TAUNTON'S

Fine WoodWorking

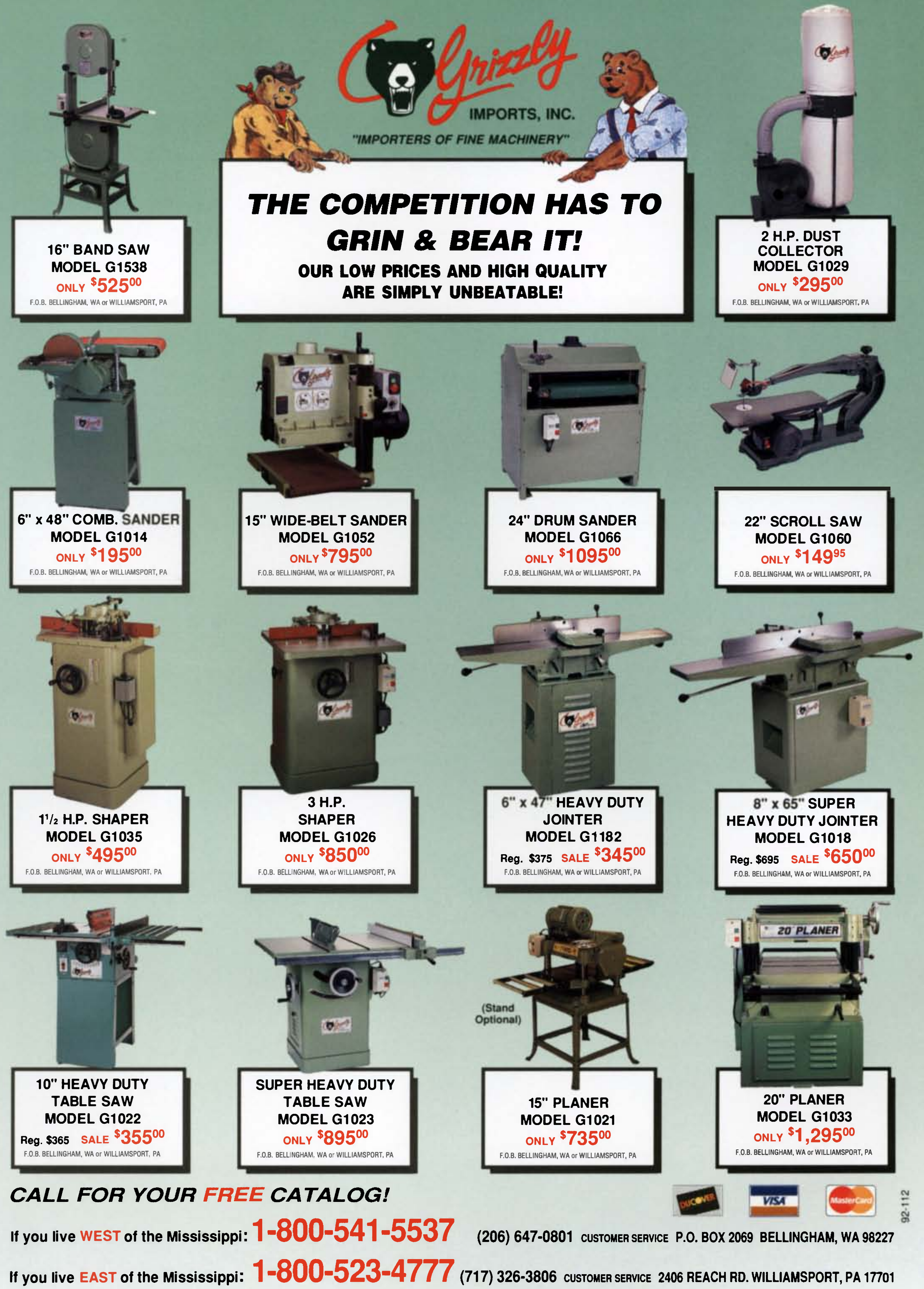
October 1992, No. 96
U.S. $5.95
Canada $6.95
U.K. £3.60

Barrister's bookcase

Power feeders

Woodworking glues

Toggle clamps



READER SERVICE NO. 102

Fine WoodWorking
September/October 1992 No. 96

DEPARTMENTS

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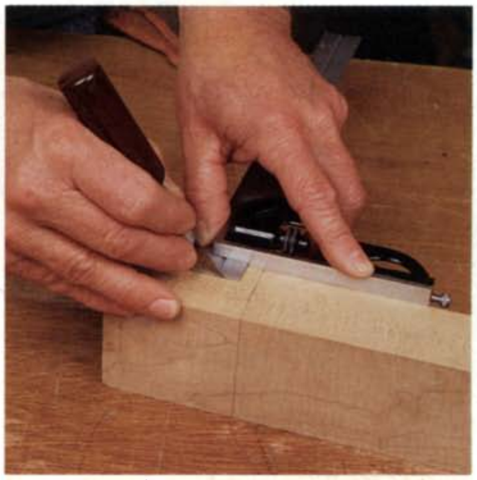

Working with a combination square, p. 60

On the Cover: *Mark Duginske adjusts his tablesaw miter-gauge jig before making a second series of cuts on a pin board as part of his machine dovetail method, p. 66. Photo: Sandor Nagyszalanczy.*

Fine Woodworking (ISSN 0361-3453) is published bimonthly, January, March, May, July, September and November, by The Taunton Press, Inc., Newtown, CT 06470-5506. Telephone (203) 426-8171. Second-class postage paid at Newtown, CT 06470-5506, and additional mailing offices. U.S. newsstand distribution by Eastern News Distributors, Inc., 1130 Cleveland, Rd., Sandusky, OH 44870. GST #123210981

PostMaster: Send address changes to *Fine Woodworking*, The Taunton Press, Inc., P.O. Box 5506, Newtown, CT 06470-5506

Drilling deeper—I really enjoyed Bernie Maas' article on drill press use (*FWW #94*). I would like to expand on his good safety instructions with the following example.

Making an existing hole deeper is easy with metal-cutting point bits because the point of the bit lends itself to position correction when dropping a spinning bit down into a hole. With Multi-spur, Forstner and larger brad point bits, it is likely that any misalignment will result in the outside cutters of the bit striking the wood first and tearing things up. It is always best to stop the drill press, lower the bit down in the existing hole, lock the spindle, clamp the work to the table in that position and then withdraw the bit, turn on the press and drill.

I didn't follow this procedure once when using a 2½-in.-dia. Multi-spur bit to deepen an existing hole, and the spinning rim of the bit grabbed the wood. The result required the services of a surgeon to reattach my left thumb that was severed right behind the knuckle. —*Bob Vaughan, Roanoke, Va.*

Avoid striking metal parts with hammer—Robert Vaughan's article on tuning up drill presses (*FWW #94*) was interesting, but the photograph of adjusting runout of the quill with a claw hammer is wrong.

Use a brass, plastic, rawhide, or wooden mallet. Lacking that, use a piece of wood between the hammer and the shaft. Never hit a machined shaft with a steel hammer. It will leave a flat spot, which will make it tough to accurately replace the chuck.

Leaving the dial indicator against the shaft while you hit it is very bad for the dial indicator. Pull it back away from the shaft. Inside a dial indicator is a very small, precisely machined rack and gear set made of brass. Also, there are several delicate springs.

Never strike a steel shaft with a claw-type hammer. Ball-peen hammers are made of a slightly more malleable steel and are less prone to chip or to flatten the struck shaft.

—*Linwood Fiala, Baudette, Minn.*

Douglas-fir: the name, the myth and the memory—I enjoyed the superb article by Jon Arno about Douglas-fir (*FWW #94*) and I would like to add a little more information.

The common name of the tree came from honoring David Douglas, the plant collector for the Horticultural Society of London, who, in the spring of 1824, saw the fir tree along the banks of the Columbia River on his first voyage to the Pacific Northwest. This was some 31 years after Menzies first collected the species while accompanying Captain George Vancouver on his ship Discovery in 1793. Douglas introduced 254 Northwest plant species to Britain in those early years.

It didn't take long for the tree to be introduced to the rest of Western Europe. Today it may comprise up to 30 percent of some of the stands in the Black Forest of Southwest Germany. It

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is an aggressive competitor with the native species, both in growth rate and natural regeneration. The Germans call the tree and the wood *Douglasie.* Although it is the strongest coniferous wood for millwork in Europe, it also finds its place as a construction wood. In the future, large sized trees with slower growth rates may furnish "old-growth" type wood for their furniture and millwork industries. *–Russ Hudson, Libby, Mont.*

I read the article in *Fine Woodworking* #94 on the virtues of Douglas-fir with a mixture of approval and amusement; approval that woodworkers are finally elevating this beautiful wood to the position it deserves and amusement that the myth of the "Carey Fir" has again surfaced.

Between 1976 and 1983, the Forest Service of British Columbia published a very fine magazine called "ForesTalk" with the intent of bringing the people of British Columbia closer to the history and the current status of the vast forest resource of the province. The fabled Carey Fir (allegedly 417 ft. tall and 25 ft. through the stump) was highlighted in the spring 1978 edition as a hoax–an example of the mythology surrounding the stature of the forests that apparently greeted the first settlers off the coast of British Columbia. Those who doubted the story were convinced that the photograph was of a California redwood or that the photo had been doctored by superimposing the people and tools onto a photo of a Douglas-fir tree with the appropriate scale manipulation.

The spring 1980 edition carried a follow-up story on the Carey-Fir hoax, which stated that the photograph is indeed authentic but depicts a Douglas-fir that was felled in the Kerrisdale district of Vancouver, B.C. in 1896. This still-growing tree was 13 ft., 8 in. in diameter and nearly 400 ft. tall; still a record tree in anyone's book even though it lacks the legendary size of the Carey Fir.

The fascination with large trees seems to be growing (excuse the pun) as our ancient forests come under increasing pressure for development. Public pressure to preserve the last large tracts of coastal rainforest in British Columbia has resulted in a moratorium on harvesting old growth forests in the province until an accurate assessment of this resource and the identification of management options can be presented to the public. It is hoped that an acceptable solution on the use of these areas can be found so that these old growth forests can be managed for their inherent beauty and still satisfy the need for them to contribute to the economic well-being of society. One solution is careful selection and harvesting of mature individuals and the conversion of these trees into products of lasting beauty and high value. Your article goes a long way toward achieving this by highlighting the beauty of furniture carefully crafted from old growth Douglas-fir. The ancient rainforests of British Columbia thank you!

–Michael K. Pelchat, Victoria, B.C., Canada

The articles on Douglas-fir brought back fond memories of New England rural kitchens panelled with narrow tongue-and-groove Douglas-fir planking and farmhouses in eastern Ontario where the same planking covered every ceiling and wall, producing incredibly warm, friendly, dark rooms. Sadly, this lovely rustic turn-of-the-century style has largely disappeared as more modern and less humane fashions gained popularity.

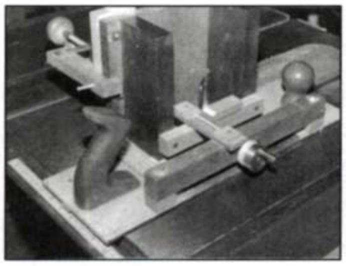
–Ed Margerum, Salem, Mass.

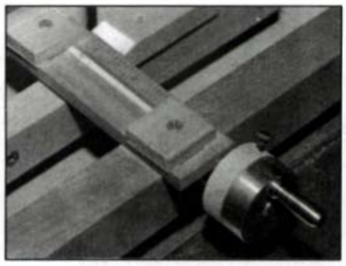
Digital multimeters are better–I read Ted Meyers' article, "Confessions of a Junkyard Motor Junkie" (*FWW* #94) with enjoyment. I too am a bit of a scavenger, and I found his article to be quite accurate.

I would like to suggest, though, that readers take a look at the newer generation of electronic multimeters. They use liquid-crystal displays and are highly visible under any lighting condition including direct sunlight. Their high sensitivity eliminates the need for the two meters that Meyers carries. They are also very rugged. The one I use has been dropped onto the concrete shop floor more times than I care to think about, which will, almost always, destroy a moving-needle multimeter.

The price for one of these meters (I am partial to the Fluke Model 12 that lists for $90) is about what a good sawblade would cost. *–Dave Halliday, Seattle, Wash.*

A better tenoner–The beautifully crafted tenoning jig by Lyle Kruger (*FWW* #93) would have its usefulness enhanced by the addition of a micrometer dial graduated in .001-in. increments. Three years ago, I put such a dial on a tenoning jig that I had made 30 years previously (see the photos below), and now I enjoy freedom from cumbersome fractions.





The dial is a .75-in.-thick laminated disc mounted on the threaded rod between the crank and the thrust plate. The disc should be capable of rotating freely around the threaded rod but must also have a knurled setscrew for clamping it to the rod. A strip of heavy paper on which are marked 62.5 divisions is glued to the circumference of the disc. Rotation of one division translates the slide .001 in. A further improvement would be to replace the threaded rod with either a ¼-in. or ½-in. rod with 20 threads per inch. In either case, there would be 50 divisions on the dial, each representing .001 in. *–Frederick W. Weissborn, Cincinnati, Ohio*

Taking power tools to Europe–In the June 1992 issue of *FWW*, Bard Schive asked about bringing U.S. power tools to Europe. My own experience may be of interest–I returned to the United Kingdom from Canada in 1985 with several 110-volt (v) tools.

110v transformers are easily obtained in the U.K. as a lot of 110v power tools are bought by professionals (for site use I'm told; apparently they are safer).

I bought a 1,500-watt transformer for 90 pounds ($160) and I run a router, sander, portable drills and saws through it. I also run a Sears bandsaw with a ½-HP motor without problems. My Sears radial saw required a 240v, 50-cycle replacement motor, as Ed Cowern suggests.

The transformers are supplied with special 3 pin plugs (which prevent plugging a power tool into a 240v supply). Mine has two 110v outlets. *–Alan Axwall, Dorchester, England*

Caulking up a bandsaw tire–I have just received the latest *Fine Woodworking* (#95) with the article on installing bandsaw tires. Just last week I was faced with exactly that job, but with complications. I have a three-wheel bandsaw made in Taiwan, and the distributor, Universal Products, was unknown to me or anyone else. The dealer, now bankrupt, was no help. Where to get a new tire? Even though I'm not a professional, I use my bandsaw more than any other power tool, sometimes daily, always having some project or another going, and I would miss not having it available.

So, left to my own devices, I cut a template out of the plastic lid of a coffee can to match the cross-section of the tire, laid a bead of silicone caulking in the center of the wheel and shaped it with the plastic template. When it dried in 20 minutes or so, I smoothed on an additional layer of silicone, shaped it, then when it was almost dry, smoothed it with a wet finger.

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The saw was ready to use the next morning, and I've used it since. I have no idea how long it will last, but it's quick and dirty and it works. If I had to do it again, as I'm sure I will, I would use a caulking that sets up hard, rather than the soft silicone.

—Cliff Moore, Rocky Hill, N.J.

On/off switches aren't safe—My Craftsman tablesaw has a potentially dangerous on/off switch. This warning might also apply to numerous other brands with 110 volt switches using similar internal mechanisms. This is the type of switch with the yellow button in the center. My saw did not stop when I flipped the switch to off. Upon moving the toggle on/off again, the power was cut, and I imagined that a bit of sawdust must have held the internal parts in the on setting. It worked okay—so I thought—until one day my wife came into the house and asked me why the saw had suddenly started as she walked through the shop. This time it did not stop without pulling the plug. I disassembled the switch and found that both teeter-totter contacts had stuck shut.

Since the contacts weren't burned, I decided to re-engineer the switch. A new one would be of questionable quality anyway. After polishing the contacts, I bent the pivot beams slightly for a little greater contact clearance. Then, by increasing the spring tension a bit, the switch may well be better than a new one. In the future, I'm going to be more concerned with pulling the plug when I change blades on my machines. I'd suggest to everyone who has had a machine switch stick "on," even momentarily, that you repair or replace it pronto. One leg of the switch circuit may already be stuck on. *—Marvin Collins, Eureka, Calif.*

Last nut takes the load—In the article "Machining raised panels" (*FWW #94)* Joe Beals suggests, "Screw on a jam nut and tighten it against the spindle nut." Beals does this to prevent his shaper spindle nut from loosening while running in reversed rotation.

However, jam nuts should be put on before the heavier, load-bearing spindle nuts. The last nut tightened is the nut that takes the load. When the lighter jam nut is put on last and then tightened, the jam nut carries the load, and thread deformation is likely.

This is a very common misapplication of fasteners.

—John Douglas, Milwaukee, Wis.

Getting "tung oil" to dry—Regarding the problem that Antony Porter had (*Fine Woodworking* #94, p. 26) trying to duplicate the methods I demonstrated in my videotape *Wood Finishing*. Porter's problem is that he used pure tung oil. I did not. Pure tung oil is very slow to dry and will never produce the results depicted in the tape.

The product I used in the tape is Waterlox. It dries quickly and, by applying many coats, as I do, it provides more than the marginal protection of an oil finish. For years I have called Waterlox an oil finish, a tung-oil finish, and a polymerizing tung oil, largely because that's what the manufacturer's marketing people want to call it. Bob Flexner, who is writing a book about finishing, tells me that in fact, though tung oil is used to make it, it is not tung oil. It is a thinned varnish—specifically a tung-oil varnish made from tung oil and phenolic resin. Once the oil and resin are cooked together, it is no longer an oil, it is a varnish. Packaging the varnish thinned makes it easier to apply. You can build quite a protective, glossy finish, as I demonstrate on the tape, merely by wiping on a number of thin coats, as if it were an oil. We've all been calling wiping varnish "oil" for years. It's a misnomer. *—Frank Klausz, Peapack, N.J.*

Approaching a perfect fit—The August 1992 issue of *Fine Woodworking* has some very delightful articles. After reading the article by Chris Kulczycki, I am bound and determined to make a bent-plywood kayak—hopefully sometime this decade.

But the article that prompted this letter is "Dealing with Woodworking Mistakes" by Sandor Nagyszalanczy. I recently solved a problem in a manner similar to Richie Starr's advice for dealing with bookshelves that are ripped too narrow: "make a narrower bookcase."

I had just completed gluing up a box to hold wooden dominoes when I discovered that I had built it just a tad too small. Unable to stretch the box or to find an alternate way to pack the dominoes, I cleverly changed the problem.

My box wasn't too small; the dominoes were too large. I trimmed each by 1/64 in. on my tablesaw, sanded the corners a trifle and they now fit perfectly. Of course, this solution was helped by the fact that the dominoes are large, unfinished maple pieces so that the new ends are indistinguishable from the old ones. *—Andrew F. Vesper, Townsend, Mass.*

Continuing evolution—Although I might agree with Jeremy Singley's opinion ("Letters," *FWW* #93) that for many of today's professionals woodworking is not art, I would like to point out that it has been in the past, and it may again be someday. Let us not forget the 18th-century work of Goddard and Townsend. I think that most of us would agree that some of their work is art, which accounts for its value today. Note also the number of successful craftsmen who are duplicating the best of this work.

Most of us woodworkers get so involved in the craft—surfacing and finishing stock, making good joints, even the business aspects of woodworking—that we can lose sight of the higher target. It gets clouded with production deadlines and economic constraints, as it must also have for Goddard and Townsend. After all, they had to make a living, too. But then, what makes their work art. I think it is training in the art forms and an understanding of the recognized rules of shape, color and proportion that Seth Stem describes in his book, *Designing Furniture*. This is what makes some objects rise above craft to achieve a higher level of art.

Which brings us to the current trend in art furniture. The trend itself should not worry us, it should stimulate our imagination. I personally don't like chairs that remind me of a jungle animal, but who is to say that this will not lead to improvements in ergonomics, joinery, even paint and glue materials? Not to mention the further development of new furniture styles. The first time anthropomorphic legs appeared on a Queen Anne high boy, they must have seemed strange indeed.

No, rather than mourn the current trend, I welcome it. The crafts movement is evolving, as it has since the beginning—someday, perhaps, again into art. *—Jim Hale, Saline, Mich.*

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, publisher

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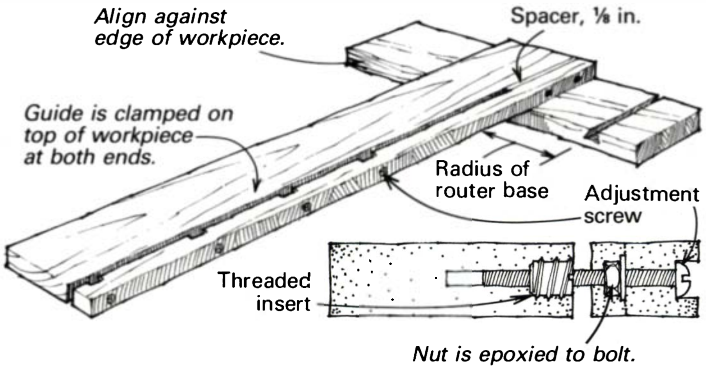
Unlocking drill-press depth-stop nuts

Drill-press depth stops that consist of two nuts and a threaded rod have an annoying habit of locking together. Although tightened by just finger and thumb pressure, they inexplicably resist the same or greater pressure to loosen them. I solved this problem by inserting a red fiber washer between the nuts. Such washers, used in fuel lines and carburetors, are easily obtained in auto-parts stores.

—Kenneth Wells, Portsmouth, England

T-guide for cutting sliding dovetails

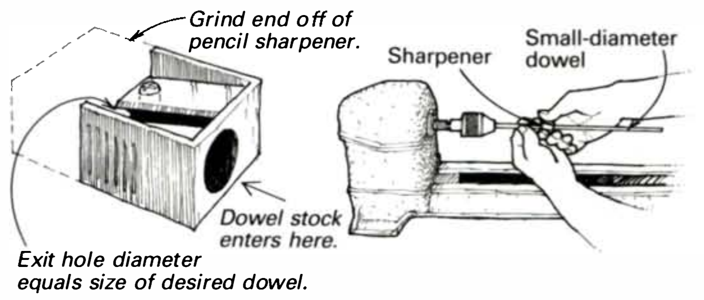


This T-guide adjusts so you can rout a sliding dovetail slot that is slightly wider at one end, such as for the rear of bookcase ends. The tapered slot allows easier insertion of the dovetail cleat but does not compromise the integrity of the joint. Construction of the guide is straightforward, as shown above. For the adjustment action, I installed ¼-in. machine bolts and threaded inserts every 6 in. along the arm. Nuts epoxied to the screw threads provide leverage for moving the arm in and out.

To rout a tapered dovetail, I clamp the guide to the panel at both ends, making sure the head of the guide is at the end of the panel where the joint will be the tightest. After making one pass with the router to cut a uniform-width dovetail slot, I turn the adjustment screws to move the flexible part of the guide arm out a bit—just a quarter turn or so at the far end is usually enough. Then I make another pass with the router to produce a slot that is slightly wider at one end. To complete the joint, I cut the dovetail on the cleat in the standard way using a router table.

—H. Wesley Phillips, Greer, S.C.

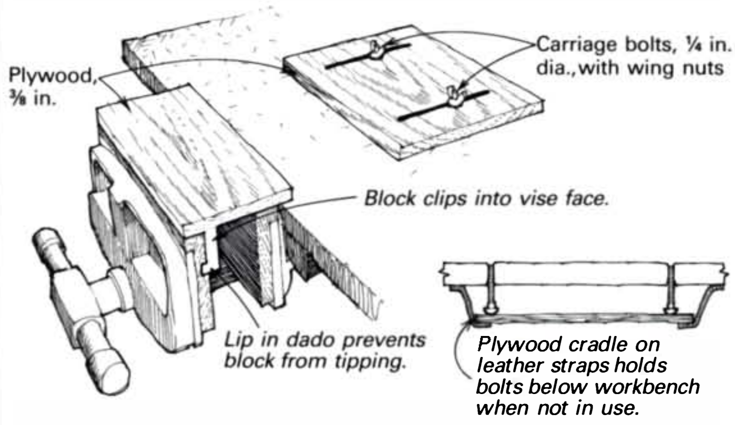
Making miniature dowels



As an amateur model furnituremaker, I often need small dowels. To make mini-dowels, I use a modified twist-type pencil sharpener. I grind the small end (blade and all) off the sharpener so that the size of the exit hole corresponds to the diameter of the dowel I need. To use the tool, I chuck square stock that's small enough to enter the sharpener's wide end (mouth), and with my lathe at its lowest speed, I just run the modified sharpener down the stock. This device works like the old rounding planes that were popular in the hand-tool era. As an alternative, you could also tighten the sharpener in a small vise, and with the stock chucked into a hand drill, carefully push the spinning blank through the sharpener.

—Louis J. Lauler, Churt, England

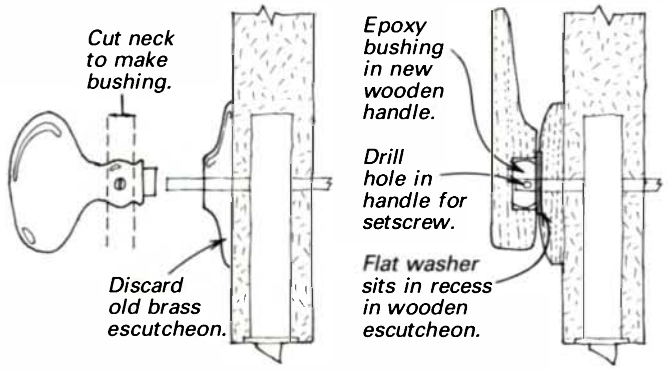
Bench hold fast



My rather restricted workshop/garage does not allow me to add a tail vise to my bench. So I designed this simple hold fast to secure long pieces of wood while I'm planing them on the benchtop. The device consists of two parts, a hardwood block that clips into the vise face and an adjustable fence. Both parts can be easily removed to return the bench to its original usage. I added a leather and plywood cradle below the bench to hold the carriage bolts when they are not needed, but the cradle allows the bolts to be pushed up easily when attaching the fence. The device provides a considerable grip and restrains most workpieces.

—D. A. Kennedy, Rugby, England

Making wooden door handles



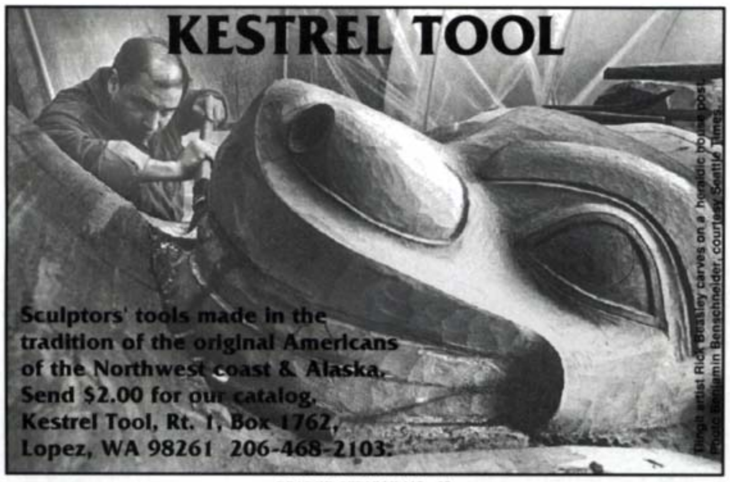
Inspired by pictures that show the variety of wooden door handles in Sam Maloof's house, I came up with a method that enables me to add new wooden handles to original door hardware.

First, throw away your door's original stamped brass rose (escutcheon), and saw the neck of the doorknob, as shown above, to produce a brass bushing about ½ in. thick. Epoxy this bushing in a flat-bottomed hole in the back of the new wooden handle. Drill a hole in the bottom side of the handle to align with the setscrew hole in the bushing. Don't make the handle so heavy or off-center that its weight withdraws the latch bolt. Also, the handle must turn 90° to fully withdraw the latch, so make sure there is enough clearance (for the handle and your hand) between the handle's end and the door casing. Next, make a wooden escutcheon to replace the brass rose. Counterbore a shallow recess in the face of the new escutcheon, and epoxy a washer that sits just proud of the face. Drill the washer the same size as the shaft if necessary. The washer provides a bearing for the shaft as well as a wear surface for the handle to turn on.

—Nelson Hicks, Milford, Conn.

Quick tip: Put paste wax on the threads of the glue bottle to keep glue from sticking and making the bottle hard to open.

—Tom Schrunk, Minneapolis, Minn.



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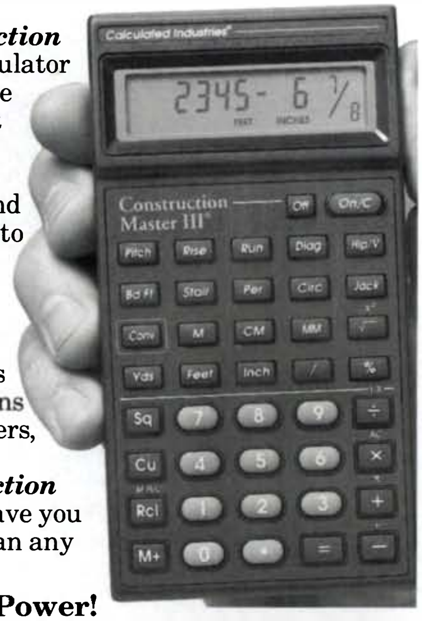

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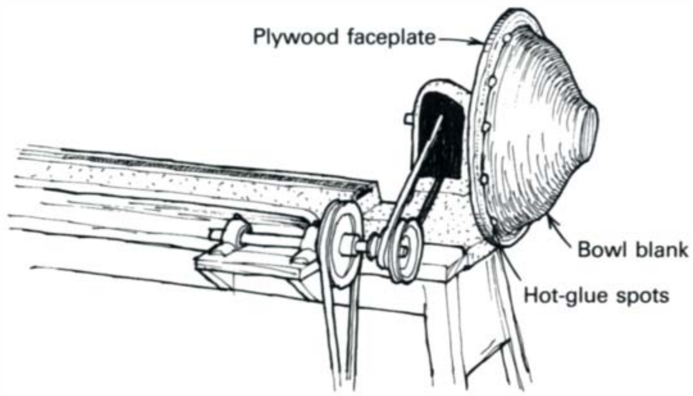
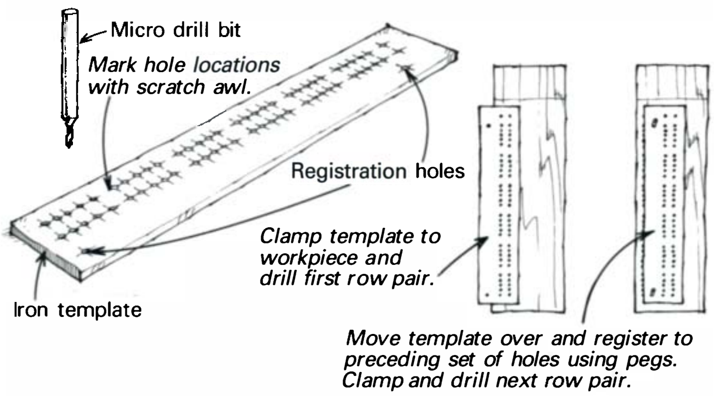
Finishing bowl bottoms



This simple but effective method for finishing bowl bottoms utilizes a plywood mounting plate and hot-melt glue. To make the mounting plate, I attach a plywood disc to a 6-in. faceplate, true it and, with my parting tool, score it in concentric rings about ³⁄₁₆ in. apart. I turn the inside of the bowl on a standard faceplate in a conventional way, and after I've turned, sanded and finished the inside, I part the bowl from the lathe and apply mineral oil to the rim. Centering the bowl face down on the plywood plate, I apply several penny-sized dabs of hot-melt glue around its circumference, each dab should be half on the mounting disc and half on the bowl rim. I use more dabs for larger bowls, fewer for smaller ones. For example, on a 16-in.-dia. bowl, I use about 10 spots of glue, one every 5 in. or so around the rim. Until you develop a feel for the strength of the glue, it's best to apply more dabs of glue rather than too few. I then screw the mounting plate on the lathe's arbor exposing the bottom of the bowl for turning, sanding and finishing.

When these operations are done, I pry the bowl loose from the glue spots. The mineral oil minimizes any glue sticking to the rim, although I sometimes have to use the corner of a flat chisel to lift the glue off the plywood mounting plate. I use this hot-melt glue technique in all my woodturning, ranging from small wine goblets to burl bowls over 3 ft. dia., and I've been consistently pleased with the results. *—Maurice Gamblin, Perth-Andover, N.B., Canada*

Boring cribbage-board holes revisited



Here's a cribbage-board drilling method that's more straightforward than the one offered by Charles Whitney in *FWW* #92, p. 20. Start with a piece of ⅛-in.-thick flat iron long enough and wide enough to accommodate three rows of holes. Using a scratch awl, lay out lines on the iron that correspond to the locations of two rows of holes plus two registration holes, as shown above. Carefully center punch each line intersection. Drill the

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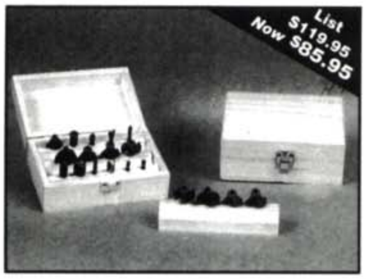

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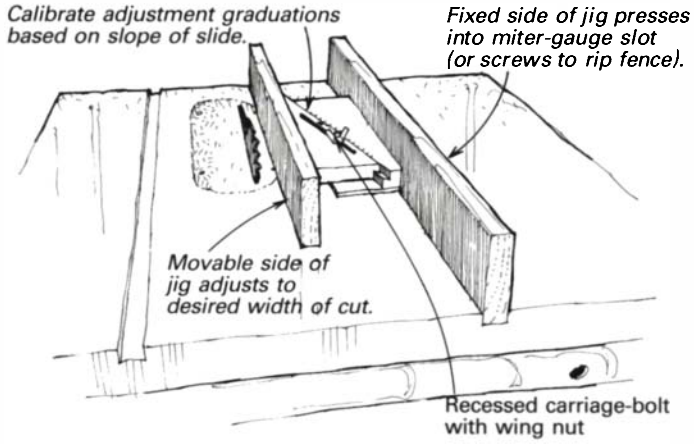
holes with a drill press and a thick-shank bit specially designed for drilling small holes (about 7⁄64 in.) in iron. Regular twist-drill bits have a tendency to bend out of line.

Clamp the iron template to your cribbage blank, and drill the first pair of rows. Unclamp the template, and move it over so that the registration holes are right over the two end holes on the previously drilled rows. Use pegs to register the template, and then reclamp and drill the second pair of rows. Repeat for the third row pair. *—M. E. Woodbury, Orangevale, Calif.*

Micro-adjustable auxiliary fence

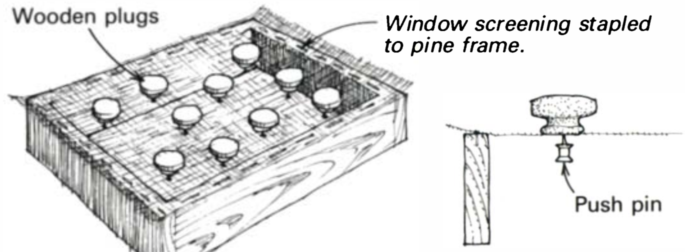


In the past when I wanted to adjust the width of a cut just a hair, I usually just bumped the tablesaw fence with my hand—with unpredictable results. To make my fence more precisely adjustable, I designed this auxiliary fence based on the principle of a machinist's parallel. The jig produces accurate and repeatable results, is easy to build and is adaptable for all kinds of power saws and router tables. The jig's dimensions and hardware can be chosen to suit the machine and job requirements. I used a 9° angle on the slide. Although the half-dovetail slide is not required, it does help hold the parts together.

You can attach the auxiliary fence to a tablesaw in two ways: One, screw it to an existing rip fence, or two, press it into the miter-gauge slot, as shown. Although fastening the auxiliary fence to the rip fence gives a wide range of adjustment, the advantage of pressing the fence into the miter slot is that the unit can be removed while other work is being performed. Later, the auxiliary fence can be replaced with its setting undisturbed.

—Boyd Ewing, Depew, N.Y.

Spray finishing small items



When I needed to finish a few dozen oak plugs for a new stair rail, I came up with a technique that solves most of the hassles of spray finishing small objects. I nailed together a scrap pine frame and snugged and stapled window screen across it. I then secured the plugs by inserting push pins through the screen into the bottom of

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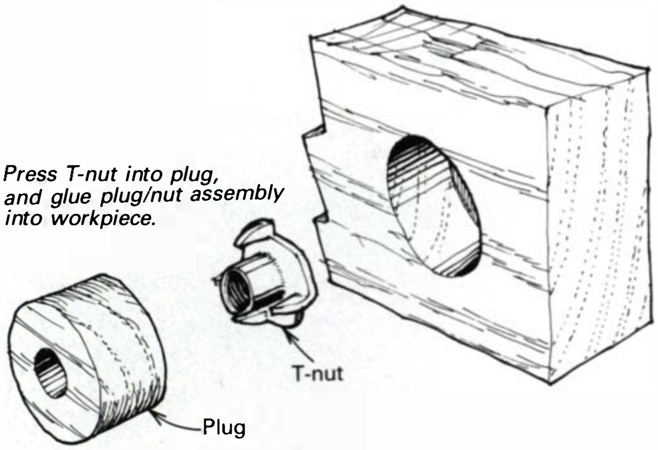
each plug. Air flow through the screen eliminates sprayer blow back, which, in turn, eliminates blobs of paint or finish from forming on the bottoms of the plugs. *—James T. Jones, Jr., Fairfax, Va.*

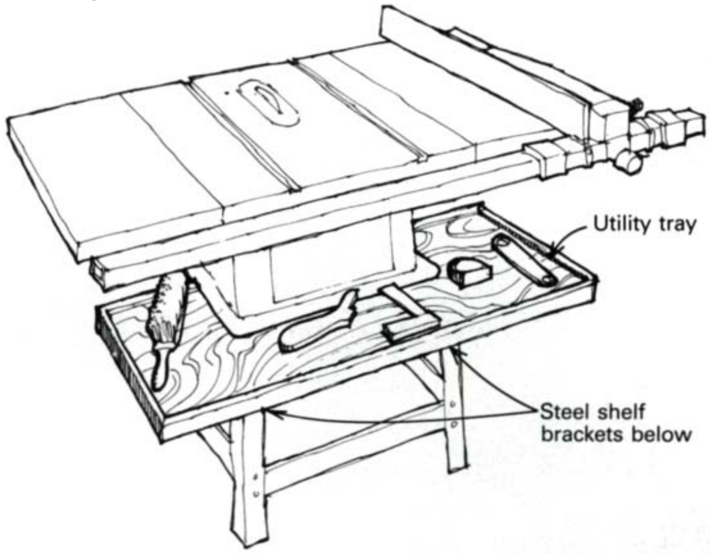
Concealed T-nuts



I use the following procedure to conceal T-nuts. Clamp a piece of stock in the drill press, and drill a hole to accept the T-nut shaft. Change the drill bit to a plug cutter just a bit larger than the T-nut flange, drill out the plug and cut it free. The result is a plug with a centered hole. Press the T-nut into the plug, and glue the plug/nut combination into a matching hole in the work.

I find T-nuts installed this way hold far better than brass threaded inserts, and they are less conspicuous and far less expensive. Three or four Forstner bits with matching plug cutters will cover most any application. *—Terry Lavallee, Sitka, Alaska*

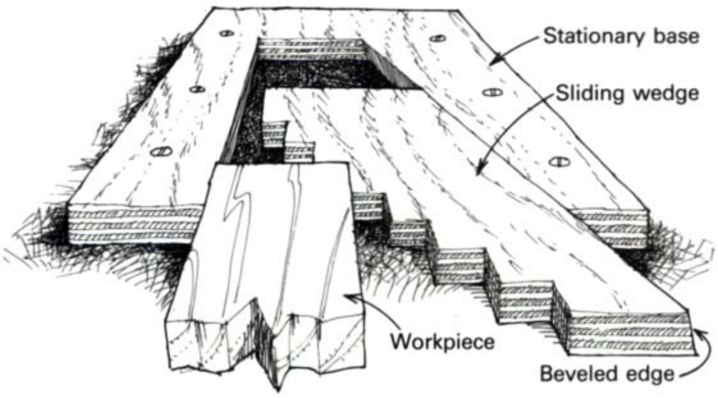
Utility shelf for the tablesaw



I find that a shelf built around the front of my tablesaw base is invaluable for keeping items (pencil, tape measure, miter gauge, bench brush, push sticks, blade wrench) handy. I built the shelf from ¾-in. plywood, supported it with two steel shelf brackets and finished it with scraps of molding around the edge. *—Robert E. Brown, Watertown, N.Y.*

Quick tip: On dark woods, such as walnut, go over your pencil line with chalk. The chalk will adhere to the wood, not to the graphite, resulting in a black-on-white line that's easy to see. *—E. S. Martin, Montrose, Ala.*

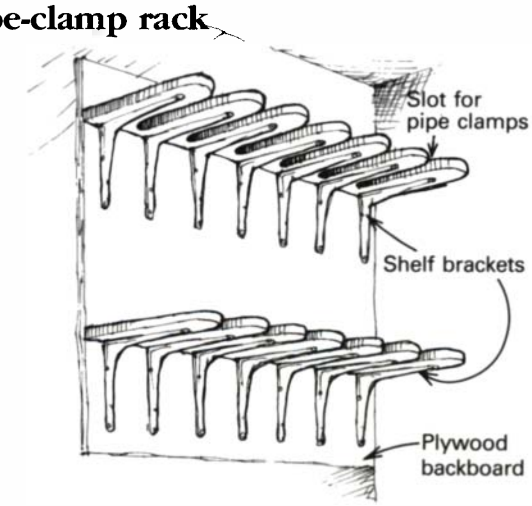
Portable vise



As a youngster, some 60 years ago, I often watched my father doing finish work using a light workbench, which he hauled from job to job. One of the attachments on that bench was a shopmade wooden vise, like the one shown in the drawing above. I reproduced the vise from memory and find it a versatile aid for holding stock both on edge for planing or flat for scraping.

To make the vise, I selected a scrap rectangle of ¾-in. birch plywood, cut the sliding wedge from it with a beveled edge on the angled side, then notched the other side of the wedge at ½-in. intervals. I fasten work in the vise by finding the notch that fits and then tapping the wedge tightly into the jaws. A quick tap on the other end of the sliding wedge will loosen the workpiece. If I were making another, I would use ⅝-in. material so ¾-in. stock would stand a bit proud of the vise and thus be easily dressed. *—Alfred S. White, Los Angeles, Calif.*

Pipe-clamp rack



To hang pipe clamps in my shop, I made the brackets shown above from 11-in.-wide, ¾-in.-thick plywood strips. Comb-like slots hold the clamps. Each slot is 1⅛ in. wide and spaced 3 in. apart. Two sets of supports help the clamps hang straight. Each slot in the supports holds five clamps and accommodates either ½-in. or ¾-in. pipe. Metal shelf brackets between each slot support the heavy clamps. Before mounting the rack, I covered the wall with plywood, so I wouldn't have to worry about hitting studs with the bracket screws.

—Robert C. Hendrick, DeLand, Fla.

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Cutting mild steel on the bandsaw

I would like to use my 12-in. bandsaw to cut mild steel every once in a while. What kind of pulley changes would I have to make to slow my saw down enough to do that?

—Thomas J. Cavanaugh, Tappan, N.Y.

Robert Vaughan replies: Mild steel can be cut well enough with a metal cutting blade running at 300 ft. per minute. But there's more to it than just slipping the appropriate-sized pulley on your saw. Assuming your 12-in. bandsaw has a 1725 RPM motor and a 2½-in. drive pulley, you would need to fit a 45-in.-dia. pulley on the saw's driveshaft. A 14-in. bandsaw would require a 52-in.-dia. pulley, and a 20-in. saw would take a 75-in.-dia. pulley. As you can see, changing a single pulley is not very practical.

To accomplish the speed reduction, I'd recommend using a jackshaft: a separate shaft assembly with two pulleys on either side of an arbor that can be bolted to the machine's base. Set up the jackshaft with a 6-in. pulley on one side, connected by a V-belt to a 2½-in. pulley on the motor shaft. A 2½-in. pulley on the other side drives a 6-in. pulley on the saw's driveshaft. This setup will give satisfactory RPMs for occasional steel cutting on your 12-in. bandsaw. Most likely, some modifications will have to be made to the stand to accommodate the jackshaft. A speed reducer would be technically better, but these devices are much more expensive and more complicated to rig up.

[Bob Vaughan is a contributing editor to *FWW* and a woodworking machinery rehabilitation specialist in Roanoke, Va.]

Spray finishing small parts

I make carved wooden buttons from various exotic and domestic hardwoods. When I try to spray lacquer them, the buttons get blown around by the force of the compressed air. How can I get them to stay put while I spray them?

—Les VanCleef, Lubbock, Texas

Spider Johnson replies: When spraying small items, like the wooden marquetry jewelry that my wife Lora and I produce, it's difficult to get a fine spray finish without using so much air pressure that the pieces go flying. An efficient means of preventing this is simply to place them on a screen, so the air/lacquer overspray can continue through and not blow back. Plaster screen typically comes in 2-ft. by 4-ft. sections and is available at masonry supply houses or lumberyards. It makes a strong, inexpensive and effective surface for those small items, and it can be cut to any convenient shape to suit your spraying purposes. Additionally, the twists in the expanded metal screen create tiny points that lift the object being sprayed, so they have little surface contact with the screen.

To facilitate spraying in my own small shop, I screwed a round piece of plywood to a lazy-Susan bearing and attached a piece of plaster screen to the plywood base with sheetrock screws. Short (2-in.-long) sections of conduit were used as spacers between the screen and the base to lift the screen enough to allow the overspray to escape. I placed the lazy Susan atop a 24-in.-dia. plywood turntable powered by a 6 RPM fractional-horsepower motor (#22806, available from W.W. Grainger, 5959 W. Howard St., Niles, Ill. 60648; 312-647-8900). I can spin the lazy Susan by hand at any time, or I can switch on the turntable to automatically rotate the screen so that I can spray a lot of small items evenly.

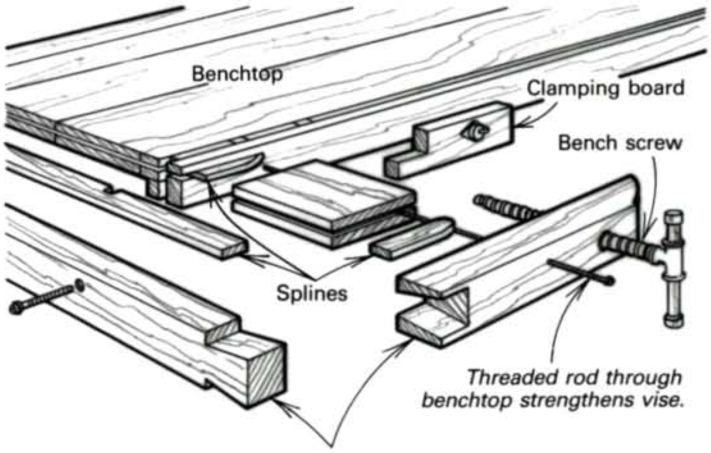
To complete my inexpensive spray booth, I set the screen turntable in a corner of my shop and used an exhaust fan salvaged from a junked walk-in freezer to pull away the fumes and overspray. To speed drying, I mounted a squirrel-cage blower, fitted with an adjustable angling attachment (to vary air flow direction onto the object being sprayed), above the turntable. The fan and blower are wired to the same switch for convenience. I also clamped a flood lamp above the turntable, so I can see what I'm doing and check the evenness of the finish as I spray.

[Spider Johnson is a professional artist from Mason, Texas]

Strengthening a workbench shoulder vise

I am in the process of building a European-style workbench with a Scandinavian or dog-leg shoulder vise. This vise, although very versatile, has the inherent problem of having weak clamping pressure. One method for solving this problem is putting a threaded rod through the entire width of the benchtop and securing it with a nut to keep the vise from pulling away from the benchtop. But I'm concerned about the affect of seasonal wood movement with this method. Are there other solutions to this problem? —Bruce Wilding, Berwyn, Ill.

Scott Landis replies: You're correct in noting the weakness of the dog-leg shoulder vise, as shown in the drawing below, but the threaded rod may be your best bet. I shared your concerns



about wood movement when I reported on Frank Klausz's bench in *The Workbench Book* (see pp. 56-57), but Klausz found that expansion and contraction in his Northeastern shop presented no serious problems. According to Klausz, "as the seasons change, the washer sinks in slightly or the head gets loose (and it's easily tightened). It moves only as much as ⅛ in."

I'm sure you could minimize the impact of expansion and contraction by using a shorter bolt and securing it with a captured nut a few inches inside the front edge of the bench. But that tends to be a weak spot in the benches I've seen, and Klausz advised against it. Of course, be sure to use well-seasoned wood for the top (narrow laminations are better than wide planks), keep it well oiled on both sides and protect it from wide fluctuations in humidity.

[Scott Landis is a writer in Coatesville, Pa.]

Removing milk paint

For the past several years, I have been looking for a miracle stripper to remove the milk paint on an antique walnut corner cupboard I am refinishing. Do you know of a stripper that will remove the milk paint without damaging my beautiful antique? —Stephen R. Courtner, Knoxville, Tenn.

Chris Minick replies: In the process of drying, milk paint undergoes a chemical reaction, forming a resin called calcium caseinate. Calcium caseinate (the binder in some waterproof wood glues) is responsible for milk paints tenacious adhesion, solvent resistance and water resistance. As you probably already know, common solvent-base paint strippers are totally ineffective for removing old milk paint. However, highly caustic strippers like those used in automotive paint-stripping dip tanks will usually remove the paint. Caustic strippers chemically attack the calcium caseinate binder, converting it to an easily removed, water-soluble sludge. Unfortunately, this stripper often attacks the wood fibers, too, turning them to a soft pulpy mass. Further, caustic strippers are extremely dangerous to use: They are highly corrosive and will cause irreversible damage to eyes and skin if improperly handled.

If you must chemically remove the paint from your cupboard, take it to a professional furniture refinisher who is properly equipped to handle caustic strippers and jobs of this magnitude.

Sanding the wood to remove the paint is an option that I find particularly distasteful. Sanding removes all the patina and other wear marks of age from the wood, making it look new and making a valuable antique look like a reproduction.

Preserving the cupboard without removing the paint may be your best alternative. Thoroughly clean the cupboard with soap and water, and then apply a coat of Watco oil to the dried wood. This treatment will protect the remaining painted areas and preserve the authenticity of your antique cupboard. If the milk paint is badly worn, you might also consider repainting. After all, the craftsman who originally constructed the piece painted it; perhaps, you should do the same.

[Chris Minick is a product development chemist and an amateur woodworker in Stillwater, Minn.]

Using shaper cutters on the router?

I just received a woodworking catalog that offers a "router adapter," a ½-in. shaft that allows shaper cutters to be used with a router table. This adapter would afford me a lot more flexibility and variety in my wood-shaping endeavors, but I am concerned about the safety of using shaper cutters in this manner. —*Larry A. Keinath, Havertown, Pa.*

Mark Duginske replies: Being able to use the huge variety of available shaper cutters on the router table seems like a great idea. But shaper cutters are designed to run between 6,000 and 10,000 RPM while most variable-speed routers I've seen only go down to about 12,000 RPM at their lowest speed setting. And even though some variable-speed routers, like the Porter-Cable model 7539, are capable of running at 10,000 RPM (the upper limit for most shaper cutters), there's still a chance that you might accidentally forget to select the slowest speed before switching on the router—a very dangerous possibility. Another potential problem is that regular router bits are balanced with shaft and cutting flutes as a single unit. Although a router-adapter shaft may be well-balanced and a shaper cutter may be well-balanced, the combination of the two may not have proper dynamic balance for safe use.

As a rule, it's best to use router bits in routers and to use shaper cutters in shapers. The two are really quite different machines and require different areas of expertise to set up and to use safely.

[Mark Duginske is a contributing editor to *Fine Woodworking* and a woodworker, teacher and author living in Wausau, Wis.]

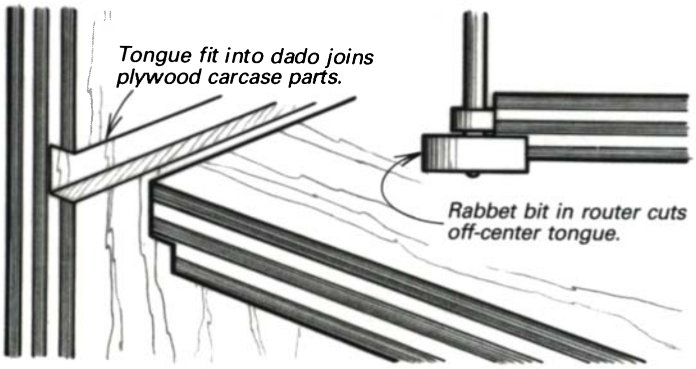
Plywood thickness and carcase construction

I am in the process of building some bookshelves using birch plywood. I planned to rout dadoes in the carcase sides with a ¾-in. straight bit. My problem is that my plywood is thinner (about 1/32 in.) than ¾ in. Is there a source for a slightly undersized router bit, or is there a better way to make the dadoes? —*Walter L. Flanigan, Pensacola, Fla.*

Sandor Nagyszalanczy replies: It's one of woodworking's bugaboos that materials that are said to be one dimension are often another. As you have discovered, ¾-in. plywood sheetgoods are usually less that ¾ in. thick. Many times, this is because they are imported and manufactured in metric sizes: 6mm, 12mm and 18mm. If your plywood is consistently 23/32 in. thick (18mm), you can purchase a special undersized dado bit for your router from Woodhaven (5323 W. Kimberly Rd., Davenport, Ia. 52806; 800-344-6657). However, in my experience, even a sin-

gle sheet of higher-quality cabinet plywood can vary in thickness—a 3/4-in. sheet can measure anywhere from about 47/64 in. to 23/32 in. or less. That is why few cabinetmakers I know will try to cut a dado to fit plywood's exact thickness. Usually the result is carcase joints that fit too loosely or too tightly.

One solution to perfect plywood carcase joints is to cut accurately sized tongues or rabbets on the end of plywood shelves or carcase parts and fit them into dadoes in the adjoining parts. Cutting a centered tongue has the advantage that both edges of the dado will be covered up when the joint is assembled in case the dado cut is a little ragged. However, unless you have a special tongue-cutting bit for your shaper or router table, you'll have to cut the tongue in two passes. I prefer to shape a rabbet



on the plywood edge instead, as shown in the drawing above, like a sort of off-centered tongue. You can shape this tongue using a regular rabbet bit, top piloted by a ball bearing slipped down over the bit's 1/4-in. shank. The pilot bearing runs against the edge of the plywood (as shown). The length of the tongue can be adjusted by changing pilot bearings. To adjust the fit, you can fine-tune the thickness of the tongue by varying the router bit's depth of cut. I usually make a test dado in scrap plywood first—cut with either a 1/2-in.-dia. straight router bit (for 3/4-in. ply) or with a dado blade on the tablesaw. Then I make a test tongue in scrap to try the fit and adjust the cut until tongue thickness is just right. With this method, you'll get snug joints regardless of thickness variations in the plywood.
[Sandor Nagyszalanczy is managing editor of *Fine Woodworking*]

Problems of an aging motor

My single-phase motor seems to be starting slowly. Is my motor just getting old or is there some other problem?

—Nathan James, Colorado Springs, Colo.

Ed Cowern replies: There are two common points of failure in single-phase motors. One is the starting switch and the other is the starting capacitor.

The starting switch is usually a centrifugal device built to snap open and switch off the starting circuit when the motor reaches approximately three-quarters of its full speed. This switch usually has weights and springs, like a fly-ball governor you'll see on old steam engines in museums. Frequently, in woodworking shops, the moving components of the switch get fouled with sawdust or pitch and become stuck or operate sluggishly. If the switch sticks in the open position, the motor will hum but not start; if it gets stuck in the closed position, the motor will be quite noisy and if left on, the motor will get very hot and possibly fail. Starting-switch problems can be prevented by keeping motors clean and blowing away accumulated sawdust before it gets into the motor. In a very dusty shop, it might be a good idea to switch to a TEFC (totally enclosed, fan-cooled) motor.

The second failure point on single-phase motors is the starting capacitor—this is a black plastic cylinder usually mounted externally (in some cases, its mounted inside the motor). Occasionally, the capacitor will weaken or short out. When the capacitor weakens, the motor becomes slow starting. If the capacitor shorts, the motor will be very noisy, may start or run slowly and exhibit the same symptoms as if the starting switch is stuck in the closed position. When it fails completely, the motor hums but doesn't start just as in the case of a starting switch that's stuck open.

It is relatively easy to replace a bad capacitor if it's externally mounted. It is more difficult to replace an internal capacitor or to replace a bad starter switch, but these jobs are still within the capability of most people who are handy. You must always make sure the motor is fully disconnected from the power system before attempting any repair. Replacement parts are available through most electric-motor service shops. The value of the motor's capacitor is usually given in terms of microfarads (mfd) and operating voltage, such as 125 volts AC. This information is usually stamped on the capacitor.

[Ed Cowern is an electrical engineer and president of EMS, a company that distributes Baldor electric motors.]

The growth and anatomy of a burl

To my knowledge, there has never been an article or note describing exactly what a burl is. How do they form, in what species and under what conditions? Also, is it possible to artificially plant burls on living trees?

—Jim Ludwig, Tunbridge, Vt.

Bruce Hoadley replies: The subject of burls is a challenging one, for although we can describe them in terms of what we see, the exact cause and physiology of their development remains essentially unexplained. Burl formation has been attributed to a number of causes ranging from fungi, bacteria, viruses and insect attack to frost, fire and mechanical injury. However, any detailed or scientifically sound verifications of any of these causes has escaped my attention.

The term burl (the English use the term *burr*) is commonly defined rather broadly as any large, abnormal bulge that forms on the trunk or limbs of any kind of tree. Burls appear to have one common characteristic, that of a localized condition which produces prolific and abnormal cambial cell division, resulting in the protruding mass of irregular cell structure. The outer surface of a burl (not including the bark) may be smooth, irregular or furrowed. Internally, the burl may have irregular pockets of included bark or may have irregular patches of heartwood and sapwood. Commonly, burls also include numerous dormant but persistent buds, singly or in clusters, which give an eye-like figure to the wood.

The protrusion of the burl beyond the surface of the tree trunk or limb is the consequence of the uncontrolled cell division, which produces more numerous cells (rather than just larger cells). Not only are the "growth rings" of the wood locally distorted by the curvature of the burl but also the grain is swirled and twisted. Although the cells are arranged in such a way that burl wood is completely unlike normal wood in appearance, many of the key microscopic features of the cells are retained so that the species of a burl usually can be identified by microscopic examination of tissue sections.

It is probable that burls can and do occur in virtually every species although some species, such as redwood, maple and oak, are apparently more commonly afflicted than others. In the world of woodworking, some burls are more noteworthy and

prized, such as walnut and Carpathian elm (*Ulmus procera*). In some trees, a knob of burl-like wood is formed below ground at the tree's base. One of the more notable of these is thuja burl (not related to the Thujia genus of conifers). I have not heard of any methods of artificially inducing burl growth in trees.
[Bruce Hoadley is professor of wood technology at the University of Massachusetts at Amherst and a contributing editor to *FWW*]

Safe woods for children's toys

I am planning to make some toys for my grandson who is at an age where everything goes into his mouth. What woods would be safe to use? —***Walter Shulruff, Wilmette, Ill.***

Jon Arno replies: Wooden toys demand special thought, both in design and consideration of potential hazards. Young children lack the necessary experience and critical judgment to foresee dangers that might be obvious to an adult. Toxic compounds in some woods are certainly of concern, but this does not top the list of potential hazards. Very few woods are so toxic as to be lethal when ingested in small quantities—the leaves and fruit of common house plants present a far more dangerous source of toxins in a child's environment. However, it still doesn't make sense to get too experimental in the use of unfamiliar and especially exotic species of woods when making toys. Hundreds of foreign timbers have been introduced into the market in recent years that have not yet been thoroughly tested with respect to their chemical makeup. Also, there is the slight added risk that imported lumber might contain exotic organisms or germs picked up before shipment.

When making toys for infants and young toddlers, I would stick with kiln-dried, domestic species, and my first choice would be hard maple (*Acer saccharum*). For a number of very good reasons, this wood has long been used for making toys and kitchen utensils. It is so chemically friendly that its sap can be used for making sugar, and its fine, diffuse-porous grain doesn't provide a lot of hiding places for germs to grow. In addition, it is strong enough to withstand a lot of abuse, has excellent working characteristics and produces a smooth, painted surface without the need for fillers. While a number of other woods can match some of maple's better features, there are some which come with potential disadvantages. Walnut, for example, contains a natural sedative and laxative, which could cause discomfort if a child were to chew on it for a while. Also, many woods contain fairly high concentrations of acid, which might cause an upset stomach. Members of the Salicaceae family, such as willows, poplars and aspens, fall into this group as do oaks, which all contain high amounts of tannin.

When you are choosing a finish for wooden toys, read the label for affirmative statements that they are not toxic. Salad bowl finishes, for instance, are clearly sold as non-toxic finishes. Do not assume that a finish is safe simply because it doesn't say it is poisonous.

Setting aside issues of toxicity, faulty design is perhaps the most serious risk in toy making. It is absolutely critical that no removable part of the toy is small enough to be ingested and become lodged in a young child's throat. The toy also should be thoroughly checked to be sure that sharp edges, points, springs or other parts aren't likely to do physical damage if the toy is misused or broken.
[Jon Arno is a wood technologist and consultant in Schaumburg, Ill.]

Send queries, comments and sources of supply to Q & A, Fine Woodworking, *PO Box 5506, Newtown, Conn. 06470-5506.*

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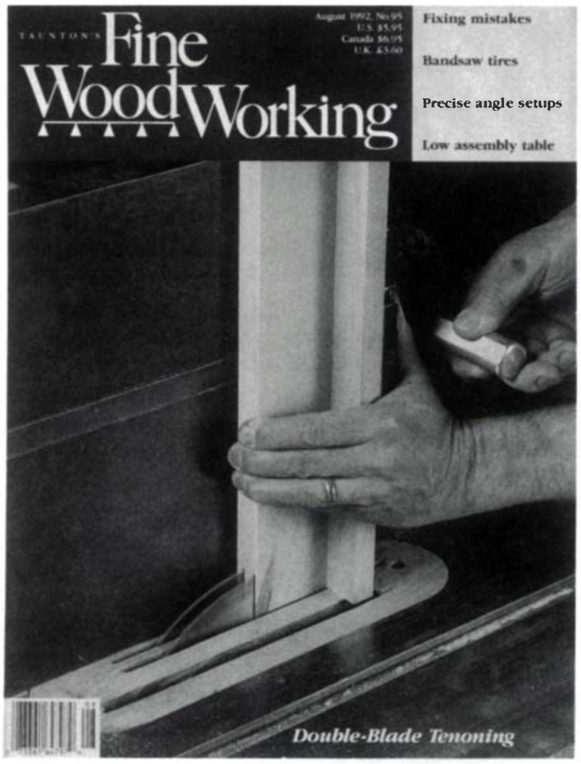

How often in some woodworking magazines do you see a caption that includes the words, "Saw guard removed for photographic clarity"?

In reality, the guy in the picture probably doesn't own a saw guard, and the magazine editor had the choice of taking the picture without a guard or no picture. Shop safety is a real problem when writing about woodworking.

Here at *Fine Woodworking*, we take very seriously the publisher's safety message that appears near the end of the letters column (page 10 in this issue). And although, woodworking is inherently dangerous, we believe it can be a safe hobby and occupation if we (and you) pay attention to safety all the time.

We publish technical material written by real woodworkers about what they actually do in their own shops. Many expert craftsmen do not always follow standard safety practices. What they do may be perfectly safe for them but not so safe for you.

All of this brings me to the cover of our last issue (*FWW* #95), where Mac Campbell demonstrates double-blade tenoning on the tablesaw. We've been expecting some letters about safety, and two of them appear below along with Campbell's reply.

Most woodworkers take pride in the cleverness of their jigs. Some woodworkers also take pride in being conscientious about safety. Their attitude is that we should put as much ingenuity into safety as we put into the design of the cutting procedure itself.

For example, there's nothing to stop Campbell (or you) from adding a toggle clamp to the backup board. You also could screw a retainer over the miter-gauge tongue, so it couldn't flop out of its groove.

But I'd go one step further. Years ago, visiting a little shop on Salt Spring Island off the coast of British Columbia, I noticed a smooth piece of 4x6 Douglas-fir parked on the tablesaw. It had nicely chamfered edges, was a little longer than the width of the table, and had some battle scars.

The shop owner called this timber his insurance policy. He'd clamp it across the saw table whenever he felt that his fingers might be at risk, as a barrier between his hand and the blade. If he were using Campbell's setup, he'd clamp the 4x6 just to the left of the jig's path, under the heel of the left hand.

And, finally, as reader Tom E. Moore of Madison, Va., points out in a letter to Campbell, "Take off the wedding ring. A ring caught in a machine cuts off a finger before you could know what has happened." □

John Kelsey, editorial director

Hands too close to the blade—I cringe every time I look at the cover of *FWW* #95. What Mac Campbell chooses to do or not to do in his own shop is his business. What you show him doing on the cover is just outrageously dangerous. I hope that no novice learning woodworking attempts double-blade tenoning using the method Campbell uses and describes—and that you alert your readership to the dangers of what he is doing. Professional woodworkers I have polled since the issue arrived all feel Campbell's hands are too close to the blades and that it is sheer stupidity to have a loose miter gauge hanging out above the 90-MPH blades.

—John McAlevy, Warner, N.H.

An invitation to disaster—I find it distressing to have the cover of the August 1992 issue of *FWW* showing an invitation to disaster. It looks like Mr. Campbell has already lost his little finger to this arrangement although I know it's the way the photograph was taken. However, techniques like this might convince some woodworker that it is okay to put his hands or fingers in jeopardy so close to those unguarded sawblades.

It would be a much safer operation if there were an adjustable hold-down to keep the stile firmly against the jig's base. That way, the operator's hands could be kept safely away from the rotating sawblades. It would be better to take a little extra time setting up this cut than having the board slip and losing body parts. *—Greg Isaman, Brier, Wash.*

Mac Campbell replies—McAlevy and Isaman have a valid concern regarding the safety of the tenoning procedure as shown. There are, however, a couple of things that should be pointed out. The first is that I do have all my fingers after 14 years of full-time work building furniture. Second, the setup is more stable than it might first appear, in that the backup board is screwed solidly to the miter gauge and sits squarely on the saw table. Finally, the position of my hands in the photograph was arranged to allow the greatest clarity for the photo. My left hand would normally be higher so that the heel of my hand would rest on the upper portion of the miter gauge. Photographing it in this position, however, obscured the miter gauge almost completely. We tried. I confess we should have caught this and perhaps rearranged the photo altogether.

The only safety device that's worth a damn is the one between the woodworker's ears. This is not to say that all the rest are useless, far from it. But it does point out that absolute attention at all times is essential, and there are no mechanical devices that can substitute for this. I have found the jig pictured to be safe, efficient and effective when used with care. That is the only way I would consider using it, and certainly the only way I would suggest that anyone else use it.

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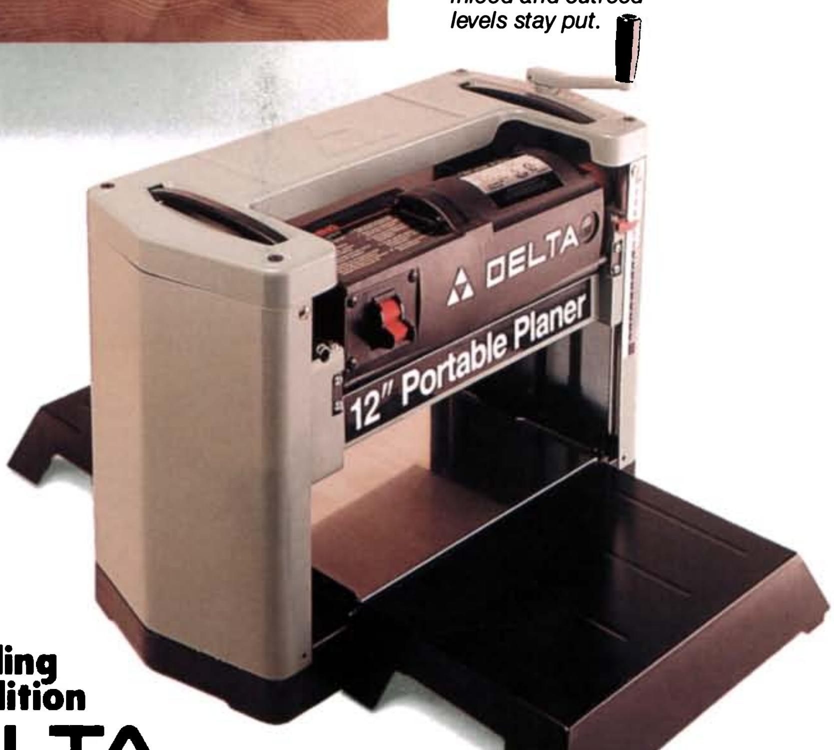

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0219-1	9.6 volt cordless Drill with case	304	175
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5936	Belt Sander 4 x 24 w/bag 10 amp	419	238
6747-1	Drywall Gun 0-2500rpm 5amp	179	99
6016	1/4 sheet Palm Grip Sander	89	55
6017	6016 Sander with dust bag	97	57
6012	1/3 sheet 12,000 orb/min 5 amp	204	115
8975	Heat Gun 570° & 1000°	91	59
8980	8975 Heat Gun with case, air reduction, hook, deflector, & spreader nozzles	138	88
3202-1	D-Handleright angle w/cse 350 rpm	360	198
3102-1	Plumbers rt angle Drill Kit 500 rpm	360	198
3002-1	Elec. right angle Drill Kit 600 rpm	360	198
5660	Router 1-1/2 HP 10 amp	325	180
5365-1	Hawk 1" Rotary Hammer	585	345
6378	8-1/4" Worm Drive Saw 15 amp	334	185
6256	Variable speed Jig Saw 3.8 amp	254	135
6460	10-1/4" Circular Saw 15 amp	459	274
6527	NEW Super Sawzall with case	299	164
6528	above Sawzall with wired cord	295	164
6125	NEW 5" Random Orbit Sander	200	119
6126	NEW 6" Random Orbit Sander	205	125
0399-1	12 volt cordless Drill Kit complete	304	164
0402-1	above Drill with keyless chuck	309	168
0395-1	9.6 volt cordless Drill with case	284	158
0224-1	3/8" Drill 4.5 amp magnum	203	114
0234-1	1/2" Drill 4.5 amp mag 0-850 rpm	223	118
0244-1	1/2" Drill 4.5 amp mag 0-600 rpm	223	118
0222-1	3/8" Drill 3.5 amp 0-1000 rpm	189	105
0228-1	3/8" Drill 3.5 amp 0-1000 rpm	183	102
0375-1	3/8" close quarter Drill	223	127
0379-1	1/2" close quarter Drill	254	145
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6546-1	cordless Screwdriver 200 & 400 rpm	138	79
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5399	1/2" D-handle Hammer Drill Kit	319	184
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6511	2 speed SawZall with case	234	134
6750-1	Drywall Gun 0-4000 5 amp	162	93
6507	Original SawZall with case	249	135
6508	Above Saw with wired cord	245	135
6170	14" Chop Saw 15 amp	489	279
6014	Orbital Sander 1/2 sheet	214	118
8977	variable temp. Heat Gun	122	75
5397-1	3.8" var. speed Hammer Drill Kit	244	138
5371-1	1/2" var. speed Hammer Drill Kit	335	185
3107-1	1/2" var. speed right angle Drill Kit	370	198
6754-1	Drywall Gun 0-4000 5.4 amp	192	114
3300-1	1/2" variable speed right angle Drill	329	184
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6215	16" Chain Saw	309	172
0235-1	1/2" Drill w/keyless chuck magnum	223	125
6145	4-1/2" Grinder 10,000 rpm	162	98
6142	6145 with case & accessories	199	129
6749-1	Drywall Gun 0-2500 5.4 amp	224	119
5353	Eagle 1-1/2" Rot. Hammer with case	910	499
6365	7-1/4" Circular Saw 13 amp	214	120
6367	above Saw - double insulated	209	125
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LM72M010	Ripping 10"	24	66	35
LU73M010	Cut off 10"	60	82	44
LU87M010	Thin Kerf 10"	24	70	37
LU88M010	Thin Kerf 10"	60	86	42
LU91M008	Compd Mitre 8-1/2"	48	67	43
LU85M015	Mitre Saw blade 15"	108	175	105
LU98M010	Ultimate 10"	80	125	67
LU89M010	Ferrous metal 10"	72	102	58
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SD308	8" Dado - Carbide		229	119
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F10	#10 - 2-1/8" x 3/4" Bisuit 1000 Qty		42	29
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FA	Assorted Biscuits 1000 Qty		44	29
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WC106	6 piece Chisel set with case 1/4" - 1"		85	54
WC110	10 pieceChisel set w/cs 1/4" - 1-1/2"		140	84
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6010DWK	3/8" cordless Drill Kit 7.2 volt	173	97
6010SDW	3/8" cordless Drill Kit 7.2 volt	96	59
DA3000DW	3/8" Angle Drill 7.2 volt	241	136
4390DW	9.6 cordless Recip Saw Kit	234	129
4300DW	9.6 volt Jig Saw Kit	237	135
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6092DW	variable speed Drill Kit complete	257	127
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6095DWE	6095DW Drill Kit w/2 batteries	270	139
632007-4	9.6 volt Battery	47	30
632002-4	7.2 volt Battery	39	28
5007NBA	7-1/4" Saw with electric brake	243	127
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B04510	1/4 sheet Pad Sander	93	54
9900B	3" x 21" Belt Sander with bag	283	144
9924DB	3" x 24" Belt Sander with bag	299	159
9045N	1/2 sheet Finishing Sanderw/bag	246	129
4301BV	Orb. var. speed Jig Saw 3.5 amp	262	142
JR3000V	Var. speed Recip Saw with case	239	129
LS1020	10" Mitre Saw 12 amp	571	299
9820-2	Blade Sharpener	394	194
1900BW	3-3/4" Planer with case	221	116
1911B	4-3/8" Planer 7.5 amp	255	139
1100	3-1/4" Planer with case	434	229
9207SPC	7" Sander/Polisher variable speed	294	154
3601B	1-3/8 HP Router	261	139
B04550	1/4 sheet Pad Sander with bag	91	56
DA3000R	3/8" Angle Drill variable speed	285	152
HP2010N	3/4" var. speed Hammer Drill w/cse	304	167
2708W	8-1/4" Table Saw	519	269
2711	10" Table Saw with brake	868	485
1805B	6-1/8" Planer Kit with case	731	369
5005BA	5-1/2" Circular Saw	238	135
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6510LVR	3/8" Drill Rev. 0-1050 rpm	152	83
6820V	0-4000 rpm Drywall Gun 5.2 amp	160	90
6013BR	1/2" Drill Rev. 6 amp	263	139
5402A	16" Circular Saw 12 amp	675	345
3612BR	3 HP Plunge Router	347	164
9401	4" x 24" Belt Sander with bag	343	174
4302C	Variable speed Orbital Jig Saw	283	159
5077B	7-1/4" Hypoid Saw	260	138
LS1440	14" Mitre Saw	759	429
LS1030	NEW 10" Mitre Saw	428	225
5007NB	7-1/4" Circular Saw 13 amp	214	114
3612B	3 HP Plunge Routersquarebase	347	165
2012	12" Portable Planer	913	468
LS1011	10" Slide Compound Saw	859	439
3620	1-1/4 HP Plunge Router w/case	196	115
9901	3"x21" Belt Sander w/bag 6.7 amp	208	119
GV5000	5" Disc Sander	112	69
9514B	4" Grinder 4.6 amp	101	69
9501BZ	4" Grinder 3.5 amp	132	69
4200N	4-3/8" Circular Saw	238	135
2414	14" Cut-off Saw AC/DC	359	205
4320	V/spd economy Jig Saw 2.9 amp	141	88
5012B	11-3/4" elec. Chain Saw 11.5 amp	258	148
2030N	12" Planer/6" Jointer	3450	1885
6302	1/2" Drill 0-550 rpm 5.2 amp	204	115
6013BR	1/2" Drill 550 rpm 6 amp	263	139
DA6300	1/2" angle Drill 300/1200 rpm	438	239
BO5000	NEW 5" Rand Orbit Sander	118	68

BOSTITCH AIR NAILERS

Model	Description	List	Sale
N80S-1	Stick Nailer	Super Sale	359
N80C-1	Utility Coil Nailer	845	409
N12B-1	Coil Roofing Nailer	845	418
N60FN-2	Finishing Nailer 1-1/4" - 2-1/2"	625	355
T29-30	Brad Nailer 19 ga. 5/8" - 1-3/16"	445	265
T31-3SX5035	Stapler 5/32 crown 1/2" - 1"	270	164
T28-5	Finish Stapler 5/32 crown	475	265
MIIIFS	Flooring Stapler 15 ga	895	539
N100S	Stick Nailer 2" - 4"	895	555
T31	Brad Nailer 5/8" - 1"	270	162
CWC100	1 HP Pancake Compressor	445	295

PANASONIC CORDLESS

Model	Description	List	Sale
EY6205BC	NEW variable speed 12 volt Drill with 15 minute charger & case	390	178
EY6200BC	NEW 2 speed 12 volt Drill D-handle with 15 minute charger & case	350	178
EY6281BC	NEW variable speed 9.6 volt Drill with 15 minute charger & case	350	159
EY571B	variable speed 9.6 volt Drill Kit	239	128
EY571BC	EY571B w/case & extra battery	275	158
EY6900BC	NEW 12 volt Hammer Drill var. speed with 15 minute charger	396	199
EY6207BC	NEW 12 volt 1/2" Drill w/keyless chuck var. spd w/15 min. charger & case	421	218

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PORTA NAILER

Model	Description	List	Sale
401	Porta Nailer complete	265	189
501	Face Nailer complete	265	189
1000	Genuine Porta Nails 1000 Qty		15.89
5000	Genuine Porta Nails 5000 Qty		71.50
10,000	Genuine Porta Nails 10,000 Qty		121.85

SUMMER KIT SPECIALS

Model	Description	List	Sale
6093DWH	Makita cdls var. spd Drill Kit w/clutch & brake. Includes extra battery & holster	313	167
9852K	Porter Cable New 9852 Drill Kit Includes: extra Porter Cable battery		185
9853K	Porter Cable NEW 9853 Drill Kit Includes: extra Porter Cable battery		185
7334K	Porter Cable 5" Random Orbit Sander w/case & 1 roll 100X & 150X discs.	253	152
7335K	Porter Cable 5" v/spd Random Orbit Sander w/cse & 1 roll 100X & 150X discs	273	162
7336K	Porter Cable 6" v/spd Random Orbit Sander w/case & 1 roll 100X & 150X discs.	278	169
555K	Porter Cable Plate Biscuit Jointer with case & 1000 assorted biscuits	339	192
JS100K	Freud Plate Biscuit Jointer with case & 1000 assorted biscuits	351	186
1581VSK	Bosch Top Handle Jig Saw with case & 30 Bosch blades	305	182
1582VSK	Bosch CLIC Barrell Grip Jig Saw with case & 30 Bosch blades	305	182
1605-02K	Skil biscuit Jointer with case & 1000 assorted biscuits	244	146
JM100KK	Ryobi biscuit Jointer with case & 1000 assorted biscuits	475	232

BIESMEYER FENCES

Model	Description	List	Sale
B-50	50" Commer. Saw Fence	329	295
T-SQUARE 52	52" Homeshop Fence	249	235
T-SQUARE 40	40" Homeshop Fence	242	209
T SQUARE 28	28" Homeshop Fence	230	198

WEDGE SMART LEVEL

Model	Description	List	Sale
SM-PR2	2 FT Level with sensor	120	88
SM-PR4	4 FT Level with sensor	150	105
SM-PR6	78" Level with sensor	180	139
SERIES200	NEW 2FT Level with sensor		54.95

Model	Description	List	Sale
Msx636	FEIN Electric Oscillating Triangle Sander Kit	Sale	279
LPN672	PONY Air Palm Nailer with glove	Sale	94.99

BOSCH

Model	Description	List	Sale
1581VS	Top Handle Jig Saw	265	131
1582VSC	NEW CLIC Barrell Jig Saw	265	131
	Bosch Metal Case for above Jig Saws	34	32
	Bosch 30 blade assortment for Jig Saws		26.99
1942	Heat Gun 600° - 900°	111	69
1272D	3" x 24" Belt Sander with bag	329	178
1273D	4" x 24" Belt Sander with bag	345	187
1289D	1/4 sheet Sander	98	59
11-212VSR	Bulldog 3/4" SDS Rotary Drill	370	199
1194VSR	1/2" variable speed Hammer Drill	264	145
1194VSRK	above Hammer Drill with case	292	179
1195VSR	3/8" variable speed Hammer Drill	211	135
1608	5.6 amp Laminate Trimmer	149	84
1608LX	5.6 amp Laminate Trimmer w/guide	170	112
1608T	5.6 amp tilt base Trimmer	170	112
1608U	Underscribe Laminate Trimmer	203	135
1609K	Lam Installers Kit with 1609	309	175
1609KX	Deluxe Installers kit	361	198
1600	2-1/4 HP D-handle Router	411	259
1601	1 HP Router	184	110
1602	1-1/2 HP Router	215	132
1603	1/2 HP D-handle Router	252	143
1604	1-3/4 HP 2 Handle Router	236	128
1604K	Same as above w/case & access	287	165
1606	1-3/4 HP D-handle Router	273	155
3258	3-1/4" Planer with blade guard	239	137
3258K	3258 Planer with steel case	265	152
3270D	3" x 21" Belt Sander with bag	260	142
1273DVS	var. speed 4" x 24" Belt Sander	370	188
1615	NEW 3 HP Plunge Router	395	228
1615EVS	NEW 3 HP w/spd Plunge Router	460	255
1613	NEW 1-3/4 HP Plunge Router	286	164
1613EVS	NEW 2 HP v/spd Plunge Router	320	184
1614	NEW 1 HP Plunge Router	220	128
1614EVS	NEW 1-1/4 HP v/sp Plunge Router	255	149
1632VSRK	Recip Saw 8.4A orb-v/spd	225	145
3050VSRK	9.6V cordless v/spd Drill Kit comp	256	135
3051VSRK	3050VSRK with keyless chuck	266	145
1370DEVS	6" Random Orbit Sander	481	249
3283DVS	5" Random Orbit Sander	159	98
3283DVSK	3283DVS Kit	220	129
3272	3-1/4" Planer 4.2 amp	147	88
3272K	above Planer with case	162	105
1347AK	4-1/2" Grinder with case & access	170	108
1348AE	5" Grinder 8.5 amp	195	118
11304	"The Brute" Breaker Hammer	2055	1219
11305	Demolition Hammer 10 amp	1198	685
11310EVS	Demolition Hammer	819	489
11202	1-1/2" Rotary Hammer 450 rpm	739	425
11214VS	1-3/4" var. speed Rotary Hammer	1140	635
1021VSR	3/8" Drill 4.8 amp 0-1100 rpm	180	95
1022VSR	3/8" Drill 4.8 amp 0-1100 rpm	193	109
1023VSR	1/2" Drill 4.8 amp 0-550 rpm	199	109
11210VSR	3/4" Rotary Drill var speed	335	195
1420VSR	Drywall Gun 4.8 amp 0-4000 rpm	158	84

We stock the complete line of Bosch Router Bits. Please call for huge discounts!

DAVID WHITE INSTRUMENTS

Model	Description	List	Sale
LP6-20	Sight Level package - 20x	310	198
L6-20	Meridian Level - 20x	290	189
LT8-300	Level Transit - 26x	650	445
LT8-300P	above Level with optical plum	769	525
LT6-900	Level Transit - 20x	389	245
ALT6-900	Automatic Level - Transit - 18x	549	385
ALTP6-900	above Level with tripod & rod	600	435
AL6-18	Automatic Level - 18x	439	319
ALP6-18HD	above Level with tripod and rod	550	372

RYOBI SPECIALS

Model	Description	List	Sale
JP-155	6-1/8" Jointer/Planer	611	295
R500	2-1/4" HP Plunge Router	331	155
R501	Above Router with trigger	335	158
TS-254	NEW 10" Mitre Saw	397	198
TS-254K	above Saw with access. kit & B&D 73-770 carbide blade	495	245
AP10	10" Surface Planer 13 amp	820	355
RA200	8-1/4" Radial Arm Saw	520	244
RE600	3 HP Plunge Router var speed	431	204
BE321	3" x 21" var. speed Belt Sander	272	129
SC160	NEW 16" Bench Scroll Saw	261	139
TFD170VRK	9.6 volt cordless Drill Kit	292	149
TFD220VRK	12 volt cordless Drill Kit	325	165
JM100K	NEW Biscuit Jointer with case	431	204
RS115	NEW 4-1/2"v/sp Random Orb Sndr	134	74
BT3000	NEW 10" Table Saw	699	539
W660	BEST BUY 7-1/4"Circ Saw 13A	179	88
TSS220	NEW 8-1/2" Slide Comp. Saw	790	449
TS260	NEW 10" Compound Mitre Saw	454	239
BT2500	10" Bench Table Saw	613	305
TS200	8-1/4" Compound Mitre Saw	314	159
BE424	NEW 4" x 24" var. spd Belt Sander	351	165
TR30U	3/4 HP Trimmer	164	85
AP12	NEW 12" Bench Planer	840	425

PORTER CABLE

Model	Description	List	Sale
690	1-1/2 HP Router 8 amp	240	128
691	1-1/2 HP Router D-handle	260	141
695	1-1/2 HP Router/Shaper	335	204
696	HD Shaper Table	185	123
351	3" x 21" Belt Sander without bag	245	140
352	3" x 21" Belt Sander with bag	255	142
360	3" x 24" Belt Sander with bag	330	178
361	3" x 24" Belt Sander without bag	310	174
362	4" x 24" Belt Sander with bag	345	188
363	4" x 24" Belt Sander without bag	330	184
315-1	7-1/4" Top Handle Circular Saw	210	118
9315-1	315-1 comp. w/case & carbide blade	240	137
617	7-1/4" Pushhandle Saw	210	119
9617	617 comp. w/case & carbide blade	240	137
314	4-1/2" Trim Saw	240	138
9314	4-1/2" Trim Saw 4.5 amp w/case	270	148
97750	1/2" var. speed Hammer Drill w/case	260	155
9548	X HD Bayonet Saw with case	320	202
9629	Recip Saw var. speed 8 amp	250	144
666	3/8" HD var. speed Drill 0-1200 rpm	200	125
621	3/8" HD var. speed Drill 0-1000 rpm	170	104
320	Abrasive Plane 3 amp	190	125
9118	Porta Plane Kit 7 amp	360	204
7545	0-2500 Drywall Gun 5.2 amp	185	114
505	1/2 sheet Pad Sander	210	114
7511	3/8" variable speed Drill 5.2 amp	200	113
7514	1/2" variable speed Drill 0-750 rpm	210	118
7515	7514 with keyless chuck	215	124
330	Speed Block Sander 1/4 sheet	103	58
555	Plate Biscuit Jointer with case	315	165
345	6" Saw Boss 9 amp	180	102
9345	345 comp. w/case & carbide blade	210	124
100	7/8 HP Router	175	105
5116	16" Omni-Jig	400	255
9647	TIGER CUB Recip. Saw	195	115
9637	Full var. speed Recip Saw 8amp	250	138
7519	3-1/4 HP Router 2 Handle	410	224
7518	3-1/4 HP 5 speed Router	475	259
7536	2-1/2 HP 2 Handle Router	355	199
7537	2-1/2 HP D-Handle Router	375	209
7538	3-1/4 HP Plunge Router	410	224
7539	NEW 3-1/4HP v/spd Plunge Router	475	262
7399	5.6 amp Drywall Cutout Unit	140	85
7310	5.6 amp Laminate Trimmer	150	88
7312	5.6 amp Offset Base Lam Trim	215	124
7319	5.6A Tilt Base Lam Trimmer	170	100
97310	Laminate Trimmer Kit comp	345	192
7334	5" Random Orbit Sander	210	119
7335	5" var. spd Rndm Orbit Sndr	230	129
7336	6" var. spd Rndm Orbit Sndr	235	134
73333	NEW Dust Collection system		24.50
693	1-1/2 HP Plunge Router	295	165
6931	Plunge Router Base	120	75
9852	12V 3/8"Drill w/cse 0-1000rpm	270	149
9853	9852 with keyless chuck	270	149
9854	12V 1/2" Drill w/cse 0-360 rpm	280	159
8500	12V battery for above drills	Sale	39
368-1	8-1/4" Circular Saw	230	134
9627	Recipro Saw 2 speed 8 amp	235	135
7549	Top handle Jig Saw 4.8 amp	250	149
7649	NEW Barrel-grip Jig Saw	260	159
7556	1/2" Right Angle Drill w/case	365	219
5009	Mortise & Tenon Jig	65	45
5060	"Stair Ease" Stair Templet	200	139
5061	"Stair Ease" Hard Wood Templet	210	145
9367	NEW 367 Planer w/case	295	154
9652	Versa-PLane w/carb cutter & cse	460	279
5008	Dovetail Template	110	77
7402	NEW 7" Disc Sander	250	159

NEW TOOLS BY PORTER CABLE

Model	Description	List	Sale
332	Palmgrip Random Orb Sander	109	64
333	above Sander with dust bag	125	74
352VS	3 x 21 Belt Sander w/bag v/spd	280	164
7116	24" Omni-Jig	470	268

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DELTA BENCH TOP TOOLS

Model	Description	List	Sale
23-700	Wet/Dry Grinder	234	155
23-680	6" Bench Grinder 1/4 HP	86	75
23-880	8" Bench Grinder 1/2 HP	151	115
11-950	8" Drill Press	199	144
28-160	10" Hobby Band Saw	210	145
31-050	1" Belt Sander 2.0 amp	104	78
31-460	4" Belt\6" Disc Sander	198	145
31-340	NEW 1" Belt/8" Disc Sander	268	188
31-080	NEW 1" Belt/5" Disc Sander	134	94

NEW TOOLS BY DELTA

40-560	16" 2 speed Scroll Saw	266	183
11-990	12" Bench Drill Press	276	209
11-090	32" Radial Bench Drill Press	399	285
43-355	3/4" Shaper 1-1/2 HP	964	709
43-505	1/2" Bench Router/Shaper	399	279
22-540	12" Bench Top Planer	595	398
36-220	10" Compound Mitre Saw	350	235
28-180	Bench Band Saw	232	167
40-640	NEW 20" Bench Scroll Saw	466	325
23-675	NEW 6" Grinder / 3 x 24 Belt Sander	141	105
14-600	Hollow Chisel Mortiser	668	445
46-700	12" Wood Lathe	548	419

DELTA STATIONARY

34-444	Table Saw complete with/1-1/2 HP motor & stand	812	615
34-445	34-444 Saw with 30" unifence	1200	815
34-446	34-444 Table Saw complete w/30" Unifence and 32-010 EMS system	Sale	835
28-283	14" Band Saw with enclosed stand and 50-274 mobile base	910	729
22-662	13" Planer with 2 HP motor, stand, and 32-011 EMS system	1436	1169
17-900	16-1/2" Floor Drill Press	441	395
40-601	18" Scroll Saw with stand and blades	942	719
34-080	10" Mitre Box	Xtra Special	198
34-761	10" Unisaw 1-1/2 HP	1715	1325
33-990	10" Radial Arm Saw	818	589
37-280	6" Motorized Jointer	488	395
50-179	3/4 HP 2 stage Dust Collector	483	335
50-181	2 HP Dust Collector	885	615
70-200	20" Floor Drill Press	1049	815
37-154	DJ15 6" Jointer with 3/4 HP motor	1420	1079
33-055	8-1/4" Sawbuck comp with legs	865	579
34-330	8-1/4" Table Saw 13 amp	343	228
34-670	10" Motorized Table Saw	511	395
32-100	Station Plate Jointer	645	265
36-040	8-1/4" Compound Mitre Saw	224	165
34-915	30" Unifence	385	239
34-897	50" Delta Unifence	525	279
36-755	10" Tilt Arbor Saw	1264	919
36-380	10" Table Saw	550	425
33-890	12" Radial Arm Saw	1720	1359
14-040	14" Bench Drill Press	360	319
28-560	16" Three Wheel Band Saw	456	385

HTC Mobile Bases for above Machines

HRO-10	fits Delta 34-444 Table Saw	88.50
HRD-10X	fits Delta 34-445 Table Saw with fence	132
HRLS-5	fits Delta 28-283 Bandsaw	88.50
HPR13	30" Roller Stand	34.95

AMERICAN CLAMPING - Bessey "K" Body Clamps

Item	Throat	Opening	Jaw Length	List	Sale
K3.512	3-1/2"	12"	5"	44.35	30.99
K3.524	3-1/2"	24"	5"	48.65	33.99
K3.531	3-1/2"	31"	5"	52.85	36.99
K3.540	3-1/2"	40"	5"	56.95	39.79
K3.550	3-1/2"	50"	5"	60.65	42.39
K3.560	3-1/2"	60"	5"	64.50	45.09

NEW DEWALT TOOLS

DW364	7-1/4" Circ. Saw w/brake, 13 amp	245	148
DW946K	12 volt cdls 3/8" Hammer Drill Kit	312	179
DW306K	8.0 amp Recip Saw w/case var. spd	254	159
DW610	1-1/2 HP 2 handle Router	250	139
DW411	1/4 sheet Palm Sander, 1.7 amp	87	54
DW705	12" Compound Mitre Saw	555	339
DW704	12" Mitre Saw	480	289
DW100	3/8" Drill, 4 amp, 0-2500 rpm, rev	110	65
DW250	4.5 amp Drywall Gun, 0-4000 rpm, rev	146	89
DW254	4.5 amp Drywall Gun, 0-2500 rpm, rev	146	89
DW124K	1/2" joist & stud Drill with case, rev	504	295
DW102	3/8" Drill, 4.5 amp, 0-1200 rpm, rev	154	92
DW103	3/8" Drill, 5.0 amp, 0-1200 rpm, rev	189	115
1707	8-1/2" Slide Compound Mitre Saw	815	439

SKIL SIZZLERS

3810	10" Mitre Saw	263	205
3810K	3810 with 60 tooth carbide blade		229
77	7-1/4" Worm Drive Saw	230	144
5825	6-1/2" Worm Drive Saw	255	159
2735-04	12 volt cordless Drill Kit	210	135
2735-04X	2735-04 with keyless chuck	235	137
1605-02	NEW Biscuit Jointer with case	200	119
7584	NEW 5" Random Orbit Sander	160	104
5510	5-1/2" Circular Saw	165	114
5660	NEW 8-1/4" 60° Circular Saw	225	145
5860	NEW 8-1/4" 60° Worm Saw	275	179
5625	6-1/2" Circular Saw	210	139
4560-02	Top Hdle Jig Saw with case	134	97
5790	10-1/4" Circ. Saw 15 amp	459	289

New Skil Bench Top Tools

3400	10" Table Saw	250	179
3330	16" Scroll Saw	200	135
3380	8" Drill Press	200	135
3370	4" Belt/6" Disc Sander	200	135

Receive FREE #2210 SKIL SUPERTWIST Screw-driver with purchase of any Skil Bench Top Tool !

JORGENSEN STYLE 35 ALUMINUM BAR CLAMPS

Model	Size	List	Sale	Lots of 6
3524	24"	27.10	17.45	99.45
3536	36"	29.07	18.65	106.25
3548	48"	31.95	20.59	117.35
3560	60"	35.58	22.99	129.95
3572	72"	38.47	24.95	142.00

JORGENSEN ADJUSTABLE HANDSCREW KITS

Model	for Jaw Length	List	Sale	Lots of 6
J-04	4"	7.38	4.85	27.99
J-06	6"	8.46	5.55	32.15
J-08	8"	9.48	6.19	35.45
J-10	10"	11.09	8.95	50.99
J-12	12"	13.74	10.55	59.39
J-14	14"	16.50	10.99	62.00
J-16	16"	17.96	11.69	65.00

JORGENSEN ADJUSTABLE HANDSCREWS

Item#	Jaw Length	Opening Capacity	List	Sale	Box of 6
#5/0	4"	2"	13.80	8.35	48.59
#4/0	5"	2-1/2"	14.80	8.95	51.99
#3/0	6"	3"	15.90	9.59	55.75
#2/0	7"	3-1/2"	17.10	10.35	58.95
#0	8"	4-1/2"	19.00	11.89	61.00
#1	10"	6"	21.76	12.89	70.65
#2	12"	8-1/2"	24.95	14.95	80.95
#3	14"	10"	31.61	18.95	104.95
#4	16"	12"	42.30	24.95	143.95

JORGENSEN STYLE 37 2-1/2"Throat 1/4"x3/4"

Item#	Jaw Length	List	Sale	Box of 6
3706	6"	9.86	6.25	34.75
3712	12"	10.92	6.75	37.75
3718	18"	12.05	7.25	40.75
3724	24"	13.16	8.19	43.75
3730	30"	14.70	9.10	49.75
3736	36"	16.05	10.19	55.75

JORGENSEN STYLE 45 5" Throat 1-3/8" x 5/16"

Item	Jaw Length	List	Sale	Lots of 6
4512	12"	30.07	19.39	109.99
4518	18"	31.73	20.45	116.99
4524	24"	33.55	21.75	123.99

PONY CLAMP FIXTURES

Model	Description	List	Sale	Lots of 12
50	3/4" Black Pipe Clamps	13.61	7.89	84.99
52	1/2" Black Pipe Clamps	11.37	6.50	69.50
53	Double 3/4" Pipe Clamps	38.50	24.45	274.00

JORGENSEN STEEL "I" BAR CLAMPS

Model	Size	List	Sale	Lots of 6
7224	24"	31.46	18.45	107.00
7236	36"	33.77	20.19	115.45
7248	48"	37.12	22.19	126.95
7272	72"	42.71	26.79	149.95

ELU BY BLACK & DECKER

3338	2-1/4 HP var. speed Plunge Router	427	249
3304	1 HP variable speed Plunge Router	292	164
3375	3-1/8" Univ. Planer 7.2 amp	313	155
3380	Biscuit Jointer with case	542	248
4024	3 x 21 variable speed Belt Sander	322	184

BLACK & DECKER

1166	3/8" Drill 0-2500 rpm 4 amp	100	65
2600	3/8" Drill 0-1200 rpm 4.5amp	142	89
1703-1	10" Mitre Saw with 73-770 blade	313	179
4011	1/4 sheet Palm Sander	82	59
79-034	Workmate 400	175	105
1349-09	1/2" Timberwolf Drill 2 speed	489	279
1180	3/8" Drill rev. 0-1200 rpm 5 amp	182	104
2037	Drywall Gun 0-4000 5.0 amp	175	97
2038	Drywall Gun 0-2500 rpm 5 amp	175	99
3157	Orbital var spd Jig Saw 4.5 amp	220	145
2665K	NEW 3/8" cdls 12V Cyclone Drill	280	165
5045K	MACHO Rotary Hammer Drill	742	409
5071	3/8" Hammer Drill with case	239	144
5073	1/2" Hammer Drill with case	282	163
2054	Tek Gun 0-2500 5.0 amp	269	152
2660	Drywall Gun 0-4000 4.5 amp	142	88
2700	7-1/4" Worm drive Saw 13 amp	250	149
1321	1/2" Spade hdle Drill 450 rpm 7 amp	292	165
2750	4-1/2" Grinder 10,000 rpm 6 amp	149	83

2694	7-1/4" Super Sawcat Circular Saw	248	137
2695	8-1/4" Super Sawcat Cricular Saw	271	153

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73-757	7-1/4	40	31.30	16.89
73-759	8-1/4	40	44.65	24.99
73-719	8-1/4	22	19.65	11.95
73-769	9	60	72.75	39.89
73-715	5-1/2	16	13.70	7.99
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D1220-2	20'	17'	27#	130.00
D1224-2	24'	21'	33#	145.00
D1228-2	28'	25'	42#	175.00
D1232-2	32'	29'	53#	200.00
D1236-2	36'	32'	62#	239.00
D1240-2	40'	35'	73#	265.00

ALUMINUM FLAT STEP TYPE 1- 250# RATED EXTEN.

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D1320-2	20'	17'	32#	145.00
D1324-2	24'	21'	39#	165.00
D1328-2	28'	25'	50#	195.00
D1332-2	32'	29'	62#	235.00
D1336-2	36'	32'	77#	270.00
D1340-2	40'	35'	85#	295.00

ALUMINUM FLAT STEP TYPE 1A- 300# RATED EXTEN.

D1516-2	16'	13'	31#	139.00
D1520-2	20'	17'	37#	159.00
D1524-2	24'	21'	45#	179.00
D1528-2	28'	25'	56#	215.00
D1532-2	32'	29'	66#	239.00
D1536-2	36'	32'(250# rating)	79#	279.00
D1540-2	40'	35'(250# rating)	89#	309.00

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D524-2	24'	21'	49#	230.00
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D6128-2	28'	25'	60#	259.00
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OFS50	1HP Plunge Router	299	175

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C7BO	7-1/4" Circular Saw with brake	230	127
M12V	NEW 3 HP variable speed Router	447	225
TR12	Plunge Router 3 HP	354	169
F1000A	12" Planer/6" Jointer	2835	1519
C10FA	10" Deluxe Mitre Saw	538	274
C12FA	NEW 12" Mitre Saw	632	305
C8FB	8-1/2" Slide Compound Saw	899	445
FREUD LU91M008	8-1/2" carb. blade 48 tooth	68	43
C15FB	15" Mitre Saw	745	379
FREUD LU85M015	15" carb. blade 108 tooth.	180	105
F20A	3-1/4" Planer 3.4 amp	172	99
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LS5	Pinner 1" - 1-1/2"	399	285
SPS	Stapler 1" wide - 3/4" - 1-1/2" length	460	335
PW	Stapler 1" wide - 1/2" - 1-1/4" length	505	345
MW	Stapler 1" wide - 3/4" - 1-3/4" length	520	365
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Adhesives for Woodworking

Using the right glue can make or break your project

by Chris Minick

***Less than a dozen popular woodworking adhesives** perform 99 percent of the gluing tasks in the shop today. But different types of glue have different characteristics that make them better suited for some jobs than others. From left to right, the adhesives are cross-linking polyvinyl acetate (PVA), white PVA, two-part epoxy, cyanoacrylate ("super glue"), solvent-based contact cement, yellow PVA (aliphatic) resin, urea formaldehyde, resorcinol and hot-melt glue sticks shown with the glue gun that heats them for application.*

Everyday, woodworkers across the country glue wooden parts together to make furniture, cabinets, toys, boats, turning blanks and musical instruments. Yet most of us don't pay much attention to this critical operation until, for some reason, our standard glue fails. Then the search for an alternative adhesive is on. Although about 1,500 adhesive products are manufactured in the United States, less than a dozen of them are suitable for most woodworkers' needs (see the photo above). In this article, I'll explain the most common types of woodworking adhesives, how they work and what to expect when you use them. And in the sidebar on p. 49, I will discuss the steps necessary for successfully gluing wood, from preparing the stock to clamping up.

How glue bonds wooden parts together

Before I discuss individual adhesives, it's helpful to understand a little about the chemical makeup of wood and how an adhesive interacts with these components during the bonding process. Wood is a complex mixture of organic chemicals and water. About 95 percent of a board consists of cellulose, lignin and hemicellulose, which form the structural matrix of wood and give it its strength, rigidity and elasticity. The remaining five percent contained in dry wood is composed of resins, tannins, essential oils, gums, coloring agents and sugars. This chemical mixture of extractives is responsible for wood's smell, color and decay resistance. Unfortunately, extractives in some resinous woods, such as teak and rosewood, can interfere with the gluing process (for an explanation of how to overcome this problem, see the sidebar on p. 49).

Once an adhesive is applied to adjacent wood surfaces and the pieces are clamped up, the structural elements of wood are linked together by the bonding process. First, the liquid adhesive is absorbed into the wood, and its polymer molecules intermingle with the structural fibers of the wood. Next, the adhesive's polymer molecules coalesce (come together), surround the structural fibers and harden, mechanically interlocking the fibers. *Thermosetting* glues, such as epoxy, urea formaldehyde and resorcinol, cure by a chemical reaction (usually after two components have been mixed) while *thermoplastic* adhesives, such as white and yellow glue, cure by evaporation. Once either type of glue is dry, the thin

Photos: Sandor Nagyszalanczy

layer of cured adhesive between the two wood surfaces acts like a bridge holding the boards together.

Although all the glues in this article (except hot melts) will produce bonds that are actually stronger than wood itself, each adhesive has special properties that make it better suited to some gluing tasks than others. These factors are discussed in the chart (summarizing adhesive properties) on the following page.

Polyvinyl acetates

White and yellow glue are probably the two most popular glues used in woodshops today. Both are polyvinyl acetate (PVA) adhesives that come in three main varieties: white or craft glue, yellow aliphatic resin glue and cross-linking PVA emulsions. All of these have a balanced set of properties, which make them ideal for gluing wood. They are easy to use, have quick grab, set rapidly, clean up with water, are non-toxic and work in most wood-gluing situations. Also, the liquid adhesives will spoil if frozen. However, PVA adhesives have poor creep resistance (under a sustained load the adhesive slowly stretches), and they should never be used in structural assemblies, like load-bearing beams, without some form of mechanical fastening.

White glue—While general-purpose white glues are considered by many woodworkers to be hobby glues, white glues have a unique flexibility and a high sheer strength that make them particularly well-suited for use in flexible joints, such as bonding the canvas backing to wood slats for tambour doors. The flexible adhesive bonds allow the slats to move freely, and the high peel strength prevents the cloth from pulling loose. On the down-side, dried white glue forms a rubbery glueline, which gets gummy from the heat generated during sanding and clogs the sandpaper. White glues have no water resistance whatsoever and should only be used for indoor projects that won't get wet.

Yellow glue—Aliphatic resin glues are probably the best all purpose wood adhesives made today. Technically, both yellow aliphatic resin and white glues contain the same polymer: polyvinyl acetate; the yellow color is a dye added to distinguish the two glues. Aliphatic resins share many properties with their white cousins—high bond strength, easy cleanup and rapid set. But yellow glues have better moisture resistance, improved creep resistance, higher tack and better sandability. They do have a pretty short shelf life, though; after about a year, most brands are usually too viscous to be useful. Adding a small amount of water to revive a slightly thickened adhesive will do no harm, but resist the temptation to salvage one that is stringy out of the bottle, as shown in the top photo at right. It's better to buy a new bottle than risk having the joints fail on your project.

Cross-linking PVA glue—Once only available to large shops and commercial users, cross-linking PVA glues like Franklin's Titebond II are the most advanced members of the PVA family. Titebond II is a one-part self cross-linking glue that does not require the addition of a catalyst to activate the adhesive. Chemical bonds formed within the adhesive during drying improve the toughness of the glue bond and increase its water resistance. I've found that Titebond II handles like regular yellow glue but has a little higher tack and a shorter drying time. To test Titebond II's water resistance, I prepared identical maple test panels: one glued with Titebond II, the other with regular aliphatic resin glue. Both panels were submerged in a bucket of water and allowed to soak overnight. The next morning, the aliphatic resin sample came apart as I pulled it from the bucket. But after 48 hours underwater, the Titebond II sample was still holding firm, and I could not break the joint by hand. To test Titebond II's gap-filling ability, I glued up some maple boards with gap sizes ranging from a tight fit (zero gap) to 1/32 in. After the samples had dried for a week, I tested them on a laboratory tensile tester to determine the bond strength of the joints. All the samples with gaps up to 1/64 in. split apart at about 2,600 psi (pounds per square inch) before the glueline failed. At a gap size of 1/32 in., huge by woodworking standards, the adhesive strength of Titebond II was close to 1,700 psi—sufficiently strong to keep the boards together for a typical woodworking project.

When yellow glue exceeds its usable shelf life, it becomes thick and snotty. You can test this by dipping a small stick into the container. If it's stringy as shown, throw the unused portion away (it contains no solvents, so this is environmentally acceptable).

Resorcinol and urea formaldehyde

Urea formaldehyde and resorcinol formaldehyde adhesives are most frequently used for bonding wood when strong, creep- and water-resistant bonds are required. Urea formaldehyde (UF) adhesive, sometimes called plastic resin glue, comes as a one-part powder. The powder is a mixture of dry resins and hardeners that if kept dry will remain storable indefinitely. Water is added by the user to dissolve the chemicals and activate the adhesive. The pot life after mixing is relatively long, but the viscosity of the activated glue slowly increases until, after about an hour, the adhesive is too thick to be usable. Once cured, UF adhesives produce structural bonds, and the tan glueline is hardly noticeable even on light-colored woods. Interior load-bearing beams and hardwood plywood paneling are often glued with UF adhesives. Not 100 percent waterproof, most UF glues slowly degrade in moist environments. While continuous immersion is not recommended, UF adhesives can be used outdoors, say, for patio furniture, where an occasional soaking from a passing rainstorm will not seriously affect the strength of the bond. UF has only fair gap-filling qualities; therefore, the mating surfaces must be cut accurately and clamped for 24 hours to produce a structurally strong bond. The long working life of UF glues (about 20 minutes) is a real advantage in veneering operations, allowing precise positioning and repositioning of the veneer without loss in ultimate bond strength.

Resorcinol formaldehyde, or RF, adhesives have high strength, exceptional solvent resistance and when properly cured, will withstand prolonged immersion in water, making them perfect for marine applications. RF glues come as two-part kits: one part contains the resorcinol resin dissolved in ethyl alcohol; the other contains powdered paraformaldehyde. The premeasured components are stirred together to activate the adhesive, but careful mixing is necessary to avoid lumps. I've found it best to sift the powder into the liquid resin while constantly stirring the resin (an operation that sometimes takes three hands). RF adhesives produce mahogany-colored gluelines, which show in blond woods, and are a bit harder and more brittle than those produced by UF glues. Their increased hardness makes cured RF glue squeeze-out more difficult to remove. Application procedures, clamping and cleanup with water, are the same as for urea formaldehyde glues.

Unfortunately, both RF and UF adhesive systems release formaldehyde gas when in the liquid state and present a very real health threat to some users. Although test results regarding the carcinogenic nature of formaldehyde gas are not conclusive, it is known that many people are highly sensitive to this chemical. Even low concentrations of formaldehyde in the air can cause irritation to the nose and eyes and cause pounding headaches. Working in a well-ventilated shop will decrease the risk, but I consider heavy rubber gloves and a face mask rated for organic vapors to be necessary to prevent dangerous exposure.

Epoxy

With their high strength (shear tests around 4,000 psi), great gap-filling capacity, uncanny ability to structurally join difficult-to-bond materials and waterproof nature, epoxies are surely the high-performance adhesives of the woodworking world. Epoxy adhesives are solvent-free, two-part systems consisting of an epoxy resin and an amine hardener. Typically,

Woodworking adhesive properties

Glue name/type	1 part, 2 part or water mix (W)	Gap-filling ability ▲	Moisture resistance ▼	Solvent resistance ▼	Creep resistance ▼	Open assembly time (minutes) ◗	Minimum drying time (hours) ◗	Minimum application temperature	Cleanup solvent	Safety equipment
White/PVA	1	P	P	P	P	3-5	1 ◆	40	Water	None
Yellow/PVA	1	F	F	F	P	5	1 ◆	40	Water	None
Cross linking/PVA	1	F	G	F	F	5	1 ◆	50	Water	None
Hide	W	P	P	G	G	2-5	2	70	Water	None
Epoxy	2	E	E	E	E	5-90	12-24	50 ●	Lacquer thinner	Gloves
Urea formaldehyde	W	F	G	E	E	10	12-24	65 ●	Water	Vapor mask Gloves
Resorcinol	2	G	E	E	E	10	12-24	65 ●	Water	Vapor mask Gloves
Contact cement	1	P	E	F	P	2-3 Hrs.	None	40	■	Vapor mask ◗◗ Gloves
Cyanoacrylate	1	P-F	E	E	E	30 Sec.	1-2 Min.▲	40	Acetone	Gloves
Hot melt	1	E ✱	E	G	P	10-30 Sec.	None	—	Scrape	None excess

Notes:

- ▲ E=excellent G=good F=fair P=poor
- ■ See container label for proper solvent
- ✱ Very low strength
- ▲ Much faster when accelerator is used
- ● Higher temperatures decrease pot life
- ◆ Humidity slows down drying; more clamping time needed
- ◗ Higher temperatures speed up drying time, reduce open time
- ◗◗ Not needed for waterborne contact cement

Explanation of chart headings

Gap filling: Most glues are stronger than wood when applied thin; choose best gap-filling glues for bonding imperfect joints.

Moisture resistance: Excellent-rated glues are waterproof and suitable for outdoor use; good-to-fair rated glues are only moisture resistant.

Solvent resistance: Use best-rated glues for veneered work where solvent in finish could penetrate veneer and affect glue.

Creep resistance: Choose high-rated glues for lamination and structural bonds; a poor rating means that the dried adhesive has a rubbery glueline.

Open assembly: Maximum time between application and assembly/clamp-up. Long open time best for complicated assemblies.

Drying time: Minimum time joints must stay clamped and undisturbed.

Application temperature: Lowest allowable shop temperature for optimum bonds.

Safety equipment: Some glues produce irritating fumes and require special equipment for safe handling.

equal parts of resin and hardener are mixed to activate the adhesive and start the curing process, which works by chemical reaction rather than solvent evaporation. The exact mixing proportions are fairly critical; too much of either component will adversely affect bond strength. Epoxy's lack of solvent is responsible for its low shrinkage and exceptional gap-filling ability. In tests, I've found no loss of bond strength—even on glued samples with a 1/16-in. gap. Common epoxies are designed for optimal curing at 65°F to 70°F, but curing and clamping time are temperature dependent: Below 50°F, the reaction rate slows dramatically; at 40°F, an epoxy can take several days to fully cure. Unmixed epoxies have very long shelf lives, but they will eventually go bad. If either part becomes granular, it's time to buy new glue.

Epoxies do have some drawbacks. At about $18 to $20 per pint, they are expensive. Undried epoxies are irritating to the skin and can cause contact dermatitis in sensitive people, so it's best to wear gloves when using them. Epoxies have very low tack and poor uncured strength, so joints have to be clamped until the adhesive is fully cured, usually overnight. Uncured epoxies are not soluble in common workshop solvents, making cleanup difficult (acetone or lacquer thinner can be used in a pinch). Cured epoxy sands and machines well, but the completely hardened squeeze-out is difficult to scrape or sand off. I've found it easier to let the squeeze-out harden until it is rubbery and scrape it off with a sharpened putty knife. Rapid-setting "five-minute" epoxies are a poor choice for woodworking because they are generally lower in strength, and once mixed, they gel very quickly.

Contact cement

Synthetic neoprene rubber forms the base of most modern contact cements. As you might expect, these adhesives have very low strength in the traditional woodworking sense and suffer from high creep. Contact cements are easy to use and produce instant clamp-free bonds, but they aren't suitable for structural uses. Their strong suit is their ability to bond a wide variety of porous or non-porous materials (such as metal or plastic to wood), which explains their popularity for gluing plastic laminates, such as Formica, to particleboard substrate for kitchen countertops.

Contact cements come in three main varieties based on solvent type: flammable solvent, non-flammable solvent and waterborne. The choice is more a matter of preference than performance; I've found all three types bond equally well. Safety is another matter.

Japanese rice glue: the edible adhesive

by Sandor Nagyszalanczy

Contrary to the western attitude that the best glue is the strongest, Japanese craftsmen consider more than strength when choosing the ideal glue for a job. Traditionally trained craftsman Toshio Odate uses rice glue for his shoji screens because "It is a super assistant; rice glue not only secures the mortise and tenons that join the shoji screen parts but also acts as a lubricant to aid assembly." Rice glue is also tacky, so the many components of a frame don't fall apart during clamp-up. The glue dries transparent and doesn't discolor with age, so the glueline won't show on the blond woods usually used for screens. While rice-glued joints in softwoods are strong enough to sustain normal use, they can't stand shock, so a broken screen can be easily knocked apart for repair—even if it's 100 years old.

On a recent visit to his house, Odate was kind enough to teach me how to make *sokui*, which is Japanese for rice glue. This adhesive is traditionally prepared fresh, right in the shop whenever needed. The secret? "First, learn how to cook good rice," Odate said. Start with regular rice (not converted, like Uncle Ben's). Odate told me that Japanese kokuho rice (he uses Rose brand), a short-grain rice, works best. Wash the rice with cold water, rinsing until the water runs clear. Drain the rice overnight in a colander (in Japan, these are bamboo), and cover with a cloth to keep moisture in. In the morning, take one part rice, one part water and put them into a heavy lidded pot, and bring them to a rapid boil until it nearly boils over. Turn the heat down to the lowest setting, allow the rice to simmer for about 20 minutes, shut off the heat and let it sit for another 10 minutes. Get the rice kernels well-cooked but tight, not mushy.

Now in the shop, prepare a glue-mashing surface by selecting a smooth board or a small sheet of plywood clean on one side. You can make a small mashing tool, like the one Odate uses in the photo below from a piece of fir or pine. It should be beveled back about 30° and tapered to a sharp point. Take the rice to the shop in a small, covered bowl, put a small pat of rice on the work surface and bring the flat part of the mashing tool down on it. Work the tool back and forth, lifting the leading edge on each stroke. Continue mashing until the rice is smooth and pasty. Remove any bits of debris with the tool's point. Mix only as much as you can use right away; throw away any that has skinned over. Use the masher to apply the paste. If the paste is too thick to spread, add a little cool water to thin it down—but don't make it too thin.

***Toshio Odate prepares rice glue in** his workshop. Cooked short-grain rice taken from a covered bowl is mashed on a wooden work surface with a special tapered and beveled stick until it becomes a smooth and creamy paste. Odate makes a fresh batch whenever needed.*

Excess glue can be wiped away immediately with a damp rag, although any excess left on the surface won't show or splotch under stain and finish. Wait at least half a day for the glue to dry before unclamping; by then, it's easy to scrape or plane off squeeze-out. This glue won't chip your plane or chisel like dried yellow glue will. If you work up an appetite from the strenuous mashing and gluing up, Odate pointed out that you can always eat the rice remaining in the covered bowl.

Sandor Nagyszalanczy is managing editor of Fine Woodworking.

***Temporarily attaching a template** to a part to be routed is quickly done with a special adhesive tape made by 3M, which dispenses from an applicator like tape but sticks like glue.*

Because these products are usually spread over very large areas, a lot of solvent evaporates into the shop or job site. Flammable-solvent contact cements pose a very real fire and explosion hazard unless used in a well-ventilated area. Alternately, non-flammable contact cements aren't a fire hazard but release chlorinated solvents that are known to cause severe health problems in some individuals. A respirator specifically designed for chlorinated solvents must be worn while using this type of contact cement. From a safety standpoint, waterborne contact cements are best, though only for non-porous materials.

Regardless of type, the procedures for using contact cements are very simple. The bonding surface of each part is coated with adhesive and allowed to dry until tack free. One part is then positioned over the other with sticks or waxed paper between the coated surfaces. This allows alignment while preventing contact, necessary because once the adhesive-coated surfaces touch, they stick and cannot be repositioned. To prevent trapping air between the layers, remove the sticks, one at a time, and push the surfaces together as you go. On large panels, start in the middle and work toward the ends. Apply pressure to the face of the lamination with a veneering roller to complete the bond.

Cyanoacrylate

Although they're very expensive (about $170 per pound), cyanoacrylate (CA) adhesives are usually used a drop or two at a time, so they're fairly economical. These fast-setting glues are wonderful for repairing small cracks and tearouts in wood and have found popularity among woodcarvers and turners. Some use cyanoacrylate adhesives to firm up punky areas in spalted wood before turning or carving. CAs come in several forms including a low-viscosity liquid and a gelled version that's best for more porous woods, like basswood and butternut. Both varieties cure by reacting with water vapor in the air to form colorless, water-resistant joints. But while such rapid setting is a great advantage for gluing up hard-to-clamp parts, the CA bond tends to be very brittle and can be easily broken by a sharp rap with a hammer.

Gluing acidic woods like oak and walnut with CA requires special treatment because the acid content of these woods inhibits the glue's ability to dry. Special accelerators can be sprayed on the joint to neutralize the acid (wiping the surfaces with ethyl alcohol also works). Curing also can be accelerated by breathing on the glue-coated parts before assembly; the humidity starts the adhesive's polymerization reaction.

Most CAs exude vapors that are extremely irritating to the eyes, but are relatively non-toxic, so no special protective equipment is needed when working in a well-ventilated area. The biggest drawback with cyanoacrylates is their propensity to glue things together that shouldn't be glued—like the cap to the bottle or your fingers to the workpiece. Further, cured cyanoacrylates are very solvent resistant and require special CA solvent for dissolving the bond (in a pinch, try using an acetone-base fingernail polish remover). Once opened, cyanoacrylates have a short shelf life: about six months. Storing the adhesive in your freezer will considerably extend its useful life (more than two years in my experience). However, allow the glue to warm to room temperature, and dry the container before opening the bottle.

Hide glue

While modern synthetic adhesives are the workhorses of the woodshop, old-fashioned hide glue has a few unique properties that still make it useful. Fresh, hot hide glue easily bonds to old, dried hide glue, making it great for restoring pre-1940 furniture, which was probably originally assembled with hide glue. Hide-glued joints can be disassembled by applying steam or hot water, a quality embraced by those who repair furniture and stringed-instruments. Because hide glue is a natural protein, it will absorb an oil-base stain just as the wood does. Thus, if any glue remains on the wood, the piece can be stained or dyed without light splotches appearing, a common problem with synthetic glues.

Chemically, hide glue is a protein-base adhesive derived primarily from the hides and hooves of cattle. It comes in several different grades (most woodworking supply catalogs sell it) with gram strengths between 164 and 251. Gram strength is ***not*** an indication of the glue's bond strength—all grades of hide glue are strong enough for woodworking. Rather, glues with a higher gram strength are more viscous and gel quicker.

Unlike synthetic liquid adhesives, traditional hide glue is prepared by soaking the glue granules in cool water for a few hours. Typically, a mix of 1½-3 parts water to 1 part glue granules (by weight) yields the proper consistency. The exact amount of water needed is different for each glue grade (see the instructions that come with your glue), but don't exceed 3 parts water to 1 part glue because the resulting mixture will be too weak for proper bonding. When the soaked granules resemble mushy oatmeal, liquefy the hide glue by warming it. Special glue pots are available for this, but a double boiler or any heating device that keeps the glue at around 140°F will work well. Use a candy thermometer to read the temperature, and don't let the glue boil, or you'll weaken its bonding strength. Incidentally, for small jobs, you can use unsweetened gelatin powder from a grocery store, which is really hide glue that's been purified. Mixed 2½ parts water to 1 part powder, gelatin's high gram strength gives it an open time of about 60 seconds, too fast for veneering large panels but perfect for quick repairs.

Once the glue is hot and of even consistency, it is ready for use. Brush the hot glue on the joint, and assemble the pieces quickly. Regular hot hide glue has a short open time—two to three minutes—and the joint must be assembled while the glue is still liquid. Warming the wood with a hair drier will extend open time, as does adding small amounts of water to the glue. Products called liquid hide glue come premixed with chemical gel depressants (to keep them liquid and extend their open time) and are an alternative to cooking your own. While some woodworkers claim that liquid hide glue is weaker than hot hide glue, I haven't found this to be true. All hide glues cure in about 24 hours, but the clamped joints can be unclamped after two hours provided the piece isn't handled too roughly. Excess glue is easily cleaned off with warm water or by peeling the squeeze-out off the surface with your fingernail before the glue has a chance to set.

Specialty adhesives

Among the hundreds of special adhesives available to woodworkers, hot-melt glues are among the more useful. Sold in the form of solid sticks, hot melts are dispensed from an electrically heated glue gun at about 350° F and rapidly set as they cool—in about 15 to 20 seconds. Hot melt's poor penetration, thick glueline and low strength coupled with its poor sandability limit its uses in woodworking (it's also capable of burning you). I've found hot melts to be a convenient way of attaching glue blocks to furniture and for tacking drawer bottoms in place during assembly. Edgebanding veneers, precoated with hot-melt glue, are used extensively in production furniture shops to cover the edges of plywood and particleboard. This kind of edgebanding can be applied with a household iron. Also, a few dabs of hot-melt glue serve as a good temporary fastener for jigs and fixtures. The adhesive can be released by heating (a paint-stripper gun works well), and the rubbery residue is easily scraped from the wood.

An interesting adhesive I've used, Scotch brand 934 Adhesive Transfer Tape, defies categorization: The product applies like tape, but sticks like glue. An applicator rolls it on to one side of the joint, releasing it from a paper backing as you roll it along. Pressing the parts together increases bonding strength. I've used this adhesive-tape product for gluing metal and plastic to wood and as a veneering adhesive on small wooden puzzles with good success. This tape is handy for temporarily gluing templates to jigs (see the top photo on the facing page) and for stack cutting pieces on the bandsaw. After cutting, remove the tape by rolling it up with your fingers, like rubber cement. If pieces are left bonded overnight, the tape develops a tenacious bond, making it great for permanently applying small moldings. I purchase transfer tape at an office-supply store, but I've seen it in specialty mail-order catalogs, too. □

Chris Minick is a product development chemist and an amateur woodworker in Stillwater, Minn.

Three steps to good glue joints

***Jointing square edges on a board** before glue-up is essential for a strong bond. Clamping a 90° fence guide to the side of a handplane will help to keep your cuts square and true.*

The process of gluing boards together seems simple enough. Only three steps are involved: preparation of the joint or planing of the surfaces, application of the glue and clamping the assembly. It is so simple that we often take it for granted. Unfortunately, neglecting the basics during any one of these steps can lead to weak or failed bonds, regardless of the wood species or the gap-filling ability and strength of the adhesive you use.

Surface preparation

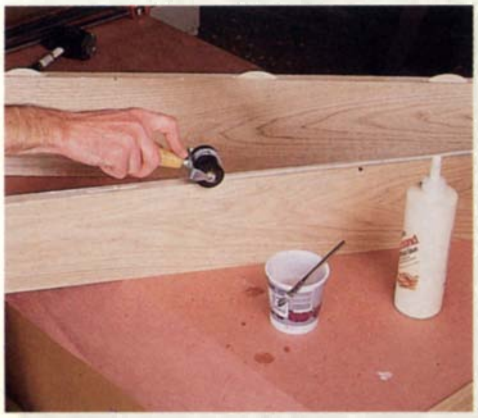
Edge-gluing boards into larger panels is probably the most frequent gluing activity in the woodworking shop. And, while matching boards for grain patterns and color is important to the final appearance of the panel, careful attention to the machining and preparation of edges before glue-up will reward you with the strongest and longest lasting joints possible. All edges should be planed straight, true and perfectly perpendicular to each face, a job for a sharp, well-tuned jointer or a long handplane equipped with a fence (as shown in the photo at left). Some woodworkers prefer to glue up boards with edges as they come right off the tablesaw. While this method probably will produce joints of adequate strength, I prefer to plane my edges for two reasons. First, sawblades damage bonding surfaces by tearing the wood fibers as they cut through the board. Subsequently, excessive clamping pressure often is required to flatten the uneven areas of the bond line. Second, a sharp jointer or handplane shears the fibers leaving an undamaged, flat gluing surface, which minimizes the clamping pressure necessary to achieve an almost invisible glueline.

It is likely that more joints fail due to having been machined with dull jointer knives than from any other problem. Dull knife edges crush and glaze the wood fibers instead of cutting them cleanly. These abused wood fibers don't absorb the glue properly, which results in a weak bond. To test for this problem, simply place a drop of water on a jointed edge; if the water stays beaded up after about 30 seconds, then the surface is probably glazed. Sharpen your knives or plane blade and resurface the edges before gluing.

Before glue-up, plan to dry-assemble each edge joint to make sure that it's tight and gap free when lightly pressed together by hand. Avoid using warped lumber, because distorted boards usually put unequal stresses on a dried glueline that may ultimately cause the joint to fail.

Highly resinous woods like teak or rosewood require special care during preparation to ensure adequate strength in the final glue joint. The extractives that resinous woods contain concentrate at the surface as the lumber dries and tend to make the wood water repellent, preventing most adhesives from being properly absorbed (check for this with the water-drop test previously described). A common practice among woodworkers is to wipe these joints with lacquer thinner or alcohol in an attempt to remove the excess resins. This practice sometimes works but often just worsens the problem as capillary action from the evaporating solvent pulls more resin to the surface, recontaminating the freshly cleaned surface. The best way to sidestep the problem is to joint the edge just before gluing: Milling temporarily removes most extractives at the surface. But don't let the wood sit around too long, the extractive will accumulate again if the lumber is stored. An alternative is to switch to a less oil-sensitive adhesive, like epoxy or resorcinol.

Endgrain gluing: The glued strength of most edge-to-edge joints, such as panels, depends on long-grain to long-grain contact. Gluing endgrain to side grain or endgrain to endgrain directly is okay for small parts but isn't recommended in most cases because endgrain is extremely porous (similar to a box of soda straws viewed from the top). Capillary action at the endgrain wicks the liquid adhesive away before it has a chance to set and bond the parts together. To achieve adequate strength in situations where endgrain must be glued (for example, a typical cabinet face frame), joints such as mortise and tenons are employed to increase the long-grain bonding area. Spline joints, biscuit joints and doweled joints also can be used for endgrain to side grain bonding with equal success. Scarf joints, popular with wooden boatbuilders, are good for joining boards end to end. A scarf joint is really a low-angle miter cut to expose as much long grain as possible. The USDA Forest Products Research Laboratory recommends a slope of about 1:8 (about a 7° angle) for best bonding strength.



Applying glue with a rubber veneer roller *is one way to ensure that the adhesive is spread evenly over the edges to be joined. The small parts brush setting on the water container (foreground) is handy for getting glue into joints, like the plate-joinery biscuit kerfs in the boards shown.*

Even clamping pressure *ensures uniform squeeze-out of excess glue and a maximum strength bond. To keep dripping glue off his workbench, Minick covers the surface with water-resistant kraft paper.*

Spreading the adhesive

Woodworkers often ask, "Should one or both sides of a joint be covered with glue before clamping?" I prefer spreading a thin layer of adhesive on both sides of the glueline because this ensures that the proper amount of adhesive will be absorbed into both parts. If only one side is coated, the adhesive may be squeezed from the joint by clamping before it has a chance to absorb into the mating surface.

For ultimate bond strength, it's imperative for the adhesive to be spread evenly over the entire bonding surface. Areas that haven't been coated with glue will not bond. I have two glue applicators that satisfy most of the gluing needs in my shop. A stiff parts-cleaning brush (I purchased mine at a local auto parts store) applies glue to tenons, dovetails and other irregularly shaped joints. I use a hard rubber veneer roller for edge-gluing solid stock (not a hard plastic roller, I find these tend to skid over the top of the adhesive and not spread it properly). A rubber roller is fast and easy to use and automatically coats the entire surface with the proper amount of adhesive (see the top photo). To mix two-part thermoset adhesives, such as epoxy, I use disposable paint brushes or small sticks as disposable applicators because these adhesives are hard to clean up. Incidentally, fingers don't make good applicators for any type of adhesive. It's hard to get an even coating of adhesive with your fingers, and besides, you're more likely to contaminate some other part of the project with adhesive residue and get your clothes gluey.

Clamping

The object of clamping is to hold the parts in position until the adhesive has set. Dry-assembling parts before glue-up will ensure that everything fits together as it should and also provides an indication of the number of clamps needed and where to place them. When the joints are tight and properly milled, surprisingly little clamping pressure is usually needed to achieve good bonds. Small gaps and cracks can not always be avoided, and they can usually be closed with slight pressure. If excessive clamping pressure is needed to close a joint during the dry-assembling stage, then the glued joint will be under high stress and may spring apart once the clamps are removed or sometime in the future. In such cases, it is best simply to recut or to resurface the joint.

How tight should you make the clamps? If the joint surfaces are well-machined, just enough pressure to squeeze any excess glue from the joint is plenty; try to keep clamping pressure even by spacing clamps uniformly for long glue-ups and using clamp blocks to distribute clamping pressure. Blocks also keep the wood from getting dented by the clamps. While it's not advisable with structural components or large surfaces, you can even achieve decent adhesive bonding by rubbing two glued parts together, a common practice for adding glue blocks to reinforce a carcase. In theory, excessive clamping pressure will force the adhesive from the glueline, starving the joint and resulting in bonding failure. Further, as the density (weight per volume) of a wood species increases, its ability to absorb adhesive decreases. Thus, overclamping dense woods, like birch or rock maple, can lead to starved joints.

I wanted to test this theory of excessive clamping in a fairly scientific fashion, so I prepared and pull tested three sets of hard-maple samples, one rubbed together, one standardly clamped and one overly clamped (to the point of crushing the mating surfaces). The results were somewhat ambiguous: I found that all three samples had glue joints of acceptable strength. Using moderate clamping pressure still yields the strongest joint and seems to make the most sense, if for no other reason than to avoid dents in clamped edges.

The drying time for a glue and glue-curing time are often confused. Drying time (as shown in the chart on p. 46) is the average amount of time, under normal conditions, that glued joints must remain clamped and undisturbed before the assembly can be handled. But curing time is the length of time necessary for the *maximum* bond strength of the adhesive to develop. Most adhesives take much longer to cure than to dry—typically two to three days. Other conditions, such as excessive or inadequate temperature or humidity, also can affect drying time. Extending the clamping time beyond the minimum specified by the glue manufacturer is necessary for joints whose mating surfaces are less than perfect. The extra time allows the glue to cure more fully and minimizes the chances of joint failure. —*C.M.*

How to Build a Barrister's Bookcase

Stackable cases with retractable overhead doors

by Jeff Greef

***Jeff Greef's walnut lawyer's cabinet** resembles a garage for books, complete with overhead doors. A pair of carcase modules capped with a top unit (left) waits to be stacked onto another pair resting on a base unit (right). Greef waxes the back side of one of the retractable doors, which is guided by a simple pulley mechanism that's patterned after the guide system used in the 1906 cabinet in the photo below.*

Among the victims of California's 1989 Loma Prieta earthquake was a sectional bookcase (also known as a lawyer's or barrister's bookcase) belonging to a friend of mine. When she asked me to rebuild it, I inspected the parts she had laid in her garage. Damage was minimal, mostly disassembled joints rather than broken wood, so repairs would be easy. The bookcase was composed of separate cases stacked together and aligned by tongues, grooves, dowels and holes. There were also pedestal and crown units that attached to the bottom and top of the assembled cases. Each shelf module had a glazed door, which pivoted at its top, then slid into a pocket above the opening.

I also saw something that mystified me—a curious system of metal bands, wooden channels, and small wooden pulleys, around which the bands were wrapped. Closer investigation revealed that the purpose of the mechanism was to guide the doors, so they would slide parallel to the case sides and not turn askew and bind with the carcase when opened. I was so intrigued by the guide system on this 80-year-old set, I resolved to build a stacking bookcase with a similar wood and metal mechanism for myself (see the photo above).

The refurbished bookcase, labeled "The Viking," was patented and built by Skandia Furniture Co. of Rockford, Ill (see the photo below). Patent dates on the label, and the owner's recollection, put the time of the case's manufacture around 1906. I was disappointed at first to see the basic construction for the carcase modules was rabbets and nails. But practical experience contradicted my negative judgment—all the nailed joints survived the thrashing of the earthquake, whereas half the hide-glued joints broke. After reconsidering, I decided to use the same construction as Skandia with only minor changes. I broke the project down into four assemblies: top and bottom units, carcases, doors and parallel mechanisms.

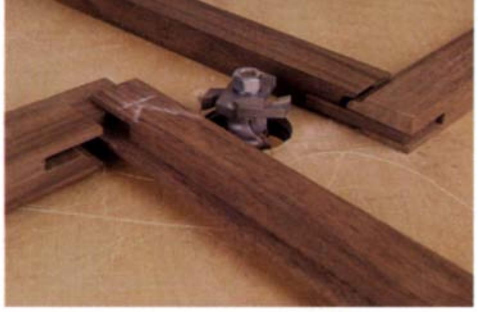
Materials and case construction

All visible wood on the Skandia cabinet was darkly stained oak, and all the unexposed parts were made from either poplar or alder. For my case, I used air-dried California black walnut for the primary wood and poplar for the secondary wood. I edge-glued walnut to poplar for the cabinet bottoms (bookshelves) and for the rear rail of the top unit. Instead of gluing up the carcase sides, which had cupped on the oak original, I used single pieces of quartersawn walnut. I grain matched the sides to create a continuous pattern from top to bottom and did the same for the walnut end caps and door stiles. I used poplar for the stretcher and back rail of the bottom unit and also for the carcase tops, which serve as the base for the door guides. I also used poplar for the pivot-post guide channels and all the wooden pieces needed to make the parallel mechanism.

Top and bottom units—The shaped front rail (fascia) of the top and bottom units adds a nice profile to an otherwise rectilinear construction (see the drawing on the facing page) I cut the coves on the rails by clamping an angled fence on my tablesaw and running the workpiece over the blade several times taking a 1/16-in.-deep cut with each pass. To make way for the tops of doors as they are swung open, I also coved the bottom of each walnut shelf front and the underside of the cap edge of the top unit. Using my miter gauge on the tablesaw, I crosscut the angled groove that receives the front rails in both the top and bottom units' sides. The inside grooves for the rails on the bottom unit's sides can go right across the piece and not be seen, but not so on the top unit's sides. I stopped the top's grooves for the front and rear rails and likewise for the grooves that hold the raised panel top. Next, I cut the tenons on the ends of the rails in two passes on the tablesaw: one with the piece flat to define the shoulder; and the other with the piece upright to cut the tenons' cheeks. Then I fitted the rails' tenons into the grooves and scribed the rail profile onto the sides. I found that it was much easier to match the leading edge of the sides to the contour of the rails than vice versa. After bandsawing the front edges of the sides, I scraped and sanded them smooth. To complete the joinery for the top unit, I cut shallow, stopped rabbets in the sides to receive the cap edge. To hide this joint from the front, I cut 3/8-in.-long tongues on the ends of the cap edge to overlap the joint (see the drawing on the facing page).

Carcases—Though the basic construction of the carcases is simple rabbet joints (which I screwed together rather than nailed), the alignment of the numerous rabbets is involved. I scrutinized the Skandia cabinets and dimensioned my carcase to make assembly as easy as possible (see the drawing). The solid-wood sides have face-frame-like front end caps that have a rabbet onto which the doors overlap. This overlap inhibits dust intrusion, hides the door guides and stops the door from swinging inward. Another rabbet crosses the top of the end caps to make way for the doors to slide by. The end caps run the full height on the front of the sides, minus 1/8 in. at the top. This 1/8 in. equals the length of the tongue at the top of the sides that joins each carcase module to the case above it or to the top unit. The bottom of the top unit's and cases' sides must, therefore, have a corresponding groove.

The carcase bottoms fit into rabbets in the sides and are notched to fit around the front caps, as shown in the drawing. The 1/8-in. tongue at the front of each bottom (edge-glued walnut piece) overhangs the end cap much like the cap edge on the top unit. I also rabbeted the inside of the carcase sides for the poplar tops and for the 1/4-in. plywood backs. Finally, I installed a dowel in the top of each front end cap and drilled a mating hole in their bottoms to keep the stacked components aligned.



To make the bookcase door frames, the author used his router table and a set of reversible cope-and-stick cutters, and then he strengthed the joints with solid loose tenons. The stiles and the rails are also rabbeted for the glass.

***By spring-loading one of the 3/16-in.-dia. brass pivot posts in each door,** the author can install or remove the doors with ease. A brass setscrew, which threads into each spring-loaded post, retains the post in the frame. To avoid weakening the door's stiles, he chiseled the setscrew's beveled access slots in the top rail.*

Doors—Although the Skandia door-frame moldings were probably shaper cut, I cut the sticking on my router table. To make the recess for the glass, I rabbeted the back of my door frames with a set of reversible cope-and-stick router cutters. Because I don't like to rely on a stub tenon alone, I dadoed out the mating frame parts and inserted solid loose tenons (see the top photo). I sized the door's width, leaving about 1/32 in. clearance on each side and rabbeted the back of the door stiles to mate with the rabbet on the end caps. Just before installation, I trimmed the door's top and bottom to fit the case opening. To retain the glass, I nailed a 1/4-in. darkly stained poplar molding around the inside of the frame.

One of the two pivot posts on each door must be retractable to install the doors in their guide channels. On one side of each door, I bored a 3/16-in. hole for the fixed post, which fits tightly with no adhesive. For the spring-loaded post, I bored a 13/64-in. hole 2 3/4 in. deep and then bored two 3/16-in. holes right next to each other in the rear face of the door frame directly over the long hole. I then chiseled the two holes to form a beveled slot (see the bottom photo at left). Next, I inserted a spring in the pivot-post hole, followed by a 2 1/2 in. length of 3/16-in.-dia. brass rod. I pushed the rod in until the spring was fully compressed, and then I scribed a mark on the rod through the beveled slot. I removed the brass rod, bored a hole at the scribe and tapped threads to accept a brass machine screw, which acts as a stop to retain the spring-loaded pin.

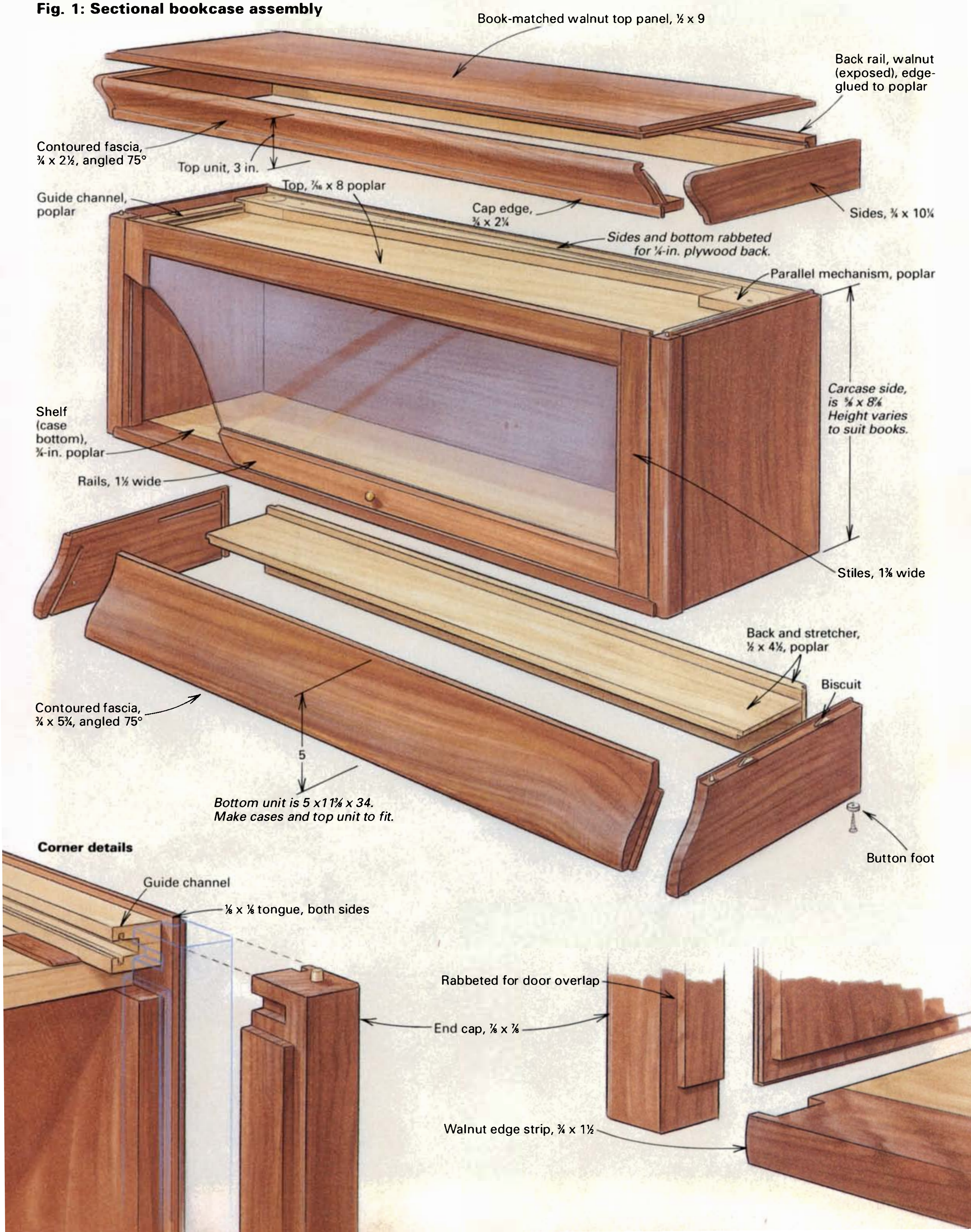
Making the parallel mechanism

As shown in the drawing on p. 54, the parallel mechanism consists of three parts: guide channels along the carcase sides, a pulley and a track at the back, and two steel bands. Both pivot posts protrude through holes in the front end of the bands. Each band follows its own guide channel, wraps around a pulley, and meets in a common track in the rear where the ends of the two bands are connected. When one band moves, the other moves an equal amount, thus the door stays parallel. And since the bands slide inside the guide channels and the rear track, they can't buckle.

Guide channels—The channels along the carcase sides serve two functions, as shown in the drawing detail on p. 54. They support the pivot posts as the door slides as well as guide the bands. Although each Skandia channel was made from one solid piece, I made mine in two parts, as shown in the detail. I routed track for the bands with the thinnest (0.050-in.) slot cutter my tool man could find. To use his three-winged cutter, I needed a special arbor as well. (Arbors and cutters are available from Steve Cash, Santa Cruz Saw and Tool, 1115 No. 9 Thompson Ave., Santa Cruz, Calif. 95062; 408-462-6936.) I crosscut the channels just shorter than the side width (to allow for shrinkage of the case's sides) and bored and countersunk oversized screw holes within the guide channels. I set the channels in place and used the holes to guide pilot holes

Photos: author; drawings: Bob La Pointe

Fig. 1: Sectional bookcase assembly



into the sides before I screwed the channels to the case, as shown in the photo at right.

Pulleys, corner block and rear track—At the rear of the guide channels, there are two different blocks to guide the bands. In the left corner, there's a wooden pulley block; in the right corner, a curved guide block. For the curved guide, I just bandsawed a quarter of a 1-in.-radius circle in a 2x2 block. I cut the pulley from a 2x2 block using a standard hole saw. I found that the plug from a 1⅝-in. hole saw fit snugly within the hole cut by a 1½-in. hole saw. To trim the pulley down for a looser fit, I put a bolt through the pulley's center hole, chucked the bolt in the drill press, and on low speed, took a file to the perimeter of the pulley. For the rear track piece, I first tapered the leading edge on the jointer from 2 in. wide at one end to ½ in. wide at the other. Next, I set up the slot cutter in my router table and cut slots to house the bands. I carefully adjusted the height of the cutter to make the slots tangent to the pulley hole. Then I cut the tracks in the pulley corner block. To center the pulley in its hole, I used the hole-saw arbor bit and a pulley as a center punch. Finally, I screwed a pulley block, curved guide block and track piece to each case top.

To allow for wood movement in the side of his case, *Greef fastens a guide channel by first drilling oversized holes in the guide. Then he installs three screws within the channel using needle-nose pliers and a tiny screwdriver. To complete the door-guide system, he glues a pair of walnut skids at the front of the case and a pair of cork bumpers at the rear.*

Bands—After experimenting with a variety of banding materials, I ended up using ⅜-in.-wide spring banding from an old Stanley ½-in. by 12-ft. measuring tape (not the tape measure itself, but the spring steel at the end of the tape). The springs are thin and strong, and their cupped cross section keeps them rigid when straight. I cut two bands slightly longer than needed for each mechanism. Then, after I scuffed the paint off the ends and cleaned the mating surfaces with solvent, I epoxied the band ends together. Next, I fed the band assembly into the guide systems and extended the two bands beyond the front of the channels to mark the pivot-post hole locations. Then I removed the bands to drill the holes.

Boring holes through brittle spring steel is difficult. My first attempts using the drill press yielded shattered metal. But, by placing the band between two blocks of wood and taping the end of the band over a guide hole bored in one of the blocks, I was able to clamp the pieces in my vise and bore through the guide hole. Once the bands were bored and back in place, I trimmed the ends with tin snips, so they would not protrude beyond the closed doors.

Installation—After chiseling slots in the back of the end caps in line with the side channels to allow clearance for the pivot posts, I trimmed the posts to length and fitted the door in place. Then I inserted the fixed post in a band hole, retracted the other spring post and released it into its hole. The door slid smoothly, quietly and parallel along the guides. Out of the corner of my eye, I saw the Viking smiling from the Skandia cabinet's label.

Final assembly

After installing all the doors, I applied finish to the individual bookcase sections. To mount the bottom edge of the lowest case's sides to the bottom unit, the Skandia cabinets had used separate tongues and arc-shaped slots, which resembled biscuits. In keeping with the original construction, I used my plate joiner to install two biscuits in each bottom side to align the carcase above. I then stacked all the shelf cases on the base unit and placed the crown unit on top. With the bookcase put together, I noticed that when each door was opened, the rabbet on the door's edges bore down on the front end of the guide channel. The channel is about 1/16 in. thick at this point, and I recalled several of the originals had cracked there. To avoid this, I installed rubbing skids on the case top where the back sides of the door stiles contact the guide channels. I also added cork door bumpers at the rear of each case. Before placing any books on the shelves, I waxed the guide channels, pulleys, door edges and pivot posts. Because the original Viking bookcase survived this long, I figured that earthquakes not withstanding, my bookcase should outlive me. □

Jeff Greef of Santa Cruz, Calif., is a woodworker and journalist.

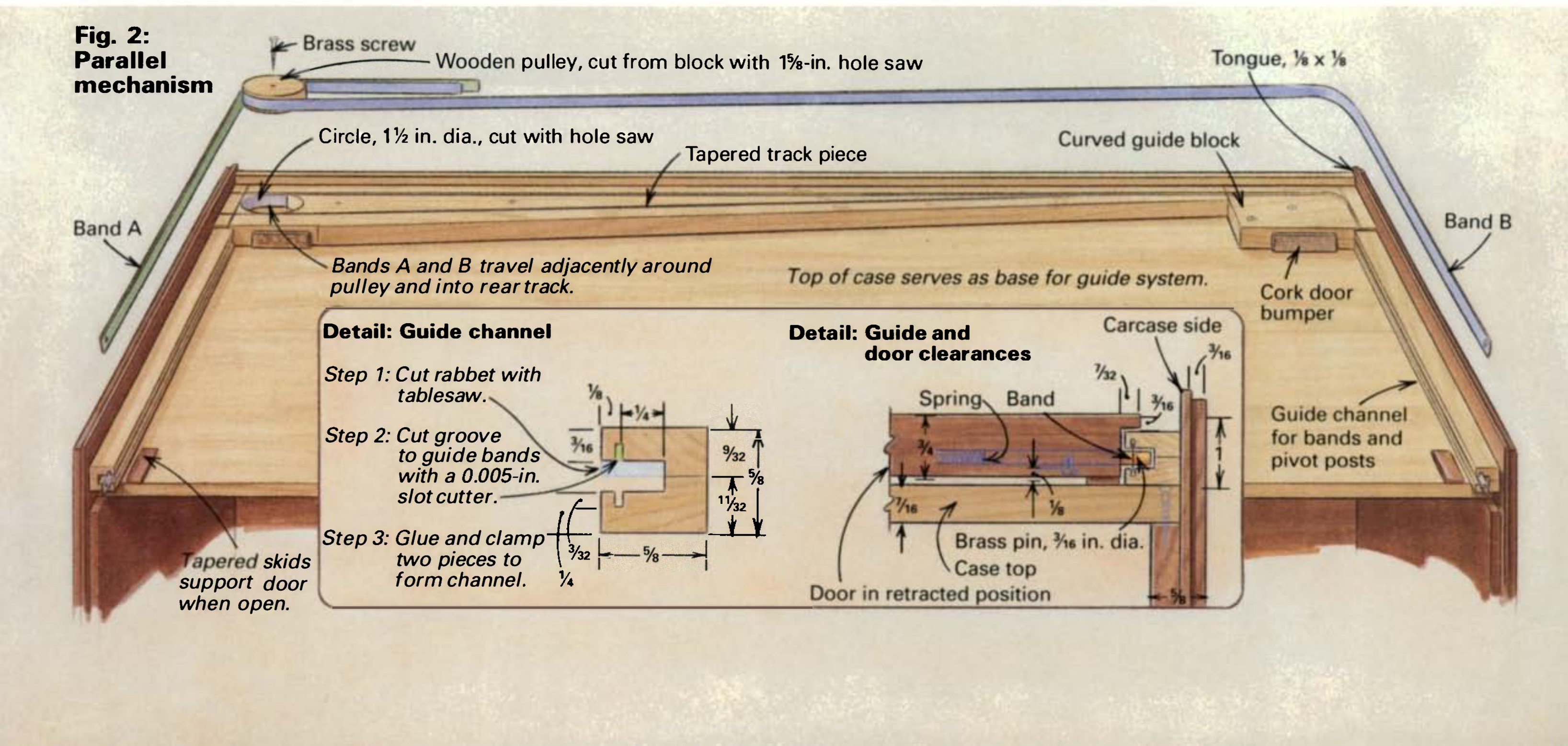


Fig. 2: Parallel mechanism

Simple guides align overhead doors

by Alec Waters

Retractable overhead doors used in traditional lawyer's bookcases are a handsome way to keep your books dust free. But many woodworkers are reluctant to make bookcases like this because they are intimidated by complex door-alignment mechanisms. Over the years, several guide systems have evolved for keeping doors straight and parallel to their tracks. And fortunately, for those who don't want to build exotic rack-and-gear or pulley-actuated retractors, a couple of these guides are very simple.

Jeff Greef of Santa Cruz, Calif., discovered a fairly common scissor-guide system in many antique barrister's bookcases. The scissors are amazingly simple; they are attached to the back side of the top of each door, crisscross to form an "X" and then connect again to the rear of the case (see the drawing at right). The curve at the ends of the bars is critical because the ends must slip easily through the eyescrews when the door is opened and closed. A pair of pivot posts and guides enable the doors to swing open and support the top of the door, when it's retracted. Of course, the bottom of the opened doors must be held up by guides or cleats on the case sides.

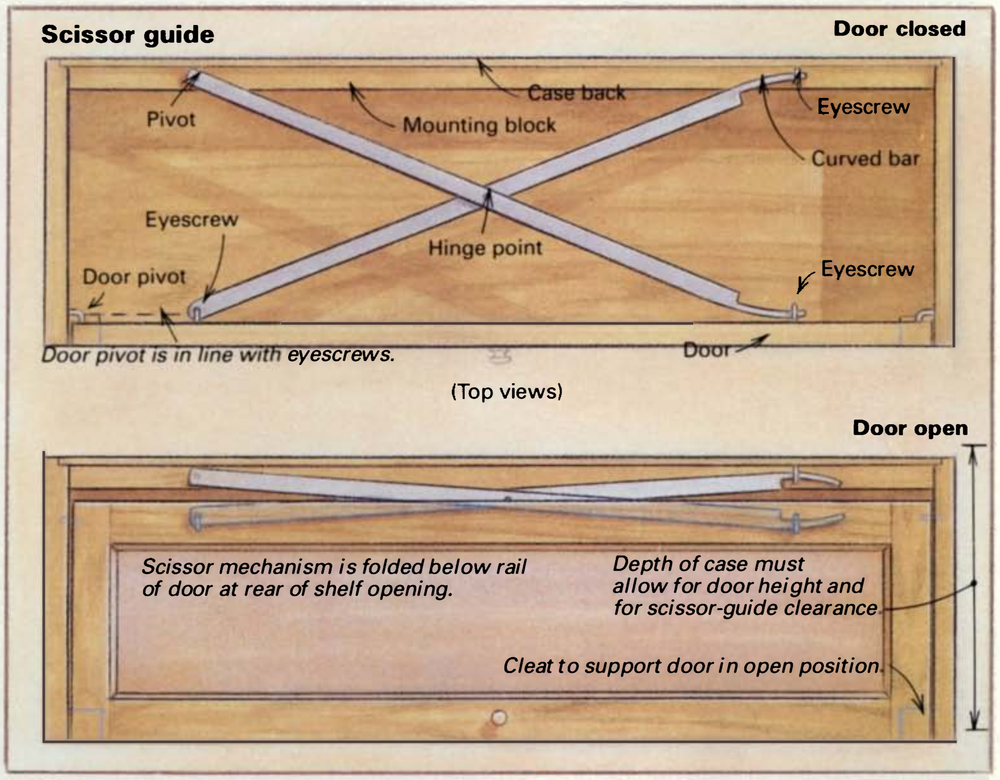
For his bookcase, Greg Moore of Comox, B.C. Canada, made a single carcase with shelves rather than individual stacking shelf units. Instead of using dowel, biscuit or mortise-and-tenon joinery for the case, Moore cut finger-like ends in the shelves, bottom and top to penetrate the laminated sides of the case. To create the spaces in the case sides for the fingers, he staggered the lengths of adjacent oak strips before gluing and splining them with plywood.

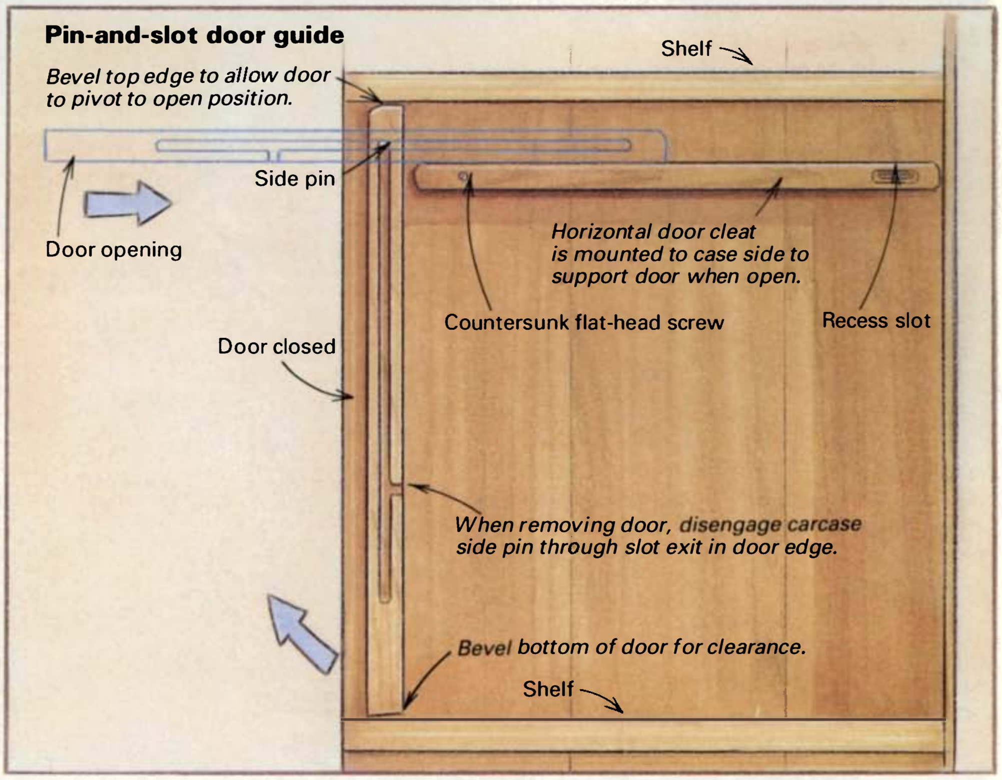
Moore chose a basic pin-and-slot arrangement to hang his doors. He routed stopped grooves along both edges of each door to receive brass pins that project from the case sides. When the doors are closed, they hang on the pins, and when open, the end of the groove functions as a stop, so the doors can't be pushed all the way into the cabinet. Tight clearances keep the door from jamming (see the drawing at right).

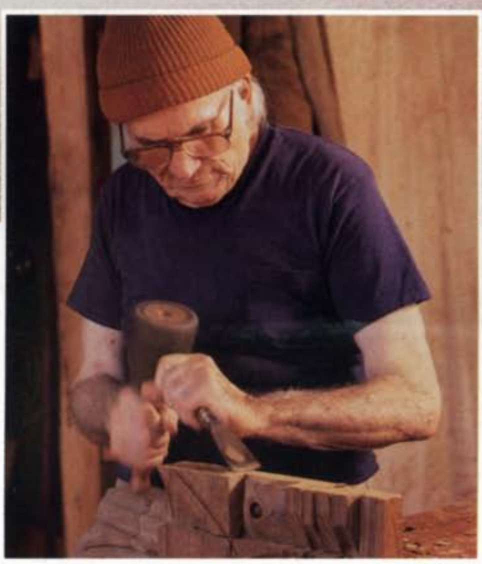
So the door can be removed or installed on the case pins, Moore chiseled an escape slot in each groove. He located the pins so the distance from the top of each pin to the bottom of the shelf above it equals the thickness of the door frame plus 1/16 in. He also fastened a pair of horizontal cleats to the case sides to help suspend each door when opened. A screw-head slot superimposed over a groove in one end of each cleat lets the case sides move freely during seasonal moisture changes. Moore also left clearance between the rear end of the cleats and the back of the case to accommodate side shrinkage. Although Moore first feared that without stops, the doors would swing in and out of the cabinet like saloon doors when closed, he discovered that when released from a horizontal position, each door automatically comes to rest when it reaches a vertical state. A cushion of air that gets trapped inside the cabinet provides the braking action.

With both the scissor guides and the pin-and-slot system (when the components are precisely aligned and properly waxed) the doors slide smoothly and remain parallel. I suppose that there is one drawback, though; now that I know about these simple guide systems, there's no excuse for omitting retractable doors in the next bookcase I build. □

Alec Waters is an assistant editor for FWW.







A self-taught sculptor, Leroy Setziol makes no distinction between functional craft and art. "A well-made tool is a hell of a lot more beautiful than a copied oil painting," he says. "That it's utilitarian is beside the point."

Much of Setziol's work is in the public domain like this pair of relief panels, which dominate the lobby of the Salem Hospital in Oregon. Carved in black walnut, the panels are 10 ft. and 8 ft. wide.

Leroy Setziol's Sculpture

Grid-like carvings merge order and chaos

by Scott Landis

Leroy Setziol's wood sculpture is a study in contrasts. It is at once intimate and monumental, symbolic and abstract, geometric and organic. Rough-hewn seams gnaw through burnished surfaces, and sweeping curves terminate in compact excavations. Setziol has been called the father of woodworking in Oregon. His work can be found in hundreds of homes, churches, hospitals and other public spaces all over the state. And Setziol has been presented with the governor's award for lifetime contribution to the arts. Indeed, not since the native carvers of the last century has a wood sculptor placed more carved art in the public domain of the Pacific Northwest. Still, his work is largely unknown.

In his life as well as his work, Leroy Setziol is the perennial outsider—an Easterner transplanted to the Northwest—a "city boy" in the country—an untrained sculptor with a highly developed style. He was born near Philadelphia in 1915 and raised in East Buffalo, N.Y. The son of a Polish window trimmer, the closest Setziol came to any formal art training was in grade school and on the job with his father. He became a Presbyterian minister and served as a chaplain during World War II.

Setziol quit the church in 1951 and took up sculpture. In 40 years at the bench, he has worked with clay, stone and even glass, settling on wood, in part, because the material was so readily available. Except for his own house and furnishings and occasional carved bowls and trenchers, Setziol manipulates the material not to form functional objects but as a medium for his art. Many of his carved relief panels have been used for doors, but he is not a doormaker. In several major installations, he has carved entire walls, but he is neither an architect nor a builder.

"People who work with clay totally dominate their material," Setziol explains, "but you can't do that with wood." Stone has its own structure and "an internal power" that he finds captivating, but "working with wood is a much more sensual experience. With wood, an artist is halfway home. Even if people hate what you do, they still love the wood." In wood, Setziol continues, "a defect becomes an opportunity." A troublesome knot may illuminate the richest color and grain.

Setziol ushers me into his cavernous machine room with a dramatic flourish, unveiling two sawn slabs of knot-free, straight-grain red cedar, 3 in. thick by nearly 4 ft. wide, he intones in his mellifluous voice, "You can bow low before some pieces of wood." Such exceptional specimens are a far cry from the salvaged wood and driftwood Setziol carved in his early career, but they can inhibit as well as inspire creativity. "They're so important in and of themselves," Setziol says, "I hate to do anything with them."

Turning to the workbench in his sunlit carving room, he considers a less intimidating prospect—a freshly planed teak panel, about 2 in. thick by 20 in. long. "This is a complicated piece," he notes, turning it over to examine some erratic figure. He ticks off a row of irregularly spaced chalk marks along two adjacent edges of the panel and then extends them vertically and horizontally across the surface with a straightedge. He incises the lines with a hand-held circular saw, and a crosshatched grid begins to emerge.

Setziol likes to have material around to "bump into," and his work reflects a cooperative expression of artist and medium. This 55-in.-wide endgrain relief carved into 8-in.-thick black walnut is in the collection of Oregon Cutting Systems.

Composing on and around a grid

For three decades, Setziol's grid has been the foundation for his finest work. It is the musical staff upon which he composes his sculptural score. The discipline of the grid enables Setziol to work without drawings, models or tape measure—spinning out his ideas on the brink of chaos. With the grid defined, he chalks a free-form design directly on the one uninterrupted flat surface of the panel. It is what Setziol calls the major sculptural statement of the piece, and it will be supported, embellished and further defined by the rest of the work. Scale relationships, conceptual relationships, geographic relationships will enhance the composition.

Seeking a balance between the unifying features of the grid and the sculptural statement (see the top photo on the following page), Setziol refines his vision. This is the "disciplined part," he explains, in which "I see what I can see in it" and discard the rest. His lanky 6-ft. frame crouched intently over the design, wisps of white hair curling out from under his woolen watch cap, Setziol vigorously edits his work, rubbing off excess chalk with a rag and revising the design. Satisfied with the result, for now, he traces over the remaining chalk lines with a black waterproof marker.

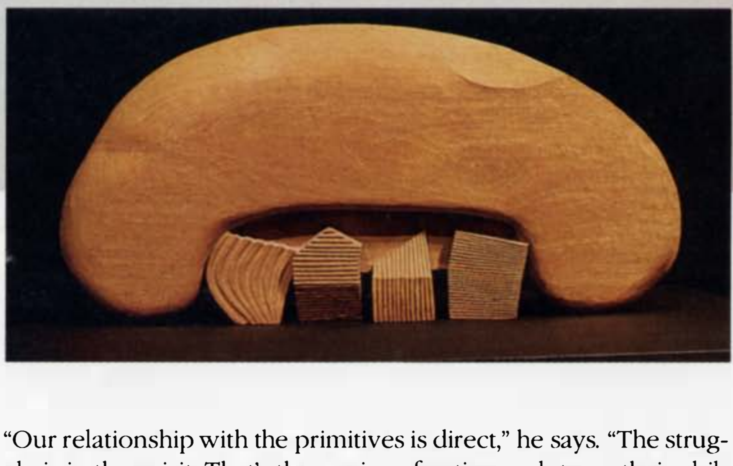
One small section of every panel is allocated to the split grain of the material—wood fiber otherwise unmolded by tool or human hand. "This is the one I usually split off," Setziol says, taking a smart whack on his chisel at the lower left corner of the panel. Like the intentional flaw in a Persian rug, this untooled segment is the sculptor's comment on perfection and a reference point for the grain, the color and the structure of the wood.

Scanning the piece intently for a few more moments, Setziol emits a deep-throated hum. He pulls the cap off the marker and traces a gentle arc across the grid. Catenary or reverse curves are familiar elements in many of his compositions. Embossed or incised on the grid, the curve relieves its static geometry. "One of my precepts," he explains, "is to invent a system and then violate it."

Setziol didn't actually "invent" the grid. He stumbled on it by accident while clearing stock from the center of a large myrtlewood carving about 30 years ago. In an attempt to speed the excavation of the dense wood, he began sawing large blocks that could be chopped out and reused in other carvings. Sawing in tighter and tighter rows to remove material more quickly, an interwoven pattern emerged. Setziol liked what he saw and decided to try it again. "Stuff like that happens all the time," he says. "The important thing is to recognize it."

Setziol is intrigued by natural imagery—at the beach or in the forest, under an electron microscope or even in his own backyard. (In one recent piece, he integrated the long stem and voluptuous bulb of a leek harvested from his garden.) "I sometimes see things from airplanes," he says, recalling the circular furrows of the Palouse River Valley in Idaho, which he noted while flying across country.

Such sources are filed away for future reference, perhaps to ap-



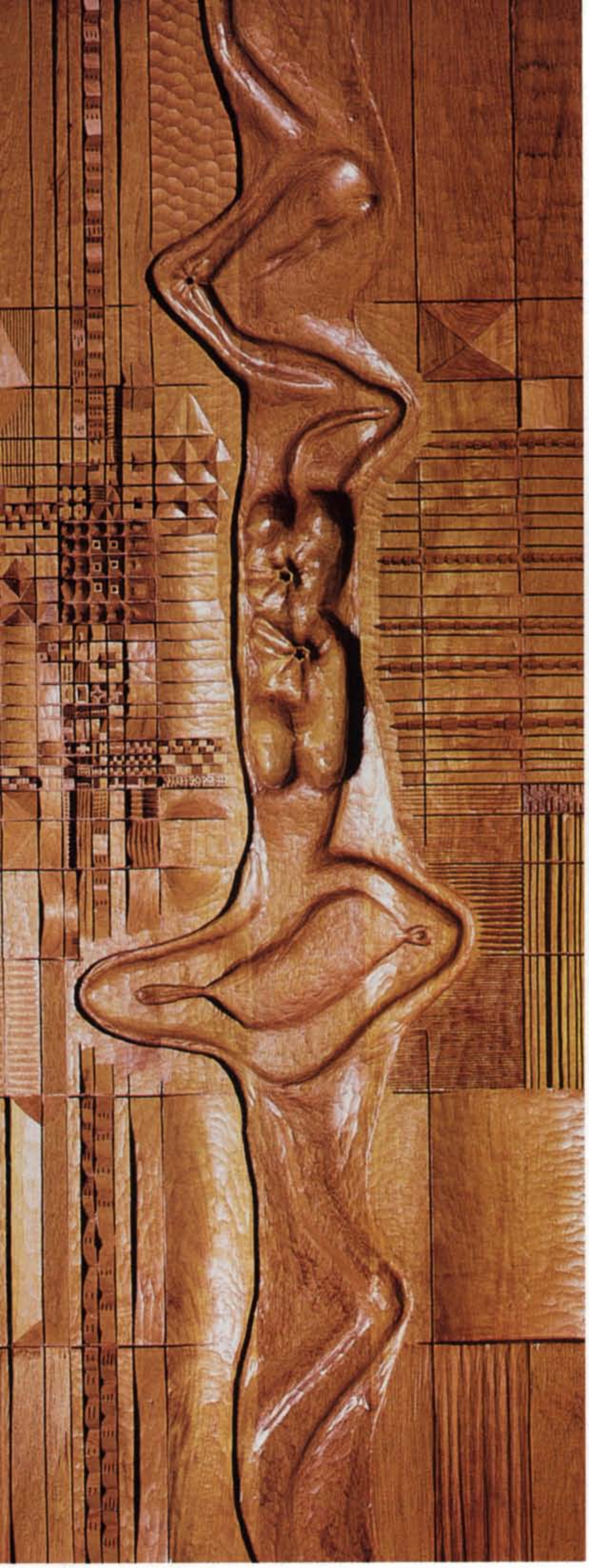
The restraining geometry of the grid enhances the dramatic effect of the framed "sculptural statements" in the Salem (Ore.) Public Library's 84-in.-high by 148-in.-wide freestanding screen (above). Horizontal form (right), from the collection of Mr. and Mrs. Joseph Macca, was carved from Honduran mahogany in 1982. The piece is 18 in. high by 37 in. wide.

pear again in wood (see the photo at left on the facing page). If they do, Setziol stresses, "I won't copy them, but I'll use them." Occasionally, the references are more self-conscious and reflect a keen awareness of the location or a respect for the people who will live with the piece.

"I make discoveries or find inspiration in the middle of work," Setziol says. "In that sense, I'm always contemporary. I have less of a feeling for the work I've done than for what I'm doing. One idea leads to another. And it's in the middle of that swampy search that something discovers you or you discover it."

Setziol's work is often called "primitive" and it is sometimes compared with the native sculpture that flourishes in the Northwest. "Our relationship with the primitives is direct," he says. "The struggle is in the spirit. That's the genius of native sculpture...their ability to approach the myth that lies beyond the bear or fish to say something about existence. As an artist, I don't recognize any distinction between us. I'm working in the same area as they did. I suppose you could call that inspiration." □

Author and photographer Scott Landis of Coatesville, Pa., writes widely about woodworking craft and tradition. This article is adapted from his catalog essay for Leroy Setziol's 1991 retrospective exhibition. The catalog is available from the Museum of Art, University of Oregon, Eugene, Ore. 97403-1223. ($29 postpaid).



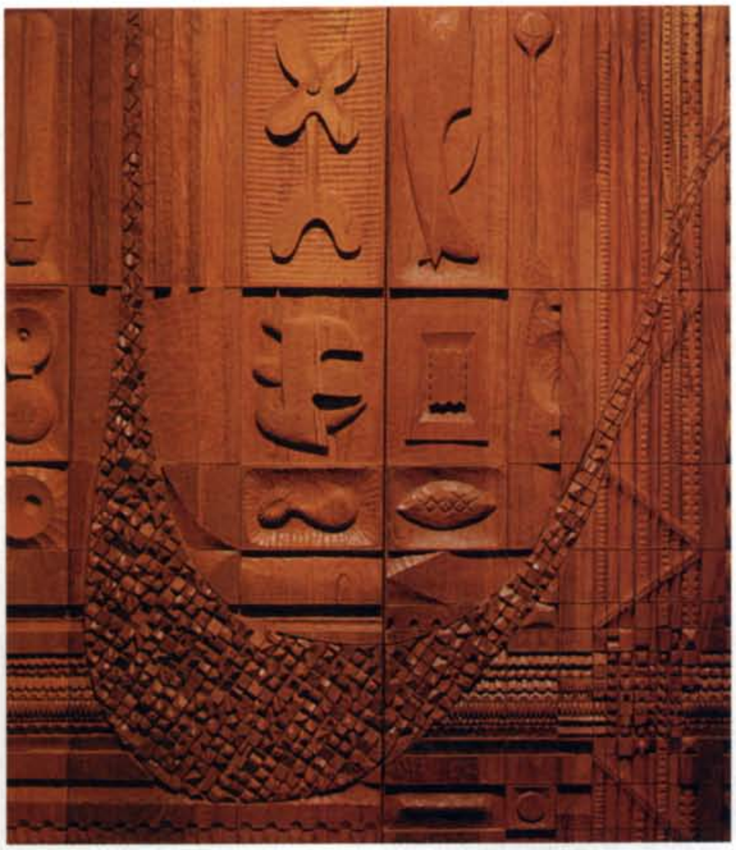


Photo: Scott Landis

Setziol's juxtaposition of organic and geometric imagery invites interpretation, but the sculptor offers only his art in explanation. From the collection of Eric Kittleson and Carole Smith, the teak panel (above) is 73 in. wide.

This relief panel (far left) evokes the meandering flood plain, orderly agriculture and tumultuous geologic history of the Willamette River Valley in central Oregon as it might be seen, or imagined, from the air. First National Bank, Salem, Ore., owns this 96-in.-high teak panel.

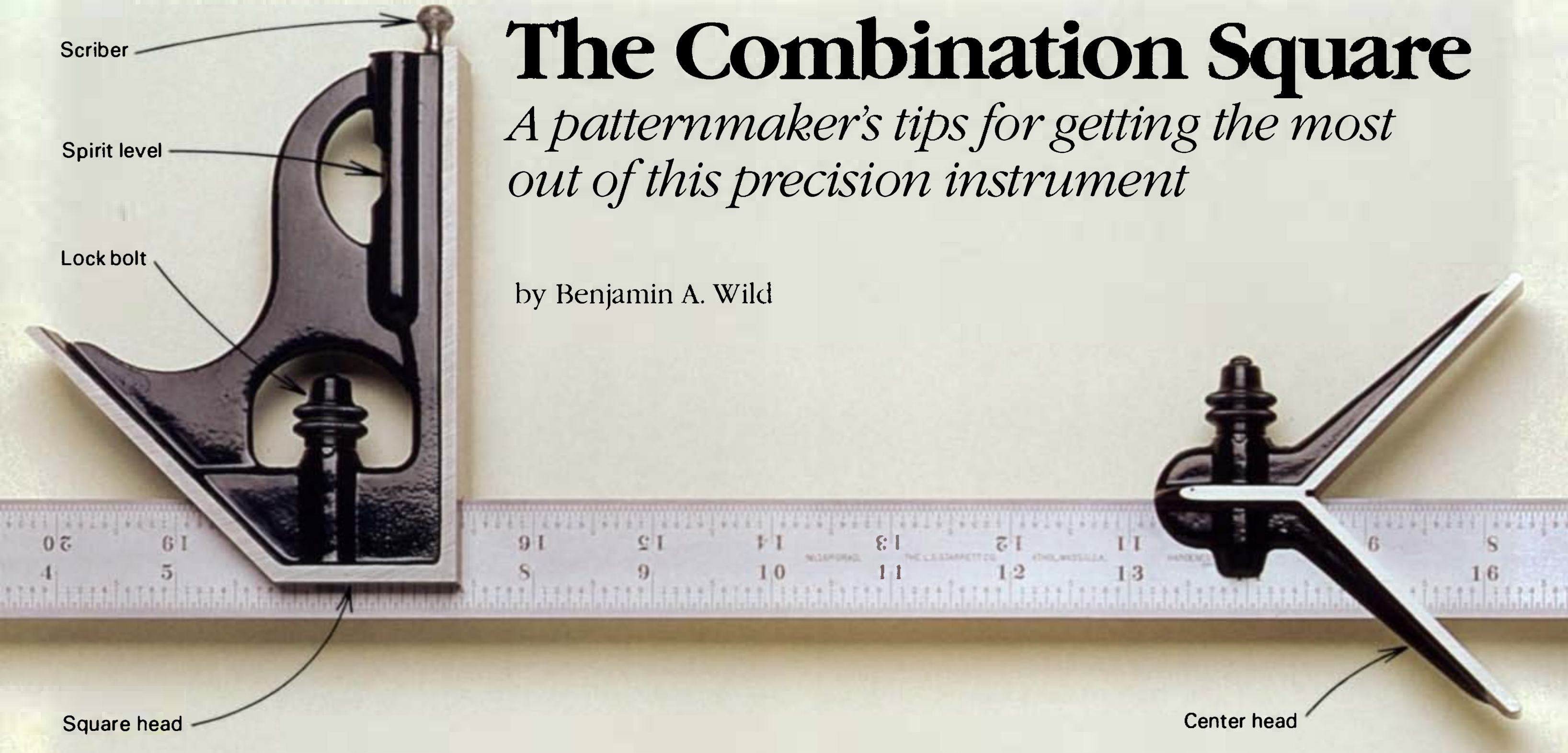
Setziol's garden sculptures resemble the mythical totems of Northwest coast natives. According to Setziol, "Our relationship with the primitives is direct—the struggle is in the spirit." This 102-in.-high sculpture (left) is carved from Alaskan yellow cedar and is one of many in the collection of Dr. Janet Neuberg.

Photos unless otherwise noted: Jack Liu

The Combination Square

A patternmaker's tips for getting the most out of this precision instrument

by Benjamin A. Wild



When I started my patternmaking apprenticeship 16 years ago, I was told to show up for work with a hammer and a combination square. I understood the need for a hammer, but I wondered why the square was so important. Besides the obvious use of laying out square and 45° miter lines, I soon found the combination square indispensable for accurately setting up and checking out machines as well as other layout work. Because a combination square is adjustable, it works quite well as a marking gauge and a height, depth and thickness gauge. It also transfers lengths of preset measure. Accessories, such as a protractor head for laying out angles and a center head for finding the center of round and square stock, extend the tool's usefulness. In addition to these techniques, I'll discuss some of the basic considerations for buying and using one of these versatile instruments.

Buy quality

When the boss saw the shiny, new, bargain-basement square that I bought, he threw it into the garbage. He then took me to the store and bought a Starrett square, protractor and center head set for me and deducted the cost from my first paycheck (L. S. Starrett Co., 121 Crescent St., Athol, Mass. 01331; 508-249-3551).

That Starrett square has fallen off benches, scaffolds and boats. The level vial is smashed, the scriber is lost and the paint is chipped. Recently, I put a 24-in. blade into it, set it on a surface plate (a precision ground granite table) and put it up against a 24-in. machinist's try square. I couldn't see light between the blades anywhere. After 16 years of hard use, it's as good as the day it was made. The cheap square, which I secretly retrieved from the garbage, went out of square and was thrown into Dad's toolbox years ago.

Quality materials and precision machining set the Starrett and other good squares, such as Brown and Sharpe's (Brown and Sharpe Manufacturing Co., Precision Park, 200 Frenchtown Road, North Kingstown, R.I. 02852-1700; 401-886-2000), apart from run-of-the-mill squares. The heads are forged and hardened; the rule blades are made of hardened steel and are available in a polished or satin-chrome-plated finish. I recommend the satin-chrome finish because it reduces reflection and glare, making the rule much easier to read. As a bonus, the chrome plating protects the blade from rust and wears exceptionally well.

Starrett squares also have what the manufacturer refers to as "quick reading graduations," which are staggered graduations with the inch subdivisions numbered as well as the inches, as shown in the photo above. A variety of graduation schemes are available, from all fractional, decimal or metric to some combination of these divisions. The decimal graduations, because of their predominant use in the aerospace industry, have become known as aircraft scales. These scales are handy if you use a calculator for determining layout dimensions because you can measure directly in decimals without converting to fractions.

My personal preference for a square is Starrett's catalog number C33HC-12-16R. This unit has a square head and a center head, and the 12-in.-long, satin-chrome blade has quick reading 32nds and 64ths on one side and aircraft quick reading 50ths and 100ths on the other side. A 24-in.-long blade is convenient for many applications, but the 12-in.-long blade does the job 90 percent of the time.

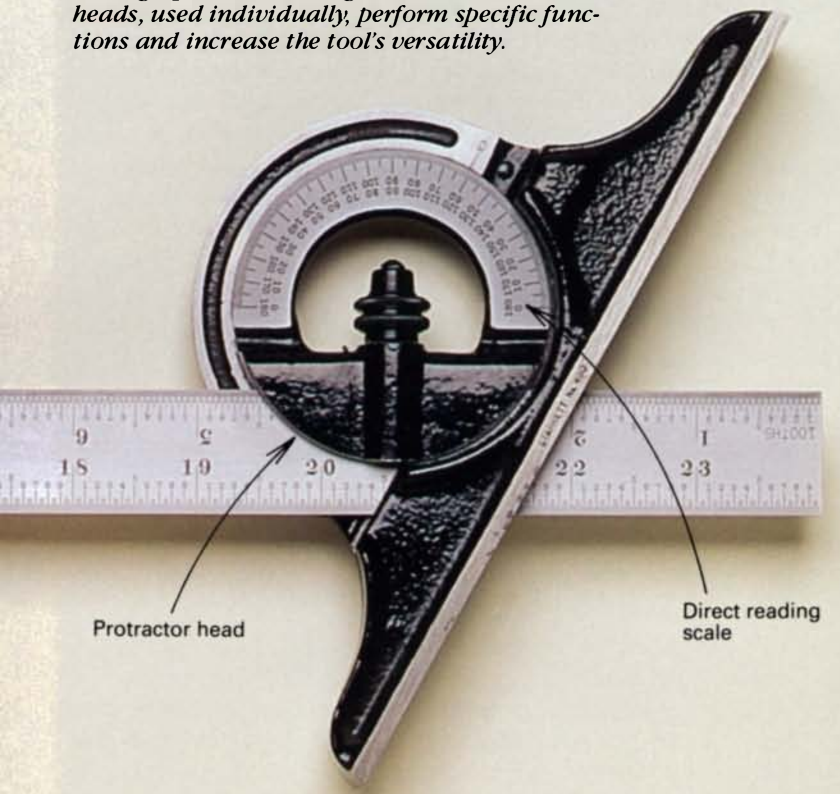
The center head makes quick work of finding the center of round or square work. Simply butt the edges of the stock against the V of the head, with the rule extended across the end of the stock, and scribe a line. Rotate the tool approximately 90° and scribe another line. The intersection of these lines marks the center of the piece. A protractor head is a useful, optional accessory for machine setups and for transferring angles.

Care and maintenance of the square

With proper use and care, a good square can be passed on for generations, so I've developed some techniques to maintain the quality and accuracy of my square. When sliding the blade back and forth or taking it out of the head, I push on the lock bolt to re-

Photo: Susan Kahn

A quality combination square is an invaluable aid in any woodshop as a marking and measuring gauge, for scribing lines, for transferring measurements, and for setting up and checking machines. The various heads, used individually, perform specific functions and increase the tool's versatility.



lieve the tension of the spring. This makes it easier to get the blade in and out of the head and prevents wear on the lock bolt and the head contact surface. To lubricate the blade, I use paraffin because it doesn't attract dust as oil will.

It's also a good idea to check the square's alignment every so often, especially after the square has been dropped or otherwise abused. Hold the square head against a jointed straight edge of a board with the rule extended across the surface of the board. Mark a line along the rule on the board's surface; then flip the square over so that the head is against the same straight edge, but the rule is on the opposite side of the line. Any gap between the rule and line will be double the amount that the square is off.

If the square is out of alignment, check the blade to see if it is straight and doesn't have any dings or burrs that might interfere with proper seating in the head. Burrs can easily be smoothed out by rubbing lightly with a flat sharpening stone. For more serious problems, contact the manufacturer for reconditioning.

Using the combination square

I learned one of the most important tricks for using a square from an old Southern craftsman, named Wes, while working at a Virginia boatyard. Pete, a young apprentice, was having trouble with out-of-square cuts and approached Wes for advice. Wes drawled out a couple of inquiries, "Did you mark the line straight? Did you cut directly on the line?" When Pete quickly responded "yes," Wes asked, "Pete, can you see straight?"

From that interchange, I learned to look at what I'm doing. I look to be sure the head of the square is tight to the edge of the workpiece. After marking a line, I look at it. If it looks wrong, I check it. I've avoided many mistakes with this simple procedure, and as I've gotten better as a woodworker, I've learned to trust my eye and recheck anything that doesn't look right.

When using a square, a bump or defect as small as 1/32 in. along the edge of the board, can cause the blade to be more than 1/8 in. out of square. To avoid errors, the combination square's head must be held tightly to the workpiece. I wrap my thumb around the curved part of the head with my palm pushing the head down and in against the edge of the workpiece. My index finger pushes down on the blade as far away from the head as I can comfortably reach. With this grip, I can slide the square along the board while keeping the head of the square pressed firmly against the edge. For the most accurate line, I place my knife or pencil on my mark, slide the square up to the marking instrument and then draw or scribe the line. (See the sidebar below for a discussion on marking lines with a knife vs. a pencil.)

The square as a marking gauge

The square can be used as a marking gauge by setting the desired length from the end of the blade to the perpendicular face of the head. Then, while holding a marking instrument against the end of the blade, slide the square's head along the edge of the board, as shown in the top left photo on the following page. This technique requires some dexterity and practice for best results. Because the wood's grain has a tendency to throw off the marking instrument, I only use this method for quick parallel lines when the layout is not critical. For more exact lines, I use a marking gauge.

The square as a thickness, depth and height gauge

My first rule of measuring is "don't, if you can avoid it." The ability to slide and lock the blade of a square lets me establish a consistent frame of reference that helps me avoid measuring in several different situations. Rather than measure the thickness of a board to plane another board to the same dimension, I use the square as a thickness gauge. I place the reference board on a flat table and

Accurate layout depends on a fine line

In any operation that requires handwork, the results are predicted by how clearly and accurately the line is marked. The clearest and most precise lines are made with a sharp knife that cuts the wood fibers. Lines scratched with an awl tend to be fuzzy, particularly across the grain. And a pencil line (no matter how sharp the point) is a lot wider than a carefully scribed line. The wide pencil line can lead to confusion about whether to work to the near side, far side or middle of the line.

To help make a scribed line more visible, I run a hard lead (4H) drafting pencil with the tip sharpened to a chisel shape along the score line. This darkens the line without affecting its accuracy. Sand paper (180-grit) glued to a piece of wood works well for sharpening the pencil.

My favorite layout knife is the X-Acto model with a large plastic handle, as shown in the top left photo on the following page. The thin X-Acto blades produce very clean lines. The thicker the blade and the deeper the cuts, the less accurate the line will be. And, if you make a mistake, a thin, lightly scored line is easier to sand away.

When scribing, make sure that your finger doesn't hang over the edge of the rule; I've found that most patternmakers have at least one scar as a result of having made this mistake. *—B.W.*

***The combination square** also can serve as a marking gauge. Simply hold a knife or pencil against the end of the blade while drawing the square's head along the edge of the stock.*

***As a depth gauge,** the combination square can be used to check the thickness of planed stock, as shown here. The square also can check mortise and dado depths and the lengths of tenons and tongues.*

***Lay out evenly spaced divisions** with the combination square by first setting the square to the desired increment. Then align the rule's end with the starting point, and score a mark at the square's head. Without lifting the knife, move the square along the board, butting the rule's end to the knife blade, and make the next mark at the square's head, as shown here.*

***With a set of parallel uprights and a story stick,** you can accurately lay out and transfer measurements from irregularly shaped objects. Mark the top edge of the story stick to be sure that it is properly oriented when transferring measurements.*

hold the head of the square vertically on the board with the blade hanging over the board's edge, as shown in the near left photo. I then extend the blade to the tabletop and lock it in place. That set measurement can be used as a "feeler" gauge to judge the thickness of the board I'm planing. I've found that my sense of touch is much more accurate than trying to measure in these situations.

The height of a tablesaw blade or router bit can be set using this same technique. I set the square to the desired depth of cut using the comparative technique described above whenever possible or the rule's scale. Then, with the end of the blade resting on the saw table or router base, I adjust the blade or bit to the square's head. Again, feeling when the bit or blade just contacts the square's head provides a more accurate setting than trying to see the adjustment.

I've also used the square in this manner to check and compare tenon lengths to mortise depths and the tongue lengths on shelf ends to dado depths in carcase sides.

The square as a spacer

The square, set for a specific dimension, can be used to evenly space elements in a project, such as pickets in a fence, slats in a crib or dividers in a set of pigeonholes. I generally use a calculator when determining element spacing, and this is where the Starrett's decimal graduations come in handy. I can set the square directly from the calculator readout without the need to convert back to fractions thus eliminating another possible source of error.

Using this technique of laying out an element by referencing from the previous element or layout mark does introduce the possibility of cumulative error—an insidious mistake that quickly grows as the number of elements increases. However, in this situation, cumulative error can be minimized by aligning the blade end of the square with the reference surface and scribing along the perpendicular square head with a knife blade. After scribing the line, but before lifting the knife, I move the square down and butt the end of the blade against the side of the knife blade. I then scribe the next line against the perpendicular square head, as shown in the photo at left. I continue to leap frog the square and knife down the board until I get near the opposite end. Then I determine the amount of cumulative error and divide it among the last few increments to make the error all but undetectable.

Transferring points with a square

Lines or points are easily transferred from one side of a board to the other or even from piece to piece by setting the blade to the desired length. The key to accurate transfers is to establish datum surfaces that are straight, flat and square to each other and then always to measure from these datum surfaces.

This technique works fine for square projects, but what about curved surfaces? For irregular surfaces, machine shops have a coordinate measuring machine—a device that rides on a track above the part and measures the distance between points. For our purposes, however, a combination square, a story stick and a set of parallel blocks will accomplish the same thing. The story stick is held over the object by the parallel blocks and becomes the datum surface for measuring all the features of the object. Using the square, as shown in the photo at left, I transfer all the desired points from the object to the story stick. Marking a datum surface on the stick helps keep the stick from getting turned around. I can then transfer these dimensions from the story stick to create another piece or to make a drawing. □

Ben Wild, a former patternmaker, runs an apprenticeship program and teaches vocational training for the Rochester, N.Y, school district.

Photos: Charley Robinson

***For practice cutting dovetails,** this cabinet with drawers is a great project. Through dovetails join the carcase while tapered, sliding dovetails secure the shelves and vertical dividers. The banks of graduated drawers include lots of through and half-blind dovetails.*

Making a Case for Dovetails

A wall-hung tool cabinet that will hone your joinery skills

by Carl Dorsch

When I needed a tool cabinet, I saw it as a great opportunity to practice cutting dovetails. The cabinet I designed features through dovetails, half-blind dovetails and tapered, sliding dovetails. All of these joints can be cut either by hand or by machine; I cut mine by hand except for the tapered, sliding dovetails, which I cut with a router (see the sidebar on the following page).

Because my cabinet shown in the drawing on p. 65 and in the photo above has doors, it protects the tools from dust and curious visitors, yet it leaves them readily available. The upper portion of the cabinet displays my antique planes. The shelves are spaced to hold the handplanes upright, and the cabinet is deep enough so that two planes fit side by side. The bottom of the cabinet contains several drawer banks for storing accessories and other tools.

Building the carcase

The carcase sides are joined to the top and bottom with through dovetails. (For machine techniques on cutting through dovetails, see Mark Duginske's article on p. 66 in this issue.) I cut the dovetails with the tails on the sides and the pins on the top and bottom so that the mechanical lock of the joint resists the weight of the cabinet and its contents. I used stopped, tapered, sliding dovetails for the shelves and drawer dividers because I prefer them functionally and aesthetically. The taper makes this strong joint easy to assemble, as discussed in the sidebar below, and stopping the dovetail leaves a cleaner appearance than exposed joinery. After cutting the tapered, sliding dovetails, but before assembling the carcase, I trimmed the back of the shelves to provide space for the flush back. The back of the top section of the cabinet must be rabbeted to accommodate the inset cabinet back and the hanging cleat.

Drawer construction

The drawers have through dovetails at the back and half-blind dovetails up front. Instead of installing the bottom in grooves in the sides and in the front, they're screwed to the assembled drawers and extend past the sides to create slides that ride in dadoes routed in the carcase sides and dividers, as shown in the drawing on the facing page. The bottom drawer in each bank slides on the shelf beneath it. I leave the bottoms slightly wide until the drawer bodies are attached, and then I plane each one to fit its dado.

Making and fitting the doors

The doors are typical frame-and-panel construction and overlap where they meet at the cabinet's center. To accommodate the overlap and to keep the gap between the doors centered, I made the center stile of the left door ¼ in. wider than the center stile of the right door. Both of these stiles are rabbeted to make the lap joint.

Because the knife hinges that I used to mount the doors have no provision for adjusting the doors' fit, they must be accurately mortised in place. I've found that by mounting the hinges to the doors first and leaving the hinge mortises in the carcase slightly short, I can chisel out the mortises to sneak up on a perfect fit.

The cabinet can be set on a bench or hung on the wall. I hung mine on the wall using beveled cleats, one on the rear of the cabinet and one on the wall. When using this hanging system, the wall cleat should be fastened with two screws into each stud. □

Carl Dorsch is a woodworker in Pittsburgh, Pa.

Tapered, sliding dovetails with a router

Sliding dovetails provide extremely strong carcase joints. But the wider the stock, the more difficult it is to slide home a straight dovetail because glue tends to bind and grab the tight-fitting pieces. By tapering one side of both pin and socket, the joint remains loose, as the two pieces are assembled, until the pin is fully seated in the socket.

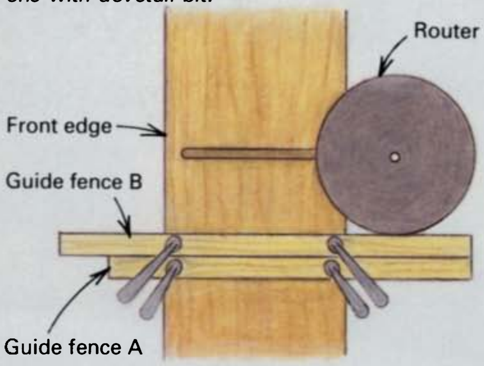
The trick is to get a matching taper on the pin and the socket for a perfect fit. To ensure an identical taper, I use the same 1/16-in.-thick shim for routing first the socket and then the pin, as shown in the drawing below. I cut the tapers on the upper edges of the dovetails; the straight bottom edges of the dovetails then serve as references to ensure that the shelves are flat, square and evenly spaced. *—C.D.*

Routing tapered, sliding dovetail sockets

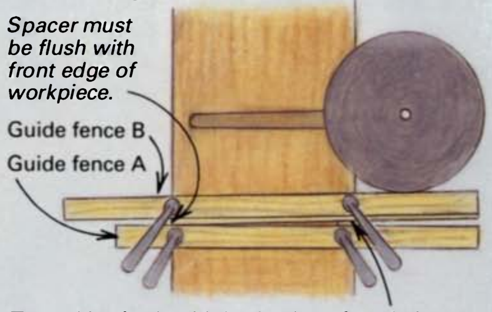
When routing tapered, sliding dovetails, the socket stock (cabinet sides) and pin stock (shelves) must be the same width, or the tapers will not match. Trim shelves to accommodate cabinet backs after routing the mating sockets and pins.

Routing a tapered dovetail socket requires three passes. For ¾-in.-thick pin stock, make the first pass with a ⅜-in.-dia. straight bit to hog out most of the waste. For the second pass, use a ½-in.-dia. dovetail bit, and cut a typical straight dovetail socket. The final pass with the same dovetail bit, but with the guide fence shimmed at a slight angle, routs the socket's tapered top edge.

First and second pass: Clamp guide fences A and B to the cabinet component to align the cutter with the dovetail layout line and use this setup for both passes; one with straight bit, one with dovetail bit.



Third pass: Leave guide fence A clamped in place, and insert a spacer and a shim between fence A and B. The spacer determines the width of the socket (use a ⅛-in.-thick spacer for ¾-in.-thick pin stock). The 1/16-in. shim creates the taper angle.

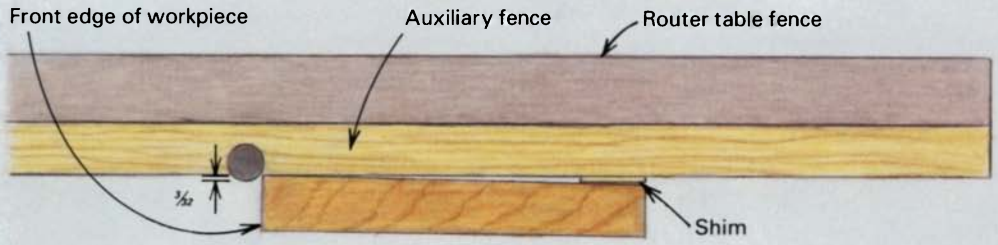


Tape shim flush with back edge of workpiece.

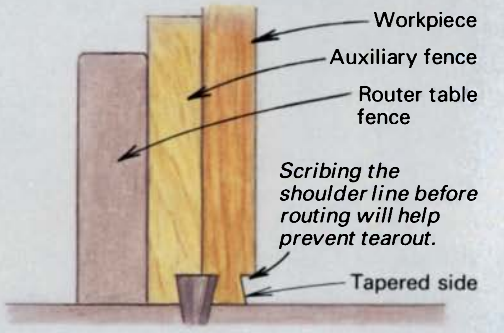
Routing tapered, sliding dovetail pins

The pins are cut in two passes using the same dovetail bit as for the sockets but in a table-mounted router. The tapered pin side is cut in all stock before resetting the fence to rout the straight pin side. Be sure to rout a tapered side on some scrap stock to test fence setup for routing the straight side.

First pass: Adjust fence so that the dovetail bit protrudes 3/32 in. Tape a 1/16-in.-thick shim flush with rear edge of workpiece and high enough to clear router bit.

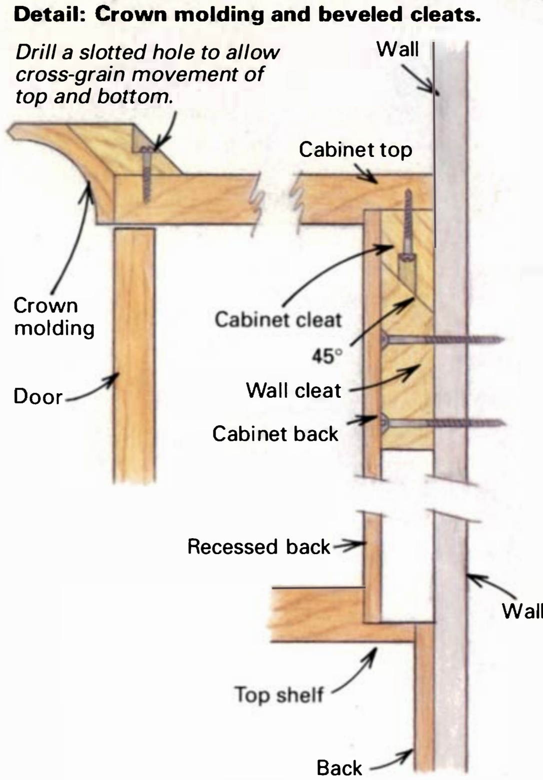


Second pass: Set the fence to dovetail the pin's straight side. Make a test cut on the scrap stock and readjust as needed for a snug fit in the socket.

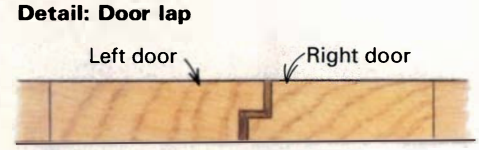


A dovetailed tool cabinet

Detail: Crown molding and beveled cleats.



Detail: Door lap



Detail: Drawer

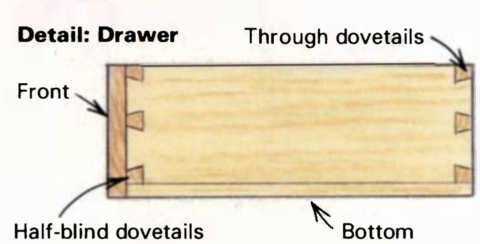
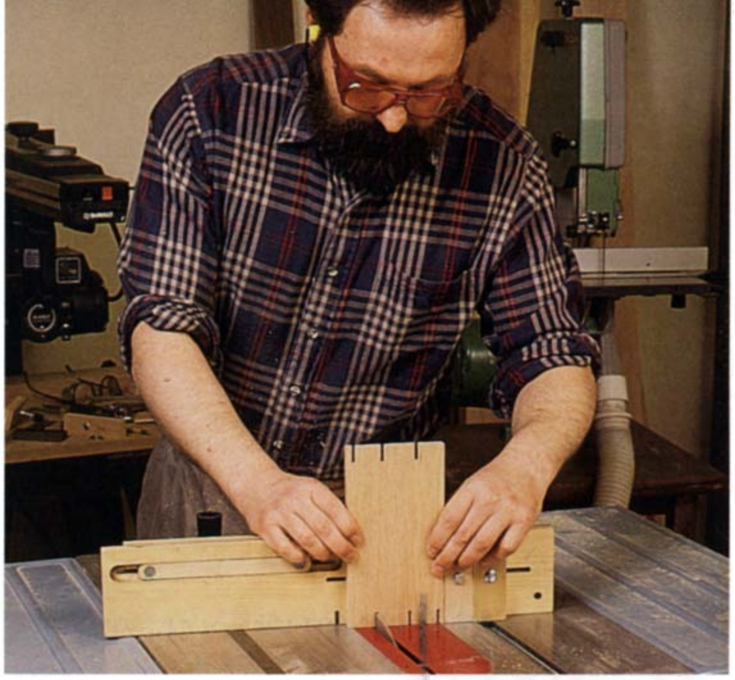


Photo: author; drawings: Lee Hov

Machine-Cut Dovetails

The look of hand-cut joints from the tablesaw and bandsaw

by Mark Duginske



Duginske's method produces machine-cut through dovetails with hand-cut accuracy. Both tails and pins are sawn using a shopmade jig on the tablesaw and trimmed with a narrow blade on the bandsaw. An ingenious system of spacer blocks and shims determines the layout of the joint and maintains a precision fit.

The dovetail is a classic joint that many craftsmen consider to be the hallmark of quality joinery. But the traditional method of cutting dovetails by hand requires skill and patience, and unless you're in practice and up to speed, all that sawing and chiseling is slow work. Making dovetails with a router and jig is one alternative, but the monotonous look of most router-cut dovetails leaves something to be desired.

I have always felt that there was a missing link between the tedium of hand-cutting and the limitations of router jigs. After years of experimentation, I developed a method for cutting through dovetails, which combines hand-tool flexibility with machine-tool speed and accuracy. It's a great system for the small-shop because it is fast, simple to use, costs next to nothing and allows you to design the size and layout of dovetails to suit most applications.

How the system works

In a nutshell, the system employs two machine tools: the tablesaw and the bandsaw. A simple shopmade jig shown in figure 1 on the facing page mounted to the tablesaw's miter gauge supports the workpiece on edge for cutting both pins and tails with a standard sawblade. The blade is tilted for cutting the tails; for the pins, the miter gauge and jig are angled. While the jig maintains the angle of cut, a set of spacer blocks mounted to the jig spaces the sawcuts to produce a perfectly fitting joint without the need to mark the boards individually. After the tablesaw cuts are made, the waste is removed with a ⅛-in.-wide blade on the bandsaw using the saw's regular rip fence as a guide. The narrow bandsaw blade slides into the kerfs left by the tablesaw blade and cleans up the sharp corners between tails and pins almost perfectly. Shims, used along with the blocks, allow fine-tuning the joint's fit. Depending on the width of the spacer blocks and the setup of the jig, you can vary the angle, width and spacing of the pins and tails for practically any aesthetic effect.

The dovetail joints' precision fit can be fine-tuned by adding or subtracting paper shims when the pins are cut with the tablesaw jig.

Although my system is straightforward, it involves quite a few steps that must be performed in order. The procedure is better illustrated with photographs and sketches than with a written description alone; therefore, I've included a step-by-step account in the sidebar on p. 68 of how to cut a typical through dovetail joint. Before you begin cutting, there are a few preparatory tasks including making the tablesaw jig, designing the layout of the desired dovetail joint and cutting out the spacer blocks.

Designing the joint and cutting the spacer blocks

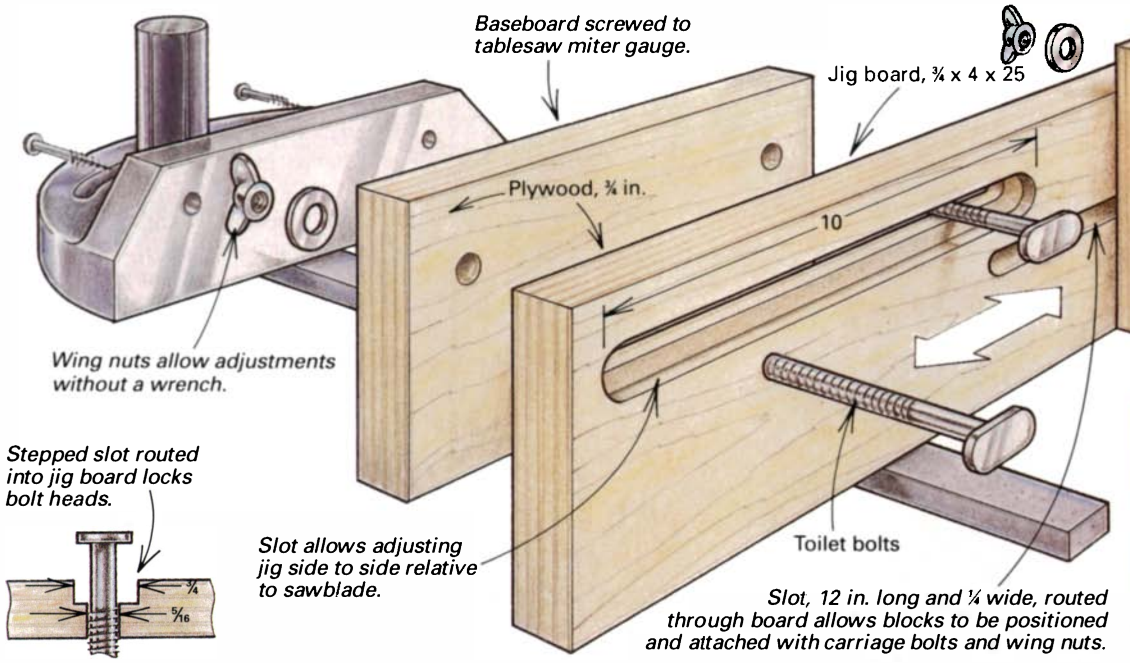
The hinge pin of my entire dovetail system is the spacer block: Mounted to the tablesaw jig, the blocks provide a way to cut all pins and tails without having to mark out each board. Before cutting the blocks, you must design your dovetail layout including the number, size and spacing of the pins and tails. This will determine both the number of spacer blocks you'll need and their widths.

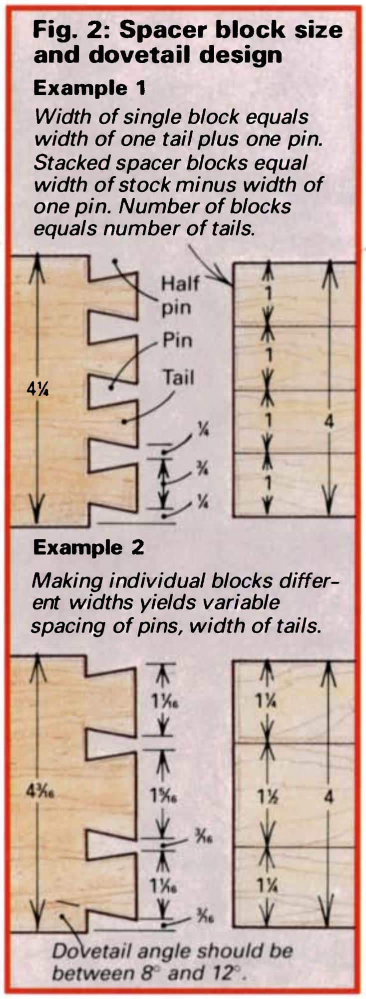
Following figure 2 on the facing page, you'll see that the number of spacer blocks needed equals the number of tails in the joint. In example 1, four blocks produce a joint with four tails, three full pins and two half pins. Once you've chosen the number of dovetails, you'll need to decide on their size and spacing. It's possible to make the pins and tails the same size, but I find this is too mechanical looking, not consistent with high-quality work. One of the advantages of my system is you can easily vary the sizes of pins and tails to make joints look more like they were hand-cut. Traditionally, the tails should be larger than the pins, but avoid making the pins too narrow. (Unless you use a special thin-kerf tablesaw blade, you won't be able to cut pins less than about 3⁄16 in. wide at their narrowest point and, in my opinion, really skinny pins are too weak for most applications.) For the dovetail angle, I'd recommend 10°, but avoid an angle outside the range of 8° to 12°. If the angle is less, the pins can slide between the tails, defeating the locking quality of the joint. If the angle is greater, the sharp corners of the tails and pins are fragile and can break easily under stress.

My system allows you to alter the width of *individual* tails and

Photos: Sandor Nagyszalanczy Drawings: David Dann

Fig. 1: Tablesaw dovetail cutting jig





the spacing of pins along a single joint. In example 2 in figure 2, the center tail is wider than the tails on either side of it. You could just as easily make the outer tails wider or make two wide tails, two narrow tails, two wide and so forth—as long as the resulting layout is symmetrical relative to the center of the joint. This last point is required for this cutting system to work correctly.

Once you've finalized the dovetail layout, you're ready to cut the spacer blocks. As you can see in figure 2, one block is equal to the width of one tail at its widest plus the width of one pin at its narrowest. In example 1, each block equals one ¾-in. tail plus one ¼-in. pin (notice that all pins, including half pins, are the same size). Depending on your design, your spacer blocks may all be the same width or varying widths, but in either case, the total width of the spacer blocks should equal the width of the stock minus the width of one pin. Both of the examples in the drawing employ spacer blocks that add up to 4 in. wide, yet the number of tails and the layout of each design is completely different.

The spacer blocks are made from scraps of ¾-in. plywood. I cut two sets: One set is drilled for the bolts that mount the blocks to the jig board (an extra block is cut and drilled as the end block). The second set is left undrilled and used to mark the first tail board, which is necessary for setting the jig before cutting. If your joint has tails of varying sizes, number your spacer blocks, so they can be kept in the correct order (see the top photo on p. 68).

Making the tablesaw jig

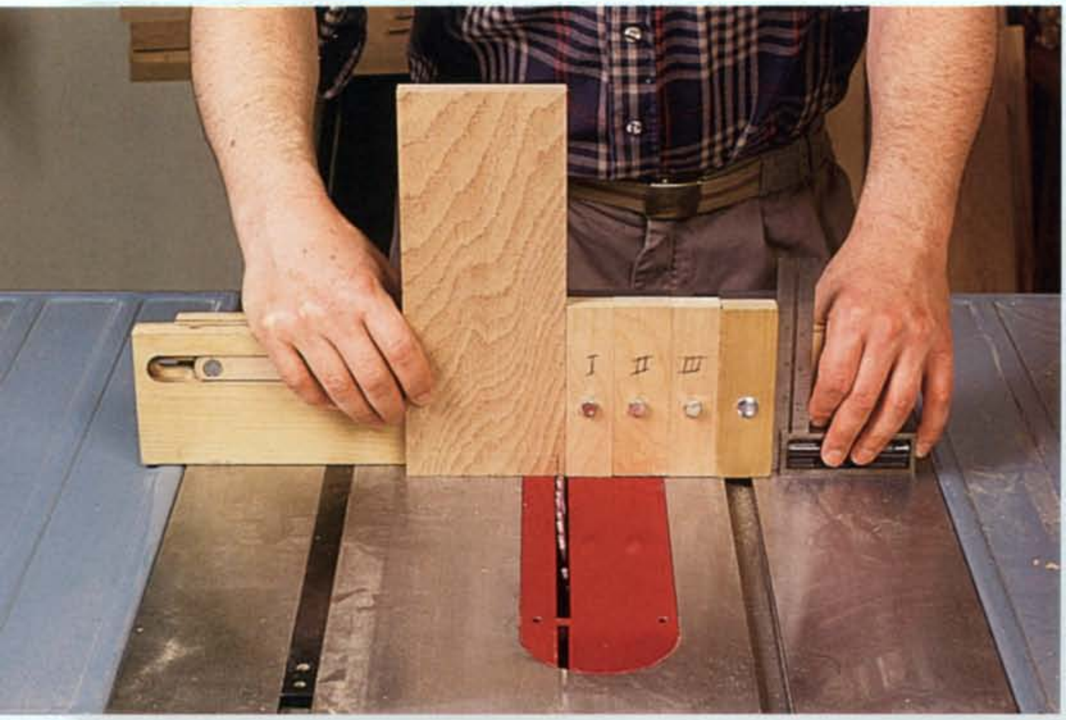
I made the tablesaw jig shown in figure 1 from ¾-in. plywood. The jig, which mounts to the tablesaw's regular miter gauge, consists of two parts: a 4-in.-high baseboard that bolts through the gauge's head and a jig board that attaches to the baseboard. To allow the jig to be adjusted back and forth for setting different dovetail arrangements, the jig board is bolted through a 5/16-in.-wide slot. A pair of toilet bolts, or closet bolts (available in the plumbing department of your local hardware store), connect the two parts of the jig. The slot is stepped (routed in two passes) to fit the toilet bolts' heads (see the detail in figure 1), allowing them to slide, yet not turn when the wing nuts, which lock the jig board to the baseboard, are tightened. Another slot routed through the jig board allows the spacer blocks to be positioned and bolted in place. You will need a 2-in.-long, ¼-in. carriage bolt, with washers and a wing nut, for each block that you use.

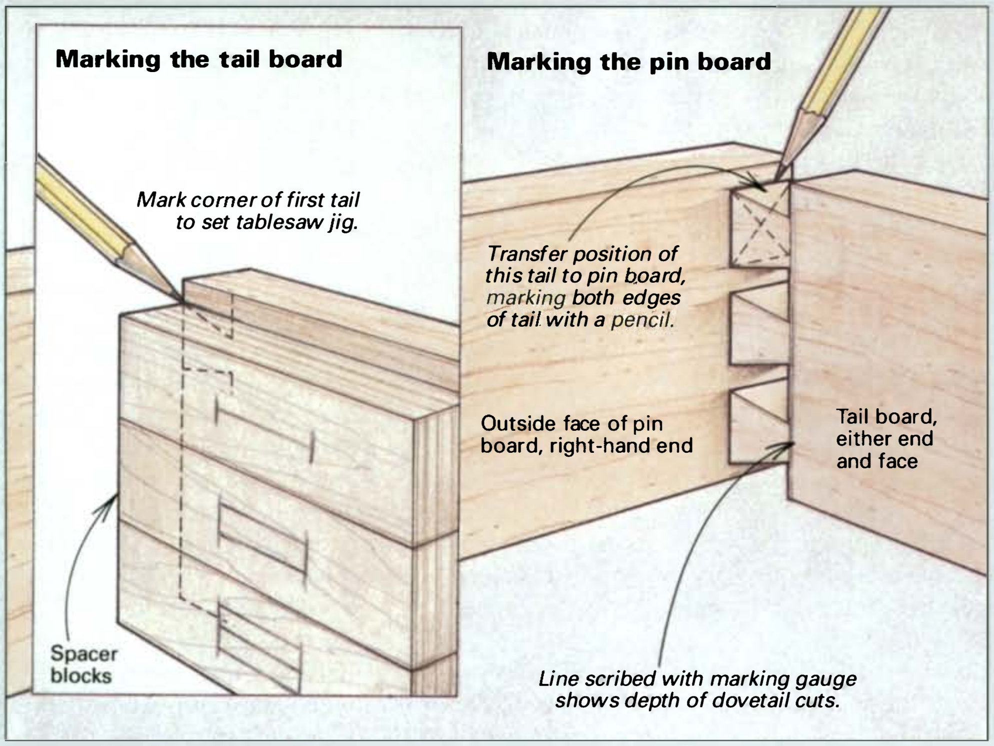
System limitations

All woodworking methods have some advantages and disadvantages, and mine is no exception. First, the jig I built will only handle workpieces up to about 12 in. wide, so it won't cut dovetails on wide carcase sides. Another limitation is the length of the workpiece. I find it's not practical to handle stock longer than 2 ft. standing straight up on your tablesaw top. If you must make dovetails on boards wider than 12 in. or longer than 2 ft., I suggest you either use a commercial router dovetail template system (Leigh and Keller both make good ones). Or, if you only need a few dovetails, cut them by hand. Finally, my system doesn't allow pins that vary in width in a single joint or a non-symmetrical arrangement. In other words, you can't make a drawer side with pins and tails that are progressively wider from top to bottom. But I can think of very few instances where you'd want to do this anyway.

It'll probably take some study and experimentation for you to master the process, so don't plan to make drawers from your precious stash of bird's-eye maple the first couple of times that you try the system. I am a real believer in practice makes perfect. The more you use this system, the better you will get at it. □

Mark Duginske is a woodworker, teacher and author who lives in Wausau, Wis. His book and video Mastering Woodworking Machines *is available from The Taunton Press.*





Step-by-step dovetails

Here are the steps you will need to follow for cutting out a set of through dovetails. The demonstration joint shown in these photos illustrates a typical joint, such as you might use for building drawers. Layout and dovetail size variations, as well as the construction of the tablesaw jig and spacer blocks needed to cut the joint are discussed in the main article.

Prepare stock: Dress all stock to final dimensions with tail boards and pin boards of equal thickness; make sure ends are square and trimmed to final length. Set marking gauge to thickness of stock, which will equal the depth of the dovetails, and scribe both faces at each end of tail boards and pin boards. Stack dovetail spacer blocks and mark position of first tail's edge on one tail board (see ***left drawing below***).

The tails

Cutting on the tablesaw: Set bevel of sawblade to desired dovetail angle (10°) and square miter gauge to blade. Attach three spacer blocks and end block to the jig, squaring them to the saw table before bolting them on (see ***top photo***). Lower sawblade slightly below depth of dovetail cuts. Now butt the edge of marked tail board up to third spacer block and slide the jig board until mark aligns with sawblade, as shown in ***top photo***. Tighten bolts that lock jig board to baseboard.

Place a tail board against jig, and take a trial cut on one side of the first tail. Set depth of cut by raising blade and recutting until cut reaches scribe mark on stock. Now flip the board end for end and take second cut. For third cut, rotate board edge for edge, then end for end for fourth cut. Remove spacer block one and repeat four cuts, flipping as before. Remove spacer two and repeat same sequence of cuts to complete tails (see ***bottom left photo***). Now perform entire cutting sequence on each of the tail boards.

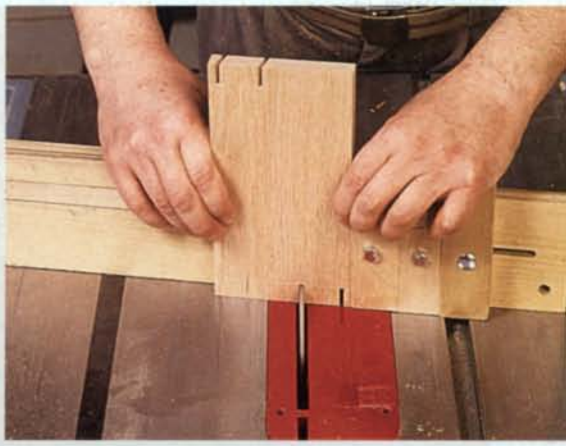
Bandsawing tail waste: Fit bandsaw with a ⅛-in. blade and adjust the rip fence so cutting depth to outside of blade equals depth of dovetails. Trim waste from between tails by sliding the stock into the blade via the sawkerfs cut on the tablesaw earlier, as shown in ***bottom right photo***. Flip stock over and bandsaw again to clean up corners between tails. Do this on all tail boards

The pins

Sawing first side: Square tablesaw blade to table and lower blade height slightly. Set miter gauge to dovetail angle (10°) with right side of jig board sloping away from blade and replace all spacer blocks. Transfer tail position to one pin board (see ***right drawing facing page***) and then hold pin board (inside face toward jig) against first spacer block and adjust the jig board so the end mark lines up with the sawblade, as shown in ***top left photo***. Take a trial cut and adjust blade height as before. For second cut, flip board end for end, keeping same face against jig. Now repeat first two cuts on all pin boards. Remove spacer block one, take two cuts (flipping board end for end as before), and repeat on all pin boards (see ***top right photo***). Remove spacer block two, and repeat cutting sequence on all pin boards.

Sawing second side: Reset the miter gauge so that it angles (10°) in the other direction. Reattach spacer block two, but before bolting, slip a stack of a dozen or more paper shims between end block and spacer three. Align mark to blade and set jig board, as shown in ***photo at right***. Cut only the marked pin board (keeping its inside face against the jig), and follow the sequence of taking two cuts, flipping board between cuts, removing a spacer block and cutting again until you've removed all three spacer blocks (see ***bottom left photo***).

Bandsawing pin waste: With the same bandsaw rip-fence setting as before, carefully tilt pin board at necessary angle and slip blade into a sawkerf; then lower board flat onto table and cut away waste (see ***bottom right photo***). Hold the board securely as the blade will want to grab and pull the board down as you begin each cut. After sawing each pin waste, move the small waste blocks away from the blade with the eraser end of a pencil, for safety sake. Repeat to saw away waste on first pin board. Now trial fit a pin board with a tail board. If the fit is too tight, remove as many paper shims as necessary, replace spacer blocks two and three, and recut trial pin board. Recheck joint fit and remove more shims if needed until dovetail joint slides snugly together. Retaining this shim arrangement, cut and trim all remaining pin boards as you did with the trial board. *—M.D.*



Bent-Corner Boxes of the Northwest Coast

Kerfed and steamed corners turn a board into a box

by Gregg Blomberg

The bent-corner (or kerf-bent) boxes and bowls produced by the aboriginal peoples of the Northwest Coast are among their most significant woodworking achievements. Although not as dramatic as the totems or dugout canoes, these containers were an integral part of everyday life and were used for everything from cooking to burial. They varied greatly in size and ornateness, as in function, from small, relatively plain bent-corner bowls to the great carved, painted and inlaid chests. Smoke-dried salmon was dipped into bent bowls filled with fish or seal oil; fire-heated rocks would be dropped into a box to heat a soup or a stew; larger boxes were used to store food, clothing and all the paraphernalia used in the ceremonial winter dances. The boxes often constituted most of a house's furniture, and oft times they were even piled up and used as room dividers.

The boxes are a tribute to the technological prowess of the pre-industrial native peoples. Through a system of precisely cut kerfs and a primitive steambending technique (the steam "chamber" consisted of a trench for each kerf filled with red-hot rocks covered by seaweed and eelgrass), they were able to bend a board into the four sides of a box. A rabbeted base and lid completed the water-tight box.

Bent-corner boxmaking is one of my most popular classes on Northwest Coast art. I think it's because the magic of wrapping a flat board into a box is so compelling, yet the process is actually quite simple. In this article, I'll explain how to make a dome-top chest (see the photo below). The dome top is only one of many styles of lid, but the techniques for making the sides and base are the same for any bent-corner box.

Layout and kerf-cutting

Traditionally, boards for boxes were riven (split) from the log and surfaced with adzes. Most likely you will purchase your lumber instead and plane it to the desired thickness. Vertical-grain western red cedar is the wood of choice, but any long-grain softwood should work. Rip the board to width, and then cut it roughly to length. I finish the inside of the board before laying it out, using a surfacing adze or a crooked knife; you may want to just sand it smooth. After surfacing, crosscut the board to length. Make sure your cuts are

Three corners of this cedar box are steamed and bent; *the fourth is rabbeted and pinned. The dowels used to pin the box's fourth corner, although at 45° to the corner, are at odd angles vertically to mechanically secure the joint.*

perpendicular to the edges so that the box will close tightly and squarely.

For a box that's approximately 6 in. by 12 in., lay out your board, as in figure 1 on p. 72. There were quite a few different traditional kerf styles, but the most commonly cut kerf today is relatively modern (see figure 2 on p. 72). Although machine tools could speed up production, the kerf shown lends itself to a hand tool approach. I prefer to use a combination of Japanese handsaws and various traditional Northwest Coast knives.

Figure 2 shows the steps and the tools I use to cut the kerfs. I've noticed in my classes the boxes that fail have overly large kerfs or knife cuts that are too deep, so exercise restraint when cutting and cleaning the kerfs. Relieving the back of the kerf (the outside of the box) with a knife and a bit of sanding allows the board to bend more readily, creates a more graceful corner and helps to prevent it from breaking out. The last step before steaming is to rabbet one end of the board to receive the other. I usually rout the rabbet, but I have my students cut the rabbet line with an azebiki, a Japanese flooring saw (shown in figure 2), then chip out the rabbet with a knife and clean it up with a rabbet plane.

Steaming, bending and assembly

There are as many different steam-bending setups as there are woodworkers bending wood. If you've never steam-bent before, you may want to try one of the simple but effective systems described in the sidebar on p. 73.

People often want to know how long to steam the wood, but the truth is that it depends—on the wood, its dimensions, the kind of kerf you've cut and more. As a rule, though, 20 minutes is generally sufficient for green red cedar (the traditional material and the one that I use most), and twice that will render most any suitable wood sufficiently pliable for bending.

When the board is ready, I remove it with gloves from my steaming apparatus. I offer up a quick prayer (for many of us, carrying on this craft is more than mere woodworking, it's an affair of the spirit), and while the board is still warm, quickly but steadily bend the board into shape. I overbend each corner to prevent springback and so the box will hold its shape without needing to be clamped diagonally across the rabbeted corner. Then I check for square by measuring diagonally across the top of the box both ways, comparing and adjusting till I've got it right. Squaring the box is really not that important: old boxes were seldom truly square, and some adjustment is still possible by trimming the open corner. I clamp the box (without gluing it) and let it cool for at least 20 minutes.

When the box has cooled, I unclamp the box, glue the joint, reclamp it and let it set. After the glue has set, I take off the clamps and drill for the pegs that will join the rabbeted corner. The pegs shouldn't show on the inside of the box, so I sight down from the top, mark a line on either side of the corner and keep my drill centered on these lines, both entering and exiting the box. To minimize the possibility of the corner coming undone (and in keeping with tradition), I drill the holes for the pegs at odd angles (see the photo on the facing page). For this box, I used four 3⁄16-in. birch dowels although the pegs were traditionally made of the same material as the box. After I've drilled the holes at the corner, I glue in the pegs.

Next, I check the top and bottom surfaces of the box's sides for flatness. To do this, I smear a little Prussian blue (a machinist's marking fluid) onto a sheet of plate glass and rub the top and bottom edges of the box on the glass. This marks the box's high spots, which I plane off. I repeat the procedure until both edges are flat. Finally, I cut off the pegs and round over the pegged corner using a crooked knife. Then, I blend sides and corners, planing and sanding until they flow nicely.

Base and lid

Traditionally, the pegged corner was the right rear corner. I position the bent board accordingly (on the board for the base), check the sides for square again (a bar clamp across the longer diagonal will bring the box back to square if it's slightly out) and then mark the inside of the baseboard for a rabbet and the outside 1⁄8 in. oversize. I cut the board first and then the rabbet, which should be about 5⁄16 in. deep.

Once the sides and the base fit snugly, I drill holes for the pegs that connect the sides to the bottom. Before pegging the

Photos except where noted: Susan Kahn

two together, however, I mark the board that is going to be the lid for a rabbet (just as with the base, I first check and adjust the sides for square) and then mark for the perimeter of the lid about ¾ in. out from the line for the rabbet. Then I cut out the lid, rout the rabbet and clean it up with a rabbet plane if necessary.

After texturing or sanding the inside of the base, I peg the sides and base together. As with the rabbeted corner on the box's side, the pegs should not be visible on the inside of the box. For a box of this size, I use two pegs at each end, 1¼ in. in from the corners, and four pegs in the sides, more or less evenly spaced with the outer two pegs about 1¼ in. from the corners. Use your judgment on larger or smaller boxes.

After cutting the rabbet for the lid, I mark a line ½ in. inside the rabbet and scribe diagonal lines from corner to corner. Then I hollow out the center third of the underside of the lid (for this box, a rectangle 2 in. by 4 in.) with a Forstner bit to a depth that leaves ½ in. of stock remaining. Next, I cut along the diagonal lines, and then taper the inside of the lid from the outside edge of the hollow to within ½ in. of the rabbet. I texture this tapered surface with a crooked knife. Then I mark the edge of the lid ⅝ in. up from the rabbet and taper and texture the outside of the lid as well.

Discussing the carving, painting or inlaying of these boxes is beyond the scope of this article, but examples that might serve as inspiration abound. Most major muse-

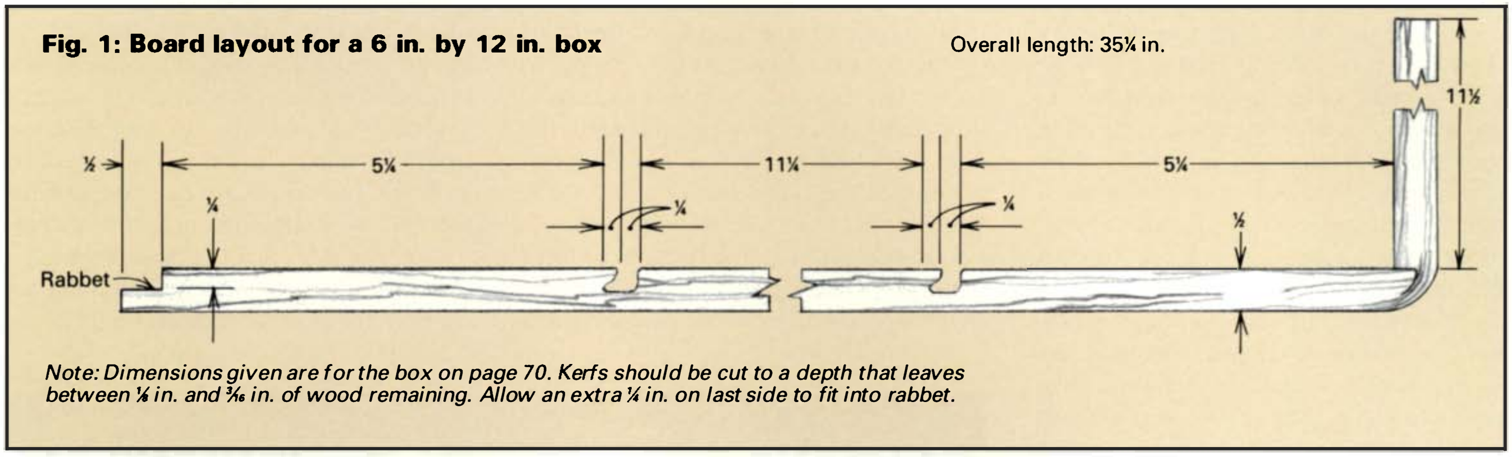


Fig. 1: Board layout for a 6 in. by 12 in. box

Note: Dimensions given are for the box on page 70. Kerfs should be cut to a depth that leaves between ⅛ in. and 3/16 in. of wood remaining. Allow an extra ¼ in. on last side to fit into rabbet.

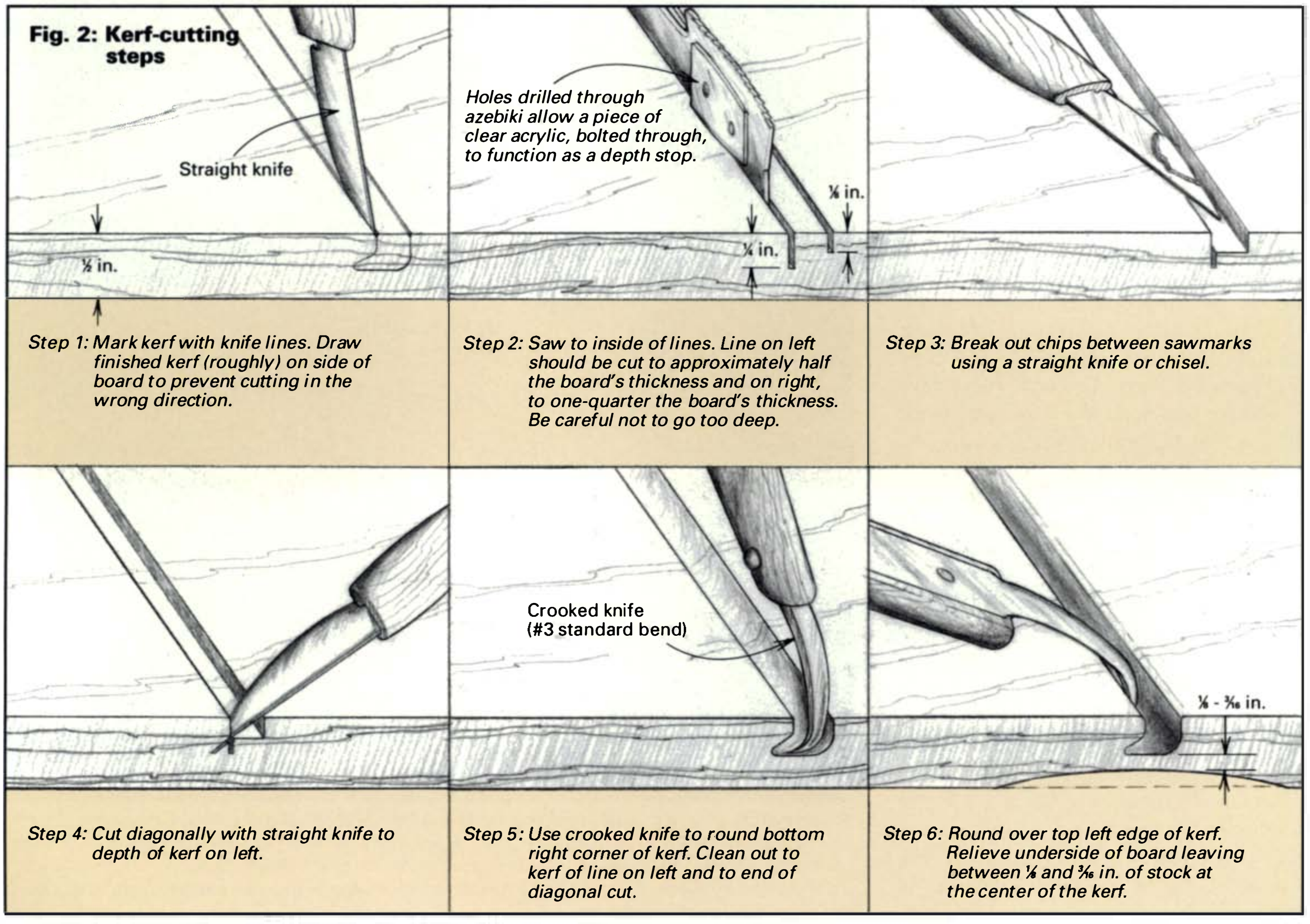


Fig. 2: Kerf-cutting steps

Step 1: Mark kerf with knife lines. Draw finished kerf (roughly) on side of board to prevent cutting in the wrong direction.

Step 2: Saw to inside of lines. Line on left should be cut to approximately half the board's thickness and on right, to one-quarter the board's thickness. Be careful not to go too deep.

Step 3: Break out chips between sawmarks using a straight knife or chisel.

Step 4: Cut diagonally with straight knife to depth of kerf on left.

Step 5: Use crooked knife to round bottom right corner of kerf. Clean out to kerf of line on left and to end of diagonal cut.

Step 6: Round over top left edge of kerf. Relieve underside of board leaving between ⅛ and 3/16 in. of stock at the center of the kerf.

Drawings: Maria Meleschnig

ums coast to coast have collections that include Northwest bent-corner boxes, chests and bowls, and there are a number of excellent publications on the subject (see the further reading box at right). □

Gregg Blomberg operates Kestrel Tool on Lopez Island, Wash., and offers workshops on Northwest Coast art and crafts. Tools and information about his workshops can be obtained from Blomberg by writing him at: Route 1, Box 1762, Lopez, Wash. 98261.

Further reading

Davidson, Susan, "Kerf-Bent Boxes," *Fine Woodworking on Bending Wood*, The Taunton Press, Newtown, Conn., 1985 .

Holm Bill, *Northwest Coast Indian Art: An Analysis of Form.* University of Washington Press, Seattle, 1965.

Inverarity, Robert Bruce, *Art of the Northwest Coast Indians,* University of California Press, Berkeley, 1950.

Sturtevant, William C., compiler, *Boxes and Bowls: Decorated Containers by Nineteenth-Century Haida, Tlingit, Bella Bella and Tshimian Indian Artists.* Smithsonian Institution Press, Washington, D.C., 1974.

Cheap steam

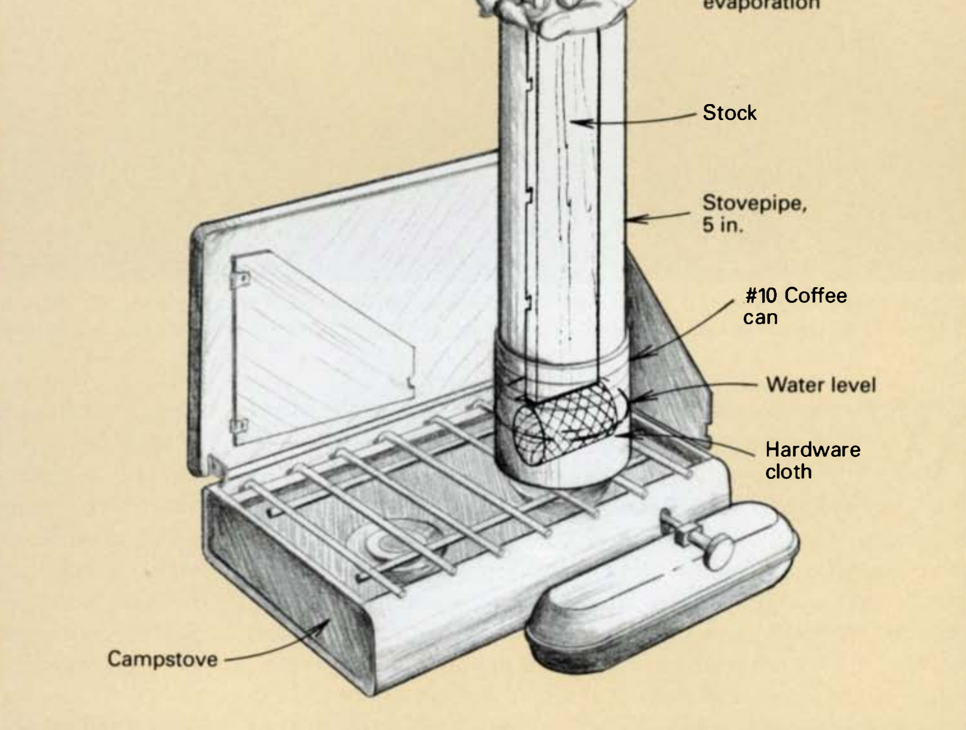
Anyone who's had occasion to do much steam-bending has a favorite system. Some are bare-bones simple, some are quite elaborate. I've used a number of systems over the years and still vary the apparatus I use depending on the situation, but generally speaking, the simpler the setup, the more to my liking.

One such system, at the "appropriate technology" end of the spectrum, is a campstove with a standard #10 coffee can on the burner. (Gasoline campstoves should always be used outdoors.) By fortuitous circumstance, 6-in. stovepipe fits nicely just inside a can of this diameter. A bit of hardware cloth or chicken wire in the coffee can and a rag stuffed in the top of the stovepipe complete the system (see the drawing at right). The hardware cloth keeps the board out of the water, and the rag slows evaporation and catches much of the escaping steam.

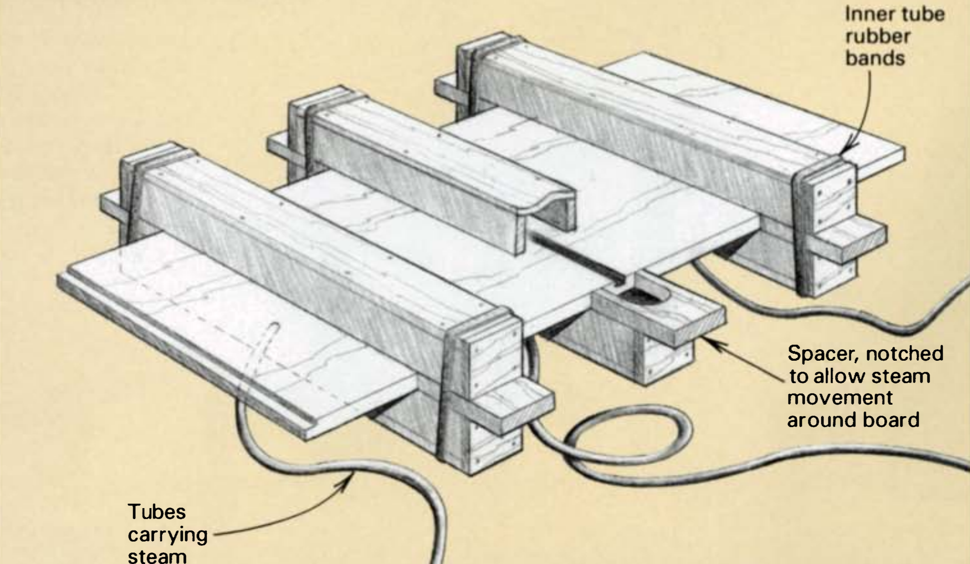
Variations on this system include adding a steambox to accommodate wider boards and substituting a Freon refrigeration bottle or tea kettle for the coffee can. Used refrigeration bottles are available, usually for free, at refrigerator and/or air conditioning repair shops. They're normally just thrown away. A ⅜-in. hose fits neatly onto the spout on these bottles. The refrigeration bottle offers the advantage of greater volume over the coffee can. When using a coffee can, you've got to be very careful not to let the water entirely boil away.

To steam wide boards that won't fit in a stovepipe, you can use boxes that steam each individual kerf, as shown in the drawing at right. Make the boxes to handle a wide board, as shown, and adjust the size of the spacer blocks for narrower boards. Another boxmaker I know uses plastic airport ski bags to steam wood in. Let ingenuity be your guide. —*G.B.*

Stovepipe steamer



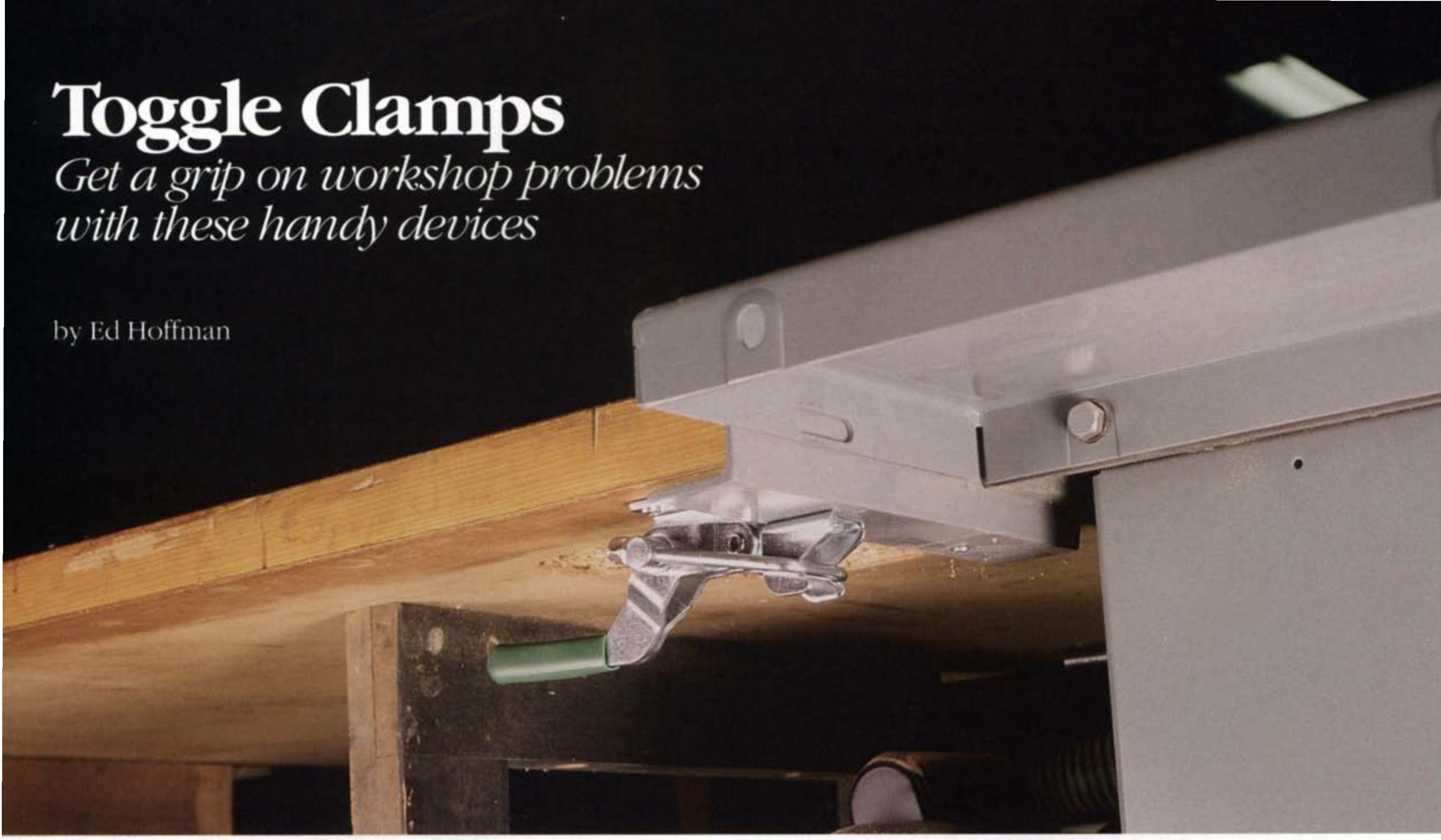
Individual kerf steamers



Toggle Clamps

Get a grip on workshop problems with these handy devices

by Ed Hoffman



***Toggle clamps come in a wide variety of styles, shapes and sizes.** Here, pull-action toggle clamps firmly, yet temporarily, attach an outfeed table mounted on wheels to a tablesaw. By just flipping a couple of handles, the table can be rolled away for other uses.*

We've all done it—hand-held that small piece of wood to drill, shape or cut it on a power tool while thinking there must be a safer way to do the job. Those of us who were lucky can still count 10 fingers. The others will wish they had heard of toggle clamps before they made that cut. It's been more than 50 years since the Detroit Stamping Co., now De-Sta-Co, introduced the toggle clamp. Although there are more manufacturers today and toggle clamps are available from most woodworking mail-order sources, the clamps are just now appearing with regularity in woodworking shops. Toggle clamps exert exceptional holding force, have a positive locking action and are fast and easy to use with just one hand. These features combined with reasonable cost ($5 to $20 for most clamps) make toggle clamps ideal for holding workpieces to jigs, fixtures and workshop tools.

Toggle clamps operate through a system of pivots and levers joined together so force applied to the knee lever (or handle) straightens the arrangement of pivot points and creates endways pressure on the mechanism (see the drawing). When fully extended to its locked position, the middle pivot point is moved slightly beyond the centerline of the outer pivot points. The clamping force now creates endways pressure to push the middle pivot point down against a stop, locking the toggle clamp in position.

Mechanical toggle clamps

Toggle clamps come in a dizzying variety of styles. In fact, toggle clamps offer more mechanical, pneumatic and hydraulic varia-

***These hold-down toggle clamps are just a sampling** of what is available. They illustrate a variety of features including open and solid clamping arms, flanged and straight mounting bases, vertical, horizontal and T-handles, and a choice of clamping spindles. The clamp, far left, automatically adjusts to accommodate variations in workpiece thickness up to 1¼ in. The spring-loaded spindle, second from left, has a ⁵⁄₁₆-in. clamping range.*

tions than any other type of clamp. Some of the major differences in the mechanical clamps are the handle design (arrangement and placement), mounting styles and holding capacity. Holding capacity, which ranges from 60 lbs. to 16,000 lbs., is defined as the maximum amount of force that can be applied to the clamping bar in the closed position without permanently deforming the clamp.

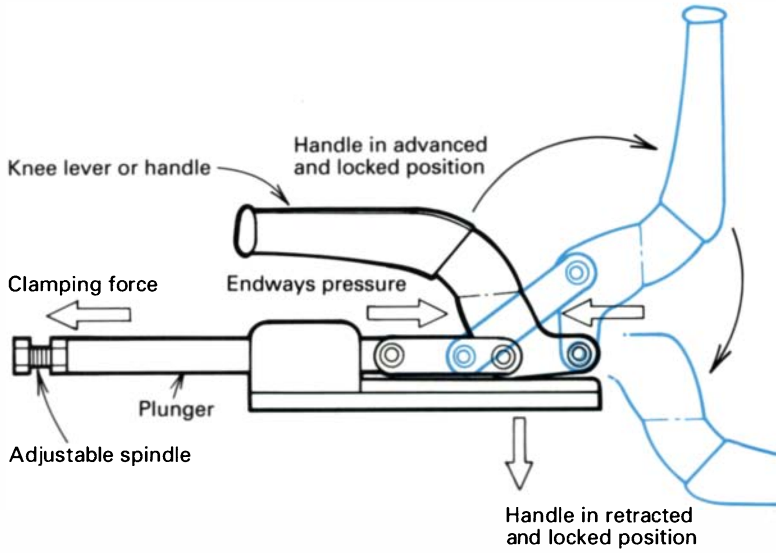
The basic mechanical toggle clamp is available in four different types: hold-down, straight-line, pull-action and squeeze-action clamps, as shown in the photos below. The hold-down and straight-line types have proven to be the most useful in the woodworking shop. The straight-line clamps have a push or pull action, and some of these clamps can apply pressure at either end of the clamp stroke. Pull-action clamps draw parts together much like the lock on an extension table. And squeeze-action toggle clamps, also called toggle pliers, hold parts with a pinching action, operating like a parallel clamp or C-clamp.

Hold-down clamps—Hold-down toggle clamps offer the most design options, including a T-handle or a straight handle in a horizontal or vertical format; solid or open clamping arms with a high, low or angled profile; and flanged or straight mounting bases. The open-arm style has the greatest clamping flexibility because it allows the adjustable spindle assembly to be moved along the clamping arm and positioned to suit the task. The threaded spindle can be adjusted up and down to accommodate workpieces of varying thicknesses. To get the maximum holding force, the spindle assembly should be positioned close to the handle. For maximum reach, the spindle is moved to the other end of the clamp arm. The solid-arm clamps generally use a welded-on bolt retainer to mount the adjustable spindle. Or a customized workholder could be welded or bolted onto the arm. Although a flanged base is the most frequently used mounting system, hold-down clamps are available with a straight base for special applications. (The photo below shows a variety of handles, arm styles and mounting bases.)

Hold-down toggle clamps can increase the quality of work when used, for example, to eliminate stock creep while crosscutting miters on the tablesaw, as shown in the top right photo on p. 76. These toggle clamps can also increase safety by keeping the fingers away from the cutters when template routing small pieces, as shown in the top left photo on p. 76.

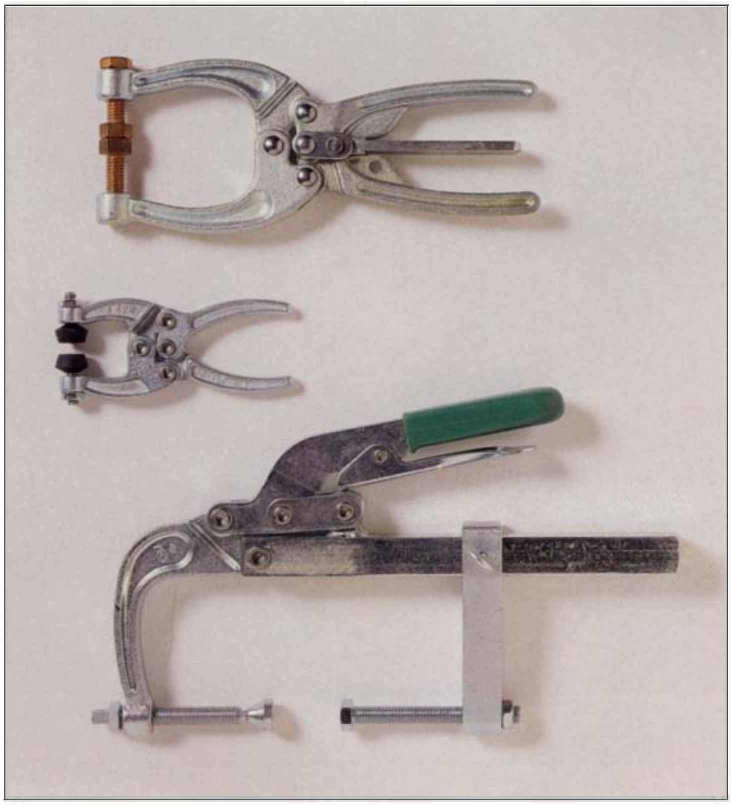
Straight-line clamps—Straight-line toggle clamps provide a pushing or pulling action; most straight-line clamps will lock in the

Toggle clamp basics



In the fully extended position, endways pressure on the lever from the clamping force pushes down on the middle pivot point, which is slightly below the centerline of the outer pivot points, to lock the clamp.

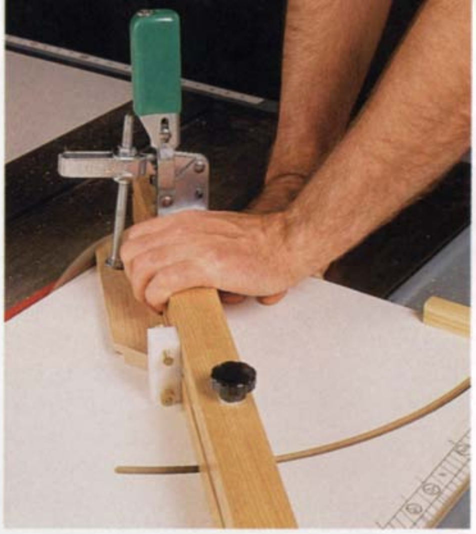
Photos below: Susan Kahn



Straight-line clamps (two at left below) *can push or pull and work well for jig and fixture applications.* ***Pull-action clamps (two at right below)*** *are great for making band clamps or for securing machinery and guards.*

Squeeze-action clamps (at right) *are available as hand-held toggle pliers or in a larger form that can be machine mounted.*

Photos unless otherwise noted: Charley Robinson, Drawing: Maria Meleschnig



***A hold-down clamp quickly secures the workpiece** for safer and more accurate work. The toggle clamp (above), unusual because it can automatically accommodate variations in workpiece thickness up to 1¼ in., prevents stock movement when cutting miters on a sliding table.*

***Jigs and fixtures should include a stop or fence** (left) to resist the force of the tool and should support the workpiece opposite the clamping force to prevent distortion.*

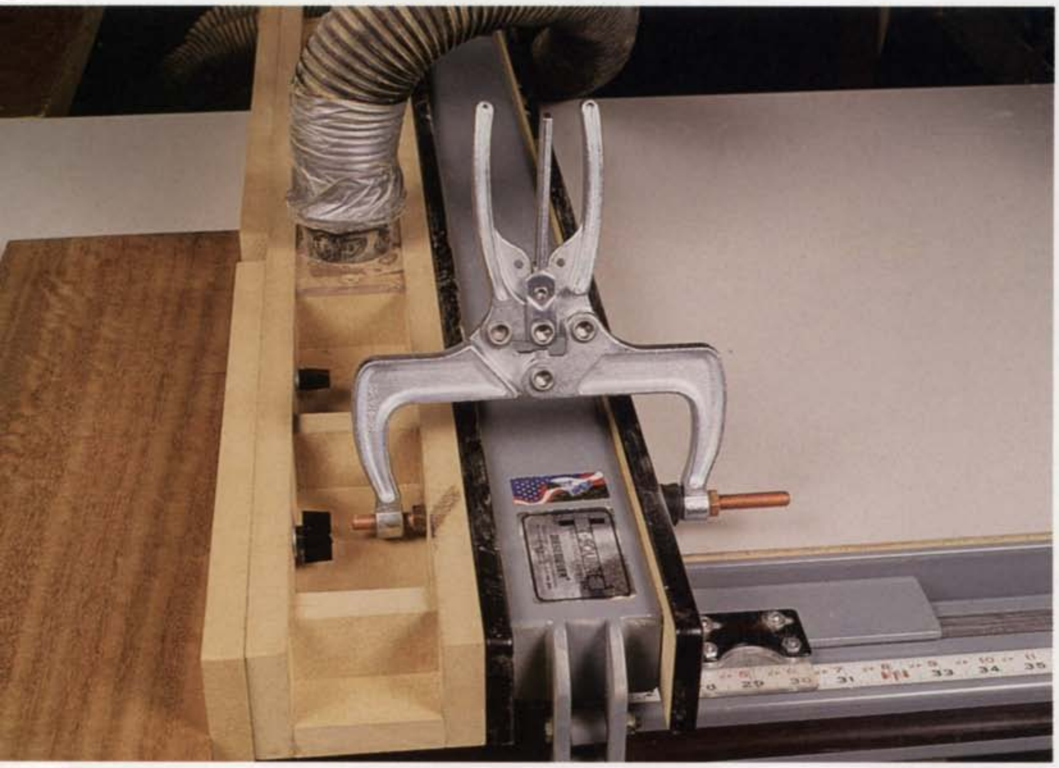


Photo: Vincent Laurence

***A cone-shaped tip on this straight-line clamp** (above) automatically registers the workpiece for shelf-bracket holes while holding the workpiece in place.*

***Squeeze-action clamps, or toggle pliers,** (left) make easy work of clamping an auxiliary fence in place. These clamps are particularly useful when the clamped object is frequently adjusted or when it's removed and replaced.*

Sources of supply

Due to their increased popularity in woodworking applications, toggle clamps are available from many hardware and tool stores, home centers and most mail-order catalogs. However, if you can't find the clamps locally or if you want a complete catalog, you can contact the following manufacturers directly.

Carr Lane Manufacturing Co., 4200 Carr Lane Court, PO Box 191970, St. Louis, MO 63119-2196; (314) 647-6200.

De-Sta-Co, PO Box 2800, 250 Park St., Troy, MI 48007-2800; (313) 589-2008.

Te-Co, 109 Quinter Farm Road, Union, OH 45322-9796; (513) 836-0961.

fully extended or retracted position. The plunger is generally internally threaded to accept a standard hex head bolt. The bolt serves as an adjustable spindle for fine-tuning clamping position and force. Some styles of this clamp have an externally threaded plunger to mount custom workpiece holders. Straight-line clamps are available with either a flange mount or a threaded body for mounting the clamp directly through a panel, plate or angle bracket.

For woodworking applications, straight-line clamps are handy for gluing jigs where items of the same size, like the frame parts for cabinet doors, are regularly assembled. Used with a special cone-tipped spindle, these clamps are also great for positioning and holding work (see the bottom right photo on the facing page).

Pull-action clamps—Pull-action clamps, or latch clamps, are designed to draw two parts together. A familiar application is the common toolbox latch. With this clamp, the handle is raised to advance the clamping element, usually a hook or U-bolt. Once the clamping element is engaged, the handle is moved to a horizontal position to pull the pieces together and lock the clamp. Threaded ends on the hook or U-bolt allow the clamps to be precisely adjusted. These clamps also are available in a right-angle configuration that pulls perpendicularly to the base. Pull-action clamps can make quick work of applying a band clamp, securing machinery guards or, as shown in the top photo on p. 74, for holding equipment in place.

Squeeze-action clamps—Squeeze-action clamps combine the normal grip of a pair of pliers with a toggle action. The hand-held type, often called toggle pliers, is designed for applications where C-clamps might ordinarily be used. These clamps use either one threaded spindle with a fixed jaw or two threaded spindles to set the clamping thickness. Most toggle pliers include a lever between the handles that will quickly release the clamp when squeezed. Toggle pliers are especially helpful when the clamped object needs to be repositioned frequently, such as the auxiliary fence shown in the bottom left photo on the facing page.

Automatic toggle clamps

For all their many benefits, one drawback to standard toggle clamps is their limited ability to compensate for different workpiece sizes. Once set to a clamping height, most toggle clamps can only accept slight variations in stock thickness. Although an optional, spring-loaded spindle is available, it only increases the clamping range to 5⁄16 in. Larger variations often require readjusting the clamp spindle.

A new toggle clamp shown in the top right photo by Carr Lane Manufacturing Co. (see the sources of supply) has resolved this problem. A standard toggle clamp is made of fixed-sized components connected by pivot pins to provide the clamping action. With this new toggle clamp, however, one of the fixed components (the handle) has a variable length; the clamp correctly adjusts itself to fit the workpiece by automatically altering the pivot length within the handle with a self-adjusting and self-locking wedge arrangement.

In use, the adjustable spindle of the automatic toggle clamp is set at the average workpiece height. Once set, the clamp automatically adjusts to suit workpieces that are up to 3⁄8 in. thicker or thinner than this setting. The clamping force of the automatic toggle clamp can be adjusted, up to a maximum of 500 lbs., by turning the screw located in the end of the handle. □

Ed Hoffman is a writer and consulting engineer in Colorado Springs, Colo.

Putting toggle clamps to work

by Douglas W. Ruffley, P.E.

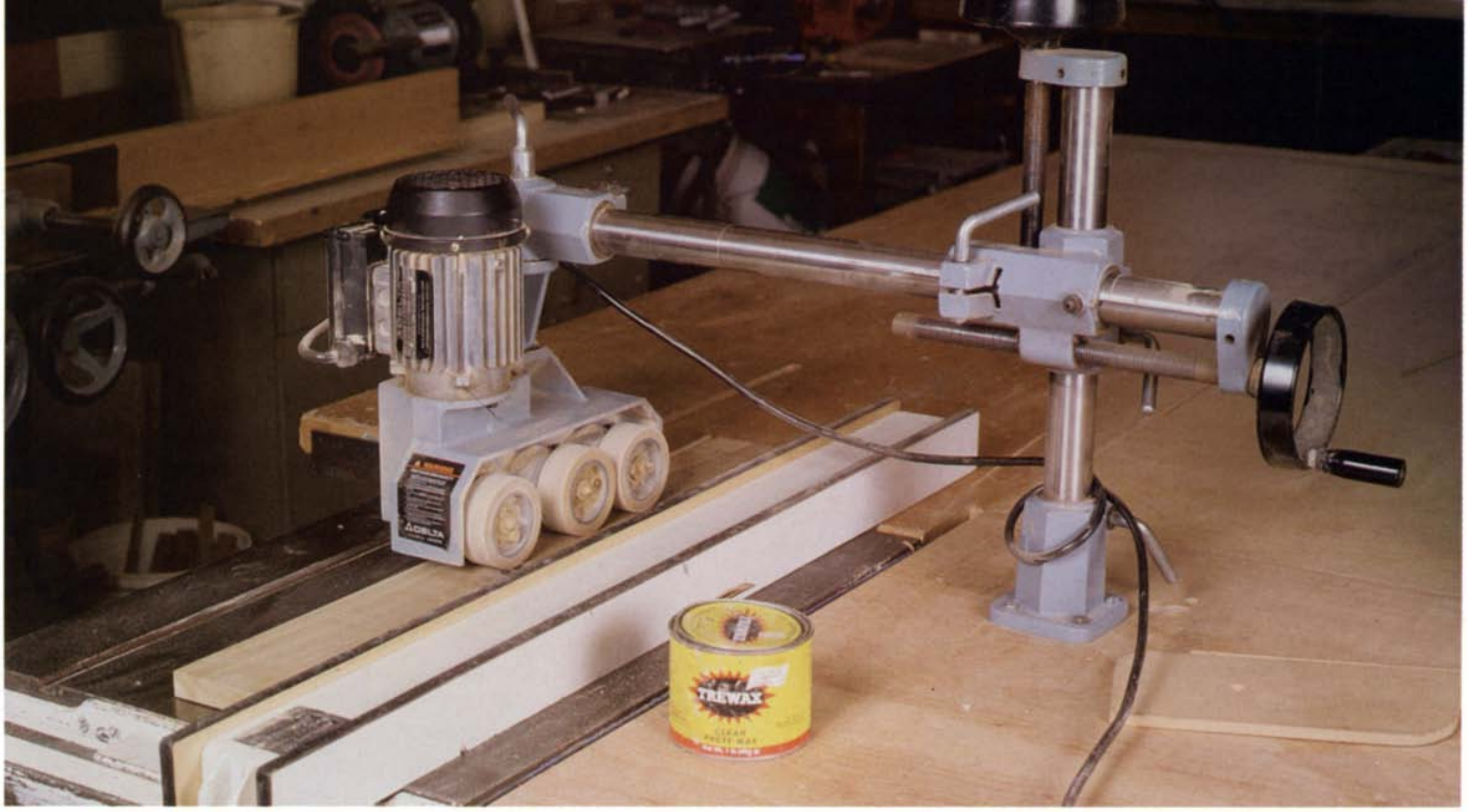
Because of the wide variety of toggle clamps available, you should select the appropriate clamps for the job before designing any jigs or fixtures on which the clamps will be used. Clamps should be selected on the basis of holding force, action, configuration and mounting, as discussed in the main article. Once the right clamp is at hand, you also need to consider the clamp setup and proper jig design.

Clamp setup: The adjustable spindle can affect the clamp's exerting force (the force with which the clamp holds a workpiece). The exerting force can be adjusted from very light pressure up to the maximum-designed holding force (the point at which the clamp deforms) of the clamp. The force should be snug, but it should not be adjusted so tightly that the clamp becomes difficult to operate. Sixty lbs. is about the maximum amount of force an operator can exert repetitively; however, for safer and more comfortable operation, the spindle should be adjusted to require handle forces from 30 lbs. to 40 lbs. If the clamp is too hard to operate, the operator's hand may slip into the machinery. When applying force to a clamp handle, it is best to keep the wrist straight because the operator can generate more force with less stress on the arm's muscles and tendons.

Optional spindles: In addition to the standard adjustable hex head spindle, there are a variety of other spindles that are better suited to woodworking applications. Spindles tipped with a flat-bottom, molded-neoprene cushion, as shown in the top left photo on the facing page, help protect the wood from being damaged by the clamping force and help compensate for slight variations in stock thickness. The cone-shaped, neoprene tip, as shown in the bottom right photo, is excellent for clamping into holes, slots and corners. Also available is a swivel-foot spindle in a variety of materials with a steel, stainless steel or delrin clamping pad for holding sloped or irregular surfaces. A spring-loaded spindle that can compensate for up to 5⁄16-in. variation in stock thickness is handy, but this unit requires welding the spindle retainer to a solid-arm clamp.

Jig considerations: Clamped parts should be positioned against a fence or a fixed stop so that tool forces are resisted by the stop, not the clamp. Be certain that the clamp bar, including the spindle, clears the area for easy loading and unloading of the part. Clamped pieces should be supported opposite the clamping force by the jig, fixture or work surface. Otherwise, parts could distort, and the part could vibrate and move out of position. If vibration or an overhead mounting position might cause a clamp to open accidentally, use a clamp with an added locking-release lever. And, finally, for the safety of tool and operator, be sure that all parts of the clamp clear the tool path. □

Doug Ruffley is the chief engineer for De-Sta-Co Industrial Products Group in Troy, Mich.



***A power feeder will do the work for you once you've set it up properly,** not only pushing the board through the blade or past the cutter but also holding it tightly against the fence or the table. Always wax both table and fence well to prevent boards from sticking.*

Power Feeders: Unsung Heroes

Mechanical helpers save fingers and improve the performance of most machines in the shop

by Louis Kern

After more than a decade of power feeding on the tablesaw, jointer, shaper and router table, I can't imagine woodworking without a power feeder. I've used a power feeder on just about every machine and for just about every operation in the shop, from ripping on the tablesaw and on the radial-arm saw, to cutting crown molding on the tablesaw and shaping profiles in straight, curved (including circular, oval and elliptical) and helical stock. I've used a power feeder to assist me in jointing boards—both faces and edges because the power feeder can be turned so that the axes of its wheels are perpendicular to the jointer bed—and rabbeting them on the jointer as well. Finally, I use a power feeder whenever I'm climb cutting (see the sidebar on p. 80). Almost any shop , regardless of size, can benefit from a power feeder.

The only circumstance in which I wouldn't recommend a power feeder is on a tablesaw with less than a 2 HP motor. As a rule of thumb, it takes about 2 HP to rip 4/4 stock safely with a power feeder and 5 HP for 8/4. With jointers, shapers and router tables, horsepower isn't as critical because there's no danger of pinching a board between fence and blade or of binding the blade. A 1 HP router or a 2 HP spindle shaper can handle power feeding at slower speeds. Let me explain the benefits of using a power feeder.

More consistent results— A power feeder's constant feed rate eliminates sawmarks and chatter. The only time I've experienced any inconsistency has been when I've failed to keep the table and fence waxed or when pitchy woods have clogged the rubber tires on the feeder.

More efficient use of time— A power feeder does more than merely propel a board forward; it also exerts pressure down—onto the table and, if necessary, toward the fence. For this reason, a power feeder replaces all the fingerboards and hold-down gizmos in the world, saving you the time you would have spent making and setting up these devices.

Although my main power feeder can move boards as quickly as 64 feet per minute (FPM), I seldom use it at more than 25 FPM; most work is in the 10 FPM to 20 FPM range—about the rate of most thickness planers. But the real time savings of a power feeder isn't speed; it's efficiency: a power feeder saves time by freeing you up *while* you're machining stock. Say, I'm power ripping a pile of boards. I can infeed one, pick up the next and carefully inspect it for grain direction and pattern while the first board is cruising through. I can pick up a clipboard and check my tally, mark boards with a crayon for future reference, collect the boards coming off the table and stack them neatly for the next operation. I can relax and plan my next task or even just stare out the window. The time saved and the stress alleviated over an entire career (or even within a year) is immense compared to the cost of a power feeder.

Reduced potential for injury— If, like me, you've lost a finger to the trade, then the idea of working more safely probably strikes a chord in you. Having a power feeder propel your board past a blade or shaper cutter means that your hands are safely away from any whirring metal. As an added bonus, the body of the feeder stops the rain of chips that pelt your body and face when hand feeding, making it easier to concentrate on the task at hand. And I've never experienced kickback while power feeding. Properly set up (I'll explain below), a power feeder grips the stock so firmly that kickback is just about impossible.

Since I bought my first power feeder in 1980, using power feeders has become second nature to me. But that wasn't the case at first. I bought that first unit because I had a job that required a lot of ripping. It was a used machine in good working order, and I figured I understood the rudiments of its operation sufficiently well to get on with the job at hand. After two days of trying to get the feeder to work right, I became convinced of a couple of things: The machine had a mind of its own, and I didn't. I needed reliable information on how to operate the beast, but none was available. I learned the hard way—by making all the mistakes. What follows is some basic information on power feeders and then a distillation of my experience.

Anatomy of a power feeder

A typical power feeder consists of three basic parts: the stock feeder, the support stand and the base assembly. A complete setup can cost from as little as $350 to over $1,500. That may seem like a lot of money at first, but a feeder's versatility and durability will show it to be a bargain in no time.

The base assembly is a heavy casting, which can either be bolted to the table of a stationary tool or screwed to an auxiliary table; the auxiliary table can then be moved from tool to tool as needed, and clamped in place. This is particularly useful when you first buy a power feeder because the auxiliary table allows you to experiment with different placements of the base. As a general rule, the farther the base is from bit or blade the better because your fence will have a less restricted range. If you're going to be using the power feeder on more than one tool on a regular basis, additional bases (which remain bolted in place once you've determined optimal positioning for them) are a good investment. Moving the base assembly each time you need the power feeder on a different tool is a hassle at best. If you do move the feeder with its base, however, remember to tighten the base before you lift the feeder. Otherwise, the base could fall off and break. And if your foot happens to be situated beneath the base when it lands, the base may not be the only thing that breaks.

The support stand both supports and positions the stock feeder. The stand consists of vertical and horizontal columns that intersect at a T-joint bracket. The vertical column, which simply sets into the base assembly, pivots 360°. The stock feeder's vertical movement is controlled by a handwheel atop the vertical column that raises and lowers the T-joint bracket. Another handwheel moves the

***The power feeder is an extremely versatile tool** capable of replacing a hold-down and a fingerboard as well as making the operation infinitely safer. When shaping (or routing) curved shapes, positioning the front wheel even with the cutter, and slightly angled into it, will ensure a smooth, chatter-free cut.*

The basics of safe power feeder operation

There's no substitute for experience. The more you work with a machine, the better you understand what makes it tick—what can go wrong and what you can do to *prevent* things from going wrong.

I've been using power feeders extensively for a dozen years, and there's a sequence of preparatory steps I follow that's become second nature by now. Using this list to check your setup can help you work more safely.

- Level the wheels.
- Center the blade or cutter between the more widely spaced wheels.
- Give the wheels about ⅛ in. of bite into the stock.
- Cant the wheels (about ¼ in. from front wheel to rear), so they push the stock against the fence.
- Tighten *all* locking levers, especially the lever on the base.
- Crank the blade or cutter down below the table, and do a few test runs. Grab the board during one test run and try to hold it; if you can hold the board, something's wrong. Usually the wheels are dirty or you haven't set the feeder down far enough.
- Start with slowest feed rate and take a light cut.

—L.K.

Photos: Sandor Nagyszalanczy

Power-fed climb cutting yields clean cuts safely

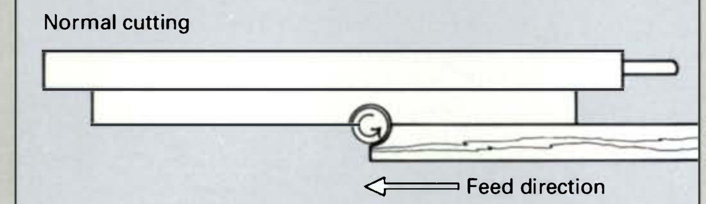
Climb cutting is running stock "backward" past the cutter—usually a shaper knife or a router bit. By feeding the workpiece into the cutter so that the workpiece is moving in the same direction that the cutter is rotating (rather than opposite the direction of rotation, as is normally the case), chipping, splintering, grain fracture and tearout are almost completely eliminated (see the drawing below). I've run fiddleback and bird's-eye maple, myrtlewood, wild-grain walnut and cherry and other difficult woods through the shaper with zero blow out. I've also shaped profiles in thousands of feet of splintery woods like Douglas-fir and redwood with beautiful, problem-free results.

You should approach climb cutting cautiously, however, and only after you're thoroughly familiar and comfortable with your power feeder. The torque generated by a heavy-duty router, or a spindle shaper, with a panel-raiser chucked in it is tremendous. Neither fingers nor fingerboards can control this force. A power feeder can, but it has to be set properly.

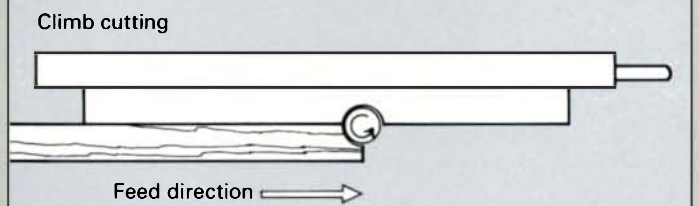
All the basics of operating a power feeder hold true for climb cutting, only more so. The cutter must be sharp, and the tires of the power feeder must exert sufficient pressure on the workpiece to keep it on the table and from becoming a projectile. As with normal feeder operations, set the wheels 1/8 in. to 3/16 in. less than the thickness of the stock with the stock feeder angled in 1/4 in. from the front wheel to the rear.

It's important, too, that you take a number of light passes, rather than one pass to full depth and that you feed very slowly. The best feed rate is usually the slowest. As you gain experience, you can always tweak it up a notch. Any apparent increase in the amount of time spent milling or profiling is more than offset by the (usually) complete elimination of waste. And that's as good for the head as it is for the wallet. *—L.K.*

Climb cutting vs. normal cutting



Climb cutting on a shaper or with a heavy-duty router is extremely dangerous without a power feeder. With a properly set up power feeder, however, you can get virtually perfect cuts and profiles every time.



horizontal column through a sleeve in the T-joint bracket, moving the stock feeder in or out as required. Finer adjustments can be made at the bracket attaching the stock feeder to the horizontal column. This bracket is articulated much like a human wrist, permitting adjustment of the stock feeder from side to side, nose up or down and 360° in the bracket's sleeve.

Stock feeders have always looked to me like tiny all-terrain vehicles. Most have three wheels (although some have four or more), each of which is independently suspended. Usually two wheels are spaced quite near one another with a substantial gap separating them from the third. This provides for blade or cutter clearance, so the more generous the gap the better. Tires made of neoprene (or some other type of rubber) are mounted on the wheels, which are usually aluminum. These tires, which provide both flexibility and traction, are fairly cheap and easily replaceable. To improve traction, I usually scruff the tires up with a 36-grit disc sander when they're new and whenever they start slipping while feeding. If, for some reason (usually because you forgot to lock one of the levers on the support stand), the stock feeder creeps into blade or cutter, chances are all you'll lose is a tire, leaving the wheel and the blade or cutter undamaged. In fact, when cutting very thin, narrow stock, you sometimes can't help but sacrifice a tire or two. It just becomes part of the cost of the job.

Setting up

After positioning your base (either permanently or on an auxiliary table), swing the stock feeder roughly into position, lower it until it just touches the table and check to see if the tires are all touching the table; most likely they won't be, so you'll have to adjust the feeder to get it parallel. Loosen the lever that locks the stock feeder's nose angle, crank the feeder down a notch (using the top-mounted handwheel) so that all the wheels are touching the table, and then retighten the nose-angle locking lever. Crank the handwheel back up until the wheels are just off the table. The feeder head should now be level or very close to it. Since each wheel is independently suspended, they only need to be within 1/16 in. of each other. You'll need to level the feeder every time you move it from one machine to another, anyway. It's also usually necessary to level the feeder each time you install new tires.

Assuming your fence and blade are already set, the next step is to position the feeder. Normally, I set my feeder so there are two wheels in front and one behind the blade. An advantage of positioning the feeder in this way is that the feeder will deflect chips; running a vacuum hose on either side of the fence will keep the chips cleared away. In some cases, however, there are advantages to positioning the feeder either completely ahead of or behind the cutting action. When working with sticky, pitchy wood, I put the feeder behind the action; otherwise, the chips and dust will stick to the tires and they'll lose their traction. Also, when shaping curved stock, I'll position the leading tire just even with, and angled slightly into, the cutter. This focuses all lateral pressure on the workpiece precisely at the cutter, which is critical when shaping curves (see the photo on p. 79).

Setting the feeder to exert the right amount of pressure at the right spot is the real crux of working with a power feeder. Becoming comfortable and competent in this regard *does* involve a lot of hands-on experimentation, but there are a couple of short cuts.

First, the pressure that holds the board down also serves to create the friction between board and tire that powers the board across table or bed, so you really only have two adjustments to worry about: downward pressure and lateral pressure. I've found that for almost all applications, the feeder works best if the wheel height is 1/8 in. to 3/16 in. less than the thickness of the stock. With the

Drawing: Maria Meleschnig

power off, the power feeder's wheels leveled and the feeder roughly positioned, I take a short piece of the stock I'll be machining and lower the feeder until the wheels just touch it. Then I pull the piece out and lower the crank 1½ turns. The number of turns will vary according to your machine, but the technique still applies.

All that remains is to set the stock feeder's angle to the fence (see the photo at right). I've found about ¼ in. difference (nose in) from front wheel to rear is ideal. With the stock feeder set at this angle, it will hold the board tightly against the fence, yet still move it steadily across the stationary tool's table or bed.

Putting a power feeder to work

A power feeder functions identically regardless of the host machine on which it's working. Ripping can be a bit trickier than most operations, though, so that's what I'll discuss. Let's assume that you want to rip a board to 4 in. wide. On most power feeders, the tires will fit easily between the fence and the blade at this setting, and clearance won't be an issue. If you wanted to rip a board narrower than the width of the wheels, however, you'd have to center the blade in the wider gap between the second and third wheels (on most feeders). In some instances, the blade may cut into the tires, but as mentioned before, sometimes sacrifices are necessary.

Everything should be set now. The stock you're going to rip should already have one edge jointed. Always wax the table well (same for the bed in the case of a jointer) before using a power feeder. Before turning on the saw, crank the blade down below the surface of the table, so you can make a few trial runs with just the feeder operating. Send the first board through, and then repeat a couple of times. Keep an eye on the feeder, watching for movement: You want to give all of the locking levers an opportunity to loosen now *before* you bring the blade into the picture. Retighten any levers that loosen, and check to see that they're all tightly secured. Almost every mistake or accident I've ever witnessed with a feeder was due to someone forgetting to tighten one of these levers. The lever at the base which keeps the vertical column from turning must be very tight. The only other cause of an accident with which I'm familiar is setting the feeder too low or the blade too high. When a board leaves the feeder, the feeder drops down a little and bounces; it could bounce right down on the blade, sending a few teeth flying. Conceivably, the blade could even slice a groove into the belly of your feeder, opening up the gear box. Make sure you've got at least ⅜-in. clearance from belly to blade.

If everything is fine, turn on your saw, raise the blade about halfway up and run the first board through again. It should cruise effortlessly through. Slowly crank the blade up until it clears the surface of the stock as you feed, and then run that first board all the way through one final time.

Inevitably, in ripping a whole stack of lumber, you're going to encounter a few particularly nasty boards. You may decide to just run them through anyway, and you may have problems. If a board binds, shut the power feeder off immediately. If the saw quickly regains RPM, try turning the feeder back on. If it starts to bind again, stop the feeder, lower the blade all the way and feed the board off the table. Set it aside in an "offending board" pile. If I suspect beforehand that a board is going to give me a hard time, I lower the blade halfway (or more) and rip it in several passes instead of cutting all the way through in one pass. Power feeding for ripping on the tablesaw is as tough as it gets (because of the danger of pinching and binding), and even then it's not that difficult. On any other machine it's even easier. □

Louis Kern is a master stairbuilder and furnituremaker in San Francisco.

***Stock feeders can be positioned almost anywhere** within the range of the power feeder's support stand. Vertical and horizontal adjustment within a circular range get the unit roughly positioned, and then finer adjustments at the stock feeder itself get it precisely situated. Here, the author tightens the locking lever after setting the angle of the feeder to the fence.*

Sources of supply

The companies listed below either manufacture or distribute power feeders or replacement parts. Prices for power feeders range from around $350 to over $1,500.

Rudolph Bass Inc., 45 Halladay St., Jersey City, NJ 07304; (201) 433-3800. Distributor of Holz line.

Delta International, 246 Alpha Drive, Pittsburgh, PA 15238; (800) 438-2486.

Grizzly Imports, Inc., 1821 Valencia St., Bellingham, WA 98226; (206) 647-0801.

Jet Equipment & Tools, PO Box 1477, Tacoma, WA 98401-1477; (800) 274-6848.

Lobo Power Tools, 9034 Bermudez St., Pico Rivera, CA 90660; (310) 949-3747.

Northwood Industrial Machinery, 11534 Commonwealth Drive, Louisville, KY 40299; (502) 267-5504.

Seco Woodworking Machinery Division, 315 Cloverleaf Drive, Suite C, Baldwin Park, CA 91706; (818) 333-1799.

Sunhill Machinery Inc., 500 Andover Park East, Seattle, WA 98188; (800) 544-1361.

TCM, Inc. (Transpower), 322 Paseo Sonrisa, Walnut, CA 91789; (800) 654-7702.

Western Roller Corp., 63393 Nels Anderson Road, Bend, OR 97701; (503) 382-5643. Western Roller sells replacement wheels and tires directly to woodworkers.

Wilke Machinery Co., 3230 Susquehanna Trail, York, PA 17402; (717) 764-5000.

Integrating Lathe-Turned Components in Furniture

Turning and joinery combine to produce balanced, unified designs

by Christopher Weiland

Weiland integrates turned components into his furniture in subtly functional and structural ways. For his glass-top coffee table, he relies on exposed joinery to accentuate the intersection between the padauk cross rails, the curly maple disc and the table's turned maple legs.

The author also includes turned elements in his sculptures. He turns a large stave-constructed oak column (left) on his shopmade lathe.

"What I enjoy about this piece is that it doesn't shout: 'Look at me, I'm turned.'" This comment, made by my friend Artie Reitmeyer about a bench I was building for a woodturning exhibition, made a lasting impression on me.

Integrating turned components into my furniture allows me to explore new forms and joinery systems (see the leg-to-table-top joint on the coffee table in the photo above). But, whenever I attempt to incorporate turned elements into a design, I remember Artie's comment and exercise great caution to avoid an overdose of its effect. Turned components should not be so bold as to overshadow other features of a piece of furniture; they must work together with all other parts in the piece.

Although my sculptural pieces often require more innovative turning methods (see the inset photo above), the same logic still applies. Each structural and visual element plays an important role in making a piece balanced as a design. In this article, I will focus on design and some of the basic principles that I follow to avoid the "overkill effect" as it applies to turned components. I'll also describe how I cut joinery and preassemble parts in preparation for turning them on the lathe (see the sidebar on p. 84).

Structure: a visual design element

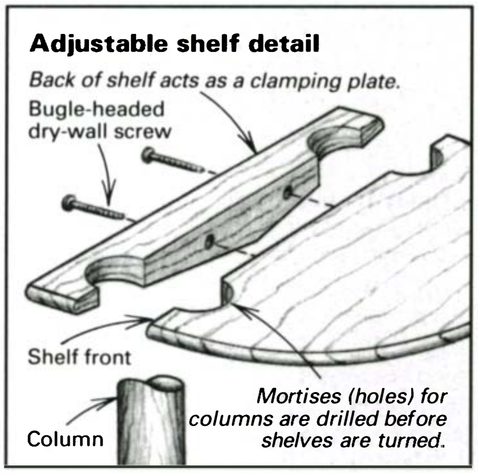
Over the past 16 years, I have concentrated, more or less, on open frame construction in most of my commission and exhibition work, and I have included lathe-turned components in my furniture for about seven years. One of my first woodworking pieces that incorporated lathe-turned components was a small jewelry box (see the bottom left photo on the facing page). The box's design focuses on the subtle transitional points where two or more parts come together. Offsetting the various connective parts produces open and closed spatial effects that complement these transition areas with highlights and shadows. The result is a lot of quiet, visual energy.

The box was neither a complex design nor a difficult one to construct. I used frame-and-panel construction with a combination of straight and bent-laminated pieces. For the ends of the lid, I turned a disc and divided it in half and then

Photo inset: author

***The design for the desk in this office suite (left) was inspired by the jewelry box** in the photo below left. The desk's semicircular glass-top ends mimic the box's two end compartments, and the pairs of rails that connect the legs and support the top are patterned after the dual rails that form the box's hinge and handle support. The desk's 3-in.-dia. legs taper $\frac{3}{16}$ in. from top to bottom.*

***To make the curly-maple shelves in this wall-hung system,** Weiland turned two cone-shaped discs, bandsawed them in half and mounted them (inverted) to a pair of cylindrical wenge columns. The shelves can be locked in position anywhere along the columns by tightening two screws in the separate back pieces, as shown in the drawing.*



splined the two half discs to the frame. I also turned the cylindrical handle suspended at the end of the lid's frame. Although I only produced four boxes, they marked the beginning of some interesting furniture—pieces that were direct descendants of the boxes.

Variations on turned themes

A clear carryover of the jewelry-box design can be seen on the desk above that I made for an architect, who has a passion for exposed joinery and open-frame construction (I couldn't have asked for a more ideal client). In all my work, maintaining efficiency of function, sound construction and aesthetic sensitivity are certainly my most important goals. In the design of the desk (as well as a conference table that I made later), the forms had to work together. I started by developing a balance of overall form and proportion of shape and size between the top surface and the base units. In the design of the top frame-and-panel assembly, trestle beams, cross rails and legs, I incorporated a related visual and structural geometry. The shape of the legs was influenced by the semicircular top frame and the glass panels; cylindrical legs seemed the perfect choice to complement the top's shape.

Once the initial design of the desk was complete, I developed a series of quarter-scale drawings that featured slight changes of position of the components to ensure the best overall composition. During this time, I laid out several full-scale drawings

Photos except where noted: Roy Engelbrecht; drawing: Mark Sant'Angelo of select parts and joinery details. Careful calculation of proportions at all intersection and transition points was crucial. Too much offset, recess, joint exposure, color change or shape variation could easily make these regions disproportionate to the overall design of the desk.

Throughout the entire design phase, I must have constructed the desk at least 10 different ways in my mind. Then to begin work in the shop, I built several full-scale mock-ups of the leg and top frame connection, which led to a few more slight modifications from the original drawings and also helped me precisely lay out and cut the joinery later on.

Assembling cylinders and discs

After completing the desk and the conference table, I developed several furniture pieces featuring a similar slip mortise-and-tenon joinery detail. I refer to these pieces as the *Cylinder and Disc Series*, and although each of their turned components is a relatively simple form, the main visual energy of the pieces comes from the delicate details, like tapered edges and recessed surfaces and from the subtle integration of parts at the connection points.

Floating tabletops: In the coffee table shown in the photo on p. 82, I wanted to impart a sense of suspension to the central disc that sits on the double cross rails. The recessed areas in the disc that accept the rail pairs act as transition points, which visually bridge the central disc to the outer leg and rail structure. (For more on preparing the table legs for the rails, see the sidebar below.) To further the illusion of floating, I added a ½-in.-thick glass top, which also protects the table's understructure from everyday wear and dust. On a later version of this table design, I tapered the ⅞-in.-thick disc to ¼ in. at the edge.

Adjustable shelving: My most recent piece to emerge from the *Cylinder and Disc Series* is a wall-hung shelving system (see the photo at right on the previous page). Fully assembled and fixed to the wall, a shelf unit can be viewed at different heights offering variations for displaying objects or the details of the piece itself. Selecting the shape of the cylinder for the columns and half-discs for the shelves was instrumental to both the function and design of the piece. Visually, the connections of the shelves to the vertical columns enhance the structural integrity of the piece through their obvious clamp-like appearance. Turned details at the top and bottom of each column add further continuity to the design.

Each shelf is composed of two parts: a half section cut from a turned, cone-shaped disc and a back plate. The two columns are turned straight cylinders that are sectional. This combination of shapes allows for complete vertical adjustability of the shelves (see the adjustable shelf drawing on p. 83). The front and back of each shelf form a locking collar around the columns when screwed together from behind the back plate. □

Chris Weiland teaches furniture design, woodturning and woodworking through the College of Fine Arts at Indiana University of Pennsylvania and the Pittsburgh Center for the Arts.

For clean connections, cut joints before turning

Whether I'm turning a table leg or a shelf, accurate layout and clean, precise joinery depend on the order I do things: namely before or after turning. It's much easier to lay out and cut joinery on perpendicular planes than it is to work from curved surfaces, so I perform as many operations as I can while my stock has square corners and flat faces. I also use a preassembly technique that prevents tearout while I'm turning. A good example of these methods is the way I prepare a leg blank.

Leg layout and joinery cutouts: To dimension stock for a leg, I squarely machine the wood ⅛ in. thicker and wider than the finished diameter of the leg I need. I then cut the blank exactly to length. Next, I lay out the double-slot mortises on the top of the leg using the leg's centerline as my primary reference. As shown in the photo below left, I use a tablesaw tenoning jig to cut out the slot mortises. I clean out the bottom of the mortise with a chisel; at this stage, it's nice to know that any minor chip-out at the joint exterior will be removed when I turn the blank on the lathe.

Filler blocks and end caps: I fit temporary filler blocks firmly into the rail mortises and spot glue them in place (endgrain to endgrain at the bottom of the mortise). The blocks ensure that no tearout or roundover occurs at the edges of the mortise cuts during turning. I also spot glue end caps to the top and bottom of the blank, as shown in the blank standing in the photo near left.

Once the glue has set, I bandsaw off the corners of the blank to save time while I'm shaping the leg into a cylinder. I mount the blank on the lathe using a spur chuck and cup center; the rest is just routine turning.

When I've completely shaped and sanded the leg, I remove it from the lathe, and then I detach the end caps and filler blocks by tapping them with a hammer. The resulting mortises are accurate and have clean shoulders, as shown in the photo at left. To be sure that the mating components fit the joint perfectly, I cut and plane the cross rails to the size of the mortises. To complete the joinery, I drill the holes for the pins that lock the rails in the *mortises*. —C.W.

***Weiland glues filler blocks and end caps** to a leg blank to keep its rail mortises and ends from tearing out during turning. First he cuts mortises in the square leg blank using a tablesaw tenoning jig (left); then he adds the filler blocks and end caps. Once the leg is turned (right), he taps the blocks and caps loose with a hammer.*

Photos this page: Alec Waters

End-Work Router Fixture

Stable support for routing tenons and more

by Patrick Warner

An end-work platform holds workpieces vertically for cutting tenons or rounding the ends of frame members with a router. The slats attached to the bottom of the router keep it from tipping as the router passes over the window in the top of the fixture.

Routing or shaping the end of a board can be a tricky proposition. Even on a router table fitted with a fence, the small amount of surface area on the end of a board doesn't provide much stability when you try to run the piece vertically past the bit. And if the stock is very long, the task is simply impossible because of the difficulty of handling a long piece on end, even if your shop's ceiling is high enough to allow it. My router end-work fixture provides a safe and simple solution for routing tenons as well as other joints or shapes on the end of a board.

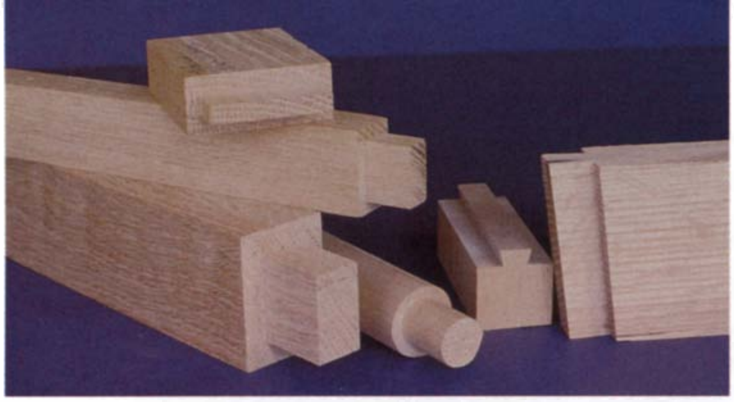
How the fixture works

Basically, this is the way the fixture works: A frame member or other workpiece is clamped to the fixture, which references it for the desired cut. The fixture's large platform top provides a stable support for the hand-held router, and a window cutout in the platform allows access for the bit to shape the narrow end of the workpiece, as shown in the photo above. The fixture features an indexing fence that's adjustable to facilitate angled tenons, such as those used to join seat rails to the rear leg of a chair. The method of guiding the bit depends on the job. Some joints, such as stub tenons, can be done with a piloted rabbeting bit that rides the faces of the stock. An auxiliary router fence can be used to create more complicated tenons, sliding dovetails or other shapes on the end of stock, including roundovers or chamfers. The stock can be any shape—square, rectangular or even round, as shown in the top left photo on the following page. Practically any bit normally used on the edge or face of a board can be used with this fixture. Because the router bit slices the wood fibers parallel to the grain when shaping the end of a board, the fibers are effortlessly peeled away rather than sheared, as is the case with cross-grain router cuts.

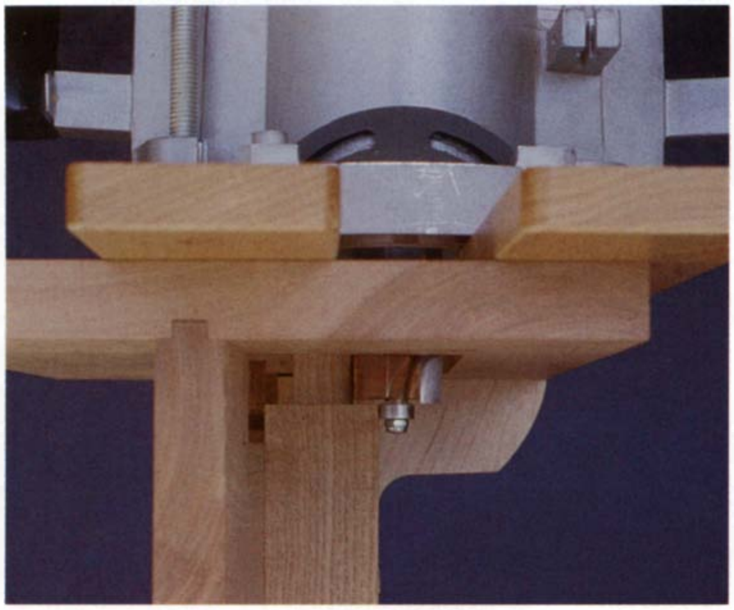
Building the fixture

The parts for the fixture can be made from any hardwood; beech, maple and birch are good choices (I built mine from birch), or you can use a good-grade of ¾-in. or 1-in. medium-density fiberboard (MDF). The fixture consists of a router platform with a rectangular window cutout for the router bit; a workpiece clamping board, joined at 90° to the platform with a tongue and groove and reinforced by two corner braces; and an adjustable indexing fence (see the drawing on the following page). After cutting the platform to size, I rout a ⅜-in.-wide by 3/16-in.-deep groove the length of the bottom surface to receive the mating tongue on the clamping board. I rout the groove by running the router's accessory fence along the edge of the platform to ensure that the face of the clamping board will be parallel to the edge. Next, I cut out the window slightly undersized with a sabersaw. Then I trim it to final size with a router and a flush trimming bit following a template. A 3¾ in. by 6 in. window allows routing on stock up to about 2 in. by 4 in. with bits up to 1½ in. dia. If larger stock or bigger cutters are used, make the window and/or platform larger.

After cutting the clamping board to size and rabbeting its top edges to form the tongue, I cut out a portion of the top edge for router bit clearance when the fixture is put to work. I rough out the cut with a sabersaw and trim it using one side of the same template I used for the platform window. The 1-3/16-in. by 6¼-in. cutout in the drawing allows for routing workpieces to a depth of about



A variety of joints can be routed *with the end-work platform, including all kinds of square or angled tenons and sliding dovetails. Tenons can even be routed on the ends of round stock.*

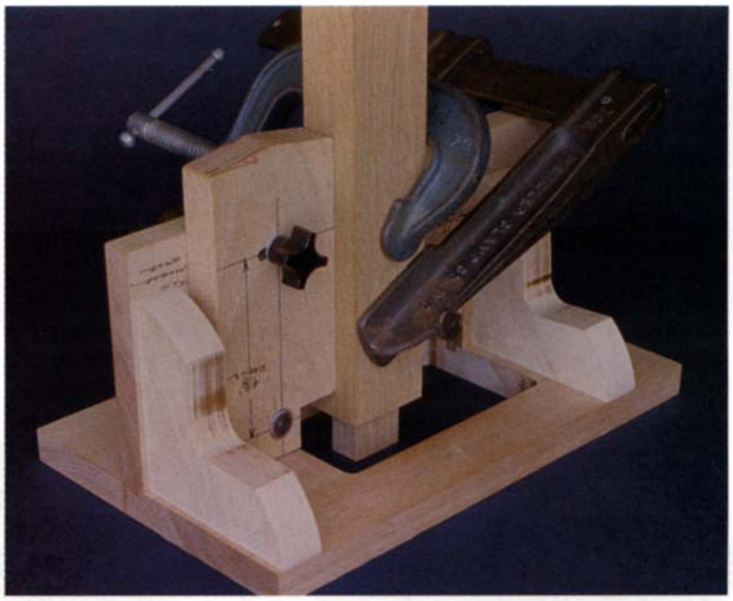


Shaping tenons with a piloted rabbet bit *is simple: The pilot bearing rides on the face of the workpiece as the short tenon is cut.*

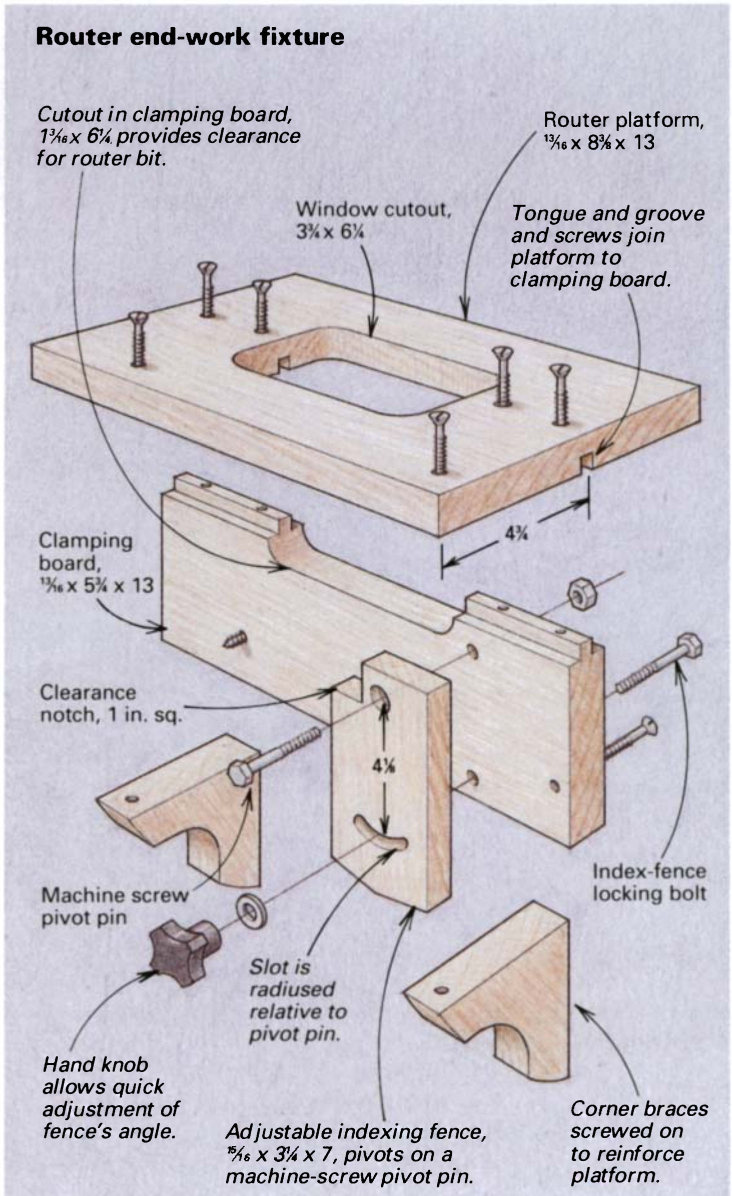
1⅞ in. (if you take deeper cuts, make the cutout deeper, too). I bandsaw the corner braces from 15/16-in.-thick pieces about 4¼ in. sq.

I use the tongue-and-groove joint to accurately register the clamping board to the platform, but I screw all the parts together instead of gluing them, so it's easier to disassemble and realign the parts later if necessary. To ensure that the screw holes in the platform align perfectly with those in the clamping board, I first drill four 13/64-in.-dia. holes (for #10 flat-head screws) in the platform—two on either side of the window and centered on the groove. Then I use a 13/64-in.-dia. transfer punch to mark the pattern for the pilot holes from the platform to the clamping board (see the sidebar on the facing page). I also use the same punch along with a countersink to perfectly prepare the holes for the heads of #10 flat-head screws (described in the sidebar). I use the same transfer and drilling process for drilling pilot holes in the corner braces.

Adustable fence—Now I saw out the adjustable fence and cut out a 1-in.-sq. clearance notch from one corner, as shown in the drawing. I drill a ¼-in.-dia. hole, centered ¾ in. from the top end of the fence, for a pivot pin. Then I fit my plunge router with a ¼-in.-dia. straight bit and a circle cutting jig for routing a curved slot in the fence. This curved slot, which is centered on the fence about 4⅛ in. from the pivot pin, allows the fence to be pivoted side to side and set either square to the platform or askew for angled tenons. Next, I clamp the fence to the clamping board so that the fence's corner notch is aligned with the clamping board's clearance cutout, and its top edge is about ⅛ in. below the platform. Then I use a ¼-in.-dia. transfer punch to accurately mark the fence's pivot hole and



After setting the adjustable indexing fence *for shaping either a square or angled tenon, the fixture is held upside down on a flat surface, and the workpiece is clamped in place with its end flush with the top of the router platform. The fixture is then flipped over and clamped in a bench vise for routing.*



Photos: author; drawing: Vince Babak

the center of the curved slot on the clamping board. These hole centers have to be precise, or the fence won't adjust easily. After drilling both holes with a 7/32-in. drill bit, I thread the holes in the hardwood with a 1/4-20 tap and install a 1 3/4-in.-long, 1/4-20 machine screw for the pivot pin and a 1 1/2-in.-long 1/4-20 flat-head machine screw for the fence locking bolt. A threaded hand knob on the locking bolt makes fast fence adjustments without a wrench.

End routing stock

To use the fixture for routing basic tenons, first set the indexing fence precisely 90° to the router platform. Now, set the fixture upside down on the bench, position the stock to be tenoned against the indexing fence with the stock's end flat on the bench, and secure it to the clamping board with a couple of C-clamps (see the photo at right on the facing page). This indexes the workpiece square to, and flush with, the top surface of the platform. Flip the entire assembly over and clamp the workpiece in the bench vise so that the router platform is at a comfortable working height.

To eliminate any chance that the router will tip as it passes over the window in the fixture's platform, I screw a couple of 1/2-in.-thick strips of wood to the router base. You also could cut out and screw on an oversized subbase, made from Masonite or Plexiglas. If the desired cut can be made at a single pass, such as for a stub tenon, any standard router will do. Simply chuck up a piloted bit, set the cutting depth (which determines the tenon's length) and guide the bit around the stock (see the bottom left photo on the facing page) Rabbet bits and pilot bearings of various diameters can be mixed or matched to produce tenons with shoulders from 1/16 in. wide to 9/16 in. wide. Fit the router with an auxiliary guide that runs along the platform's edge when unpiloted cutters are used.

For deep cuts, like tenons that are longer than the cutting depth of the bit, a plunge router is my tool of choice. I set my plunge router's rotary depth stop to three different cutting heights and then shape each tenon in three passes, resetting the stop to take a deeper cut each time. By changing bits and cutting heights, tenon shoulders can be cut at different heights, centered or offset. □

Pat Warner is a woodworker and instructor at Palomar College in San Marcos, Calif. His book, Router Joinery, *will be published next spring by The Taunton Press.*

Machinist's transfer punches find a niche in the woodshop

***A set of machinist's transfer punches** is a worthwhile investment for any woodshop. Not only do the precisely dimensioned punches provide a great way to transfer hole positions between parts, they can be used for other drill-press jobs, such as centering previously drilled holes.*

***A transfer punch can be used with a countersink mounted on it** to cleanly and accurately prepare previously drilled holes for flat-head screws.*

Transfer punches are steel rods used to accurately mark the location of holes from an already drilled part to one that will be drilled to match. While they are tools from the machinist's chest, woodworkers can make good use of them as well. Typical jobs where transfer punches come in handy include drilling holes in a new router subbase using the old subbase as a pattern; locating and screwing a plinth or cornice to a carcase; and drilling pilot holes in jig parts that must fit accurately together (see the main article). While any of these jobs can be accomplished with a scratch awl, using a transfer punch is much more accurate.

Sets of transfer punches are sold in either standard fractional or metric sizes as well as special drill letter and number sizes. I purchased my set, as shown in the top photo, for about $15 from Enco Manufacturing Co. (5000 W. Bloomingdale, Chicago, Ill. 60639), but they are also available at any good machinist supply house. Each punch is a few thousandths smaller in diameter than its corresponding drill size, so it's easy to slide in and out of an already drilled hole. The end of each rod is turned to a point so that it will put a dimple exactly in the center. To use a punch, first clamp the already drilled part in position over the part to be marked, insert the punch into the hole and lightly tap with a hammer. The slightly indented punch mark creates a starting dimple for the drill. Drill the new holes with a brad point bit, and you'll be amazed at the accuracy.

Other uses: While punches excel at transferring hole positions, there are other uses for them in the woodshop. When drilling for flat-head wood screws, I often use an 82° countersink designed to be locked onto a drill bit with setscrews (available from W.L. Fuller, Inc., P.O. Box 8767, Warwick, R.I. 02888; 401-467-2900). I've found that these countersinks work better when mounted on a transfer punch, as shown in the bottom photo. Using a transfer punch instead of a drill as a pilot has two advantages: The unfluted punch doesn't tear up the hole, and the countersink stays cooler because the smooth punch doesn't trap the chips produced by the countersink's cutters (as a drill bit does).

A transfer punch also can be used to center a previously drilled hole on the drill press either to counterbore it or to increase its depth or diameter. First tighten the appropriate-sized punch in the chuck, then lower it into the hole and lock the drill-press quill. Now you can clamp the part to the drill-press table, unlock the quill, insert the new bit and rebore as desired. A punch chucked in the drill press can also be used with a machinist's square to check the drill-press table for squareness to the bit. This same method also works to check square between a router's collet and a baseplate. A punch can be inserted into any hole, and its angle to the work surface can be checked with a machinist's square.

Finally, the rods can be used as form-sanding cauls for small coves. Because the punches come in almost any small diameter (less than 9/16 in.), the thickness of the abrasive can be compensated for, and a perfect fit obtained, by using a smaller punch than the desired cove. Also, each set of transfer punches comes in a holder, and the holes in these holders can be used as a drill gauge for those drill bits that have lost their identity. *—P.W.*

Design a Chair that Fits like a Glove

An adjustable rig supplies the critical dimensions for comfort

by Glenn Gordon

***One size does not fit all,** whether you're talking shoes or chairs, and that's the premise behind John and Carolyn Grew-Sheridan's chair-fitting rig. The rig makes it possible to tailor a chair's contours and size to fit individuals, one at a time.*

"The problem of chair design is considered to be the most demanding in furniture—and for good reasons," says John Grew-Sheridan, who has thought about it a lot. Structural integrity is critical, even more so than for other furniture. At the same time, a chair must be comfortable and pleasing to the senses. The world has no shortage of ugly chairs that are comfortable or pretty chairs that aren't, so we have plenty of evidence that combining strength, comfort and comeliness in one design is not without its difficulties. San Francisco furnituremakers Carolyn and John Grew-Sheridan have worked out an approach to chair design that ensures a chair will be comfortable while demonstrating that "the dictates of comfort need not interfere with aesthetic considerations because," as John says, "there are an infinite number of ways to connect the critical structural and support points of a chair."

The Grew-Sheridans have been making chairs since 1975, and teaching others how to make them since 1980, when the University of California invited the couple to give a seminar on the subject. In preparing for the seminar, the Grew-Sheridans designed an adjustable rig for measuring individuals for custom-fitted chairs (see the photo above) and developed an inexpensive way of making full-scale mock-ups of their designs. Using the adjustable rig, they determine various chair dimensions, plot them as points on a graph and then transfer the coordinates onto a perspective drawing grid (available from art-supply stores). The result is a skeletal perspective sketch, or stick figure of the chair, showing all the critical dimensional relationships but still devoid of any form or structure (see the drawing at right).

After working through the aesthetic and structural aspects of a chair's design on tracing paper over the grid, the Grew-Sheridans next make a full-scale model of the chair by laminating ordinary corrugated cardboard into "lumber" with thinned white glue, shaping the cardboard lumber into chair parts and hot gluing the "joints" (see the center photo). This technique allows them to make modifications with a minimum of effort, saving wood, money and grief.

From the general to the specific

The Grew-Sheridans gathered their information on essential body measurements for chair design from two publications. Most works on ergonomics, in trying to get to the bottom of seating comfort scientifically, proceed from an engineering mentality that tends to pay serious technical attention to everything except the seat of the pants. However, there are two classics in the field that Carolyn and John say they find tremendously useful. The first, a homely little pamphlet without the slightest aspiration to scientific importance, is called *Basic Design Measurements for Sitting* (by Clara Ridder, University of Arkansas, Agricultural Experiment Station, Fayetteville, Ark., 1959). The second is *Humanscale 1/2/3* (by Niels Diffrient et al., Cambridge, Mass., The MIT Press, 1978), a portfolio containing a booklet and three cleverly laid-out plastic reference cards with rotating dials. Turning these dials reveals all sorts of biometric data through numerous windows cut into the plastic cards. All the parts of the Grew-Sheridan's rig were sized, and the ranges for its various adjustments determined, from data in these two publications. The rig can accommodate just about any size human being, from the tiniest nymph to a nose tackle the size of a bison.

The beauty of the Grew-Sheridan's rig is its specificity because ideal chair dimensions—based on averages—exist only on paper. When a class of the Grew-Sheridan's chairmaking students averaged all their own measurements together and set up the rig accordingly, the result wasn't comfortable for a single person in the class. The chair industry (one size fits all) necessarily has to work to a happy medium, which will inevitably entail a certain amount of individual unhappiness. The Grew-Sheridans, meanwhile, have worked out a way for a custom chairmaker to make people happy, one at a time.

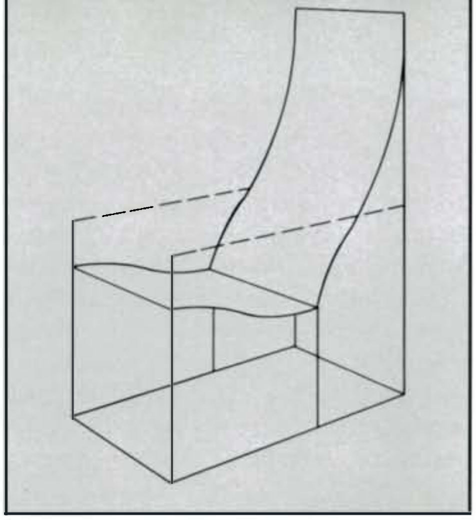


Photo below: Carolyn Grew-Sheridan

From plotted points to cardboard mock-up to finished chair, *the Grew-Sheridan's process not only ensures that a chair will fit its owner perfectly but also that the chair's design will have been considered from every perspective, not just side and front views. By designing a chair in the round and building a prototype, a better-looking chair is almost guaranteed.*

Finding and mapping a fit

The first step in the Grew-Sheridan's fitting procedure is to get a series of rough measurements of the person for whom the chair is being designed (see the sidebar on the following page for a detailed explanation of the fitting process). These initial measurements are taken with the person seated not in the rig but on a flat picnic bench or anything similar. The Grew-Sheridans then make preliminary adjustments to the rig based on those initial measurements and ask the person to have a seat. With the person seated in the rig, the Grew-Sheridans proceed to refine the rig's adjustments. Working by trial and error, and relying on their experience, they first establish an optimal seat depth, height and angle to the floor (in that order), and then they establish the height of the armrests (when appropriate) and the angle of the back to the seat. Then they adjust the series of back supports on the back rail, working from bottom (sacral support) to top (head support).

When all adjustments have been made so that the rig feels right to the sitter, the settings of the rig (in side view) are plotted on graph paper, along with distances measured from the floor to various points on the body (to determine a horizontal reference). Connect the dots, and you have a side view of a chair—or, more accurately, not of the chair itself, but of the "comfort-curve" for the person being fitted.

The next step is to render that view in a three-quarter front view using a perspective grid, as shown in the drawing above. This provides a three-dimensional skeletal view of the chair, a perspective armature over which can be drawn, on tracing paper, any number of structural and stylistic variations. Every chair sketched will be in scale, will show the correct curves and angle for the back, and will have the seat the right height and angle off the floor. Each variant drawn will be the same size and depicted from the same point of view as all the rest for clear, side-by-side comparisons.

From paper to prototype

The Grew-Sheridan's adjustable rig can help a designer resolve questions about a chair's size, proportions and comfort, but neither the rig nor the perspective sketches generated with it can give you a realistic representation of the chair in the round. A perspective sketch can take you part of the way, but it's easy to ruin lumber: If you have a change of heart about a detail halfway through building a chair, it can cost you.

It's helpful, therefore—before you cut

any stock—to see what a chair will look like in three dimensions. One way to do that is to make a scale model. A better way is to make a full-size mock-up. The Grew-Sheridan's technique for making full-size mock-ups is quick, cheap and surprisingly effective at evoking the look of the finished chair. The material they use—corrugated cardboard, found just about anywhere—usually for free—has good modeling properties: body, thickness and even a certain amount of strength. Using thinned white glue, they laminate the cardboard to whatever dimension of stock they need, then draw the pattern for, say, a chair arm on it, and bandsaw it out just as though they were working a piece of wood. They then use disc sanders, rasps and files to shape the arm, which goes quickly because the corrugated cardboard is really mostly air. Because the material is so easily worked and can usually be had for nothing, there's no reluctance to experiment.

Form follows function

Practicality, directness and an economy of means characterize the Grew-Sheridan's work as chairmakers. Their premise as designers is reflected in some passages John quotes from *Form and Function,* by Horace Greenough, first published in 1843: "The most beautiful chairs," wrote Greenough, "invite you by a promise of ease, and they keep that promise; they bear neither flowers nor dragons nor idle displays of the turner's caprice."

Fitting the chair to the customer

by Carolyn and John Grew-Sheridan

The first step in the fitting process is to measure the person sitting on a plain flat bench. This provides a set of starting measurements of the person's body that we can transfer to the rig. We're careful to make absolutely clear to the person we're fitting that this is *only* a preliminary setting or starting point. We've found if we don't emphasize this point, often people will refrain from telling us that the seat-to-back angle's too acute or the thoracic support is too low. We try to loosen them up and get them involved in the fitting process.

Taking measurements

The first measurement, known as the popliteal, is taken by measuring from the floor to the underside of the thigh at the knee. The customer should have on the same shoes that will typically be worn when sitting in the chair. Then we measure from that same point in the crook of the knee to the surface of the back. Next, holding a yardstick against the person's back with the end of the yardstick on the bench, we measure the height of the waist. We determine the location of the waist by having the customer bend to the side while seated. As it turns out, if you carry the waist measurement around to the back, that's just about where most people like to feel lumbar support.

We measure from seat to elbow to determine armrest height and note the relaxed spread of the arms as well for the width of the armrest at the elbows. The angle of the armrest is less predictable, we've found, so we just experiment until we hit upon a comfortable angle. Next, we measure from the seat to the underarm. This measurement is required for dining chairs in particular because it tells you approximately where to position upper back support.

Just as a dining chair requires upper back support, each type of chair has its own special traits and requirements. All chairs need to be wide enough in the seat—obviously—to get in and out of, so we take a seated hip width measurement; shoulder width isn't that significant a measurement unless you're building a chair that will partially envelop its owner, such as a large stuffed chair or recliner. Nevertheless, while we're measuring, we get all the information we can; there's no telling when a client we're fitting for a reading chair will want to order a set of dining chairs.

The final two vertical measurements that we take are from the seat to the nape of the neck and from the seat to the back of the head. These measurements are most critical for a chair designed primarily for relaxing in, where head support is absolutely essential.

Next, with the yardstick (or some other straight edge) still in place against the person's back and the person sitting up straight, we measure the horizontal distance from straight edge to lumbar (waist measurement transferred to the back), then from straight edge to the juncture of head and neck (the nape) and last, from straight edge to the back of the head.

Adjusting the rig

Setting the rig is straightforward once we've got all the above measurements (see the drawing on the facing page for information on where various parts of the rig are adjusted). The measurements and angles vary for different kinds of chairs, but for the sake of explanation, let's presuppose we're designing a reading chair. (Information on the requirements for various types of chairs can be found in the book, *Basic Design Measurements for Sitting,* mentioned on the previous page.) We set the seat depth first to about 2 in. less than the measured under-thigh length and then set the seat height at the knee to about 3 in. less than the popliteal measurement. We drop the rear of the seat 3 in. from the front setting (or 5 in. from the popliteal). We set the arm width at the elbow next (this generally falls in a fairly narrow range—between 21 in. and 23 in.) and then set the arm height at the elbow about 1 in. to 2 in. greater than the seat-to-elbow measurement.

For this preliminary setting, we position the back at 105° to the seat. Since we're adjusting the rig to fit the customer, this seat-to-back angle will often change. If we run out of range as we're adjusting the settings of the back supports, we can change the seat-to-back angle.

We adjust all the back supports using the measurements just taken, beginning with the sacral (1 in. forward of the back rail, 3 in. up from the seat). Proceeding up the back, we adjust the lumbar support—probably the most important— (usually 8 in. to 10 in. up, 1 in. to 2 in. forward of the back rail), thoracic support (set at the height of the underarm, at the same distance from the back rail as the sacral adjustment) and, finally, the neck and head supports. These last adjustments vary widely: a survey of 55 of our former and current chairbuilding students revealed a vertical range of 14 in.

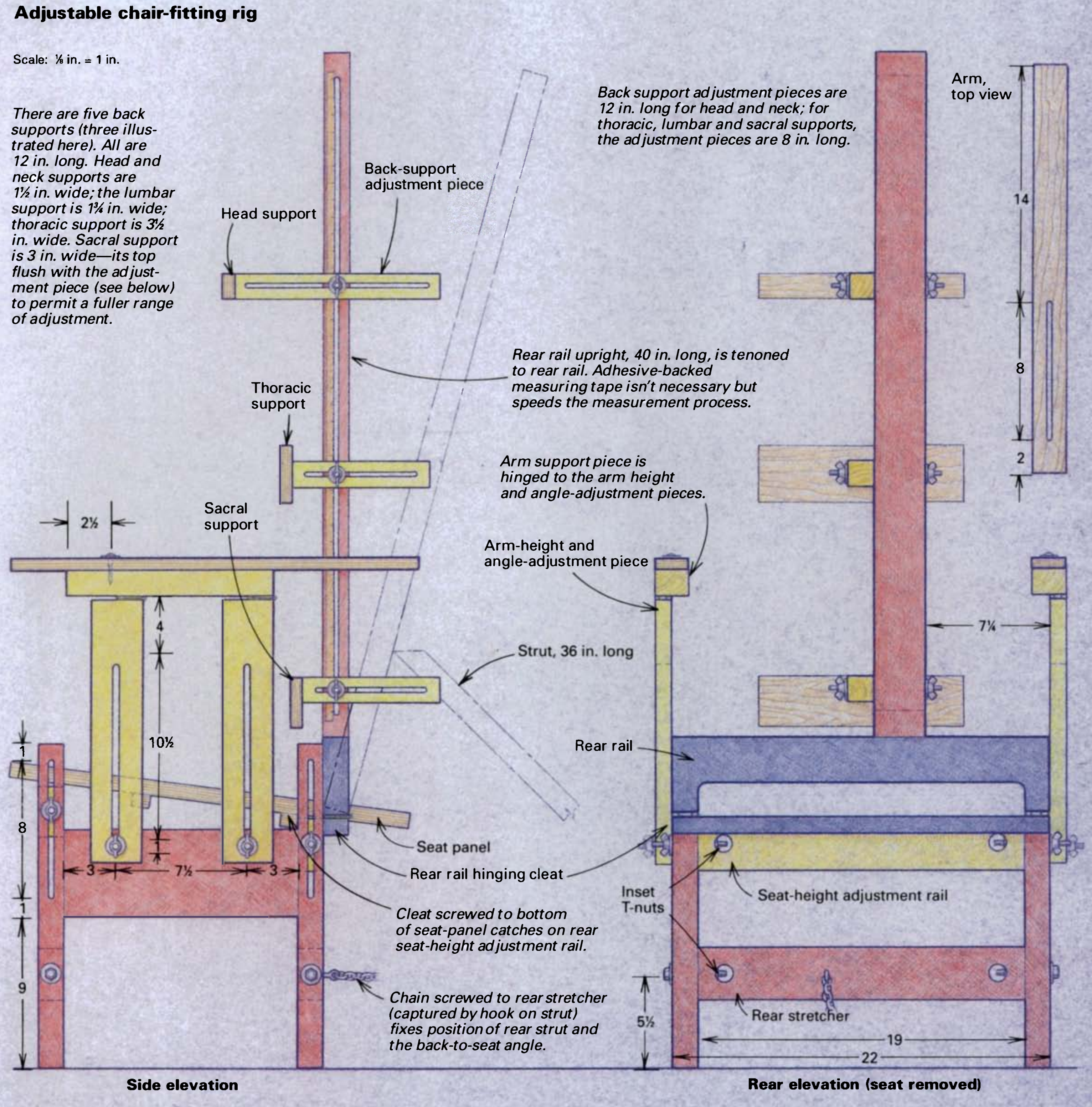
From this point on, it's really just a question of using your common sense and making increasingly finer adjustments. The chair's intended use, how it will relate to other furnishings (such as a dining or end table) and whether the chair's owner wears heels, flats, sneakers (or is barefoot) all need to be considered when translating the information gathered on the rig into a chair design. When we schedule a fitting, we encourage the customer to bring whatever is necessary to make the fitting absolutely realistic. That might mean a pair of slippers and a book or a newspaper—or even a bowl, spoon, box of corn flakes and a quart of milk. Pretending to eat a bowl of cereal while reading the paper just isn't the same as actually doing it, and we want the chair to be comfortable in use. □

Carolyn and John Grew-Sheridan design and build furniture and teach furnituremaking in San Francisco.

"Greenough was searching for great principles of construction," explained Carolyn. "He argued that one should first look at the use and only then turn to the decorative elements. He believed the conflict in design is between the essential and the pretentious." In other words, everything in the design of an object, whether it's a canoe or a shoe or a chair, ought to be subordinate to function. If this idea is respected—if function is clearly understood and sympathetically addressed and the consciousness of it extended to such considerations as the chair's interaction with the sitter's body, the finish of the wood, the feel of the fabrics, the intention in the flare of the curves—form will flow from it. The most comfortable (and the most beautiful) chairs aren't conceived as cakes to be decorated with a pastry tube. The beauty of a chair—whether it's the ancient Greek Klismos chair or one of Hans Wegner's contemporary pieces—comes instead from the character of its response to structural necessity. They maintain a tradition in the design of functional objects in which practicality and beauty aren't at odds but are rather in equilibrium—are, in fact, one and the same, a tradition that John and Carolyn Grew-Sheridan are helping to sustain. □

Glenn Gordon, a writer and craftsman, lives in St. Paul, Minn. His past contributions to FWW include articles on James Krenov and Gerritt Rietveld.

Adjustable chair-fitting rig



Drawing: Heather Lambert

Variations on a Perfect Fit

by Vincent Laurence

What do an orthopedic surgeon, an airport baggage handler and the San Francisco Police Department's high-speed driving instructor have in common? That's right, they're all students of the Grew-Sheridans. Since they began offering classes 18 years ago, the Grew-Sheridans have seen an astonishing variety of students come into their lives, and an equally astonishing array of projects—from cutting boards to credenzas—go out the door.

Chairs are among the more challenging projects students endeavor to build, but the Grew-Sheridan's chair-fitting rig helps ensure that the results are comfortable. What's almost as important is that the rig doesn't get in the way of design. Any chair, regardless of style, can be made more comfortable if it's designed specifically to fit its future owner. And where style and comfort clash, the chairmaker can still mediate. The chairs pictured here are good examples of the success of that mediation. □

Vincent Laurence is an assistant editor at FWW.

After retiring from their jobs in New York City and selling nearly everything they owned, William Jensen and his wife donned backpacks and headed for Europe—and a new life. Both were in their early sixties. The sprightly pair of sexagenarians traveled as the spirit moved them and rented houses in Denmark, the Greek isles and elsewhere.

Eventually, they began spending a good part of each year in San Francisco, where William signed up for woodworking classes with the Grew-Sheridans. He used their rig on one of his earliest projects (the chair at left) to determine seat height, seat angle and back-to-seat angle. Jensen wanted the foam cushions and plywood supports to appear as if they were floating on air above the Japanese oak rails that support them, so he swept the rails up to help create that illusion (see the detail at left).

Architect Tobin Kendrick's Craftsman-inspired dining chair traces its lineage to the chairs of Gustav Stickley, Frank Lloyd Wright and Charles Rennie Mackintosh. Kendrick's attraction to these Craftsman masters is based on their aesthetic kinship with the late Modern architecture he favors—with its pure forms and sheer functionality—and with his own appreciation of the warmth and beauty of naturally finished wood. Kendrick's white oak dining chair is a worthy successor aesthetically, but it's also an improvement in terms of comfort over the chairs of Wright and Mackintosh.

Kendrick used the chair-fitting rig to size his chair and to obtain the basic angles. By canting the piece of plywood supporting the leather-covered seat cushion within the confines of the rails, Kendrick was able to disguise the fact that the seat angles backward. He then made minute back-to-seat angle adjustments on a poplar mock-up until the fit was ideal.

Sarcophagi and stone friezes don't provide very accurate dimensions, but when you're working with a chair design that's over 2,000 years old, there's not much else to go on. Taking his cue from the ancient Greeks, Larry Doyle enlarged and modified the Klismos chair using the measurements from the Grew-Sheridan's rig.

To size the chair, Doyle copied a photo of a sarcophagus lid, on which the chair is depicted, made a transparency of it and superimposed it (using an overhead projector) onto a full-size perspective rendering of the "comfort curve" from the Grew-Sheridan's rig. The chair is birch, and the thongs supporting the leather-covered cushion are sewing-machine belts.

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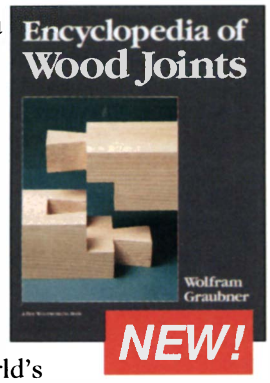

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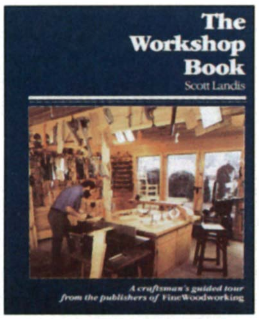

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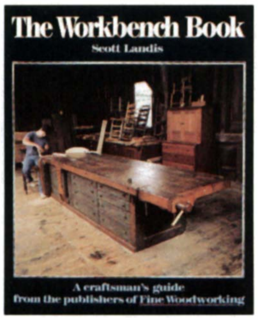

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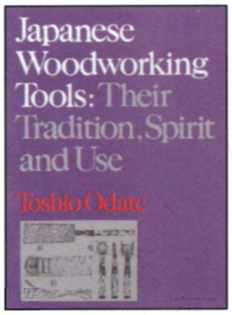

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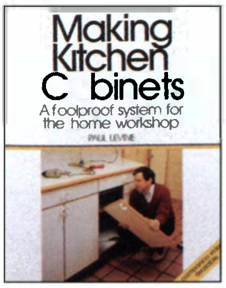

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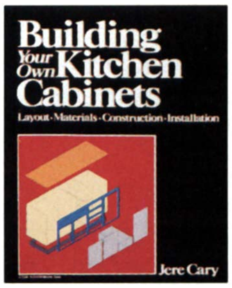

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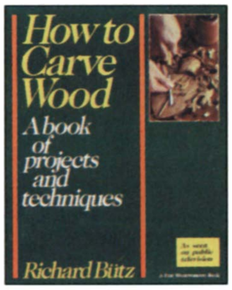

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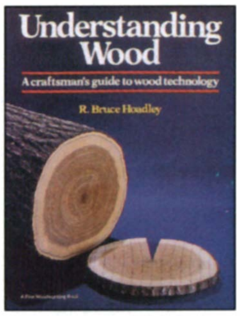

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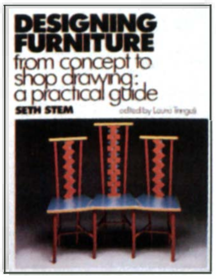

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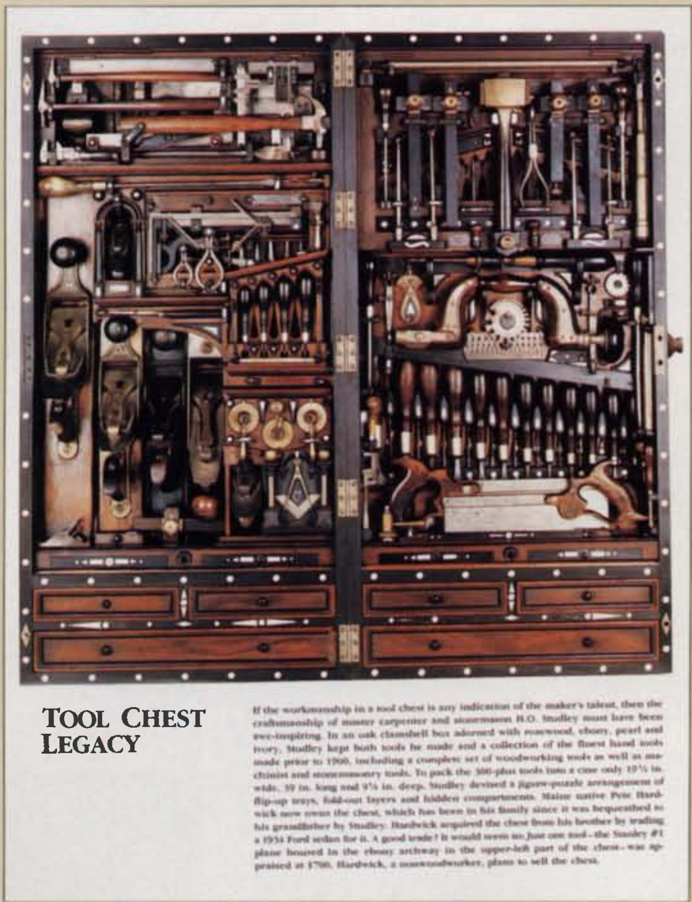

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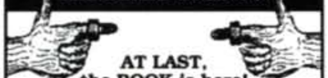

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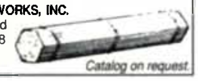

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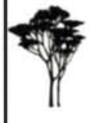

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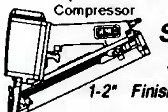

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0222-1	3/8" Drill	104
0224-1	3/8" Magnum	114
0234-1	1/2" Magnum	115
0235-1	0234 w/Keyless chuck	125
0375-1	3/8" RA Drill	127
0379-1	1/2" RA Drill	145
3300-1	RA Magnum	178
5392-1	3/8" Hammer Drill	114
6365	7 1/4" Circular Saw	116
6368	7 1/4" saw Kit	134
6507	VS Sawzall	131
6508	VS Sawzall	129
6527	Super Sawzall	164
6528	Super Sawzall	163
6539-1	Cordless screwdriver	72
6546-1	VS Cordl' screwdriver	79
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2467	48"	45

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100	7/8 hp Router	94
315-1	7 1/4" Circular Saw	115
332	**NEW! R.O SANDER**	68
333	**R.O SANDER w/bag**	78
351	3x21 Belt Sander	132
352	3x21 Belt Sander w/bag	136
360	3x24 Belt Sander w/bag	176
361	3x24 Belt Sander	169
362	4x24 Belt Sander w/bag	184
363	4x24 Belt Sander	178
505	1/2 Sheet Sander	115
513	Lock Mortiser	679
59381	Door Hinge Kit	159
690	1-1/2 hp Router	127
693	Plunge Router	164
6931	Plunge Base	74
695	1 1/2 hp Router Table	199
696	Router Table only	119
7310	Trim Router	84
9118	Door Plane Kit	190
9345	SawBoss Kit	122
9629	Recipro Saw	137
97310	Trimmer kit	184
9851	12v Cordless Drill	135

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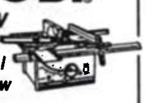

BE321	3x21 Sander	126
BT3000	10" Pro Table Saw	539
JP155	6" Planer	295
JM100K	Biscuit Jointer	204
JS045	Jig Saw	85
L1323ALSK	Plane	125
R501	2hp Plunge Router	148
RE600	3hp Plunge Router	199
RJ100VK	Reciprocating Saw	89
S550A	Palm Sander	45
SC160	Scroll Saw	137
TFD170	9v Cordless Drill Kit	148
TFD220	12v Cordless Drill Kit	164
TS260	*NEW!* 10" Comp. Miter	215
TSS200	*NEW!* 8.5" Slidesaw	447

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C10FA	10" Miter Saw	269
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CR10V	Recipro Saw	116
DH38YE	Roto Hammer	378
F20A	Plane	89
M12V	3 1/4hp Plunge Rtr	223
SV12SA	Palm Sander	45
TR6	Trim Router	93
TR12	Plunge Router	168

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VS280	1/2 sheet sander	59

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LU84M011	10" 50T Combo	38
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TK906	10" 50T Combo	27

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11212VSR	SDS Roto Hammer	194
1370DEVS	5" R.O. Sander	229
1604K	1 3/4 hp Router kit	163
1609K	3-base Trimmer kit	164
1608U	Underscribe Trimmer	117
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1615EVS	New! Plunge Router	249
1942	Heat gun	67

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- Experiment with lesser-known species.
- Use recycled wood or wood from well-managed sources.
- Plant a tree.
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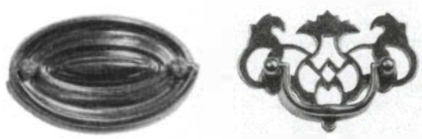

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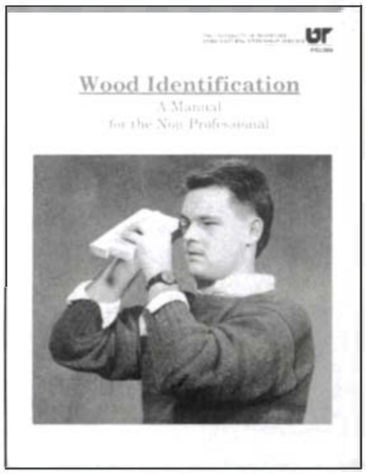
READER SERVICE NO. 307

Wood Identification: A Manual for the Non-Professional by John B. Sharp. *University of Tennessee Agricultural Extension Service, Forestry and Wildlife Extension, P.O. Box 1071, Knoxville, Tenn. 37901-1071, publication #1389. 1990. $7.00, paperback; 107 pp.*



As wood-identification texts go, this one lags well behind the pack in thoroughness, and that is its strength—it is the best manual I've seen for helping an absolute novice get started in wood identification. The ardent student already has a choice of good references: Panshin and De Zeeuw's *Textbook of Wood Technology* provides a wealth of information, but only if you already know something about wood anatomy and Latin nomenclature; and R. Bruce Hoadley's *Identifying Wood*, perhaps the best all-around reference in the field, sticks so strictly to the subject that the beginner must search elsewhere for those tidbits on a species' working characteristics and uses that are essential for understanding the real nature of a wood. Sharp's manual is beguilingly untechnical yet informative, and reading it doesn't make you feel you're cramming for an exam. Sharp begins with a brief personal statement thanking those who have helped him prepare the manual, while absolving them of responsibility for any mistakes. This is good, because he makes a few. Next he describes how to use the manual in conjunction with a well-sharpened pocket knife and a hand lens to examine actual wood samples. Then he moves on to wood anatomy, discussing rays, pores and other structural components of wood. This brief but well-organized and clearly written section prepares the reader not only for the balance of the manual but also for more technical references like those mentioned above.

A hand-lens key in the second section is designed to allow the reader to examine a sample of an unknown wood and then, by answering a series of "yes-or-no" questions, arrive at its probable identity. Like most keys, this one is virtually worthless. It incorporates only a few dozen species, when the unsuspecting novice could be holding a sample of any one of literally hundreds if not thousands of domestic or imported woods. In the final section of the manual, endgrain photomacrographs accompany descriptions of 35 species of wood. This section is a joy to read. It covers most of our commercially important, domestic hardwoods and softwoods. True, the black and white photomacrographs are a bit muddy, but then so is the typical view of a wood's endgrain through a hand-held lens. What makes this section so appealing is that each species is treated like a precious cameo, with a description of the tree, its native range, the traditional uses of the wood and, on occasion, trivia about the tree's foliage, fruit or other uses. As you progress from species to species, you sense Sharp's love for our native woods. But alas, this book isn't perfect. For example, the botanical names for Eastern red cedar and red mulberry are misspelled in large, bold type. But how important are these cavils to the reader who just wants the basics of wood identification? All in all, this is an informative, well-written and very enjoyable book. *—Jon Arno*

The Wood Users Guide by Pamela Wellner and Eugene Dickey. *Rainforest Action Network, 301 Broadway, San Francisco, Calif. 94133, 1991. $10.00 ppd., paperback; 68 pp.*

In the introduction to their guide, Rainforest Action Network (RAN) authors Pamela Wellner and Eugene Dickey note that in 1989 "RAN initiated a campaign to ban the U.S. import of tropical timbers" (with exceptions for "truly sustainable" logging operations). This strategy of boycotting tropical timber puts RAN at odds with not only major timber corporations but also with some environmental organizations. Many tropical forest experts believe that bans are counterproductive and lead to the conversion of forests to marginal agriculture or other land development.

The Wood Users Guide, according to the authors, is designed to spread the RAN philosophy to a broader audience of "woodworkers, architects, designers, and the public in general." As a founding member of Woodworkers Alliance for Rainforest Protection (WARP), an organization opposed to generic tropical-wood bans, I was predisposed to be skeptical of this RAN publication. A careful reading, however, has convinced me that the RAN philosophy is "softening" a bit. The authors have made a sincere effort to provide some alternative strategies for wood users. The traditional RAN philosophy as stated on the book's back cover: "Avoid the use of tropical wood," is, in fact, modified somewhat in the text. For instance, the Peruvian Yanesha Co-op (which imports wood through WARP's John Curtis), Ecological Trading Company of England and Tradewinds of Vermont (which owns a logging operation in Mexico and imports cocobolo and bocote) are all mentioned as "good guys." (The major corporation list of "bad guys," of course, is also served up for scrutiny.)

The Wood Users Guide serves as a starting point in an ongoing process of wrestling with the issue of global sustainability of forest resources. I have some difficulty, however, with the position taken by the authors on some of their wood selections—for instance, North American redwood, western red cedar and Douglas-fir are promoted (albeit with the caveat of trying to use second growth or salvaged wood) as substitutes for tropical woods. They also promote the use of butternut, despite the fact that this species is being rapidly decimated by a fungus canker in the eastern United States (in 1990, butternut was added to the list of candidates for protection under the U.S. Endangered Species Act).

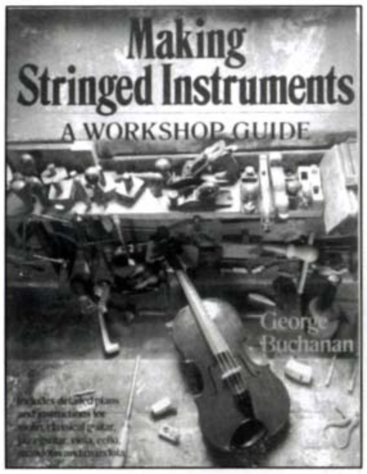
A careful reading of the booklet reveals other discrepancies and misjudgments. The dipterocarps (Philippine mahoganies) are repeatedly cited as endangered, but members of this group are threatened only in certain countries. Spanish cedar is listed as endangered, but careful reading reveals that only *Cedrela fissilis* is *possibly* endangered; not mentioned is the most commonly exported wood, *Cedrela odorata*. Similar criticism could be leveled at the broadscale treatment of the ebonies. To be fair, however, the authors point out that this effort is their best guess and they "encourage readers to research other woods."

Perhaps the most glaring inconsistency in the book is the authors' heavy promotion of reconstituted wood materials (chipboard, oriented strand board, particleboard). Not only are these materials often a poor substitute and a health risk (formaldehyde fumes), they are now increasingly being made from woods grown in the tropics—both native and exotics.

Despite these shortcomings, the guide provides some useful strategies—greater use of lesser-known temperate species, recycling wood (salvaging old buildings, for example) and substituting non-wood materials.

The dwindling supply of forested lands coupled with exponential population growth provide the ingredients for ecological disaster in many tropical countries. The solutions will not be simple nor the same throughout the tropics. Cooperation, rather than confrontation, will be needed. *The Wood Users Guide* does not deal with many of these complexities, but as one strategy in the effort to preserve tropical forests this book would be a useful addition to the library of the environmentally concerned user of wood. *—Richard Jagels*

Making Stringed Instruments: A Workshop Guide by George Buchanan. *Sterling Publishing, 387 Park Ave. South, New York, N.Y., 10016; 1990. $19.95, paperback; 205 pp.*



The attractive cover of this book pictures a cozy old workbench littered with an intriguing assortment of wooden hand tools, with the late afternoon sun streaming in. All that's missing is a steaming cup of tea. The title, however, is misleading. This is really a beginner's book about violin making. Buchanan has written chapters for other instruments (the cello, mandolin, mandola, classical guitar and "jazz" guitar), but they are superficial at best. Presumably, once you've mastered violin making, you will be able to build any other stringed instrument rather easily. While this may be somewhat true for bowed instruments, it's not at all the case for the guitar. The construction methods Buchanan suggests for the guitar are at best unconventional and at worst disastrous. For example, he omits the rather crucial metal truss rod in the steel-string guitar neck, which is meant to counter the tension of steel strings. Without it, your guitar neck will bow like a willow in a hurricane when you put your first set of strings on it. (Potential guitar makers would do better to read William Cumpiano's excellent guide "Guitar Making—Tradition and Technology.")

In contrast, Buchanan is clearly at home describing violin making. From selection and preparation of wood to bending the sides and preparing hide glue, he guides you over the hurdles that lie between you and a finished violin. A basic toolmaking chapter will help the first-time builder get started without expensive, specialized tools. If you don't have a finely measured drawing, Buchanan advises measuring and copying an available instrument. He also suggests methods and jigs for measuring difficult arched surfaces using inexpensive and effective tools.

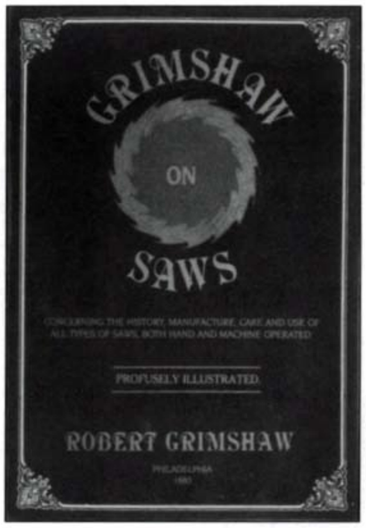
The quality of the information in this book is uneven. The descriptions of the woods used in instrument-making don't say enough about the acoustical and structural properties of each species. After all, "acoustics" is what an instrument is all about. (Also keep in mind that the author is British, so when he says "pine" is an accepted topwood, North Americans should read "spruce.")

Arching of the back and top is a difficult and crucial step of the construction and an easy place for a novice to get confused. Buchanan describes how to carve the arches but not why to. Detailed arching templates would have been helpful. Also, the relationship of the strings, the bridge and the arching top deserves more clarification. The assembly of violin sides and the difficult task of bending curly maple, however, are well explained.

It's hard not to be impressed with the book's numerous detailed drawings, which are well-drawn, but unfortunately not labeled. The unlabeled drawings, combined with sometimes confusing explanations of construction methods, left me scratching my head. For example, a description of cutting the violin's f-hole instructs you to hold the carved top to your chest and, with the scalpel pointed toward your chest, begin cutting. I'm sure Buchanan is not suggesting that you perform open-heart surgery on yourself, but that's how it reads.

Many a woodworker has toyed with the idea of building a violin only to be intimidated by the achievements of Stradivarius and the conflicting research on how to proceed—debates are still simmering about the correct side of the tree to cut or whether one really must soak the wood in sea brine for five years. This book attempts to alleviate fears so that anyone with a heated garage and a few tools will feel comfortable building a violin. It's a noble idea. With so few books written about instrument-making, any addition is welcome. However, if you have serious intentions about making violins, there are better books. *—Linda Manzer*

Grimshaw on Saws by Robert Grimshaw. *Astragal Press, Box 338, Morristown, N.J. 07963-0338, 1991. $19.95, paperback; 176 pp.*



It was 1880, four years after Mark Twain published *The Adventures of Tom Sawyer*, and a decade after Charles Dickens' death. That year, Robert Grimshaw, a 30-year-old American engineer, published a technical treatise on the saw, striking a literary blow for his country's emerging status as an equal among European industrial manufacturing powers. Recently reissued, the book stands as a comprehensive early reference, and reveals an era when gentlemen engineers rolled up their sleeves in grimy shops only slightly less hellish than Dickens had described. Will this book help you sharpen your own saws and blades? I can't see how it could fail, given the amount of information here. Grimshaw will sharpen your awareness of what's happening when you saw wood, and he knows more about teeth than most dentists.

Like Dickens (and bearing a Dickensian name), Grimshaw hauls his characters out of obscurity to display their quirky widgets and gizmos, the ancestors of today's computer-driven tools. The world has long forgotten Boswick, but thanks to Grimshaw and Astragal Press, we have a wonderful illustration of "Boswick's Emery Gummer." During the same period, firewood was being cut with big two-man crosscuts or perhaps the comical-looking device called the Giles Drag Sawing Machine, upon which a woodcutter allegedly perched as if on a combination seesaw and rowboat.

Beyond woodworking, Grimshaw describes 19th-century saws that cut iron, gold, and (gulp) bone. Fans of splatter flicks will be charmed to see an illustration of what Grimshaw blandly refers to as "the ordinary surgeon's chain saw," a hand tool resembling an ominous manual eggbeater.

The period illustrations, combined with Grimshaw's genteel style, convey a powerful sense of the era. The drawings show heavy iron machinery cast in the feminine Victorian mode. They include equipment advertisements of the time, rich in extravagant claims and typefaces. With characteristic formal brevity, the author declares: "As the office of a saw is to sever by removing or wasting material, the thinner it can be had, the more economical of time, power, and material."

As a patriot and engineer, Grimshaw was a priest of America's new religion of national boosterism linked with a faith in noble technology. At the same time, his technical treatise pays homage to the individual inventors, foundry workers, tinkerers, and sawmill filers who spent their working lives improving tools that cut things into smaller pieces. *—Richard Ewald*

Jon Arno is a wood technologist and consultant in Schaumburg, Ill.; Richard Jagels is professor of forest biology at the University of Maine, Orono; Linda Manzer is a luthier in Toronto, Canada; Richard Ewald is a freelance writer in Westminster West, Vt.

Listings of gallery shows, major craft fairs, lectures, workshops and exhibitions are free, but restricted to happenings of direct interest to woodworkers. We list events (including entry deadlines for future juried shows) that are current with the time period indicated on the cover of the magazine, with overlap when space permits. We go to press three 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.

ARIZONA: **Exhibition**—Harvest Festival Fall Tour, Westworld, Scottsdale, Oct. 30–31; Nov. 1. Contact Lori Loane. (707) 778-6300.
Juried show—Redefining the Lathe-Turned Object, Dec. 13–Jan 31. Deadline: Oct. 1. For prospectus, send SASE to Arizona State University Art Museum, Nelson Fine Arts Center, Tempe, 85287-2911. (602) 965-2787.
Show—North Scenic 7 Holiday Showcase, Oct. 16–18. Contact Highway 7 Artists & Crafters Co-Op, PO Box 326, Jasper, 72641. (501) 428-5224.

CALIFORNIA: **Exhibitions**—Harvest Festival Fall Tour, Sept. 25–27. Fort Mason, San Francisco; Sept. 25-27. Sacramento Community Center, Sacramento, Contact Lori Loane (707) 778-6300.
Shows—San Diego Woodworking Show, Nov. 13–15. Del Mar Fairgrounds, 2260 Jimmy Durante Blvd., Del Mar.; Southern California Woodworking Show, Nov. 20–22. Long Beach Convention Center, 300 East Ocean Blvd., Long Beach; Northern California Woodworking Show, Dec. 4–6. San Mateo County Fairgrounds, 2495 S. Delaware St., San Mateo. (800) 826-8257.
Carving competition—Palm Springs Wildlife Art Show & Wildfowl Carving competition, Oct. 10–11. Riviera Resort and Racquet Club, 1600 N. Indian Ave., Palm Springs. Contact Lloyd MacBride, Decoy & Wildfowl Carvers Assoc., PO Box 8215, Hemet, 92545. (714) 845-2237.
Juried exhibition—Artistry in Wood '92, Sept. 11–Oct. 25. Sonoma County Woodworkers Association Sonoma County Museum, 425 Seventh St., Santa Rosa. (707) 579-1500.
Show—A Garden of Carvings, Tri-Valley Woodcarvers. Sept. 12–13. The BARN, 3000 Pacific Avenue, Livermore.
Exhibition—Classical Chinese furniture, thru Nov. 1. San Francisco Craft & Folk Art Museum, Fort Mason, San Francisco 94123-1382. (415) 775-0990.
Show—15th annual wood carving show, Sept. 19-20, Central Coast chapter of California Carvers Guild, Coast Union High School, Cambria. (805) 927-1750.

COLORADO: **Show**—Colorado Woodworking show, Nov. 6–8. National Western Complex, Expo Hall, Humboldt St. & E. 47th Ave., Denver, 80216. (800) 826-8257.
Juried exhibit—8th annual Woodworkers Guild of Colorado Springs, Nov. 7–Dec. 6. Deadline: Oct. 30–31. Colorado Springs Pioneers Museum. Contact John Lewis, 918 N. Royer St., Colorado Springs, 80903. (719) 632-8548.

CONNECTICUT: **Exhibit**—Turned and Fabricated Forms by Bob Stocksdale and Kay Sekimachi, thru Nov. 23. Brown Grotta Gallery, 39 Grumman Hill Road, Wilton. (203) 834-0623.
Juried exposition—New England Woodcarving and Wildlife Art Exposition, Oct. 24–25. Radisson Hotel, Cromwell. Contact Laurence Appleton, 795 Hoop Pole Rd., Guilford, 06437. (203) 453-1571.
Workshops—Inlaid wood turning, veneers for woodworking, more, thru Nov. Brookfield Craft Center. (203)-775-4526 or (203) 853-6155.
Exhibition—14th annual Holiday Festival of Crafts, Nov. 7–Dec. 24. Deadline: Sept. 18. For application, send SASE to Holiday Festival of Crafts, Guilford Handcrafts, PO Box 589, Guilford, 06437. (203) 453-5947.

DISTRICT OF COLUMBIA: **Show**—Washington D.C. Woodworking Show, Sept. 25–27. D.C. Armory–Main Hall, 2001 E. Capitol St. (800) 826-8257.

FLORIDA: **Exhibition**—41st Florida Craftsmen Statewide Exhibition, Jan. 15–Mar. 14. Deadline: Nov. 2. For prospectus, contact DeLand Museum of Art, 600 N. Woodland Blvd., DeLand 32720-3447.

GEORGIA: **Show**—Woodworking World Atlanta show, Oct. 9–11. Radisson Hotel Atlanta, Courtland & International Blvd., Atlanta. (800) 521-7623.

ILLINOIS: **Juried exposition**—8th annual American Craft, Sept. 10–12. Henry Crown Sports Pavilion, Evanston. Contact Shelly Robinson, Winger & Assoc., 320 N. Michigan Ave., Suite 1901, Chicago, 60601 (312) 263-4313. For taped info, (708) 570-5096.
Show—Chicagoland Woodworking show, Sept. 18-20. Odeum-North Hall, 1033 N. Villa Ave., Villa Park. (800) 826-8257.
Show—22nd annual Midwestern Wood Carvers, Nov. 7–8. Belleville Wood Carvers Club. Belle-Clair Exposition Hall, 200 South Belt East, Belleville. Contact Don Lougeay, 1830 East D St., Belleville 62221. (618) 233-5970.

INDIANA: **Festival**—Chautauqua of the Arts, Sept. 26–27. Madison. Contact Dixie McDonough (812) 265-5080.

LOUISIANA: **Juried show**—Lafayette Art Association annual art competition, Mar. 9–Apr. 8. For prospectus, send #10 SASE to J.K. Sommer, Lafayette Art Gallery, 700 Lee Ave., Lafayette, 70501.

MARYLAND: **Juried exhibitions**—17th annual Maryland crafts festival, Oct. 8–10. Maryland State Fairgrounds, Timonium; 18th annual Autumn Crafts Festival, Nov. 19-21. Montgomery County Fairgrounds, Gaithersburg;16th annual Winter Crafts Festival, Dec. 10-12. Montgomery County Fairgrounds, Gaithersburg. For info and applications, contact Deann Verdier, Sugarloaf Mountain Works, 200 Orchard Ridge Drive, Suite 215, Gaithersburg. (301) 990-1400.

MASSACHUSETTS: **Workshop**—Traditional Timber Framing with Jack Sobon & Dave Carlon, Sept. 30–Oct. 4. Hancock Shaker Village. Contact Dave Carlon, PO Box 223, Windsor. (413) 684-3612.
Show—10th annual Woodworking World New England show, Oct. 16–18. Eastern States Exposition Center (Big E), 1305 Memorial Ave., West Springfield. (800) 521-7623.
Show—22nd annual Christmas show, Nov. 27–29. Boston Bayside Expo Center, Boston. Contact Fieldstone Shows, 6 Deerfield Dr., Medfield, 02052 (508) 359-6545.
Exhibition—Portsmouth Furniture: Masterworks from the New Hampshire Seacoast, Sept. Currier Gallery of Art, Harrison Gray Otis House, 141 Cambridge St., Boston. (617) 227-3956.

MICHIGAN: **Show**—Metro-Detroit Woodworking Show, Oct. 16–18. Michigan Fairgrounds, Community Arts Bldg, 1120 W. State Fair Ave., Detroit, 48203. (800) 826-8257.
Seminar—Power tool setup and usage, Frank Klausz, Oct. 24–25. Woodcraft Supply, Heritage Plaza, 14695 Telegraph Rd., Redford. Contact Joseph Hoover (313) 537-9377.

MINNESOTA **Show**—Twin Cities woodworking show, Oct. 2–4. Minn. State Fairgrounds, Snelling & Como Aves., St. Paul, 55108. (800) 826-8257.
Exhibition—Northern Woods, Minnesota Woodworkers Guild, Oct. 1–4. Write Minnesota Woodworkers Guild, PO Box 8372, Minneapolis, 55408.
Course—15th annual kiln drying short course, Sept. 14-17. Univ. of Minnesota, St. Paul Campus. Contact Harlan Petersen, Dept. of Forest Products, Univ. of Minnesota, 2004 Folwell Ave., St. Paul, 55108. (612) 624-3407.

MISSOURI: **Fair**—Third annual Woodcraft fair, Oct. 24–25. Paxton Lumber, P.O. Box 6714, 6311 St. John, Kansas City. For information, call Kevin Sickel (816) 483-0659.

MONTANA: **Exhibition**—Good Wood III, Oct. 2–4. Ramada Inn, Billings. Contact Montana Woodcarvers Association, 2919 Lynn Ave., Billings, 59102. (406) 656-2051.

NEVADA: **Exhibition**—Harvest Festival Fall Tour, Las Oct. 23–25, Vegas, Cashman Field Exhibition Center; Reno, Oct. 23–15, Reno Livestock Events Center. Contact Lori Loane (707) 778-6300.

NEW HAMPSHIRE: **Meeting and juried exhibition**—Guild of New Hampshire Woodworkers, Sept. 26. Demo by Grant Taylor on solar kilns. South Alworth; Exhibition, Oct. 19. Killian Gallery at the Sharon Arts Center, Sharon. Contact John Skewes, 132 Drinkwater Road, Kensington, 03833. (603) 778-7360.
Workshops—Various woodworking workshops thru Dec. 5. Canterbury Shaker Village, 288 Shaker Rd., Canterbury. (603) 783-9511.

NEW JERSEY: **Exhibition**—Carvings of Gary Giberson, thru Jan. 3. Noyes Museum, Lily Lake Road, Oceanville. (609) 652-8848.
Juried festival—Waterloo Arts & Crafts Festival, May 1–2. Deadline: Jan. 15. Waterloo Concert Field, Waterloo Road, Stanhope. For application, call (201) 384-0010.

NEW YORK: **Show**—Woodworking World Suffern show, Oct. 2–4. Rockland County Community College, 145 College Road, Suffern. (800) 521-7623.
Show—Third annual ESCA at Syracuse Fine Crafts Market, Nov. 20–22. Jefferson Street Armory, Syracuse. Contact Linda Faulkner (518) 584-1819.
Show—Sixth annual Woodworking World Central New York State show, Oct. 30–Nov. 1. New York State Fairgrounds, Syracuse. (800) 521-7623.
Exhibition—Third Craft Art, Sept. 19–Nov. 29. Burchfield Art Center, State University College at Buffalo, 1300 Elmwood Ave., Buffalo, 14222-1095.
Classes—Building a Shaker blanket chest; advanced Shaker furniture design, fall semester. Adult Education division of Jamestown School system. Contact Division of Adult Education, 350 E Second St., Jamestown 14701. (716) 483-4384.

NORTH CAROLINA: **Show**—North Carolina Piedmont Woodcarvers, Oct. 3. Contact Bob Williams, Route 7, Box 234, Mooresville, 28115. (704) 663-3736.
Show—8th annual Woodworking World Carolina show, Sept. 25-27, Omni Durham Hotel, Durham. (800) 521-7623.
Tour— Crafts and Chalet Tour of Switzerland, Sept. 29–Oct. 8. Contact Country workshops, 90 Mill Creek Road, Marshall, 38753. (704) 656-2280.

OHIO: **Show**—Third annual Woodworking World Berea show, Oct. 23–25. Cuyahoga County Fairgrounds, 164 Eastland Road, Berea. For information, (800) 521-7623.
Show—Greater Columbus Woodworking Show, Sept. 11–13. Ohio Expo Center/Fairgrounds, 600 E. 17th Ave., Columbus. For info call (800) 826-8257.
Exhibition—Great Lakes Regional Furniture exhibition, June. Deadline: Sept. 30. For entry form, send SASE to Tops & Bottoms: Tables & Chairs, Ohio Designer Craftsmen, 2164 Driverside Drive, Columbus, 43221. (614) 486-7119.

OKLAHOMA: **Seminar**—General woodworking with Michael Fortune, Oct. 23–24. Green Country Woodworker's Club of Tulsa. Tulsa County Vo-Tech School, Lemley Campus Cabinet Shop, 3420 S. Memorial Dr., Tulsa. Contact Larry D. Anderson, 2439 S. Gary Place, Tulsa, 74114. (918) 743-2038.

OREGON: **Show**—Oregon Woodworking Show, Oct. 30–Nov. 1. Portland Expo Center, Exhibit Hall C, 2060 N. Marine Dr., Portland. For info, call (800) 826-8257.
Seminar—Faux Finishes for Furniture with Carol Connett, Oct. 25 and Nov. 1. Oregon School of Arts & Crafts, 8245 Southwest Barnes Road, Portland 97225. (503) 297-5544.
Show—Holiday gift show, Nov. 5–Dec. 24. Hoffman Gallery, Oregon School of Arts & Crafts, 8425 Southwest Barnes Rd., Portland 97225. (503) 297-5544.
Student sale—Holiday student sale of crafts, Dec. 11–13. Oregon School of Arts & Crafts, 8245 Southwest Barnes Rd., Portland 97225. (503) 297-5544.

PENNSYLVANIA: **Show**—Fourth annual Woodworking World Central Pennsylvania show, Nov. 20–22. Pennsylvania Farm Show Complex, West Bldg., 2301 North Cameron St., Harrisburg. (800) 521-7623.
Exhibition—Studio Days '92, Sept. 25–Oct. 4. Open to mid-Atlantic artists. Contact Studio Days '92, Chester Springs Studio, PO Box 329, Chester Springs, 19425. (215) 827-7277.
Show—Woodworking World Pittsburg show, Nov. 6–8. Expo Mart, 105 Mall Blvd., Monroeville. (800) 521-7623.
Show—Delaware Valley Woodworking Show, Oct. 9–11. Valley Forge Convention Center, Pennsylvania Hall, N. Gulph Road & First Ave., King of Prussia. (800) 826-8257.
Call for entries—Holiday ornament juried sale and exhibition, Palmer Museum of Art, Penn. State Univ. Any Medium. Entry fee $10, 1 to 5 ornaments. Deadline, Nov. 1, 1992. SASE to Catherine H. Zangrilli, Friends of the Palmer Museum of Art, Penn. State, University Park 16802-2507. (814) 865-7672.
Show—Philadelphia craft show, Nov. 5–8. Philadelphia Civic Center, 34th St. & Civic Center Blvd., Philadelphia. For info, call Public Relations Dept., Philadelphia Museum of Art (215) 787-5431.
Exhibition—William Rush Woodcarvers' ninth annual woodcarving and wildlife art show, Oct. 24–25. Pennsylvania State University, Delaware County Campus, Lima. For info, contact Fred Diehl, show chairman, 668 Parrish Road, Swarthmore, 19081. (215) 328-2138.

TENNESSEE: **Seminar**—Quality Lumber: Sawing, Grading, and Drying. Sept. 25–26, Norris. Contact Bill Parrish, TVA Forestry Bldg, Norris, 37828 (615) 632-1656.
Workshops—Woodworking with Handtools, Graham Campbell; Woodturning, Joe Looper, Oct. 24–25; Handmade for the holidays, woodturnings, Charles Alvis, Nov. 21. Appalachian Center for Crafts, Tenn. Tech. Univ., Box 430, Route 3, Smithville, 37166. (615) 597-6801 or 597-6802.

TEXAS: **Show**—7th annual Rio Grande Valley Woodcarvers, Inc, Jan. 13–24. Contact Dorothy Chapapa, R.R. 2, Box 150, McAllen, 78504. (512) 581-2448.
Meeting—Los Amigos del Mesquite, 10th anniversary meeting, Sept. 24-27. Contact Roger Craig, Los Amigos del Mesquite, 1 Mesquite Tree Lane, Marlin, 76661. (817) 583-7957.

VIRGINIA: **Show**—17th annual Richmond Craft and Design Show, Nov. 20–22. Richmond Centre for Conventions and Exhibitions. Contact Hand Workshop, 1812 W. Main St., Richmond, 23220. (804) 353-0094.
Exhibition—Guild of Maine Woodworkers, Oct. 19–Nov. 28. Thos. Moser Galleries, 601 South Washington St., Alexandria. (703) 548-3447. Contact Jack Versery (207) 829-6650.
Exhibitions—In the Folk Tradition, thru Sept. 11; Student Gallery Retrospective, Sept. 22–Nov. 6; Cutting Edge, Nov. 17–Jan. 2. Crestar Bank Gallery, 500 Main Street, Norfolk 23510.

WASHINGTON: **Show**—12th annual woodcarving, Nov. 7–8. Western Washington Fairgrounds Expo Hall, 9th and Meridian, Puyallup. Write Northwest Carvers Assoc., PO Box 6092, Federal Way, 98063-6092.
Show—Western Washington Woodworking Show, Oct. 23–25. Seattle Center, Exhibition Hall, Mercer St. at 3rd Ave. North, Seattle. (800) 826-8257.

WEST VIRGINIA: **Workshops**—Wooden Hand Planes with David Finck, Oct. 16–18. Crafts Center, Cedar Lakes, Ripley 25271. (304) 372-7005.

WISCONSIN: **Show**—3rd annual Milwaukee show, Nov. 13–15. Waukesha County Exposition Center, NI W 24848 Northview Rd., Waukesha, 53188. (800) 521-7623 or (603) 536-3768.

CANADA: **Conference**—Canadian Vocational Assoc., Oct. 28–31. Victoria Conference Centre, Victoria, B.C. Contact Paul Mantell, 1992 Canadian Vocational Assoc. Conference, c/o Camosun College, 4461 Interurban Road, Victoria, B.C. V8X 3X1. (640) 370-4000.

A sculpture with a secret

The Water Curtain Cave by Joseph Ascrizzi, appears to be a freestanding sculpture, but it is really a secretary (personal writing center) with carved, tamboured doors. The piece is a scaled-up version of his small box sculptures, which incorporate original carvings and found objects, such as roots, stone, glass and metal transformed by cutting and polishing.

The four big, tamboured doors, which enclose the 98-in.-high by 60-in.-wide secretary are carved basswood. A yellow pine root surrounds the central male and female figures. Other carvings have been inlaid with bits of shell, bone, glass and stone. All four doors are gessoed and some of the details are gold leafed. The rest of the surface is coated with up to 17 layers of pigmented casein and rabbit skin glue-size to build up depth of color.

The tambour mechanism allows each of the four doors to be rolled back independently on three tracks made of black oak, which curve around the outside of the piece at the top, bottom and middle. Each of the door's carved slats is attached to adjacent slats with a piano hinge, and the slat is held to the tracks above and below by pins made from rock maple. The weight of each door assembly is carried by steel bearings, which ride atop one of the tracks.

Opening the doors reveals the interior of the secretary and a variety of wood species used in its construction: spalted-maple side panels; yellow-birch frames, rear panels and

The Water Curtain Cave ***is a freestanding sculpture*** *that hides a secretary. The piece was a carte blanche commission that was built without financial or creative constraints and required artist Joe Ascrizzi more than 2,000 hours to complete.*

Rolling open the four carved tambour panels *transforms the piece of art into a functional writing center with a pull-out worktable and plenty of storage.*

Photos: Thayer Smith

shelves; a native Maine cherry crown; red-oak desktop and drawer sides; corner posts of white oak with zebrawood accents and drawer fronts of elm rimmed with hornbeam. The teak pulls are inlaid with abalone shell. The desktop, which has a leather insert, pulls out to create a writing surface above a bank of 10 drawers.

Although this was a commissioned piece, Ascrizzi was unencumbered by the creative and budgetary constraints normally imposed by a customer. In fact, the only drawings he made were to work out some of the technical details for the carcase and tambour door construction. Ascrizzi spent more than 2,000 hours over the course of a couple of years completing the piece.

—Sandor Nagyszalanczy

Photo: David Gidmark

***Birchbark-canoe building classes** offer a challenging option for a summer vacation. The 16-day class is comprehensive, from harvesting the bark to launching the finished canoe. Here, a student fits the cedar gunwale caps on a nearly completed canoe.*

Announcements

Fund-raiser, veneer auction

This fall, the Woodworkers' Alliance for Rainforest Protection (WARP) will auction nearly one million sq. ft. of mostly hardwood veneers. The inventory varies from five to 25 years of age and includes more than 50 tropical and temperate species. Most of the veneers in this offering are thicker than current standards, and many species are no longer available.

All proceeds will benefit WARP and will help the nonprofit organization develop an information phone line and a testing program of lesser-known species. The veneer auction will be held September 17–19, at Westover Industrial Airpark in Chicopee, Mass. For a complete list of available species and quantities and directions to the site, send a stamped, self-addressed envelope to WARP Veneer, P.O. Box 133, Coos Bay, Ore. 97420.

—Scott Landis, Coatesville, Pa.

Kiln drying guidebook

Quality Drying of Hardwood Lumber Guidebook Checklist is a new publication offered by the USDA Forest Service's Forest Products Laboratory. Although written to help commercial kiln operators reduce checking and warping when drying hardwood lumber, it should also prove helpful for home kiln operators as well by focusing on lumber handling and kiln operations and maintenance. Copies of the guidebook (General Technical Report FPL-IMP-GTR-2) are available from the Forest Products Laboratory, One Gifford Pinchot Drive, Madison, Wis. 53705-2398.

—Charley Robinson

New newsletter aimed at the professional woodworker

Woodworker's Business News is a monthly newsletter published by Woodworker's Supply, Inc. (1108 N. Glenn Road, Casper, Wyo. 82601; 307-237-5528) that is directed specifically to the needs and interests of professional woodworkers. Although $60 for 12 issues might seem a little pricey, the editor says that readers will save many times that amount with the marketing, production and other trade information contained in the newsletter. If you're interested in subscribing to or writing for the newsletter, contact the editor at *Woodworker's Business News,* c/o Woodworker's Supply, Inc., 5604 Alameda Place N.E., Albuquerque, N.M. 87113; (505) 828-2574.

—C.R.

Birchbark canoe building courses

Courses on building a wood-and-canvas canoe or a cedar-strip canoe are offered throughout the year in a variety of locations. However, finding classes on building a birchbark canoe is a much greater challenge. David Gidmark and his wife Ernestine, the great-granddaughter of a native Ojibway birchbark canoe builder, provide classes on this traditional craft each July on the shores of Lake Superior at Port Wing, Wis. Participants in the 16-day class work together to build a full-sized (13-ft.-long) Algonquin-style canoe called a *wabanaki tciman.* The $750 course fee includes lodging. For more information, contact David Gidmark, P.O. Box 26, Dept. FW, Maniwaki, Quebec, Canada J9E 3B3.

—C.R.

1993: Year of American craft

According to a resolution that was passed by the U.S. Senate (and one pending in the House of Representatives at the time of this writing) 1993 is the Year of American Craft (YOAC). The purpose of YOAC is to bring attention to craft throughout America, recognize the breadth of the contributions made by the craft community and demonstrate that craft, as an expression of values, is a link that joins humankind. This Pan-American celebration of craft includes not only every state across the nation but also some Latin American and Caribbean nations and Canada. A variety of exhibitions and workshops are being sponsored by public and private museums and galleries.

A YOAC Participation Guide that lists each state's activities and includes a state coordinator that you can contact for further information is available from the American Craft Council (c/o Hortense Green, 72 Spring St., New York, N.Y. 10012) for $6. If your group has any exhibitions or other activities planned for 1993, contact Hortense Green at the address above or call (212) 274-0630 to be added to the list.

—C.R.

Rolling out some new designs

When Carlton Cook asked for 35 new bowling balls, few customers at the bowling proshop seemed surprised. They probably assumed he was an alley manager. But when they realized he had ordered each ball with just one finger hole, drilled straight through the middle .... "The room froze," Cook recalls. "It was like an E.F. Hutton commercial. One hole? Straight through the middle?"

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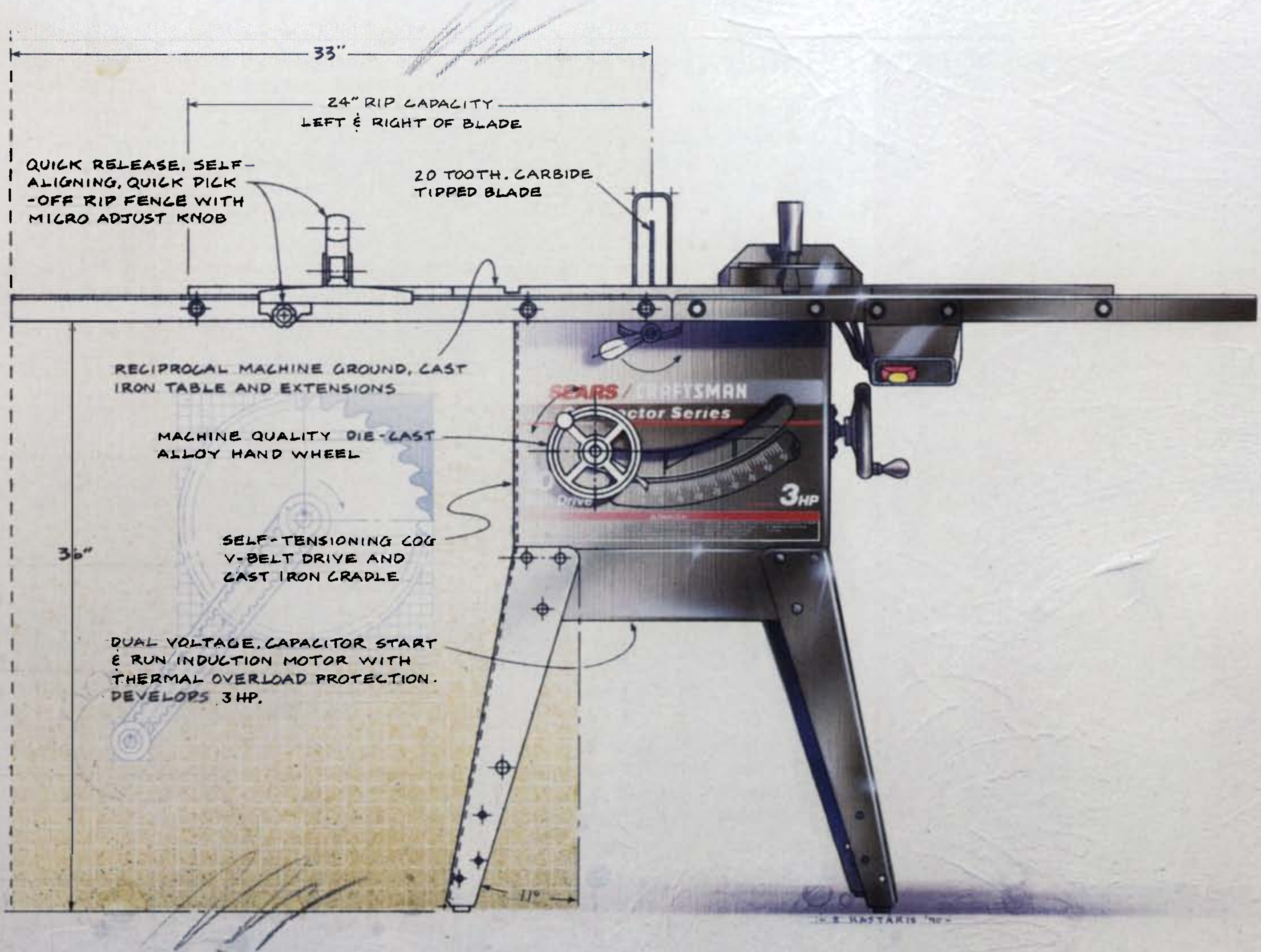

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Carlton Cook is a Houston furnituremaker who uses ordinary materials in extraordinary ways. Of bowling balls, Cook explains, "I love round shapes. But why go to the trouble of turning spheres when millions of perfect balls, such as bowling balls or marbles, are cheap and readily available?"

For the cabinet below, Cook resawed and book-matched sugar-pine boards, and incorporated the bead-like dried glue squeeze-out as part of the design. The rippled, irregular surface left by the bandsaw further enhances the textural effect of the piece. As for the bowling balls, a metal rod through the center secures each one yet leaves the impression of delicate balance.

—Shelley Schlender, Boulder, Colo.

Photo: Carole D. Cardon

***Rather than recreating spheres,** which are difficult to hand-craft, Carlton Cook, a Houston woodworker, takes advantage of readily available shapes, such as bowling balls, billiard balls and marbles, to add variety and interest to his furniture.*

Photo: Jimmy Reina

***This Stanley No. 7 jointer plane,** twisted and misshappen by the fire that swept through Oakland, Calif., last summer, serves as a reminder of the damage that 2,000° can wreak.*

Hotter than Hades

In the aftermath of the firestorm that swept the Oakland, Calif., hills and destroyed my house last October, I picked through rubble for shards of the past. I found melted wedding-gift stemware and Pyrex baking dishes, ceramic dishes and coffee cups that crumbled when touched, but no recognizable non-metallic building materials could be seen.

The devastation was overwhelming, but I felt the worst pain when I sifted through the remains of my shop. The table on my Shopsmith 510 had melted in half; a stack of carbide sawblades were fused together; a 14-in. bandsaw lay on its side, twisted and rusting; and the distorted, melted upper half of a power miter box was still supported by its cast-iron lower half.

A metallurgist told me that my Sorby lathe tool set couldn't be re-tempered, and my well-honed Japanese chisels were lost too. But I'm holding on to my Stanley No. 7 jointer plane shown in the photo above as a reminder of what 2,000° can do.

—Jimmy Reina, Oakland, Calif.

Rosewood adios

For more than 400 years, Brazilian rosewood has been the premier wood of the South American forests. Effective June 11, 1992, however, it became the first tropical hardwood banned from legal import and export under the Convention on International Trade in Endangered Species of Flora and Fauna (CITES).

Last March, CITES, at the request of Brazil, voted to include *Dalbergia nigra* (Brazilian rosewood) in the Appendix I classification, which includes species imminently in danger of extinction. This is the same classification as ivory and tortoiseshell. The 115 member countries have agreed that import of rosewood for primarily commercial use is prohibited.

In the 1500s, just prior to the establishment of Spanish settlements, Brazil had one of the most diverse rainforests on earth. It covered approximately 400,000 sq. mi. from the state of Rio Grande do Norte at the eastern-most tip of South America, south along the coast of Rio Grande do Sul (the southern-most state of Brazil) and inland from one to 100 miles. Within this rainforest, the rosewood tree grew up to 125 ft. tall with a short, often buttressed, trunk of 3 ft. to 4 ft. dia. Oddly enough, old trees with hollow and defective stems produced the most attractive wood. The European history of Dalbergia nigra (*Jacaranda* or *Caviuna*, as the natives called it) began when Spanish ships brought the wood back from their Brazilian settlements. It was an immediate favorite in the court of Louis XIV, where it was known as *Palisandre,* and became very popular during the Empire period. In England during Victoria's reign, it was called Palisander. Because of its agreeable scent, Americans call it rosewood.

Today, the Atlantic Coast is the most densely populated area in Brazil with approximately 150 million people. The forests have been reduced to between one percent and five percent of their original range, and precious little of these are in protected reserves.

There are no rosewood plantations because it grows too slowly to be profitable. It is too late for sustainable harvest of rosewood. Some countries are lobbying CITES to place other threatened woods, such as Honduras mahogany, *Swietenia macrophylla,* under the sustainable regulation of Appendix II. (Appendix II includes species that are not presently threatened but that may become so unless trade is regulated.)

I believe that furnituremakers and other woodworkers should support efforts in responsible forestry in order to sustain a supply of hardwood forever and to ensure that no further species are reduced to the fate of Brazilian rosewood.

—Alton Bowman, Flower Mound, Texas

INDEX TO ADVERTISERS

Photo: Charley Robinson

Supremely versatile and built to last, *the Tucker vise follows in the tradition of the Emmert and other great patternmaker's vises. It rotates 360° and tilts up to 90°, and its 12-in. jaw capacity allows it to grip (or clamp) almost anything.*

Product reviews

The Tucker Vise, *Veritas Tool Inc., P.O. Box 1720, Ogdensburg, N.Y. 13669-1720; (800) 667-2986 or Lee Valley Tools, Ltd., 1080 Morrison Dr., Ottawa, Ont., Canada K2H 8K7.* About 10 years ago, I went to an auction hoping to buy an old Emmert patternmaker's vise. I was shocked when the first vise sold for $735 but hoped that by the time the auctioneer got to the fifth (and last) Emmert, interest would have waned, allowing me to pick one up for a bit less. I watched in horror as each successive vise sold for more than the previous one, the last going for $1,045. I eventually got an Emmert #1 from an antique dealer, and though I've paid less for used autos, I wouldn't be without it. Of the six vises in my shop, it's always the first I go to.

My Emmert not only works well as a normal woodworking vise, but also rotates 360°, tilts up to 90° from its normal horizontal position and locks in place anywhere in its range. Its front jaw pivots to hold tapered pieces, and rotating the vise 180° reveals smaller extended jaws, useful for metalworking or carving. With its 18-in. jaws (capable of opening to 13 in.), it can hold just about any piece of wood, regardless of shape, at any angle.

Recently, I had the opportunity to work with Veritas Tool's new (introduced in 1991) Tucker Vise for a few months. Designed and manufactured by Veritas, the Tucker is the heir apparent to the Emmert, encompassing all the best aspects of the Emmert, addressing its weaknesses and adding some innovative and useful features that the folks at Emmert never considered. The Tucker is not a souped up knockoff of the Emmert but rather a completely reconceived solution to some of the same problems the Emmert addressed. It can do everything my Emmert can do and then some.

The Tucker's castings are of ZA-12, a zinc-aluminum alloy that is stronger than cast iron, not nearly as brittle and only 80 percent as heavy; the castings are guaranteed against breakage for life. At 13 in. wide by 4 in. deep, the Tucker is about the same size as the Emmert #2 and has the same jaw capacity (12 in.–13 in. with the integral dogs). The jaws are fitted with a cork and rubber composition liner that helps prevent dings and dents.

One of the most innovative features of the Tucker is its quick-release mechanism. None of the Emmerts or other patternmaker's vises (as far as I know) have this feature. You can open the jaws up to 7 in. by either pressing on a top-release bar or stepping on a foot pedal. This leaves both hands free to wrestle a particularly unwieldy workpiece or precisely position parts for clamping.

Another outstanding feature of the Tucker is its mounting system. You can remove the main body of the vise from the mounting plate, which is permanently attached to the bench. The vise can then be used with another mounting plate on another bench or separately as a clamp for laminations—a function for which patternmaker's vises are particularly well-suited. Even if other factors were equal, Tucker's mounting system alone would give it an edge over the Emmert.

Although I've been very happy with my Emmert, the Tucker is a quantum leap forward with every detail well thought out and an overall superb design. Perhaps best of all is the price. While $495 may be a lot of money (particularly when compared with the cost of a Taiwanese knockoff of a Record), what you're getting is an heirloom-quality tool. If you're a serious hand-tool user or if you do restoration and repair, the Tucker is a dream come true. It's a wonderful feeling using a tool that you know to be the very best made. It inspires you to work to its standards.

—Mark Duginske, Wausau, Wis.

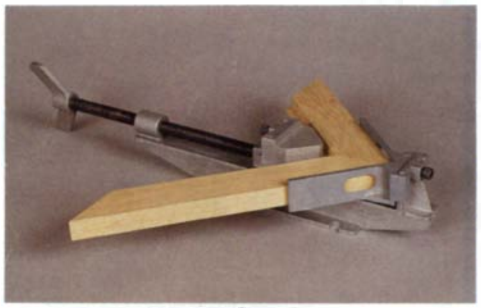
Other virtuous vises

It may come as a surprise, but you *can* still get a new Emmert vise. Robert Kinslow bought the remaining stock, the dies and the right to the Emmert name in 1985. Although he hasn't yet started casting new parts, he's selling off the remaining stock, and he plans to get the whole operation going again. All that's currently available are #1s, which sell for $575 each. For a brochure and a price list write to: Emmert Vise Co., P.O. Box 3553, Hagerstown, Md. 21742; (301) 733-0730.

A similar vise is available from the Kindt-Collins Co., 12651 Elmwood Ave., Cleveland, Ohio 44111; (800) 321-3170. The vise retails for $1,450. *—Vincent Laurence*

Cabinet Clamp, Framing Clamp, *Leichtung Workshops, 4944 Commerce Parkway, Cleveland, Ohio 44128; (800) 321-6840.* Engineered and sold by Leichtung, both the Cabinet Clamp and the Framing Clamp are useful shop clamps that feature die-cast aluminum bodies and steel screws with large, easy-to-grip winged handles. The Framing Clamp ($19.99) is designed to clamp two

Photos: Vincent Laurence



The wide wing-nut handles *on both the Framing Clamp (top) and the Cabinet Clamp (bottom) make them easy to use. The cam on the Cabinet Clamp is released by simply tapping on the workpiece held by the clamp (after opening the screw).*

pieces with 45° mitered ends at exactly 90°. Large oval slots in both of the clamp's outside jaws provide access so that the corners of the miter joint can be drilled and/or nailed together. The Framing Clamp is capable of handling stock up to 4⅝ in. wide, but with the angled jaws removed, the clamp will handle straight stock up to 8⅜ in. wide.

The Cabinet Clamp ($14.99) features a novel cam-action stop. The stop is useful for holding two frame members, such as a stile and a rail, at a right angle to one another for gluing up or drilling pocket holes and driving screws to join them together. This clamp is also great for aligning and securing parts for a square frame, say, a box or a bookcase. In this application, you can use it both at corners and where a bulkhead or divider meets a side.

Thanks to a covering of coarse sandpaper, the Cabinet Clamp's cam grips workpieces from ⅛ in. to 2⅛ in. wide securely, and the flat jaws hold stock up to 3½ in. wide. It's easy to remove the clamp when you're done: Simply tap the workpiece to release the cam.

—Sandor Nagyszalanczy

Notes and Comment

Got an idea you'd like to get off your chest? Know about any woodworking shows, events or craftsmen of note? Just finished a great project? If so, we'd like to hear about them. How about writing to us? And, if possible, send photos (preferably with negatives) to Notes and Comment, Fine Woodworking, *PO Box 5506, Newtown, Conn. 06470-5506.*

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CARVED HARPSICHORDS

Retired crafts teacher Everett Traylor wasn't satisfied with the two harpsichords he built from kits. For his next project, he obtained drawings of a spinet harpsichord built in 1620 by the Flemish master Andreas Ruckers. After Traylor modified the case and lengthened the keys to be closer to modern length, he constructed the Honduras mahogany instrument shown in the photo at left. The harpsichord features faux-malachite inlays in the carved flowers on the lid and appliqué carving on the non-resonant areas of the soundboard (see the bottom photo at left). For his ottavino, a one-third sized bent side harpsichord shown in the photo below, Traylor started with drawings from an Italian instrument from about 1650, added a lid and music rack and carved the stained-poplar case with a Victorian-style acanthus leaf pattern.

Photos: Ponterelli Studio