presents his material in a smooth-flowing style that is every bit as easy to read as the daily newspaper. The text is organized by furniture categories, with chapters on boxes and chests, tables, chairs and seats, cupboards and cabinets. Each chapter opens with a brief discussion of the history and evolution of these various types of furniture and the functional necessities that dictated their structure and influenced their design. Blandford is not a purist, however, and while he discusses the old joinery methods, he does not worship them. Every effort is made to describe techniques for achieving comparable results using modern tools.

Overall, this is a good book and especially appropriate for the woodworker who finds comfort in knowing a little more about a specific piece than simply how to build it. The drawings are clear and understandable enough to guide the amateur to success. The layout, however, suffers a little in that some of the illustrations read horizontally with the text while others are vertical, causing the reader to constantly turn and twist the book to follow the flow.

The book's one inexcusable shortcoming is its shallow and inaccurate coverage of wood species. A three-page section is devoted to this topic early in the text, and were it not for the author's excellent treatment of other topics, the errors here would have destroyed my confidence in his expertise. For example, the book's general theme is colonial-American furniture, but the scientific names provided for various woods are, in part, those of European species, and out of a total of 15 hardwoods mentioned, at least four of their scientific names are misspelled. For this kind of inaccuracy to survive into a second edition is surprising and doesn't serve the author's credibility. *—Jon Arno*

Router Jigs & Techniques by Patrick Spielman. *Sterling Publishing Co., Inc., 2 Park Ave., New York, N.Y. 10016; 1988. $14.95, paperback; 383 pp.*

Spielman's *Router Jigs & Techniques* might be seen as a sequel to his earlier *Router Handbook*. While I found the handbook to be an entry-level how-to with a sometimes out-of-date survey of routers and related items, this book is packed with up-to-the-minute product reviews, theory and enough tips and techniques to fill two shops with sawdust. Well organized and written for easy reading, the book targets a broad audience, from weekend hobbyists, through school labs, to production shops. Although Spielman opens his chapters with assumptive generalizations, when he gets into the subject matter, it's solid meat and potatoes.

Viewing the router scene, Spielman breaks the book into six sections: bits, safety, commercial aids, commercial machines, shopmade jigs and the ultimate router table.

The first section alone is worth the cost of the book. Here he takes a long look at the revolution in bits, cutter technology and cutting theory. Next comes a much-needed focus on safety that goes beyond the "roll-up-your-sleeves-and-tuck-in-your-tie" clichés I grew up with. Concerned with the working environment, Spielman outlines hearing protectors, hold-downs and dust collection. He cautions against the misuse of the new oversize bits.

The chapters on commercial aids and devices and commercial router machines look at such products as benchtop must-haves, questionable hobbyist gadgetry and spectacular self-contained routing machines that encompass joining, duplicating and pin-routing. Spielman winds up with a frank put-down on commercial router tables vis-à-vis professional needs. His look at several backs up his assertion that the market thrust is at casual amateurs.

The book closes with the chapter "Ultimate Router Table," which attempts to concentrate all the router's potential into one grand fixture. Building it looks like a major undertaking. Before launching into it, I'd make sure of my needs.

Judging from the book's design, some color and innovation in layout would perk things up visually. Also, an appendix codifying source addresses would be welcome. For those of us who still can't visualize a millimeter, including a metric conversion chart is a nice touch.

Overall: Two thumbs up for *Router Jigs & Techniques*.

—Bernard Maas

Woodcarving: A Complete Course by Ron Butterfield. *Guild of Master Craftsmen Publications Ltd., 166 High St., Lewes, Sussex BN7 1YE, England; 1987. $14.50 plus $3 postage and packing, softbound, 128 pp. (Also available from Garrett Wade Co. Inc., 161 Ave. of the Americas, New York, N.Y. 10013.)*

This book comes very close to living up to its title, at least where the beginning carver is concerned. The introduction states simply that woodcarving to one degree or another can be learned by almost anyone and that the "most important requirement when considering taking up the subject is the desire to do." From this point, Butterfield, in a very logical and workmanlike manner, proceeds to guide the reader through the areas of project concept, wood selection, equipment, tool care and sharpening, finishing and a progression of projects.

Throughout the book, instructions are never intimidating and always given with obvious thought to how it was to have once been a novice carver. A basic set of chisels and gouges is recommended to get started; others are to be added after the carver gains experience. The reader is warned not to get caught up with the acquisition of needless tools and gadgets.

Sharpening is explained in the most clear manner I've seen, and the carver who follows these basic techniques will develop, with practice, a solid feel for the edge. Polishing and finishing are presented from the viewpoint of achieving a natural look and bringing out the wood's integrity. Butterfield has an interesting formula that feeds the wood and allows for a hand-rubbed finish. Color is not mentioned; this is the only fault in the book.

The first project is a very simple chip carving, and as with all of the projects, a brief history of the style procedes the instructions. This project is followed by several relief carving exercises, each a little more challenging than the one before. Some are illustrated with very nice cross-section drawings to complement sharp photographs. Butterfield does not give these projects time limits, seeming to realize that this would frustrate the beginner.

The first in-the-round project is a standing bear. This is put forward in a sequence of well-developed line drawings. Upon the completion of this, the carver is taken back to carving in relief for a few projects that are more difficult than what has been attempted before. By the time the reader is brought back to round carving, he should be much more confident and competent.

There is much more to this book than I have time to relate. Suffice it to say, this is one of the finest, most well-thought-out books of its kind to come along in years.

—John L. Heatwole

Jon Arno is an amateur woodworker and wood technologist in Schaumburg, Ill. Bernard Maas is an associate professor of art at Edinboro University of Pennsylvania. John L. Heatwole is a professional wood carver with a studio in Bridgewater, Va.

Photo: Courtesy of Albuquerque Woodworkers Association

During a workshop sponsored by the Albuquerque Woodworkers Association, guest instructor Gunther Wörrlein shows participants how to carve a ball-and-claw foot.

Setting up a guild seminar program

A well-planned, well-managed education program can add a new dimension to any woodworking guild or association: It can attract new members, improve the skills of working professionals and introduce hobbyists to new techniques. A poorly executed program can become a financial drain on your treasury and damage the credibility of your group.

When I joined the Albuquerque, N.M., Woodworkers Association (AWA) in February 1984, I was excited about woodworking and volunteered to head up the AWA's new education program. I had about five years experience as a hobbyist furnituremaker. My full-time (nonwoodworking) job involved setting up management workshops, so I had experience with developing practical workshops and was able to transfer some of these skills to the AWA program. Here, I'd like to share some of these experiences.

The AWA began as a small group of designer/craftsmen. Not so much a guild, but more a voluntary association, the AWA's membership is open to both professionals and hobbyists (see *FWW* #60, p. 84), so its education program needed to serve a broad spectrum of woodworking skills and interests. Our first three workshops were taught by AWA members in their own shops. The topics included hand-cutting dovetails, router joinery, and shaping and smoothing techniques.

Since that time, the AWA has sponsored one or more demonstrations, workshops, seminars or slide lectures each month (in addition to our monthly meeting). Attendance has averaged 20 people per event, with as many as 50 people for some special projects. AWA's membership has grown from about a dozen woodworkers in 1983 to more than 160 members today. More importantly, the AWA's credibility with local woodworkers, suppliers and the public has been enhanced by its successful education program.

Planning and coordination—Establishing a guild education program requires overall planning and needs assessment, locating suitable instructors, marketing events to members and others, obtaining suitable workshop sites, day-of-event tasks, dealing with the financial aspects (fees, expenses, income) and finally evaluating the results. It can be as simple or as sophisticated as the guild members desire. You can "plunge in" and hold two or three events, learning from your early mistakes and successes. Or, you can preplan a year's program in infinite detail. We did some of both.

Your guild will face a diverse range of issues as you plan the typical education program. The key to its success is to appoint an education coordinator to handle the day-to-day arrangements for the program. This person should have a strong commitment to your group and to a quality program. I averaged eight hours a week planning the AWA program, meeting with prospective instructors, developing workshop topics, informing the media of our plans and attending the workshops. As education coordinator, I made monthly reports to the AWA Steering Committee and frequently met with or called the guild officers to advise them of what I was doing. However, the education coordinator needs some authority to make quick interim decisions, say when the group has a chance to take advantage of an out-of-area craftsman's unexpected offer to lecture or give a demonstration in Albuquerque during a brief visit to the area.

In order to gauge the education needs, the AWA surveys all members approximately every 18 months. We have been getting about a 60% response on these questionnaires, so we feel the results are fairly accurate. We ask members their preferences for the workshop day, length and time. We also list 20 or more possible workshop topics and ask each member to list their top three choices. About once a year, the AWA tries to bring in a well-known craftsman from out of state. We ask members to list their preference for these special programs. In 1987, AWA members asked that Australian Richard Raffan teach a two and one-half day turning workshop.

Working with instructors—For instructors, the AWA draws on the skills of its members as well as on some excellent nonmember woodworkers throughout the state. We presently pay each instructor a $150 honorarium for two two-hour demonstrations. Instructors of longer, hands-on workshops are paid on a negotiated rate. We try to find instructors who are highly skilled and who can communicate their ideas clearly during the workshop.

Local suppliers refer us to several prospective instructors. Woodpecker's Tools in Santa Fe, N.M., suggested we contact Gunther Wörrlein, a carver and chairmaker in Lamy, N.M. He has taught two well-received workshops for the AWA, including last year's two-day program on how to shape a cabriole leg and carve a ball-and-claw foot.

Because many woodworkers do not have a teaching background, we try to work closely with each instructor prior to his or her first workshop. A couple of members may preview the demonstration and suggest changes or visual aids. (A common problem with early workshops was that instructors tried to cover too many topics in a single session.)

While I rarely used formal contract forms with instructors, I did always utilize a "letter of understanding." After meeting with the instructor at the workshop site, I would follow up with a one- to two-page letter detailing the terms of the agreement: what is expected of each party; the size of the group (in many hands-on workshops, the limit is eight or 10 people); the date, time and place of the workshop; the amount, method and time of payment; how the purchase of supplies will be handled; etc.

For out-of-area instructors, we sometimes provide lodging and meal allowances, although most craftsmen prefer to stay with AWA members during their visit. Because they may see their visit to New Mexico as a tourist opportunity, I always had the State Tourism Department send our instructors a map and brochures. Workshop space for seminars is provided by individual instructors, other AWA members, schools or supply stores. Frank Paxton Lumber Co., Kitts Enter-

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prises, Woodworkers Supply and the Albuquerque public schools all regularly provide free use of their space for AWA events. The type of educational events will, of course, dictate the size of space needed.

Safety and follow-up—The safety of participants and instructors is a concern in all AWA workshops. We do not encourage instructors to demonstrate experimental or questionable techniques. We ask that instructors and participants wear safety glasses or shields and use appropriate blade guards.

During one of our earlier workshops, a participant once accidentally backed into a lathe switch and started a large bowl blank spinning, only inches from his back. Nobody was hurt, but now we do a quick safety check of the facility right before the workshop begins. I unplug machines, check the floor for hazardous extension cords and check each stationary power tool for dull or broken blades. We make sure a well-stocked first-aid kit, fire extinguisher and directions to the nearest hospital emergency room are available, too. At the start of each workshop, we clearly state the rules to the group and ask each participant to sign a liability release. While not absolutely protecting the organization in any legal sense, this form does provide a warning to participants. After several years of workshops, we've had nothing more serious than wood splinters.

As the organizer of the AWA education program, it was my job to ensure the workshop space was "ready." In a two- or three-hour workshop, you simply can't afford any delays due to the lack of necessary tools or supplies. I was there to ensure that the demonstration was not held up due to preventable causes. I tried to make sure that extra bandsaw blades, 100-grit sandpaper, a 3⁄32-in. Allen key or scrapwood were available. If the site did not have a blackboard, we brought in a large easel, tape, newsprint and marking pens.

The AWA's education program is marketed to members and nonmembers alike. We send fliers on AWA workshops, seminars, films and slide lectures to woodworkers throughout the state. The AWA also tries to serve the working cabinetmakers among the membership. We asked Rick Koenlinger to teach a class on working with plastic laminates, which was attended by several two- and three-person shops.

At least three months prior to any event (certain hands-on workshops are planned 10 months in advance), we mail out a typewritten press release to national woodworking publications. There is generally no charge for this publicity, and it helps us reach a large audience. Each month, the AWA newsletter spotlights the upcoming events. Both Frank Paxton Lumber Co. and Woodworkers Tools have included AWA educational reports in their sales fliers.

If you do the required preplanning, you will experience few surprises the day of the workshop. At the start of any hands-on workshop, the instructor reminds participants of the safety rules and distributes any handouts. During the presentation, the education coordinator may assist the instructor with his presentations. Most instructors appreciate an extra hand to hold up the end of a long board, set up a clamp or bring in supplies. And, it goes without saying that we ask all participants to assist with the clean-up.

The education coordinator can also be helpful with any problems or complaints of participants or instructors. The most common request is for written notes or a bibliography on the instructor's presentation. If we can't provide these at the workshop, we'll try to mail them at a later date to all names on the sign-up sheet. We generally provide coffee and tea at the workshop, but anything more seems to add unnecessarily to the cost. (I don't like to allow alcoholic beverages at the workshop site, even after the work is done and the tools are put away.)

Some other issues may arise. You should develop a policy on refunds for participants who are unable to attend or who are dissatisfied with the quality of the workshop. The AWA provides at least a partial refund for cancellations, as long as we receive advance notice. In an effort to anticipate future problems, we ask each participant to evaluate the longer workshops.

The AWA takes a careful look at the financial aspects of each workshop. We try to balance the expenses and revenue of each event or series, but some events do not generate sufficient revenue from participant fees. Also, we like to provide a number of no-fee workshops throughout the year. For these, we rely on sponsorship from local businesses and suppliers; in return, they ask that the event be held in their store showrooms. These events generally attract much larger audiences than could be accommodated for in most small shops.

I prepare a line-item budget of projected income and expenditures for each event. This details income from fees paid by participants, donations from businesses, as well as expenses such as instructor's fees, travel expenses, supplies and publicity. I try to be as realistic as possible so there are no surprises. We use member volunteers as much as possible. Very occasionally, the workshop instructor donates his fee to the AWA, although in light of the substantial preparation involved and the time consumed by the actual workshop, most instructors end up donating a chunk of their time anyway.

The financial risk from hands-on workshops, however, is substantial. I wouldn't recommend you undertake such a program without the full discussion and support of your group membership.

—William Pike, Albuquerque, N.M.

Photo: Courtesy of League of N.H. Craftsmen

This prize-winning Windsor side chair is cherry with ash spindles.

Award winners

James R. Becker of Lebanon, N.H., won the Ballentine Best-In-Show Award at the League of New Hampshire Craftsmen Foundation's 14th annual juried exhibit last fall for his contemporary-style Windsor chair, above. The chair, 40½ in. high, 22½ in. wide and 22¼ in. deep, is cherry with ash spindles.

Becker, a former chemistry major, opened his studio, Jas. Becker, Cabinetmaker, two years ago in Lebanon and specializes in custom-designed furniture and reproductions.

Among the other craftsmen honored at the exhibit at the University Art Galleries of the University of New Hampshire in Durham was J. Paul Fennell of Topsfield, Mass., who earned the Woodworkers Gallery Wood Award for his redwood "Turned Wood Vessel #1." The owner of a Salem manufacturing business, Fennell says he devotes his spare time to woodturning as a "passionate avocation." His work is also on display in the International Turned Objects Show (ITOS). For more on this traveling show, see *FWW* #74, p. 116.

Notes and Comment

Do you know something we don't about the woodworking scene in your area? Please take a moment to fill us in. Notes and Comment pays for stories, tidbits, commentary and reports on exhibits and events. Send manuscripts and color slides (or, black-and-white photos—preferably with negatives) to Notes and Comment, Fine Woodworking, ***Box 355, Newtown, Conn. 06470.***

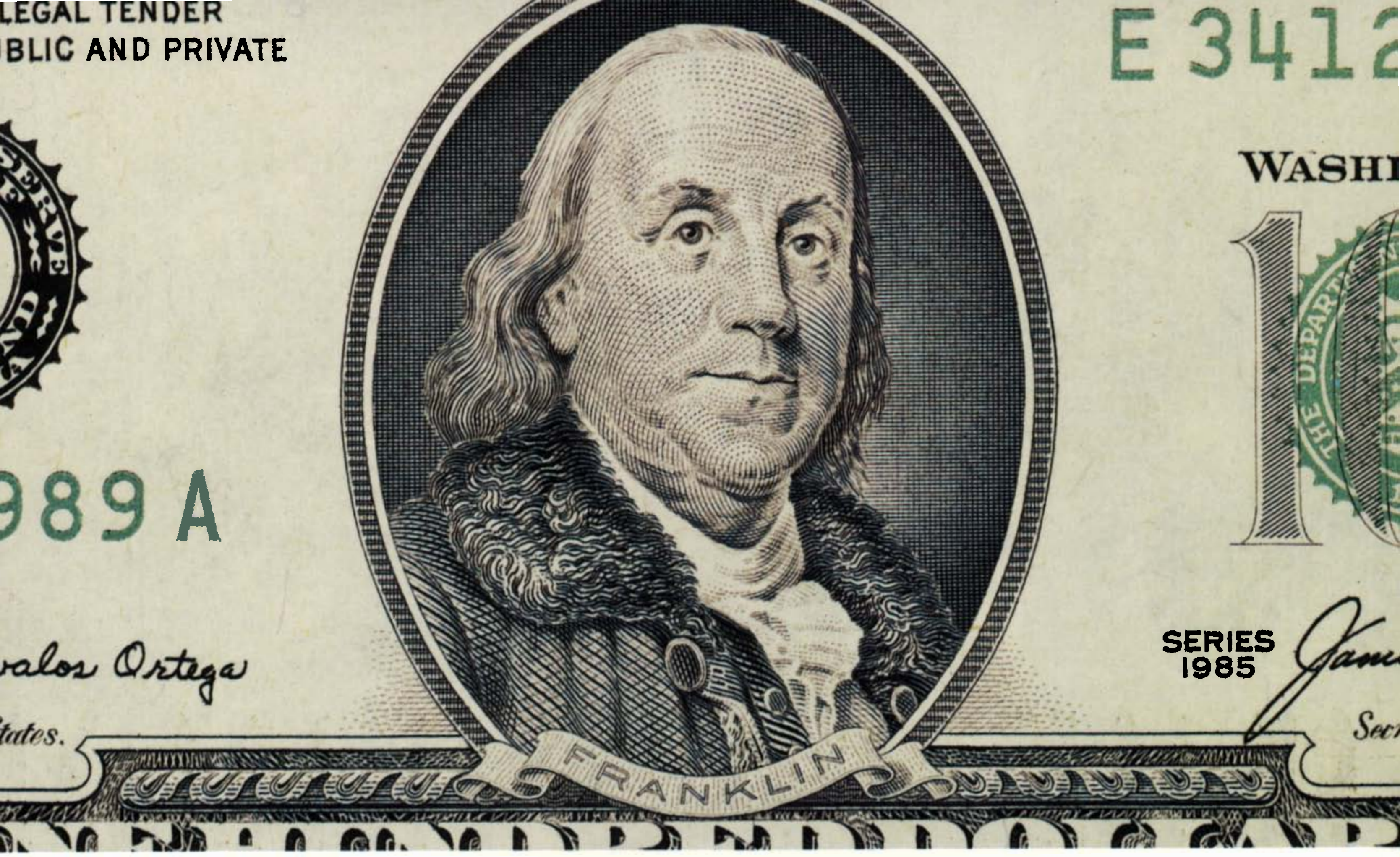

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TABLE DESIGNS HIGHLIGHT PHILADELPHIA REUNION

The tables shown here were among the highlights at a 10-year reunion for three graduates of the former Boston University Program in Artisanry during a joint show last winter at the Snyderman Gallery in Philadelphia, Penn.

James Schriber of New Milford, Conn., veneered the top of his dining table, above, with Swiss pear bordered with lacewood and holly, and edged it with solid lacewood. Squares of holly veneer in the four corners mimic the cross section of the four-piece solid lacewood legs. Two leaves extend the 40-in. by 62-in. table to 90 in.

Michael Hurwitz, director of the Wood Program at The University of the Arts in Philadelphia, sandblasted the parts of his 3-ft.-dia. hickory tea table, below left. He then painted them with white enamel and sanded the surface to get the painted-grain effect.

The curly maple and Swiss pear nightstand, below right, was one of a matched pair shown by Timothy Philbrick of Narragansett, R.I. The drawer case is a spline-mitered box that nestles into cut-out corners in the delicate turned legs.

Photo above: John Kane; below: Tom Brummett; right: Ric Murray