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Fine WoodWorking

CELEBRATING 25 YEARS

April 2000
No. 141

Foolproof gluing and clamping

Dust collection for small shops

How to choose the best finish for your project

From garage to versatile shop

Basswood, a carver's dream

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Trestle table with breadboard ends

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Fine WoodWorking®

Departments

On the Cover:
Charles Durfee has built quite a few trestle tables over the years, allowing him to have developed a basic design that is easily adapted. For this issue, he builds a traditional trestle table with breadboard ends. See p. 74
Photo: Michael Pekovich

Gluing and clamping strategies, p. 44

Picking the best finish for a project, p. 58

From garage to great shop space, p. 51

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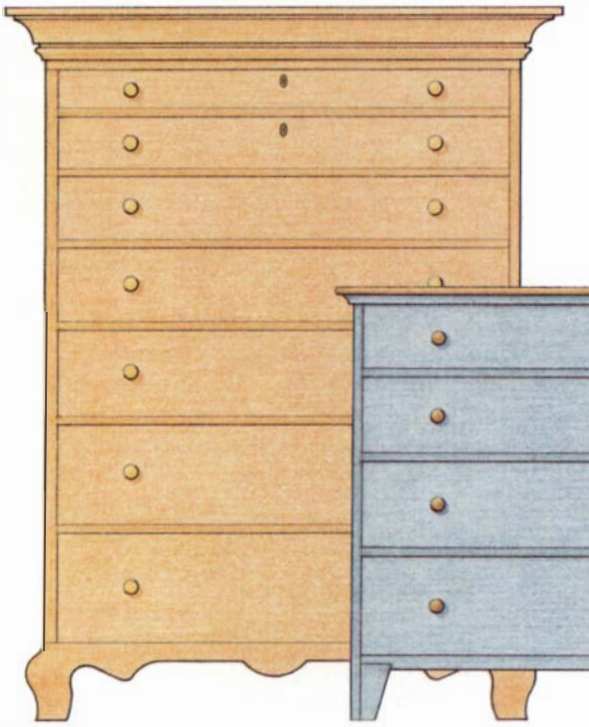
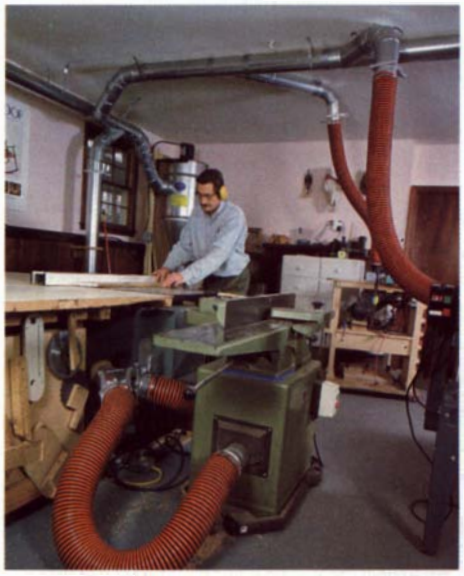
Articles



Graduated drawers, p. 56



Dust collection for small shops, p. 82

Contributors

Craig Vandall Stevens ("Building Without Plans") studied fine arts in college and, after graduation, made log houses for a living. This led, inevitably, to a stint at James Krenov's College of the Redwoods program in woodworking and a career making fine furniture. From his basement shop outside Columbus, Ohio, Stevens makes custom furniture embellished with marquetry and chip-carving designs inspired by nature. He sings tenor in the Columbus Symphony Orchestra Chorus.

Frequent *Fine Woodworking* contributor **Lon Schleining** ("Gluing and Clamping Strategies") has taught woodworking at Cerritos College since 1995. He also teaches woodworking seminars with The Woodworking Shows, is just finishing his first book, about chests, for The Taunton Press and is researching and writing a book for Linden Publishers about bending and curving wood. He has had his own shop in Long Beach, Calif., for 25 years.

Chris Becksvoort ("Graduated Drawers"), a contributing editor to *Fine Woodworking,* has been a woodworker for more than 30 years. He runs a one-man shop and design studio in New Gloucester, Maine, and is the author of *The Shaker Legacy* (The Taunton Press, 1999).

Chris Gochnour ("Turning a Parking Place into a Great Shop Space") builds a wide range of custom furniture in his expanded garage shop and particularly likes making French country pieces. A devoted user of handplanes of all types, he enjoys reconditioning old ones and has made quite a few from scratch. He lives in Salt Lake City, Utah, and when he's not watching his two children while his wife, Natalie, is playing soccer, he's often skiing or hiking the challenging slopes of the nearby Wasatch Range.

Jon Arno ("Basswood, Linden or Lime") wrote his first article for *Fine Woodworking* back in 1979; the subject was milk paint. Since then he has developed his own niche with articles that explore the many facets of different species of wood. He has, in fact, written more articles for this magazine than any other individual. Arno runs a lumberyard near Detroit, Mich., and works as a consultant on furniture styles and wood identification for antique dealers and museums.

Jeff Jewitt ("Think Finish First") is a finishing dynamo. He maintains two businesses from his shop in Cleveland, Ohio, restoring furniture and selling finishing supplies. He writes frequently for this magazine, and his latest Taunton Press book, *Great Wood Finishes,* was just published. He spends much of his free time racing his bicycle.

Charles Durfee ("Trestle Table with Breadboard Ends") grew up in western Massachusetts. He graduated from Oberlin College in Ohio in 1968 and then did a tour in Vietnam, which he recalls as a "sad, unfortunate time." He finally settled in Woolwich, Maine, after attending boatbuilding school in Bath. His shingled, wood-heated shop, just downhill from the house he shares with his wife and two children, is situated on five acres of granite and forest. From the windows beyond his bench he can look across a wide field that he hopes will never be developed.

Ever since he took a woodshop class in high school, **John F. Matousek** ("Shop-Built Horizontal Mortiser") has been building furniture. He spent his professional career in the aerospace industry. "We worked on the military's information system development," he said. "Today they call it computers." He lives with his wife in Englewood, Colo.

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Letters

25th anniversary: A new department and a special issue

With this issue, *Fine Woodworking* begins its 25th-anniversary celebration. We plan to start this celebration rather quietly and build to a special 25th-anniversary edition of the magazine at the end of the year, exactly 25 years after issue No. 1, Winter 1975. In addition to the special anniversary logo you see here and on the cover, we begin our celebration with a new department in this issue—a gallery of inspirational woodworking from our readers (pp. 88-91). For the name of this gallery, we reached into our archives and resurrected the name of an old, popular feature: Current Work. But if the name is from the past, the purpose is quite new. Since we stopped publishing *Home Furniture* magazine, woodworkers have told us they would like *Fine Woodworking* to find a way to publish more examples of the well-crafted furniture being made by woodworkers throughout the world. We'll be on the lookout for good examples, so if you'd like your work to be featured in Current Work, see the instructions on p. 88. Let us know if you have any ideas about how we might celebrate our special 25th anniversary.

—Timothy D. Schreiner, editor

Routed reeds without a router-cut look—Regarding John Van Buren's article "A Jig for Cutting Curved and Tapered Reeds" (*FWW* #138, pp. 56-57): Over the years I have reeded a number of turnings in a similar fashion. However, I take the reeding one step further. After I rout the reeds and while the leg is still in the lathe, I carve each end of the reeds out to the shoulders. This eliminates the rounded ends of the reeds and the "router look," and gives the furniture the look of a more traditional reed.

—Milton Parker, Durham, N.C.

Wants plans and a cut list—First, I look forward to each issue of *Fine Woodworking*, but I have a small gripe. I have been wanting to buy or build a woodworking bench for my shop, and your "New-Fangled Workbench" (*FWW* #139, pp. 98-101) is just about perfect for my purposes. A more detailed drawing and cut list would have been greatly appreciated. The workbench can be built with the limited information contained in the text, but a drawing and cut list would allow me to better visualize modifications. Thanks, and keep on publishing the magazine as is: "If it's not broke, don't fix it."

—Jeff Cisler, Marietta, Ohio

Chisel review sparks reactions—Rex Alexander has produced an informative article on the impact resistance of commercially available chisels (*FWW* #139, pp. 52-57). A few of his technical points need clarification, however. The two processes, machine- or hand-forging, are intended to be identical solutions to the need to provide near net-shape forming as well as alloy homogenization and particle size reduction.

After forging, these tools are reheated for austenitizing (generating the prequench phase), which incidentally, also anneals them. Subsequently, they are all quenched, either in air or fluid, depending on the steel composition, to produce the hard but disastrously brittle phase called martensite. Final heat treating to a couple of hundred degrees Fahrenheit literally tempers the brittleness, sacrificing a little hardness while gaining ductility or its consequence, toughness: The elastic response of the steel is insensitive to common tempering regimens. He is quite correct in cautioning the reader that indentation hardness alone will not determine chisel durability: Neither will impact testing, except for impact durability.

Most of the tool steels used in these instruments contain carbide formers (tungsten, vanadium, etc.), and these particulate phases may or may not contribute to impact durability of an edge. The resulting carbides will, however, most definitely contribute to edge stability in the paring or shaving mode of use; thus, a chisel with a Rockwell hardness of 62 may outperform competitors in one application but appear inferior in other use contexts.

—Richard A. Queeney, professor of engineering mechanics, Penn State University

We here at Pfeil in Switzerland read with interest Rex Alexander's informative

Writing an article

Fine Woodworking is a reader-written magazine. We welcome proposals, manuscripts, photographs and ideas from our readers, amateur or professional. We'll acknowledge all submissions and return those we can't publish. Send your contributions to *Fine Woodworking*, P.O. Box 5506, Newtown, CT 06470-5506.

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"Bench-Chisel Review," especially because our new bench chisels were included. Two additional aspects not addressed in Mr. Alexander's well-done test report are important to mention.

Many woodworkers are environmentally conscious. As consumers they choose to avoid woods such as cocobolo and rosewood taken from threatened tropical forests and transported over long distances. The wood used for handles on our Swiss-made tools is one aspect of our environmental responsibility program. The hornbeam comes from our local, sustainable, environmentally managed forests, and transport is minimal. Handles are finished with oil instead of solvent-based lacquer. The large round handle of our 12mm chisel allows the tool to roll, as Mr. Alexander astutely noted. We will correct this by providing a flat area on these handles in our future production.

Most woodworkers highly value a ready-to-use factory edge on the tools they buy, which is why we hone and strop all cutting edges to razorlike sharpness. Your scientific testing gives no information on this subject. In fact, all 17 test chisels were reground prior to testing. Readers desiring information on factory edges should see the test report on 25 bench chisels in the August 1999 issue of *Wood* magazine. This test examines additional important practical and technical aspects. Paired with your fine report, the two articles give woodworkers a complete overview of the market. Interestingly, their Rockwell measurements differ up and down from yours by as much as 3C, and their approach, observations and conclusions are substantially different—specifically regarding tool balance, handle comfort, blade toughness and, of course, the factory edge.

—Felix Zulauf, CEO, Pfeil, Langenthal, Switzerland

Being a part-time blacksmith as well as a part-time woodworker make me feel very

Attention, professional furniture makers

The Taunton Press is planning to publish a directory of 150 independent furniture makers whose work shows good design and solid craftsmanship. To participate you must have been a professional furniture maker for at least two years, and you must supply four to eight publishable photos. Submissions will be judged by a panel of professional woodworkers. There is no charge to enter or to be included in the directory, if accepted. Contact us for an entry package at: Independent Furniture Makers, Books Department, The Taunton Press, 63 South Main St., Newtown, CT 06470, or send e-mail to furnmake@taunton.com. You may also call (800) 926-8776, ext. 610. The deadline for submissions is June 15, 2000.

disappointed in your pseudo-scientific article on bench chisels. I think a better test for toughness would be one that would simulate the paring action on the cutting edge of the chisel.

However, what really turns me off and reduces the credibility of the article is the misleading explanation of the heat-treating process. The very important step of hardening, which should take place between annealing and tempering, has been omitted. I have enjoyed *Fine Woodworking* for many, many years. Keep up the good work.

–Paul Carlson, Hickory Corners, Mich.

Of the various magazine reviews concerning the performance of bench chisels, your article was the best I've read. However, I have a differing opinion about two matters:

I don't agree with using a diamond lap for the harder steels (i.e., Japanese chisels) because I believe that the laps have a tendency to work-harden the surface and actually make the edge of the chisel more brittle, therefore susceptible to "teeth."

I also disagree with honing only through a 1,200-grit diamond lap and not refining the edge further. The edge is still going to have a lot of teeth and again is more susceptible to chipping.

Having said that, I believe the test still indicated the toughest chisels. Of course the test omitted the "human feel" that is extremely subjective. I know from experience that some of the harder chisel steels don't bite the wood as effectively once they get the least bit dull; as opposed to slightly softer steel.

I'm sure I am not alone when I say that I am always going to be searching for the ultimate chisel.

–Brian T. Derber, Oconomowoc, Wis.

The straight scoop on plunge-cutting—Regarding Pat Warner's article, "Spiral Router Bits vs. Straight Router Bits" (*FWW* #140, pp. 62-65): He states that "you can't really plunge any deeper than about ⅛ in. with a typical straight bit." The bit pictured is actually one of our (CMT) mortising bits (#801.627.11). For your readers' information, all CMT straight bits have a "Z" grind on the tip of the bit that includes a sharpened edge on the web, to facilitate plunge-cutting.

–Dan Sherman, CMT USA, Greensboro, N.C.

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

–Timothy D. Schreiner, editor

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Methods of Work

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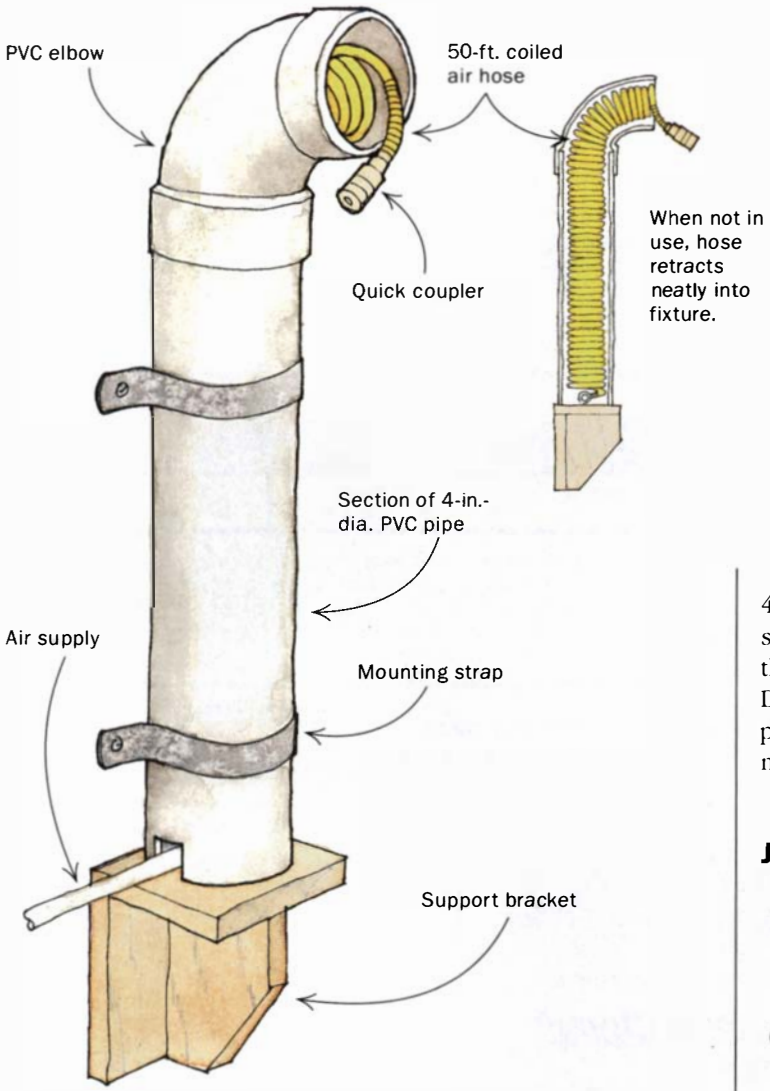
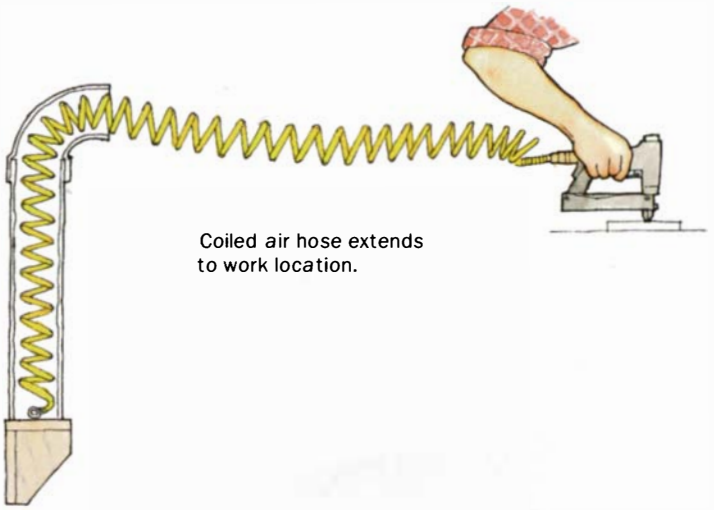




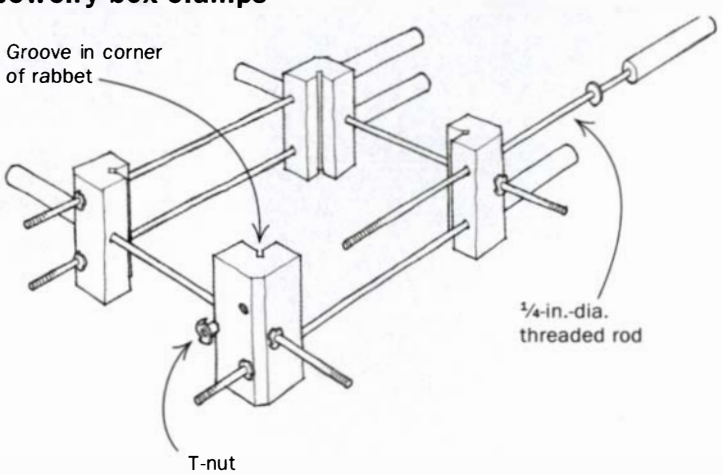
Retractable air-hose fixture

You need a readily available air supply in your shop if you use air-powered tools. An air hose that snakes across the floor or over benches and machines is an awkward nuisance and can be a real safety hazard. Shown above is an inexpensive PVC-pipe fixture that puts your air supply right where you need it. A 50-ft. coiled hose has a reach of about 25 ft., and the hose retracts into storage when you're finished with it. The fixture can be attached to a wall, a post or under a bench.

To make the fixture, buy a coiled air hose, a section of straight 4-in.-dia. PVC pipe and a matching elbow. Glue up a length of the straight pipe to the elbow so that the total length of the pipe plus the elbow is a couple of inches shorter than the coiled air hose. Drill a hole or notch the pipe at the bottom to receive the air supply. Support the pipe with a bracket at the bottom and a couple of mounting straps wrapped around the straight section.

—Ed Grant, Ulster, Pa.

Jewelry-box clamps



The inexpensive but effective homemade clamps shown above are designed for gluing up small jewelry boxes, 8 in. to 10 in. on a side. Start by cutting four 4-in. blocks from 1¾-in. square stock. Cut

A reward for the best tip

Ed Grant won an engraved Lie-Nielsen handplane for the winning tip shown above. His idea is a practical and inexpensive solution that brings order to the chaos that air hoses can sometimes cause in a woodshop. Grant is retired and lives on a small farm in northeastern Pennsylvania, where he accomplishes most of his woodworking in the winter months. He learned woodworking from his father and passed on the passion to both of his sons. Send us your best tip, along with any photos or sketches (we'll redraw them), to Methods of Work, Fine Woodworking, *P.O. Box 5506, Newtown, CT 06470-5506.*

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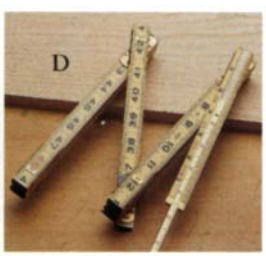

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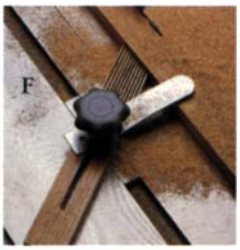
E / A Self Centering Punch

It's tricky to center pilot holes when mounting hardware. This clever and inexpensive tool does the job easily. A cone shaped nose insures that the prick-pointed plunger will hit exact center.

35K08.01 Self Center Punch $ 9.95



SALE **F / Universal Table Saw Feather Board**

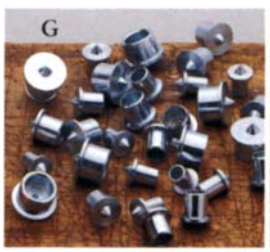
Exceptionally effective in controlling a rip cut. Keeps the stock tight against the fence and saw table throughout the cut. Top-mounted hold-down arm ensures smooth feed. Unique expanding table slot bar makes positioning quick and easy in the ¾" wide slot standard on most saws. On large saws use 2 feather boards.

		Regular	*Sale*
88K01.01	Feather Board (single)	$17.95	$13.95
88K01.10	Feather Board (Pair)	$35.90	$24.95

G / Deluxe Dowel Centers

A Full Set of 32 centers, 8 of each size. Outside diameters are: ¼, 5⁄16, ⅜ & ½", inside measures 3⁄16, ¼, 5⁄16, & ⅜".

35K09.01 Set of 32 Dowel Centers $9.95



SALE **H / The Historic Stanley "#1 Odd-Job"**

Originally made by Stanley from 1888 to the early 1930's, as useful to us today as it was then.

Made in the USA of solid manganese bronze casting, carefully machined to .0015" tolerances on all sides. The screws are stainless steel.

It's an inside mitre and try square, a depth gauge, a scribing tool for arcs and circles, a T-square, a depth marking scribe, a plumb level, and a 6" brass bound rule (also marked in mm). Rules are laser engraved.

23N02.01 #1 Odd Job $59.95

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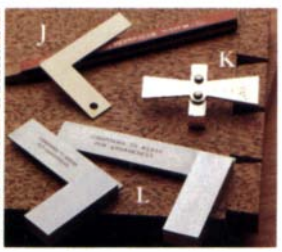
83K04.01 Gross (144) Utility Brushes $18.50

J / Small Brass Quick Check Square Slips Right Into Your Pocket

This precise, solid brass square has legs 1¾" and 2⅜" long. Weighs less than ½ oz. Perfect to keep with you all the time to check your work as it progresses. Made in England.

70N02.01 Quick Check Square $9.95



K / Solid Brass Dovetail Marker

Overall length 2½", it can mark dovetails up to 1" long. 2 ratios: 1:5 for softwood and 1:8 for hardwood. Made in England.

71J08.01 Brass Dovetail Marker $28.50

L / Engineer's Squares

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39N04.05	2"Engineer Square	$ 8.25
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SALE **M / "Wonderbar" Makes Your Old Tools Look Like New**

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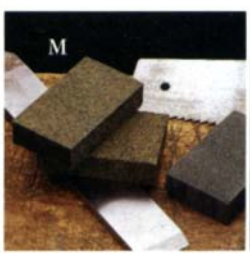
		Regular	*Sale*
06K03.02	Set All 3 Blocks	$17.25	$14.95



N / Key Knife For Your Key Ring

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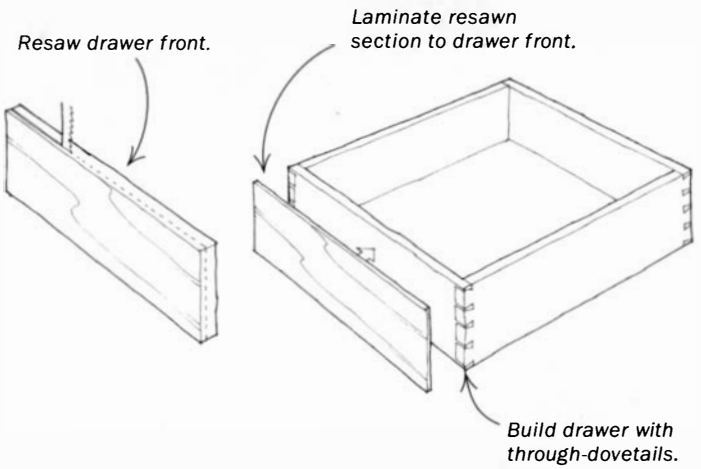
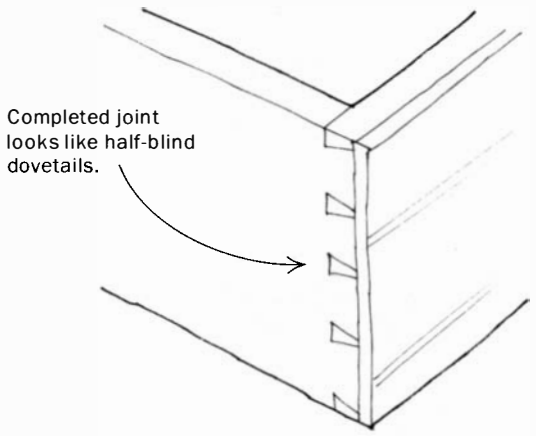
a rabbet in one corner of each block to fit over the corners of the box, and cut a groove into the corner of the rabbet so that it doesn't interfere with the edge of the miter joint.

Cut six lengths of ¼-in.-dia. threaded rod and, using epoxy, glue 1-in. dowel handles on one end of each rod. Drill three holes in each block with a 9/32-in. bit, install T-nuts and assemble the clamps as shown in the sketch. *—Jose L. Martinez, Niceville, Fla.*

Quick tip: An old computer mouse pad on the workbench will dampen the vibration from a sander and keep it from skittering across the bench when you set it down. You can also cut small pieces from a pad to use as protective, nonskid feet for finished projects. *—Jim Van Dreese, Wisconsin Rapids, Wis.*

A faster way to make half-blind dovetails





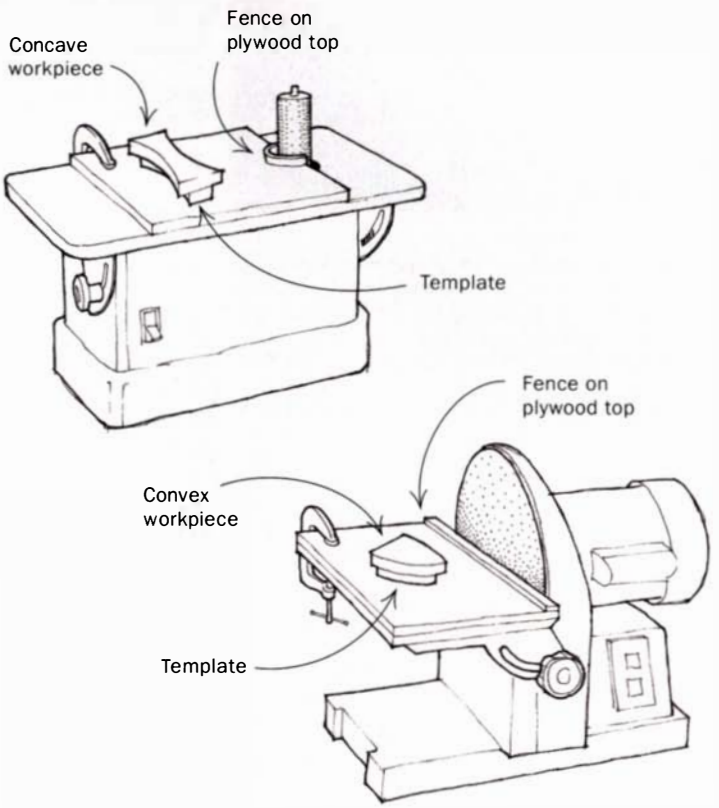
I was fortunate to learn how to cut dovetails from one of the best in the craft. In 1987, I spent two weeks as Alan Peter's assistant at the Anderson Ranch Arts Center. After all of that training, I can cut a set of through-dovetails as fast as I can set up a router jig.

But cutting half-blind dovetails is another story. Although there are some tricks to speed up the process using a router, removing the bulk of the waste from between the pins is mostly a slow and tedious process using a chisel. My solution is to start with a thick drawer front and rip a fat, ⅛-in.-thick slab off the front (see the drawing below left). I do this while the drawer front is still oversize in width and length. Then I plane both pieces and set aside the ⅛-in. piece. After that, I cut regular through-dovetails—front and back—and assemble the through-dovetailed drawer. Once the drawer is together, I simply laminate the ⅛-in.-thick piece back onto the drawer front. After trimming the front piece flush on all four sides, I have (from all appearances) a set of perfect half-blind dovetails.

Another advantage of this approach is that I can rip a set of drawer fronts in sequential order from one thick board, resulting in a nicely matched flitch pattern on the fronts of all of the drawers.

—Rob Cosman, Grand Bay, N.B., Canada

Making duplicates on a disc or spindle sander



Here is a simple way to duplicate curved pieces using a template and a disc or spindle sander. This technique is useful when tearout is a problem or when extra-thick workpieces make template-routing impractical.

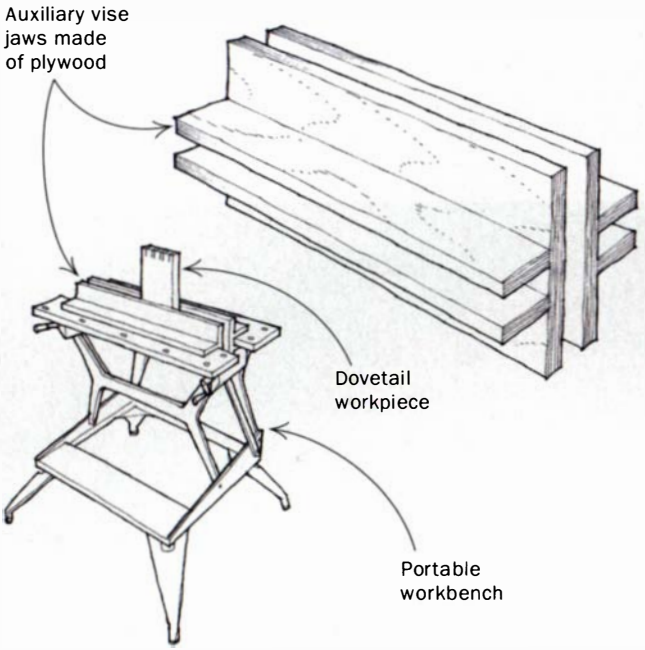
The key to this technique is clamping a scrap of plywood over the metal tabletop of your sanding machine and then securing a fence for the template to the plywood. Make the sanding template any convenient size smaller than the workpiece and adjust the fence forward or back to make the final size of the workpiece larger or smaller. Convex shapes can be sanded entirely on the disc sander. Concave shapes require a similar setup on a spindle sander. *—Gregg Roos, San Francisco, Calif.*

Quick tip—When I wanted to build a router table, I checked out the phenolic and acrylic inserts in the mail-order catalogs and decided they were too expensive. Then I came up with the idea to use a

plastic cutting board, the kind found at any store that sells cooking utensils. The board machined well and cost less than $5.

—Rick Grinstead, Charlotte, N.C.

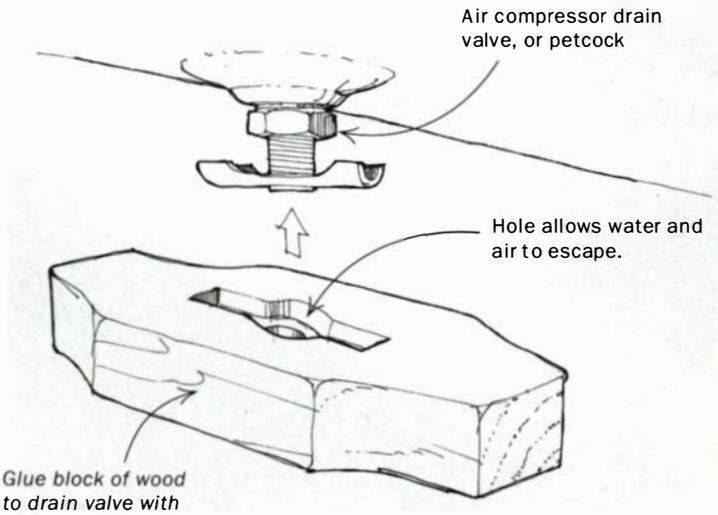
Auxiliary vise jaws for portable workbench



I like to saw dovetails by hand, but it's difficult without the proper vise. Before I equipped my shop with a good bench vise, I made these auxiliary plywood jaws for my portable bench—a setup that enabled me to get by fairly well. The jaws fit snugly over the regular jaws and hold vertical workpieces securely.

—Bob Key, Snellville, Ga.

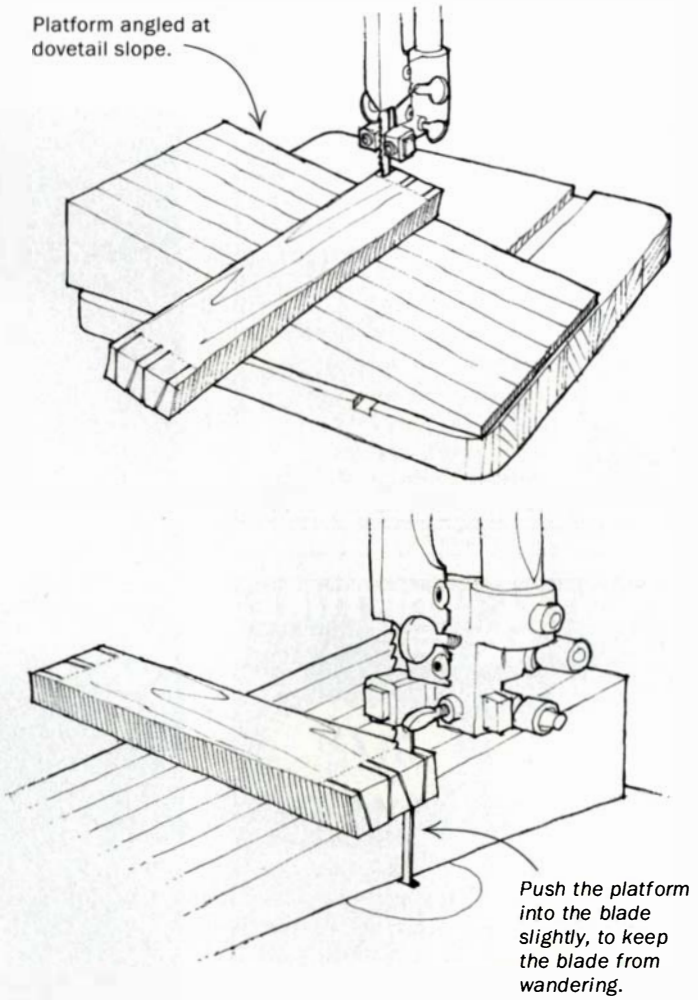
Wrench for air-compressor drain valve



I know it is important to drain water from my compressor often to prevent rust in the tank. But the ditzy little drain valve, or petcock, mounted on the underside of the tank is difficult to use. So I solved the problem by making a new wrench. I routed a channel in a hardwood block to fit the valve and drilled a hole through the block to let air and water escape. I then shaped the outer edges to make the wood wrench easy to hold and glued it onto the valve with epoxy.

—John Weidner, San Francisco, Calif.

Bandsaw dovetail fixture

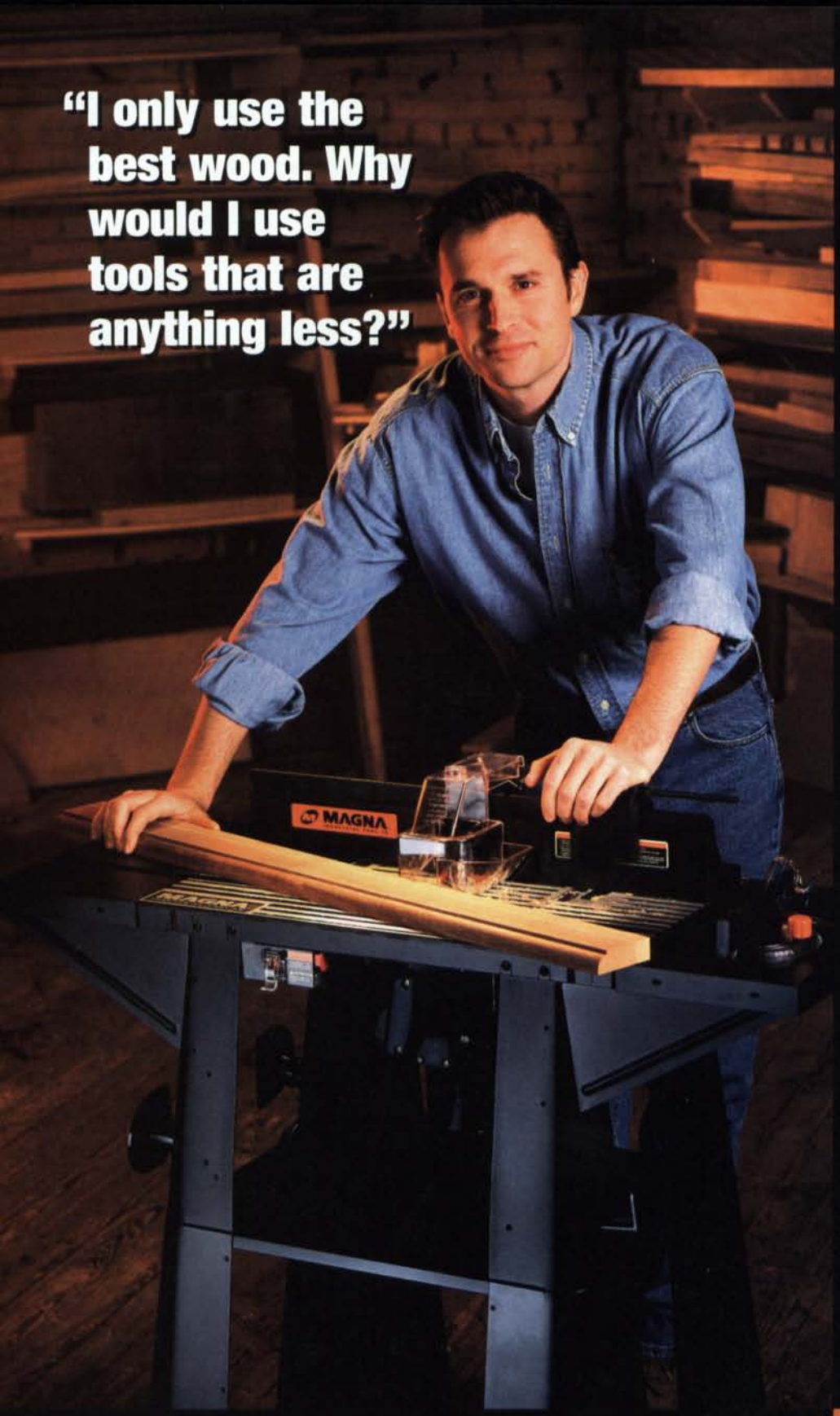


To cut dovetail joints, I start with the pins, cutting everything on my bandsaw. One problem that I ran into was that the table on my bandsaw—like that on most bandsaws—tilts in only one direction, limiting me to cut only one side of the pins. To overcome this problem, I built a small platform of laminated plywood that is angled at the correct dovetail slope.

I simply place the platform in front of the bandsaw blade, pushing it into the blade slightly to keep the blade from wandering. I cut one side of all of the pins, flip the platform around and cut the other sides. I then remove the waste with a chisel, mark the tails from the pins and saw the tails on the regular bandsaw table. This approach results in quick and accurate dovetails.

If you like to use different dovetail angles in different woods, just build two platforms—one for softwood and one for hardwood.

—Bruce Petersen, Canby, Ore.



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Notes & Comment

Cuban mahogany, a scarce treasure to woodworkers, is now available in the United States

A rare and valuable stash of timber. *Shown here is part of the first batch of Cuban mahogany trees felled on the islands of Palau and brought to market in the United States by Blue Moon Exotic Wood.*

From the realm of good news, this is a story in which everybody wins. For the first time in many years, a substantial load of Cuban mahogany (*Swietenia mahagoni*) has hit the market in the United States, available to woodworkers who are able and willing to pay $20 to $35 per board foot to get it.

Cuban mahogany—the stuff of cabinetmaking legends, called by some the "king of woods," by others the "wood of kings"—originally grew on Caribbean islands before it was virtually wiped out as a source of commercial lumber. This new supply comes from half a world away, on the islands of Palau. The Republic of Palau, populated by fewer than 20,000 people, consists of a group of small islands in Micronesia, where the Pacific Ocean meets the Philippine Sea, just north of the equator. Large barrier reefs, a tropical climate and fertile soil have all contributed to the health of the tropical forests that flourish there.

To understand how Cuban mahogany got to Palau, you need to know that the wood was coveted by boatbuilders as much as it was by cabinetmakers. Spanish missionaries planted groves of Cuban mahogany on the islands when they settled there more than 300 years ago. Because of their isolation, these trees were spared the ravages of pyralid moths and ambrosia beetles that devastated many of the first-growth stands not felled by loggers.

Native Palauans own the land and the business—Blue Moon Exotic Wood, LLC. (877-894-9663)—that is harvesting the forests in a sustainable program meant to ensure a continuing supply of about 50,000 bd. ft. of Cuban mahogany each year. They are also harvesting a dozen other tropical woods, including narra and Macassar ebony, and using oxen teams to minimize damage to the forests. For the first shipment of mahogany brought to market, they cut down 26 trees (average age 60 years) and planted several hundred saplings. The oldest trees, some of which were planted by the original Spanish missionaries and exceed 7 ft. dia., will remain untouched for their supply of seed stock.

—William Duckworth, associate editor of Fine Woodworking

Freshly cut Cuban mahogany is pink, *but it begins to darken right away. This prized log was cut and stacked "in the boule," meaning the plainsawn boards were stickered in the order in which they came from the tree.*

Wood webs

Looking for plans on-line?

Click on Sites to See at www.finewoodworking.com, and you'll find 30 linked sites that cover a wide array of topics. But this is just the tip of the iceberg. The web has a plethora of sites that offer woodworking plans. Some examples:

www.teleport.com/%7Ehippo1/images/mission/mission.shtml
Cap't Zoom's Mission Furniture Plans offers free downloadable plans for a dining and Morris chair.

www.charm.net/~jriley/woodware.html
Woodware Designs has very basic free plans on building and modifying different style computer desks.

www1.minn.net/~mozart/index.html
At Lake Superior Design, Terry Walton has available 42 project plans of different skill levels that are generated with a CAD program.

www.furnituredesigns.com
Furniture Designs, Inc., offers woodworkers full-sized plans that come with a bill of materials and an exploded drawing. The site has a wide range of project plans.

craftedimages.virtualave.net/woodworkplans.htm
Crafted Images & Design is the mother lode of woodworking plans on-line. The site currently offers 229 plans for the beginner woodworker, 166 for the intermediate and 133 for the expert.

buildit.shopalberta.com
Interested in 12th-century medieval furniture? At Build It Plans and Ideas, you can take a step back in time and find plans for medieval reproductions such as beds, candle lamps, chairs and tables.

www.wallbed.com
If you've always wanted a Murphy bed, look no further. At Create-A-Bed you can purchase the Murphy-bed mechanism that comes complete with hardware, templates and instructions.

Photos, this page: William Duckworth

Illusions don't just appear—they have to be built

Trading magic for help. *In exchange for help hauling the occasional cabinet job, Ohio woodworker Bill Ewing designs and builds illusions for a local magician.*

For me, the creative challenge of furniture making takes several forms. Sometimes I rework an old design; other times I design and build something original. For the last few years I've taken the same approach building illusions for a local magician.

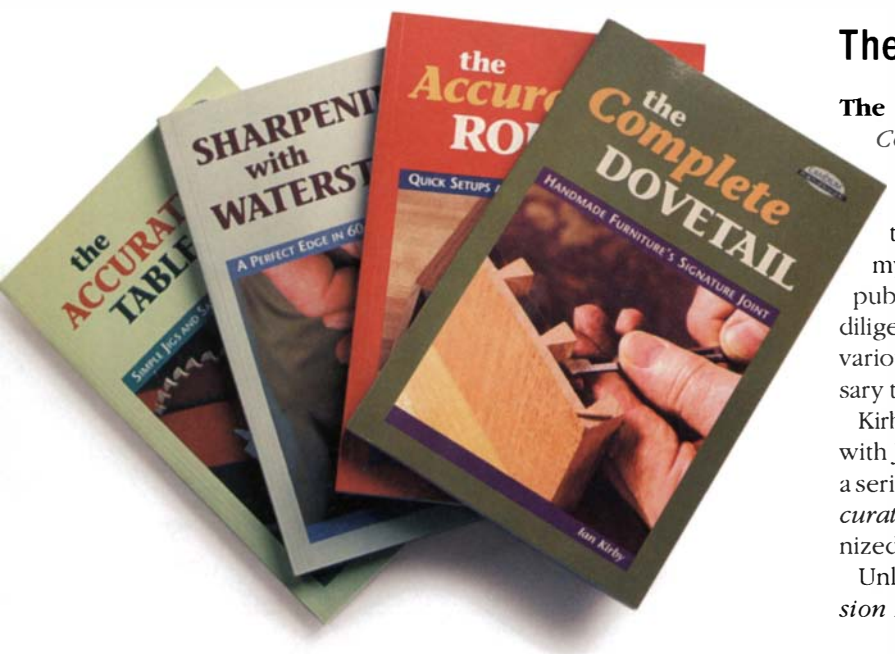
The similarities between furniture making and building illusions are many. Both require attention to detail, close tolerances and smoothly working hardware. The big difference with illusions is that the crucial parts and long labor have to go unseen. In magic, nothing is as it appears. Collapsible structures appear rigid, hollow legs look solid, and seemingly small spaces hide improbably large objects. It's all magic, and it's my job to make it work.

Sometimes the most technical part of an illusion is intentionally hidden from view. Unfortunately, this is usually the part that takes the most work. I have designed complex triggering mechanisms that take hours to perfect, but no one sees them. In other illusions, what is hidden is in plain view of the audience. One uses two mirrors and a tambour door, and the audience sees both without knowing it. In another one, there is a trap door that remains undetectable, even under close inspection.

One original illusion, which we call Diabolical Dissection, incorporates both hidden and not-so-hidden elements. An audience member chosen at random is secured to an upright board by a yolk around her midsection. A blade is inserted into the yolk and shoved through so that it emerges from the other side. Not a drop of blood is shed.

In lieu of cash, my magician friend pays for the illusions by helping me deliver cabinets. Throughout the years, I have received compensation for my work in many forms. Sometimes it's a family member's appreciation; other times it's a customer's approval and a check. But nothing compares to the applause of an audience.

—Bill Ewing, Girard, Ohio



The traditional approach to dovetails

The Complete Dovetail *by Ian Kirby. Cambium Press, Bethel, Conn.; 1999. $14.95 softcover; 152 pp.*

If you're looking for a well-organized manual on hand-cutting dovetails, *The Complete Dovetail* is it. The book is easily my favorite in a series of craft books written by Ian Kirby and published by Cambium Press (P.O. Box 909, Bethel, CT 06481). It diligently covers all of the basic and time-tested information on the various types of dovetails and the preparation of the tools necessary to cut them, as well as on preliminary milling of the stock.

Kirby, a long-time woodworker, teacher and author, has coupled with John Kelsey, an experienced editor and publisher, to put out a series of books—including *Sharpening with Waterstones, The Accurate Router* and *The Accurate Tablesaw*—that are all well organized, easily understood and quite thorough.

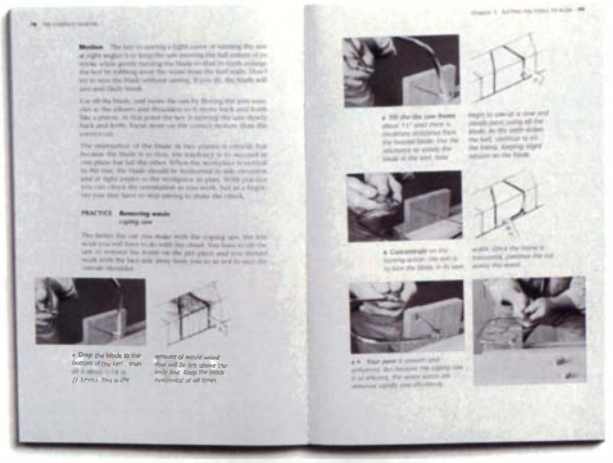
Unlike Cecil Pierce's colorful and entertaining book, *The Precision Handcutting of Dovetails* (Monmouth Press, 1995), which

Photo, this page (top): Bill Ewing

presented some quirky and unusual techniques that involved the use of a hacksaw, Kirby's new book covers the more traditional tools and techniques. Entire chapters are devoted to the execution of through-dovetails, single-lap (half-blind) dovetails, double-lap dovetails and secret (full-blind) dovetails. The generous attention Kirby gives to each variation ensures that the reader won't be left stranded. In addition, there are plenty of tips to help the beginner avoid common pitfalls and recover from mistakes.

I always enjoy books illustrated by the author, because they have the immediate and personal quality of an artist's sketchbook. Kirby's drawings are first rate. Each sketch is full of clear detail but still has a warmth and casual quality often missing from the blueprint-type illustrations commonly found in woodworking books. These handsome sketches remind me of George Nakashima's *The Soul of a Tree*.

The abundant photos in the book are also clear, full of information and well placed to illustrate and support the text. I've seen Kirby in action, and I know him to be a forceful teacher, often convinced that this methods are the best. And his sound convictions stem from many years of experience at the workbench perfecting techniques passed down through generations. I wish Cambium could have injected some of the friendly bluster that is clearly part of Kirby's personality and appeal into the text of the book. And I also wanted to learn about his experience as a traditional English craft apprentice. Without a sprinkling of colorful English tales and anecdotes, the book reads a little flat and sterile.



A personal touch. *The photos in Kirby's book are abundant and informative, and the author's sketches lend the book an immediate friendliness.*

I guess I'll have to wait for Kirby's memoirs. I also wish the book could have been printed in a larger format. Although the books in this series are a compact and handy size, they are a little difficult to lay onto a workbench for reference in the shop.

Overall, the series is clear, methodically laid out and thorough. I recommend Kirby's latest as a very encouraging place for beginners in their quest to cut perfect dovetails.

—Mario Rodriguez, contributing editor to Fine Woodworking

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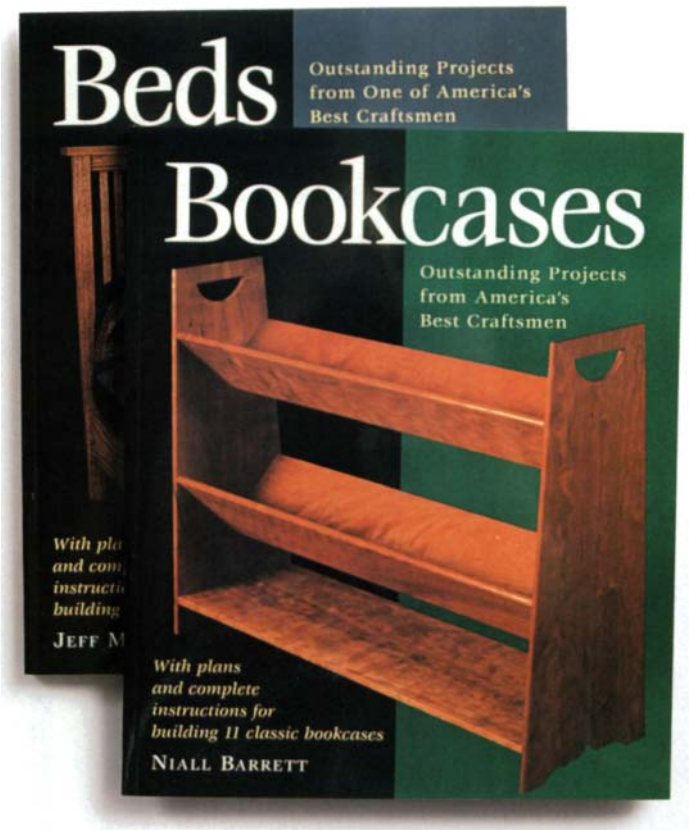

A new book series from The Taunton Press

Bookcases: Outstanding Projects from America's Best Craftsmen *by Niall Barrett. The Taunton Press, Newtown, Conn.; 1999. $24.95 softcover; 186 pp.*

Beds: Outstanding Projects from America's Best Craftsmen *by Jeff Miller. The Taunton Press, Newtown, Conn.; 1999. $24.95 softcover; 186 pp.*

Taunton recently released the first two titles in a series of project books. Jeff Miller's *Beds* and Niall Barrett's *Bookcases* both cover a wide range of projects. For each project they provide step-by-step instructions, cut lists and drawings that even a novice woodworker could follow. Miller's book discusses the basics of bed construction, then walks you through building nine of his own designs—from Windsor to Arts and Crafts and from bunk beds to pencil posts.

While Barrett's book opens similarly—with a basic introduction to bookcase design and construction—the 11 projects offered are designs from various woodworkers, but the construction methods are Barrett's own. In this book he details the building of a Shaker wall shelf to hutch-style and barrister bookcases.

Other books in the series are slated to appear over the next few years and will include desks and tables.

–Matthew Teague, associate editor of Fine Woodworking

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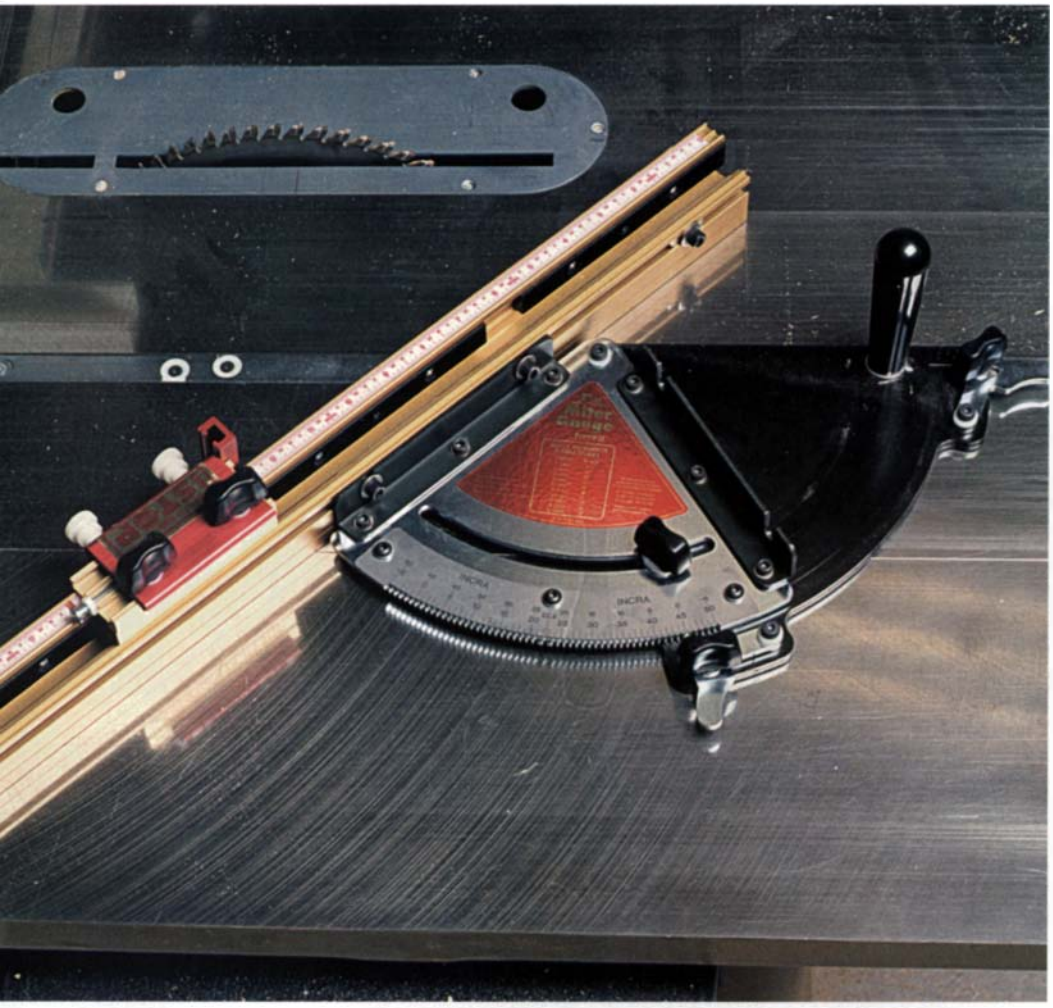
Tools & Materials

An accurate miter gauge from Incra



The Incra miter gauge works with any tablesaw. *The miter slot bar is adjustable for a snug fit, and all moving parts have fine adjusting mechanisms built in.*

Incra's new miter gauge boasts a sturdy construction. It has provisions for positive stops in 1° increments over a scale of 55° by way of a toothed plate and indexing pin. The positive-stop feature can be disabled for even finer adjustments.

It took me about half an hour to set up the gauge. The instruction manual is easy to follow, and the setup is straightforward. Once the gauge was adjusted 90° to the blade, it was easy to cut very accurate miters with the 27-in.-long fence. An optional 52-in. fence can be ordered for $50. Or you can simply attach an extended wooden fence to the aluminum fence and cut it for zero clearance. The gauge even comes with extra screws to make it a cinch to attach such a fence.

The gauge's optional adjustable Shop Stop will provide a solid surface for registering stock and making accurate, repeatable cuts. The stop allows you to make minute adjustments and lock them in place. A movable scale that fits into the fence of the miter gauge allows the gauge to be zeroed to the blade at any angle, on any saw. My only gripe with the stop is that it must be removed for cutting extralong stock. I'd like it better if it could be flipped out of the way. The miter gauge costs $184.95; the Shop Stop is an extra $32.95. For more information, contact Taylor Design Group at (972) 243-7943.

—Roland Johnson

Nail gun for fine detail work

Micropinners, also called headless brad nailers, shoot a very thin nail (approximately 23 gauge) and are used to fasten moldings, beading and small trim pieces. The small hole that's left is virtually invisible and can be easily filled and finished.

While not designed for continuous production-type use, the Accuset A 100MP is well made for occasional use. The gun I tested never misfired, nor did it leave a noticeable impression, often a problem with brad nailers, even on softwoods.

The tool is nicely dampened, important when installing glass-retaining molding. In three month's use, I didn't break one pane of glass. Additionally, because the nails are so small, even the tiniest carved moldings can be pinned without fear of splitting them. The tool is lightweight and exhausts air and oil out the back, away from the workpiece.

At about $129, this is an affordable, special-purpose tool. For more information, call (888) 222-8144. *—Jeff Jewitt*

Accuset's pneumatic micropinner leaves nearly invisible holes. *The fine-gauge nails are good for delicate trimwork or tacking parts together for gluing.*

Photos, except where noted: Anatole Burkin

A classic wooden plane resurfaces

The coffin-style plane is back. *Clark & Williams produces a line of wooden planes including this coffin plane, which measures 8¾ in. long.*

Go to a typical flea market, and you'll see antique wooden planes stashed in boxes, peeking from beneath quilts or laid in neat rows. Dragged from basements and attics, following years of neglect or abuse, these pathetic relics will probably never work wood again and often end up used as paperweights. But wooden planes in good working order are a joy to use. For those unwilling to risk buying an old tool, Clark & Williams in Eureka Springs, Ark., is now producing a wonderful coffin-shaped smoothing plane made of clear beech and modeled after 18th-century examples. The plane has a single blade with no chipbreaker and measures 8¾ in. long.

When Clark & Williams was just starting out, the company took its prototype to the resident tool experts and historians at Colonial Williamsburg in Virginia. They got an earful. And judging from the plane I inspected, they were paying close attention. The plane is as functional as it is beautiful. The wood has been finished smooth but with small details bearing the marks of the maker.

The coffin plane is adjusted by tapping the body and iron with a hammer, just like the originals. Adjusted properly, the plane will produce very thin shavings. The secret of the plane's performance is the 2¼-in.-wide blade coupled with a tight mouth, which allows only the finest shaving to pass through.

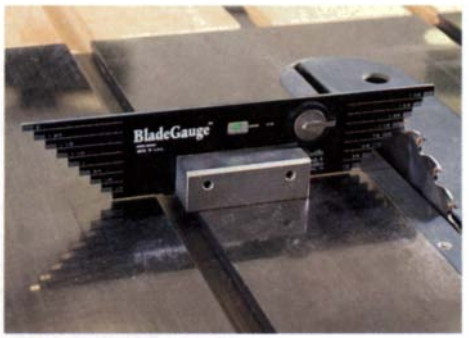
This plane, which costs $265, is not for everyone. But if you have an appreciation of wooden planes and are willing to invest the time to learn how to adjust such a tool, you will be rewarded with something that functions very well. For more information about this or other tools produced by the company, call (501) 253-7416.

—Mario Rodriguez

Electronic blade-height measuring gauge

The BladeGauge is a cool little gadget that doesn't cost a lot and is very simple to use. Made of electronic circuit-board material attached to a magnetic base, the BladeGauge allows you to dial in the height of a tablesaw blade, useful when cutting joinery. When the blade touches the contacts of the device, placed at ⅛-in. increments, from ⅛ in. to 2 in. high, an LED lights up. The biggest problem with all blade-height gauges is, of course, finding the exact spot on the tablesaw to set the gauge to read the highest point of the blade. This device doesn't solve that issue. BladeGauge costs $49.95. For more information, contact the manufacturer, Pacific Rack & Machine, at (541) 830-0340 or (877) 220-2699.

—Anatole Burkin



BladeGauge uses simple electronics to indicate blade height. *When the blade touches one of the contacts, placed at ⅛-in. increments, an LED lights up.*

Gel removes glue squeeze-out

Glue remover in gel form. *De-Glue Goo contains acetic acid and will remove recently applied PVA glues and hardened hide glue.*

As its name suggests, De-Glue Goo is a glue remover designed for use on hide glue and polyvinyl acetate (PVA) glues. It's basically an inert gel that contains acetic acid, the primary ingredient in vinegar.

De-Glue Goo is easy to use and performs as advertised, readily softening hardened hide glue and recently applied PVAs (white and yellow glues). De-Glue Goo, however, won't remove cured PVA glue, which is not surprising considering PVA becomes harder as it ages. De-Glue Goo also won't soften cured type-II PVAs. That glue crosslinks as it cures, making it resistant to moisture and solvents.

I don't bother using De-Glue Goo on assemblies like edge joints, which can be cleaned up easily with machines and hand tools. However, De-Glue Goo is superb for cleaning up complex assemblies like carcases and chair frames. Sponge the work with water afterward to remove any leftover remover.

At about $10 for 8 oz., De-Glue Goo is pricey, but it keeps well and goes a long way. I only wish the gel were a little thicker so that it didn't run when used on vertical surfaces. For more information, contact the manufacturer at (540) 261-1622.

—William Tandy Young

Photo, this page (top left): Mario Rodriguez

Triple roller stand can support heavy loads

Jim Tolpin

A stable roller stand. *Wolfcraft's triple roller stand can be folded for easy storage.*

I have not had much luck with inexpensive, portable roller stands. Most are too light and flimsy to be of much use unless weights are placed across their base frames, which defeats the purpose of an easy-to-set-up, portable device.

Wolfcraft's triple roller stand is different. Though priced under $80, it is sturdily built and can support heavy loads without additional base weighting. The wide stance and relatively heavy base frame (the whole unit weighs 32½ lbs.) resists any tendency to tip under load, even when I asked it to support a sheet of ¾-in.-thick plywood. The stand extends up to 43½ in. high to accommodate tall machines and folds up quickly into a flat package that can be hung out of the way.

An unusual and unique feature of this stand is its two-position roller system. Set at standard height for typical usage, the rollers clear their side supports and offer rolling support. When set at the lower position, however, the rollers drop below the supports, which can then act as an attachment frame for a solid surface. The stand then becomes a portable worktable that can adjust to a variety of heights. While this feature may be useful for construction-site woodworking, where multiuse tools are more appreciated, I found it annoying. Because the rollers tend to drop into the lower position whenever the stand is moved around, you have to check each roller every time you make a setup.

Out of the box, the roller support arms did not sit parallel to the support base. This meant that the rollers would not orient parallel to a level work surface, forcing one of the rollers to do most, if not all, of the work. It was an easy fix, however: I simply loosened the bolts holding the arms to the vertical supports and shifted the assembly slightly. Wolfcraft's stand is available at many home centers and hardware stores. *—Jim Tolpin*

Shellac from Hock

I like shellac. It is a durable and versatile finish. It can be sprayed, brushed or wiped on and used as a topcoat, sealer or barrier between disparate finishes. If you've never tried shellac, consider getting a small sample kit, now available from Ron Hock, known for his plane blades.

A Hock shellac kit consists of enough shellac flakes and denatured alcohol to mix up a 9.5-oz. batch, just enough finish for a small project. A brochure includes a bit of shellac history and directions for applying the product (brush, pad or spray). Hock sells both blond (light-colored) and orange (darker) shellac.

Why buy unmixed when you can purchase ready-mixed at the home center? Premixed shellac is usually only available in orange and has a short useful life span. Shellac loses its water resistance and drying ability over time. Mixing fresh shellac from flakes guarantees good performance of the product.

Considering that shellac is available in dry form for around $20 per pound, the kit price of $19.95 is an expensive way to buy shellac. It is, however, a convenient, informative and well-packaged introduction to using the finish. The product is available from Woodcraft (800-225-1153) or from Hock (888-282-5233). *—Michael Pekovich*

Shellac starter kit. *Plane-blade maker Ron Hock sells a kit containing shellac, denatured alcohol and instructions for application.*

Roland Johnson works wood in Sauk Rapids, Minn.; Jeff Jewitt refinishes furniture in Cleveland, Ohio; Mario Rodriguez is a contributing editor to Fine Woodworking*; Anatole Burkin is a senior editor of* Fine Woodworking*; William Tandy Young is a woodworker and author from Stowe, Mass.; Jim Tolpin is a woodworker and writer in Port Townsend, Wash.; Michael Pekovich is associate art director of* Fine Woodworking.

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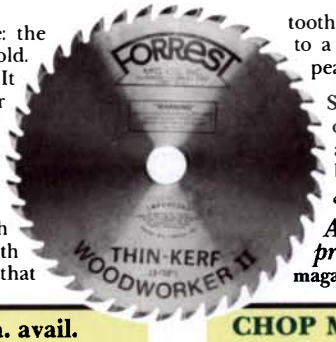

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10" x 80T x 5/8" Delta, Bosch, Hitachi, Makita, Ryobi, AEG & all	~~$139~~	$ 125	$ 111
12" x 80 T x 1" Delta,Hitachi, Makita, B&D, Sears & all	~~$149~~	$ 134	$ 119
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Gluing and Clamping Strategies

Lots of tape, lots of cauls and lots of clamps make glue-ups easy

BY LON SCHLEINING

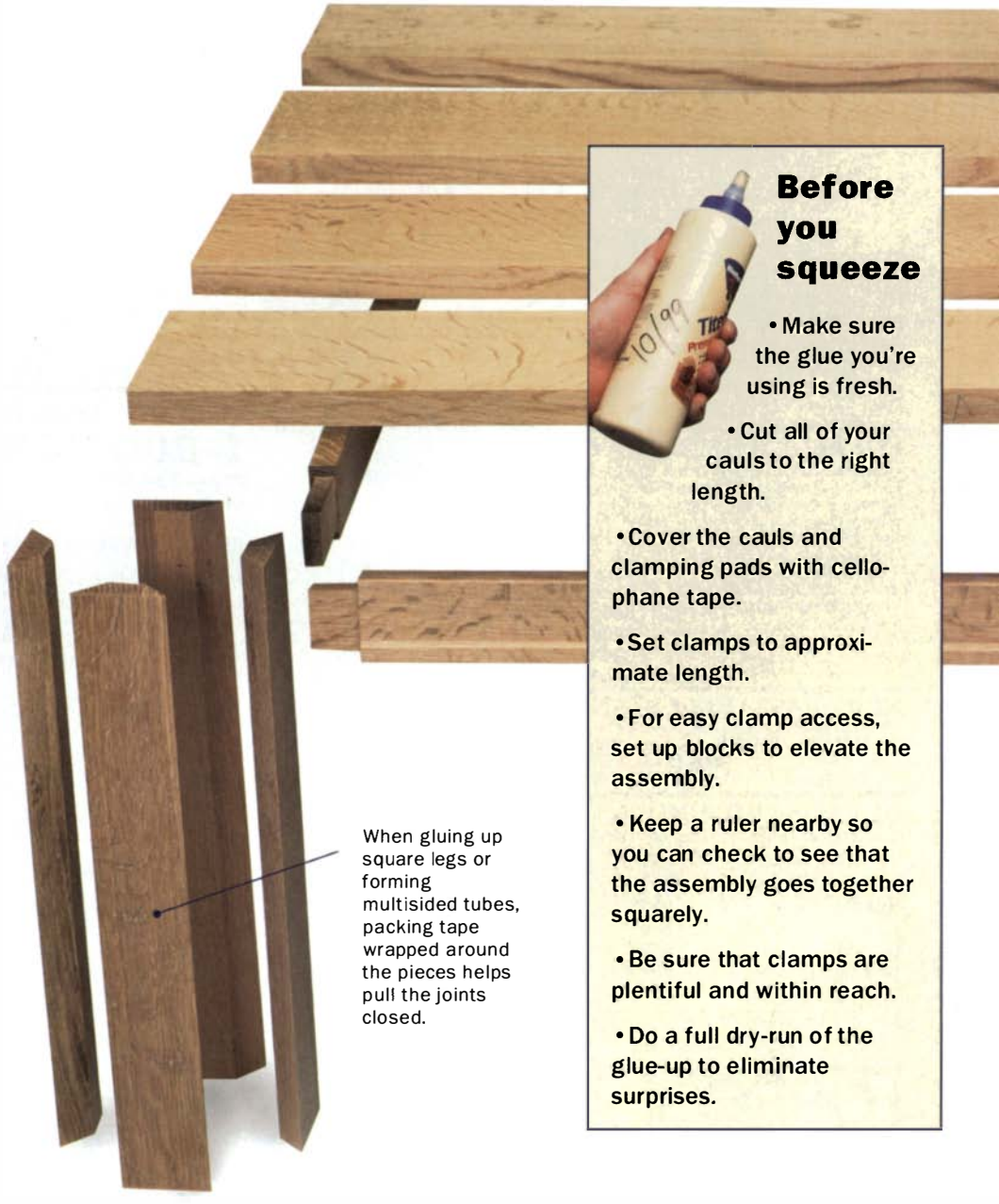
If you don't have complete confidence in your gluing systems, perhaps it's time to take a closer look at them. When I ask a group of woodworkers how many trust their glue-ups completely, very few hands pop up. Personally, I couldn't sleep if my gluing techniques were suspect. When my stairbuilding shop is really cranking, it is not unusual to go through 10 gal. or 12 gal. of glue in a year. That's not much by some standards, but it represents a fair amount of gluing for a three- or four-person shop. We've developed systems for gluing that are reliable and fast, not so much because we set out to do so, but because we have to have reliable glue joints so that we can sleep at night.

In this article I'll outline a few common gluing situations a woodworker has to tackle and provide a few tips that, hopefully, even the seasoned woodworker can use.

It's easy to test your gluing system

If a glue joint fails, the first suspect is the glue itself. But the glue is seldom the real problem. Modern glues are so effective as to be nearly foolproof. More often than not, operator error is the problem, not the glue.

You can easily test both the glue and

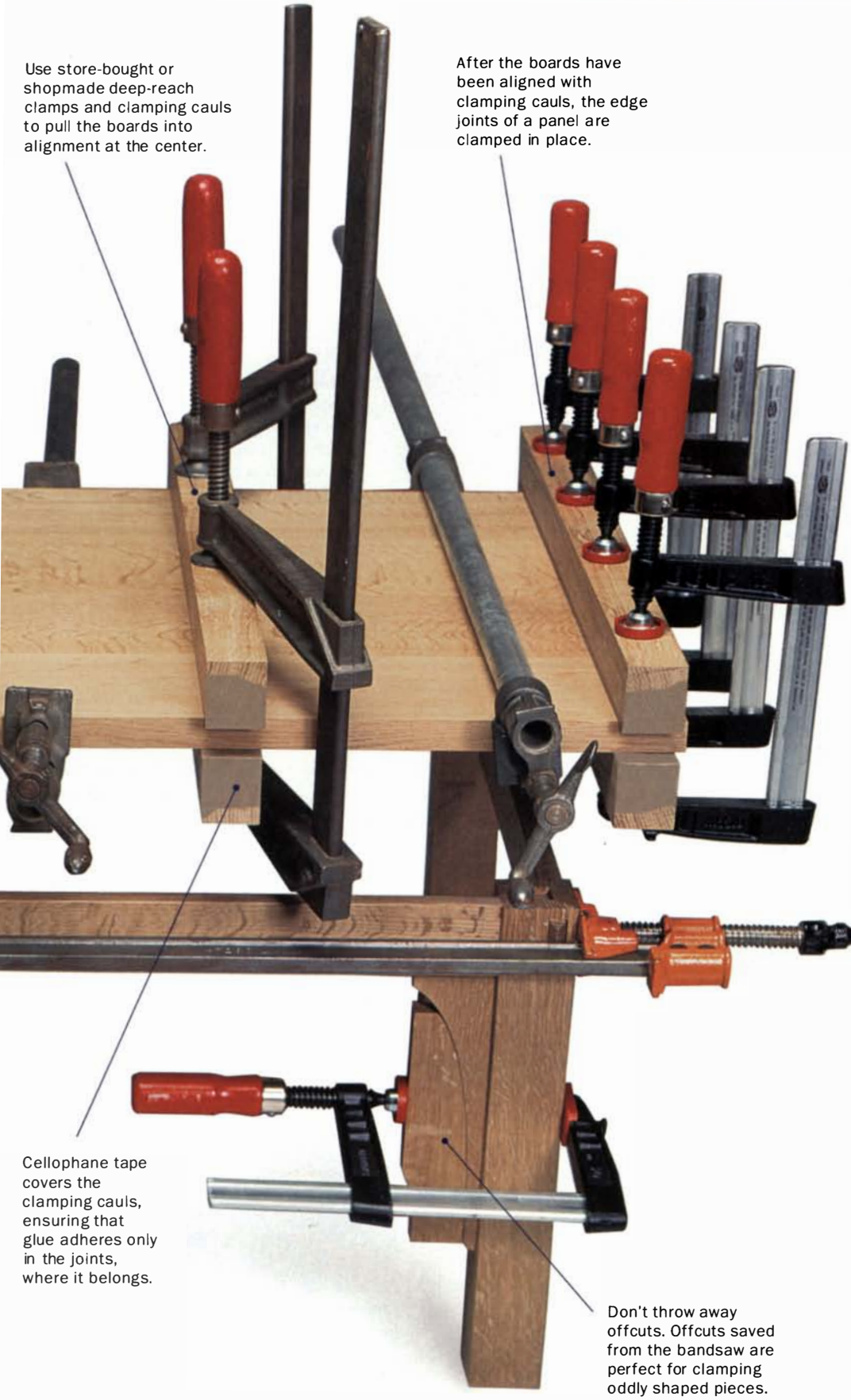


When gluing up square legs or forming multisided tubes, packing tape wrapped around the pieces helps pull the joints closed.

Before you squeeze

- Make sure the glue you're using is fresh.
- Cut all of your cauls to the right length.
- Cover the cauls and clamping pads with cellophane tape.
- Set clamps to approximate length.
- For easy clamp access, set up blocks to elevate the assembly.
- Keep a ruler nearby so you can check to see that the assembly goes together squarely.
- Be sure that clamps are plentiful and within reach.
- Do a full dry-run of the glue-up to eliminate surprises.

Photos, except where noted: Matthew Teague; this page and facing page: Michael Pekovich



your gluing system to increase your confidence. Simply glue up a sample, let it cure, then break it apart. If the sample breaks at the joint, you have a problem with the glue or the joint. If the wood does not break along the glueline, the test demonstrates that the joint is stronger than the wood, which is what you want. If necessary, keep modifying your system until you achieve satisfactory results.

Glue has a limited shelf life

On those rare occasions when the glue itself fails, either the type of glue being used is unsuitable for the job at hand or the glue has exceeded its shelf life. Remember, some glues have a very short shelf life—as little as three months in some cases. One year is more common, although it varies a great deal. One thing is certain, though: If you are still using that bottle of glue you got from Uncle Harry before he died a few years back, it's at least suspect. Do yourself a favor and buy a new batch.

I recommend buying small quantities of glue, as much as you'll likely use in a few months, from a place where the turnover of merchandise is high. That way, you'll run out of glue before it gets a chance to spoil. When you bring home a new bottle, write the date on the bottle with a felt-tipped marker. Relatively speaking, glue is cheap. When it gets old, throw it away.

Many glues are susceptible to spoilage from freezing or excessive heat. It's important to keep track of temperature for both storage and actual gluing.

Different operations require different types of glue

Before you even buy a bottle of glue, read the label. Glue manufacturers want your glue-ups to be successful. They make a point to tell you exactly what you need to know right there in the fine print. If the label says the glue is unsuitable for use around moisture or under stress, no doubt they mean

just that. Lamination bending, for example, puts the glue joint under constant stress. Yellow glue, tough but flexible, is unsuitable. Epoxy or plastic resin is a better choice.

Some glues, the polyurethanes for example, like dampness, but most glues do not. Another reason to read the label and do some testing.

Well-fitted joints are a must

Clean, dry, well-fitted and porous edges glue well. If the mating pieces do not fit well enough without clamping pressure, perhaps the work is not yet ready for gluing. Joints ought to fit naturally without being forced by oversized clamps. If you have to force the joint together, you're asking a lot of your glue to keep it that way once the clamps are released.

Porous edges allow the glue to ooze into the pores and strengthen the joint. If you make a very slow pass over a dull jointer, chances are you'll pound the fibers of wood together instead of cleanly slicing them. This forms a glazed, nonporous surface that won't be suitable for gluing.

Cauls and dry-fitting are the keys to success

Moving too slowly may well be the most common cause of glue failure. Very quickly—especially in warm, dry weather—the surface of fresh glue will form a skin, a sort of blister. This blister prevents liquid glue from adhering to the other surface. If the glue skins over before the two mating pieces come together, you might as well call it a day. Sure, you can scrape off all of that excess glue, but the residual glue will seal the surface. The edges will need to be remilled, not just cleaned.

One sure way to reduce the time it takes to get something clamped up is to practice. Especially if the gluing operation is complex or large, a rehearsal helps ensure that you have all of the clamps you need and that all of the little blocks and pieces of masking tape are at hand. It's a good idea to dry-fit and clamp up the project entirely, as if you had spread the glue already, to make sure one last time that the pieces actually go together.

Keep in mind that the addition of glue

EDGE-GLUING

Tape is the Teflon of glue-ups. *Cellophane tape prevents the cauls from sticking to the glue joint and also provides a slick surface so that the pieces can slide together easily once pressure is applied to the cauls.*

Raising the panel allows room for clamps. *With glue and clamps at hand, begin by laying cauls on blocks so that it's easy to keep boards flat and in place.*

When woodworkers edge-glue boards, it's common to see them relying on clamps not only to squeeze the joint together but also to keep the boards in alignment. These two jobs are easier if they are done separately. Shop-built clamping cauls align the boards first. Then the clamps squeeze them together.

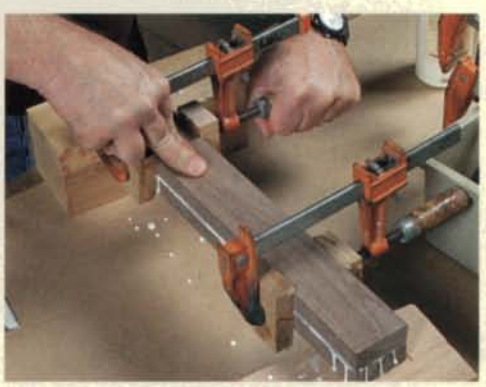
Clamping cauls are nothing more than straight, surfaced clamping blocks covered on one side with cellophane tape. Clamping the cauls from above and below pulls boards precisely flat, even if they are warped or cupped. The cauls also will hold the boards flat as they are squeezed together, even if their edges aren't milled perfectly square.

I make cauls from 8/4 square hardwood. Make sure they are

FACE-GLUING

Nothing is more frustrating than having the boards you're trying to clamp together move around when the clamps are applied. You have to unclamp the whole mess to move them back again, and by that time they're usually stuck in place. Enter our old friend, the clamping caul.

Cauls for face-gluing work just as well as they do for edge-gluing, making the job much quicker and easier. For face-gluing you need only small blocks covered with cellophane tape. First use cauls to control the alignment, then apply pressure to the glue joint. It's that simple.



Clamping face-glued joint with cauls. *First, use cauls to keep pieces aligned, then squeeze the joint together. Glue flows more easily when you start at one end and work toward the other.*

Tape and scrap make simple and effective deep-reach clamps. *Tape a spacer between two stout scrap boards and slide the assembly over the cauls. Pressure applied near the edge is transferred to the middle of the panel.*

Cauls keep edge joints aligned. *As the cauls are clamped together, the boards are pulled into perfect alignment. After the cauls have been firmly clamped in place, use bar clamps to pull the joints together.*

Bar clamps squeeze the joints together. *Apply just enough pressure to close the joints—too much pressure will force glue out. Keep the bar clamps above the surface because black marks will appear everywhere the clamps touch the wet glue.*

straight, then apply cellophane tape to one side. The tape prevents the cauls from adhering to the project and allows the gluing pieces to slide together once they're under control. Start by putting the lower cauls on blocks so you can get access to them for clamps. Then spread glue on the edges, place the boards into position and begin clamping the cauls down securely.

Start by clamping the caul in the center of the panel. Deep-reach clamps are great to have, but they're expensive. I find that a shop-built version works just as well. Just tape a few scraps of wood into a U shape and slide the assembly over the cauls (see the left photo above). With this setup you can easily clamp the center of even a 4-ft. panel. After clamping the center cauls, move toward the ends. Feel the alignment of the edges along the joints. Add a new set of cauls any place one board is above another. Once the assembly is perfectly flat, use bar clamps to squeeze the joints together. The boards slide between the cellophane-covered cauls with no trouble.

Because the joints fit very nicely, it takes only a little pressure—just enough to make contact between the two boards. Too much pressure forces the glue out of the joint.

If your test glue-up indicates that a joint is stronger than the surrounding wood already, it's hard to justify using something to strengthen it further. When you use cauls during a glue-up, most reasons for using dowels, biscuits or splines go out the window.

MITERED FRAMES

Picture frames and mitered boxes—both basically end-grain glue joints—present some of the biggest challenges for gluing and clamping. This is the perfect time for biscuit joinery; and the more biscuits you use, the better. Although clamping is tricky, I prefer plain, old bar or pipe clamps over the various gizmos on the market for clamping picture frames.

Glue up all four corners, keeping the pieces in alignment as much as possible. Set a bar clamp across each corner as close to the center of the joint as possible. Keeping the frame down on a flat surface, apply pressure very gradually to one clamp at a time, squeezing the joint into alignment as you go, back and forth until the pressure is even and the joints are aligned. Remember that light pressure is usually sufficient. Tighten just enough to keep the joint together, but stop before forcing all of the glue out of the joints.

Two biscuits make a stronger joint. *Biscuits provide ample gluing surface and keep the pieces aligned. Once clamps go on, check the diagonals to make sure everything is square.*

in the joints will change the operation a great deal. It lubricates the pieces just enough for them to move around when you don't want them to. Then the glue begins to set up and grab the pieces, holding them in place just when you want them to move. But these problems are easily solved. The key for almost every gluing situation is to use clamping cauls. Simply put, clamping cauls hold boards in alignment while other clamps close up the joints.

Clamping time—The amount of time a project has to remain clamped up depends on temperature, humidity and the complexity of the project. It's important to follow the directions on the label of the glue you're using. If the label says clamping time is an hour, give it an hour. If the label says overnight, wait until the next morning to remove the clamps.

TIP
PVC pipe cut into narrow sections works like mini spring clamps. The pressure varies by the diameter of the pipe, its thickness and the width of the section you cut off.

Remember that the temperature requirements are critical. If the label says the minimum is 50°F, that means the air, the glue and the material itself must be at least that warm. It also means that the materials must stay that temperature for the duration of the curing time. It's worth noting that a simple light bulb inside a small, insulated enclosure will keep the contents quite warm, even if the rest of the shop is cold.

Cleanup—Gluing over butcher paper or newspaper certainly saves you from having to do a great deal of cleaning up. Wearing vinyl gloves not only keeps hands clean but also helps you avoid contact with toxic chemicals.

With most of the common polyvinyl acetate (PVA) glues, under normal conditions, a project usually has to stay in the clamps about an hour. I have been accused of using too much glue, but

DOVETAIL AND BOX JOINTS

When gluing a box or drawer together, all four corners typically have to go together at the same time. This might be as simple as a small drawer or as complex as a chest carcase, but the processes are the same.

Nowhere is a rehearsal more important than with a box joint or dovetail glue-up. There is no time to fuss with cutting clamping cauls when the glue is beginning to set up. This is one instance when it's nice to have an extra set of hands.

Cauls set just back from the joint on all four corners provide a clamping surface but still allow the joint to move together without interference. The cauls also help spread the clamping pressure evenly.

Apply glue to all of the surfaces and immediately press each corner together. Once all four sides are together and the joints have been hand-fit as much as possible, set the cauls in place and begin to apply light clamping pressure. As soon as the joint comes into contact, that's enough pressure. It's entirely possible to bend and permanently distort the sides of the box by applying too much clamping pressure.

The box needs to be glued up on a flat surface. To be sure there's no twist in the box, see if it rocks. If it does rock, use clamps to apply downward pressure on the high sides until you bring it back into alignment.

To check that the box is square, and while the glue is still soft, measure diagonally across the corners. If the box is square, the measurements should be the same. If it's slightly out of square, a single bar clamp, placed diagonally, will bring it square. Checking the squareness by measuring the diagonals is usually preferable to using a square because it's faster and more accurate, especially if excessive clamping pressure has pulled a curve into the sides of the box.

Masking tape keeps your project clean. *Apply glue sparingly to the joint. With clamps handy and everything in place, apply masking tape along the inside of the joint. The tape eliminates the need to clean excess glue out of the inside of the box.*

Clamping cauls spread the pressure. *Dovetail and box joints are squeezed together from both directions, so make sure the cauls don't cover the joint. Cauls placed right next to the joint evenly distribute the pressure of the clamps.*

MITERED BOXES OF ANY SIZE

Packing tape binds the box. *Stranded tape with imbedded fiber has tremendous strength. Strips of tape are laid on the face side of the box, keeping everything in place.*

Mitered parts roll up to form a box. *After the pieces have been turned over, glue is spread in the miters, and the box is rolled up.*

Shopmade blocks allow opposing clamps. *Shop-built clamp blocks provide a perpendicular pad for the clamps. As opposing clamps are tightened, the box is pulled square.*

Mitered boxes are quite easy to glue up by using shop-built blocks, stranded packing tape and a bit of patience. Lay the four pieces faceup along the bench, and run the tape every few inches across the faces of the boards. Turn the assembly over, spread glue in the joints and roll it up like a tool pouch. It sounds simple, and it is.

To ensure that the box remains square, clamp the box diagonally with the help of clamping blocks. The blocks are made of 2x2 stock and have a mitered groove on one side (see the right photo above). By placing the clamps opposite each other, you can easily check along the box with a square to see that everything is in place. It's easy to make adjustments accordingly.

Packing tape makes clamping even a complex shape like an octagon very straightforward. Start with the pieces faceup on the bench. Using the same technique as the mitered box, apply the tape across the faces every few inches, leaving an overlap to pull the last joint together.

Turn the assembly over, spread glue and roll it up, pulling the tape ends tight. Check to make sure the distance between faces is even all around so the assembly will be square and consistent.

MORTISE-AND-TENON DOORS

A little glue goes a long way. *Apply glue only deep into the mortise and on the end of the tenon to keep squeeze-out to a minimum.*

More often than not, well-fitted mortise-and-tenon joints align themselves, but you still have to keep everything square and flat. The center panels, if solid wood, need to float so they can expand and contract freely. For ¼-in. panels, little rubber pellets, called space balls, can be placed in the dadoes that accept the panel. These space balls keep the panel centered and securely held. On wider panels I trim pieces of cork to fit in the groove and never apply glue to the panel.

Frame-and-panel doors using cope-and-stick joints usually are glued up without dowels. Considering the amount of use a door might get, it's worth placing a couple of dowels in the corners. The dowels should fit loosely in the holes to allow a bit of room for glue and expansion.

If the cope-and-stick joint is not-quite perfect, cauls are an easy way to keep the pieces flat and aligned. It's important to make sure the door is flat and square, adjusting it as you would a box.

Let the panels float

Cork cushions keep the panel centered but allow it to expand and contract. No glue is applied to the floating panel. Use a utility knife to cut cork slightly oversized. Space balls—perfect for ¼-in. dadoes—are hard rubber pellets designed to do the same job as cork (available from louis and company: 800-422-4389).

because scraping glue before it hardens is so simply done, I see no need to skimp on glue.

Along a glueline, I want to see at least a thin bead of glue. When the glue has set up in the joints and the clamps are removed, the excess glue should still be soft and pliable. This is the perfect time to remove the excess with a scraper. I never wipe up glue with a wet rag, because the added water will raise the grain and the finished surface will be uneven.

My favorite glue-scraping tool is a small hook scraper, available in the paint section of almost any paint or hardware store. With a good edge on it, a small hook scraper will remove excess glue while it's still soft, thus saving hours of sanding. If you wait until the glue has hardened to scrape off the excess, it is very likely, especially with softer woods like mahogany, that you'll tear chunks out of the surface.

TIP

Use inner-tube strips to hold laminae together for bending. The strips hold firmly yet allow the bundle to flex as it bends.

I do my best to use a simple and quick system for gluing. Once the glue has been spread, I use every trick I know to speed it along. I always follow the manufacturer's instructions to the letter. When in doubt, I call the manufacturer on the phone. Manufacturers have always seemed more than happy to discuss individual situations. I have a habit of testing my glue joints constantly. If I trim a glue-up to length, I take the scrap piece and snap it over the corner of the bench to make sure the joint is reliable. I am always happiest when it breaks ½ in. away from the glueline. Your confidence builds with every test. If you adopt this habit, you'll soon be confident in the boards you glue together. You'll sleep better, too. □

Lon Schleining builds custom stairs in Long Beach, Calif.

COOPERED PANELS

A simple form keeps the curve uniform. *Nowhere is the caul system more useful than with gluing up a coopered panel. By making a female caul, the staves are kept in alignment. Holes in the form's ribs serve as clamp pockets. A little tape keeps the staves from being glued to the form.*

A simple form for clamping curved shapes is easy to make and extends the clamping-caul principle to include shapes that are not flat. The idea is the same.

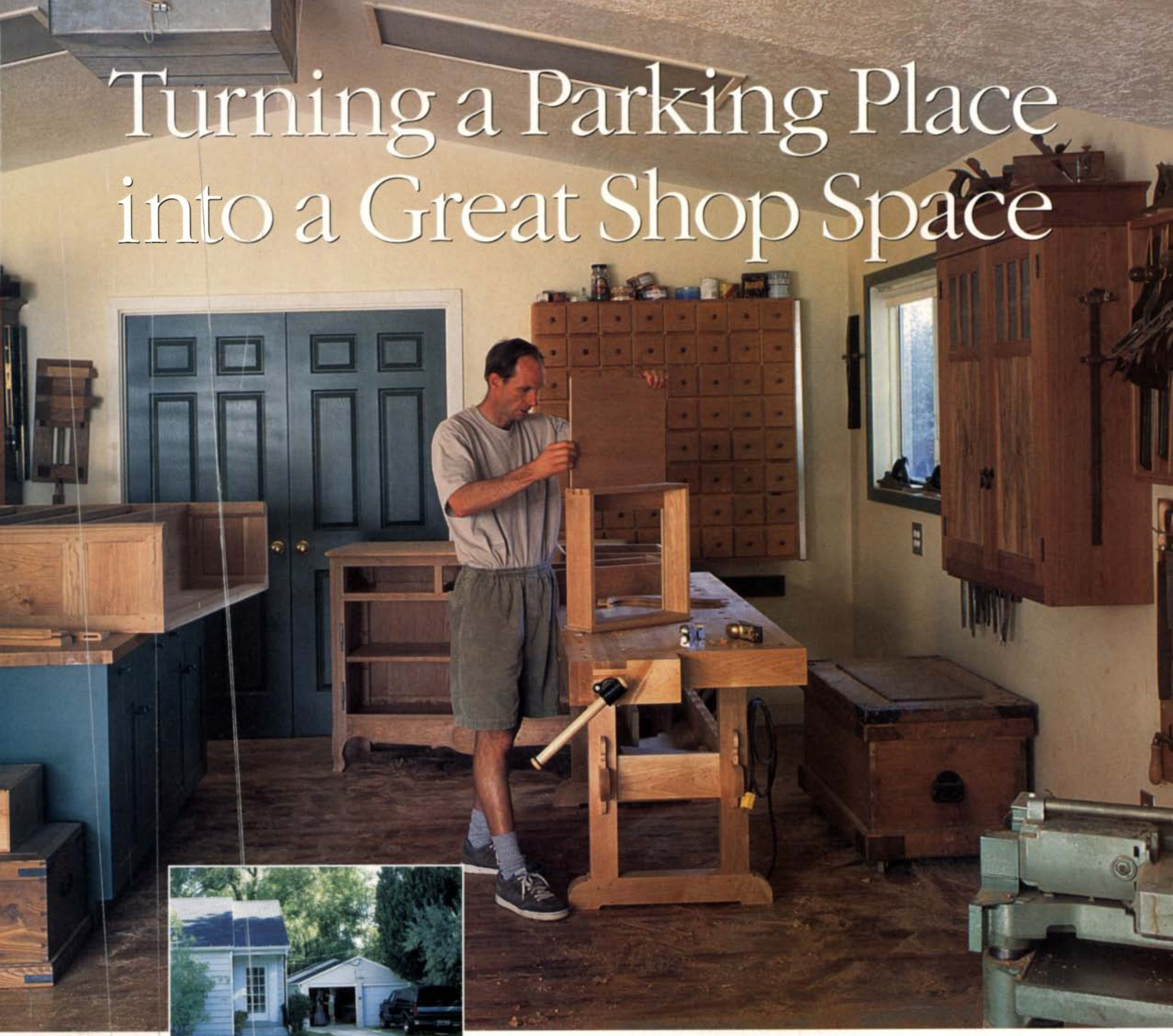
With this form, the alignment of the staves is easy. The form sits flat on bench blocks to make sure there is no twist. Use cellophane tape to prevent the form from being glued to the project and to allow the staves to slide. Drill holes in the ribs to serve as clamp pockets for the clamps on each side.

Align the pieces, in the case of a coopered door or chest lid. Lay all of the staves in the curve of the form. Then, and only then, clamp the staves together to force the glue joints to close up. Gently apply pressure to one clamp at a time until the joints close.

Clamp pressure must be distributed evenly. *Clamps grab onto the pockets drilled into the form's ribs, allowing the author to apply even pressure with opposing clamps.*

Hook scraper removes excess glue. *A hook scraper, filed razor sharp, quickly removes excess glue once it has blistered over but before it hardens.*

Turning a Parking Place into a Great Shop Space



Expansion and a thoughtful layout make an excellent professional workshop from a two-car garage

BY CHRIS GOCHNOUR

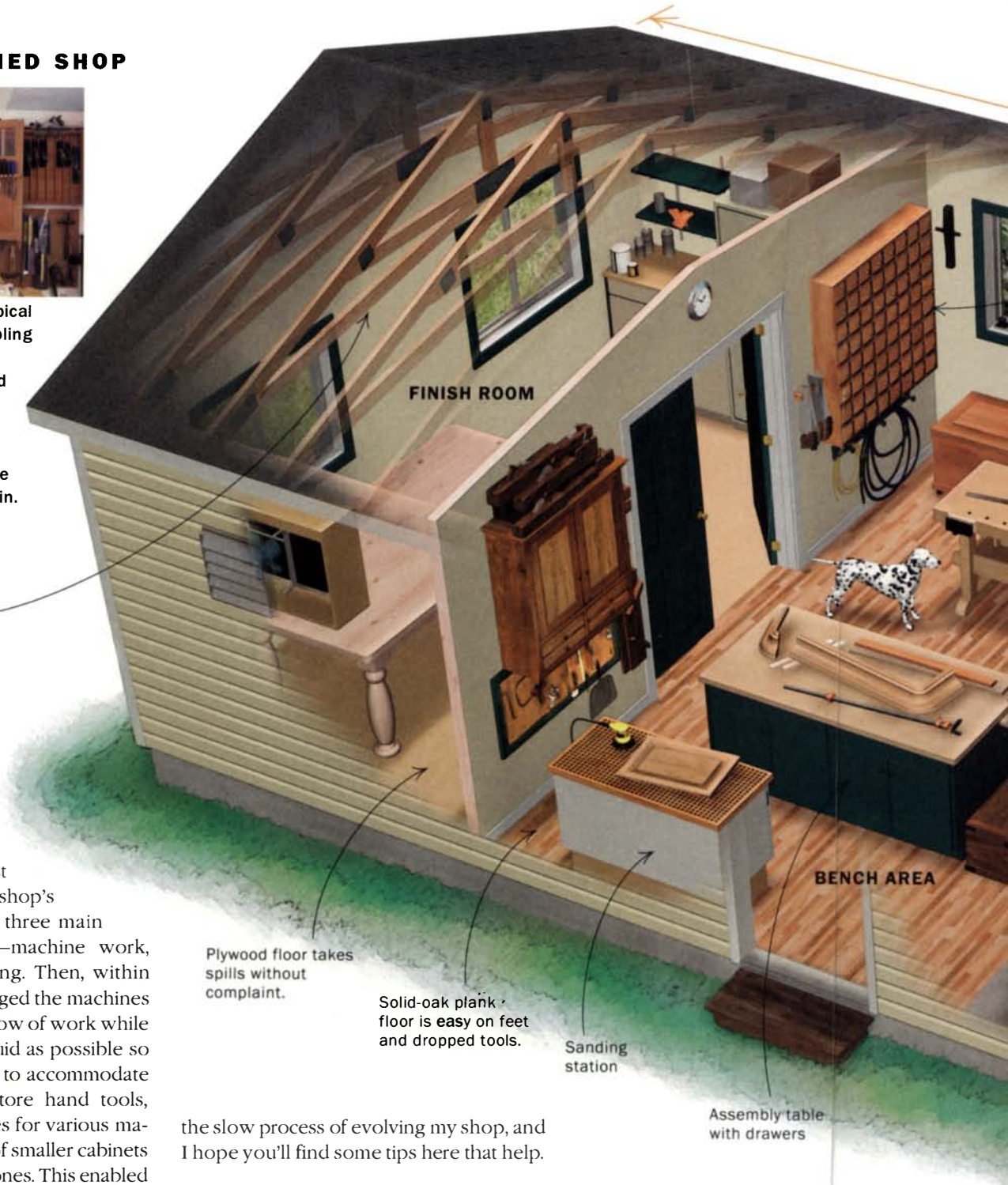
When my wife and I bought our house 15 years ago, I set up my first real shop in the freestanding two-car garage. Built in the 1940s, the garage was 18 ft. by 20 ft., with a concrete slab and wood siding. I entered and exited through the overhead garage doors, attempted to heat the space with electric radiators and worked with low ceilings, no insulation, a lot of airborne dust and very little natural light. I loved it. At least for a while. As I acquired more tools and machines, the space quickly became crowded. In the mean time, I had quit my job and begun making furniture full time. When I took that step, I realized I needed to retrofit the shop completely. I took the opportunity not just to enlarge the space but to revamp the layout using all that I'd learned about the way I work.

Several core decisions have made my shop a pleasant and effi-

Photos: Jonathan Binzen

A WELL-DESIGNED SHOP

The author expanded a typical two-car garage shop, doubling the space by adding on at the back. As he rebuilt and rearranged the shop, he based his decisions on aesthetics as well as efficiency, creating a space that is a pleasure to work in.



cient place to work. Most important, I divided the shop's layout according to the three main activities of my work—machine work, bench work and finishing. Then, within those three areas, I arranged the machines and tools to reflect the flow of work while keeping the layout as fluid as possible so that it could be changed to accommodate different projects. To store hand tools, hardware and accessories for various machines, I built a number of smaller cabinets rather than several large ones. This enabled me to place tools and equipment right where they are most often used. I also put a lot of effort into aesthetic improvements. For instance, I took the time to build handsome cabinets for tool storage instead of whacking them together from scrap.

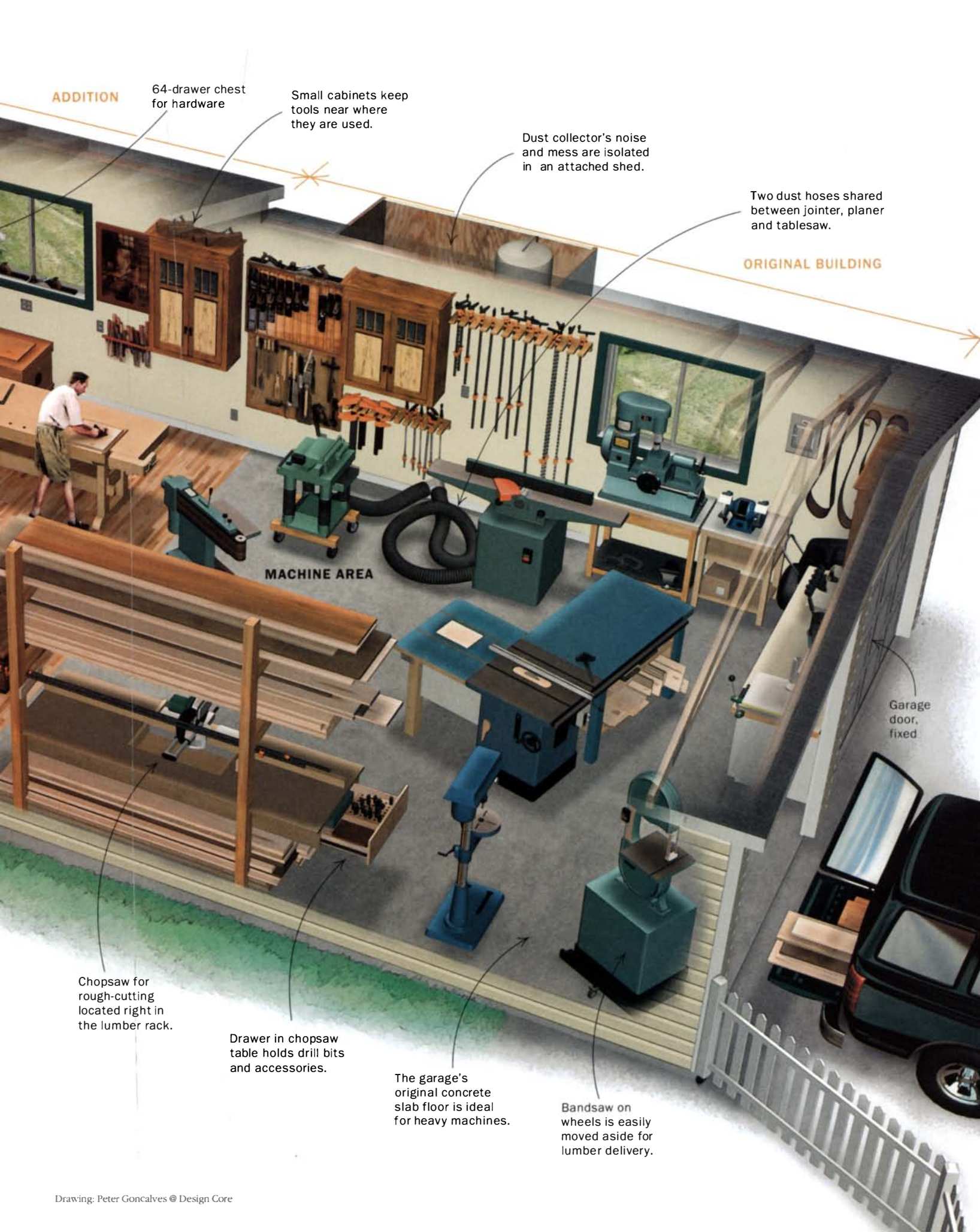
Most of the ideas I've built my shop around can be adapted to any workspace. Even so, I don't expect them all to suit yours, because designing a personal workshop is just that—personal. The best design is the one that responds directly to the way you work. But I've put a lot of effort into the slow process of evolving my shop, and I hope you'll find some tips here that help.

Enlarging my garage

Because the lot is small and my budget was modest, it made sense to enlarge the garage rather than to put up a separate shop building. I started the renovation by making my best decision first: I chose not to tackle the whole job myself. As a furniture maker, I may be familiar with a carpenter's tools, but that doesn't make me a carpenter. So I hired a contractor friend and signed myself up as a laborer.

The roof was the key to the renovation. We replaced the old rafters and collar ties with scissors trusses, and where I used to have a flat 8-ft. ceiling, I suddenly had a ceiling that is 8 ft. at the side walls and rises to 11 ft. at the center. Hallelujah.

Along with a higher ceiling, I brought far better lighting to the renovated shop. The first improvement came with installing two large windows in the bench area. The added natural light throughout the shop helps with color matching and simply makes me feel better. In addition, instead of reinstalling the suspended fluorescent



Drawing: Peter Goncalves @ Design Core

The tablesaw is king. *In the machine area, the tablesaw stands fixed near the center, and the other machines are arranged around it.*

lights I had before, I recessed some fluorescent fixtures in the ceiling and covered them with Lexan. This was a miraculous improvement—it looked much better, provided even illumination and meant there'd be no more whacking of dust-laden light fixtures with the end of a board.

To help retain the heat (and the noise), I added better wall insulation and replaced the old garage doors with insulated metal ones. I installed a basic dust-collection system, placing the collector outside in a small shed attached to the building, which reduces the noise and makes it less messy to empty. I supplemented the dust collector with a ceiling-mounted dust filter.

In the end, the only parts of the original shop that were preserved were the concrete slab floor and the front and side walls. The whole job took about seven weeks and cost about $13,000. Although I can't claim that the outlay was painless, in most ways the renovation was extremely low-impact. Even though the headroom had increased dramatically and the floor space had doubled to 720 sq. ft., if you were looking at the garage from the street, you'd never guess that anything had changed.

Machine area

The space once occupied by automobiles became my machine area. It was in the right place in terms of workflow—just inside the overhead doors—and it had a good floor for heavy machines: the garage's original concrete slab.

All of my work starts with rough lumber, so I built my lumber rack near the one still-operable garage door, along the side wall. When I buy lumber, I back my truck up to the garage door and unload the wood directly onto the rack. The rack I made has a pair of vertical posts bolted to the wall and support arms cantilevered from the posts. This provides unobstructed access to the wood and takes up the least possible space in the shop.

I use a chopsaw for rough-cutting lumber to length, and I wanted it right where the lumber was. So I cleared out a shelf of lumber and used the same cantilevered support system to hang a chopsaw table. I built the table using torsion-box construction and attached the chopsaw to a small, removable section at the middle of the table. When I need the saw on an installation, I simply unscrew two bolts and lift the saw and its small platform out of the table.

In arranging the major machines, I started by placing the tablesaw, with its huge demands for infeed, outfeed and side support, in the center of the machine space. All of the other machines were placed on the periphery, arranged to work in harmony with the tablesaw.

Whenever feasible, I put my machines on wheels. Flexibility in the layout of a small shop is imperative, and wheels help tremendously with this. I have all of my major standing machines on wheels except for my tablesaw and jointer.

The jointer and planer are near the tablesaw, which makes sense from the perspective of workflow, and it also helps with dust collection. Arranged this way, these three primary generators of dust can share the two hoses that I have hooked up to my dust collector. In my old shop, I had ceiling-mounted PVC pipe running to every machine. I found it to be overkill, and it produced enough static electricity to keep my hair standing on end much of the time. These days I simply have flexible hose running on the floor. It may be a slight nuisance to step over, but it works fine, is a more adaptable system and doesn't mess with my hair.

The tablesaw took precedence not only in laying out the machine area but also in my tool budget. My theory of machine purchases is this: For machines I use most heavily and rely on most for precision work—tablesaw, jointer, planer, mortiser, pin-router—I cough up the money for high-quality, heavy-duty equipment. For more peripheral machines, where accuracy is less critical—edge sander, grinder, dust collector—I tend toward Taiwanese knock-offs.

Bench area

The two main work surfaces in my bench area summarize the work I do there. One is a traditional cabinetmaker's bench, and the other is a broad assembly table. Having the two in proximity—they are parallel and stand about 6 ft. apart—is extremely functional. Both are movable (with some effort), and I can change their locations depending on what I am building.

Whereas the cabinetmaker's bench is

open underneath, the assembly table is packed solid: I utilized the large space beneath the top by filling it with cabinets and heavy-duty drawers. These hold all of my handheld power tools and their accessories and much hardware. This way, the tools are stored within arm's length of where they are used. The drawers are also easily reached from the workbench. The assembly table has several outlets built in under the top, and I added one to the workbench as well.

The cabinetmaker's bench is fairly traditional, but I did make a few departures. One was to leave out a tool trough in favor of a larger work surface. I built in a tail vise, which is invaluable, but in place of a traditional shoulder vise I opted for a commercial metal side vise. I find a shoulder vise to be a bit of an impediment, and these metal vises are hard to beat with their convenient quick release, great holding power and easy installation.

Building my own bench meant I could design it for just the way I work. Working with handplanes a lot, as I do, a good, solid bench is almost as important as a sharp blade. You want all of your energy transferred into the workpiece and the cutting action—not into a rickety bench that racks and wobbles with every stroke.

For tools used primarily at the workbench, I built shallow, two-door cabinets and hung them on the wall by the bench. They store chisels, handplanes, scrapers, spokeshaves and other supplies. Storing tools and supplies behind doors helps with dust problems, and keeping the cabinets shallow makes for simpler storage and easier retrieval of the tools.

My approach in building storage cabinets is a little different from some. Instead of building shop furniture quickly and cheaply, I put real effort into building it. If I can save some labor or money, I do—two of the tool cabinets were extras from custom kitchens I built. But considering how much time I spend in my shop, it makes sense to please myself with the environment there. And the effort is not lost on clients who visit my shop. The cabinets demonstrate the type of work I do and the pride I take in my work and my tools.

My bench area has a third table, where I do most of my sanding. I may be a handplane fanatic, but I am practical enough to know that sanding is a reality. When I must sand, I want it to be as painless as possible. Thus, I built a dedicated sanding station. It is essentially a big box with a perforated top surface and a couple of vacuum motors below: One vacuum motor pulls the sanding dust down through a series of furnace filters; the other works as a hold-down system to keep the workpiece in place without clamps. The thing works so well that I don't need a dust mask, even when sanding with aggressive paper. I placed the station next to a window so that my time spent sanding is enriched by the changes of the seasons in my backyard. I still don't love sanding, but this device has certainly taken the sting out of it.

I put a hardwood floor in the bench area. The wood floor is easier on my feet and back and more forgiving if I drop a tool. Better yet, the wood is honestly more inspiring to work on. I've even draped off a wall and used the bench area as a place to photograph my work.

Finish room

I decided to separate the finish area from the rest of the shop, and I'm glad I did. Having it walled off keeps the dust in the workshop and the fumes in the finish room. I kept the ceilings high and installed large double doors that lead to the bench area. Even though the floor space in the finish room is fairly limited, the high ceilings and wide doorway make it easy to move even dining tables and tall case pieces in and out. It is also nice to be able to close the doors and not see the oversprayed walls and the clutter in there.

The importance of aesthetics. *In building his storage cabinets, shop furniture and cabinetmaker's bench, the author took the time to make things that would be visually pleasing as well as functional.*

Lumber and a place to cut it. *A system of cantilevered arms provides easy-access lumber storage as well as support for a chopsaw table designed for rough-cutting planks.*

Perhaps as important as anything else in a finish room is the lighting. Two large windows bring in natural light. The natural light helps in matching color when mixing stains and in seeing just how a coat of lacquer is laying down. And the windows, in combination with the door and an explosion-proof fan, provide good ventilation. I also have fluorescent lights recessed in the ceiling. To make them explosion-proof, I put the lights behind sheets of Lexan that are sealed at the perimeter with a rubber gasket. I also ran the switch to the bench area. To provide raking light for bringing out the details of a finish, I use a couple of portable halogen spotlights.

The floor in my finish room is just plywood. That way I don't feel so bad about lacquer overspray or stray splashes of pigments and stains. I keep all of my supplies in a metal cabinet and have a small work area for pouring and mixing finishes.

It has been six years now since I renovated the shop. With the added space, functional layout and aesthetically pleasing surroundings, it's been a great place to make furniture. But the evolution continues. Future improvements include more windows, upgraded electrical service and, perhaps most important, a better place for my wife to park. □

Chris Gochnour makes custom furniture and cabinets in Salt Lake City, Utah.

Graduated Drawers

A little arithmetic is all it takes to enliven the proportions and increase the utility of a case, a cabinet or a built-in

BY CHRIS BECKSVOORT

A CASE WITH AN EVEN NUMBER OF DRAWERS

The formulas for the example here—a four-drawer chest with 1-in. graduations—can be used for any chest with an even number of drawers.

To get the usable drawer height, subtract the dimensions of the top (1½ in.), base (5¼ in.), and drawer dividers (3 × ¾ in. = 2¼ in.) from the chest's total height (36 in.):

36 – (1½ + 5¼ + 2¼) = 27

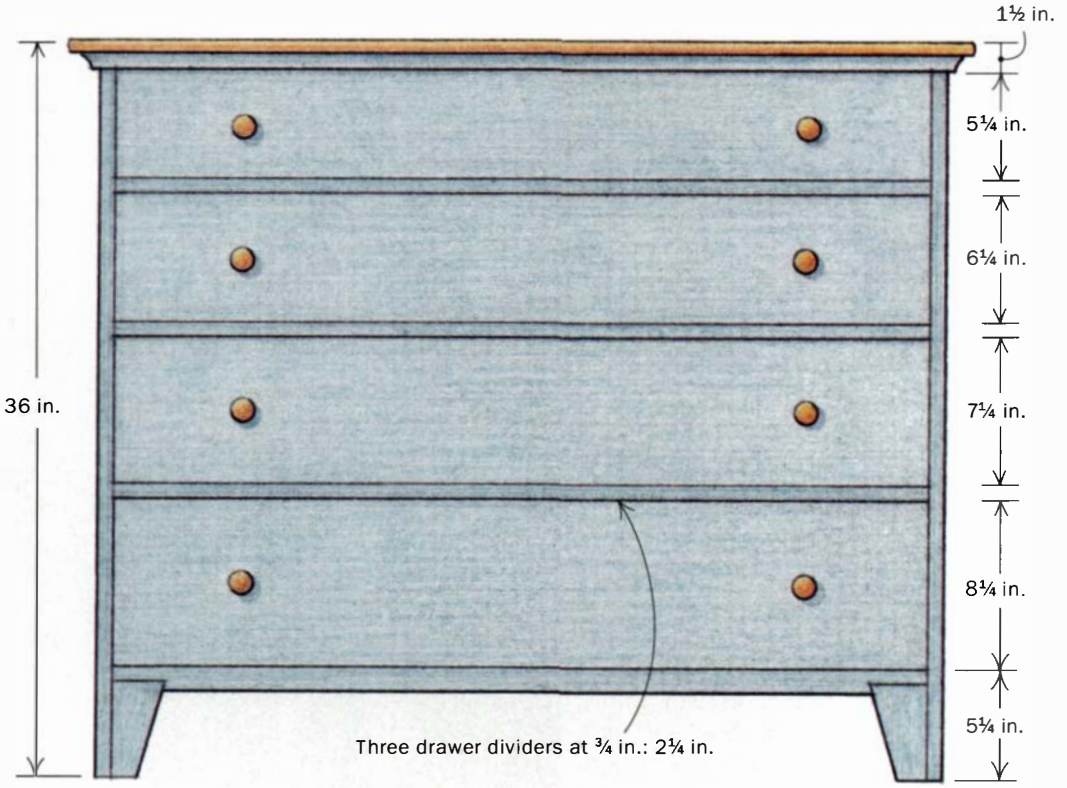
To find the average drawer height, divide the usable drawer height (27 in.) by the number of drawers (4):

27 ÷ 4 = 6¾

To find the height of the drawer below the middle divider, add one-half the graduation increment—½ in.—to the average drawer height (6¾ in.):

½ + 6¾ = 7¼

Add 1 in. to the drawer height below and subtract 1 in. from the two above.



The Shakers were among the primary proponents (and practitioners) of graduated drawers, although there are lots of cases—Chippendale, Federal and Queen Anne—that have graduated drawers. Under the dictum "a place for everything and everything in its place," the Shakers built drawers to house specific items. There is no reason for a drawer that will hold cassette tapes to be as deep as one that holds CDs, or for your underwear drawer to be as high as your sweater drawer.

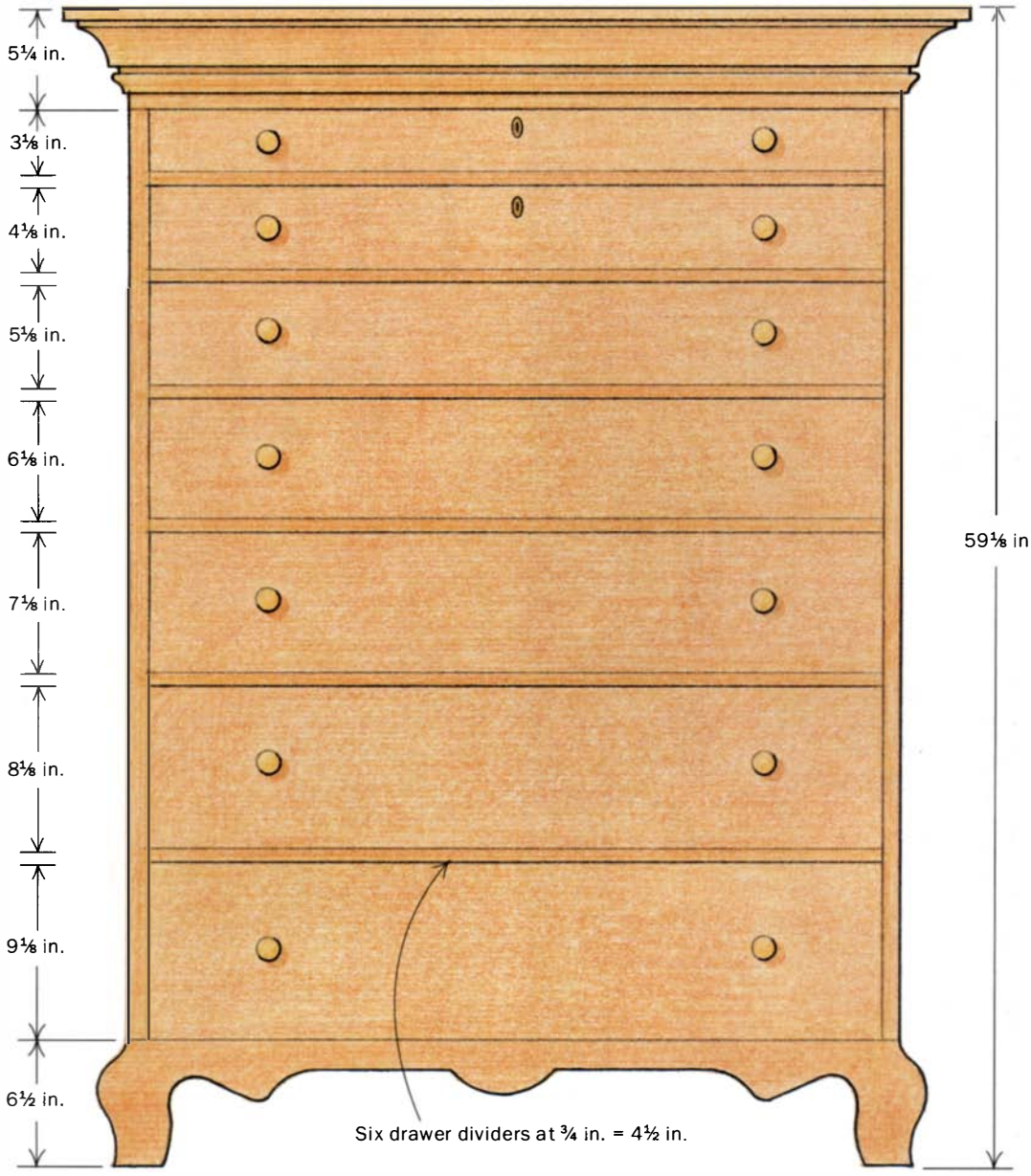
Also, I never build solid wood drawers much more than 9 in. high. Because of seasonal wood movement, anything higher will leave too wide a gap in midwinter (even with overlay drawers), and the drawer could bind in summer.

Another consideration is overall proportion. Small drawers in desks or in a collector's cabinet may graduate in only ¼-in. to ⅝-in. increments. In bureaus used for clothing, on the other hand, the drawers can be graduated in ¾-in. or 1-in. increments. If you are a stickler for detail, you may also want to consider graduating the size of the knobs or drawer pulls as well.

Find the usable drawer height, then figure the average drawer height

Once you know the height of the case and the number of drawers in the case, laying out graduated drawers is straightforward. To get the available drawer space, subtract from the total height the dimensions of the top, bottom and all of the dividers. The number of dividers in a case will always be one less than the number of drawers: e.g., a five-drawer case will have four dividers. Dividing the available drawer space by the number of drawers will give you the average drawer height. Regardless of whether you're building a case with an odd number or even number of drawers, the average drawer height is the most important dimension.

If you have an odd number of drawers, the middle drawer will



A CASE WITH AN ODD NUMBER OF DRAWERS

A case with an odd number of drawers has a middle drawer with an equal number of drawers above and below it. The method of determining the average drawer height is the same as for a case with an even number of drawers. The formulas for the example here—a seven-drawer chest with 1-in. graduations—can be used for any chest with an odd number of drawers.

To get the usable drawer height, subtract the dimensions of the top (5¼ in.), base (6½ in.) and drawer dividers (6 × ¾ in. = 4¼ in.) from the chest's total height (59⅛ in.):

59⅛ – (5¼ + 6½ +4½) = 42⅞

To find the average drawer height, divide the usable drawer height (42⅞ in.) by the number of drawers (7):

42⅞ ÷ 7 = 6⅛

For the drawers below the middle drawer, increase the drawer heights in 1-in. increments. For the drawers above the middle drawer, decrease the drawer heights in 1-in. increments.

be equal to the average drawer height. For the drawers above, simply subtract the amount by which you want the drawers to get smaller—the graduation interval—and add this amount to the drawers below the middle one.

When figuring drawer graduations for a case with an even number of drawers, you still need to find the amount of available drawer space and calculate the average drawer height. However, there will be no average-height drawer in the case when you are through; the average drawer height is just the starting point in your calculations. Determine an average drawer height, then add or subtract one-half the graduation increment to or from that average height to get started. Then proceed by full graduations.

Always remember that you have some flexibility. If needed, you can add a fraction of an inch to the top molding or remove a fraction of an inch from the base to make the numbers work in a simple way (making your life a lot easier) without compromising the chest. You probably can't change the dimensions of your dividers, though, which have to be a specific size if they are to fit into dovetails or dadoes cut with a standard router bit.

The illustrations above are examples of how to graduate the drawers for a case with an even number of drawers and for one with an odd number of drawers. Here's an important thing to keep in mind: You can graduate drawers by any increment—1 in., 2 in., 3 in., even fractional inches—as long as you subtract the increment from the drawers above the average-height drawer and add the increment to the same number of drawers below the average-height drawer. The formulas can be used for any number of drawers, from the smallest case with three drawers to a floor-to-ceiling built-in with 16. □

Chris Becksvoort is a contributing editor to Fine Woodworking. *He is also the author of* The Shaker Legacy *(The Taunton Press, 1999).*

Drawings: Vince Babak

Think Finish First

BY JEFF JEWITT

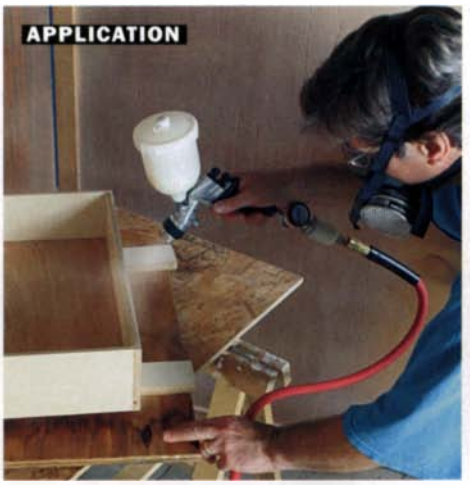
Before you start your next furniture project, consider a finish's appearance, its method of application and its durability

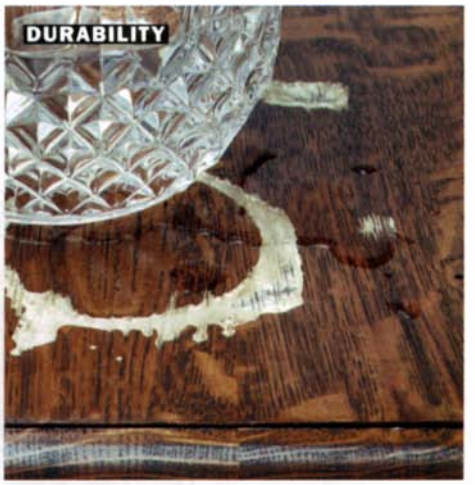
Finishing is one of the biggest bugaboos for many woodworkers. Though they remain undaunted by complex joinery or intricate and precise machining, scores of woodworkers still cringe at the thought of applying a finish to their work. "What's the best finish for my project?" is a question I often hear. Being able to answer that question confidently and comfortably is an important hurdle to overcome.

Finishing products can be grouped into manageable categories, based on general working qualities and the degrees of protection they offer: waxes, oils, varnishes, shellacs, lacquers and water-based finishes. Different finishes offer varying degrees of protection, durability, ease of application, repairability and aesthetics. Unfortunately, no single finish excels in all of these categories—a finish that excels in one may fail in another—so in choosing a finish you must accept trade-offs.

As a professional refinisher, I routinely ask my customers a series of questions to determine the best finish for their furniture. I've modified my standard questions for this article and added a few as a checklist (facing page) for woodworkers trying to decide which finish to use on their own projects. Answers to these questions will point you toward the right finish to use on a given project, based on how well you need to protect the surface, how well the finish will hold up, how easy it is to apply and how you want it to look.

TO DETERMINE THE BEST FINISH,





ASK THE RIGHT QUESTIONS

- **How will the item be used? Will it be subjected to a lot of moisture, solvents, food, scrapes and dents?**
- **What is your skill level, and how big is your work area? Does it stay clean, and is it heated and dry?**
- **What do you want the wood to look like? Do you want an "in-the-wood" natural look or a thicker film finish that accentuates depth?**
- **Will you be filling the pores to attain a highly polished finish?**
- **Will you be rubbing out the finish to achieve a particular sheen?**
- **Do you want the finish to alter the color of the wood? Is yellowing an issue? Do you want to minimize color changes as the wood ages?**
- **Safety and health: Are you sensitive to some solvents or concerned about flammability or the environmental impact of certain finishes?**
- **Toxicity of the finish: Will it be used near areas of food preparation?**

To get a better understanding of the choices, let's first take a look at the different categories of wood finishes.

An overview of what's out there

All wood finishes can be classified as one of two distinctly different types, based on how they dry, or cure. Evaporative finishes—such as lacquer, shellac and many water-based finishes—dry to a hard film as the solvents evaporate. (Water is not a solvent—it's a carrier for the finish emulsion.) These types of finishes will always redissolve in the solvent used to thin them, long after they've dried, so they tend to be less durable than reactive finishes. Most reactive finishes—such as linseed or tung oil, catalyzed lacquers and varnishes—also contain solvents that evaporate, but they cure by reacting with either air outside the can or a chemical placed in the can before application. These finishes undergo a chemical change as they cure, and after that they will not redissolve in the solvent originally used to thin them. Except for the pure oils, reactive finishes tend to hold up better to heat and chemicals.

Waxes—I don't consider wax an appropriate finish in and of itself. I use paste wax (carnauba mostly, sometimes beeswax) to polish furniture but only over other finishes, such as lacquer or shellac.

The true oils—Linseed oil and tung oil, the drying oils most often used in finishing, are readily available and relatively inexpensive. These finishes are called *true oils* to distinguish them from other products hyped as oil finishes and to separate them from naturally nondrying or semidrying oils used in finishes, such as soybean oil. These true oils change from a liquid to a solid through polymerization, a process that strengthens the cured finish.

Linseed oil is available in several forms. Unrefined, it's called raw linseed oil, which is rarely used on wood because it dries so slowly. Finishers long ago discovered that by boiling the oil, the resulting product was thicker and dried more quickly. Even though linseed oil that has actually been boiled is still available—it's called heat-treated or polymerized oil—most of the boiled linseed oil sold these days is raw oil that has been mixed with chemical additives to speed up the drying time. For wood finishing, you should use only boiled linseed oil.

Tung oil is derived from the nuts of trees that are native to Asia but have been cultivated in other parts of the world. Tung oil is available in a pure, unrefined form and in a heat-treated or polymerized form. The heat-treating process makes the oil a bit more durable and speeds up the drying time. It also minimizes a tendency of tung oil to "frost" (dry to a whitish, matte appearance). Tung oil is paler in color and has better moisture resistance than linseed oil.

Both linseed and tung oils are penetrating finishes, which means they penetrate the fibers of the wood and harden. These are the easiest finishes to apply: Wipe them on, allow them to penetrate

Photos, except where noted: Michael Pekovich

APPEARANCE

1 *On light-colored woods, the color of the finish matters. On these samples of ash, the warm, amber tone of nitrocellulose lacquer (top) is just right. The orange shellac (left) and water-based lacquer (right) impart too much or too little color to the wood.*

2 *Do you want that tabletop filled? With the open pores of some woods (such as mahogany and walnut), and on large horizontal surfaces (such as dining tables), filled grain (top sample) will make a huge difference in the way a finish looks.*

3 *The kind of finish you choose will greatly affect the way it looks. Some people prefer the flat look of oil finishes (bottom); others prefer a film finish such as the acrylic lacquer (top) that reflects more light.*

4 *Most finishes turn yellow over time; some don't. To illustrate the difference, the author applied a CAB acrylic lacquer (left) and a standard nitrocellulose lacquer (right) over panels coated with white paint (bottom). The CAB acrylic lacquer is your best choice to avoid the effects of a yellowing finish.*

5 *Slow-drying finishes collect dust. Shellac and most lacquers dry so fast that small amounts of airborne dust don't pose a threat to the end result. Oil-based varnishes, on the other hand, are virtual dust magnets and can be problematic in dusty shop environments.*

6 *Use oil as a sealer to highlight depth. The swipe of linseed oil across this curly maple tabletop shows what a difference it makes in bringing out the figure in the wood. You can apply a topcoat of just about any other finish over a dried coat of oil.*

7 *A thinned finish goes on easier and looks better. Both of these samples of white oak have two coats of polyurethane varnish. The bottom sample was thinned to avoid the obvious buildup you can see on the top sample.*

the surface of the wood and wipe off the excess with a rag. These oils are usually not built up with enough coats to form a surface film, like that of varnish or lacquer, because the film is too soft.

Varnishes—Varnish is made of tough and durable synthetic resins that have been modified with drying oils. Labels on cans of varnish will list resins such as alkyd, phenolic and urethane, and the oils used are tung and linseed, as well as other semidrying oils such as soybean and safflower. Varnish cures by the same process as true oils—polymerization—but the resins make this finish more durable than oil. In fact, oil-based varnish is the most durable finish that can be easily applied by the average woodworker. Varnish surpasses most other finishes in its resistance to water, heat, solvents and other chemicals.

Varnishes that contain a high percentage of oil are called long-oil varnishes. These include marine, spar or exterior varnishes and some interior varnishes for sale on the retail market. Long-oil varnishes are more elastic and softer than medium- and short-oil varnishes that contain a lower percentage of oil. Medium-oil varnishes comprise most interior varnishes on the market. Short-oil varnishes (also known as heat-set varnishes and baking enamels) require extremely high temperatures to dry, so they're used only in industrial applications.

The type of resin used in the varnish determines the characteristics of the finish. Alkyd varnish is the standard all-purpose interior variety with decent protective qualities. Phenolic varnish, usually made with tung oil, is predominantly for exterior use. Urethane varnish, also called polyurethane, offers a better resistance to heat, solvents and abrasions than any other varnish.

Varnish is typically applied with a brush, although a highly thinned and gelled version, called wiping varnish, can be applied with a rag.

Oil and varnish blends—These mixtures, mostly oil with some varnish added, offer some of the best attributes of both ingredi-

A COMPARISON OF COMMON FINISH PRODUCTS

	Product	Ease of application	Repairability	Flame resistance	Health and safety	Water resistance	Chemical resistance	Scratch resistance
EVAPORATIVE finishes dry as their solvents disperse into the air. They will always redissolve into the solvent originally used to thin them, making them easier to repair but also a little less durable.	**Wax**	Excellent	Excellent	Good	Good	Poor	Fair	Poor
	Shellac	Good	Excellent	Fair	Excellent	Fair	Poor	Fair
	Nitrocellulose lacquer	Fair	Excellent	Poor	Poor	Good	Good	Fair
	Most water-based finishes	Good	Poor	Excellent	Fair	Good	Good	Good
REACTIVE finishes undergo a chemical change as they cure, making them not only more difficult to repair but also more durable (except for linseed and tung oil) than most evaporative finishes.	**Linseed oil**	Excellent	Excellent	Good	Excellent	Poor	Fair	Poor
	Tung oil	Excellent	Excellent	Good	Excellent	Fair	Fair	Poor
	Oil-based varnish (alkyd resins)	Good	Poor	Good	Poor	Excellent	Good	Good
	Oil-based polyurethane	Good	Poor	Good	Poor	Excellent	Excellent	Excellent
	Catalyzed lacquer (and conversion varnish)	Poor	Poor	Poor	Poor	Excellent	Excellent	Excellent

ents: the easy application of true oils and the protective qualities of varnish. (Watco-brand Danish oil, teak oil and a number of other finishes fall into this category.) It's difficult to ascribe accurate protective qualities to these products because manufacturers don't usually disclose the ratio of oil to varnish. Oil and varnish blends will dry a bit harder than true oils, and the finishes will build quicker with fewer applications.

Shellacs—While most people think of shellac as a liquid finish found at a paint store, in its pure form it's a natural resin secreted from a bug that feeds on trees, mostly in India and Thailand. The secretions, in the form of cocoons, are gathered and eventually refined into dry flakes, which are then dissolved in denatured (ethyl) alcohol to make the shellac solution that winds up in cans at the store.

Shellac is available in several varieties. You can buy it premixed, or you can buy it in flake form and mix it yourself with denatured alcohol. The premixed variety is available in orange (amber) and clear, which is shellac that's been bleached. With the flakes, shellac is available in a wider variety of colors and wax contents than with the premixed version (which contains wax). The wax in shellac decreases the finish's resistance to water and prevents some finishes from bonding to it.

Lacquers—Most professionals still regard lacquer as the best all-around finish for wood because it dries fast, imparts an incredible depth and richness to the wood, exhibits moderate to excellent durability (depending on the type used) and rubs out well. There are several different types of lacquer, and they exhibit different performance characteristics.

Nitrocellulose lacquer is the most common. If the label on the can says lacquer, it's most likely nitrocellulose, which is made from an alkyd and nitrocellulose resin dissolved and then mixed with solvents that evaporate quickly. This type of lacquer has moderate water resistance, but it's sensitive to heat and certain solvents. The biggest drawback is the finish's tendency to yellow as it ages, which shows clearly on light-colored woods.

Acrylic-modified lacquer is made from a mixture of a nonyel-

APPLICATION

1 *By atomizing the finish into a fine spray, you can achieve a smoother, more even finish faster than you can with any other method. You can spray shellac and oil-based varnishes (including polyurethane), as well as water-based, nitrocellulose and catalyzed lacquers.*

2 *Whether you use a disposable sponge brush or the more traditional bristles, laying on a coat of finish with a brush will require fewer applications. Careful technique means everything toward the goal of a neat job. Brushes work best with oil- and water-based varnishes.*

3 *The time-honored French polish is essentially many coats of shellac put on with a rag. Besides oils, you can also apply varnishes using this method, which is time-consuming but almost foolproof. Wiping on a finish requires patience.*

lowing cellulose resin (called cellulose acetate butyrate, or CAB) and acrylic. This lacquer possesses the same general properties of nitrocellulose lacquer, except it is absolutely water-white, meaning it will not show as an amber color when applied over light-colored woods. Also, the finish won't turn yellow over time.

Catalyzed lacquer bridges the gap between the application traits of nitrocellulose lacquer and the durability of varnish. Catalyzed lacquer is a complex finish composed of urea formaldehyde or urea melamine and an alkyd that has some nitrocellulose resin added to make it handle like normal lacquer. The addition of an acid catalyst initiates a chemical reaction that forms a very tough, durable finish. Catalyzed lacquer comes in two versions: precatalyzed and post-catalyzed. Precatalyzed lacquer has the components premixed, either by the manufacturer or at the store when you buy it; post-catalyzed lacquer is a two-part system that you must mix in your shop, following precise ratios. Once the catalyst has been added, these lacquers have a fairly short pot life (the time in which they can be used).

Water-based finishes—Water-based finish contains some of the same ingredients as varnish and lacquer—notably urethane, alkyd and acrylic—but many flammable and polluting ingredients have been replaced with water. The chemistry in this product is complex. Because the resins don't have a natural affinity for water, they must be chemically modified or forced to combine with water.

Water-based finish is usually made with either an acrylic resin (sold as water-based lacquer) or an acrylic urethane mixture (sold as water-based polyurethane). As with varnish, the addition of the urethane makes the resin tougher and more scratch resistant, but water-based urethane does not have the same solvent and heat resistance as its oil-based counterpart.

What finishes are more durable?

The durability of a finish is measured by its resistance to water, chemicals, solvents (such as those in alkaline cleaners and acidic foods), heat and scratches. Wax, shellac, lacquer and some water-based finishes will be damaged if exposed to water long enough. Most of these products also scratch easily; however, they rub out well. (That's the flip side of scratch resistance.) Wax is surprisingly resistant to acids and alkalis. Aside from that, it is the least durable finish. Shellac is neither resistant to alkalis such as ammonia nor to alcohol. Of all the evaporative finishes, lacquer (nitrocellulose and acrylic, water- and solvent-based) fare the best in terms of overall durability. Oil-based polyurethane is the most durable finish you can apply by hand, and catalyzed lacquer and varnish are the most durable sprayed finishes.

Choose a finish to match your skill level

Your level of experience, the environment in which you work and whether you're set up to spray all play a part in deciding which finish to use. The temperature and dampness of your shop, as well as the amount of sanding dust in the air, will affect your choice. Dust falling onto a finish does not pose as great a problem with lacquer or shellac as it would with a slow-drying finish such as varnish. Shellac and lacquer are also the least temperamental when it comes to cold temperatures, and they can be modified with retarder additives for hot and humid conditions. Oils and oil-based products dry slowly in cold temperatures and humid conditions, and dust is always a problem when it has time to become embedded in the dried film.

Spray equipment requires a larger budget and, in most cases, expensive equipment to exhaust the overspray. There's also a learning curve with spraying, so it will likely take some practice before you get decent results.

The type of finish will notably affect the look of the wood

Do you want a natural "in-the-wood" finish? Or does your work demand an elegant, deep, glass-smooth finish? Is the color of the finish a problem, or will yellowing of the finish be a problem down the road?

Traditionally, woodworkers have turned to oil, wax or oil and varnish blends (such as Watco) for a natural-looking finish. None of these easy-to-apply finishes dries to form a hard surface film.

Photo, this page (left): William Duckworth

DURABILITY

1 *Catalyzed lacquers and conversion varnishes will hold up to heat damage better than any other finishes.*

2 *Alcohol is the original solvent for shellac, an evaporative finish, and will melt right into the dried film in no time.*

3 *Standing water (from a leaky vase or one that collected condensed moisture from the air) can wreak havoc on most finishes. Catalyzed lacquers and oil-based varnishes fare the best against moisture damage.*

4 *A dining table might make a nice racetrack—especially to a child who hasn't noticed his rubber tires are missing. Polyurethane and catalyzed lacquers resist scratches better than any other finishes.*

5 *Damage to an evaporative finish, such as the shellac on the surface of this cherry table, is relatively easy to fix.*

However, you can get a natural-looking effect with any finish—including varnish, shellac and lacquer—as long as you don't build it up more than a few coats and you rub out the dried film with steel wool. But if your goal is a filled-pore, deep, lustrous finish, you must use a hard, film-forming finish (varnish, shellac or lacquer). This type of finish is also mandatory when you have to perform complex coloring options like toning and glazing.

The color and the penetration of the finish itself may be an issue. Orange shellac and phenolic-resin varnish both have colors that may be too dark for woods that you may want to keep as light as possible. In addition, many finishes deepen or darken the wood surface. In most cases this is desirable, because it adds depth and increases luster. However, you may want to downplay any deepening effect. Some delicately figured woods (such as pearwood) will appear muddy when an oil finish is applied.

Oil and oil-based varnish, solvent-based lacquer and shellac all deepen the color of the wood and increase surface luster the most. These finishes wet the cells of the wood, penetrating into the surface. Other film finishes—notably water-based finishes and some catalyzed lacquers—tend to lie on the surface. By not penetrating it as much, they make the wood appear lighter in color.

The plastic look that's sometimes ascribed to polyurethane and catalyzed lacquers has more to do with the incorrect application of these finishes than it does with the finishes themselves. On open-pored woods (plainsawn ash or oak, for example) the application of thick varnish and lacquer can result in a soupy look on the surface. This is a consequence of the finish film bridging across the open pores rather than flowing into them. By thinning these finishes you can achieve more attractive results. My favorite method to apply oil-based polyurethane is to thin the finish 50% with mineral spirits and wipe it on.

A finish film that turns yellow with age will be noticeable with unstained, light-colored woods, such as maple or birch. An acrylic finish, water- or solvent-based, does not have this problem. Paste wax and some catalyzed finishes also will not yellow.

Think about safety and the environment

A solvent-based finish, such as varnish and lacquer, contains a good deal of organic solvents, which can affect the environment as well as your health. It's also highly flammable. If these particulars pose a problem for you, use a water-based finish to eliminate the fire hazard and to mitigate the environmental and health impact. Pure oil is a surprisingly good alternative to a solvent-based lacquer or varnish: Pure oil contains no solvents and comes from renewable resources. However, oil-soaked rags must be disposed of carefully. Shellac is also a good alternative. The solvent for shellac, denatured alcohol, is distilled from corn, and most people don't find the fleeting odor objectionable.

All finishes are nontoxic when fully cured, despite what you may have read or heard. Once the solvents have evaporated, any cured film is safe for contact with food. This does not mean that the finish itself is safe to gobble up. It means simply that additives such as heavy-metal driers and plasticizers are encapsulated well enough that they do not migrate into your food. Wax and shellac (apples and candy are coated with these) are the only edible finishes that I'm aware of, besides mineral oil, which is sold as a laxative.

Spraying wastes a great deal of the finish material, and the organic solvents are dispersed into the air. Brushing or wiping on a finish is a practical, though less speedy, alternative. □

Jeff Jewitt writes frequently for Fine Woodworking. *His latest book,* Great Wood Finishes, *was recently published by The Taunton Press.*

Photo, this page (bottom right): William Duckworth

Basswood, Linden or Lime

By any name, this wood, a carver's delight, proves that it's sometimes good to be weak and bland

BY JON ARNO

To understand the virtues of basswood, you must adopt a totally different mindset. A wood need not be strong, durable and stunningly beautiful to fulfill a role in fine woodworking, and you could find no better example than basswood to prove that point.

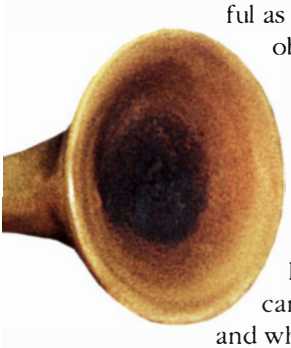
A quick review of basswood's technical properties makes you wonder why anyone would want to use it. With an average specific gravity of only 0.32, it is the softest and weakest of our commercially important domestic hardwoods—softer even than our softest white pine, which weighs in at 0.34. Basswood's extremely fine and even texture makes it appear to have no figure, and its anemic, off-white to creamy-tan color is downright dull. Its average volumetric shrinkage of 15.8%, green to oven dry, is exceptionally high, and its resistance to decay is so poor that it might best be described as pure fungi fodder when used in any exterior application. And though all of this seems to suggest that basswood, sometimes called linden or lime, is a real loser, nothing could be further from the truth.

A wood with one special purpose

No other wood is so perfectly suited for intricate carvings and detailed scroll-saw projects. Basswood is so soft and its texture so fine that it yields to a cutting edge with hardly any effort applied. Its ability to hold sharp detail is outstanding, and the freshly sheared surface is so smooth that it is comparable to sculpted marble. Very little about basswood suggests that it is even wood. In fact, a painted basswood carving looks more like glazed ceramic. But this deception melts the moment you pick up the carving and sense how light in weight it is.

In this respect, the very essence of basswood is that its benefits are contrary to those of other woods. While a cab-

inetmaker typically selects a wood because its natural beauty will enhance a completed project, sometimes the objective is to choose a wood that offers the least visual competition. This is often the case in carving, and few woods are as masterful as basswood in playing this unobtrusive, supporting role.



The basswood family tree

Four species of basswood are native to temperate North America, but only two of them are commercially important timbers: American basswood, *Tilia americana*, and white basswood, *T. heterophylla*. The woods of these two species are so similar that the lumber trade does not segregate them. Also, scant evidence exists to distinguish these two species from the 20 or so Old World lindens that belong to the *Tilia* genus.

It may seem rational to conclude, therefore, that the basswood family is a rather homogeneous clan, but this is true only of the north-temperate genus. The basswood family, Tiliaceae, is primarily tropical in distribution, totaling about 40 genera and nearly 400 species, including vines and herbs as well as trees. From a broader botanical perspective, hints of its kinship with the cocoa family, Sterculiaceae, can be found in its chemistry.

Historic and modern uses

Settlers on the American frontier once used the oven-dried flowers of basswood for making a cocoa-like tea. Also, the honey produced when bees have access to basswood groves has a unique and much-prized flavor. In Europe, the flowers of the linden—also called the lime tree—are used to produce lime-flower oil, an ingredient found in perfumes. Another common feature of many members of the basswood family is the tough, stringy inner bark, called bast. The bast fibers of European linden and American basswood were used for making rope and coarse floor mats. The "bass" in the American name for the tree probably stems from this now, almost forgotten bast industry.

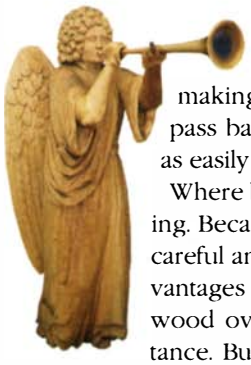
Considering the lack of strength and durability of the lumber, it is surprising how important a role basswood and its European cousin have played in our woodworking tradition. Linden was the wood of choice for the inspired religious carvings found in Gothic cathedrals and in the royal palaces of the Renaissance. In the 19th century, basswood was the source material for beautifully carved carousel horses and decorative circus wagons that charmed a generation of children and that draw crowds even today. It is still one of the preferred woods for piano soundboards, and its cabinetmaking uses have changed little since the 18th century. No synthetic or composite material has managed to replace basswood as a practical choice for drawer dividers, interior panels, scrollwork and light-duty substrates for veneered projects. Basswood comes to mind when a woodworker needs a relatively inexpensive wood that can be easily worked and that will perform well in a structurally undemanding role.

Basswood substitutes

A multitude of other woods vie with basswood in its various roles. Yellow poplar, aspen, red alder and soft maple are relatively interchangeable with basswood as secondary woods in many cabinet-

Basswood is heavenly. *Master wood-carver Fred Wilbur carved these four angels (left and right) as a commission bound to adorn the organ of a church in Savannah, Ga. He finished the figures with an oil and varnish mix and gilded the trumpets. Carvers prize basswood for good reason: It peels off the edge of a chisel effortlessly and crisply (top photo).*

Photos, facing page: Fred Wilbur; this page: William Duckworth



making applications. Most of them surpass basswood in strength, but few are as easily shaped and finished.

Where basswood truly excels is in carving. Because the carving process involves careful and tedious effort, fairly subtle advantages in the working properties of one wood over another are of great importance. But even within the carving world, basswood has its rivals, and some of them have cornered a private segment of the market: tupelo, or black gum, buttress-cut stock for duck decoys and olivewood for chess sets.

Also, a few other woods stand out as important carving and pattern-making species: jelutong, mahogany and sugar pine. In terms of density and texture, perhaps jelutong is the most serious rival, but this Southeast Asian cousin of the rubber tree has latex ducts in the wood that limit the size of clear lumber it can produce. Mahogany, still available in large sizes and possessing outstanding stability, has a coarser texture and is denser than basswood. And finally, sugar pine, only slightly more dense than basswood, has prominent resin canals that can interfere with finishes. As most carvers know, basswood is hard to beat, and being plentiful and inexpensive makes it all the more appealing.

What the connoisseurs look for

Selecting the very best basswood can be a downright demanding skill. While it's normally important to identify the correct species when choosing most cabinet woods, pedigree is of little consequence when it comes to basswood or its cousin linden. Selecting just the right material rests on other factors relating more to growing conditions and how the wood has been processed.

Most carvers prefer sapwood because it is slightly softer. However, there are some aficionados who extend their demands to an almost cultlike level, believing that only the air-dried sapwood of northern trees is worth dulling a gouge on. Personally, I think the right way to buy basswood carving stock is to look at it and decide if it has precisely the characteristics that you want for a given project. But the aficionados cannot be wholly dismissed: Sapwood is softer, and the wood of the northern trees does seem to be slightly finer and more evenly textured. The controversy over how it should be dried rests on far more complex and subtle issues.

Ordinarily, kiln-dried lumber contains less drying stress and is more stable than air-dried stock, but basswood isn't your typical hardwood in this respect. Although basswood undergoes a high volumetric shrinkage in the drying process, it seems to develop little stress and is quite stable once it has dried. I can cite no laboratory results to confirm it, but I suspect basswood remains stable no matter how it's dried because the cells of its wood tissue have thin walls. Instead of fracturing, the cell walls flex and deform to absorb the drying stress.

Also, the high temperatures of kiln-drying give basswood a slightly darker, sort of dirty gray-tan color. And although color is of little importance if the finished project will be painted, the attitude that whiter is better seems to be the prevailing quality standard. Then again, achieving white wood by air-drying is not as simple as it sounds, either: Basswood is extremely susceptible to sticker stain, and moisture can foster bacterial growth that will result in a rank, sour odor. If you are a carver who intends to cuddle up to a chunk of basswood for days on end, every subtle nuance of its character is important. Even the scent. □

Basswoods make good shade trees. *European lindens (photo above) are often planted as ornamental trees, prized for their full shapes and abundant foliage.*

No knots allowed. *Solid blocks of clear basswood make up the stuff of carvers' dreams. The microscopic view at right reveals why: The pores are small and evenly distributed, lending a smooth texture to the surface of the wood.*

Jon Arno, a frequent contributor to Fine Woodworking, *profiles various woods of the world.*

Drawing: Bobbi Angell; photos (clockwise from top left): Fred Wilbur, William Duckworth, R. Bruce Hoadley, Michael Pekovich

Shop-Built Horizontal Mortiser

BY JOHN F. MATOUSEK

Using a router and two sliding tables, this homemade setup is a versatile joint-making machine

My wife and I had just transformed our basement into a sitting area, home office, alcove and bar, but it was clear to me that we weren't finished. I envisioned three major furniture projects I'd have to complete. We needed a built-in storage cabinet in the sitting area for a television and VCR; base cabinets in the office for a computer, a printer, a copier and a fax machine; and shelf units in the alcove for books, albums and assorted art objects. I planned to build the shelf units in a Craftsman style, based on some bookcases I'd seen in an article by C. Michael Vogt (*FWW* #110, pp. 58-60). I could foresee dozens—if not hundreds—of mortise-and-tenon joints, and I began to question my plan to tackle all of these projects.

I had read an article about mortise-and-loose-tenon joints, and I remembered that loose tenons are simple to make. If I could speed up the mortising process, I could complete my three projects in a reasonable amount of time. So I began to design a machine to make mortises.

The machine is designed to make accurate cuts

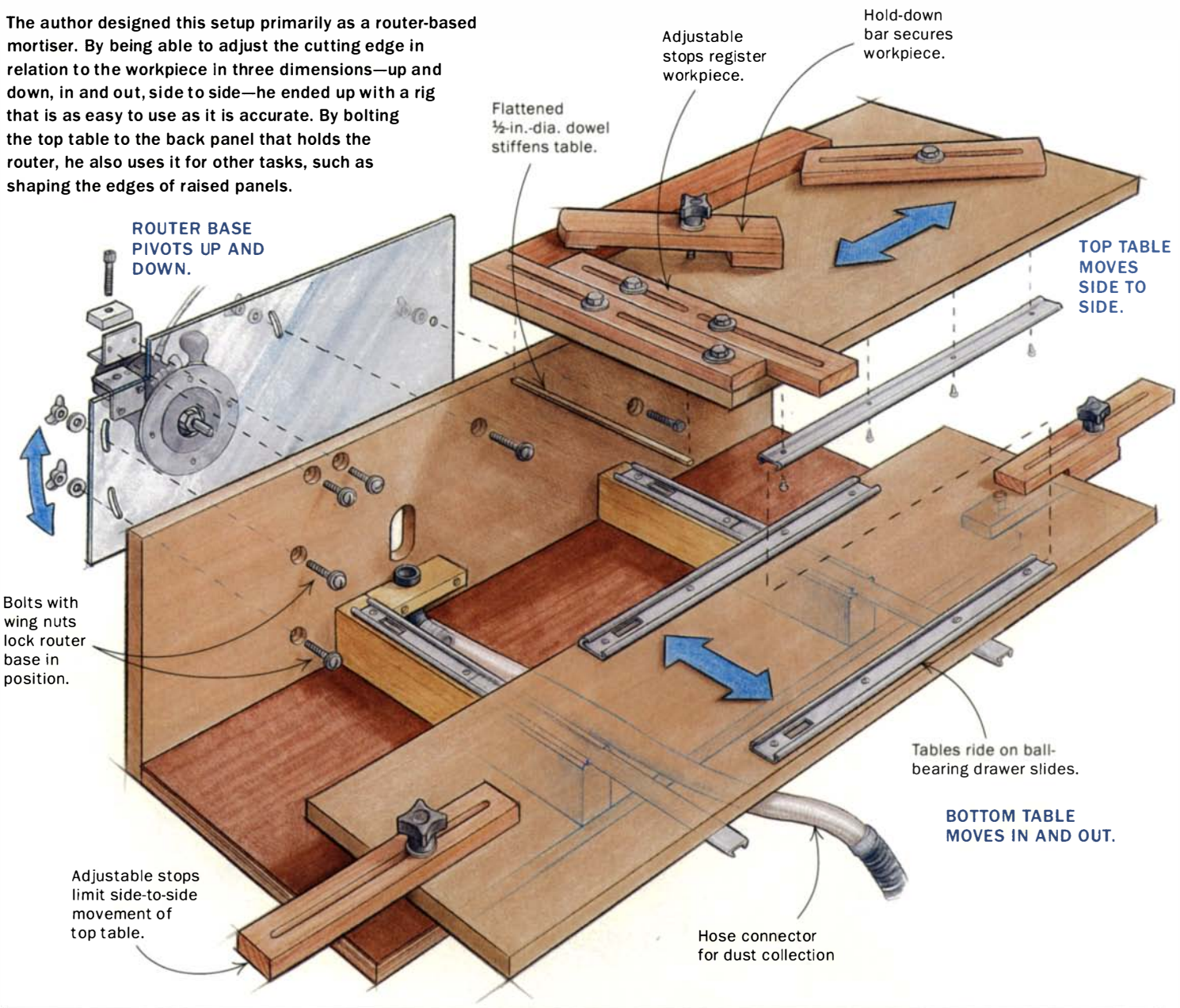
I wanted a system that could be set up easily and be operated safely and that could accurately duplicate a mortising operation. Also, I needed a machine that could raise or lower the cutting bit as necessary for precise adjustments. But I wasn't sure that my scheme would work, and I didn't want to spend a lot of money on a failed experiment, so I built this setup with scraps and hardware left over from previous projects. The design I finally built (see the drawing on p. 68) was that of a horizontal compound-mortising table. As designed, it is meant to mortise mostly ¾-in.-thick lumber workpieces, using a solid-carbide, ¼-in. spiral upcut bit, powered by a standard 1½-hp router, which I mounted on a vertical back panel. (I did buy a new Porter-Cable model No. 690 router, figuring that I could use it in the shop even if my experiment failed.)

The machine has two movable tables. The top table moves

Photos, except where noted: Jefferson Kolle

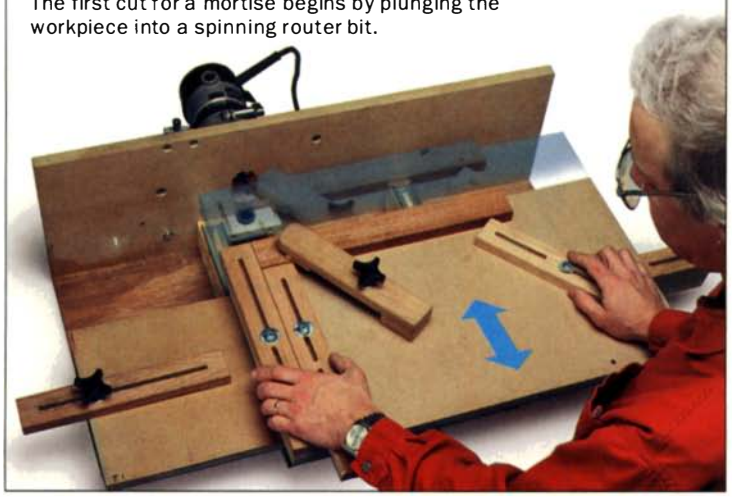
ONE NIFTY SHOP-BUILT MACHINE

The author designed this setup primarily as a router-based mortiser. By being able to adjust the cutting edge in relation to the workpiece in three dimensions—up and down, in and out, side to side—he ended up with a rig that is as easy to use as it is accurate. By bolting the top table to the back panel that holds the router, he also uses it for other tasks, such as shaping the edges of raised panels.

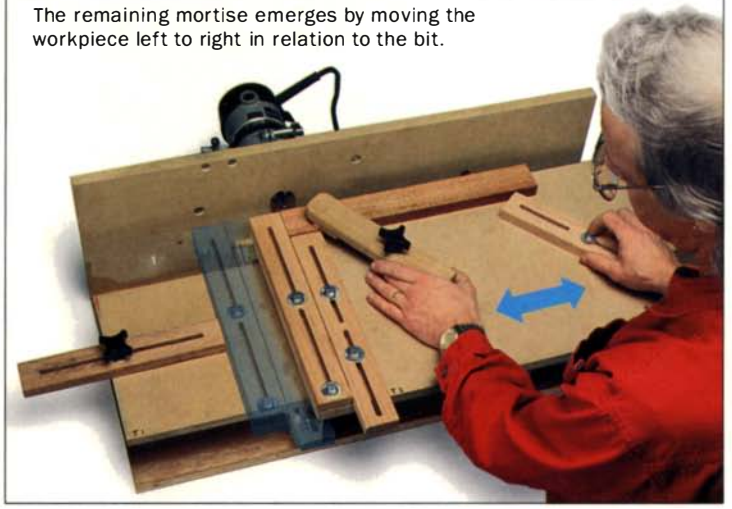


HOW IT WORKS

The first cut for a mortise begins by plunging the workpiece into a spinning router bit.



The remaining mortise emerges by moving the workpiece left to right in relation to the bit.



Drawing: Bob La Pointe

at right angles to the bit, and the bottom table moves parallel to it. I mounted two drawer slides (Accuride model No. C-1029 center-mount slides) under the tables to provide for the side-to-side and front-to-back movements of the tables. Movable stops at each end of the bottom table can be set to control the distance the top table can move and thus the length of the mortise.

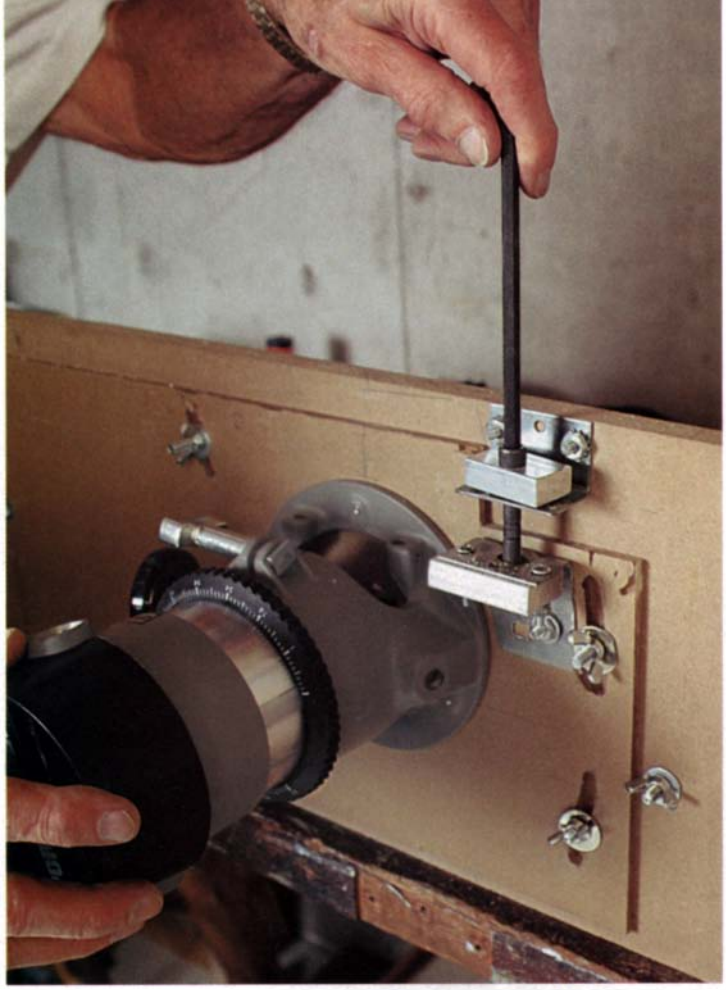
Indexed adjustments are the key to accuracy—To improve accuracy and to speed up the mortising process, I wanted stops wherever possible to position the workpiece for mortising rather than to depend upon pencil layout lines. By butting the workpiece against a stop, I could ensure the accuracy and the reliability of matching stile-and-rail joints.

For a given frame or set of frames, I wanted to position the stops only one time for both left and right mortises. The other option would have been to reposition the stops when going from a left to a right mortise, but it would be faster to flip the workpiece over, end for end.

To position the mortise with such a high level of precision in the center of the workpiece, the router would have to be mounted on the back panel so that it could be raised or lowered until the bit cut into the exact center of the workpiece. Using a threaded bolt to raise and lower the router (see the photo above) and a dial indicator to check the adjustments, I could fine-tune the height of the cutting bit very easily.

To make a mortise near the middle of a stile—such as that required for a center rail—the stops have to be removed, and you must use layout lines to position the workpiece for the cut.

The original setup needed some tweaking—The prototype of this machine worked beyond my expectations, except for one defect.



One turn of the threaded bolt can raise or lower the router. *The author rigged up the adjusting device shown here to enhance his ability to fine-tune the height of the router bit in relation to the workpiece. The router swivels up and down on a Plexiglas base that is hinged on one end of the vertical panel to which it is secured.*

When moving the top table forward into the cutting bit, I tended to press down on the table with enough force to deflect it sufficiently that it cut the mortise off center. To correct this, I snugly fitted a flattened ½-in. dowel to the underside of each end of the top table and added a little wax on the surfaces where the dowels slid against the bottom table.

Also, I added a hold-down bar on the top table for safety and to improve the accuracy of each setup. And finally, a 1¼-in.-dia. vacuum hose (mounted directly beneath the router bit and connected to a standard shop vacuum) collects most of the dust and chips generated by mortising operations.

Use this machine as a mortiser or as a conventional router table

After setting up the machine to cut a mortise, it's best to plunge the workpiece repeatedly into the cutting bit, drilling a series of holes, by moving the bottom table in and out and adjusting the top table a little for each plunge.

After that, clean up the sidewalls of the mortise by moving the top table left to right between the stops (which are mounted on both sides of the bottom table). Also, by clamping a fence on the top table 45° to the back panel, you can drill mortises into the ends of a 45° miter using essentially the same procedure.

By bolting the top table to the back panel—using two brackets on the underside—you can turn this machine into a router table, good for any number of shaping tasks. For years I've wanted to cut raised panels, but I've always felt uneasy about using either a 4½-in.-dia. shaper cutter or a vertical router table. The amount of spinning steel in a large cutter scares me, and using a vertical panel-raising bit in a vertical router doesn't appeal to me because it's awkward to move a large panel through the cutter resting only on its edge. But by using a vertical panel-raising bit horizontally in this machine, I was able to address all of my concerns and to get good results because the panel lies flat on the table, and it's easy to control.

Loose tenons can be made in large quantities—I manufacture a variety of loose tenons before I need them, making 100 or so at a time in varying widths and lengths. I use ¼-in. hardboard, ripped to width, and I round over the edges with a ¼-in. bullnose bit. Because the length of the mortise can be controlled with considerable accuracy by the mortising machine, the width of the tenons is not a critical dimension, and I'm able to stockpile a pretty good supply without worrying about whether they will fit later on.

I completed my three projects in a reasonable period of time and in the process made several hundred mortise-and-loose-tenon joints with safety, accuracy and speed. This machine is quite specialized, and I don't have to use it very often, but when I do, it saves me a bundle of time. □

John F. Matousek lives in Englewood, Colo., and is retired from his career as an information systems engineer.

Photos, facing page: Michael Pekovich

Building WITHOUT Plans

Rough sketches and quick mock-ups offer an unintimidating way to design your own furniture

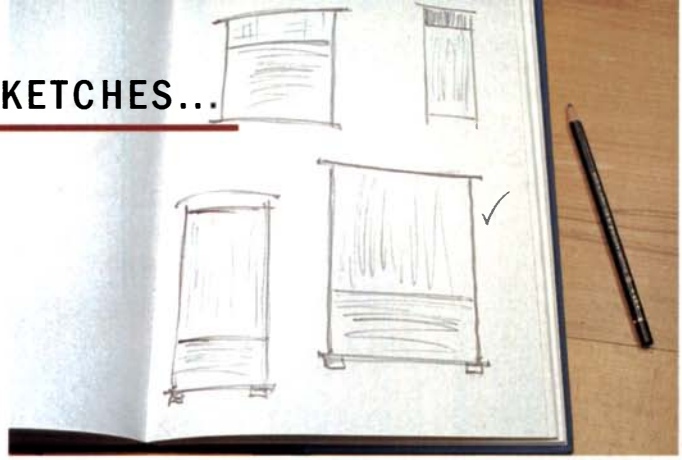
BY CRAIG VANDALL STEVENS

Most of us who work with wood began by making at least some things from plans. I was no exception. But working from plans can begin to feel restrictive. At some point we all wonder, "What if I designed it myself?"

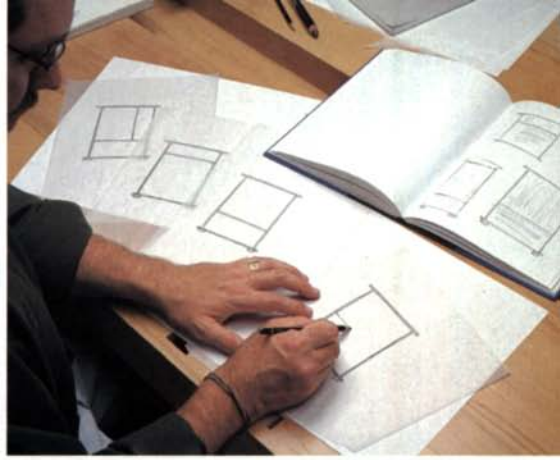
Making a standing screen presents a wonderful chance to explore the design aspect of woodworking. With its straight lines and straightforward joinery, a screen presents a minimum of construction challenges, opening the way for thoughts of design. The length of the project usually can be measured in days rather than in

FROM QUICK SKETCHES...

You don't need finely detailed drawings to design a good piece of furniture. Small drawings without much detail provide a good way to explore overall proportions.



The proper proportions. *Early on, while he's searching for an overall shape he likes, the author draws quickly, placing a handful of drawings on a page to make comparing them easier.*



Tracing refines the sketch. *Once he's picked a drawing he likes, the author uses tracing paper to refine some details. Here, he traced the proportions of the frame but experimented with different ways of dividing the panels.*

weeks, and that can reduce the pressure of working with your own design. Still, although I've chosen to illustrate the process of design by following the development of a standing screen, the techniques I outline in this article apply not just to screens but also to any type of furniture. If you take the leap into designing your own work, I think you'll see it's a very rewarding process.

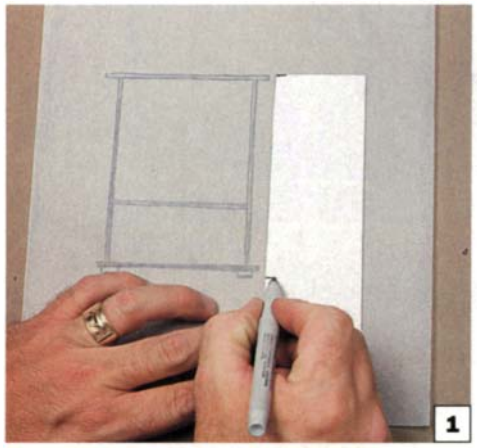
Rough sketching is fine

I develop furniture ideas by sketching. I tend to make small sketches and make them quickly, especially early in the design process. I don't want to get hung up on a lot of detail early on, when I'm trying to establish the overall form of a piece. Finding attractive proportions is one of the most challenging aspects of designing furniture, and sketching quickly enables me to explore proportions effectively. I don't think you need to be talented at drawing to design good furniture, and drawing small and quickly reduces the artistic burden.

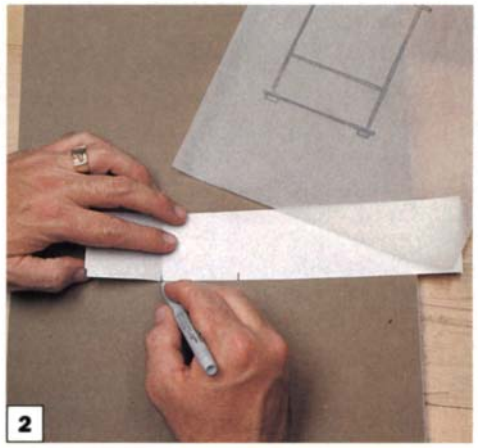
I have a number of sketchbooks, large ones that I use in the shop and small ones that go on the road. I typically use a soft pencil, but in a pinch I'll use anything handy. I have a 9mm mechanical pencil that makes clean lines and doesn't arouse suspicion at church in my choir folder. I also have some fat drawing pencils that are great for putting the first idea for a piece down on paper. The line they leave is wide enough that I'm not tempted to draw a lot of detail, just shapes and proportions. Whatever pencil I use, I resist the temptation to erase—I just live with errant lines or work them into the drawing. The main idea is to get some ideas down, not to make the

TO A SIMPLE SCALE...

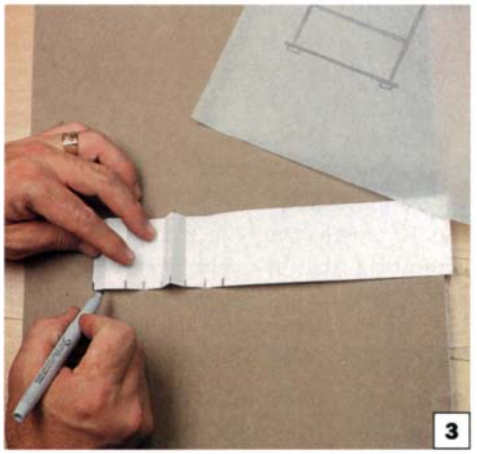
An easily made paper scale enables you to assign dimensions to your drawing and make the leap from a small, freehand sketch to a full-scale mock-up.



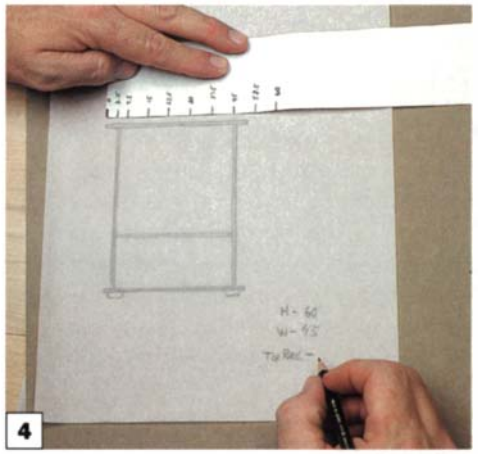
The first dimension. *Assign a measurement to one dimension; the author decided the screen would be 60 in. tall. Tick off the top and bottom of the piece, and the distance between them will represent 60 in.*



Fold, crease, mark. *Fold the scale so that the first two tick marks meet. Then tick the crease halfway between them—it will equal 30 in.*



Keep on ticking. *Continue folding the scale in half and marking the creases.*



Rough sketch gets real dimensions. *Once the scale has been marked, it can be used to measure any part of the screen.*

Photos, except where noted: Jonathan Binzen

Sizing up the frame. *Before determining any of the details, the author considers the overall proportions of the screen and the placement of the crossbar.*

drawing perfect. If you can't keep your fingers off the eraser, try drawing with ink.

When one of these sketches strikes an idea I like, I usually draw a number of variations of it. I'll often sketch out half a dozen or more takes on it in a sketchbook or on a large sheet of paper. Then I choose the one I like best and refine it further. I often use tracing paper to duplicate the basic shape of the piece a number of times, and then I sketch in variations on the details. Aside from saving time, tracing ensures that the part of the original drawing I like—the overall proportions, say—remains constant while I play with various details I'm less certain about.

Homemade scale provides dimensions

The freehand concept drawings I've described are a great way to arrive at shapes and proportions you find pleasing. But if you don't draw to scale or in accurate perspective, how do you turn a small, rough sketch into something you can build from? While a student of James Krenov's at the College of the Redwoods, I learned to use a simple homemade scale to assign dimensions to a concept sketch.

To make the scale (see the photos on p. 71), you need to assign a value to one dimension of the piece you've drawn. The measurements of all other parts will be derived from that first one. For example, in the case of my standing screen, I decided its overall height should be 60 in. On a piece of scrap paper slightly longer than my sketch of the screen, I made pencil marks that corresponded to the top and bottom of the screen. That gave me my scale: For this sketch, the distance between the two marks would equal 60 in. I folded the paper in half with the pencil marks touching, creating a crease halfway between the marks that equaled 30 in. I made a tick mark at the crease. I folded the scale in half again and again until it was folded up like a Japanese fan. I put tick marks and the appropriate number of inches at each of the folds, and the scale was ready to use. Holding the scale horizontally across the

TO A FULL-SCALE MOCK-UP...

Many details can be worked out at the mock-up stage. Built with 2x stock, drywall screws and kraft paper, this mock-up is quick to make and easy to revise.

Get me out of the shop. *Placing a mock-up in a room for a few days can help clarify the design's strengths and weaknesses.*

To the big board. *A piece of plywood propped on a chair (another old mock-up) serves as an easel for sketching the carving design. The author uses a fat pencil to produce a flowing line.*

sketch, I used it to measure the width of the screen. Such a scale can be used to determine most all the dimensions of a sketch.

Mock-ups let you see the piece before building it

Once I have dimensions on my drawing, you might expect that I'd make a dimensioned shop drawing. Instead, I move at this point directly to making a mock-up of the piece. Making a mock-up is one of the most helpful steps along the path of building a piece of furniture. A full-sized mock-up allows me to see the object in three dimensions and to make informed decisions regarding proportions and size. A full-sized drawing of a piece doesn't give me anything like the impact of a mock-up. It also locks me into decisions on detailing before I'm ready. I generally don't make a scale model, either, because it doesn't provide the sense of physical presence that a mock-up does.

My mock-ups aren't built to last. I use common materials (for the screen I used 2x stock for the frame and kraft paper for the panels) and the quickest possible joinery (drywall screws, brads). I want a mock-up to be as simple as possible to make and easily modified again and again until I'm comfortable with the design. I probably spent about an hour and a half building the screen mock-up. The less time it takes to build one, the more inclined I'll be to alter something I don't like. And that's the whole point of a mock-up.

I use my first mock-up, like my first sketches, to determine the overall shape and proportions of a piece. When I had the first mock-up of the screen in front of me, I saw that it was far wider than it appeared in the sketch. What had looked nicely balanced on paper was somewhat clumsy in three dimensions and full size. I made decisions regarding the overall width of the screen (I decided it needed narrowing), the thickness of the lower rail (it needed thinning) and the way the feet relate to the rest of the screen (they needed to be less clunky).

Implementing such changes is easy. I don't need a second mock-up; I simply unscrew the first one (or unclamp it if I haven't yet driven the screws) and use the chopsaw to shorten some members and the bandsaw to shave a bit off the elements that look too heavy. With the bandsaw, I'm not measuring and taking off specific amounts, just taking off enough to make a difference visually. I generally start with all of the parts a little oversized and work down from there. I had roughed out a few extra blanks for feet, and I quickly cut out a couple of new possibilities on the bandsaw. I put two different feet on the mock-up to compare likely candidates.

When I finish a mock-up, I take it into the house and live with it a while. I place it so it's the first thing I see when I walk into the room. Over the next few days, I try to let it surprise me when I enter the room. The first impression I have of the proportions is telling. It's not a life-changing moment of clarity. It's usually just a quick thought like, "It's too tall," or "The feet are too fat." I pay attention to these impressions, because they are uncluttered by logic, analysis, formulas and so on. Everyone has such responses, but it may take some coaxing to get yourself to trust them.

With this new input, I take apart the mock-up, make the changes, reassemble it and take another look. At this stage, I might also add some fine detailing to the mock-up. (Before this, I have avoided including details such as subtle textures and reveals because I find them distracting early on.) The new proportions may result in the need to fiddle with the dimensions of other parts, but the mock-up is definitely making headway. Overall, I find that a mock-up provides an enjoyable and reassuring way to develop and refine a design.

TO THE FINISHED PIECE

The author developed the screen's pleasing proportions, careful detailing and calm presence without benefit of elaborate shop drawings.

How I design a carving

The screen's panels provide a wonderful canvas for the free-flowing type of carving I do. To design a carving, I use sketching techniques very similar to those used to design the screen itself. I start small, drawing on the panels of my thumbnail sketch of the screen. Working small helps me see the carving design as a whole and keeps me from getting bogged down in details.

Once I have an idea that works well with the screen design, I begin sketching full scale. I use kraft or butcher's paper from a wide roll to make the drawing. I'll prop up a piece of plywood and tape the paper to it so that I can draw while standing. I keep the small sketch nearby for reference as I work full size.

I use a soft pencil, and often instead of holding it the way I would to write, I hold it almost flat under my palm. This produces a wider, bolder line and permits my arm and hand to move in comfortable arcs, creating graceful lines more easily.

I pin the finished sketch to the mock-up so I can stand back and see it framed in the screen. Sometimes after seeing it in place, I make changes to the drawing to create a better sense of balance with the screen.

Once I'm satisfied with the sketch, I'll lay out the real panels in the order they'll take in the screen and transfer the design to the panels with carbon paper. Then the carving can begin. (For more on how to do this style of chip carving, see *FWW* #134, pp. 68-71.)

One important general tip on carving design: Resist the urge to fill the whole space. Leaving some space uncarved can significantly increase the impact of the carving. Particularly when you are working a large surface in this style of chip carving, the old maxim applies: Less really is more. □

Craig Vandall Stevens lives and works wood in Sunbury, Ohio.

Photo, this page: Stephen Webster

Trestle Table
with Breadboard Ends

Cut all of the joints before cutting any of the shapes

BY CHARLES DURFEE

The neo-Sears & Roebuck table that you have been dining at since your student days is getting tiresome. And now a big party, months in the planning, is tangibly close. It's time to unveil your woodworking skills for a large and appreciative audience. It's time to build that trestle table you have thought about for years.

First, settle on the size. A dining table for the average family, 3 ft. by 6 ft., will seat six comfortably—seven or eight in a pinch. An 8-ft. model will give you more space. Be sure to allow about 3 ft. all around the table for seating. Trestle-table widths are limited to 3 ft. for structural reasons (more on that later). Next, decide on the type of wood you want. Domestic hardwoods, especially cherry, walnut, birch and maple, work well for this project. If the R.S.V.P.s are coming back, there's no time to lose.

Build the base first

It doesn't really matter whether you build the top or the base first. Starting with the base is a good idea because it takes the bulk of the work (generally true for tables). And if that's all you have done by the day of the party, at least you can slap a piece of plywood down, put a tablecloth over it and still hear plenty of praise. But you should at least skim-plane the top boards at this time to be sure

that you will have sufficient stock to make it wide enough. Allow ¼ in. per piece, after trimming off sap and bad edges, for jointing. Tops have a way of getting narrower as you work them up.

Stop caressing that lovely, thick, cherry stock for which you just liquidated your retirement portfolio, and pick up some cardboard, thin wood or plywood to make patterns. The latter two are better choices because they can be used for pattern-shaping parts on a router table, if you are so inclined. Make patterns for the feet and cleats, as well as for the posts. Although the posts are straight and square, having a pattern for them makes it easier to lay out your rough stock to get the best yield. Make the patterns carefully and accurately. I write construction notes on them also. After seeing the table, your next-door neighbors will want you to build one for them, and the notes will help you remember how you did it.

Patterns make perfect. *Use patterns for the trestle table's foot and cleat. Construction reminders written on the patterns help you avoid mistakes and remember salient details. After tracing the patterns on the stock, joint the top and bottom of each piece and then lay out the mortises.*

For the beam, find a nice piece of 6/4 or 8/4 stock, 6 in. wide. The feet and cleats will come out of 8/4 stock, while the posts can be from 6/4 or 8/4 stock. Bear in mind that most of the base assembly will be exposed on all sides, so there is no chance to hide knots, sapwood or other imperfections. (Unless, of course, you choose to make them a design element, which I don't advocate.) You can tuck small flaws up on the inside of the cleats, if necessary.

I have two general rules for ease and efficiency in construction: 1) complete the joinery on each part before cutting out the shapes; and 2) chop the mortises before cutting the tenons. Thus, after jointing and planing the stock to thickness, rough out the feet and cleats on a bandsaw. Joint the flats on the bottoms of the feet and tops of the cleats. Rip these parts to their overall heights on the tablesaw, but don't cut the tapers yet—joinery before shape, remember? Because the posts and beam have no particular shape, the four sides can be cut to size at this time.

Now, lay out the mortises, making sure that they are centered in their respective pieces, then chop them. For chopping I use a vintage, floor-model hol-

Chopping through-mortises by hand

1 ***Cutting through-mortises requires extra precision.*** *Instead of using his mortising machine for the beam-to-post mortises, the author uses a ⅜-in. bit to rough out the ½-in.-wide mortise from both sides, which he then finishes with chisels.*

2 ***Marking with a razor knife makes for a crisp edge.*** *The through-mortises are 3/16 in. longer on the outside faces of the posts (see the drawing on p. 77). Prior to assembly the tenons will be kerfed on the bandsaw, and during assembly, wedges driven into the kerfs will close the gaps at the top and bottom of the elongated mortises.*

Photos, except where noted: Michael Pekovich; facing page: Dennis Griggs

Sizing tenons

1 ***Mortises first, then tenons.*** *After all of the mortises have been cut, hold a scrap of stock to the mortise and mark the tenon width.*

2 ***Made in the shade with a dado blade.*** *Centered tenons are easy to cut with a dado blade because the blade will cut the same amount of wood from both sides of the stock. The author makes a test cut and then raises or lowers the blade to the premarked pencil line on the scrap stock.*

3 ***Test fit.*** *After cutting the scrap to the marked lines, the author tests the fit in the mortise. When the fit is right—it may take several tries—he cuts tenons on the real stock.*

low-chisel mortising machine that crunches out the slots with authority. But in my earlier days, I would have drilled out the waste and pared the sides with a sharp chisel—an inexpensive method that works very well. Indeed, this latter method is preferred for the post-to-beam through-mortises (see the bottom photo on p. 75) because hand tools will provide the crisp outline you want. For these mortises, mark out on one side and transfer the marks to the other side. Waste and pare halfway in from each face. Slightly lengthen the ends of the slots on the outside faces by 3⁄16 in. top and bottom, which creates a dovetail effect when the beams are wedged.

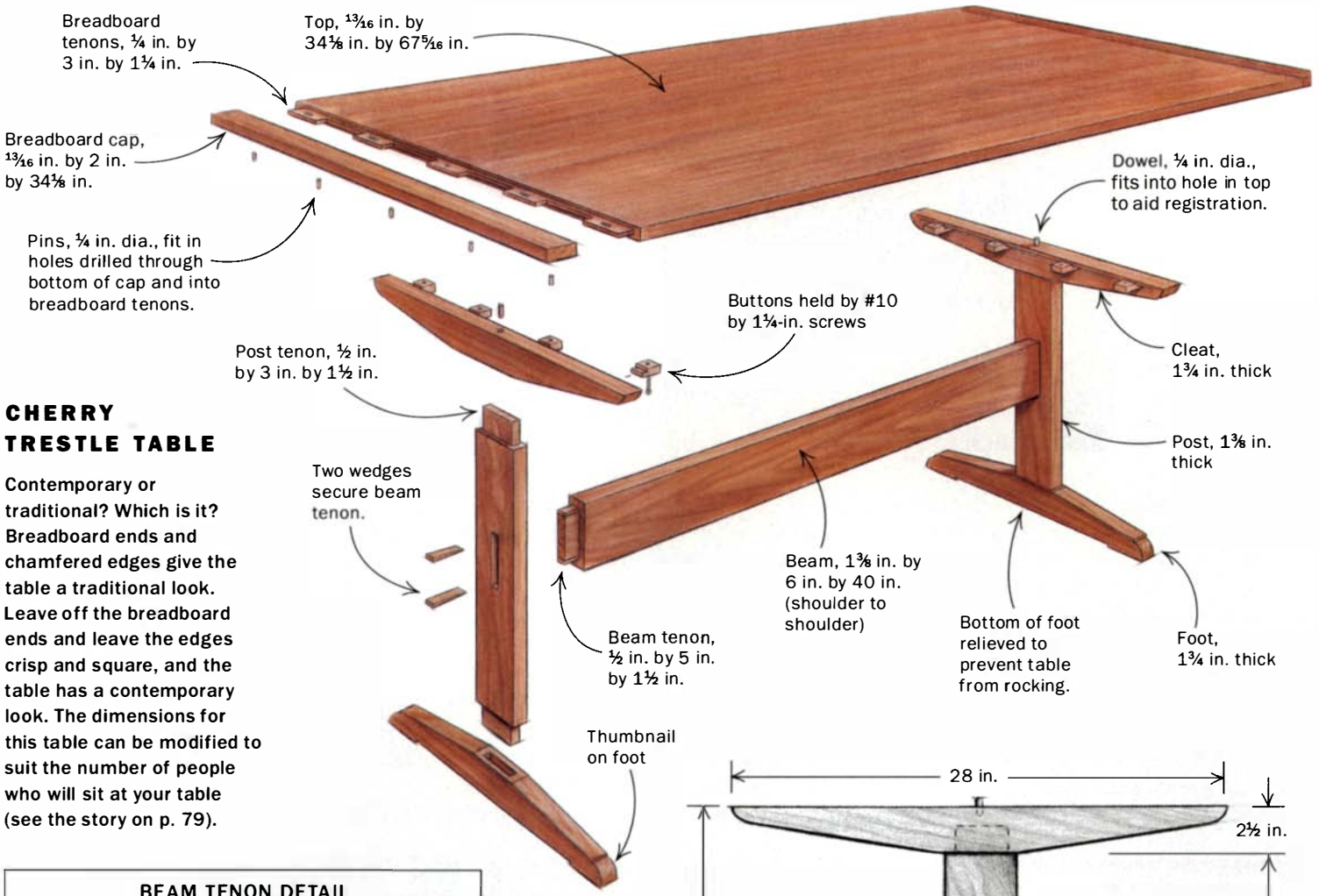
For the layout, mark from the mortised piece onto the to-be-tenoned piece. Tenons can be cut with a handsaw and chisel or by machine. I prefer to cut them laid flat on a tablesaw fitted with a dado head. Use the miter gauge to push the piece across, and the fence as a stop. A sharp dado blade will cut the shoulder and cheeks cleanly in a few passes, with one setup. I don't like standing a piece on end to cut tenons. The thought of a long piece of wood waving about above the sawblade doesn't inspire confidence. And even with a jig to hold the piece, getting the sawcut plumb into the cheeks can be difficult.

It's a good idea to make test cuts in some scrap that's the same thickness as the posts and beams. Set the blade a bit shy of the correct height, and raise it in increments, as needed. Flipping the piece over and cutting off the same amount from both sides will automatically center the tenon.

Test the fit, and if necessary, use a rabbet plane to trim the tenon just right. I often have to do this, no matter how carefully I had done the machine work. You should be able to push the tenon into the mortise simply using hand pressure. If you feel like you have to hammer the tenon into the mortise, don't. Stop, and pare the cheek more. If it drops in with its own weight, it's too loose. In that case, glue a shim of veneer to one cheek and try again. The shoulders can be back-cut slightly to improve their fit.

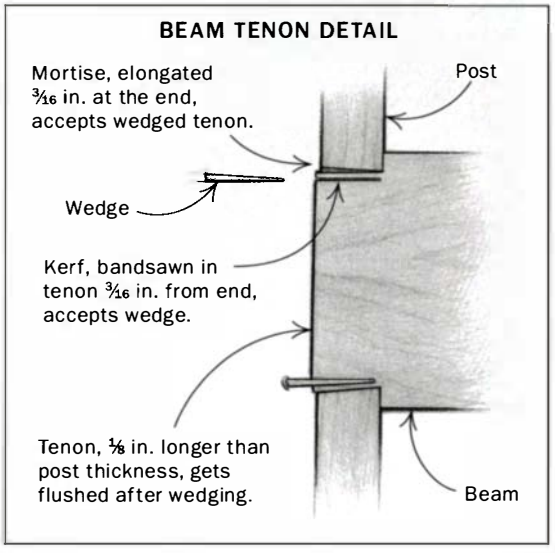
Test-fit the mortise-and-tenon joints, including the beam-to-post ones. Take your time, and have patience to make them right: snug fits for the cheeks, no daylight under the shoulders and everything square. Give yourself a chance to feel the

Bandsaw to shape; finish by hand. *Feet and cleats, the only curved parts of the table, are cut on a bandsaw and then finished with a plane and scraper. The ends of the feet are adorned with a thumbnail, which the author shapes with a rasp and file.*



CHERRY TRESTLE TABLE

Contemporary or traditional? Which is it? Breadboard ends and chamfered edges give the table a traditional look. Leave off the breadboard ends and leave the edges crisp and square, and the table has a contemporary look. The dimensions for this table can be modified to suit the number of people who will sit at your table (see the story on p. 79).



pride in a job well done—it's worth it!

Shape the feet and cleats with a bandsaw; finish with hand tools

Now shape the feet and cleats. Mark the areas where the post shoulders will land so that you don't cut into these areas. The tapers can be roughed out on the bandsaw and easily finished up using a handplane, rasp and scraper and, if necessary, doing some light sanding. If you're dying to use the router table, attach the pattern to the stock with double-stick tape and trim away using a flush-trimming bit.

It is helpful to clean up the surface on each piece before assembly. Use a handplane or cabinet scraper—both are efficient to use and crisply focus the grain patterns. As a bonus, you can listen to music instead of the loud whine of a power sander. But sand, if you must. Whichever method you use, go lightly in areas where tenon shoulders touch down, so you do not ruin the careful joinery work. (I must confess that I do sand on occasion, but only lightly and after assembly to prepare the surface for finish-

Drawings: Bob La Pointe

Clamp and measure. *After a dry run with clamps, the author spreads glue on the tenon faces and on the mouths of the mortises and clamps together the leg assemblies. Before the glue has time to set, he measures from the tips of the feet to the tips of the cleats, making sure the distances are the same.*

ing. I also sand spots where the grain stubbornly resists being cut cleanly.)

Now use a router to knock off a moderate 3/16-in. chamfer on all of the edges. Just how much you trim from the edges depends on the look you want: Trim more for the antique effect, less for the contemporary.

Begin assembly by putting together each foot-post-cleat unit. After brushing glue on the tenon cheeks and in the mouth of the mortise, press the parts together. Usually, a clamp or two from top to bottom will close the joints nicely. Check that the cleat and foot are square to the post and that the measurements from the cleat tips to feet tips are equal. It's easier to clean up glue now than it is to chisel it out later. Of course, the real trick is to use only enough glue to have a tiny bit of squeeze-out. I have some high-tech tools I use for glue cleanup: an old toothbrush, a corner of a plastic credit card and a sharpened stick wrapped with a damp rag.

After the post assemblies are dry, they can be joined to the beam. Make the wedges and cut the kerfs for them. I use my bandsaw to cut both the wedges and the kerfs in the beams for the wedges.

Now you are ready for the final assembly of the base. Being too impatient to wait for my wife or the UPS man to be on hand, I usually do this step alone. But it's tricky and goes more smoothly with some help. Maybe a dinner guest can come early to help out?

Make a dry run, but don't drive the wedges. Once you're sure everything fits, brush glue around the joinery, assemble the pieces and pull tight. Don't muscle down on the clamps too much, or you risk cracking the posts across the beam. It's best to have one clamp on each side of the beam, as shown in the left photo below.

Once the joints have been pulled tight, you can begin to drive the wedges. Dip the tip of the wedge into the glue and, working quickly before the glue sets, place it into the kerf.

Drive the top and bottom wedges at the same time with the hammer, giving them alternate taps. When the sound of the hammer blows changes from ringing to dull, you know the wedges are home.

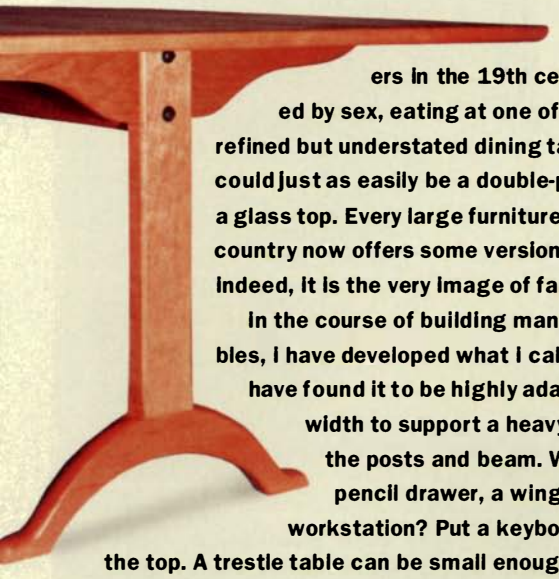
Again, clean up glue squeeze-out before it sets in the inside corners. Leave the outside of the wedged mortise and tenon until later; you'll be able to attack it easily. When you do, cut off the protruding wedges, and flush off the whole end with a sharp handplane. A low-angle one works well here. The base

Put clamps near the through-mortises. *Protect the posts from clamp tracks with blocks of wood held by smaller clamps. Do not put the long clamps too high on the posts or on the feet or cleats; there's a danger of bending the posts or, worse yet, splitting the mortises with too much pressure.*

Wedges close the gap. *Remember those mortises you elongated? It's time to close them up with bandsaw-cut wedges. Dip the wedge tips in glue and tap them into the kerfs cut in the beam. Alternate hammer taps: hit one wedge, then the other. You'll know the wedges are home when the sound of the taps changes from ringing to dull.*

Variations on a basic design

Mention the trestle table, and many images come to mind. It could be a Colonial family gathered for dinner around a few rough planks over a crude X-trestle. It could be Shakers in the 19th century, silent and divided by sex, eating at one of their elegant and refined but understated dining tables. For myself, it could just as easily be a double-post trestle supporting a glass top. Every large furniture manufacturer in the country now offers some version of the trestle table. Indeed, it is the very image of family life.



In the course of building many types of trestle tables, I have developed what I call my basic design and have found it to be highly adaptable. Need more width to support a heavy glass top? Double up the posts and beam. Want a desk? Add a pencil drawer, a wing and an organizer. A workstation? Put a keyboard tray underneath the top. A trestle table can be small enough for breakfast or big enough for a grand banquet. By placing extra sets of posts and legs along the way, a table can be stretched out to at least 12 ft., as the Shakers did.

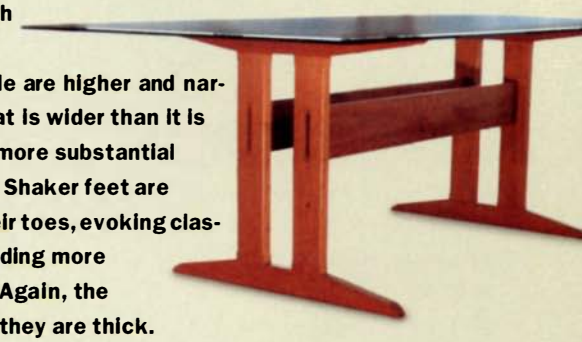
There are limitations, of course. Although not constrained in length, the design is very much so in width. While you need a minimum width of 32 in. to 34 in. for dining—less than that becomes a knee-knocker—a top wider than 36 in. will put too much stress on the post-to-cleat joint. One solution is to adopt a double-post and beam design, which gives the piece a contemporary look. Several years ago, a customer requested a base design to go with a plate-glass top, to be 42 in. by 84 in. Using my basic design, I doubled the posts and beams and made the feet and cleats proportionately longer. The result turned out to be very successful—the glass nicely complemented the openness of the trestle base, which was strong enough to support the weight. A word to the wise, however: As you add width to the table and begin to approach square, the design loses its point of view and should be abandoned in favor of a leg-and-apron, pedestal or other type of base.

Moving out of the dining room and into the office, you can find a lovely cherry trestle table being used as a writing desk. Because you work only from one side, a width of 26 in. is fine. The height can be the same as that of a dining table, i.e., 30 in. Again, the length can be as short or long as desired. A pencil drawer hung under the top provides useful storage, and there is plenty of leg room to stretch out into as you chew on ideas. When I built the first of these desks, typewriters were still in use. Now, typewriters are only at the Smithsonian. But the trestle-table desk can be adapted to the digital age. A keyboard tray can replace the pencil drawer. Or, if you have enough room, keep the main desk for writing and set the monitor on a wing (this time kept flush with the main surface), with the keyboard tray under the wing. Wires can be clipped up under the top. Other computer components can be put on the desk or in a separate piece of furniture.

Design decisions can be made about the base as well. The Shakers raised the standard beam out of harm's way—underneath the top. This idea makes for good leg room and gives the table a wonderfully light, almost floating, effect. You don't need to be an engineer, however, to know that this will make the base less rigid. Indeed, at least one of the Shakers' tables showed trouble in that regard. Their solution to improve this was to use a drawbolt arrangement, as I had in my reproduction of the Hancock table design. The Shakers adopted this system because they could disassemble the table and transport it to another community to be shown as a model. However, when assembled, it was surprisingly solid, with no water spilling when the turkey was being carved.

On my basic design, the beam is about two-thirds of the way off the floor, giving good leg room and avoiding the Shakers' bolted joint. The beam is 6 in. wide, through-mortised and wedged into the post. No water spills.

Many early Colonial trestle tables had feet that were broad and flat, combined with posts nearly square in section. This setup often has problems with rigidity, however. The feet on the basic table are higher and narrower, with a post that is wider than it is thick, which affords more substantial joinery. The Hancock Shaker feet are arched and up on their toes, evoking classical styles and providing more landing for the joint. Again, the posts are wider than they are thick.



A good furniture design will work well in a variety of settings. The music of Bach has been played as jazz and pop, used and abused. So too has the trestle table. But it is healthy, and it endures. Rightfully so.

is now done and can be pressed into use for your dinner party.

A good-looking top begins at the lumberyard

Look for consistency in grain and color in the wood that will make up the top. Sapwood on one face can be turned under, but you'll need the outer two edges clear.

Try to have no boards under 6 in. wide; wider boards are preferable. However, it looks awkward to have one very wide, monster board among some narrower ones, so look for consistency here as well. The lumber can't have much warp or twist, either. Beginning with 4/4 stock, you won't have a lot to give while achieving a clean, flat surface that's 13⁄16 in. to 7⁄8 in. thick.

Because you are beginning with rough stock, you can keep design options open. Avoid stock that's already been planed to ¾ in., as you are paying for a barrel of chips, which you may have wanted back on the board. The tabletop will look more

Making breadboard ends

1 ***A circular saw in a woodworker's shop?*** *Using a saw guide made from two strips of ¼-in. plywood, the author roughs out the breadboard tenons by cutting a series of kerfs on both sides of the top.*

2 ***Slick work.*** *A few passes with a wide chisel cleans up the debris between circular-saw kerfs.*

3 ***Plunge-router cleanup.*** *After sawing and chiseling the breadboard tenons to their rough thickness, the author uses a plunge router to get the breadboard tenon to the exact thickness of the mortise he'd previously cut in the breadboard end cap.*

substantial if it is thicker than ¾ in., especially if it is longer than 6 ft. Learn to develop the X-ray vision needed to tell what's under the surface of rough lumber, or buy lumber that has been only skim-planed. If you can't thickness the lumber yourself, have the yard take it down to about ⅞ in., which leaves a whisker for cleanup.

Joint the edges and test clamp. I recommend using biscuits to help align the top boards while gluing. They aren't needed for strength, so there's no need to glue them in. But they will help with the dressing process afterward and will maintain the thickness you want. After glue-up, it's a good idea to take the top to a mill shop with a thickness sander wide enough to accommodate the top's width.

Add breadboard ends for stability—and tradition

Putting breadboard ends, or caps, on a tabletop is time-consuming. At minimum, you should allow a day's work for them. They can be dispensed with, if you wish. The reasons for having them are both aesthetic and structural.

Caps give a rectangular shape an ending point, dressing off the ends of a tabletop, drop-front desk lid or, not surprisingly, a breadboard. The caps help keep the top flat, especially at the ends where it is floating freely. For this table, though, the best reason for caps, in my opinion, is tradition. Put them on, and you have a classic Colonial table. Leave them off, and it looks contemporary. Aesthetically and structurally, a top will do just fine without breadboard ends.

The construction process for caps can be as simple or difficult as you wish. On many antique pieces, the caps were simply nailed onto the ends. The next step on the road to fine joinery is to plow a tongue-and-groove joint, then nail the caps on. Screwing on the caps gives a bit more longevity to the joint. Although this method doesn't accommodate seasonal wood movement, I must confess to having done this years ago on some tables. To this date the caps, after almost 20 years, show no signs of loosening.

However, I prefer to join the caps to the top by cutting a series of tenons, connected by a tongue that is stopped at the ends. The tenons fit into a corresponding series of mortises, and the tongue fits into a dado that also stops short of the ends. The center mortise-and-tenon joint is glued and pinned. The others are pinned and left dry, with the holes in the tenons elongated (see the top right photo on the facing page) to allow for wood movement. This method makes a firmer connection and allows for the top's seasonal expansion and contraction. One final touch is to spring the cap-to-tabletop joint by planing the inside edge of the cap slightly concave. When clamped on to the top, the middle of the cap will be sprung in, holding the ends tightly.

Apply the finish, then attach the top to the base

Dressing the top and base can also be done by hand with planes, scrapers or sandpaper, which will give you a nice workout in preparing a surface for finishing. I find it difficult to see the difference between one sanded to 180 grit and one done to 400 grit. For some reason, the finer grit equals more boasting rights. Typically, my surfaces are handplaned and scraped, and then, if necessary, gone over with 180 grit before finishing. After all, I'm not looking for guitar-body quality in a tabletop that's meant to be used. The color will be lovely, with the grain in focus. The smoothness will be in the finish.

Okay, now it's time for true confessions. How many of you get to this point of a project and go for the quickest, simplest fin-

4 ***Tongues and tenons.*** *A jigsaw quickly cuts the long, single breadboard tenon into a tongue-and-tenon sequence that will fit into mirror-image mortises already cut in the end cap.*

5 ***Extralong cap comes off with a tap.*** *It'll take some fussing and fiddling to get the cap to fit just right. It's a good idea to leave the cap a few inches long on each end while fitting, and then after everything is fit, drilled, glued and pegged, you can cut the caps flush with a handsaw.*

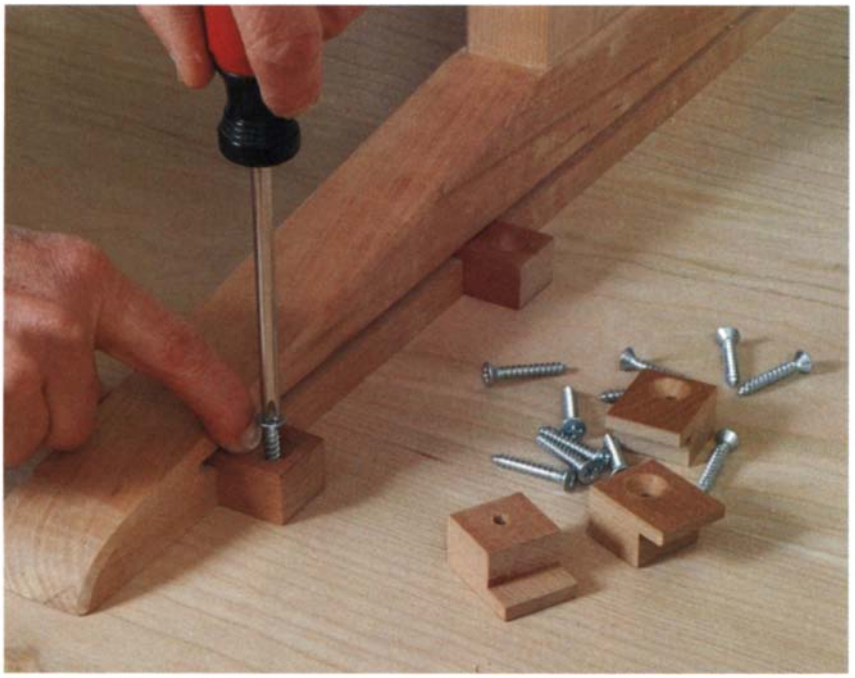
6 ***No glue in the long holes.*** *The center tenon has a round hole, which will get glued and pegged during assembly. The other four tenon holes are elongated to allow for wood movement. When assembled, the long holes are pinned without glue.*

ish available? I'm sure many hands are up. Being one of that group, I use an oil-varnish blend. With a bow to those who use varnish, shellac or lacquer, it's hard to beat an oil-varnish finish for ease of use and maintenance and for bringing out the wood's natural tones. Cherry and walnut do especially well with it. The varnish will give some body to the penetrating oil but not any more surface buildup than you want.

Although in the past I've mixed my own brews, I now use, with satisfaction, Minwax Antique Oil Finish. Three coats will generally do the trick. The second and third coats are sanded while wet with 320- or 400-grit wet-or-dry sandpaper before wiping off. The finish is smooth and silky. People will invariably walk up to a table and run their hands over it. The look is plain and informal but handsome.

To allow for expansion, fasten the top to the base using wood buttons (my preference) or metal clips from Rockler (800-279-4441). The slots for these are on the inside edges of each cleat and are easiest to do before assembly with a router or tablesaw. Stop the cuts before each end. Also, to keep the top from slipping sideways, have a short ¼-in. dowel protruding about ⅜ in. from the top center of each cleat. It fits (unglued) into a corresponding hole in the underside of the top.

That does it. Remember to sign your name under the top. It is time to bring the table into the house, just in time to serve dinner to the "oohs" and "aahs" of an impressed audience. □



Four buttons in a long slot. *Cherry tabletop buttons get screwed to the underside of the tabletop and fit into a slot router-cut into the inside of the cleats. Make sure to stop the slot 1 in. back from the end of the cleat.*

Charles Durfee lives in Woolwich, Maine, building furniture since 1978.

Dust Collection for the One-Man Shop

How to get the most performance from 1-hp to 2-hp dust collectors

BY ANATOLE BURKIN

Don't throw away the broom just yet. Even the best dust-collection system won't eliminate the need for occasional sweeping. A good system, however, will keep the broom and your lungs from wearing out prematurely.

There are two main points to consider when choosing a dust collector. First, figure out the air-volume requirements of the machines in your shop (see the chart on p. 84). Next, decide on what kind of hookups you are going to use: flexible hose, PVC pipe or metal duct.

To see what size and type of collector would best suit a one-man shop, I gathered a sampling of machines, from 1-hp single-stage units to 2-hp two-stage collectors, including one cyclone: Delta (1½ hp single stage), Dust Boy (2 hp two stage), Jet (2 hp single stage), Oneida (1½ hp cyclone) and SECO UFO-90 (1 hp single stage). I used the collectors with my tools, which include a 10-in. cabinet saw, a 15-in. planer, an 8-in. jointer and a 16-in. bandsaw.

The horsepower rating is a fairly reliable guide to the performance of a dust collector (see the chart on p. 85). Hookups, however, are everything. Too much flexible hose will rob even a big collector of power. PVC pipes, in short runs, work fine with a sufficiently powered collector, 1½ hp or more. Metal duct, not unexpectedly, performs best. Even an 8-year-old, 1-hp col-

Photos, except where noted: Anatole Burkin; this page: William Duckworth

lector can collect chips from machines 25 ft. away when hooked up to a properly designed system. Using a 1-hp collector this way may seem misguided, like putting a racing exhaust system on a subcompact car, but the experiment illustrates how you don't have to spend a fortune to get decent results. Every shop is different, of course, and your results may vary, so use my findings as guidelines, not absolutes.

A 1-hp single-stage collector can handle any machine in my shop

The biggest sawdust producer in my shop is a 15-in. planer. And even a 1-hp single-stage dust collector can handle that machine, hooked up with about 6 ft. of 4-in.-dia. flexible hose. I borrowed a new UFO-90, same as my old collector, to see if anything had been changed. It's still the same machine, rated at 650 cu. ft. per minute (cfm) by the manufacturer, but when hooked up to 6 ft. of flexible hose, it moves about 420 cfm. That's slightly less than the 500 cfm recommended for a 15-in. planer, but 90% of the time the 1-hp collector can handle it because I rarely plane 15-in.-wide stock.

One-hp single-stage collectors cost about $200. Some woodworkers buy two units and station them strategically in their shop. At 82 decibels (measured at 8 ft.), a 1-hp dust collector isn't much noisier than a vacuum cleaner, and each one takes up about 3 sq. ft. of shop space.

I also used the 1-hp collector with a PVC duct system (4-in.-dia. pipe and fittings) and measured the moving air volume at the tablesaw-jointer connection, which is

1-HP COLLECTORS

Small, portable collectors are easy to move around the shop. Make connections to one tool at a time using a short piece of flexible hose.

Three styles of dust collectors

The most economical and biggest-seiling dust collectors are the two-bag, single-stage models. Single stage means the dust is sucked through the impeller (fan) and dumped into the lower bag. The upper bag collects fine sawdust and lets the exhaust air back into the shop.

Two-stage collectors are the next step up. The motor and impeller sit atop a barrel. Chips enter the barrel and are directed downward, although the swirling air inside may occasionally move smaller chips upward. A filter bag hangs off to one side and collects the finest dust.

Two-stage cyclones are at the top of the evolutionary chain. The motor and impeller sit atop a cone-shaped canister, the cyclone, which is connected to a trash can below. Chips or other large debris enter the cyclone and swirl downward, avoiding the impeller. The longer the cyclonic chamber, the greater its effectiveness at slowing down and separating large particles. Air is filtered either by a pleated internal cartridge or by one or more felt bags hanging off to the side of the machine. Internal-cartridge cyclones use the least amount of floor space. The upper bags or cartridge filters of all collectors must be shaken out occasionally to remove fine dust.

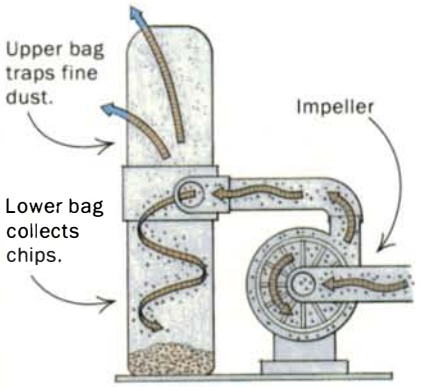
DANGERS OF SINGLE-STAGE COLLECTORS

Debris entering a single-stage collector passes through the impeller, many of which are made of steel. Even a small bit of metal, such as a screw, can cause a spark when it hits a steel impeller. Dust-collector explosions are rare, but the potential is there. Debris, metal or otherwise, not only makes a racket when it hits an impeller but also imparts stress on the bearing and will shorten its life. I heard of a woodworker whose collector's sheet-metal housing was punctured by a screw that entered the impeller.

One way to reduce the risk of fire is to choose a single-stage collector with a plastic or aluminum impeller. Although the impeller itself won't cause a spark, metal debris striking the steel housing may have the same effect. Steel impellers are fine, however, if you avoid using the dust collector to sweep up miscellaneous debris off the floor or workbench.

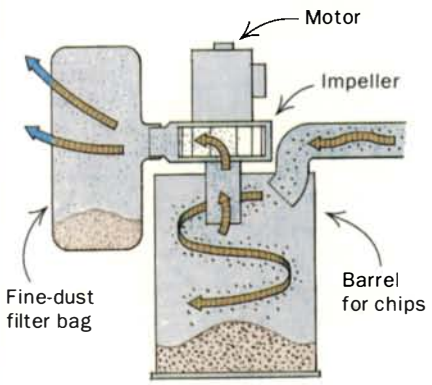
SINGLE STAGE

Sawdust must first pass through the impeller (fan) before being separated.



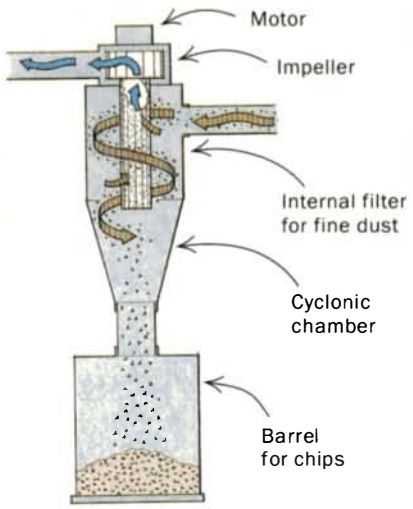
BARREL-STYLE TWO STAGE

The larger chips entering a two-stage collector tend to drop out before they have a chance to strike the impeller.



TWO-STAGE CYCLONE

The shape of a cyclone is most efficient at slowing down the speed of debris, allowing most of it to settle out before reaching the filter.



Drawings: Vince Babak

1½-HP COLLECTORS

Although collectors in this power category may occasionally be used with two tools simultaneously, for best performance, use blast gates and run one tool at a time.

at the end of about 25 ft. of pipe and hose. At that distance, because of increased resistance, the air volume drops to under 300 cfm, less than recommended for woodworking tools. In reality, however, one can live with that. But if I'm face-jointing wide boards, the collector can't always handle the volume, and chips jam the jointer's dust port. Maybe 80% of the time it works okay.

When I hooked up the 1-hp collector to a newly installed metal duct system, with my tools in the same configuration as before, I was really surprised. The air volume was back up to 360 cfm, very acceptable. Then I hooked up my old 1-hp collector, which is outfitted with oversized felt bags (available from Oneida Air Systems) that improve airflow and capture fine dust (see the story below), and I measured almost 400 cfm. That's a significant gain.

A 1½-hp collector can be hooked up to longer runs of hose or duct

As you might imagine, hooked up to one machine at a time, a 1½-hp collector does not have any trouble removing chips, even with a long (12-ft.) run of hose. Delta rates its 1½-hp collector at 1,200 cfm, a number that is derived in a lab, not under real shop conditions (for more on manufacturer specs, see the story on the facing page). Hooked up to a 6-ft. run of 4-in.-dia. flexible hose, I measured about 500 cfm with the Delta and 470 cfm using an Oneida Air Systems 1½-hp cyclone collector. Cyclones and two-stage collectors have slightly more internal air resistance; hence the lower cfm reading. That's about what you can expect from any 1½-hp collector hooked up to 4-in.-dia. hose.

I also hooked up the 1½-hp collectors to two machines running simultaneously. Performance ranged from good to so-so, depending on how much sawdust was being spit out by my tools. The best way to direct maximum airflow to the tool being used is to attach a blast gate to each hose.

Hooked up to a PVC duct system (a run of about 25 ft. of pipe), both the Delta and Oneida collectors captured most of the sawdust when running one tool.

A 1½-hp Delta collector costs about $350. A two-stage unit such as the Oneida costs almost twice as much. Penn State Industries also sells a cyclone collector. (For more on the advantages of two-stage collectors vs. single-stage units, see the story on p. 83.)

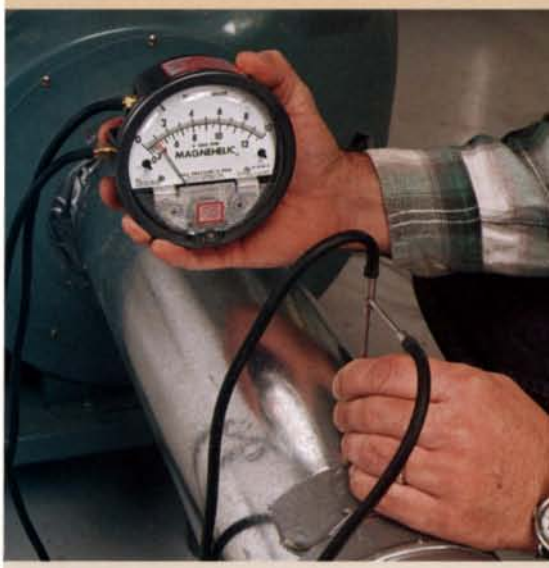
Both 1½-hp collectors performed exceptionally well when connected to metal duct and used with one tool at a time. With two blast gates open, the air volume dropped and was insufficient to operate two big machines at once.

The larger-volume bags or canisters of 1½-hp collectors hold a lot of material, about 30 gal. worth, which means fewer trips to the compost pile, a big advantage over the 1-hp machines that hold about

Go with felt bags

The standard bags issued with most dust collectors are good for capturing particles of 25 to 30 microns or bigger. A micron is 1/1,000,000th of a meter in length; looked at another way, the paper this article is printed on is about 25 microns thick. Fine dust blows right through filter fabric, back into the shop. Dust particles under 10 microns in size are the most harmful because they can get past the respiratory tract and enter your lungs. Unless you wear a dust mask while woodworking, toss out the stock bags and replace them with felt bags rated at 5 microns or less.

Fabric vs. felt. *A fabric bag, left, has less thickness and is more porous. Felt, right, does a much better job of filtering out very fine dust.*



Measurements were taken with a dial-gauge manometer (a pressure gauge) and pitot tube. *The chart at right compares the performance of a few dust collectors when using hose, PVC pipe and metal duct.*

AIR-VOLUME REQUIREMENTS OF MACHINES

TOOL	CFM NEEDED
10-in. tablesaw	350
6-in. or 8-in. jointer	300-450
12-in. planer	350
15-in. planer	500
Drill press	350
14-in. or 16-in. bandsaw	350
Radial-arm saw	350-500
12-in. disc sander	350
12-in. to 24-in. drum sander	300-500
Oscillating spindle sander	350
Floor sweep	350

PERFORMANCE OF DUST COLLECTORS UNDER VARYING CONDITIONS

Horsepower	6 ft. from collector, 6-in.-dia. straight metal duct*	6 ft. from collector, 4-in.-dia. flexible hose	6 ft. from collector, two runs of 4-in.-dia. flexible hose	25 ft. from collector, at jointer hookup, 4-in.-dia. PVC pipe	25 ft. from collector, at jointer hookup, 5-in.-dia. metal duct
1 hp single stage	550 cfm	Excellent	Fair	Fair	Excellent
1½ hp single stage	825 cfm	Excellent	Good	Good	Excellent
1½ hp cyclone	700 cfm	Excellent	Good	Good	Excellent
2 hp single stage	980 cfm	Excellent	Excellent	Excellent	Excellent
2 hp two stage	825 cfm	Excellent	Good	Good	Excellent

Fair: under 300 cfm Good: 325 cfm to 350 cfm Excellent: more than 350 cfm

* Bags or filters attached with a light coating of sawdust present.

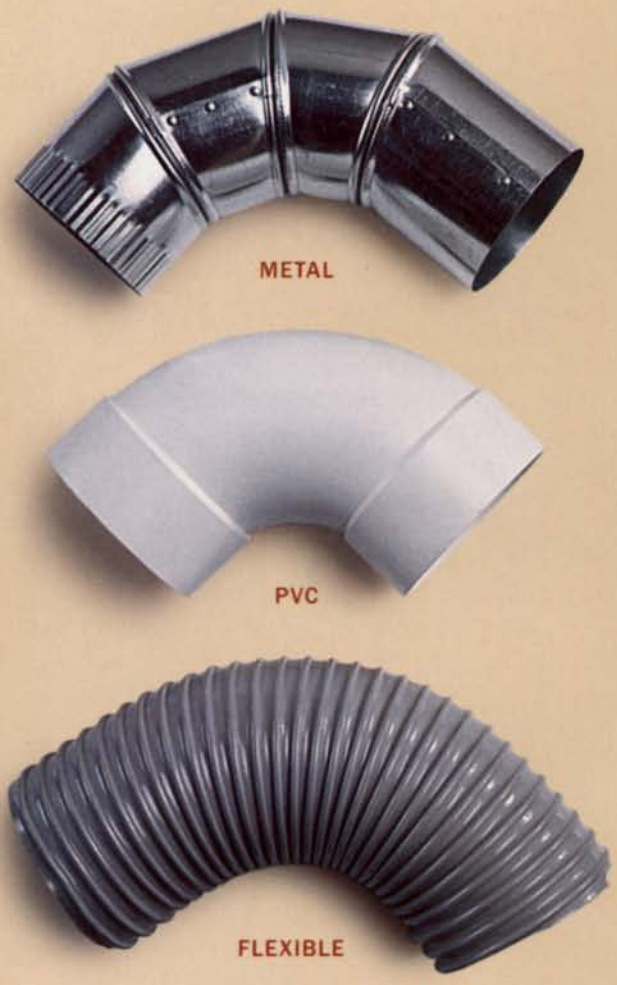
MAKING SENSE OF MANUFACTURER SPECS

There's a fair amount of misleading marketing specs on dust collectors. When an ad says a collector is rated at 1,200 cfm, what does it mean? Not much, really. Cfm stands for cubic feet per minute, a measure of the volume of air moving past a point of reference. The cfm figure needs to be put in the context of the amount of resistance, or friction, present (called static pressure, or SP). Air moving through duct or hose encounters resistance, just as a person would slipping down a water slide. The more bends and bumps, the slower the ride or the lower the air velocity and volume. Many manufacturers rate their machines without bags or duct attached.

While trying out a number of dust collectors, I measured their performances under real working conditions, using flexible hose, PVC pipe or metal duct in my 420-sq.-ft. shop (see the chart above). The resistance readings ranged from 3 in. to 5 in. I also measured collectors hooked up to a straight piece of 6-in.-dia. metal duct, just to get a baseline, highest-possible performance figure.

Collectors ranging in size from 1 hp to 2 hp have impellers (fans) sized from 10 in. dia. to 12 in. dia. All things being equal (motor speed and impeller design), a bigger impeller coupled with a bigger motor will move more air than a smaller pairing. There are some differences among collectors; to learn more, ask a manufacturer for an impeller performance chart.

As soon as any collector is hooked up in the shop, performance declines in relation to the length and type of hookup. That's why smooth-walled metal duct, with wide-radius elbows and wyes, is better than PVC pipe.



Materials that affect airflow. *The metal elbow (top), which is designed for central dust-collection systems, has a gentle sweep, which lowers resistance to airflow. Plastic PVC pipe has a tighter-radius bend and restricts airflow more. Ribbed flexible pipe also disturbs airflow, up to three times as much as metal.*

Photo, this page: Michael Pekovich

2-HP COLLECTORS

SINGLE STAGE

Many 2-hp collectors can handle two tools at once. Although 4-in.-dia. PVC pipe is not the best duct material, satisfactory results can be obtained when connected to a 2-hp collector.

BARREL-STYLE TWO STAGE

A 2-hp collector has enough power to handle larger machinery, such as this 18-in. planer (right). This collector by Dust Boy is a two-stage model with a 55-gal. drum.

half of that. A 1½-hp single-stage collector takes up about 7 sq. ft. of shop space. But a vertically stacked two-stage cyclone such as the Oneida takes up only 3½ sq. ft. of shop space, a big plus in a small shop. More horsepower does mean more noise; both registered 85 decibels at 8 ft. The Delta comes wired for 115 volts but can be switched over to 230 volts. The Oneida comes without cable or switch. It can be wired to run on either current.

A 2-hp unit can sometimes handle two machines at once

Hooked up to two 6-ft. runs of 4-in.-dia. hoses, a 2-hp single-stage collector draws over 350 cfm from each port, plenty for many woodworking machines. The 2-hp two-stage Dust Boy didn't match the power of the 2-hp single-stage Jet machine, although it has other qualities that may be preferable (see the story on p. 83). When I connected the 2-hp units to the PVC duct system, they too were robbed of considerable power, but one machine could be operated at a time with satisfactory results.

When connected to a metal duct system, the Jet collector really moved a lot of air, 570 cfm at the tablesaw-jointer connection (after about 25 ft. of duct). With two blast gates open, the air volume was reduced to less than 300 cfm, still acceptable for some operations. The Dust Boy produced slightly lower readings but still had more than enough power to run one tool at a time in any configuration. If you regularly operate more than one machine simultaneously, it would be wise to look at 3-hp or bigger dust collectors.

The 2-hp machines are no noisier than the 1½-hp collectors. They cost more, however. The Jet is priced at $400; the Dust Boy sells for about $650. Most 2-hp collectors come wired for 230 volts. The Dust Boy can be run at either 115 volts or 230 volts.

Choosing among the options

On the matter of choosing a dust collector, a two-stage cyclone gets my top vote. A small cyclone collector takes up less room, is easy to empty and runs very clean. For example, on all of the single-stage units, even after running them for only an hour, fine dust appeared on the machine and in the area around it. That's because it's difficult to get a perfect seal between the bag and housing. The Oneida cyclone, outfitted with an internal filter, rubber gaskets and wide metal ring clamps, seals better.

Two-stage units such as the Dust Boy (Delta also makes a two-stage collector) are also nice and compact. The Dust Boy takes up 6 sq. ft. and less vertical space than most collectors. The Dust Boy (as does the Oneida) comes with a Leeson motor and cast-aluminum housing and impeller (fan), and the sturdy plastic barrel holds a lot of debris, 55 gal. worth. Before it can be emptied, however, the heavy motor and housing must be lifted off.

Removing the lower bag of a single-stage collector is an easy matter of loosening a band clamp. The real fun begins when you try to reattach it. If you've ever had to put your pants on with an arm in a cast, you'll get the idea. The lower bag must be wrapped around the metal waist of the machine and held in place before the clamp can be cinched. Some manufacturers, such as Jet, add an elastic band inside the lower bag to facilitate reattachment somewhat.

Woodworker's Supply tried to solve the lower-bag problem with a clamp-on skirt accessory. The skirt and a standard 30-gal. trash can replace the lower bag. Because the skirt remains attached to the collector's housing, it's easy to cinch the lower belt that attaches the skirt to the trash can. I just wish the skirt were made of felt rather than the more porous woven fabric. This setup

***Better connections.** The Oneida cyclone collector's trash barrel is connected by a large metal ring, which simplifies reattachment (left). Woodworker's Supply sells a clamp-on skirt accessory that is used with a 30-gal. trash can (right). The skirt is easier to reattach than a standard lower bag.*

Designing a central dust-collection system

Oneida Air Systems designed my ductwork, which is very typical for a one-room shop under 500 sq. ft. The ductwork begins with a 6-in.-dia. pipe connected to the collector. At the first wye (split), the duct reduces to 5-in.-dia. branches. The 5-in.-dia. pipes serve the biggest tools (jointer, tablesaw and planer), even though they all have 4-in.-dia. dust ports, which ensure good air volume to the machines. Also, you can change the dust port to a 5-in.-dia. connection for better performance. A 5-in.-dia. to 4-in.-dia. reducer is used to make the transition.

The 4-in.-dia. branches that split off the 5-in.-dia. line serve smaller tools, such as the bandsaw and router table. Blast gates are installed at each tool. The final connections were made with flexible hose, which allows me to move my tools around.

I used 24-gauge (mostly) snap-lock pipe, spot-welded fittings and aluminum blast gates, which are available from many companies. (Avoid lighter-gauge metal duct designed for heating or cooling systems; it can collapse under vacuum.) A higher-quality system will employ 22-gauge spiral pipe and welded fittings, which are stiffer and more airtight, and yes, they cost more. Quick-Fit duct supplies from Nordfab are also premium priced, but the components go together easily and don't require duct tape or caulk.

Although individual 24-gauge components aren't that expensive (a 5-ft. run of 5-in.-dia. snap-lock pipe costs about $8), it all adds up. A very basic three-machine setup may be had for a few hundred dollars. A system for half a dozen tools and a floor sweep may cost $500 or more.

To help illustrate the photos in this article, an orange/black flex hose was used to make connections from pipe to tools; black flex hose, however, works fine. It's best to use a minimum of hose because it produces about three times the friction of metal pipe. Friction will reduce the performance of the system. All pipe seams and connections must be sealed with caulk or duct tape. Clear silicone caulk is a good choice because it's virtually invisible and is easy to remove.

SOURCES OF SUPPLY

AIR HANDLING SYSTEMS (800) 367-3828
Duct supplies and duct design

AMERICAN FABRIC FILTER CO. (800) 367-3591
Custom-made dust bags

DELTA (800) 438-2486 Dust collectors

DUST BOY (800) 232-3878 Dust collectors

HIGHLAND HARDWARE (800) 241-6748
Dust collectors

JET (800) 274-6848 Dust collectors and supplies

KRAEMER TOOLS (800) 443-6443
Dust collectors and supplies (Canada)

LENEAVE MACHINERY (800) 442-2302
Dust collectors

NORDFAB (800) 532-0830
Quick-Fit duct supplies

ONEIDA AIR SYSTEMS (315) 476-5151
Dust collectors, duct supplies and duct design

PENN STATE INDUSTRIES (800) 377-7297
Dust collectors and supplies

POWERMATIC (800) 248-0144 Dust collectors

SUNHILL MACHINERY (800) 929-4321
Dust collectors and supplies

WOODWORKER'S SUPPLY (800) 645-9292
Dust collectors and supplies

WILKE MACHINERY (800) 235-2100
Dust collectors and supplies

No screws or rivets needed. *Quick-Fit duct pipe from Nordfab is assembled using gasketed clamps.*

DESIGN HELP IS AVAILABLE

Designing the ductwork for a central dust-collection system can involve a lot of calculations. For those of us who skipped math class, there's help available.

- Air Handling Systems of Woodbridge, Conn., has an on-line duct calculator program (www.airhand.com). The company outlines the concepts of duct design in a four-page brochure.
- Oneida Air Systems of Syracuse, N.Y., will design a duct system free of charge for its customers (www.oneida-air.com). All that's required is a shop drawing showing the types and locations of woodworking machines.
- Nordfab of Thomasville, N.C., manufacturers of the Quick-Fit line of duct and fittings, offers a free design service. The company has a downloadable program (www.nordfab.com), but you need a CAD program to run it. The company also offers a peel-and-stick shop layout kit for analog woodworkers.
- If you wish to tackle duct design yourself, all of the necessary information can be found in *Woodshop Dust Control* by Sandor Nagyszalanczy (The Taunton Press, 1996).

will reduce the air volume (the collector "breathes" through both bags) when using the stock upper bag. With a larger upper bag, I found that the cfm readings were not compromised. But if you happen to vacuum up any offcuts, they will make quite a racket rattling around in a metal trash can.

Although many woodworkers, myself included, have used PVC drainpipe for duct without mishap, experts warn against using the material. The connectors (elbows and wyes) restrict airflow, and the material builds up a static charge, which may cause a spark and set off an explosion. (Running grounded copper wire inside the pipe reduces the hazard.) Use PVC at your own risk. Metal duct and fittings are obviously better and will also last longer. I've broken half a dozen plastic blast gates in as many years. If you're on a tight budget, go with flexible hose or build a metal duct system in stages, starting with only a couple of hookups. Your collector will work more efficiently, and so will you. □

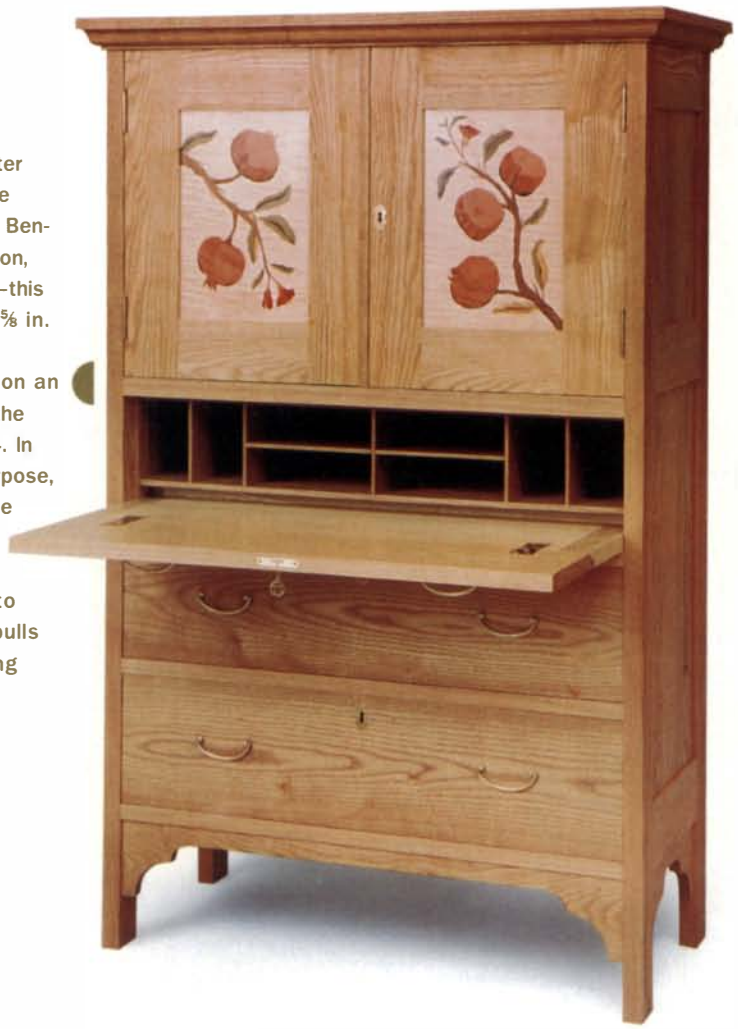
Anatole Burkin is a senior editor of Fine Woodworking.

Current Work

It's impossible for all of *Fine Woodworking*'s quarter-million readers to write an article for our reader-written magazine. But for a long time we've toyed with the idea of how to showcase the work of the many talented woodworkers, professionals and amateurs alike, who toil away in their shops, often in anonymity. Enter Current Work, our new department. Acknowledging the work of others is only one reason to launch this department; another of its purposes is to provide design inspiration. In the same way that writers learn by reading the work of others, a woodworker can learn by looking at the work of peers. We'd like your comments, and we'd like to see photos of your work. Send entries to Current Work, *Fine Woodworking*, 63 S. Main St., Newtown, CT 06470, or get more details at our web site: www.finewoodworking.com.

Nina Browne

A gift to her husband, after two years of long-distance love—she attended North Bennet Street School in Boston, and he lived in Brooklyn—this sassafras linen press (18⅝ in. deep by 40½ in. wide by 62½ in. high) was based on an original design made at the Byrdcliffe Colony in 1904. In striving to make multipurpose, functional furniture for the urban apartment-dweller, Browne made the press's top drawer into a flap-front desk, which pulls out to a 15-in.-wide writing surface. Photo by Lance Patterson.



Robert M. Ressel

A middle-school technology education teacher by profession and a furniture maker by hobby, Ressel built this chair over a number of years. The legs and stretcher are maple, the seat is pine, and the arms, spindles and crests are red oak. The 40-in.-long back spindles are turned and taper to ⅜ in. at the ends. The carved knuckles are based on a drawing Ressel found in a book titled *The Windsor Style in America* (Running Press, 1997).

J. Albert Hudson

An amateur woodworker, Hudson builds furniture for his family and friends. This Hepplewhite sideboard, 23½ in. deep by 66 in. wide by 40 in. high, is truly a panoply of exotic woods. The carcase and top are sapele mahogany; the doors and drawers are crotch mahogany; the string inlay is holly; the checkered inlay is lemonwood and ebony; and the sunburst inlays at the corners are padauk, scorched holly and ebony.

James T. Kelly

The maple and mahogany carousel, 21 in. dia. by 14 in. high, took four months to complete. Kelly says he wanted to make an old-style toy with few metal parts; in fact, aside from the wood, only nine screws and six lead weights were used in its construction. When the carousel is turned by hand, the horses move up and down.

Ted Curtin and Rob Tarule

Starting with an unseasoned oak log, Curtin and Tarule finish a piece of furniture in two weeks, using tools and joinery techniques from the 16th and 17th centuries. The striking decorative effects of the Putnam cupboard in the photo were achieved entirely through the use of applied ornamentation, without any carving. The geometrical patterns on the drawer fronts and the positioning of the split spindles were very carefully calculated to create a sense of mass and solidity.

Robbi Staples

Staples' client wanted a file cabinet that didn't look like one—something that wouldn't attract the attention of a nosy babysitter or an intruder. Placing a lamp or books on top disguised the fact that the mahogany and walnut cabinet (2⅜ in. deep by 35⅜ in. wide by 30 in. high) has a lift-up top. All panels are book-matched, including the single glued-up drawer front that looks like two drawers (it's divided by a ⅛-in. saw kerf).

Peter Shepard

The first one of these cherry cabinets was made eight years ago to store stereo components. Shepard designed the slatted sides as a change of pace from the more common frame-and-panel sides. The five squares in each door are glazed with antiqued glass, and the pulls are ebony. This cabinet is a top-seller at the shows Shepard attends, and since the first one, he has made the cabinet in all sizes, ranging from the 31-in.-high version in the photo to one that is 39 in. high, which is used as a server in a dining room.

Michael Oliver

Curves and character are what Oliver was after when he designed this dresser. He also wanted to match the look of a sleigh bed he'd made. The dresser (14 in. deep in the middle by 33 in. wide by 38 in. high) is made of cherry, curly cherry, curly maple and purpleheart. The piece is finished with Watco oil, shellac and lacquer.

Randy Block

Armed with only a photo in a design book and a drawing from a turn-of-the-century Thonet catalog, Block built this mahogany bed for a client. Each curved piece, parts of which have a diameter of less than 2 in., is made of a minimum of 12 laminations, a process that took more than 10 hours per curved piece. The project took six months to complete, but his client was thrilled and gave him a commission to design and build a matching armoire.

Dean Ludwig

When he found some walnut boards from a tree planted in the early part of the 19th century, stored under years of bat manure and dust in the back of a barn, Ludwig knew he had something special. The cabinet was built for his sister-in-law to store her photo collection. The cabinet (15 in. deep by 27 in. wide by 68 in. high) is made from those walnut boards, with the exception of the ash drawer slides. It is finished with oil and wax.

William N. Moore

It took six years of nights, weekends, holidays and vacations for Moore to complete the bottom case of his walnut and cherry block-front secretary. After retirement, it took him six months to build the top case. Research took him to Providence and Newport, R.I., Winterthur Museum in Delaware and Colonial Williamsburg in Virginia. After 18 drawers, 10 carved shells, three secret compartments and 84 dovetail joints, the piece was finished. His children are already discussing who will inherit the secretary.

Tips for photographing your furniture

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

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DELTA TOOLS

Model	Description	List	Sale
31-750	NEW Bench Random Orbit Sander		Sale 189
28-150	9" Bench Band Saw	195	155
50-860	850 CFM Air Cleaner	291	239
31-695	6" Belt/9" Disc Sander	441	299
23-710	Sharpening Center	228	155
31-460	4" Belt/Disc Sander	168	119
40-560	16" 2 speed Scroll Saw	230	129
40-540	16" var/spd Scroll Saw	243	159
11-990	12" Bench Drill Press	237	184
11-090	32" Radial Bench Drill Press	417	279
43-505	1/2" Bench Router/Shaper	398	299
22-540	12" Bench Top Planer	518	259
22-560	12-1/2" Planer w/ extra knives	572	329
36-865	Versa Feeder Stock Feeder	337	249
36-220	10" Compound Mitre Saw	294	199
37-070	6" var/spd Bench Jointer	362	265
14-650	Hollow Chisel Mortiser with chisels and bits	380	249
17-900	16-1/2" Floor Drill Press	490	329
17-924	Mortise Chisel Kit	Sale	65
34-555	Sliding Table	518	339
36-250	10" Slide Compound Saw	696	455
31-780	Oscillating Spindle Sander	261	194
40-650	Q3 18" Scroll Saw	600	389
36-905	30" Unifence	363	259
36-906	50" Unifence	454	319
36-444	10" Contractors Table Saw	852	589
33-830	10" Radial Arm Saw	851	729
37-285	6" Jointer w/ stand	424	345
37-380	8" Professional Jointer	1500	1095
31-250	NEW 18" Drum Sander	Sale	789
40-680	NEW 20" variable speed Scroll Saw	Sale	489
	Single Stage Dust Collectors		
50-850	1-1/2 HP, 1200 CFM	395	295
50-851	2 HP, 1500 CFM	588	495

The following tools have a $50.00 rebate! Price shown is before rebate. Rebates are for a limited time.

36-475	10" Platinum Edition Contractors Table Saw w/ 30" unifence, cast iron wing, table board & carbide blade	Sale	849
22-675	DC380 15" Planer	Sale	1175
28-275	14" Band Saw 3/4 HP	Sale	595
28-255	14" Platinum Edition Band Saw - 1 HP w/ mobile base. 18" rip fence, & 3/8" blade	Sale	849
31-280	Sanding Center w/ stand	1012	789
37-190	6" Deluxe Jointer	615	445
37-195	6" Professional Jointer	625	539

MILWAUKEE TOOLS

6527-6	Sawzall with case	343	169
6537-226527	w/quick lok blade change	362	179
6521-21	NEW variable speed orbital Super Sawzall	375	185
0224-1	3/8" Drill 4.5 amp magnum	240	138
0234-6	1/2" Drill 4.5A mag 0-850 rpm	255	134
0235-6	1/2" Drill w/keyless chuck	255	139
0244-1	1/2" Drill 4.5A mag 0-600 rpm	255	142
0222-1	3/8" Drill 3.5 amp 0-1000 rpm	221	128
0228-6	3/8" Drill 3.5 amp 0-1000 rpm	214	124
0375-6	3/8" close quarter Drill	255	148
6176-20	14" Chop Saw	340	179
6546-6	Screwdriver 200 & 400 rpm	150	89
6547-6	6546-6 w/bits,1/4" chuck & cs	190	112
6390-21	7-1/4" Circular Saw w/ cs	267	139
5397-6	3.8" v/ spd Hammer Drill Kit	275	145
5371-6	1/2" v/spd Hammer Drill Kit	360	194
6145	4-1/2" Grinder 10,000 rpm	182	105
6494-6	10" Compound Mitre Saw	595	329
6266-21	Top Handle Jig Saw w/ case	319	159

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

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

HITACHI TOOLS

C8FB2	8-1/2" Slide Compound Saw	1169	449
C10FS	10" Slide Compound Saw	1627	579
C15FB	15" Mitre Saw	1346	659
C10FCD	10" dual bevel Compound Mitre Saw	550	265
NV45AB	Coil Roofing Nailer	935	379
NT50AE	Pinner 3/4" - 2"	Sale	129
EC12	2 HP, 4 gallon Compressor	561	279

MAKITA TOOLS

Model	Description	List	Sale
5090DW	3-3/8" Saw Kit 9.6 volt	213	139
DA391D	3/8 angle Drill 9.6V	142	95
DA391DW	3/8" angle Drill Kit 9.6V	216	139
6095DWE	9.6 volt Drill Kit w/2 batt	240	125
6095DWLE2	6095DWE w/flashlight	263	139
632007-4	9.6 volt Battery	55	30
632002-4	7.2 volt Battery	45	28
	18 VOLT MAKITA TOOLS		
6343DWAE	1/2" Drill Kit	458	255
5620DWA	6-1/2" Circular Saw Kit	458	255
DK1016	1/2" Drill & 6-1/2" Saw combo kit	698	389
DK1021BL	18 volt Combo Kit. Includes Drill, 6-1/2" Circ. Saw, Recipro Saw, and flashlight	Sale	579
	CORDLESS DRILLS WITH 2.0 AMP HIGH CAPACITY BATTERIES		
6213DWAE	12V 3/8" Drill Kit	293	169
6233DWAE	14.4V 3/8" Drill Kit	358	205
9900B	3"x21" Belt Sander w/bag	322	165
9924DB	3"x24" Belt Sander w/bag	333	169
N1900B	3-1/4" Planer with case	268	142
1912B	4-3/8" Planer	360	205
N9514B	4" Disc Grinder 4.6 amp	106	65
DA3000R	3/8" Angle Drill	328	185
6013BR	1/2" Drill Rev. 6 amp	268	149
9401	4" x 24" Belt Sander w/bag	416	219
5007NBK	7-1/4" Circ Saw w/ case	238	125
LS1011	10" Slide Compound Saw	807	429
LS1211	12" Slide Compound Saw	1370	695
3901	Plate Joiner Kit	318	159
3612C	3 HP Plunge Router	503	265
LS1040	10" Compound Miter Saw	474	249
LS1013	10" Dual Compound Slide Miter Saw	1087	599
BO5010	5" Random Orbit Sander	121	69
LS1220	12" Compound Miter Saw	678	379
9227C	7/9" Polisher	338	195
2702	8-1/4" Table Saw	538	299
2703	10" Table Saw	568	309

SENCO AIR NAILERS

SFN30	NEW Finishing Nailer w/cse	459	239
SNS45	Stapler 7/16" crown, 1" - 2"	540	365
SLP20	Pinner w/cs 5/8 -1-5/8"	422	189
SKS	Stapler 5/8 - 1-1/2"	390	259
SN70	Framing -Clip Hd 2 - 3-1/2"	725	449
SN65	Framing -Full Hd 2 - 3-1/2"	709	369
SN600	NEW Framing 2 - 3-1/2"	699	339
SFN40	Finish Nailer 1-1/4 - 2-1/2"	569	349

BOSTITCH AIR NAILERS

Model	Description	List	Sale
N80S-1	Stick Nailer	Sale	299
RN45	Coil Roof Nailer 3/4 - 1-3/4	845	339
N60FN-2K	Finishing Nailer w/ case	557	269
BT35-2K	Brad Tacker 5/8" - 1-3/8" with case, oil, & brads	279	119
MIIIFS	Flooring Stapler 15 gauge.	902	539
S32SX-1K	Finish Stapler-1/2" - 1-3/8" with case & oil	269	135

JORGENSEN ADJUSTABLE HANDSCREWS

Item#	Jaw Length	Opening Capacity	List	Sale	Box of 6
#0	8"	4-1/2"	20.35	12.95	69.95
#1	10"	6"	23.30	14.50	79.95
#2	12"	8-1/2"	26.75	16.25	92.50
#3	14"	10"	33.85	20.25	114.95

PONY CLAMP FIXTURES

Model	Description	List	Sale	Lots of 12
50	3/4" Black Pipe	15.45	8.50	94.00
52	1/2" Black Pipe	12.65	6.95	79.00

PANASONIC CORDLESS

EY6431NQKW	NEW 1/2" 15.6V drill kit with two 3 amp-hr Ni-Mh batteries, 45 minute charger, & case	372	205
EY6431FQKW	NEW 1/2" 15.6V drill kit with two 2 amp-hr Ni-Cad batteries, 30 minute charger, & case	342	189
EY6407NQKW	NEW 1/2" 12V drill kit with two 3 amp-hr Ni-Mh batteries, 45 minute charger, & case	339	189
EY6406FQKW	NEW 3/8" 12V drill kit with two 2 amp-hr Ni-Cad batteries, 30 minute charger, & case	305	169
EYC133	5-3/8" 15.6V Wood Cutting Saw and Drill Kit	650	379

BIESEMEYER FENCES

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

AIRY AIR NAILERS

Model	Description	List	Sale
0241SK	Brad Nailer 3/8" - 1-9/16"	180	79
0626SK	1/4" Crown Stapler 3/8" - 1"	194	89
	Above nailers come w/case, fasteners, oil & wrenches		

STABILA LEVELS

25010	10" die cast Torpedo Level	Sale	21.95
24640	24" Level w/ hand holes	Sale	47.95
24670	48" Level w/ hand holes	Sale	59
24632	"Jambor Level" designed for setting door jambs. Includes 78° level	Sale	129

DEWALT TOOLS

Model	Description	List	Sale
DW124K	1/2" right angle Drill	590	329
DW321K	Top Handle Jigsaw Kit	300	164
DW364	7-1/4" Circ. Saw w/brake	294	155
DW378G	7-1/4" Framer's Saw	210	159
DW610	1-1/2 HP 2 handle Router	266	149
DW411K	1/4 sheet Palm Sander w/cs	88	58
DW682K	Biscuit Joiner with case	448	169
DW705	12" Compound Mitre Saw	734	339
DW621	2 HP Plunge Router	400	199
DW677K	3-1/4" Planer with case	268	155
DW431	3 x 21 v/spd Belt Sander	338	188
DW421	5" Palm Ran. Orb Sander	144	75
DW423	Palmgrip Random Orbit Sander - variable speed	170	92
DW272	Drywall Gun, 0-4000, 6.3 amp	160	95
DW276	Drywall Gun, 0-2500, 6.5 amp	160	99
	DEWALT CORDLESS DRILLS		
DW972K-2	3/8" variable speed w/ two 12V XR batteries	362	184
DW991K-2	3/8" variable speed w/ two 14.4V XR batteries	415	209
	Above drill kits come w/ charger & steel case!		
DW991KS-2	DW991K drill, DW935 trim saw, 2 XR batteries & case	Sale	345
DW911	Jobsite Radio & Charger	Sale	139
	DEWALT 18 VOLT CORDLESS TOOLS		
DW933K	Jigsaw Kit	468	275
DW938K	Recipro Saw Kit	520	269
DW995K-2	1/2" Drill Kit w/ 2 batt	Sale	259
DW997K-2	1/2" Drill/Hammer Drill Kit	454	249
DW936K	5-3/8" Saw Kit	458	249
DW995KS-2	DW995K Drill. DW936 Saw and case	Sale	399
DW995KC-2	DW995K 18V drill kit, DW938 18V recipro saw, & case		399
	NEW 24 VOLT DEWALT TOOLS		
DW006K	1/2" Drill/Hammer Drill Kit	560	299
DW007K	6-1/2" Circular Saw	560	299
DW008K	Reciprocating Saw	560	299
	DEWALT BENCH TOP TOOLS		
DW708	12" Slide Mitre Saw	Sale	649
DW788	20" Scroll Saw	Sale	469
DW733	12" Planer w/ extra blades	Sale	399
DW744	10" Portable Table Saw	Sale	499

DAVID WHITE INSTRUMENTS

Model	Description	List	Sale
LP6-20A	Sight Level package-20x	329	245
LP6-20XLA	LP6-20A with 9056 tripod and 7620 rod	409	279
LT8-300	Level Transit - 26x	739	579
LT8-300P	above Level with optical plum	869	649
ALT6-900	Automatic Level - Transit - 18x	666	519
ALTP6-900	above Level with tripod & rod	799	559
ALP8-22	Automatic level - 22x with tripod and rod	Sale	359
AL8-26S	Automatic Level - 26x	854	325
ALP8-26	Above level with tripod & rod	Sale	389

BOSCH

Model	Description	List	Sale
1587VS	Top Handle "CLIC" Jig Saw	292	139
1587AVSC	1587VS Saw Kit with case and *New* Progressor blades	Sale	155
1584VS	Barrel "CLIC" Jig Saw	288	164
	Bosch Metal Case for above Jig Saws		24
	Bosch 30 blade assortment for Jig Saws		29.99

1584VS or 1587VS
with steel case and 30 Bosch blades
Sale 189

1295DH	5" Random Orb Palm Sndr	155	89
1274DVS	3"x21" v/spd Belt Sander	326	175
1278VSK	1-1/2"x12" Belt Sander	242	129
1275DVS	3"x24" v/s Belt Sndr	410	219
1276DVS	4"x24" v/s Belt Sndr	443	229
1194VSRK	1/2" v/ spd Drill w/ case	256	159
1613EVS	2HP v/s Plunge Router	374	199
1634VSK	Recip Saw 10.5 amp	356	185
3315K	12V T-handle Drill Kit	298	159
3615K	14.4V Drill Kit	340	174
3107DVS	5" Random Orbit Sander	181	98
3107DVSK	3107DVS with case	213	118
3725DVS	5" Random Orbit Sander	272	145
3727DVS	6" Random Orbit Sander	283	149
3915	10" Slide Compound Saw	960	499
3912	NEW 12" Cmpnd Mitre Saw	595	329
11224VSR	7/8" SDS Rotary Drill	434	229
1703AEVS	5" Grinder - 8.5 amp	264	145
1347AK	4-1/2" Grinder with case	159	92
1638K	Drywall Cut-out Unit	181	105
1617	1-3/4 HP Router - 2 handle	307	159
1617EVS	2 HP Router w/ variable speed - 2 handle	349	189
1618	1-3/4 HP Router - "D" handle	332	179
1618EVS	1618 router w/ var/speed	360	215
1640VS	Power Tenon Saw	200	129
1640VSK	Power Tenon Saw Kit	370	209
3850K	18V cordless Drill Kit	395	255

JDS AIRTECH AIR CLEANERS

Model	Description	List	Sale
750	12"x24"x28" 1/4 hp 200 CFM - 750 CFM	Sale	249
8-12	20"x24"x44" 1/3 hp 800 & 1200 CFM	Sale	479

JET TOOLS

JJ60S	6" Jointer - open stand	Sale	429
JJ6CSXW	6" Jointer - closed stand and extra knives	Sale	499
JJ8CS	8" Jointer - closed stand	Sale	1189
JWBS14OS	14" Band Saw 3/4 HP - open stand	Sale	495
JWBS14CSK	14" Band Saw 1 HP - closed stand with rip fence and mitre gauge	Sale	579
JWTS10CW2JF	10" Contractor Table Saw with 30" Jet fence and cast iron wings	Sale	649
JWTS10CWPF	10" Contractor Table Saw with 30" Exacta fence 1-1/2 HP & cast iron wings	Sale	789
JTAS10X501	10" Tilting Arbor 3 HP Table Saw with 50" Exacta fence, table, and legs	Sale	1399
JDP17MF	16-1/2" Drill Press 3/4 HP - 16 speed with bits and mortise attachment	Sale	429
DC-650	Dust Collector, 1 HP, 650 CFM	319	199
DC1100	1-1/2 HP, 1100 CFM Dust Collector	425	299

PORTER CABLE

9444VS	Var/spd Profile Sander Kit	218	119
690	1-1/2 HP Router 8 amp	284	149
6931	Plunge Router Base	142	89
693PK	690 and 6931 plus case	381	199
9690	690 Router with case	294	159
691	1-1/2 HP Router D-handle	312	168
691RS	NEW "Ultimate Router Workshop" includes 691, 6931, & 698	Sale	325
693	1-1/2 HP Plunge Router Base	342	188
697	1-1/2 HP Router/Shaper	430	245
698	Heavy Duty Shaper Table	242	138
352VS	3x21 v/s Belt Sander w/bag	340	179
9352VSA	Above sander with case	Sale	189
360	3"x24" Belt Sander w/bag	410	225
360VS	360 Sander w/ variable speed	439	235
362	4"x24" Belt Sander w/ bag	424	229
362VS	362 Sander w/ variable speed	448	245
9125	3-1/4" Planer Kit w/ case	258	145
505	1/2 sheet Pad Sander	268	149
330	Speed Block Sander 1/4 sheet	129	69
556	Biscuit joiner w/ 5556 fence	250	135
557	Plate Jointer with tilt fence. Includes 2" & 4" blades for use with standard & face frame plates	400	205
5563	Face frame plates for 557		7.99
7529	2 HP variable speed Plunge Router	415	209
97529	Above router with guide, dust collection, and case	480	249
7519	3-1/4 HP Router 2 Handle	502	275
7518	3-1/4 HP 5 speed Router	550	295
7539	3-1/4 HP v/sp Plunge Router	570	294
7310	5.6 amp Laminate Trimmer	182	104
97310	Laminate Trimmer Kit comp	318	194
97311	Laminate Trimmer Kit with underscribe base	390	209
7335	5" Random Orbit Sander	260	105
97355	7335 w/ case & dust pick-up	280	135
7336	6" Random Orbit Sander	265	109
97366	7336 w/ case & dust pick-up	290	139
332	Palm Grip Rndm Orb Sander	110	62
333	above sander with dust bag	120	68
333VS	Random Orbit Sander - variable speed	145	88
334	333 Sander with PSA pad	120	68
335	Palmgrip Random Orbit Sander with dual flip pad	150	88
310	Production Lam. Trimmer	260	154
347K	7-1/4" "Framers" Circ Saw with plastic case	232	129
743K	7-1/4" "Framers" Circ Saw with case - left hand version	232	129
9737	Tiger Recipro Saw	319	159
9543	Top Handle Jig Saw	300	165
97765	SDS Rotary Hammer Drill	380	199
CDA250A	Angle Finish Nailer 1-1/4" to 2-1/2"	500	269
CFN250	Finish Nailer 1" to 2-1/2"	500	279

Porter Cable Pneumatic Nailers

BN125	Brad Nailer - 18 ga. 5/8"- 1-1/4"	160	89
BN200	Brad Nailer - 18 ga. 3/4"-2"	230	128
FN250A	Finish Nailer -16 ga. 3/4"-2-1/2"	328	185
DA250A	Nailer -15 ga. 1-1/4"-2-1/2"	396	215
FC350	Framing Nailer - clipped head	502	285
FR350	Framing Nailer - round head	502	285
RN175	Roofing Coil Nailer	505	259

Porter Cable Compressors

CF1400	1 HP, 4 gal. Pancake	356	199
CF2400	2 HP, 4 gal. Side Stack	586	329

Introducing New Porter Cable Cordless Products

9866	12 volt Drill Kit	Sale	145
9876	14.4 volt Drill Kit	Sale	169
9877	14.4 volt Hammer Drill Kit	Sale	199
9884	19.2 volt Drill Kit	Sale	269
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- Bent lamination

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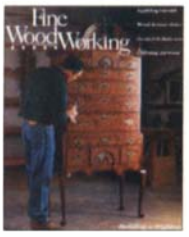

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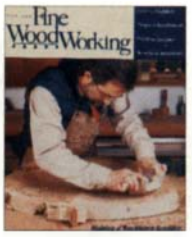

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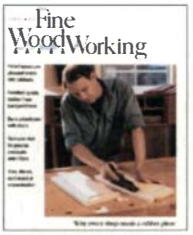

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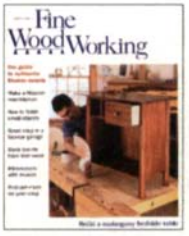

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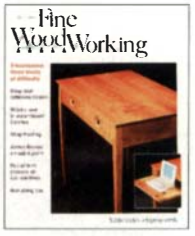

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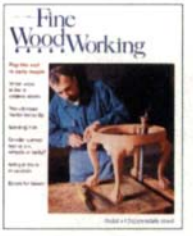

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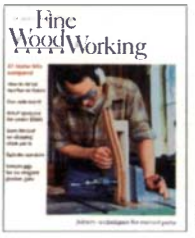

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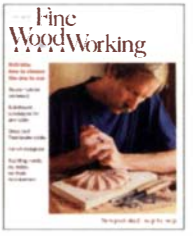

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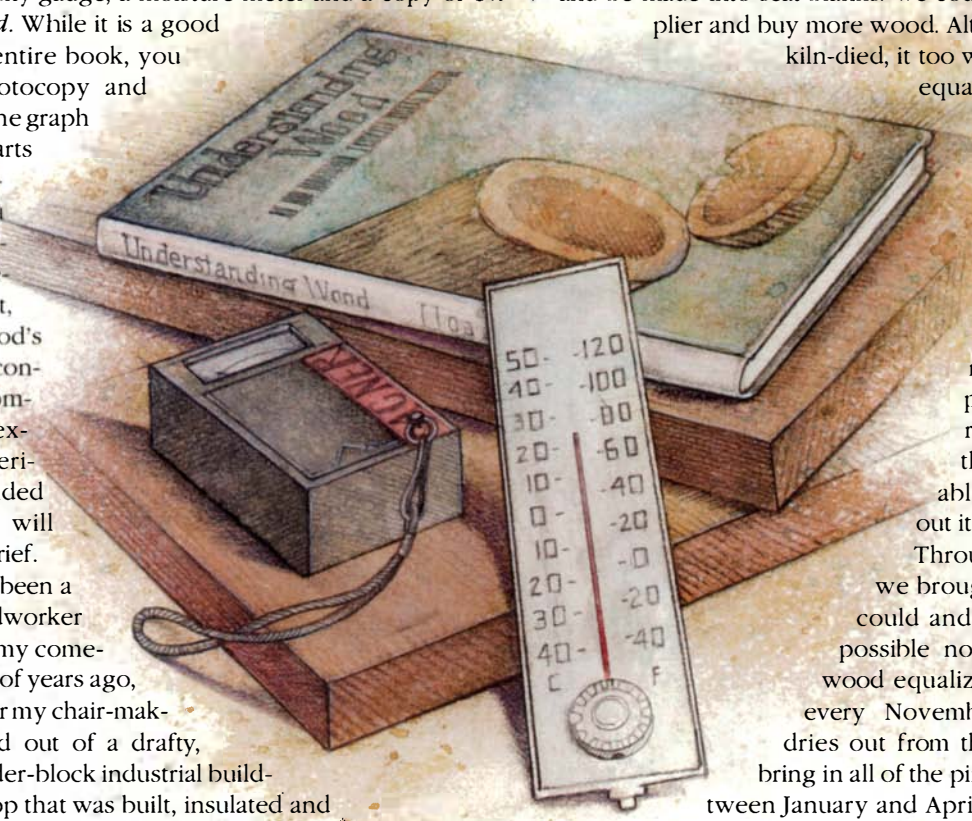
Rules of Thumb

BY MIKE DUNBAR

Wood *moves*

In the first paragraph of his book *Understanding Wood* (The Taunton Press, 1980), R. Bruce Hoadley wrote the most important words ever written for woodworkers: "Wood evolved as a functional tissue of plants rather than as a material designed to satisfy the needs of woodworkers." Everyone of us should regularly go back and read these words, but even if we do not, wood itself will remind us. In other words, we have to work around the nature of wood.

Wood's most persistent attribute is that it moves in response to changes in the relative humidity of the air that surrounds it. All woodworkers will, from time to time, be humbled by this fact. For that reason, a beginner woodworker just setting up shop should acquire not only a tablesaw, planes and chisels but also a thermometer, a humidity gauge, a moisture meter and a copy of *Understanding Wood*. While it is a good idea to read the entire book, you will want to photocopy and keep in the shop the graph on p. 69 that charts the amount of water in wood at a given relative humidity. Before beginning a project, determine the wood's current moisture content and then compare it to the extremes it will experience in its intended environment. It will save you a lot of grief.



Although I have been a professional woodworker for 28 years, I got my comeuppance a couple of years ago, the first winter after my chair-making school moved out of a drafty, poorly heated cinder-block industrial building into a new shop that was built, insulated and heated like a house. We use 50 Windsor chair seats a month for our classes and our own production. These are made of 1¾-in.-thick eastern white pine that we store in an unheated outbuilding. Roughly once a month we pull out enough planks to make up the seats needed, buck the planks into 22-in. lengths and glue them up into seat blanks.

In mid-January, after a six-week holiday break, we began our routine in preparation for the first class of the year. By the end of the day, we had gotten only as far as bucking the pine to length. We left the wood piled on the shop floor overnight. Upon arriving the next morning, we were stunned to see gaping splits in the ends of all of the pine. Eight hundred dollars of wood was ruined.

We immediately set out to discover what happened. The humidity gauge read 28%. The new building was far drier than a normal house. The heat had come on in October and had been drying out the building for several months. In a home, people cook, shower and breathe regularly—processes that help raise the relative humidity. Here, there were only a few lungs at work five days a week, eight hours a day. The centrally heated shop was like a desert. When we checked Hoadley's chart, we found that the shop's relative humidity would dry wood to under 6%. We checked the wood with a moisture meter. After a rainy fall the wood was at 12%. When brought into this extreme environment, the wood began to dry so fast that it split. We had never had this problem because our old, uninsulated shop was so drafty that it never got this dry.

We were in a bind. The wood in the outbuilding had to come in and be made into seat blanks. We could not even go to our supplier and buy more wood. Although his wood had been kiln-died, it too was stored in his sheds and equalized at the same 12% as ours. It would experience the same shock.

We brought in enough planks for several classes and piled them on the shop floor. We monitored them with a moisture meter until the planks got into the 8% range. A day or so before the class began, we were able to buck the wood without it splitting.

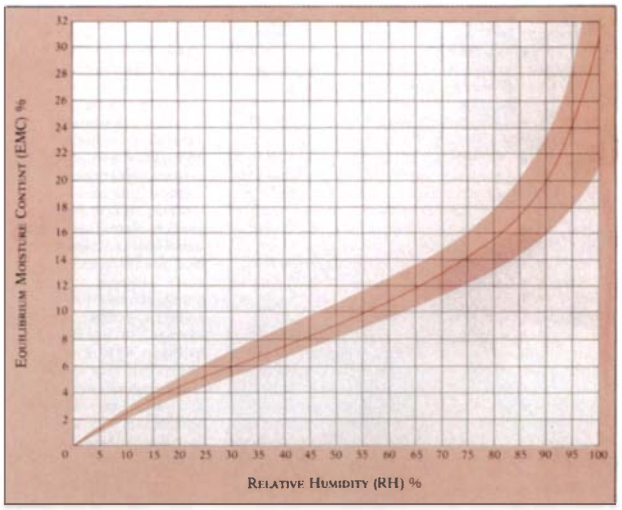
Through the rest of the winter we brought in all of the planks we could and squirreled them in every possible nook and corner to let the wood equalize with the building. Now, every November—before the building dries out from the summer humidity—we bring in all of the pine planks we will need between January and April. We buck them to length and store the 22-in. cuts in the kitchen closet and the upstairs storage room. This allows them to equalize slowly with the air in the building.

Our experience in the new building underscores a common misconception—that kiln-drying has freed woodworkers from worries about moisture content. I recently read such a comment posted on a Internet bulletin board. This posting was as foolhardy as saying because we have technology we can ignore Mother Nature. Kiln-drying may bring wood down to 6%, but it is seldom that dry when you buy it. As soon as the wood is brought out of the kiln, it starts equalizing to the higher relative humidity. Because the wood passes through lots of middle men who generally store it outdoors, there is ample time to complete the process

Drawing: Kirk Caldwell

of equalizing before you buy it.

As I was contemplating this column, I monitored a pile of clear 1-in.-thick pine purchased this summer from a local lumberyard. The wood was stored in a well-protected, three-sided shed—precisely the same conditions as at the yard. At the time of purchase the wood was at 10%. A severe drought followed, with one bone-dry, crystal-clear day after another. By mid-August the wood was down to 6%, as it probably had been when in the kiln. After Hurricane Dennis passed through and brought some badly needed rain, the moisture content increased to 12%. Only a couple of weeks later we had to endure Hurricane Floyd. The moisture shot up to 18%. Two weeks later it was between 10% and 12%. The lesson is to equalize wood in the shop before working it. Monitor it with a moisture meter.



Water in wood. *As the relative humidity increases, so does the moisture content of a piece of wood. Therefore, wood stored in your basement will have a higher moisture content than wood in your attic. In this graph from* Understanding Wood, *the horizontal numbers indicate relative humidity, and the vertical numbers indicate moisture content.*

A woodworker whose shop is in the cellar needs to be even more conscious of the problems with moisture content. The air in an average cellar is far more humid than air above ground. A dehumidifier helps some, but keep an eye on your humidity gauge. Keep your moisture meter and Hoadley's chart handy (above).

Earlier in my life I worked in a cellar. After a couple of problems with warping, I learned to store my wood elsewhere. The short stuff went in the attic. I was not beyond storing longer pieces under the bed so they could equalize with the house's air before being taken downstairs to be worked. Of course, some guys never learn. Not too long ago, a fellow woodworker sought advice for his most recent idea. He wanted to cut discs off freshly fallen logs of an appropriate diameter with a chainsaw and use these as tops for a set of bar stools. When he left he was very annoyed with me and still unable to understand why I insisted the discs would split.

Note: This year The Taunton Press will publish a revised version of *Understanding Wood.*

Q&A

Repairing the motor on a drill press

When I switch on my drill press, I have to give the chuck a twist with my hand before it will start. After that it runs fine. It is a one-phase, ¾-hp machine What's wrong with the motor?

—George Seifert, Shoreview, Minn.

Gene Holladay replies: If the motor requires a quick twist to start, the capacitor start circuit is not functioning. This may be due to the centrifugal switch not making contact, or it may be because of a burned-out capacitor.

If the centrifugal switch is not making contact, dust could be the culprit, or the contacts could be burned or carbonized. There is an ongoing debate on which is the best way to clean the dust out of the motor housing: vacuuming or blowing. I usually try a combination of both, first attempting to dislodge the dust buildup with a high-pressure air blast followed with a good vacuuming.

If this doesn't work, and you have some familiarity with motors, you can disconnect the motor, remove the four longitudinal case screws and carefully remove one or both end plates. Then take a look at the switch contacts (see the photos below). Impacted dust can be removed, if that is the problem, and the contacts can be carefully sanded or filed if there is evidence of pitting or carbon buildup. I use a small piece of 220-grit or finer sandpaper on a flat stick, making sure to clean away any loose grit when I am finished.

Once cleaned, the motor can be reassembled and tested. If it starts, the problem has been solved. If it still takes a quick twist to start it, the capacitor is suspect. By taking the part number off the existing capacitor, you can get a replacement from a motor repair shop for under $20. The shop will also do the replacement for a nominal fee. (The last capacitor I installed was on a 1-hp motor at a total cost of about $12.)

A third remote cause of the starting circuit not closing sometimes occurs in older motors that use sleeve bushings in lieu of bearings. The longitudinal bushings wear and can cause too much play in the armature. Eventually, the centrifugal switch will not close when the motor is stopped. When this happened on one of my old motors, I was able to fix it by cutting a brass shim in the shape of a washer and adding it to the armature shaft next to the sleeve bushing. This was several years ago, and the motor has worked fine since.

[Gene Holladay is a woodworker and electrical engineer in Audubon, Pa.]

A glue to endure the dishwasher

I am making stack-laminated turned wooden bowls, and I want to be able to put them in the dishwasher. What kind of glue should I use?

—Will Sanders, Chattanooga, Tenn.

William Tandy Young replies: Dishwashers generate a combination of heat and moisture that is tough on glue. The glue you choose should hold up to repeated washings and should be rigid after it cures, so your gluelines won't creep. In general, these requirements tend to rule out type-II polyvinyl acetate (PVA) glue, urea resin glue and epoxy.

Although type-II PVA glue is moisture resistant, the heat produced inside the dishwasher will likely soften it somewhat. The same thing is true of epoxy, unless it was designed to have a high heat deflection temperature (HDT). If you want to use epoxy, check to make sure that its rated HDT is higher than the drying temperature of the dishwasher.

Urea resin glue is not an ideal choice,

CLEANING THE CONTACTS OF A STALLED MOTOR

Open up. *The end plate is removed to access the centrifugal switch.*

Check the contacts. *With the motor open, inspect the contacts on the end plate.*

File them clean. *A small ignition file or sandpaper glued to a small stick is used to clean pitted or carbonized contacts.*

Photos: Matthew Teague

Four ***NEW*** *Nailers and Staplers from Porter-Cable*

If there is room for improvement, we can't find it.

Every square inch of Porter-Cable's new line of finishing nailers and staplers has been comprehensively redesigned. Each lightweight model includes so many new features, you'll be astonished at how all the innovations fit so securely in the palm of your hand.

The Textured Rubber Grip immediately reduces vibration and eliminates any discomfort or inconsistency caused by surface temperature changes while working.

The Smooth Latch Mechanism (featured on all brad nailer models) only requires a single touch to open the magazine and a gentle push to close. Simplicity of design lets you do your job more quickly and without added hassle.

The Soft Touch Rubber-Coated Magazine End Cap (featured on all brad nailers) enables a smooth, quick reload. This area also features a convenient storage compartment for the non-marring rubber tip.

The Adjustable Depth Control is standard on each model, including positive pre-set detents that offer precise depth adjustment by simply turning a thumbwheel under the trigger.

The Easy-Load Magazine Unit is designed for quick access to brads or staples, depending on which of the four new models you choose. This feature allows for a fast reload so you can get back to work.

The Side-Mounted Quick Release Mechanism ensures expedient removal of infrequent jammed fasteners without compromising your view of the wood surface. We also included a rubber tip on the foot to prevent any marring of the wood surface.

The 360° Rotating Adjustable Exhaust Port gives the operator complete command over the direction of the air exhaust. Whether the tool is positioned overhead, below, or to the side, the port can always face the opposite direction. When it comes to woodworking, we know how important the details are.

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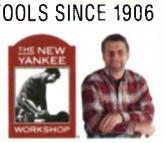

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either—even though it's rigid and water resistant—because it tends to fail with repeated exposure to a combination of moisture and heat, especially in solid wood laminations.

That leaves you with two logical choices. One is resorcinol, which is waterproof, heat resistant and has good rigidity. Resorcinol's downside is its dark maroon color, which creates visible gluelines in lighter woods.

The other good choice is polyurethane glue. While not completely waterproof (don't believe the ads), it's certainly water resistant enough to withstand dishwasher punishment. Polyurethane also has superb heat resistance, ample creep resistance and does not produce a visible glueline.

To help ensure that your bowls hold up well, use a stable, weather-resistant wood species. If possible, turn the bowl walls to a thickness somewhere between 5/16 in. and 3/8 in. so you'll have ample surface area in the gluelines while avoiding thick masses of solid wood that could overstress gluelines with moisture-related movement. Finish the bowls with a moisture-resistant finish such as Waterlox to help minimize wood movement. [William Tandy Young is the author of *The Glue Book* (The Taunton Press, 1999).]

Are bearing guides worth the price?

I'm considering replacing the block guides on my 14-in. bandsaw with bearing guides. Do the advantages of bearing guides outweigh the cost?

—Michael Danask, Mehlville, Mo.

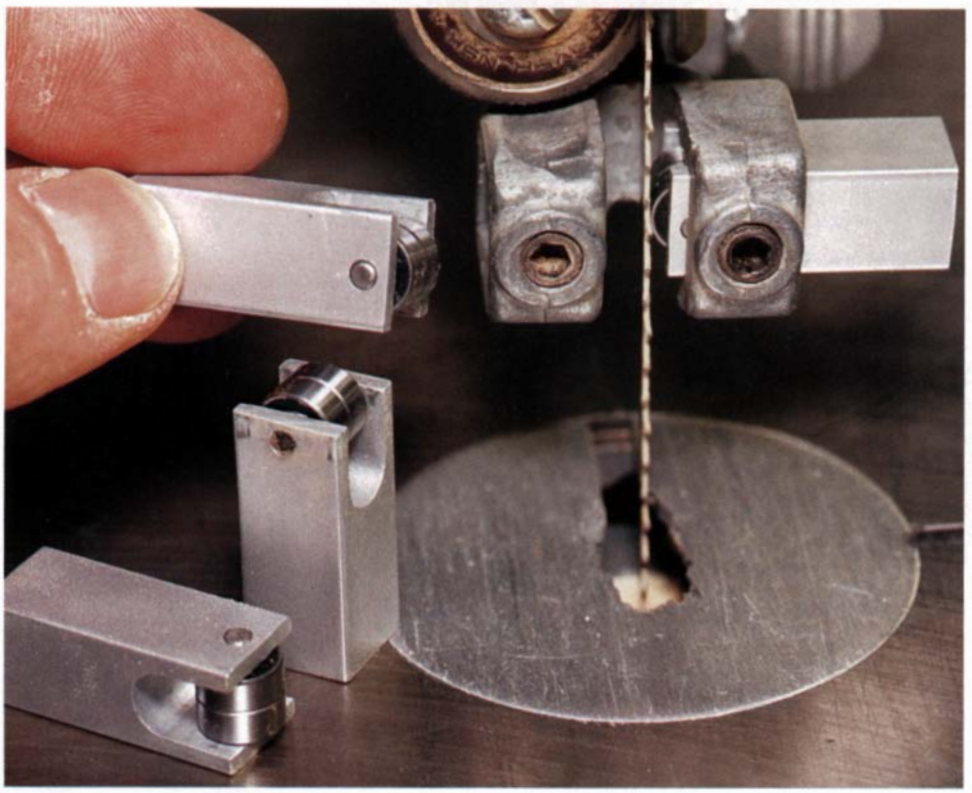
Lonnie Bird replies: In recent years there has been a lot of talk about the value of block guides vs. bearing guides. Each has its advantages. Bearing guides don't require periodic maintenance. Block guides support the blade closer to the work, and the broad surface area of blocks provides better support when cutting contours. I've used both for many years and have found the differences to be insignificant. The most important part of any bandsaw is the blade, not the guides (for more on bandsaw blades, see *FWW* #140, pp. 86-91).

Some claim that bearing guides allow the blade to run cooler and last longer. But the most damaging heat is generated at the tooth tip. This heat is caused by the friction that occurs during sawing. (Think of how hot your thumbs become when using a scraper.) The heat at the tooth tip will occur regardless of which type of guide you use. But there are a couple of ways to overcome the problem.

Carbide and bimetal blades can withstand much higher temperatures than the ordinary carbon steel blades on most new bandsaws. Although they cost more initially, carbide and bimetal blades are more economical because they retain their sharpness much longer.

Also, by selecting a blade with the proper pitch, you can effectively reduce the heat generated when sawing. For optimum results there should be six to 12 teeth in contact with the stock; so when sawing thick stock you'll need a blade with fewer teeth. As an added advantage you'll get a truer cut because the large gullets at the base of the teeth can more effectively remove the sawdust from the kerf created by the blade.

I suggest you use the guides that came with your bandsaw and keep them well adjusted. Your best bandsaw upgrade is to buy an assortment of blades and change them according to the job at hand. [Lonnie Bird is a woodworker and teacher and the author of *The Bandsaw Book* (The Taunton Press, 1999).]



Little maintenance required. *Bearing guides require less maintenance than traditional block guides but provide less surface area to support the blade.*

Can sapwood be stained to match heartwood?

Is there a way to stain the sapwood of walnut to the approximate color of the heartwood? My usual finish is an oil-polyurethane mixture.

—S.J. Donnelly, North Vancouver, B.C., Canada

Peter Gedrys replies: One of the easiest ways to match heart- and sapwood is by using a water-based dye stain. First sand your wood to 150 grit, then wipe it down with a damp rag to raise the grain. This step will also show you what your project would look like with a clean finish. Then finish-sand the piece down to about 180 or 220 grit.

With new wood I always choose water-based dyes for clarity. You have to experiment to get the color you're looking for, but I usually start with colors in the walnut family, a van dyke

brown or burnt umber. I like to make a basic mix of 1 oz. powder to 1 qt. very warm, distilled water. This is a reasonably concentrated solution that can be further diluted to the strength that matches the walnut.

Apply the dye with a brush or rag, or spray it on. While the wood is still very damp, go over the sapwood a second or third time, if necessary. This second color is easily controlled by using a cotton rag made into a pad, similar to a French polishing rubber. Charge the pad thoroughly, but not dripping wet, and pad over the sapwood. If you are not planning on staining, seal the wood with the desired finish and sand.

You can then use a gel stain or a glaze over the offending area. Let this dry thoroughly and proceed with your finish. If you are brushing on an oil finish, a very thin ½-lb. to 1-lb. cut shellac coat can be applied as a barrier or isolation coat over the glaze. This coat will eliminate the possibility of "pulling" the glaze. Above all, take the time to experiment and practice. This time is very well spent, and it takes the guesswork out of the equation.

[Peter Gedrys runs Architectural Finishes in Old Saybrook, Conn.]

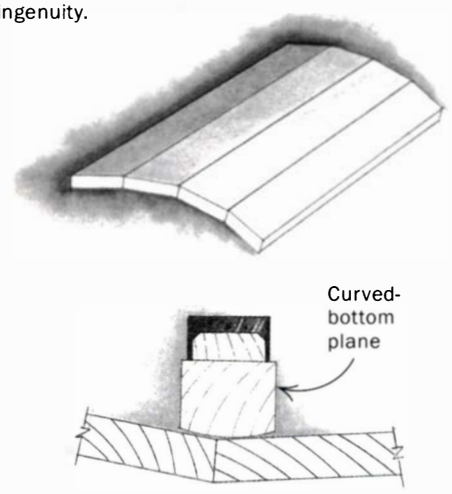
Shaping a concave curve

I am in the process of building a toy chest with a coopered lid. What is the best way to shape the inside of the coopered lid? Do they make planes to match these concave shapes? ***—Les Katz, Brooklyn, N.Y.***

Mario Rodriguez replies: Once you've glued up the coopered lid for your toy chest, the completed curved top should arch smoothly, without any flat spots. The convex top side of the lid can be shaped with conventional flat-bottomed planes and spokeshaves. However, the concave underside must be shaped with scrapers or sanding blocks cut to match the shape or with a curved-bottom plane that accommodates the curve of the lid. Obviously you're aware of the difficulties in obtaining tools to perform this critical task, and your chance of finding a plane formed to the exact radius of your coopered lid is almost nil. So, if you don't want to spend a lot of time with scrapers, think about making a plane.

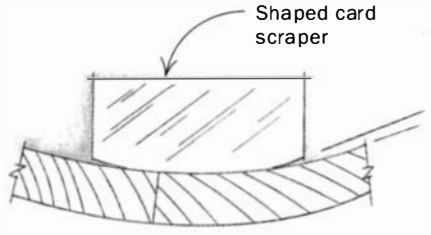
FAIRING A CONCAVE SURFACE

While the convex upper side of a coopered lid is easily shaped with planes and spokeshaves, fairing the concave side takes a little more ingenuity.



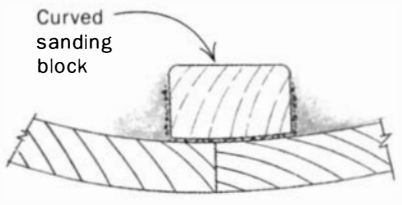
PLANE A ROUND

If you're making a plane to match the curve of a concave surface, the radius of the plane should be slightly less than that of the curve itself.



SCRAPE OUT THE TRACKS

A flat card scraper can be shaped to the curve, making it easy to clean up tearout and tracks left from the plane blade. Be sure to relieve the sharp corners of the scraper so that they won't dig into the work.



SAND IT SMOOTH

A sanding block can easily be cut to match the lid's curve.

The Japan Woodworker (800-537-7820) sells a high-quality blade with a chipbreaker already shaped to a curve. Then you'll have to obtain plans or directions for building a simple plane. I can recommend an article on plane-making by Timothy Ellsworth (*FWW* #1, pp. 22-27) or a more recent article by David Welter (*FWW* #126, pp. 67-73).

I don't know the radius of your lid, but I assume that any segment of the lid will be shaped to a fairly shallow curve. Any plane you make should be shaped to an even tighter radius, allowing you to plane to the curve easily and avoid leaving plane tracks (when the sharp edges of the plane's blade dig into the work surface, leaving unsightly "tracks").

Whatever method you choose for shaping, use a curved template to gauge your progress. If you use a plane, a shaped card scraper will clean up any rough spots. Follow this with sanding blocks shaped to the lid's curve.

[Mario Rodriguez is a contributing editor to *Fine Woodworking*.]

What causes burl?

Burl seems more common in some species than in others. What causes some trees to develop burls?

—Mitch Haines, Montpelier, Vt.

Jon Arno replies: Unfortunately, we do not yet know exactly what causes burl. The same is true for most other special figures in wood, such as bird's eye and fiddleback, which result from the formation of abnormal wood tissue. In fact, there may be multiple causes, and some of the seemingly more plausible theories include genetic malfunction, physical injury, environmental stress or the presence of some pathogen.

These abnormal figures do occur more often in some species than in others, and they tend to occur more often in tree populations that are under some sort of stress. For example, bird's eye and fiddleback, while still rare, seem to occur more often in maple than in other species. Also, the prevalence of these figures is greatest in stands of maple that are growing toward the northern extreme of the species range, at higher elevations or in dense stands where competition for nutrients and sunlight is more intense.

The theory that disease may be a direct cause is somewhat weakened by the fact that microscopic examination of samples of abnormal wood tissue has so far failed to reveal the consistent presence of a

Drawings: Mario Rodriguez

suspect pathogen. Viruses are very hard to detect, but still it seems more plausible that, if pathogens play a role in the process, they do so by inflicting stress rather than by causing a specific disease.

Genetics must play some role; otherwise, burl and other abnormal figures would occur more uniformly among species. While it is largely conjecture on my part, I suspect that stress of some sort either limits the availability of some nutrient or hinders the tree's ability to metabolize nutrients and produce certain key plant hormones in balanced amounts. Beyond this point, a more complete explanation of the process begins to get a little technical.

Plants control tissue growth by counterbalancing the growth hormone, auxin, with the regulating hormone, kinetin. Some as-yet-not-well-understood chemical signal causes these hormones to congregate on the cambium, which is the thin layer of living cells between the sapwood and the bark where growth occurs. The cells of the cambium react to these hormones by producing woody tissue and bark. Auxin stimulates the cells to multiply, while kinetin seems to tell the cells how fast and in what configuration. If kinetin is present in insufficient quantities, the cells appear to grow without purpose, but if auxin is totally absent nothing seems to happen, regardless of how much kinetin is available. In other words, the precise balance between these hormones is absolutely critical for normal cell growth. Depending upon where on the cambium layer they become out of balance and how much the balance is distorted, strange things start to happen. Burl appears to represent an explosion of seemingly unregulated growth originating at a single point on the cambium, while some of the other abnormal figures appear to be the result of more or less poorly regulated growth on a broader, less localized basis.

This explanation is certainly open to debate, but it is the only one that seems to tie together what we know about the chemistry of plant growth and what is observable in the field.

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

Science doesn't know. *No one is sure what causes burl, but most furniture makers are just happy that it happens.*

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

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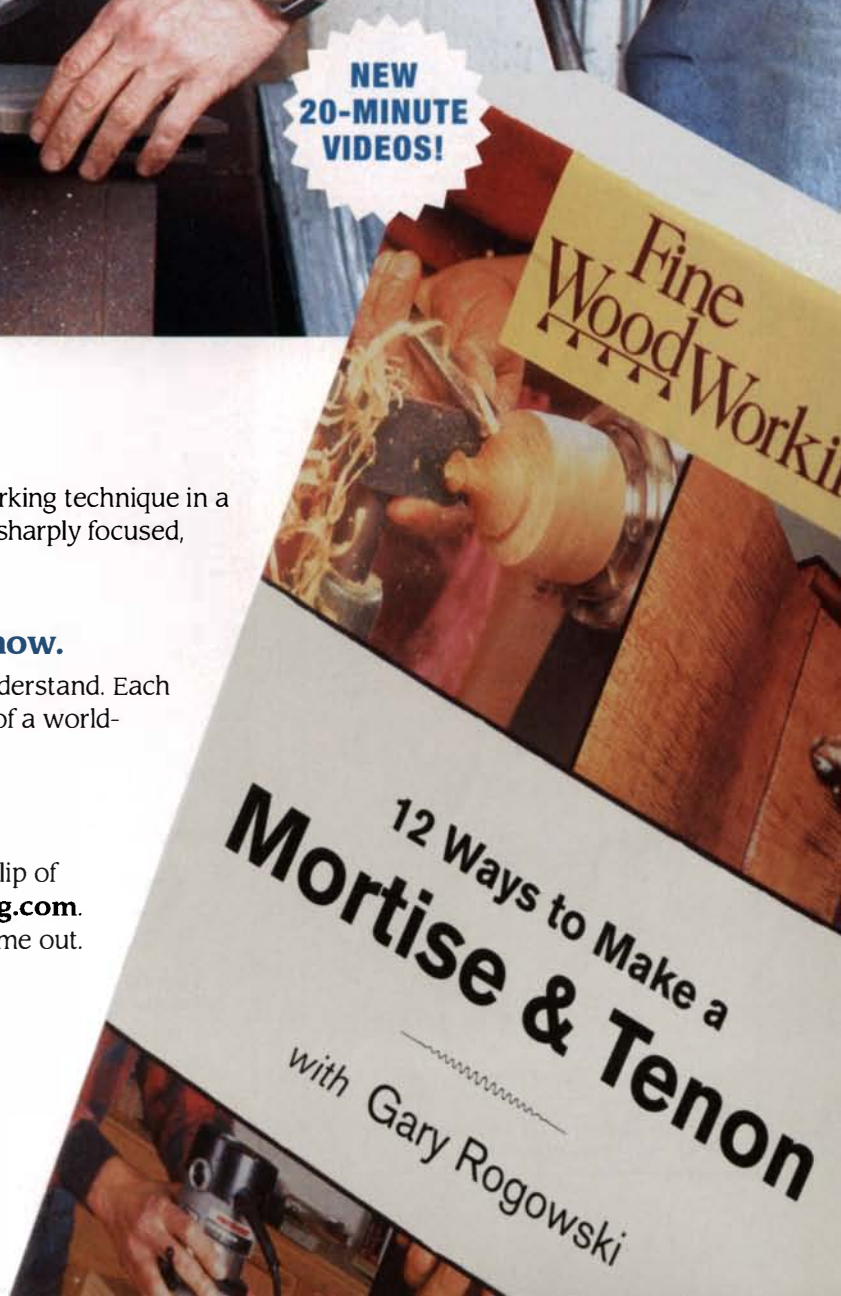

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Master Class

A short course in gilding

BY STUART M. ALTSCHULER

Gold has been prized through the ages not only for its luster and color but also for its working properties, one of the most remarkable of which is its ability to be worked as gold leaf. Gold leaf is gold pounded tissue-thin—so thin that if you rub a sheet between your fingers it turns to powder and disappears. Yet, once adhered to a substrate, gold leaf is remarkably strong and durable.

It was in the Renaissance that gold leaf gained widespread use. In houses of the wealthy, in rooms dimly lit by candles and oil lamps, large gilt-framed mirrors gleamed on the walls, their burnished surfaces serving to magnify the light. This brilliant finish was soon adopted by European carvers and furniture makers, and eventually it crossed the Atlantic and gave its name to America's Gilded Age.

There is a mystique about gold leafing and a misconception that it is a difficult art. The truth is that while traditional gold leafing like that used on the mirror frame below, known as water gilding, is a finicky, labor-intensive process requiring a dozen or more undercoats of sealer, each one

SURFACE PREPARATION IS PARAMOUNT

In laying gold leaf, the surface preparation is critical, because every flaw in the substrate will telegraph through the leaf.

SANDING

Sand fine and clean carefully. *After sanding to fine grits, remove dust with a tack cloth. Then use alcohol to clean the surface of any residue from the tack cloth.*

SEALING

Don't aerate the brush. *It's important to get as smooth a coat of sealer as possible. To avoid getting air bubbles in the finish, remove excess paint by shaking the brush downward instead of wiping it off against the can's lip.*

Avoid pooling and puddling. *After painting on the sealer, go back with a nearly dry brush to clean up any paint that pools in the corners.*

SIZING

Add a spot of color. *Sizing is nearly colorless. Adding a drop of Japan color to the sizing makes it easier to see as you brush it on.*

Start in the middle. *To get the thinnest and most even coat of sizing, begin brushing at the middle of a section, then brush out toward both ends.*

Photos, except where noted: Jonathan Binzen; mirror frame (left) by Maurice Bombar; photo by Lance Patterson

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carefully sanded, there is a much simpler approach to applying gold leaf: oil gilding. If you want burnished gold leaf of the highest reflectivity, you must use the water-gilding method (so named because the sizing is water-based). The buildup of coats creates an ideally smooth, slightly resilient surface on which to burnish the gold leaf. But if you can accept less-than-perfect reflectivity, oil gilding is the way to go.

There are four basic steps in the process of oil gilding: sanding, sealing, sizing and laying the gold.

As you prepare a surface for gilding, it is important to note that gold is the least forgiving of all finishes. It will highlight any flaw in the surface to which it is applied. So sand, sand and sand some more. Gilders refer to 400-grit sandpaper as medium. When you think that your surface is good enough, keep sanding—the results will be quite visible.

Leaf can be applied directly to metal or glass, but a porous material like wood must be sealed before gold is applied. There are several ways to seal wood to accept gold. A traditional method is with a coat of shellac. Fresh shellac is a must; a 1-lb. cut is sufficient. Shellac is typically used with a tinted undercoat to ensure that bare wood is not visible when the gold leaf is abraded. For such a treatment, using a coat of Japan color under the shellac works nicely.

Commercial sealer is a simpler alternative to shellac. Most such sealers are available in either yellow ochre or red. The yellow ochre is a particularly good choice for the beginner, because it will hide any small gaps, or holidays, in the gold.

After the sealer comes the adhesive. Traditional oil-based sizing is available in either slow (12-hour) or quick (three-hour) set. Slow-set sizing takes 12 hours to come to tack, but then has 12 hours of open time; quick set takes three hours to come to tack and then has a three-hour working window. Other sizings are available for specialized applications.

Whichever sizing you use, apply the least amount possible. The object is to get a very thin, even coat free of brush strokes. As the sizing comes to tack, it imperceptibly flows out over the surface. The more freely it flows, the less visible your brush strokes will be. I prefer 12-hour sizing, be-

LAYING THE LEAF

If the surface has been well prepared, laying the leaf goes with surprising speed. Leaf needn't be applied in any particular order; develop your own technique and rhythm.

Snip to size. *When working with patent leaf, with its paper backing, use scissors to cut workable pieces.*

Place the leaf. *Holding the sheet by the paper backing, keep it taut until it contacts the workpiece.*

Press into place. *Then press it into full contact with the workpiece.*

Overlap is expected. *Each sheet of leaf you lay should slightly overlap the previous one.*

Get into the corners. *Use your finger to get the leaf to conform to inside corners.*

Brush away the seams. *Using a circular motion, brush off excess leaf with a gold mop. As you do, the seams between sheets of leaf will all but disappear.*

Save the skewings. *If you cover your work table with kraft paper, you can crease it and easily pour the excess gold, or skewings, into a jar.*

cause it flows better and allows you more time to lay the leaf. The sizing is ready for gold when a touch of the finger finds it sticky but leaves no print.

Apply the leaf using the largest pieces you are comfortable working with. Some people lay whole sheets of gold, others find it easier to maneuver small sections. When you have one piece down, lay a second one so that it overlaps the first by ⅛ in. or so. Cover the entire surface with leaf, then go back and fill any small gaps.

Once you've covered the surface and filled any gaps, brush away the excess gold, or skewings, with a gold mop. Hold the brush firmly and use a gentle circular motion. The leaf adheres only to the sizing, not to other leaf, so as you continue to brush over the seams, they will fade, and it will be difficult to tell where each sheet of leaf began and ended.

Some people like to give gold leaf the appearance of an antique. You can create a patina to achieve this effect using caseins—water-soluble, quick-drying flat paints that can be intermixed without muddying. Mix several colors to create a dusty or dirty blend and then apply it with a rag. Rub off some of the mixture, leaving more color, or age, in corners and crevices where dust would naturally fall.

I rarely use a topcoat over gold leaf because it will dull the appearance of the gold. And for surfaces gilded with leaf 22 karat and higher, a topcoat is unnecessary, because they will not tarnish or corrode.

WORKING WITH LOOSE LEAF

Leaf without a paper backing is trickier to work with but offers a wide range of colors and types of leaf not available with backing.

Too tender for scissors. *Cut loose leaf with gentle pressure from a gilder's knife. To avoid contaminating the gilder's tip (brush), learn to hold it rather than laying it on the bench.*

Quick tip. *After cutting the leaf, lay the gilder's tip against the leaf and draw it away. The leaf should gently adhere to the tip.*

Leaf delivery. *Touch the tip to the workpiece, and the gold will cling to the sized surface.*

Coaxing with cotton. *Use a cotton swab to get the gold to conform to the main contours of a carving.*

Mop after swabbing. *A gold mop can be used after the cotton swab to press leaf into deep recesses.*

How and where to buy gold leaf

Gold leaf is sold to craftsmen by the book or by the pack. Each book contains 25 sheets of gold, and you can cover about 2 sq. ft. with a book's worth. A pack contains 20 books.

There are four main types of gold leaf used for gilding. Surface leaf is the traditional leaf used for gilding. Patent leaf, also called transfer leaf, is the same as surface leaf but comes adhered to a thin paper backing, which makes it easier to handle. Glass leaf is similar to surface leaf, but it has fewer imperfections, so it is ideal for signs on glass. Double leaf is like surface leaf but thicker (although not twice as thick); it is useful for gilding objects with sharp edges that might cause thinner leaf to break. All four types come in various shades of gold.

The karat weight of gold—an indicator of the gold's purity, not its weight—is expressed in 24ths. Leaf marked 24K (karat) is pure gold. Leaf marked 23K is 23/24ths gold and 1/24th alloy.

Leaf thickness is measured by weighing 1,000 sheets and is expressed in grams. As an example, gold leaf designated 23K, 11g, would be thinner and cost less than 23K, 14g leaf.

Gold leaf costs about $1 a sheet. You can buy gold leaf and gilding supplies from large art stores or from the following companies: Easy Leaf (6001 Santa Monica Blvd., Los Angeles, CA 90038; 800-569-LEAF); Sepp Leaf Products (381 Park Ave. S., Suite 301, New York, NY 10016; 212-683-2840); and Baggot Leaf Co. (430 Broome St., New York, NY 10013; 212-431-4653).

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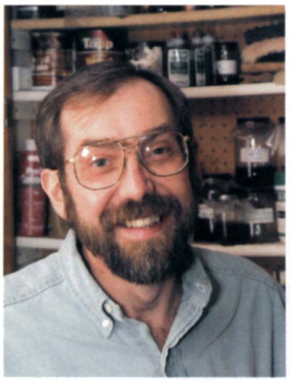
BY CHRIS MINICK

Three simple finishes



Let's face it. Applying a high-gloss, filled-and-toned finish to a piece of furniture can be a pain. Luckily, not every project requires such a fancy finish. With some jobs, an easy-to-apply, wipe-on/wipe-off finish is the perfect choice, and wipe-on finishing couldn't be simpler.

My wipe-on finishing arsenal consists of three variations: a wipe-on oil finish, a straight wax finish and a shellac-and-wax combination finish. The wood species and the final look I want determine which of these finishes I'll use. All three produce a silky smooth surface that begs to be touched. On the downside, none of these finishes does much to protect the surface from the nicks, dings and spills of everyday use. Fortunately, wipe-on finishes are easy to repair when disaster strikes: Wiping on another coat is usually all you need to do.

Good surface preparation is the key

Wipe-on finishes are applied in relatively thin coats, so they don't have enough body to cover up stray sanding scratches or other defects on the wood surface, as a brushed-on, heavy-bodied varnish would. Consequently, paying close attention to your sanding sequence is an important part of the wipe-on finishing process.

For most wood species, I sand the wood up to 180 grit with aluminum-oxide discs on a random-orbit sander, then hand-sand with 180-grit garnet sandpaper. Hand-sanding eliminates the machine-made swirl marks and generally improves the quality of the surface. I prefer garnet sandpaper for hand-sanding bare wood because the garnet mineral leaves a softer, less-noticeable scratch than other common types of sandpaper. This sanding sequence is not written in stone; you can vary the grit selections and types of sandpaper on your projects. (For more about sanding and surface preparation, see my Finish Line column in *FWW* #132.)

Oil mixed with varnish

Wipe-on finishes are nothing new to woodworking. I own a finishing manual published in the early 1800s that touts the virtues of linseed oil. However, the application schedule for straight linseed oil was quite grueling: a coat of the oil once a day for a week, once a week for a month, once a month for a year and once a year forever. Fortunately, modern oil finishes (often called Danish oil) are not nearly as demanding. Danish oils are a controlled blend of either linseed or tung oil, varnish resins, solvents and chemical driers. These oil blends offer a number of advantages: They're easy to apply, quick to dry, and they protect the surface as only varnish can.

Application doesn't get any easier than this. Lay on a liberal coat with a brush or a rag and add more, as needed, after a few minutes when dry spots appear on the surface. After 30 minutes or so, wipe away any excess oil and allow the wood to dry overnight. Buff the dry surface with a fine abrasive pad and then apply at least four more coats. Wet-sanding the second and third coats with 400- or 600-grit wet-or-dry sandpaper will produce a surface as smooth as a baby's skin. Wet-sanding levels the surface and also creates a slurry of the Danish oil and sanding dust that fills the pores of the wood. Wet-sanding is not a good idea if the project contains contrasting woods, such as holly string inlay in walnut. The dark slurry from the walnut will discolor the holly.

***Dried oil is like dried blood:** It's hard to remove after it dries. That's why you should continue to wipe off the excess oil that often bleeds back onto the surface of wood that has large open pores.*

About the only problem you might encounter is oil bleeding back up onto the surface (see the photo above). This predicament is common with large-pored woods such as oak, ash and walnut. After the first and second coats of Danish oil, the grain lines will often ooze this excess oil for hours. If you allow it to dry on the surface, unsightly shiny patches will be the result. You can avoid this problem by applying the oil early in the day and checking the workpiece every 30 minutes or so for oozing. The oozing should stop after four or five hours.

I use a home-brew Danish oil in my shop, and I rarely have bleeding problems. My formulation is rather simple: 1½ cups mineral spirits, 1 cup brushing varnish and ¼ cup boiled linseed oil. Not surprisingly, changing the proportions will affect the characteristics of the finish. For instance, more varnish decreases the drying time and provides greater protection to the wood, but it makes the finish more difficult to wipe on. The converse is true for

Photos: Michael Pekovich

the linseed-oil portion. Experiment with the formula until you find a mixture that suits you.

Wax—the easy one

Straight wax is the easiest way I know to finish wood, but it does virtually nothing to protect the wood from everyday use. That shouldn't keep you from using it though, because not all projects demand a lot of protection. Wax looks great on small boxes, turned pieces and decorative objects, and it's the only finish I use on cutting boards and wooden cooking utensils. Turnings can be finished right on the lathe.

The procedure is simple enough: Apply a thin coat of wax, let it dry to a dull haze, then buff it to a satin sheen with a clean, soft rag. Two coats of wax are all you'll need, because little improvement in luster or protection is gained by more than that. I use steel wool (000 or 0000) as a wax applicator. The steel wool pad—loaded with wax—pares away the wood surface, shearing off small protruding wood fibers as it spreads on an even coat of wax. The net result is a smoother and more evenly coated wood surface than you'd ever get with a rag or an abrasive pad.

Mix your own colors. *Shoe polish is the perfect tinting medium for custom-colored wax, and it happens to come in shades that blend well with many woodworking projects.*

In my opinion, hard paste-type furniture waxes are the only kind suitable for use as finish. Be careful in your selection, though; not all furniture waxes are created equal. Some contain a high percentage of soft waxes, predominately beeswax. These waxes remain relatively soft and seem more readily to show fingerprints and collect dust. I prefer paste waxes that contain mostly (if not solely) carnauba wax, which forms an extremely hard wax film that will buff to a high gloss. Wax manufacturers are proud of the carnauba wax content in their products and usually list it prominently on the labels.

Putting a wax finish on large-pored, dark-colored woods can be problematic. Wax collects in the pores and turns white when it dries. Short of planing or sanding it out, it's almost impossible to remove. Take heart; there's a simple solution to this dilemma. By tinting the wax to match the background color of the wood (see the photo above), this problem disappears. I tint my wax with shoe polish (the paste kind, not the liquid dye). Most shoe polish is made from carnauba wax and comes in colors that blend well with wood shades. My formulation is not exact by any means. I start with a scoop of paste furniture wax and mix in a dollop of shoe polish, then check the color on a scrap. I repeat the procedure until I'm satisfied with the color, and I usually mix my wax colors a little darker than the surrounding wood. I prefer the slight contrast the darker wax provides; however, you may not.

Shellac and wax—a good marriage

Many woodworkers only consider brushing or spraying on a shellac finish, but with a little practice, you'll find that shellac can be a wonderful wipe-on finish, too. I'm usually a staunch supporter of mixing your own fresh shellac from dry flakes for wood-finishing applications. (In fact, I've been called a dry-shellac-flake evangelist.) But in this case, I'll have to retreat from my usual stand. Premixed shellac, the kind you find in a hardware store, simply works better for wipe-on applications than fresh, shop-made shellac. I'm not sure why—it may be because of the wax content of the shellac or that the age of the solution enhances its plasticity—but experience has taught me that premixed, canned shellac is superior for wipe-on finishing.

The wipe-on procedure is simple. Saturate a clean, lint-free rag with shellac solution right out of the can. The rag should not be dripping wet, but when you squeeze it, finish should flow out of the rag. Wipe the wood with the wet rag, then immediately wipe up any drips or puddles with the same rag. The wood should look thoroughly wet, but there should not be any appreciable liquid left on the surface. After this first coat has dried for two hours or so, lightly sand the wood with 220-grit (or finer) sandpaper to remove any raised grain, then wipe on another coat. Three of these wiped-on coats will yield a nice surface luster without a detectable surface film. A coat of wax applied over the final shellac coat lends a nice, hand-rubbed feel to the piece. A shellac and black wax polish on fumed white oak is an especially great-looking finish for Stickley-style furniture (see the photo below).

Black wax over shellac. *The combination of these two finishes looks especially good when applied over fumed white oak.*

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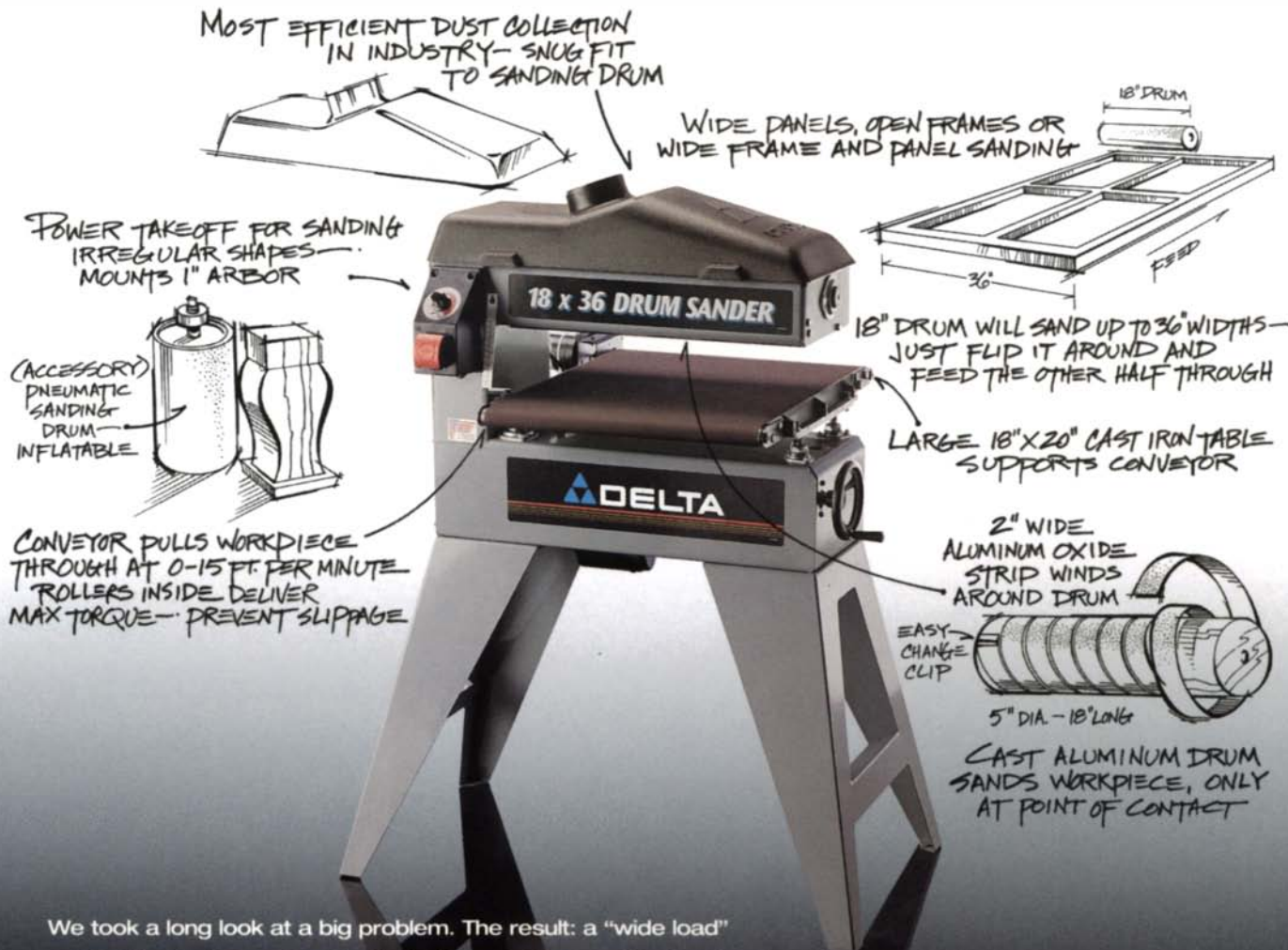

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Connoisseur of Curves

For Jere Osgood, a straight line is a missed opportunity. In 40 years making furniture, he's missed very few. A quiet man who lets his furniture speak for him, Osgood, of Wilton, N.H., has developed a vocabulary of curves that is unmistakably his and undeniably eloquent. In this recent writing desk (purchased by the Rhode Island School of Design Museum), as in all of his furniture, Osgood's flair for form is matched by a passion for technique. The legs of the wenge, bubinga and ceylonese satinwood desk are bent laminations in which each laminate is tapered—a trick he developed in the late 60s. The staved lid—inspired by the shape of a lute—is an elliptical assembly of bent-laminated pieces attached to the desk with brass hardware he made from bar stock. And the craftsmanship that brings all these curves together? It speaks for itself.

Photos, top: Dean Powell, courtesy of Pritam and Eames; bottom: Zachary Gaulkin