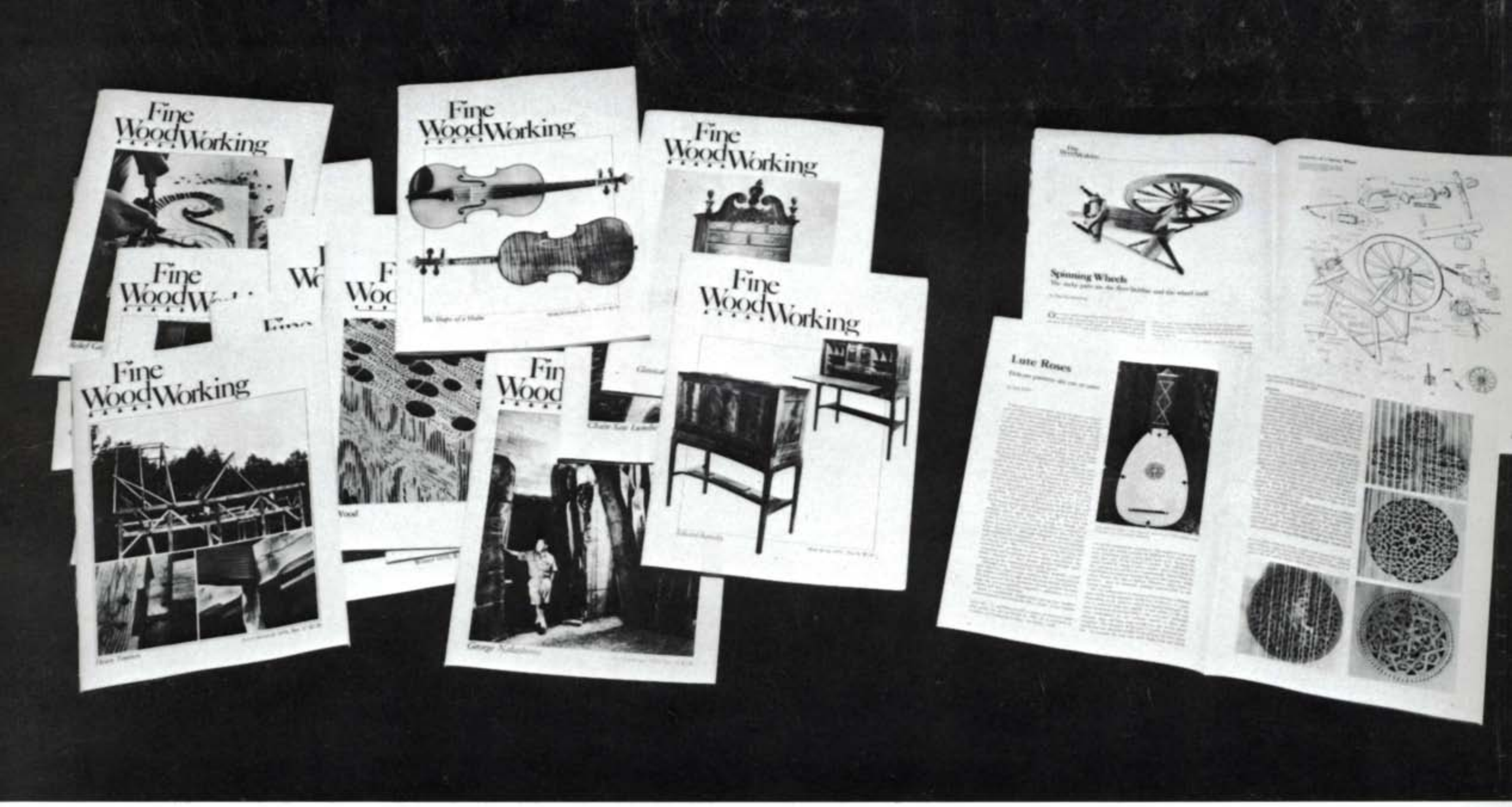
Fine WoodWorking

MARCH/APRIL 1980, NO. 21, $3.00

Hans Wegner



Find your specialties in these back issues of Fine Woodworking

Each issue of *Fine Woodworking* takes a detailed look at many aspects of our craft, in effect building a growing reference of woodcraft techniques. And because there's always so much of interest to cover, *Fine Woodworking* never repeats itself. Small wonder one new subscriber in 20 requests the complete set of back issues. Here's valuable information you can't find anywhere else and that doesn't go out of date.

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Spring 1976, No. 2—Marquetry Today, Split Turnings, Eagle Carvings, Hand Dovetails, Mechanical Desks, Textbook Mistakes, Antique Tools, Spiral Steps, Gustav Stickley, Oil/Varnish Mix, Shaker Lap Desk, Chair Woods, Back to School.

Summer 1976, No. 3—Wood, Mortise and Tenon, The Christian Tradition, Hand Shaping, Yankee Diversity, Plane Speaking, Desert Cabinetry, Hidden Drawers, Green Bowls, Queen Anne, Gate-Leg Table, Turning Conference, Stroke Sander, Furniture Plans.

Fall 1976, No. 4—Cabinetmaker's Notebook, Water and Wood, Hidden Beds, Exotic Woods, Veneer, Tackling Carving, Market Talk, Abstract Sculptures from Found Wood, Workbench, Ornamental Turning, Heat Treating, Mosaic Rosettes, Shaped Tambours, Buckeye Carvings, Hardwood Sources.

Winter 1976, No. 5—Stacking, Design Considerations, Keystone Carvers, Carcase Construction, Dealing With Plywood, Patch-Pad Cutting, Drying Wood, Gothic Tracery, Measured Drawings, Wood Invitational, Guitar Joinery, The Bowl Gouge, English Treen, Shaper Knives.

Spring 1977, No. 6—The Wood Butcher, Wood Threads, The Scraper, California Woodworking, Bent Laminations, Dry Kiln, Expanding Tables, Two Sticks, Stacked Plywood, Two Tools, Pricing Work, Going to Craft Fairs, Colonial Costs, Serving Cart, Woodworking Schools.

Summer 1977, No. 7—Cooperative Shop, Glues and Gluing, Winter Market, Three-Legged Stool, Lute Roses, Bowl Turning, Wharton Esherick, Doweling, Spalted Wood, Antiqued Pine Furniture, Solar Kiln, Carving Fans, Bending a Tray, Two Meetings, Index to Volume One.

Fall 1977, No. 8—Out West, Steam Bending, Triangle Marking, Painted Furniture, Chain-Saw Lumbering, Rip Chain, Getting Lumber, Sawing by Hand, Gaming Tables, Two Contemporary Tables, Wooden Clamps, Elegant Fakes, Aztec Drum, Gout Stool, Two Tools, Measuring Moisture, The Flageolet, Young Americans.

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Spring 1978, No. 10—Two New Schools, Wooden Clockworks, Hammer Veneering, Claw and Ball Feet, Block-Front Transformed, Hot-Pipe Bending, Furniture Galleries, A Two-Way Hinge, Laminated Turnings, Chain-Saw Carving, Circular Saws, Louvered Doors, Small Workbench.

Summer 1978, No. 11—Harpsichords, Spinning Wheels, American Woodcarvers, Drawers, Turning Spalted Wood, Scratch Beader, Leather on Wood, Notes on Finishing, Building Green, Parsons Tables, Hanging a Door, Pencil Gauges, Dulcimer Peg Box, Tiny Tools.

September 1978, No. 12—Community Workshop, Greene and Greene, Holding the Work, Scandinavian Styles, Tambours, Stains, Dyes and Pigments, Spindle Turning, Cleaving Wood, Whetstones, Sharpening, Cockleshell, Dust-Collection System, Sanding, Used Machinery, Wooden Wagon.

November 1978, No. 13—Making Ends Meet, Scientific Instruments of Wood, Making a Microscope, The Harmonious Craft, Laminated Bowls, Preparation of Stock, Tung Oil, Relief Carving, Roll-Top Desks, Shaped Tambours, Cylinder Desk and Book-Case, Basic Machine Maintenance, Portfolio: A.W. Marlow, End-Boring Jig, Scale Models, The Purpose of Making, Lumber Grading, On Workmanship.

January/February 1979, No. 14—Guitarmaking School, George Nakashima, Lester Margon's Measured Drawings, Tapered Lamination, Improving Planes, Restoring Bailey Planes, Box-Joint Jig, Five Chairs: One View, World Globe, Koa Table, Incised Lettering, Bolection Turning, Air-Powered Tools, Polyhedral Puzzles, Design Sources, Have a seat.

March/April 1979, No. 15—College Dropouts, The Shape of a Violin, Stalking Mesquite, The Mortise & Tenon Joint, W.A. Keyser, Router Tables, Treadle Lathe, Freewheel Lathe Drive, Milk Paint, Flying Woodwork, Routed Signs, Staved Containers, Carved Shells, Flight of Fancy.

May/June 1979, No. 16—Working With a Handicap, Edward Barnsley, Locking the Joint, Harvesting Green Wood, Shop-Built Vacuum Press, Five More Chairs: One View, Hollow Turnings, The History and Practice of Marquetry, Silas Kopf's Marquetry, Before the Finish, Workbench, Circular Stairway, Three Stairways, Spiral Staircase, The Machinist.

July/August 1979, No. 17—Frederick Brunner, Sawmilling, Working with Heavy Timbers, Portfolio: Woodworking Women, Bending Compound Curves, Furniture from Photographs, Routing for Inlays, Precision: Tips from the Die-Making Trade, Finishing Materials, Solid Wood Doors, Library Steps, Norwegian Woods.

September/October 1979, No. 18—Showcase Cabinets, Tapered Sliding Dovetails, The Haunched Mortise and Tenon, Methods of an Old World Cabinetmaker, Production Problem, Drop-Leaf and Gate-leg Tables, Making the Rule Joint, Woodturning Chisels, High School Woodwork, To Finish the Finish, Cabriole Legs, Making Cabriole Legs, Contour Tracer, Cabriole Template, Paneled Doors and Walls, Rhinodesk.

November/December 1979, No. 19—Wharton Esherick, Ringed Rattle, Another Rattle, Dragonfly, Two Toy Trucks, Oyster-Shell Veneering, PEG for the Woodworker, Tips from the Turning Conference, Old-Fashioned Turners' Gauges, Oil/Varnish Finishes, Portfolio: Charles Rombold, Chip Carving, Copenhagen 1979, Mortise & Tenon by Machine, East Comes West, The Jointer, More Mortising: Sloping Wedges and Shims, Band Saws, The Woodchuck, Mother Nature, Woodcarver.

January/February 1980, No. 20—Michael Thonet, A One-Piece Chair, A Glue Press, Working Woven Cane, Making a Basket From a Tree, Laminated Fishing Net, Knockdown Tabletops, Orientable, Japanese Planes, Making a Modern Wooden Plane, French Polishing, Seedlac Varnish, Shaper Cutters and Fences, Plans for a Pigeonhole Desk, Repairing Wobbly and Broken Chairs, Wood '79, Arnold Mikelson, Geometric Marquetry, Hardwood Sources.

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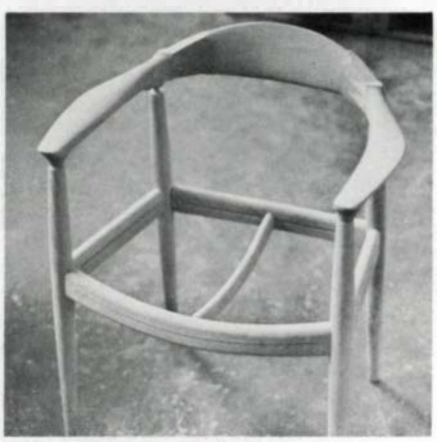
Fine WoodWorking®

MARCH/APRIL 1980, NUMBER 21

DEPARTMENTS

ARTICLES



Cover: Four views of the Classic chair (1947), in white oak and cane, by the Danish designer Hans Wegner. Mock-up, above, reveals the three-piece construction of the chair's back and arms. The pieces are first formed on the shaper, and the tapered finger joint is cut, but the wood is left square just at the joints. After assembly the joint areas are faired out by hand. Dowels connect the arms to the legs. For more on Wegner, see page 36. Cover photos: Doug Long, Photocraft; chair loaned by Design Selections International.

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In our profession the concept of harvesting trees seems inherent, but I have found that through dedication and serious intent I have been able to secure more lumber that I can use instantly through the salvaging of logs from construction of roads, lakes, power lines, buildings, etc. I wonder if there is a way that you could provide the service of helping interested persons in locating either the folks involved in clearing land on a large scale, or the other way around. Last year I worked on a 4,300-acre lake site that had so much wood destroyed I could have worked for the rest of my life and more and never begun to use the lumber available. The clearing contractor had tried to find someone to log the timber, but interest in the activity is not prevalent. Too many folks would rather simply go to the distributor and plunk down the bucks and drive off with a stack of inert mass, instead of giving the act a deeper meaning through self-acquisition. I could go on about how one comes closer to the true purpose of our work, but that concept is probably apparent to you. . . .

—*Allen L. Pogue, Fort Worth, Tex.*

EDITOR'S NOTE: Our mail includes a growing number of suggestions like Pogue's, and requests from readers who wish to connect with others to share mutual interests. We're starting a new information-exchange column, Connections, on page 32.

Re Adventures, *FWW* #16, May'79, the staircase in the Loretto Chapel is no miracle, but was done by a master staircase-builder. Many staircases of this type have been built. . . . If constructed properly, no central support is required. The runners are glued up from many handcut pieces. Because of the twist they cannot be cut by a machine. The wood grain runs always parallel with the runner—this gives maximum strength. A staircase of this size may move somewhat but will not break. It is like a coil spring; unless there are visible defects, I see no reason for concern about the safety of this staircase.

—*Hans-Josef Sandker, Strathroy, Ont.*

As an architect/furniture designer I am involved in a combination of architectural millwork, designed for production and one-of-a-kind pieces. Although I am completely sympathetic to the one-of approach to furniture that places the emphasis on woodworking as art, I feel that the participation of the designer/craftsman in the broader spectrum of production-oriented furniture projects can humanize and enrich the general public's experience with the objects they are surrounded by and use daily.

Certain designer/craftsmen like Bob DeFuccio have been able to bring their craftsman's approach to the production arena successfully. It is this junction between craft woodworking and industrial design that I would like to see more about in *Fine Woodworking*. It was interesting to see the reactions to Mel Bird's letter in the May'79 issue. I really have to join his opponents; although the knowledge and appreciation of designs of the past are vital to the development of every craftsman, man has spent much of the last few thousand years pushing out the bounds of our knowledge. I feel that it is extremely important to continue this search for new forms and processes that will add to our body of knowledge rather than repeating forms appropriate to another era.

—*James J. O'Hara, Brookline, Mass.*

. . .I was amused by the fuss several readers made over modern versus traditional woodworking. (Craft is, after all,

craft, regardless of its manifestations. Why not let time decide what is art and what is not?)

Along these lines of diversity I would like to suggest to those of us who are always seeking out new wood projects that building wooden boats is interesting and challenging. It is surprising how much ingenuity, judgment and genuine skill are necessary to build some of the old classic boats. I hope I am not sounding paternalistic about this; it's just that the Midwest is not the home of many master boatbuilders. For those among us who have fallen away from the use of our hand tools, it will be a revelation, albeit painful at times. There will, however, be little if any argument about the value or the beauty of the results. —*Don Dill, St. Louis, Mo.*

EDITOR'S NOTE: Readers who would like to learn about boatbuilding may enjoy the magazine *WoodenBoat*, $12 a year from Box 268, Brooksville, Maine 04617.

I like Rich Starr's idea on securing froe handles (Methods, March '79). They can be frustrating. Froes with straight-sided handle sockets get knocked off from club battering. Those with a tapered socket bounce back and swing loose.

The problem with Starr's through bolt is that it requires special drills to bore through seasoned hardwood end grain, especially 16 in. to 20 in. My method is to secure the froe with a large flat washer and a ½ x 4-in. lag bolt. So far I've busted over 1,000 shingles with this rig and it seems to hold just fine.

—*Drew Langsner, Marshall, N.C.*

Re the article on choosing a band saw (*FWW* #19, Nov. '79): I bought and built a Gilliom 18-in. band-saw kit and have been using it for about six months. It is the first band saw I have owned or used, so I don't have much to go on for making comparisons. However, for what they're worth, here are some comments:

The saw is reliable. The blade tracks well, and things like blade tension and wheel alignment don't have to be constantly fiddled with. I have sawn woods ranging in hardness from basswood to oak and maple, and it does reasonably well on all of them up to a thickness of perhaps 3 in. I saw tenon cheeks with it, for example. However, I was disappointed to find that it will not resaw anything much deeper without the blade curving badly to one side. . . . Also, it takes forever. The feed rate for even a soft wood 6 in. or so thick is excruciatingly slow (the motor is ¾ HP, the larger of two recommended). I gather this blade curvature is what the article calls bellying and ascribes to inadequate chip clearance. I intend to try the remedy suggested in the article, using a coarser blade, but am skeptical about whether it will make much difference. The blade that I've been using is ½ in., four teeth per inch, supplied by Gilliom.

I would not buy this saw again because a resawing capacity is too important to me. However, I should note that Gilliom gives fair warning of the saw's limitations, advertising it as a light-to-medium duty saw primarily for home workshop use. I think that the saw lives up to this.

—*Ted Sittler, New York, N.Y.*

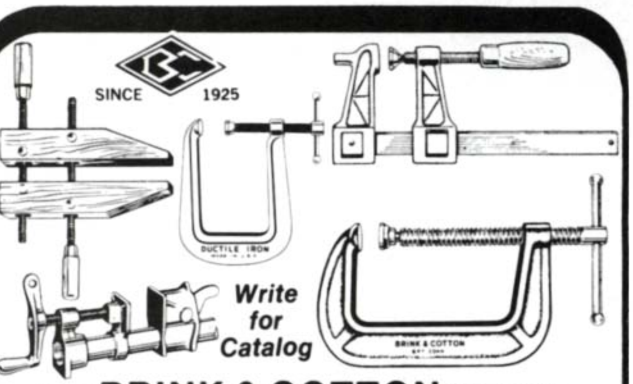
. . . As you point out in your article on band saws, many of the machines built for the home workshop are quite small, which limits their usefulness. Also, the price of a band saw dampens the desire of the prospective buyer. After thorough checking, I decided to build a 24-in. three-wheel band saw of my own design.

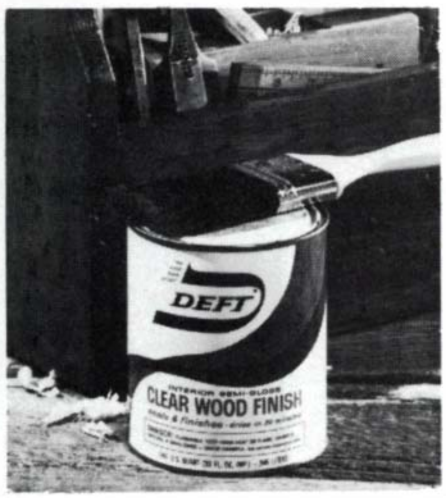
In order to accomplish my goal I checked out the band-saw castings for a 12-in. saw, made by Gilliom Manufacturing of St. Charles, Mo., and found them to be satisfactory for my

purpose. Obviously I had to purchase an extra wheel and its bearing and a shaft in order to design and build the saw to my own specifications. Also, the 12-in. band-saw kit contained some items that could not be used on the 24-in. saw, and likewise it was necessary to add an item or two. Gilliom was very cooperative in deleting from and adding to the 12-in. kit, which in the end cost me $100.84.

The saw is a floor model with a 3-ft.-by-3-ft. table, which tilts to 45°. The upper blade guide can be raised to a maximum height of 13 in. above the table. Since my shop is in the basement it was necessary to construct the base so that the saw could be raised easily and quickly onto casters for moving when necessary. The entire construction, with the exception of the castings, is ¾-in. plywood and No. 1 yellow pine. For sturdiness, in critical areas I doubled the plywood using contact cement, and a good woodworking glue on the frame members. Lag screws were used except where the size of the components dictated otherwise. The fact that the saw is a three-wheeler gives ample room beneath the table for a cabinet to store extra blades. Painting is extremely important so the wood's dimensions will not change because of moisture absorption. —*Harlan D. Price, Eureka Springs, Ark.*

. . . I bought, about three years ago, the 18-in. band-saw kit from Gilliom. I found the instructions adequate and had no particular difficulty constructing the machine. The parts generally were of acceptable quality, with one very important exception. The upper guide support arm that holds the upper blade guides and roller and has the very important function of supporting the sawblade was in rough-cast form and in no way capable of being raised and lowered with any assurance of





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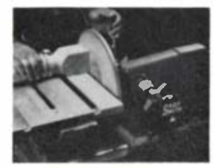

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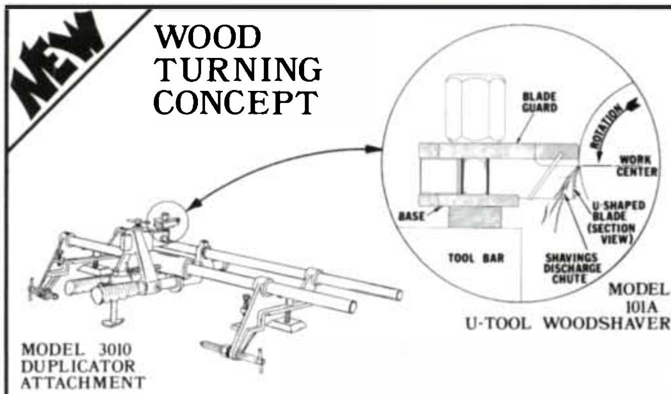
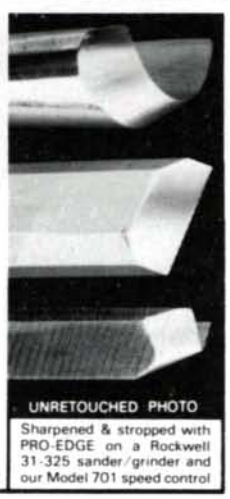




stability or alignment. Fortunately, I have a swell machine shop so I was able to mill the part and make it work properly. . . . —*George H. Rathmell, Los Osos, Calif.*

I make reference to your recent article on band saws. You indicate that the Inca 310 band saw is available from Garrett Wade Co., and make no reference to Anson Industries, Inca's exclusive representative west of the Mississippi River, in Alaska and in Hawaii. . . .

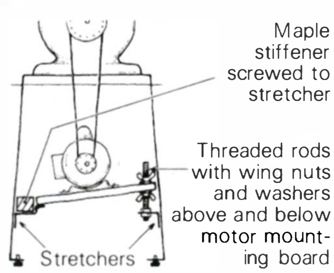
—*Anthony Randazzo, President, Anson Industries*
4115 San Fernando Rd., Glendale, Calif. 91204

I was surprised and disappointed to find that you did not include the Shopsmith 11-in. band saw in your survey of small and medium-sized band saws. I use a 1953 model in my business, and the design is the same on new saws. It is an excellent machine. Your readers should know about it.

—*Robert King, Atlanta, Ga.*

EDITOR'S NOTE: We left out the Shopsmith band saw because it is part of a multipurpose combination machine, and we plan to report on several combination machines later this year. As part of our research, we'd like to hear from readers who have been using multipurpose machines of whatever brand. Does your machine work better in some modes than in others? Does it do everything the manufacturer claims? How much trouble is changing from one mode to the next? Would you buy one again, or would you rather have separate machines?

I thought some readers might be interested in my experiences with the Rockwell 14-in. band saw. First the motor mount provided, a simple stamped hinge, seems worthless to me; it's almost impossible to get the *V*-belt tight enough, and if you can, the nuts and bolts holding the thing together are difficult to reach. I replaced it with a see-saw mount hung from the base stretchers, similar to the ones used on the Inca tools. This eliminated a lot of vibration, as did bolting the stand to the floor. The enclosed stand Rockwell sells is probably better to begin with.



More vibration disappeared after I balanced the wheels. The lower one was okay but the upper required removal of quite a bit of stock before it stopped dropping to the same heavy spot. It might be safer to glue weights to the light side, but I don't trust glues under that kind of stress.

According to the parts list, the saw used to be supplied with a hexagonal guide post for the upper blade guides, but cost-cutting apparently dictated its replacement with the current round one. Its fit in the upper frame arm is sloppy at best, and this necessitates resetting the guide blocks every time the support is raised or lowered. A few shims cut from a coffee can tightened this up. The bracket that holds the blade guides can benefit from the same operation.

The height attachment (for increasing depth of cut) works pretty well. Resawing 12-in. stock demanded more power than the ½-HP motor could put out, so I wrote Rockwell to ask how big a motor I could safely use. Their answer was, essentially, "We don't know." So I got a 1-HP motor, installed it (it won't fit the standard mount) and found that the belt and pulleys limit the power delivered by acting as a clutch. I'm thinking of experimenting with a multiple-belt drive but haven't yet. . . . In sum, I'd say this is a fair tool that probably used to be better, and can be again with a little work. . . .

—*John Gallup, Denver, Colo.*

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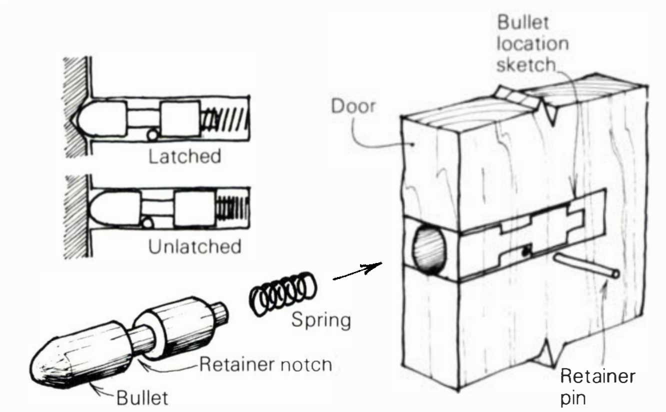
Methods of Work

Wooden bullet catch

This wooden bullet catch takes a little more time to make and install than its store-bought metal cousin. But the sound alone is worth the effort. The catch consists of a turned (or whittled) maple bullet, a small compression spring and a brass retainer pin. First turn the bullet with a retainer notch in its middle and a spring-sized finger on its tail. To complete the bullet, shape the head to a rounded point.

Next, drill a hole in the door edge just deep enough to accept the entire bullet under spring pressure. Pencil in the outline of the hole on the inside face of the door to aid in locating the retainer-pin hole. Hold the bullet on the outline of the hole (with the bullet tip protruding) and mark the retainer notch location. Drill the retainer-pin hole so that the pin fits in the notch and lets the bullet protrude just enough to catch in the jamb. The pin hole can be drilled from the inside, blind to the door's outside. But if the pin hole is drilled through to the face, the pin can be knocked out later to replace the bullet when worn.

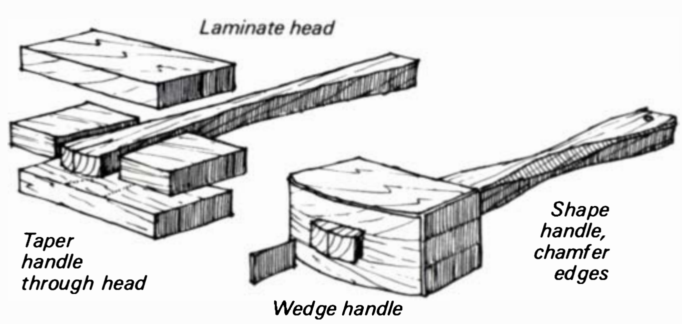
To complete the catch, drill a dimple in the jamb to fit the bullet tip, or install a wooden striker plate in a shallow mortise. If desired, a striker plate and doorstop can be combined in one unit. —*Michael Lynch, San Francisco, Calif.*



Wooden mallet

At least one wooden carpenter's mallet belongs in every woodworker's tool chest. The advantages of wood over steel are obvious—less damage to tools, work, thumbs and eyes. For the price of one steel hammer, you can make a dozen mallets, each tailored to a particular job.

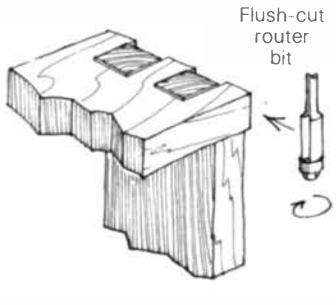
The traditional mallet has a solid-wood head mortised through for the wedge-shaped handle. My laminated head design is just as strong and much easier to make. Begin by cutting the handle and two center laminations for the head from the same 1-in. thick board (this saves a lot of fitting later). Copy the handle's wedge angle (no more than ½ in. of taper) onto one of the side laminations. Then glue up the head block, carefully aligning the center laminations with the wedge-angle pencil lines. When the glue has cured, bandsaw



the head to shape. Then chamfer all the edges to reduce the chances of splitting and insert the handle.

—Daniel Arnold, Viroqua, Wis.

Trimming dovetails



With through dovetails it's accepted procedure to cut the joints a bit long and trim the ends flush after gluing. The fastest method I've found for trimming the slight overhang is to use a router equipped with a carbide-tipped, ball-bearing flush-trim bit. Start the cut at the very corner to prevent the bit from grabbing at the beginning. Always feed against the direction of the cutter rotation. After routing, a light planing or sanding will complete the job.

—Don Herman, Brecksville, Ohio

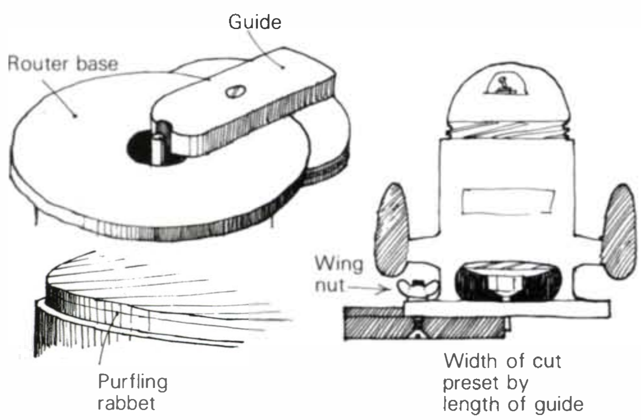
Purfling router guide

In stringed-instrument construction the router is commonly used to cut a small shoulder around the perimeter of the instrument. The dado holds an ornamental inlay (purfling) used to cover the glue seam between top and side. The chore requires a precise cut with a router guide capable of following sharp curves. Though I've tinkered with various adjustable guides, I keep coming back to simple, wooden, preset guides.

The guide consists of a wooden finger glued to a crescent-shaped piece of plywood, which ensures proper postioning. A single bolt and wing nut provide fast but secure fastening.

For inlay work I have three guides, each made to cut a rabbet width corresponding to one, two, or three layers of veneer. Thus, for any given thickness of inlay I just bolt on the right guide. No time is lost making practice cuts.

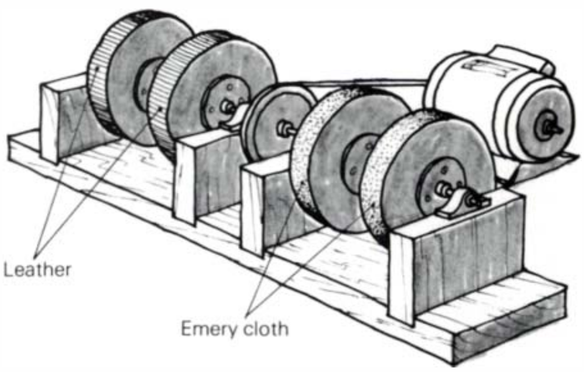
—George Mustoe, Bellingham, Wash.



Lineshaft sharpening

This inexpensive sharpening setup puts a keen edge on tools in seconds without the usual heat build-up problems of powered abrasive wheels. To construct the setup, laminate four 7-in. wheel blanks from plywood or particle board. Epoxy the blanks to shaft collars, which are set-screwed to the ½-in. lineshaft. The shaft turns in pillow blocks mounted on an oak frame. If a lathe is not available, the wheel blanks can be trued right on the lineshaft with a chisel and a temporary tool rest.

Cement emery-cloth strips (80 grit and 320 grit) to two of the wheels, lining the wheels first with burlap-backed cork (from a linoleum dealer). Cement leather to the other two



wheels. Mount the leather flesh side out to one wheel and hair side out to the other. Charge the "flesh" wheel with emery, the "hair" wheel with rouge. Using rubber cement for all mountings will make replacement easier later on.

An old ¼-HP appliance motor will provide sufficient power. Size the motor and lineshaft pulleys so the wheels turn at 500 to 600 RPM up and away from the operator.

Dull tools may need treatment on all four wheels. But most tools can be sharpened on only the finer two or three wheels.

—Robert L. Koch, Tarlsio, Mo.

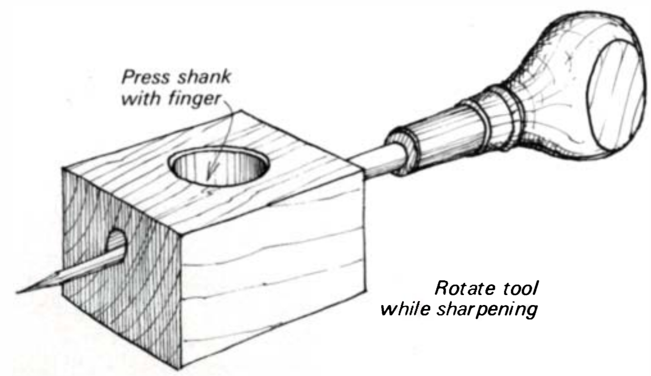
Sharpening fixture

I have always had problems grinding points on tools with tapered shanks. With this simple fixture, it's easy.

To construct the fixture, drill a hole a little larger than the shank of the tool through a hardwood block. Then drill a 1-in. hole from the top, partway through. Glue a scrap of rubber inner tube to the bottom of the block to keep it from slipping about.

To use, insert a finger in the top hole to apply slight pressure against the tool shank. Rotate the tool against the grinder or belt sander with the other hand.

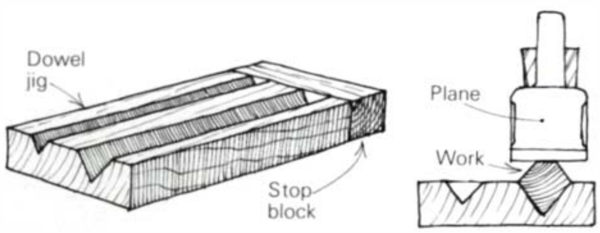
—Jay Wallace, Ashland, Ore.



Making dowels

Although I often need oak or walnut dowels, they're not readily available where I live. Not owning a lathe, I resurrected an ancient but effective dowel-making method that uses a simple jig and hand plane. Dowels made this way are, in my opinion, superior to those made by driving blanks through a steel sizing plate.

Construct the dowel-holding jig by ripping several *V*-grooves in a 2x6. A variety of groove depths will allow a wide range of dowels sizes. Screw a stop on one end of the 2x6. Place a square dowel blank in a groove and plane the top corner. Turn and plane repeatedly until the blank is oc-



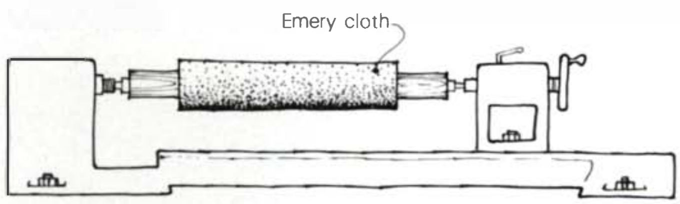
tagonal. Successive turn/plane cycles will result in a nearly round dowel, which can then be finished with sandpaper. One small drawback—the blanks must be flipped end for end as the grain direction changes.

—Frederick C. Wilbur, Shipman, Va.

Lathe sanding drum

This inexpensive but effective drum sander is made and used on the lathe. Center an 18-in. long 4x4 on the lathe and turn a cylinder of 3½-in. diameter. Carefully reduce the diameter of the cylinder until a standard sheet of emery paper wraps around the drum without gap or overlap. Glue the emery cloth (I used 100 grit) to the drum with hide glue. Wrap the entire surface with a sash cord and let dry overnight. Turn down the ends of the drum to about 1½ in. to give free working space. The size of the drum can be scaled up or down for different applications. A smaller open-end drum could easily be made using a screw center.

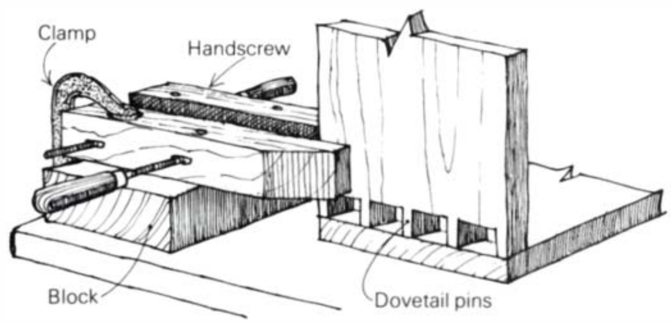
—Harland Smith, Waterloo, Iowa



Dovetail marking setup

This setup for scribing pin sockets in hand-dovetail construction eliminates hand-held slipping and repositioning problems. Put a spacer block under a handscrew on the workbench. Align the two workpieces, tighten the handscrew, then lock the whole in position with a *C*-clamp.

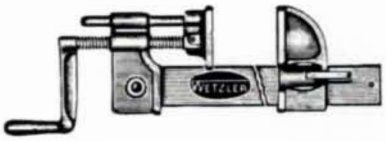
—Richard Kendrot, Windsor, N.Y.

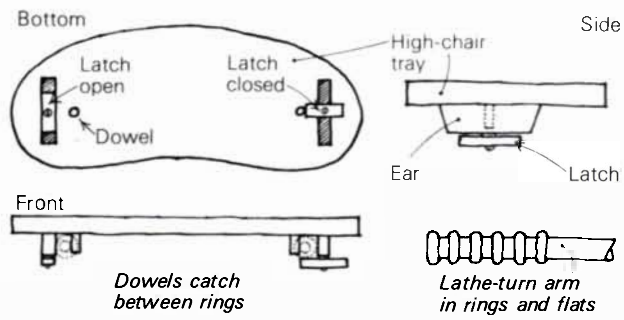


Wooden high-chair mechanism

This high-chair tray adjustment mechanism is simple, won't pinch, rust or jam and is sturdy enough to survive several rowdy babies.

Turn the high-chair arms in a series of rings and flats, then



Dowels catch between rings

Lathe-turn arm in rings and flats

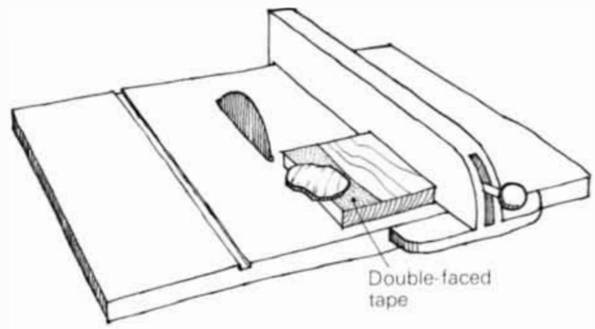
mount them on the chair level and parallel. Install two dowels on the underside of the tray to engage the inside of the arms. This gives the needed in-out adjustment. Two pivoting latch-dowels mounted on ears hold the tray down.

—*J.B. Small, Newville, Pa.*

Tape tricks for little sticks

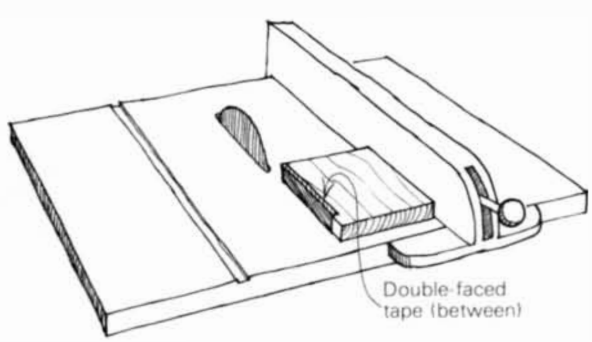
I find myself making lots of little things—small boxes, wooden jewelry and the like. Until I discovered a couple of tricks using double-faced tape, I had a devil of a time sawing the little hunks of wood needed for this kind of work.

To make a straight cut on an odd-shaped, thin slice of wood, run a scrap board through the saw using the rip fence. Stick down a length of double-faced tape to the top of the scrap, peel off the protective paper and mount the odd-



shaped slice on the tape for cutting. Don't rely totally on the tape's holding power—hold the piece down with a finger or stick while cutting.

Double-faced tape can also be used effectively in cutting thin strips from the edge of a board. Cut a scrap board with a built-in stop as shown and mount the tape along the inside



edge. The tape holds the slice away from the blade after it is cut. Use the same care in making the cut as if the tape were not there.

—*H.N. Capen, Granada Hills, Calif.*

Bandsawing duplicate parts

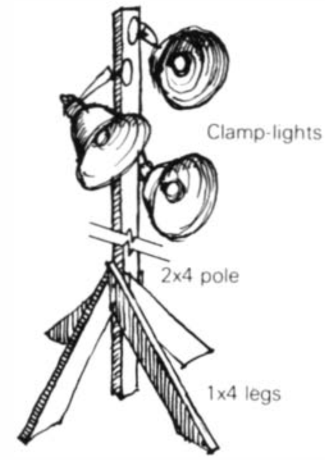
To bandsaw multiples of intricate wooden-toy parts, I stack several blanks together with double-sided tape between. The tape holds firm during bandsawing, drilling and edge-sanding operations. Double-sided tape eliminates nail holes, replaces awkward clamps and reduces layout time (lines need be drawn only once). Parts are easily separated by inserting a chisel into the tape joint and tapping lightly.

—*Larry D. Sawyer, Ridgecrest, Calif.*

Light stands

For temporary lighting in my new shop, I built a couple of light stands from 2x4s with 1x4 legs. Two or three inexpensive clamp-lights completed the fixtures. The poles are easy to move around and don't take a lot of room. They're versatile and inexpensive. Although I've added overhead lighting now in my shop, I haven't been able to do without my light stands.

—*A. Miller, Lakewood, Colo.*



Horizontal boring jig

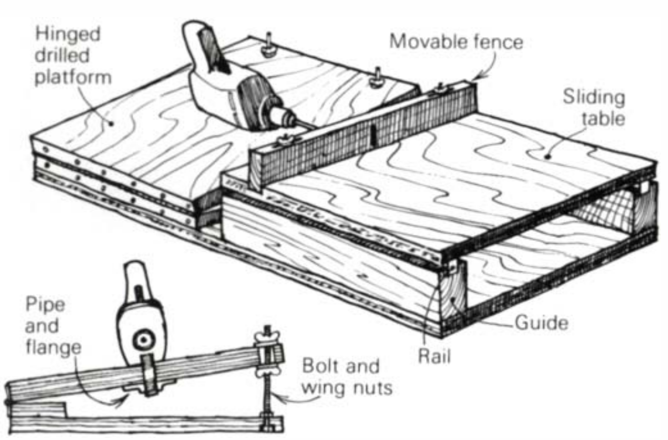
My boring jig, which uses a ½-in. portable drill, is similar to a conventional horizontal-boring machine except that the table moves rather than the drill. The jig consists of a base, a hinged drill platform and a sliding table.

Make the base and sliding table from ¾-in. hardwood plywood. The drill platform should be extra stiff, so laminate two pieces of ½-in. plywood to give a 1-in. thick platform. Spindle elevation is adjusted by raising or lowering the hinged drill platform. Install a piano hinge on one edge and two or three bolts with wing nuts for adjustment on the other edge. If adjustment is needed over a wide range (say, 3 in.), some sort of pivoting arrangement would be required for the adjustment bolts.

Most ½-in. drills have a threaded handle socket on the top or side that will accept standard ¾-in. threaded pipe. Secure the drill to the platform with a short piece of threaded pipe and a standard floor flange.

Elevating the platform swings the drill through a short arc, so the fence on the sliding table must be mounted through slotted bolt holes to allow for movement. Hardwood rails on the bottom of the table mated with hardwood guide blocks on the base provide the tracking action for the sliding table.

—*Vanessa Skedzielewski, Sierra Madre, Calif.*



Methods of Work buys readers' tips, jigs and tricks. Send details, sketches (we'll redraw them) and photos to Methods, Fine Woodworking, *Box 355, Newtown, Conn. 06470.*

Q & A

As I was browsing through the Nov. '78 Q&A section, I came across a question on staining cherry sapwood. My heart skipped a beat because I had just purchased a cherry coffee-table kit from a "reputable" manufacturer, and the tabletop had several large areas of sapwood. As I did not know the right way to stain adjacent pieces of sapwood and heartwood, I thought my prayers had been answered. Much to my disappointment, you did not answer the question to my satisfaction. I have no idea how to "experiment a bit," as you recommended. How about being a little bit more explicit?

—Ben Blackwell, Albuquerque, N. Mex.

I would use two or three thin coats of a penetrating oil/pigment stain, such as those put out by Minwax, to blend areas of cherry sapwood into heartwood. Pick the color closest to the tone of the heartwood (or buy two cans and mix your own). Apply the stain with a wad of cloth or a narrow brush, going only to the edge of the sapwood. If you run over onto the heartwood, rub or brush the color out quickly so you don't get a hard edge showing where the stain stopped. "Experimenting" involves handling the stain delicately, particularly at the edges of the sapwood, so the touched-up areas don't show. Keep in mind that when the stain dries (in about 24 hours) it will be lighter than it is when wet.

When the wood is properly colored and the stain is dry, steel-wool the surface lightly to remove any pigment residue. Then apply your finish. Minwax is an excellent material, but if you are planning to use lacquer, let the stain dry for a week before applying it. Use a thin first coat to help seal in the stain before applying full, wet coats. With varnish or oils, you need no waiting period.

—Don Newell

My uncle recently told me of a recipe for a finish that my grandfather used on oak cabinets. It calls for one part melted beeswax, one part boiled linseed oil and one part turpentine. These three ingredients are heated together until liquid, then applied while hot. After a few minutes any excess finish is buffed off. Is anybody there familiar with this finishing method? What are the merits of this type of finish when applied to oak?

—Jim Smith, St. Louis, Mo.

The recipe for hot wax you describe is not uncommon. Like many earlier finishing recipes it is extremely imprecise, though it produces an excellent finish nonetheless. The recipe calls for one part melted beeswax, one part boiled linseed oil and one part turpentine. Does this mean one part of each ingredient by volume or by weight? There is an enormous amount of room for variation, and an excess of one or the other of the ingredients will alter the result, but mildly. For instance, excess beeswax will increase drying time, though not as much as excess linseed oil. Excess turpentine will increase the speed of drying. The merit of this finish is that once warmed, it will go into the surface of the wood, and into the open grain of oak particularly well. The coldness of the wood will soon harden the mixture so it can be polished. This was frequently done with a soft brush, especially where there was any form of carving or molding. *—Ian J. Kirby, Kirby Studios N. Bennington, Vt.*

I am having a problem with a pure tung-oil finish. A tall stool/plant stand in solid cherry developed a rough surface similar to water-raised grain after the tung-oil finish has dried for several weeks, though the surface was satin-smooth immediately after application. The roughness comes out on the turned legs as well as on the top. However, the very center of the top, the 6-in.-diameter portion that was under a plant pot, has fared better. The stool certainly has received no obvious abuse that would cause such a problem, so I speculate that exposure to direct sunlight is the cause. I also have this same finish on a white oak plant table and a small walnut stool, neither of which is suffering any ill effects. I currently have only two coats of tung on the stool, and I hesitate to build up additional coats for fear of compounding this problem.
—Wm. C. Pelloüchoud, Boulder, Colo.

You do have a problem, and I don't think it's caused by sunlight or that it's raised grain caused by moisture. That other items with the same finish do not exhibit the same symptoms though in the same environment would seem to bear this out. Moreover, grain-raising is seldom uniform over the surface of a piece of furniture; it is usually much more pronounced where end grain comes to the surface, and much less pronounced where the grain runs parallel to the surface. However, the turned legs on your stool are rough all over. Try this experiment. Take some of the tung oil from your container and rub it out to a moderate thickness on a clean piece of window glass (not so thick that it runs). Let it dry for a few weeks. If a roughness develops in the film, you know the problem is with the tung, since glass is not notorious for grain-raising.

I suspect your problem is with dirty tung, and that as the surface film dries and shrinks, particles of tung that have polymerized to hard specks right in the can will emerge. Tung oil is highly reactive, and chances are that if you used the same tung for the oak table and walnut stool as for the cherry stool, enough oxygen was admitted to the container to cause the formation of hardened particles. The spot under the pot is smoother than the rest probably because handling and moving the pot abraded the graininess in that area.

—Don Newell

What is the formula for making polymerized tung oil from plain tung oil? From what source can polymerized tung be purchased?

—John Chapman, Lexington, N.C.

Tung oil is polymerized by heating to around 500°F. It is a tricky procedure that requires very sensitive temperature controls and timing to produce predictable results. You can buy polymerized tung oil (as well as tungseed oil) from Sutherland Welles, Box 639, Woodbury, Conn. 06798, or from Crosby Forest Products, Box 520, Picayune, Miss. 39466. McCloskey Tungseal is tung oil polymerized with added resins.

In "Tung Oil" (Nov. '78), William Woods states that tung oil is often recommended for use on salad bowls, butcher-blocks and other wood surfaces exposed to water, acids, oils and food residues. However, in "Oil/Varnish Finishes" (Nov. '79), Don Newell states that tung oil is not suitable for surfaces that may come in contact with food or children's toys. I would like some clarification.

—Michael McGrath, East Dubuque, Ill.

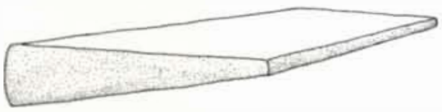
While tung oil is often recommended for salad bowls and children's toys, the possibility also exists that your particular brand of tung oil may contain some metallic driers. The reason I do not recommend tung for the above applications is because I think it is much better to be absolutely sure you have a lead-free or mercury-free finish wherever there is a possibility of its being ingested.

—Don Newell

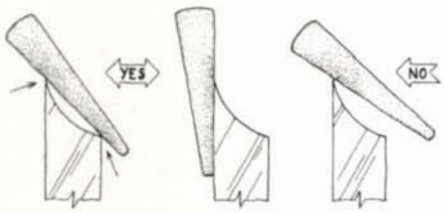
Whenever I send out my 12-in. and 6-in. planer blades to be sharpened, they come back with a jagged edge. Since I don't have a stone big enough for the 12-in. blades, I tried to clean up the edge by laying a piece of emery *cloth on a flat sheet of glass and running the knife edge over the emery cloth, which was fine for the straight edge. Then I tried to hone the bevel the same way. No good. So I put some wet valve-grinding compound on the emery cloth, which produced a beautiful polished bevel but not a keen edge. Can you suggest a suitable grinding compound or a better way to sharpen 12-in. knives?*

—Christopher Boehm, Emmaus, Pa.

You should buy a medium-fine slipstone, which looks like this:



Then put the knives in a vise and hone them with plenty of oil, first one side,



then the other a little at a time, until the jagged edge (it's called a "wire edge") is gone. *—Simon Watts*

In FWW *#4, Fall '76, Letters, a reader inquired about the process used by Danish furniture-makers to finish teak. I would like to bring up that question again. I have been trying without much success to match the finish most commonly used on imported Danish furniture, often referred to as an "oil treated on lacquer" finish. Can you describe the process?*

—Roman Sorokin, Falls Church, Va.

Because teak is an oily wood, the first step must be to remove the natural, nondrying oil so it won't interfere with the drying of the finish or with its adhesion. Either of two solvents will work well. Use chlorothene or 1,1,1 trichloroethane (which is the same as the chlorothene) or the cheapest lacquer thinner you can buy. Cheap thinner will dissolve anything on the wood, yet will evaporate off quickly and completely. Richer, more costly lacquer thinners have components that slow evaporation and can remain down in the wood, creating drying problems. Don't bother to try alcohol to remove the oil, because it won't do a thing for you.

Swab a good, wet coat of solvent on the wood, let it set for a couple of minutes and wipe dry with paper towels. The solvent will bring the oil up to the surface and the paper towels will absorb it. If you have a really oily piece of wood, cover the wetted areas with aluminum foil to retard solvent evaporation and let it soak for five or ten minutes, then wipe dry.

This should take out all the oil down to at least $\frac{1}{16}$ in., which is plenty, since the finish will never penetrate this far. Any oil left down in the heart of the wood will be no trouble.

Now that the wood is oil-free, you're ready to proceed with the finish. Unless you have really light, figure-free wood, you probably won't have to stain—fine, since the more natural you leave the wood, the more natural it appears. To approximate an "oil treated on lacquer" finish, use a well-thinned lacquer to seal the wood, either one or two coats simply brushed, swabbed or sprayed on. The lacquer seal will keep the final finish material from soaking into the wood too deeply. Once the lacquer seal has dried, rub in perhaps two coats of the final finish, with adequate drying time between. The final finish is probably something like Watco Danish oil, which works like an oil but gives a good, durable finish. Two rubbed coats will give you the appearance you want without building up a film in the grain of the wood. —*Don Newell*

Is there a known and successful process to use the fine sawdust from a particular wood you are using to make a putty for filling cavities or imperfections?

—*G. C. Scates, Covina, Calif.*

Yes, there are several. You can mix the sawdust with hide glue or with white cabinet glue. You can mix it with liquid shellac, or you can mix it with clear lacquer. (The last one is well known under the trade name Plastic Wood.)

—*George Frank*

In the Nov. '79 issue, an article on the Newtown, Pa., turning conference describes Del Stubbs' method of making turning tools by epoxying rather than brazing bits of planer-knife stock to cold-rolled steel. Brazing has caused me problems, too. Where can I purchase Devcon's "white two-ton mix?" I've tried Crazy Glue to no avail.

—*H. W. Peterson, Osage Beach, Mo.*

Devcon is available in most hardware stores, or from Paxton Paterson (5719 W. 65th St., Chicago, Ill. 60638). I should point out, however, that since the turning conference last June, I have had second thoughts about this method of securing hard steel to mild steel. After a year of use one of these bits just fell off—the notch proved an important safeguard. I experimented with epoxy not only because brazing required experience and equipment I didn't have, but because, as I understand it, it necessitates heating past where the planer-knife steel will lose its temper (though I have heard that industry brazes high-speed steel to mild steel fast enough not to affect the temper at the edge). I have recently come across a cast alloy, Tantung *G*, that is not as brittle as carbide steel, but can withstand the high brazing temperature (for distributors, contact VR Wesson, 800 Market St., Waukegan, Ill. 60085). Tools made by silver-brazing this alloy have held up well, but I'm not convinced by how it takes and hold an edge (I like at least a 65° clearance angle) that it's the best alloy for this application. There is also the possibility of using planer-knife steel (whose price, availability and edge-holding properties are optimal) and re-tempering it after it's attached to the mild steel. This would involve using a braze whose working temperature is the same as the steel's critical temperature, and brazing and hardening at the same time. Tempering would then take place at a temperature low enough not to affect the bond. (See "Heat Treating," *FWW* #4, Fall '76.) I have not had the opportunity to test this method.

—*Del Stubbs*

Follow-up

Another alternative to R. McKenzie's search for band-saw tires (Sept. '79): a fellow woodworker cut a cross section from a truck-tire inner tube, stretched it onto the band-saw wheel (without adhesive) and trimmed it to fit with a knife. Result: a seamless tire that's lasted for many months now.

—*Sy Balsen, Chatham Center, N.Y.*

Re Rod Gimpel's clockworks that don't work (Nov. '79), pianos also have precision wooden actions, often requiring lubricants to reduce friction to the absolute minimum. There are two lubricants I have been using in my grand-piano restoration shop which I would like to recommend. McLube 1725 is a colorless, dry film lubricant, available in aerosol or liquid form. It dries almost instantly to a transparent haze almost invisible on wood, and has an extremely low coefficient of friction. McLube 1708 (aerosol only) contains the same fluorinated hydrocarbon lubricant as 1725, plus molybdenum disulfide. This is an amazing, ultra-low friction coating. 1708's only limitation is its color, a matte grey-black. Sometimes this can be turned to advantage by careful masking, leaving an attractive band of charcoal "finish" that will not smear off. The advantage of both these lubricants is that they contain no oils, greases or waxes and are perfectly dry. Therefore, they don't get gummy or fouled with dust and dirt. WD-40 is great stuff, too, but is not my choice for wooden surfaces. McLube products are made by McGee Industries, 9 Crozerville Rd., Aston, Pa. 19014.

—Thomas McNeil, Lansing, Mich.

David McWethy writes in the Nov. '79 issue that he is having trouble with deterioration of the finish on exterior signs. I wonder if he has tried Awlgrip High Solids (U.S. Paint, Lacquer and Chemical, 2101 Singleton St., St. Louis, Mo. 63103). I have used this on teak steering wheels for sailboats and also on mahogany and cedar dinghies with great success. I made a 26-in. teak wheel that has been out in the weather, including salt spray, for two years, and the finish is as bright as ever. Awlgrip is usually sprayed on over a sealer coat of varnish. I do not have a sprayer and find that a fine brush used carefully does just as well. I have also used this finish on a few of my recent pieces of furniture, ones that require a high gloss. It does not scratch easily, and needs no attention except for the usual dusting.

—Frederick Johnson, Andover, Mass.

Readers want to know:

I am considering buying a single-end tenoner and have been collecting user information. Please let me know if you ever run across anyone familiar with the machine. Powermatic and Milbury are at the bottom of the price range and Newman and Oliver at the top, with no middle-range machines. . . .

—Frank S. Bowman III, Boonsboro, Md.

Readers can't find:

—Plans for a kitchen step-stool;
—Plans for an autoharp;
—Plans for a Canterbury, a small book rack mounted on casters;
—Hardware for a tantalus decanter stand;
—A kit for a four-drawer Governor Winthrop desk with serpentine front and claw feet;
—Information on, or an owner's manual or parts for, a 46-in. bed Walker-Turner wood lathe;
—Information on a J.D. Wallace universal saw, #11-1845.

Send questions, answers, comments and supply sources to Q&A, Fine Woodworking, *Box 355, Newtown, Conn. 06470.*

Books

With Hammer in Hand by Charles F. Hummel. *University Press of Virginia, Box 3608, University Station, Charlottesville, Va. 22903, 1968. Also available from the bookstore of the Winterthur Museum, Winterthur, Del. 19735. $25.75, cloth, 424 pp.*

Since the publication twelve years ago of *With Hammer in Hand*, the book has become an essential text among tool collectors and students of American material culture. The woodworkers I have spoken with, however, seem largely unaware of the book's existence, despite the fact that it contains a wealth of practical information.

With Hammer in Hand concerns three generations of East Hampton, N.Y., craftsmen who would now be considered "country," Nathaniel Dominy IV, Nathaniel Dominy V and Felix Dominy, who represent the last stages of the pre-industrial craft tradition before it succumbed to the machine and the factory. Their combined careers extended from the 1760s to the 1830s, and although they were best known for clockmaking, their activities included clock and firearm repair, house framing, wheelwrighting and surveying, in addition to furniture making. In the 1950s, the Winterthur (Del.) Museum acquired the Dominy shops, more than 1,000 tools, and their business ledgers and weatherbooks. This collection, along with their surviving work, provides the clearest insight into the life of the pre-industrial American woodworker. Hummel's book, with chapters on Dominy family history, contemporary East Hampton, woodworking and metalworking tools, Dominy products and excerpts from the business ledgers, is an example of meticulous, yet not stodgy, scholarship and clear writing, with extensive and useful footnotes and many informative photographs. The woodworker interested in pre-industrial techniques will find a coherent body of tools, procedures and products, and, despite the fact that the book is not explicitly for practicing woodworkers, it becomes more useful than many that are.

Today we are used to disposables, but that ultimate of modern throwaways, sandpaper, and its creation, dust, were unknown to the Dominys. With the exceptions of primarily saws, chisels and plane irons, they made the majority of their tools themselves, with occasional help from local blacksmiths. Steel items were generally purchased from England. The Dominy shop exemplifies the opposite of the consumerism that modern woodworkers constantly face. For those who argue that a large capital outlay is necessary to outfit a modern shop with heavy-duty power equipment, some of the data provided by Hummel is enlightening.

The Dominys valued a day's labor, albeit a long day, at about 7 shillings. The book gives a formula for pricing a piece of furniture at a third labor, a third materials, and a third profit. Because the book contains extensive entries from the Dominy business accounts and because many extant pieces of their furniture have been identified, it is possible to make rough estimates of the time it took them to produce a given piece. The results are startling. Simple slatback side chairs, made largely of turned elements, sold at 4s to 6s, so two or three were made in a day. Small, three-legged stands sold for 12s, better than one a day. A desk and bookcase, estimated by Hummel to have taken twenty days to make, sold for 208s. It stands 87¼ in. high, contains 13 drawers, fielded door panels, a fall-front desk and a bonnet top. It is important to note here that the Dominys appear to have had few apprentices other than the next Dominy generation, and that their prices are little influenced by inexpensive apprentice labor.

The cultural context of the 18th-century woodworker is considerably illuminated in *With Hammer in Hand*, and it has helped make possible a new level of investigation into the tools and techniques of the Dominys and their contemporaries. It is a most rewarding book to read.

—*Rob Tarule*

The Tool Catalog by the editors of Consumers Guide. *Harper and Row, 10 East 53rd St., New York, N.Y. 10022, 1978. $14.95, cloth, 288 pg.*

The Tool Catalog has a worthwhile goal: to provide the woodworker with an authoritative guide complete with brand-name tool ratings, prices, sources of supply and a little tool history and education thrown in for good measure. Considering the size of the task, it's no wonder the book falls short.

There's no missing the book at the bookstore—it's big and handsome with a photo-collage of mouth-watering tools on the cover. But a buyer's guide must be more than pretty. It must address formidable questions such as: What categories of tools do I include? What brands and models do I evaluate? What audience am I doing this for? How do I avoid lawsuits by calling inferior tools what they are—junk? For help with the answers, the publishers turned to two experts—R.J. DeCristoforo, a well-known woodworking author (for the power tool evaluations), and Ernie Conover, whose company manufactures specialty hand tools (for the hand-tool evaluations).

The tools evaluated are a predictable batch selected from American standard brands (Stanley, Sears, Rockwell, etc.), with a sprinkling of imported hand tools. More questions are raised by the tools left out of the evaluations than by those left in. For example, Sears' lathe is glaringly absent from the lathe section (all their other tools are here) as is Powermatic's table saw from that section. The book mentions only one manufacturer of lathe tools (Sorby) and clamps (Adjustable Clamp Co.).

I guess it's not reasonable to expect that all brands and models of all tools be evaluated. But when both good and bad tools are left out there's no way to sort out the junk. And sorting out the junk is perhaps the most valuable service a buyer's guide can provide. *The Tool Catalog* falls especially short here.

The selections on hand planes and hand saws are informative and well written, however. There's a description of Stanley's efforts to upgrade the quality of their hand planes. Their new models (look for the brass adjusting knob) are reputedly on a par with the more expensive, imported Record planes. The one-page chart on saw buying is also well done. *—Jim Richey*

Greene and Greene: Furniture and Related Designs by Randell L. Makinson. *Peregrine Smith, Inc., Box 667, Layton, Utah 84041, 1978. $27.95, cloth, 190 pp.*

The furniture made by the brothers Charles and Henry Greene might rightfully be called the most impressive contribution to the art yet made by any American. Yet Greene and Greene furniture and furnishings remain virtually unknown, both in this country and elsewhere. Author Makison and photographer Marvin Rand have made an eloquent attempt to rectify this situation. This book, following their earlier text on the Greenes' architecture, tempts anybody interested in design to sift through it not once, but often.

In the pieces designed and built by the Greene brothers, we see what can happen when fortunate circumstances enable men of extraordinary sensitivity to voice a creative vocabulary unfettered by considerations of time and material costs. Because these pieces were never mass-produced, they created little or no social impact, unlike Gustav Stickley's "Craftsman" furniture. They lacked exposure. They were made for a few members of an elite upper class to furnish California dwellings also designed by the Greene brothers. Most are one-of-a-kind and have never left the homes for which they were designed 70 years ago.

The author deals historically with the development of Greene and Greene style. He breaks up the early work into four parts encompassing the years 1900-1916. Two chapters take up the work done after 1916, when Charles and Henry split up, and delineate the further careers of each in turn.

During the first period, to 1904, the brothers were influenced by Stickley. This translated into a rectilinear, straightforward approach with minimal decorative touches, mainly protruding dowel plugs. Toward the end of this period, ends of tenons were carried through and exposed. Then there appear what the author identifies as Oriental influences, in particular in a design element he terms a "cloud lift," supposedly an abstraction of cloud forms. The Chinese used a stretcher having this form in certain classical pieces, although I doubt that its shape came from any deliberate attempt to abstract the qualities of clouds.

A second period, 1904 to 1907, saw the introduction of the square plug. Most of these "pegs" are decorative, shallow inlay; others conceal screw heads. During this particular period, the Greenes enlisted the services of John and Peter Hall, Swedish immigrants, who produced in their Pasadena shop the fixtures and furniture designed for the various interiors. Their specialized knowledge and machinery, and the talents of their old-country craftsmen, enabled dramatic design refinements to be made in the furniture. A well-defined, plainly identifiable style resulted. As the use of wood and metal inlay and other surface decoration increased during the following period, from 1907 to 1911, this style became increasingly ornate.

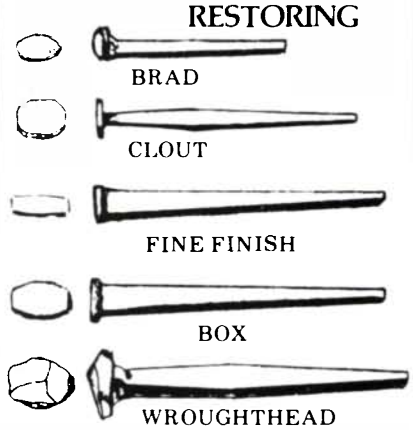
From 1911 through 1916, Charles Greene flirted with more elaborate furniture and architectural styles, most notably Empire, one of the most elegant and dignified of the classical periods. He employed several decorative devices from this period, such as sheaves of wheat and inlaid borders.

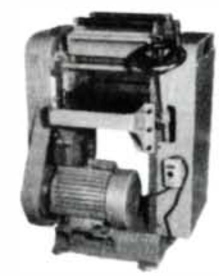
I found the photographs and instructive original drawings by far the most valuable part of the book because they convey the flavor of the designs so convincingly, their refined proportions, subtly placed contrasts of hue and texture, accents, delicate inlays, restrained carvings and the general overall cohesiveness. Makinson intended this book as a historical survey of the creative development of the brothers Greene. He achieved this in due course, but one hungers throughout the book for more interpretative, incisive passages such as the isolated one on p. 58 about Charles Greene's system of forms and joinery: "In principle, the system followed the same concepts underlying the Greenes' architecture: the total was composed of separate parts; the identity of those parts was openly expressed; the bringing together of two similar or dissimilar elements created a point of transition and the resolution of that transition often developed a totally independent, third condition which both acknowledged the joining of elements and at the same time brought an enrichment to the total composition."

I deplore the scarcity of this kind of analysis. Inevitably, when one studies furniture as well articulated as this, certain design approaches and an implied philosophy reveal themselves. In the passage quoted above, we touch on a very profound theory of the evolution of form. Whether Charles Greene was consciously aware of this approach, or whether it worked on him from deeper, unconscious sources seems immaterial. For the student of design, the value of a more sensitive examination of his work cannot be overemphasized. It remains for the reader to make the necessary analysis himself, providing he can perceive the abstractions underlying the pieces shown. Fortunately, many original scaled detail drawings show furniture and fixtures for an entire room on one sheet, and comparison reveals things that would not be apparent if one piece were examined in isolation.

Makinson's objective, scholarly approach precludes conjecture. Such a shortcoming is outweighed by the book's usefulness as inspiration for the architect and designer/craftsman. And for those of us who merely appreciate seeing beautiful work for its own sake, *Greene and Greene: Furniture and Related Designs* will occupy a special place in our libraries. —*Alan Marks*

Rob Tarule works wood and teaches in Plainfield, Vt.; Jim Richey, Methods of Work editor, and Alan Marks, West Coast correspondent, write frequently for this magazine.





Adventures in Woodworking

THE MASSACHUSETTS CHERRY LOG

BY KENNETH ROWER

One day I saw a log at Denison's Sawmill in Colrain, Massachusetts. It was cherry, eight feet long, three feet broad. Mr. Denison said he would not saw it, it had hardware in it. As it was in the way, he would sell it to me for twenty dollars. I said all right.

In a week I came back with Red Franklin. Red is a strong fellow, an ironworker. At the time he owned a Jeep pickup. Since Red had lost his driving license in a dispute with the State of Maine, I drove the ninety miles out to the mill. When Mr. Denison loaded the log the pickup sank, but not so much that we couldn't drive away. After a few miles there was a sharp report from the rear, then a lot of bumping. We stopped and found we needed to change the left rear wheel. Our jack was not strong enough to lift both truck and log. I went across the road to a house to ask for help. A woman came to the door. Quite a stump you've got there, she said.

After some time we resumed our journey. At lunch Red decided he would drive. He took the wheel and headed for Greenfield. At a junction near the edge of town we rolled slowly uphill, past a stop sign posted away off to the right, and into the side of an empty pickup traveling across our path. There was considerable noise. Red gripped the wheel tightly and shouted, They'll put me in jail for this!

They did. The truck and log were impounded in the back lot of the police station, and Red in its jail. Bail was set at ninety dollars. We didn't have it. I called my old friend George Rockwell Putnam Barber, in Amherst. It took a while for Put to get to Greenfield. When at last we sprang Red, the cell block stank wonderfully from the hundreds of push-ups he had done to pass the time.

We spent the rest of the afternoon visiting a lawyer. His office was full of signs saying, Have you made your will? That night we stayed at Put's house, and

Connections

CONNECTIONS *is designed to get readers, whose interests coincide, together. We're starting this column in response to an increasing number of letters from woodworkers forming local guild-type organizations, letters from writers compiling directories in which our readers might like to be listed, and letters from readers with special interets looking for others who share their interests.*

I own about 90 acres of exceptionally fine hardwood timber in Pennsylvania—maple, oak, ash and others. I love trees and hate the thought of cutting some, as is advised by the forester. But they should be thinned. I would be willing to do this provided I knew a craftsman who could put this fine wood to use. How can I find him? Having the wood properly used is more important to me than the financial return. Write Albert J. Lacy, Rte. 3, Box 119, Port Townsend, Wash. 98368.

Wood '80: The organizers of the Wood '79 conference (*FWW* #20, Jan. '80) plan to do it again the weekend of July 25-27, with lectures, demonstrations and workshops on grading and seasoning timber, reproduction cabinetmaking, design, and marketing through architects. They are also proceeding toward the incorporation of a Society of American Woodworkers (SAW), which would sponsor national and regional workshops and seminars, develop marketing strategies and generally advance the collective interest of woodworkers, amateur and professional. They are looking for comments and suggestions. Write Ken Strickland, Visual Arts Department, State University of New York, Purchase, N.Y. 10577.

We are compiling a reference book for architects that will list professional craftspeople who make exterior architectural ornament. It will be marketed to 80,000 design professionals. If you would like to be listed in *The Handbook of Architectural Ornament*, send your name, address and illustrative material to: Brent C. Bolin, 25 Washington Square North, New York, N.Y. 10011.

The Wooden Canoe Heritage Association (formed summer '79) seeks to preserve, restore, study, build and paddle wooden and birchbark canoes and perpetuate the craftsmanship that went into them. The initial plans of the association are to publish a quarterly journal, *The Wooden Canoe*, put out an irregular newsletter, and hold an annual wooden canoe assembly. Membership costs $10 U.S. annually ($12 Canadian). Write Jeff Dean, President, The Wooden Canoe Heritage Association, Box 5634, Madison, Wis. 53705.

I propose to bring together 16 designer-craftsmen in wood of different nationalities and backgrounds, for an intensive symposium the first two weeks of June, to explore personal, cultural and spiritual imagery. I'm looking for financial as well as creative support. Write Frank E. Cummings, 3160 Armourdale Ave., Long Beach, Calif. 90808.

Red and Put got along very well. The next day, dressed in one of Put's white shirts, Red went to court and was fined $100 for his crimes and made to agree to repay the other driver's insurance company. Red, the truck and the log were set free and I drove home to Cambridge. We unloaded the log with the rolling bridge crane at Red's shop, a disused boiler works.

There the log rested for some time. Word came down that the boiler works was shortly to be demolished. In the following days I would cycle over from my shop five blocks away, carrying a two-man crosscut saw. With it we reduced the log to three pieces. The first cut was straight across and made two different cylinders. The second cut was on the diagonal through the larger cylinder. I meant to produce two blocks, each about five feet high, for carving into heavy chairs. This cut took forty hours. Much of the time the man at the other end of the saw was Ed Howland, who was helping me then in my shop. Eddie didn't think much of this particular job.

When it was done we carted the three pieces of cherry to my shop and put them in the back room. I studied them from time to time. Many people wondered at them. Some time later my building was bought by the city for demolition, and I moved to Vermont. The cherry came along.

Six years passed. By now I had a number of other heavy things to move about in my shed. I decided to hold an auction. The cherry log was knocked down in three lots, one at eight dollars, the others at seven dollars each. The first piece, the round one, was taken back to Massachusetts by Joe Wheelwright, who carved it a little and put it under one of his sculptures. The second went to Brad Johnston, a woodworker who lives nearby. He carved a chair out of it. The last piece became the bathroom sink in somebody's house up in the woods.

The last time I saw my friend Red he had eight months' wages in his pocket. He bought the biggest steak and the best bottle of wine at the store and we had a fine dinner.

I can say three things. I made two dollars on that log. All of it got put to use. And no one ever found any hardware in it. □

Send your woodworking adventure to Box 355, Newtown, Conn. 06470. Maximum length is six typed pages, double spaced.

Events

Events listings are free but restricted to workshops, fairs, lectures and exhibitions of direct interest to woodworkers. Deadline for the May/June issue is March 7, for events beginning April 15 through June 15.

Peters Valley 11th Annual Craft Fair—July 26-27, deadline Apr. 14. Contact Linda Davis, Peters Valley, Layton, N.J. 07851.

Bruce Beeken's Furniture— Mar. 22 to Apr. 19, Vermont State Craft Center at Frog Hollow, Middlebury, Vt.

Thomas Moser—intensive cabinetry courses: beginners, June 9-21; advanced, Aug. 4-16. $395. Box 16, New Gloucester, Maine 04260.

Marquetry by Gary Wright, Shaker Reproductions by Peter Harvey. Mar. 1-30. Sterling Pond Hardwoods, 6 N. Winooski Ave., Burlington, Vt.

It's About Time—exhibition of handmade clocks, time-related mechanisms, crafts. To Mar. 14. Craft Center, 25 Sagamore Rd., Worcester, Mass.

Woodturning Symposium—Mar. 21-23, George School, Newtown, Pa. Contact A. LeCoff, 2500 N. Lawrence St., Philadelphia 19133.

Woodworking Workshops in Utah—May 29-31, lectures and demonstrations by Tage Frid, Wendell Castle, Sam Maloof, Gary Bennett, Art Carpenter and more. Fee, $75. June 2-6, Windsor chairmaking with Michael Dunbar. Fee, $125. Contact Dale Nish, 230 Snell Bldg., Brigham Young University, Provo, Utah 84602.

Omaha Craftsmen's Gallery—invitational show of contemporary woodworking. Mar. 28 to Apr. 30. Old Market Craftsmen Guild, 511 S. 11th, Omaha, Nebr.

Joint Weekend—hand and machine joinery symposium, April 11-13. With Tage Frid, Alphonse Mattia, Leonard Hildner, Bob Worth. Bucks County Community College, Newtown, Pa. $125 includes materials and meals, but not hotel. Contact A. LeCoff, 2500 N. Lawrence St., Philadelphia 19133. (215) 739-2600.

Pacific States Craft Fair—application deadline Mar. 10; fair Aug. 7-10, Fort Mason Pier, San Francisco. Contact American Craft Enterprises, Box 10, New Paltz, N.Y. 12561.

St. Louis Craft Market—application deadline May 1; show, Sept. 25-28, Checkerdome, St. Louis. American Craft Enterprises, Box 20, New Paltz, N.Y. 12561.

Dallas Craft Market (American Craft Enterprises)—Apr. 10-13. Market Hall, Stemmens Freeway, Dallas.

James Krenov on lecture tour—Mar. 1, 1 P.M., Woodcraft Supply, Boston; Mar. 3, 6 P.M., Woodworker's Store, Minneapolis; Mar. 5, 12 noon, Paxton Lumber, Denver; Mar. 7, 7 P.M., Cutting Edge, Beverly Hills; Mar. 8, 6 P.M., Woodworker's Supply, Albuquerque; Mar. 10, 6 P.M., Paxton Lumber, Oklahoma City; Mar. 13, 6 P.M., Paxton Lumber, Kansas City, Mo.; Mar. 15, 9 A.M., Colonial Hardwoods, Vienna, Va.; Mar. 17, 5 P.M., Constantine, Bronx, N.Y.; Mar. 18, 6 P.M., Garrett Wade, New York City.

Workshops—Turning, Mark Lindquist, Mar. 3-14 and 17-28. Bladesmithing, Philip Baldwin, Mar. 13-16. Write Appalachian Crafts Center, Box 5106, Cookeville, Tenn. 38501.

Confabulation—lectures, shop tours, gallery of Northwest craftsmen; comments: George Nakashima, Apr. 11-13, fee $35. Oregon School of Arts and Crafts, 824 S.W. Barnes Rd., Portland 97225.

International Woodturning Seminar—June 14-15, Parnham House, Beaminster, Dorset, DT8 3NA, England.

New Handmade Furniture: American furniture makers working in hardwood, Mar. 16 to May 18, Loch Haven Art Center, Orlando, Fla.

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EXPERIENCED antique repairman and/or refinisher for established shop. Schindler & Son, Inc., Box 8291, West Palm Beach, FL 33407.

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QUALITY tools—books—supplies. Woodcarvers Supply, 3056 Excelsior Blvd., Minneapolis, MN 55416. 68-page catalog $1; with bradawl $3.

THE TOOL BOX—Antique tools illustrated quarterly catalog, $4. 8219 Old Petersburg Rd., Evansville, IN 47711.

Western Canada Inca Tool Sales for B.C. and Alberta. Catalog, $1. ACORN WOODWORKS, 720 E. 27th Ave., Vancouver, B.C. (604) 873-2781.

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Lurem 210B multipurpose woodworking machine with shaper knives, tenoning discs, mortising bits and sharpening attachment for planer blades. Huntington, NY; (516) 427-9710.

Delta double-duty wood lathe ¾ HP, 5½-in. swing, 4-ft. bed. 16 speed, $275. John S. Meyers wood lathe, 6-in. swing, 4-ft. bed, 1½ HP, cast iron, $400. Gene Laska, 34 Dante St., Larchmont, NY 10538.

1/16 Veneer. Top-quality KD flat-sliced and scrap available. David Flatt, P.O. Box 3130, Madison, WI 53704.

Plow, circa 1860, ten irons ⅛-⅝, sleeve fence locks, one shop use, $58. Rosewood dual gauge, $7. Beech shaves, one curve, one straight, $8. Toothing plane, $9. Others. C. Seager, Rt. 3, Brevard, NC 28712.

J.A. Richards table saw, model ESDTMS. New cost $3950. Sell for half price or trade for pickup truck. Elmer Storms, 3446 E. 200, S. Marion, IN (317) 674-4966.

Wanted to Buy

Stanley planes new and old. All types from Nos. 1 to 444. Also aluminum Stanley planes, old wood planes and woodworking tools. Ivan E. Bixler, 6943 Cozaddale Rd., Goshen, OH 45122.

Thickness planer, 10 in.-16 in., fine quality, used. Rev. T. Roth, Town Landing Lane, Dedham, MA 02026. (617) 326-3666.

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Furniture/Cabinetmaker apprenticeship sought. Have basic skills, will relocate. Contact James R. Braun, 3126D Carnaby Lane, Bridgeton, MO 63044.

Experienced woodworker—David Haust. Please call Bill Merkle collect. (215) 767-6551.

Seeking apprenticeship in cabinet and furniture making. Serious student with some experience and interested in career. Dave Barrett, 3143 Ellis, Berkeley, CA 94703. (415) 841-2367.

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This adaptation of a traditional Windsor chair was designed by Wegner in 1947. Known as the Peacock chair, it is the first of Wegner's designs to attain popularity in the U.S. The subtly graduated, flattened portion in each of the back spindles provides comfortable back support, and emphasizes the dramatic size and sweep of the back. Flying supports, doweled into the bulbous ends of the stretcher, pierce the seat and hold the arms. Each support actually consists of two parts that divide at the top face of the seat, with the bottom section doweled into the upper.

Hans Wegner
A modern master of furniture design

by Irving Sloane

After World War II, a revolution in the design of furniture radically altered the style of home furnishings. A new wave of light, functional furniture using an exposed framework of naturally finished woods found a ready market. These modern designs possessed a freshness and homogeneity that encouraged free choice. The old reliance on matched living, dining and bedroom suites gave way as people began selecting pieces of furniture on the basis of individual merit and functional suitability.

Denmark was the center of this revolution, led by a handful of designers—Finn Juhl, Borge Mogensen, Hans Wegner, Arne Jacobsen. Its impact was international, and Denmark, an agricultural economy before the war, experienced a tremendous surge in furniture exports: 3 million kroner in 1950; 146 million kroner in 1960; 725 million kroner in 1973. By 1978, Danish furniture exports had reached an astonishing 1,566 million kroner.

From the standpoint of the range and quality of his extraordinary productivity, the outstanding figure of this group was, and remains, Hans Wegner. His brilliant designs are admired and sold in many countries. Many institutions have bestowed honors and awards on him, and his chairs—he is preeminently a chair designer—are in the permanent collections of the Museum of Modern Art, the Metropolitan Museum of Art, The Victoria and Albert Museum in London, the National Museum in Stockholm, the National Gallery in Melbourne, and others. Leading architects and designers have used Wegner's furniture at Harvard University, the United Nations, the World Bank, UNESCO (Paris), the Salk Institute, the Seagram Building, the Chase Manhattan Bank, and

Peacock chair: Doug Long, Photocraft

IBM headquarters (New York and Europe). The recent death of Charles Eames leaves Wegner the single most important furniture designer in the world today.

Wegner is a quiet, mild-mannered man of 65. His provincial background has given him a native reserve that melts easily into the warm geniality one often encounters among the older generation of Danes. He speaks in subdued tones, obviously sincere. He lives in an attractive modern house he designed, on a leafy terrace a few miles outside Copenhagen. The interior is all Wegner: airy spaciousness and comfort, his furniture set off by beautiful color and texture.

At lunch, I express interest in the artifacts about the room. They are things collected over the years, and he eagerly brings some to the table for closer inspection: primitive ax heads, an Eskimo carving, Japanese lacquerware. I ask him if he enjoyed his years teaching at *Kunsthandvaerkerskolen*, the School of Arts, Crafts and Design, in Copenhagen.

"It was a difficult time. I taught only from 9 to 12, worked in a design studio all afternoon, and was busy with my own design work evenings."

He says this with vague regret; teaching perhaps was not his style. I ask if design can really be taught.

"Up to a point, but unless you have some talent you can't expect to get very far. Many young people today take training in furniture design and cabinetmaking but almost all of them want to be designers. Very few seem interested in spending the time and effort necessary to become skilled cabinetmakers. Because of this, and the increasing sophistication of modern woodworking machines, I see the time coming when these skills will rest mainly in the hands of do-it-yourselfers. The professionals, in the best sense of the word—men with pride in their skill—will quietly disappear, and it's a great pity. Is there anything more fundamentally human or rewarding than mastering a trade and making a living at it?"

This talk leads to soft reminiscence about his early career. Wegner was born in 1914 in the south Jutland town of Tonder, a small provincial trading center on the Danish side of the German border. In 1914, Tonder was still part of the Danish territory Germany had seized in the war of 1864. In 1920, a plebiscite authorized by the Treaty of Versailles restored Tonder to Danish sovereignty.

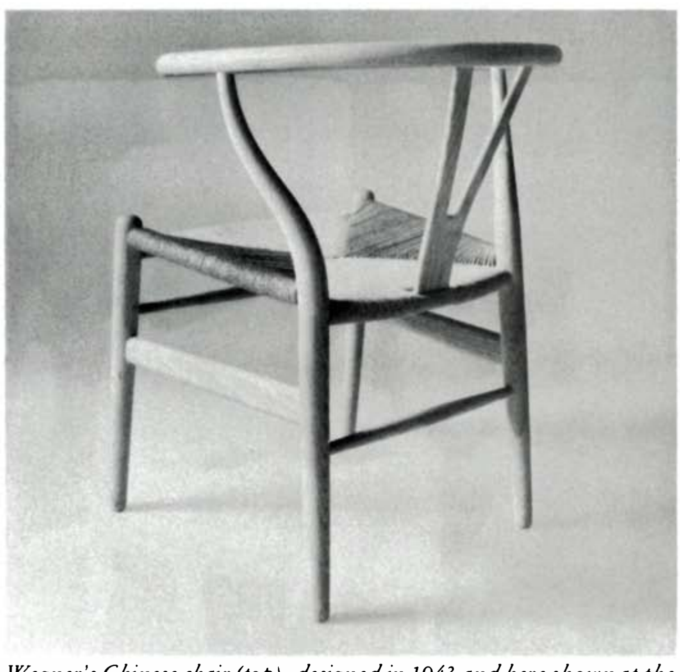
Wegner's father was a shoemaker, a skilled craftsman, so young Hans was indoctrinated early in traditional craft. At age 14, he was apprenticed to a cabinetmaker. After four years he became a journeyman and worked locally for another three years. At 21 he enrolled at the Technological Institute in Copenhagen for a course in furniture making. Then from late 1936 through 1938 Wegner trained as a furniture designer at the *Kunsthandvaerkerskolen*, where he later taught.

"My intention was to open a cabinetmaking shop, and I felt that training in design would be a valuable asset. It was a good decision, and I learned many useful things such as technical drawing and design basics. In 1938 I was offered a job as design assistant in the Aarhus design office of Arne Jacobsen and Erik Moller. I asked a professor at the school whether I should complete my school program, or take the job in Aarhus. He advised me to take the job, and I did."

Jacobsen, who later became prominent as a designer and architect, was interested, like Eames, in the possibilities of molded plywood. He is best known for his molded plywood chair with three-legged metal base, and for his futuristic, swiveling Egg chair. It was Wegner's first contact with the professional world of design. He worked there for five years, and it soon became clear that his real career lay in design.

The last three years in Aarhus were difficult. Germany occupied Denmark in 1940, movement was restricted, and curfews were in effect. Wegner spent his spare time submitting designs and winning awards in design competitions for furniture, lighting fixtures, silverware, even a service station. Most important were the annual competitions sponsored by the Copenhagen Cabinetmakers' Guild. Wegner won awards in each guild competition between 1941 and 1947. The guild members were cabinetmakers, many operating small production shops. Wegner remembers them with affection.

"The old cabinetmakers were rugged individualists. They trusted their instincts and weren't afraid to take a chance on



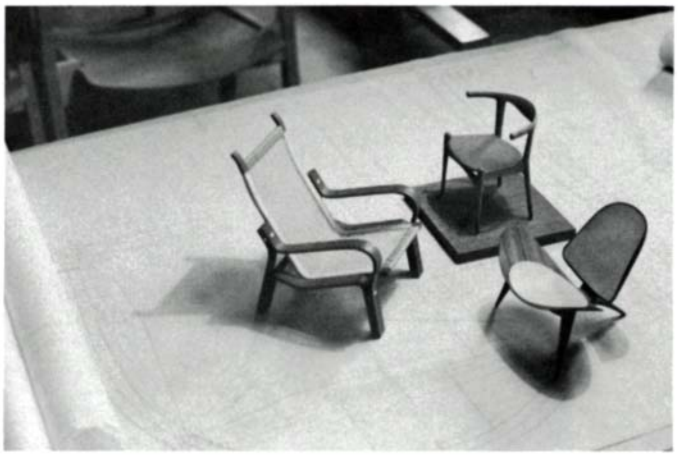
Wegner's Chinese chair (top), designed in 1943 and here shown at the museum in Tonder, where Wegner was born, is a beautifully understated adaptation of the rectilinear formalism of Chinese furniture. The wishbone chair (above) is a direct descendent of the Chinese chair, but is more centered in the Wegner style—unified arms and back, slightly splayed legs, canted, woven seat. The wishbone splat and bow are laminated, but the gracefully curved legs are bandsawn to shape.

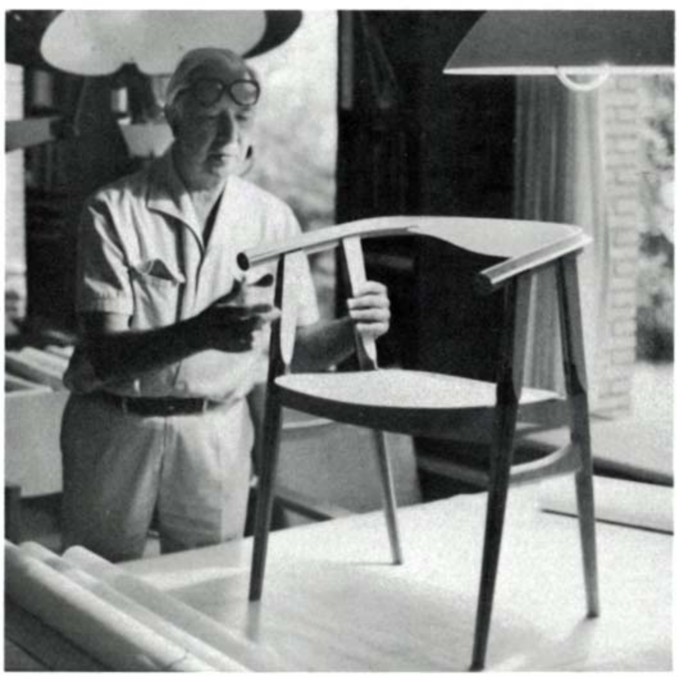
something new even though they sometimes lost their investment. The competitions were their attempt to keep from being pushed out by the big factories. It was a wonderful forum for a young designer, and resulted in my association with Johannes Hansen, a company that still produces my furniture.

"The dominant figure in furniture design in those days was Kaare Klint, the father of modern Danish design. He was a rather distant person of uncompromising standards, difficult to know, but fair in his judgments; if he liked your work, he told you so. His approach to design was that of a strict classicist. He would take a Chippendale chair, for example, and say: 'Now let's see what we can do to improve this perfectly good, attractive old chair.' Design for him was a slowly evolving process, and he saw no sense or purpose in rejecting the old for the sake of creating something entirely new.

"There was much to admire in Klint's work, and in his integrity, but it wasn't good enough for the next generation. We felt the pressing social needs of the time more than he did, and we were anxious for a fresh start."

In 1943 Wegner opened his own design studio in Aarhus. The war ended in 1945, and suddenly everything seemed possible. "It was a marvelous, exhilarating time. We were free to





Wegner always makes models of his designs, first miniature, as at top, then full-size. The one above is of cardboard, ingeniously cut and constructed to suggest mass and form.

do as we wanted, and eager to get going. In 1946 my wife and I moved to Copenhagen, and I began the busy round of teaching mornings, working afternoons in the design studio of Palle Suenson, and evenings were spent on my own design work. I had already designed a Chinese-style chair in 1943, and I had one chair in production, a Shaker-inspired rocking chair I designed for the Danish Cooperative Movement, a chain of stores.

"The Windsor chair was a popular theme, and I designed several of them. In 1947, with the help of Niels Thomsen, the shop foreman at Johannes Hansen, I built the first prototype of my Windsor chair, known in Denmark as the Peacock chair. Johannes Hansen, the owner, didn't mind our using his shop after hours, and this close collaboration with Thomsen, a fine craftsman, has continued to the present time. Hansen was indulgent, but he didn't feel the chair was for him."

Wegner also speaks warmly of his friendship with Borge Mogensen, a Jutlander like himself, and Finn Juhl, a cosmopolitan from Copenhagen. "We worked in a spirit of fun. None of us dreamed that we might one day make a living from the furniture we designed. I remember that it was during this time, 1948, I participated in a Museum of Modern Art competition with a large project on inexpensive furniture."

After lunch, he leads me downstairs to his workshop and studio, a large *L*-shaped room with desks, a drawing table and an old workbench. His daughter Marianne, an architect, is working at a table. She is his design assistant. Scale models of new chair designs stand around the room, and a large model of an outdoor lighting fixture rises between two desks. A high shelf along one wall is crowded with careful miniatures Wegner makes before going to a full-size prototype. They are done to ¼-scale, marvelously precise even to the woven seats and backs. He lifts a full-size model of a chair onto a desk. It is constructed entirely of buff-colored cardboard cut with considerable ingenuity to convey a sense of mass and form.

"I start with very rough thumbnail sketches, then an improved drawing and a miniature model. For upholstered chairs, I make models in plasticine; it doesn't harden and I can always make changes. The model brings the design to life for me. Sketches and drawings don't reveal the shortcomings in a design the way a model does. It's the most exciting part of design work for me, seeing the designs take shape and become a reality."

The studio—among his models, the rolls of work drawings, his drawing instruments—is Wegner's element. He is relaxed, expansive, his speech more animated. His woodworking tools are stored neatly in a closet near his bench, some double-iron wooden planes, chisels and other tools. He shows me a wood carving made in his boyhood, a nicely carved figure of a nude with arms outstretched.

We speak about design and public taste. I suggest that modern art has been responsible for the self-conscious approach to aesthetic judgments that asks, "Should I like this?" instead of "Do I like this?" He agrees and speaks with feeling about the unfortunate tendency of young craftsmen and designers to invest their work with a mystique it does not possess. He gives no hint himself of being prone to elegant introspection, and innately distrusts that process of emotional or psychological involvement whereby a craft object emerges as a deeply felt, personal "statement."

"A designer must maintain an objective view of his work. I've seen students—young designers—with a new design, and they think: 'This is something really precious, and I must be careful what I do with it, and to whom I show it.' When you have this kind of emotional involvement, you lose the objectivity every good designer must have. You just can't afford this kind of sentimentality."

Wegner has a shockproof detector for what he finds superficial or enfeebling in his designs. He tells about the work that led to his famous Classic chair. "I was working on the full-scale model, and was unhappy about the arm. Its form didn't seem right to me. I took a walk, thought it over, and sawed off the offending portion. I glued on a new piece and gave it the shape it has today. If I had not done it, the chair would never have achieved the success it has. It was an important lesson, and also taught me the value of making my own models. If another cabinetmaker had made it, I would have hesitated to ruthlessly saw off half an arm."

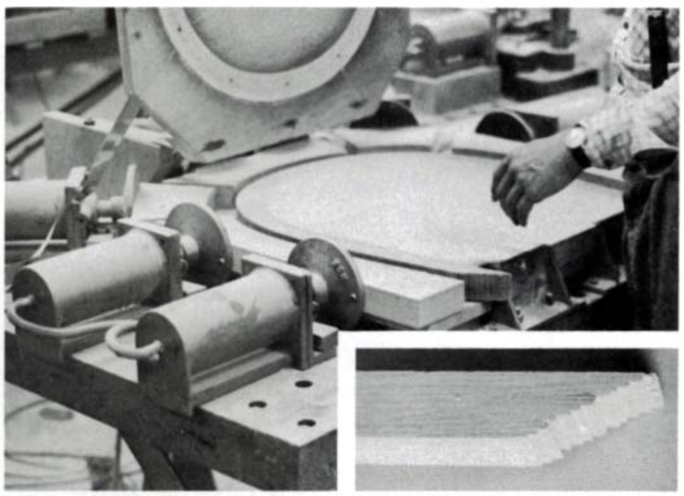
After a model reaches final form, he makes a 1:1 working drawing. It is drawn with meticulous precision, leaving nothing to the whim or judgment of the cabinetmaker.

The studio visit complete, we drive to the workshop of PP Furniture Company. Ejnar Pedersen, a stocky, bearded man in his fifties, is the working owner of PP, a medium-sized shop employing about 12 people. Pedersen declares he has never seen a craftsman with Wegner's gift for working wood. Wegner leads me around the workshops and points out items of interest. It is after 3:30 P.M. and the workers have left.

"I sometimes come here in the evenings to work on my models, and often run into other workers. Pedersen lets them come back in the evening to make furniture for themselves. It's a kind of family atmosphere."

PP manufactures a number of Wegner chairs, principally a chair that resembles a captain's chair. They also make some of Wegner's tables, tea carts and a sewing table. These pieces are distinguished by Shaker-like simplicity, purity of line and exemplary craftsmanship. Everything is made to the highest standards, and Wegner keeps a close watch. He picks up the bowed back member of the captain's chair. "If you look closely, you will see that this piece is a lamination of 15 pieces of ash; it is not bent with steam."

I examine the edges carefully, and am surprised to find that it is indeed a lamination. Yet the surface figure shows unbroken continuity—it looks like solid wood. He explains: "These 1½-mm (about 1/16 in.) ash veneer strips are not sawn—they're sliced with a big knife that cuts with a shear-

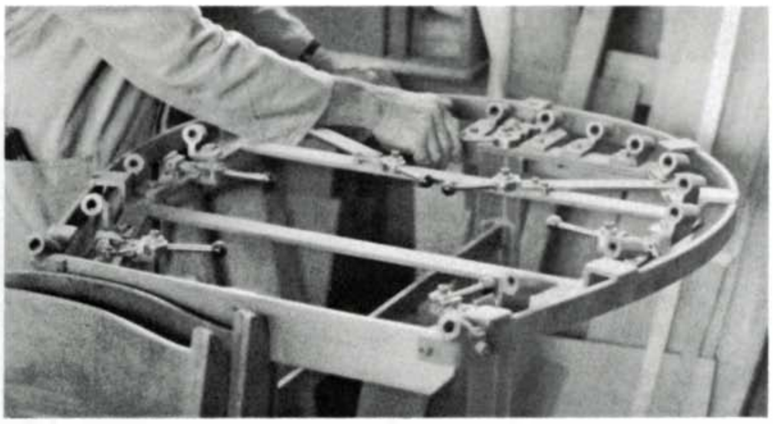


Bowed back of captain's chair consists of 15 pieces of ash, sliced, not sawn, from a single board and then glued back together on an electric form in their original order. In contrast to this technique, which conceals the laminations, Wegner uses wenge strips and splines to accentuate the joints between the other parts of the back.

Doug Long, Photocraft

At the PP Furniture Company, one of the eight firms in Denmark that produce Wegner's designs, each bin, above, holds patterns and jigs for one chair. Left, stacks of Shaker-style chairs about to be corded.

With Wegner near a stack of Peacock chairs is Niels Thomsen, foreman at the Johannes Hansen factory. Thirty years ago, Thomsen helped build the prototype for this chair.



Thomsen demonstrates a welded steel jig that clamps the bowed member of a Peacock chair in place for drilling the 16 spindle holes. Welded sections of tubing canted at the correct angles steer the drill.

ing action. They're kept in series and glued in an electric form, where they dry in two minutes. We can't use steam-bent wood because the process is not exact enough. When you are making a series of one or two hundred chairs, it's absolutely essential that each bent member be exactly like the next one."

Was there any particular wood he favored? "I like all wood and use oak, ash, cherry, maple, walnut, teak, and occasionally, mahogany. I also like Brazilian rosewood but we can't get it anymore. The walnut comes from America; I prefer French walnut but it's very hard to get. Beech is something of a problem in Denmark. It's so common that Danes burn it for firewood, and furniture made of beech would sell poorly here. Teak is out of style. It was used so much in the '50s and '60s that Scandinavians tired of it. We still use it for exported furniture. I personally like teak because it's beautiful and can easily be kept with oil.

"We use as much domestic timber as possible. Danish oak is stronger than oak from the southern regions of Europe because of our colder climate and shorter growing season. For inlay we use wenge."

The captain-style chair uses wenge as an interface veneer, and as short splines to reinforce a butt center joint. Wegner normally avoids surface decoration, but in this case he has made decorative use of a functional necessity. "It also helps in another way," he adds. "If there is some unavoidable defect like a small knot or grain irregularity, the dark center design draws your attention so that you don't notice the defect."

Production of Wegner's chairs and furniture is spread over at least eight factories. He has designed many chairs for institutional use (schools, libraries, and restaurants); these are often spray-lacquered in customer-selected colors. He has also designed wall units that come with various shelf, cabinet and drawer-case arrangements for consumer adaptation. Pedersen's entire production, except for an occasional outside job, is given over to Wegner's designs. But Wegner has refused a remunerative offer from a large American manufacturer interested in producing his furniture.

"I prefer to work with the people I've been working with for many years. I feel a certain loyalty to them, and I'm also afraid the quality would suffer if my furniture got into a real 'mass-produced' situation. Pedersen here has twelve employees; if he had twenty-five it would be too much. The quality would deteriorate."

Quality is a constant concern. Two-piece butted chair backs are bookmatched, and arms and legs are cut from the same board or flitch. Nowhere do I see a part mismatched in color or figure. Seat weaving is farmed out locally, as piecework.

We drive back to Wegner's house talking about the future of skilled work in a country with serious unemployment. Education is free, and the broad movement toward a university degree has created an oversupply of academics and professionals. College education tends to be protracted by the scarcity of jobs; undergraduates of 30 or older are not unusual. Private-sector employment is shrinking while public-sector employment grows rapidly (up 53.7% between 1970 and 1977). The government is under pressure to reverse this trend, and among the remedies is a pre-pension scheme to encourage early retirement at 60. Wegner feels this diminishes an already dwindling supply of skilled craftsmen who serve as valuable models for newcomers.

"Machines can do a lot, but my furniture still requires a great deal of skilled handwork. With the slow disappearance of these skills, I'm not sure it will be possible to make my kind of furniture in 15 or 20 years."

Many young American woodworkers think in terms of operating shops where they will be both designer and maker. But Wegner thinks, "It would be difficult to do a good job of both. It would be hard to make a decent living."

Wegner's mode of operation is to design a chair, for example, and take it up to the full-scale-model stage. He then shows it to the principals of shops that might be interested in producing it. (Despite his awesome record, many of his designs have not been produced.) If they go ahead, he makes a production drawing and with the shop people works out the production bugs. For this he gets a small percentage of the manufacturer's invoiced price. He also designs special-order furniture to match his chairs, and lighting fixtures.

We meet the following morning at the Johannes Hansen factory in Gladsaxe, just west of Copenhagen. Hansen's is larger than Pedersen's, with perhaps 20 employees. Their entire production is Wegner's designs, a working association now in its 40th year. The Classic, Peacock, valet, cow-horn and folding chair are among the chairs made here.

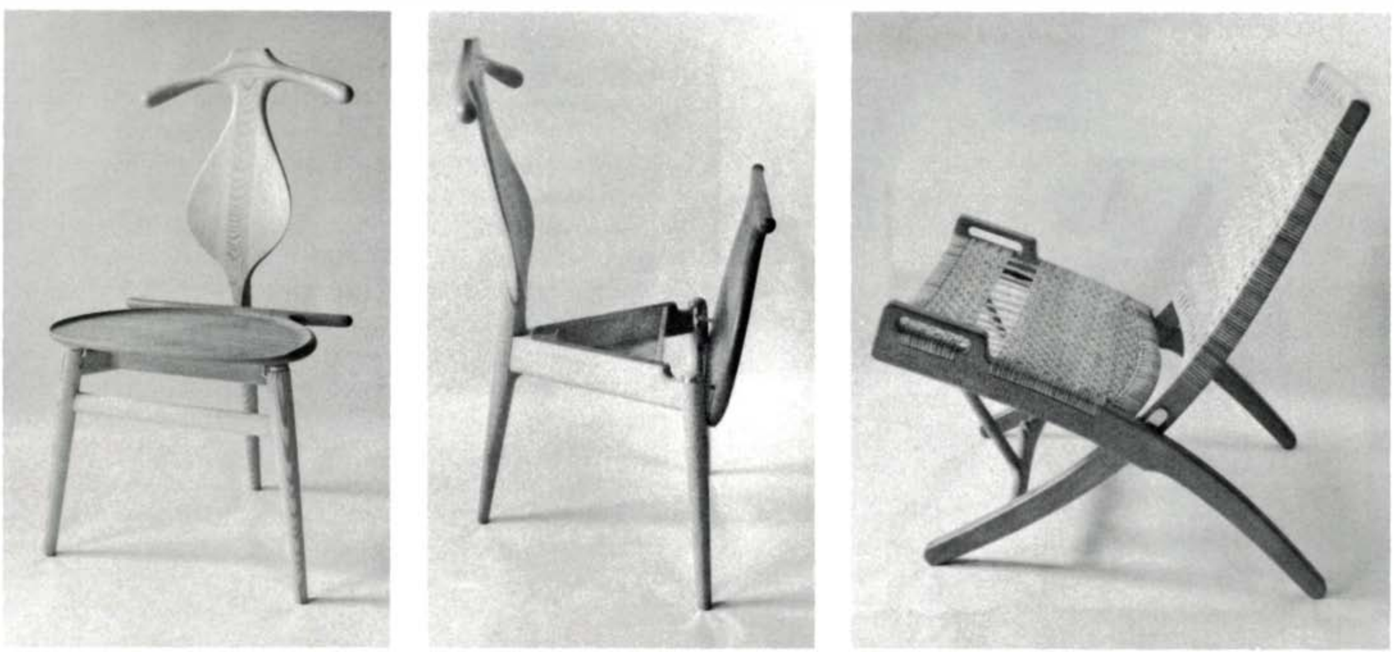
We are greeted by Niels Thomsen, Wegner's longtime friend and collaborator. He is in his late 60s and, like Wegner, apprenticed at age 14. We move through the workrooms, with Wegner and the workers exchanging friendly waves. I ask Thomsen if he gets apprenticeship applicants. "No, and anyway we really wouldn't be interested in inexperienced help. If we hear about a shop closing down we might hire the most experienced men; that's mainly how we get help. But there's not much turnover here. Most of these men have been here for 15, 20, 25 years or more."

Wegner leads me to a small room where a German six-station copying machine is shaping Peacock chair arms out of bandsawn teak billets. The machine works from precise steel masters, copying the parts with unvarying fidelity and leaving only minor hand-finishing. The Peacock chair is also made with ash arms, but Wegner prefers teak because it has less tendency to soil. For the finish, he prefers oil or wax.

He picks up a worker's wooden smoothing plane and runs his fingers over the sole. A recollection brings a smile: "When I was working as a cabinetmaker we had a little trick—whenever we went on vacation we would put a few drops of oil on the bottom of the planes and set them on a piece of glass. This helped to keep the bottom level."

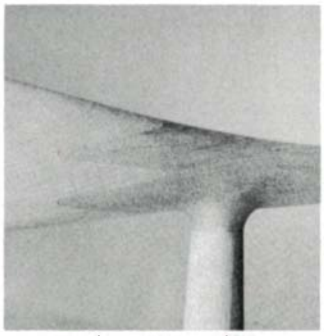
Stacks of Peacock chairs in the main workroom await seat-weaving and arm installation. The bowed back member is an ash lamination cured in a dielectric heating press. Before assembly of the 8-mm ($\frac{5}{16}$-in.) thick strips, each tapered center section is thinned on a jigged router setup so that the finished lamination is 6 mm thinner in the central, top portion of the bow. Wegner has done this for aesthetic reasons. A uniformly thick bow would unbalance the chair's appearance. The finished lamination is quarter-rounded on a shaper.

The Peacock chair is popular in the United States, and Wegner speaks again of the chair's early days. "The first prototype I put together with Thomsen's help in 1947 went with an exhibition to Holland and disappeared. We didn't



The valet chair demonstrates Wegner's inventive handling of a functional idea, in sculptural terms. The back member and legs are Oregon pine, with joinery and bold figure oriented to accentuate the hanger and backrest. A seat of teak lifts up to hold a folded pair of pants on its shaped edge, revealing a triangular tray for keys, watch and change. The late King Frederik IX of Denmark was the first purchaser of the valet chair, and was fond of presenting it as a gift. Right, a Wegner folding chair, a design often copied cheaply and common in import shops.

The Modern Chair by Clement Meadmore, courtesy Van Nostrand Reinhold



The Classic chair (also shown on the cover) is the epitome of Wegner's style. In some models the tapered finger joints between back and arms (cut on a shaper) are left exposed; in others they are wrapped with cane. The arm, left, is the original model that Wegner sawed a displeasing piece off, replaced and reshaped. The difference in grain between the two pieces indicates the graft. Below, a worker at Hansen's prepares to finish-sand a Classic Chair.

Irving Sloane's most recent book is Making Musical Instruments *(E.P. Dutton, 1978). This article owes much to his Danish wife, Lene Host Sloane, a professional interpreter.*

think too much about it, but two years later we decided the chair really had something, and we built a second one. It was exhibited here again, and Viggo Sten Moller, director of the Danish Arts and Crafts Association, sent photographs of my chairs to the American magazine *Interiors*. It was the first publicity about my chairs in America, and orders were not long in coming."

Thomsen rummages in a storage room and comes up with the original Classic chair arm of the fateful sawing episode. The pine back and arm are joined with a square dovetail. Wegner felt the joint was an eyesore and wrapped the back with cane to conceal it. The chairs were made this way until he hit on a sawtooth-style splice, aesthetically pleasing and providing a large glue surface. The joint, cut on a shaper, is attractive, though many still prefer the cane-wrapped back.

The Classic chair, designed 30 years ago, is pure Wegner at his best. It has the irreducible simplicity he is constantly striving for, and represents his most innovative contribution to chair design. A rungless chair, it is made possible by the strength of the unified arms and back, and the deep seat rails. The bow includes projections that make the dowel joints to the legs a sculptural continuity—a hallmark of Danish furniture, Wegner's in particular. The legs are turned thicker above their midpoint, where they connect to the seat. They form solid, straight lines, the front angled slightly back and in, the rear, forward and in. A comfortable chair, it has the sort of design universality that makes it at home with a desk or dining table, or as an occasional chair. The chair received international exposure during the 1960 Kennedy-Nixon debates, when each candidate sat in one.

I comment about the great design wave of the '50s and the long, relatively static situation since. "You have to remember that the war years left a vacuum; moreover, the Danish designers who were ready to fill this vacuum were fed up with the endless, tired imitations of period furniture. Looking back, I can see now that the furniture we produced was the natural result of a long process involving social and cultural factors—more evolution than revolution. And before us there was the Bauhaus with Stam, Mies van der Rohe, Breuer—they designed some of the finest metal chairs ever made.

"There is much confusion today about what is modern, what is functional, and my hope always is that people will not be drawn to novelty, but will learn to value what is simple and pure in good design. And things should do the job they are designed for. I don't think that's asking too much."

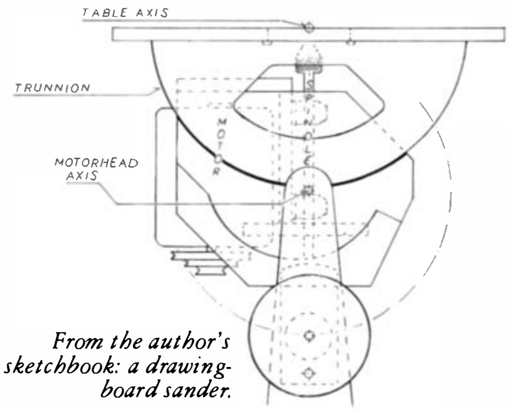
We speak about the changing context in which designers work, and his regrets over what has happened to the healthy competitiveness he feels was important to his early development as a designer. Marketing priorities have steadily shifted from what is good to what will sell. In America there is a vast, sophisticated apparatus for sifting the vagaries of consumers to divine what color, form or fashion will sell. Designers must more and more respond to fad. And as the stakes get higher, the chance for great design waves—such as the one in which Wegner figured so importantly—will diminish.

I left, turning over in my mind a conversation of some years before. In 1972 I toured the *Kunsthandvaerkerskolen* in the company of the school director, Ole Gjerlov-Knudsen. We were discussing craft education when the subject of furniture design and Wegner came up. He said: "The Danish government believes that if we train 5,000 designers, and produce one Hans Wegner, the money is very well spent." □

Making Your Own Machines

Learn what you need to know, then experiment

by Giles Gilson



From the author's sketchbook: a drawing-board sander.

If you need a machine you can't afford or are frustrated by back ordering, poor design or malfunction caused by poor quality control, you should consider building the machine yourself. It will test your creativity, ingenuity and ability to scrounge. It will require time and possibly study, but the result can be a machine custom-built to meet your needs.

Don't be discouraged by someone else's reservations. A good way to start is first to find out what you need to know, second, to get that information and third, to practice applying it. Machines are generally simple. They have a basic function and accessories that support that function. Most woodworking machines simply rotate a cutting tool into the work. Different structures control the speed or orientation of the cutter; hold, move or guide the work; protect the operator; and generally hold the whole thing together. By studying its separate parts, you can uncover a machine's principles.

I have built a number of machines and modified several more; these illustrate what experimentation and makeshift applications can yield. Combining performance, accuracy, safety and convenience is a creative task. If your materials are properly chosen and your construction is sound, your home-built machine can be better than a store-bought one.

In design work, decisions are most easily made through drawings. Some people prefer a detailed technical drawing in which most of the problems can be worked out; others draw only enough to establish reference points or to determine shapes. It is not necessary to use conventional symbols or elaborate instruments. If you plan to show your drawing to designers or suppliers, however, you must be sure they understand your terminology. The basic tool is the standard foot ruler, with which several scale sizes can be read directly; at ¼ size, for example, 3 in. = 1 ft., and ¹⁄₁₆ in. = ¼ in. You'll also need a compass, a 30°-60° triangle, and a protractor. The edges of precut paper are usually square and can be used as references from which to measure.

It may help to make a model in conjunction with the drawing. This is educational and entertaining, and when you get frustrated, you can smash it. Models help you visualize. They point out problems that may not show on the drawing, so there are fewer bugs to be worked out of the final product.

Average auto-maintenance tools will do in most cases. In addition, you should have a set of taps and dies, calipers, some metal snips, spare hacksaw blades, a dial indicator and a surface gauge. For operations that you are not equipped to handle, you can either get the tools as you need them, rent them or farm out that part of the work.

One advantage the woodworker has is that some of his machines need not be as rigid as those used for metal; therefore machine bodies and stands can be made of non-ferrous materials. Wood, including plywood and composition board, is convenient; aluminum and fiberglass might work in some applications. A new material, used in conjunction with fiberglass and under development by General Electric Co., has almost the strength of steel, but can be worked with carbide cutters. It is a single-component epoxy called Arnox, which can be bought in sheets, tubes or rods. I have bandsawn and lathe-turned sample pieces, and it has possibilities for many machine parts, including shafts, gears, plates and pulleys. If you work with this material, cut it at slow to moderate speed and feed rates, and use a good dust collector. (For more information contact G.E.'s Plastics Division, Arnox-resin Operation, 1 Plastics Ave., Pittsfield, Mass. 01201.)

One of my favorite materials for models and light-duty machinery structures is MD-44. It is produced by Masonite Corp. and comes in the same sizes as plywood, but is cheaper. It has about the same strength as fir ply, has a smooth finish and holds a clean edge when machined. It can be sculpted, but because the surfaces are tempered, it may chip a little near the faces. If you paint MD-44 or laminate it with plastic or sheet metal, you must do both faces to prevent warping.

Don't get locked into buying only new parts and materials. Wood and composition boards are often in the shop as leftovers from jobs. Metal can be obtained in small quantities and odd shapes from scrapyards. Machine parts can be found in scrapyards and repair shops, or adapted from other applications. An inventory of hardware should be kept in categories: nuts and bolts, handwheels, pulleys and belts. These can be collected over a period of time the same way you collect wood. You do not have to seal and sticker hardware; it is usually dry.

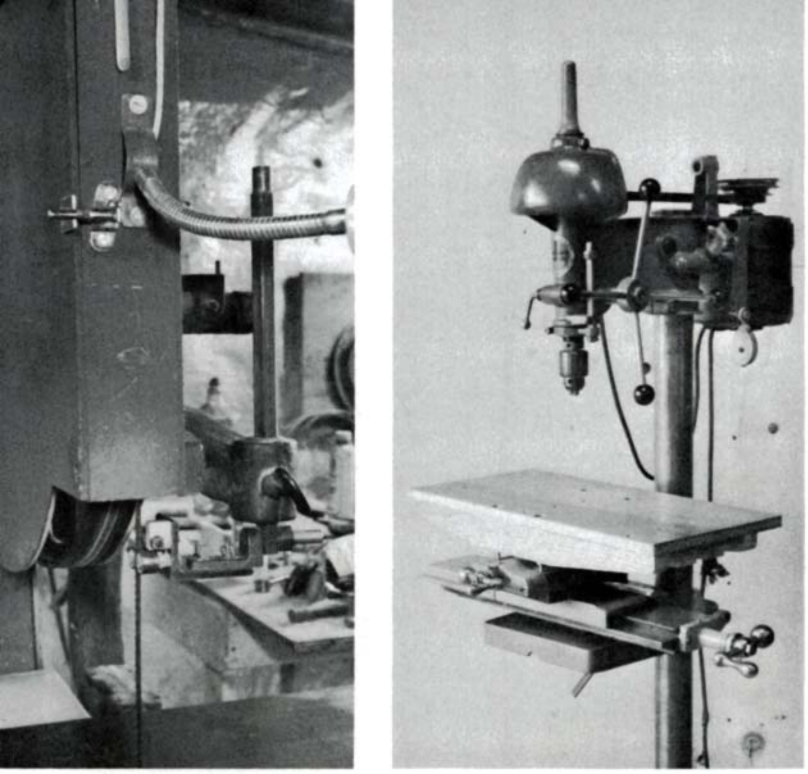
Some design considerations are evident right away, and some may not be. Often convenience to the operator is overlooked. Avoid putting adjustment controls underneath or behind the machine where they are awkward and dangerous to reach for. On some machines, there is no choice, but if there is an alternative, use the most convenient location. This also applies to accessory storage. How often have you had to use a machine whose table was too low or too high? In general, tables, lathe spindles (not ways) and the like should be the same height as your elbows. Make tables large enough for the work you plan to do, or provide for extensions.

Versatility is important as long as it does not require too much time to change from one mode to another and does not compromise performance. Adjustments should be fast and easy. Movable parts should be clamped with devices that are quickly released without additional tools.

When designing a machine, be aware of industry standards. Find out what sizes and methods are most commonly used for attachments. If you are building a disc sander and want to buy the backing disc instead of making it, what size is its centerhole? How is it fastened? These things determine shaft size. If you are building a lathe, what is the most com-

Giles Gilson, a designer/sculptor, lives in Schenectady, N.Y.

Photos, except where noted: Giles Gilson



Band-saw accessories, left, include plywood cover latched with Volkswagen convertible-roof holddown and blade guide from roller bearings, angle iron, nuts and bolts. Right, cross-slide and compound-angle jig cannibalized from metal lathe are mounted on drill press.

mon spindle thread for faceplates? Machinery catalogs usually mention spindle diameters, thread pitches, belt sizes, etc.

The choice of bearings is important. Think about how the workloads will be distributed from the shaft through the bearings to the structure of the machine. Which way will the work push against the spindle? What pressure is the drive belt putting on the shaft? What is the maximum speed? Consider the environment of the machine. What kind of foreign material will be present? Normal sawing produces fine chips as well as dust, turning produces curls and dust, and sanding produces abrasive grit and dust. What will these substances do to machinery?

Oil-impregnated bronze (oilite) inserts are made as a single piece and called sleeves, or as two halves usually called clamshells. They are good for many applications, and also inexpensive and quiet. However, they should be used only on precision-ground shafts and often must be align-bored or reamed to size after installation. This can be done by a machine shop if you do not have the facilities.

Anti-friction bearings are generally noisier than sliding types. They are more efficient, however, and sometimes require much less power to run. The most common type of anti-friction bearing is a ball bearing. These withstand side-loading well. Needle or roller bearings are simply a series of cylindrical rollers that replace the balls in a bearing. They sometimes use the shaft as an inner race, and often have no retainer, which means the rollers must be individually placed between the shaft and the outer race. This type of bearing is used where thickness is a problem. A variation on the ball and needle bearing is the thrust bearing, used to handle pressure along the centerline of a shaft. An example is the guide wheel behind the blade on most bandsaws. Thrust bearings use balls, tapered rollers arranged radially, or are simply a Babbitt bearing or bronze shoulder.

Tapered roller bearings handle both axial thrust and side loads. They are quiet, but require preloading. This means they must have a specified amount of pressure holding them in place. A shoulder or snap ring supports one race while the adjustable support for the other is set to apply the preload and locked in place. The most common method of installing bearings designed for a press fit is to freeze the shaft and heat the bearing in oil to about 200°—do not heat the bearing directly. Refer to "Basic Machine Maintenance," *(FWW # 13,* Nov. '78), which shows what the bearings look like and how to handle them, and how to align pulleys and shafts.

For mounting bearings, a pillow block is convenient. A self-aligning pillow block with a sealed ball bearing is shown in the center photo on the facing page. The grease fitting in the housing allows lubrication without having to take things apart. The advantage of a self-aligning pillow block is that if the block can't be mounted exactly perpendicular to the shaft, the bearing will line up properly anyway. The outside of the bearing fits inside a spherical casing, allowing the bearing to be oriented to the shaft even if the block is not. Pillow blocks are made with almost any kind of bearing. You must specify rigid or self-aligning, and bearing type. Bearing distributors and their catalogs are helpful. Check the Yellow Pages under "Bearings."

The best operating speed for most cutting tools has been established and can be found in owner's manuals, from manufacturers, repair shops or in reference books. There are cases, though, where experimentation will show that higher or lower speeds are more effective. Variable speed may be important. A pair of step pulleys can allow three or four speeds and, if necessary, a jack shaft can be added to increase the speed choices.

To find the pulley or gear sizes needed to attain a desired spindle RPM, you must know the motor speed. This is most often either 1725 or 3450 RPM. Divide the higher speed by the lower—this gives the ratio. Then use a pair of pulleys whose diameters establish this ratio. For example, if the motor speed is 1725 RPM and the desired spindle speed is 431 RPM, $1725 \div 431 = 4.0023$, or for practical purposes, 4. The ratio is 4:1. One pulley diameter must be four times the other. Since the spindle is to turn more slowly than the motor, the smaller pulley goes on the motor. Usually the speeds need not be exact. If you want 1200 RPM and it's easy to get 1050 RPM, 1050 RPM will probably do. Many gadgets and accessories have maximum speed ratings. Don't exceed them.

Bear in mind that *V*-belts will not bend around very small pulleys. If your calculations call for a small pulley, either find a belt that will make the bend, or enlarge both pulleys.

You will have to decide how to fasten the parts of your contraption. Welding is strong and can save space, if you are equipped to do it or can have it done, but it is difficult to disassemble welded parts. Be sure to allow for changes you may want to make later. Rivets do the same thing as nuts and bolts, but also require special equipment and are difficult to remove. They do not vibrate loose though, and look better. Pop rivets are good for some applications because they are easy to use and readily available.

Threaded fasteners are the most common choice for assembly of parts. They are sturdy and they allow disassembly. They could be inconvenient, however, if used to hold often-moved accessories. Loosening nuts and bolts to remove a guard or change a sanding belt takes time. If a threaded fastener is needed, some convenience can be added by using handwheels, knobs or thumbscrews. Handwheels may be purchased, but they are easily made by burying a nut between two or three layers of plywood, then turning, using the nut

Photos, facing page: Rick Siciliano

(or a bolt threaded into it) as the center. A handwheel should be large enough for leverage and feel comfortable to hold. If the finish is too slick. . . well, you'll see.

Nonthreaded quick-release fasteners are excellent for holding accessories, but be sure they are strong enough for the application. Latches, buckles, lever and cam devices and Dzus fasteners are listed in industrial hardware catalogs, usually with their measurements and sometimes a technical drawing of their parts. An ideal application for these is guards for band saws and belt sanders, where quick removal can facilitate blade and belt changes. Lever-and-cam clamps are good for holding fences, trunnions, belt tensioners and stops. Dzus fasteners, a form of bayonet plug used primarily in the aircraft industry, hold sheet metal in place. A dime or quarter fits into the slotted, round head to release them. If you use them, keep your pockets full of change. Spring-loaded clamps serve well as depth gauges, such as the ones found on drill presses, and movable stops along fences. Refined adjustments could be built into stops with an added miniature fence and thumbscrew arrangement.

Don't neglect safety. Keep in mind that the structure of the machine must be able to withstand heavy impact, vibration and misuse. Think about what could happen if the cutter or blade suddenly flew off and hit someone. This becomes more important as the speeds get higher. Consult machine designers or mechanical engineers who are familiar with the type of machine you are building, especially if you are not certain the material will hold up.

Remember such things as inherent movement in materials. Wood shrinks and swells; bolts through wood may come loose. Check all materials for faults. Round sharp edges and corners—brackets sticking out or sheet-metal edges can easily cut you. Moving parts like to be covered whenever possible.

No vibration should be transmitted to the machine operator. If there is vibration caused by a malfunctioning part, it should be repaired or replaced. Vibration inherent in the machine can be damped with rubber mounting devices, or where applicable by counterbalancing. Noise should also be kept to a minimum. One way is to construct with wood, which will dampen sound, unless it is a thin panel walling a hollow. Cover resonating panels with sound-deadening material, or fix them with stiffeners.

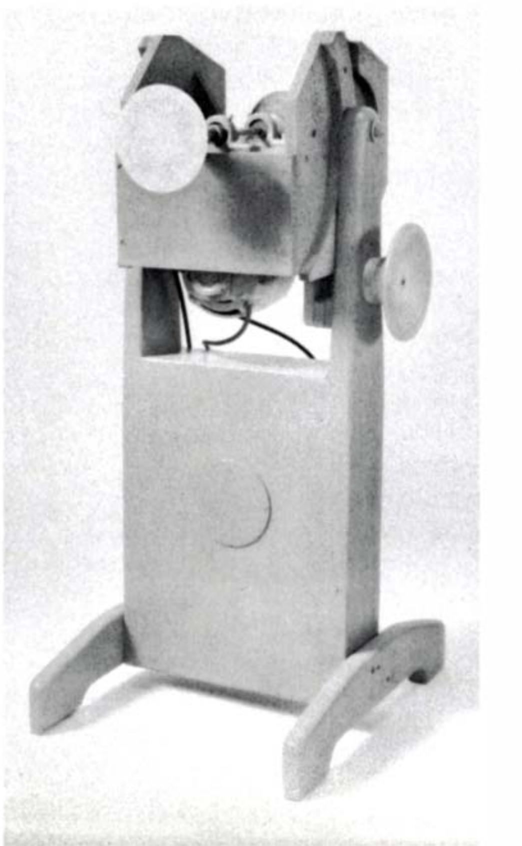
Most of the time, you can use standard electrical parts. National and local codes show procedures and required precautions. Be certain to use wiring and parts that are rated for the current that the motor calls for. The open-frame motor shown below at right was used for experimental purposes only and has since been changed to a totally enclosed fan-cooled motor in accordance with national electrical codes.

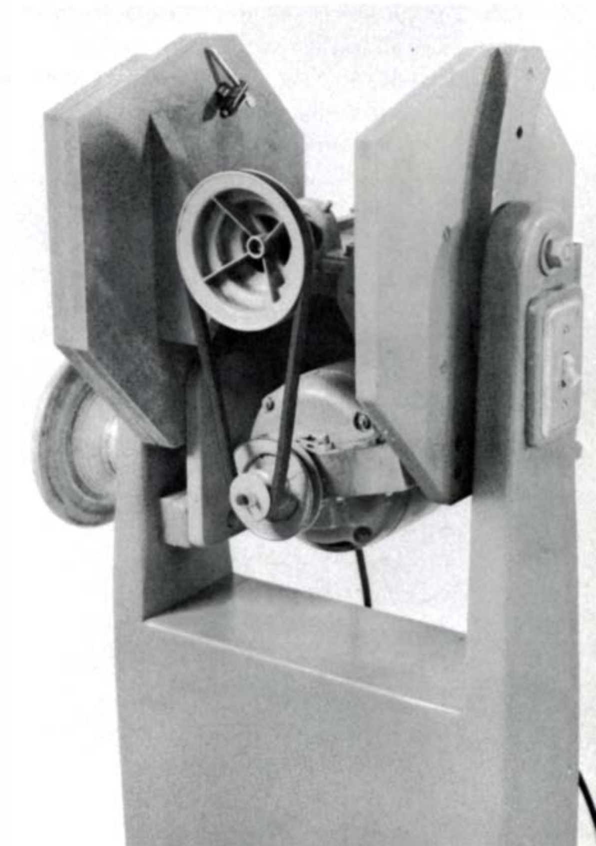
Switches and connections should be mounted in containers, usually metal conduit boxes designed for this purpose. These should be enclosed to keep out dust and chips. Wood is an insulator, so extra shockproofing is an added feature of a wooden machine.

A drawing-board sander — Now let's look at an example of a homebuilt machine. I call this sander "drawing board" because with its table tilted, that's what it looks like. I designed it for light to medium duty, but made allowances for changes to heavier components. I had two functions in mind: light spindle-sanding and foamback-disc and drum finish-sanding. (For more on foamback sanding, see "Turning Spalted Wood," *FWW* #11, Summer'78.) In the spindle-sanding mode, the motorhead and table can be tilted separately for beveling, or as a unit for comfort. The machine has two speeds, 2000 RPM for spindle-sanding and 550 RPM for finishing. I used both modes to make the sculpted boxes shown at the top of the next page, first the spindle to shape and sand the inside walls, then the disc to finish the outside contours to 320 grit.

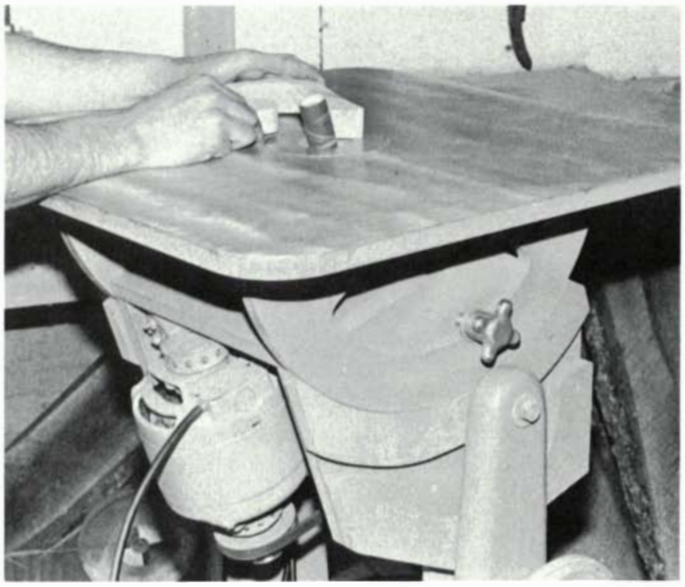
I did the rough design in my spare time by sketching ideas and forming a basic concept of the major parts. I made re-

The drawing-board sander in spindle mode, left. The table, of aluminum-laminated MD-44, measures 24 in. by 24 in., and is 48 in. high when not tilted. The base consists of 2x6s covered with plywood, and the trunnions, fixed in position by tightening the four-pronged handwheel, are birch ply. Center, the table is removed, the large birch-ply handwheel loosened and the spindle positioned horizontally to receive foam-backed discs or drums. Self-aligning pillow blocks bear the shaft. Right, the ⅓-HP motor fitted with pulleys yields 2000 RPM and 550 RPM at the spindle.





Left to right, boxes finished on the drawing-board sander: 'Geyser of Light,' 13½ in. by 9 in. by 5 in., birch ply, lauan, curly maple, East Indian rosewood; 'Antigravity Box #1: Dumping Karo Syrup on the Enemy,' 14½ in. by 13 in. by 7½ in., padauk, walnut, maple, lucite; and two views of 'Big Brother and Little Joe,' 20 in. by 13 in. by 4½ in., walnut, figured maple, rosewood.



Left, drawing-board sander spindle tilts independently of table. Right, foam-backed drum finishes the inside of a piece.

finements during construction. Because it was necessary to find certain reference points, I made a more technical drawing at the workbench. Lines that didn't provide measurements I sketched freehand to save time. I built the motorhead and table without a preliminary model, although I made a mockup of the base. This proved valuable because it demonstrated where the machine would be unstable, showed some clearance problems and indicated just how comfortable the machine would be at the planned height.

The base is made of 2x6s with plywood covers rabbeted into the fame. The motorhead and table are made from MD-44 with gussets for rigidity. The trunnions are solid birch ply because it will wear well where the parts slide. The table top is aluminum laminated to the MD-44 and finished with a low-speed sanding disc, 320 grit. The large handwheel for the motorhead clamp is made from birch plywood scraps that were on their way to the woodstove. I used self-aligning, ball-bearing pillow blocks simply because they were easiest.

A homebuilt machine is often a prototype, especially if it incorporates new ideas, and therefore will have to be "field tested" to find out what the necessary improvements are. The drawing-board sander is in this stage now. I'm compiling notes evaluating the tool for durability and actual usefulness. Already there is a need for a taller spindle. This will require heavier mountings, which can be installed because of the allowances I made earlier. The machine serves its original purpose well, but it can be changed to do more.

A valuable test is to have people experienced with similar machinery use and evaluate it. (Be sure they know it is experimental and that you know it is safe to use.) Others will spot things you might overlook. You may not want to bother making a change because you've already done a lot of work, and have become used to the tool the way it is—"it does the job," and "that can be done later." But will it? If you're taking the trouble to build a machine, why not build the best? □

Further Reading

Fundamentals of Tool Design, American Society of Tool and Manufacturing Engineers, Prentice-Hall, Englewood, N.J., 1962, $21.95. Principles and techniques of tool design: cutters, dies, jigs and fixtures. I recommend it because the better you understand what the cutter is doing, the better you can design the machine to power it.

Mechanical Design of Machines, Siegel, Maleev and Hartman, Int'l. Textbook Co., Scranton, Pa., 1965 (out of print). Highly technical. Has charts on shaft loading and describes forces on machine members.

Mechanical Engineering Design, Joseph E. Shigley, McGraw-Hill, New York, 1963, $25.50. Starts with fundamentals, and though it becomes very technical, is easy to follow. Includes drawings of welded joints and a fine section on bearings.

Pictorial Handbook of Technical Devices, Otto B. Schwarz and Paul Grafstein, Chemical Publishing Co., New York, 1971, $12.50. Valuable technical drawings of mechanical devices used in machinery; also includes structures, industrial processes and electrical parts.

A Sanding-Disc Jointer

Tapered disc on tilted arbor allows fine adjustment

by H.B. Montgomery

There are various methods for obtaining perfect edges on workpieces from thin veneers to 3/4-in. thick hardwoods. With a simple guide jig and a tapered sanding disc mounted on a tilting-arbor table saw, I am getting perfect edges, ready for gluing in a matter of minutes.

A tapered sanding disc can be machined from a piece of 3/8-in. thick aluminum. I prefer a 10-in. disc with 2° to 3° of taper. Use a heavy backing plate while cutting the taper, or the edge will curve away under the pressure of the cutting tool and the surface will not be true. Three degrees is the maximum taper you can expect the sandpaper disc to adhere to. I use Sears pressure-sensitive sanding-disc cement and cut a 3-in. hole in the center of the sandpaper. Use paper-backed sanding discs; cloth or fiber-backed discs will not stay on.

The advantage of a tapered disc is that when mounted on the saw arbor and tilted to compensate for the taper, only a small portion of the disc is at 90° to the saw table, and that portion is moving practically parallel to the grain of the work being fed past. Also, because the arbor is tilted, the crank that raises and lowers the arbor can be used for fine adjustment of the lateral depth of cut of the disc.

The guide jig, which runs between the rip fence and the sanding disc, consists of a top and bottom plate (3/4-in. hardwood plywood), a hardwood clamping reinforcement strip, two carriage bolts with wing nuts and two registration dowels. The jig should be slightly longer and wider than the stock you will be jointing. Crown the reinforcing strip about 1/16 in. to even out clamping pressure, and fasten it to the top plate from the bottom, about 1 in. back from the edge, with two countersunk wood screws located about 3 in. on either side of the center. Placing the screws farther apart might bend the plywood to the slight arc of the reinforcing strip. Now clamp the two plates together and drill through at the ends of the reinforcing strip for the two carriage bolts. Install the bolts, tighten down the wing nuts and drill two holes in the edges of the far side of the jig to receive two 1/2-in. by 1 1/4-in. registration dowels. Loosen the wing nuts, install the dowels and retighten the jig.

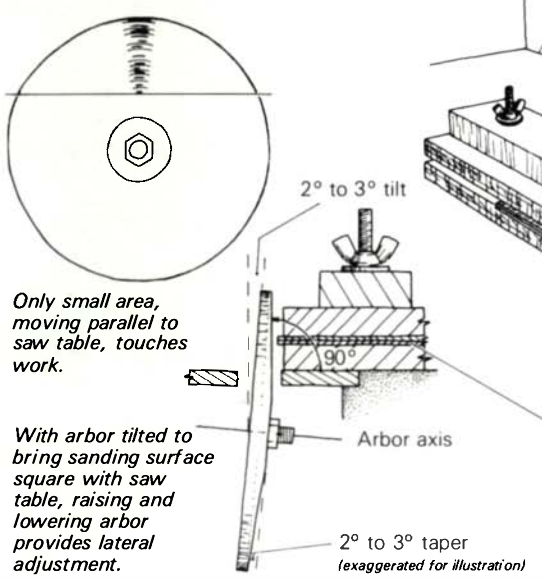
With the sanding disc on the saw, raise the arbor to its full height and, checking with a try square, tilt the arbor until the disc face is exactly 90° to the table, measured directly over the arbor. This is the only critical adjustment for the jointing operation. Lower the disc to 1 3/4 in. above the table and set the rip fence so the jig just fits between the two. Turn on the power and run the jig through several times on each edge, raising the arbor slightly between passes, until its edges are true and parallel.

To use the jig for jointing two veneers, lay the pieces side by side as they will be joined, face up, and fold them together with the good faces inside. Clamp this "book" in the jig with only 1/16 in. or so protruding, set the rip fence for the lightest cut and pass the work-loaded jig through the rotating disc. Raise the arbor between passes for a deeper cut until the veneers are flush with the jig edge; depending on the grit size on the disc, from .005 in. to .025 in. can be removed with one pass. I recommend 120 grit for finished edges.

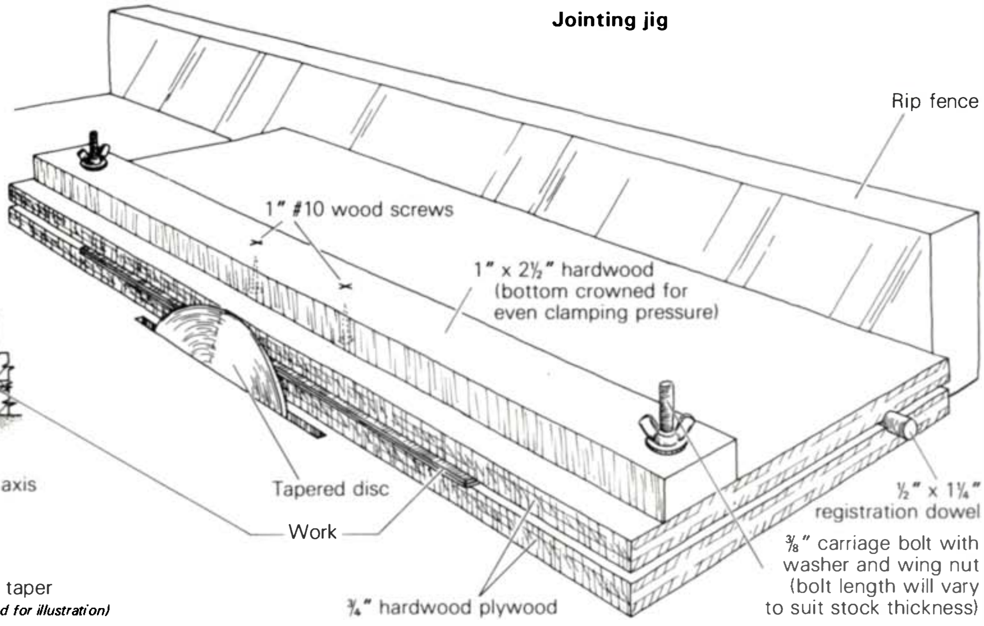
The horizontal locating dowels work best for thin stock. The jig can handle up to 3/4-in. thick stock (1 1/2 in. thick total) with a 10-in. disc, but with thick stock vertical registers should be used. □

H.B. Montgomery, a retired mechanic, lives in Seminole, Fla.

Tapered sanding-disc jointer



Jointing jig



An Inflatable Drum Sander

Rubber sleeve conforms to work

by Robert L. Pavey

Walnut bird, 11 in. high by 8 in. wide, sanded on homebuilt pneumatic drum sander.

An inflatable sanding drum is an invaluable tool for shaping and smoothing wood and other materials—both convex and all but the tightest concave surfaces can be executed with style. The sanding surface conforms to irregularly shaped work and, unlike a hard-backed sanding drum, does not leave deep sanding marks. You can inflate it hard for fast cutting, then release some pressure to make it soft for smooth finishing. It is also easy to change sanding sleeves: Simply release the air pressure, slip off one sleeve, slip on another, reinflate and on with your work. Whether you have compressed air in your shop or a bicycle pump, it takes only seconds.

Making a pneumatic sanding drum is easy. It can be run on a lathe or be driven as mine is by a ⅝-in. shaft supported by pillow-block bearings and powered by a 1725 RPM, ⅓-HP motor. I get variable speeds from half to twice that RPM with a double-flange, spring-loaded pulley system that effectively changes the diameter of the drive pulley by levering the pulleys away from or toward one another. The materials for the drum itself should be available locally:

—1 12-in. length of ½-in. water pipe

—1 tire valve stem

—1 tube silicone rubber sealant

—1 shaft adapter to fit your drive

—1 rubber stopper, ½ in. dia.

—1 10-in. length of 3-in. diameter rubber tubing (Goodyear Spiroflex 2001 water discharge hose works well)

—4 ¾-in. shaft bushings

—2 ¼-in. to ⅜-in. thick by 3½-in. dia. discs: wood, polyethylene, nylon or other material

—wire or strong, thin cord

—1 piece of canvas 12 in. by 12 in.

—2 pieces of ⅛-in. cord, 12 in. long

—Sandpaper and glue to make the sanding sleeves

EDITOR'S NOTE: For those who do not want to make their own, pneumatic sanding drums, their separate parts (with or without drive) and various-sized sanding sleeves are available from Sand-Rite Mfg. Co., 1611 N. Sheffield Ave., Chicago, Ill. 60614.

First cut the ½-in. pipe to length using a pipe cutter. The burr this leaves serves as a flange inside the pipe that will prevent the tire stem from slipping out. The other end of the pipe should be reamed to remove the burr. The tire stem must be turned down to fit snugly into the pipe. Chuck the cap end in a drill or lathe and file while it turns. Then slip the stem through the pipe and before pulling it tight against the flange, place some silicone rubber sealant under the flange to form a seal. Pull tight and let dry.

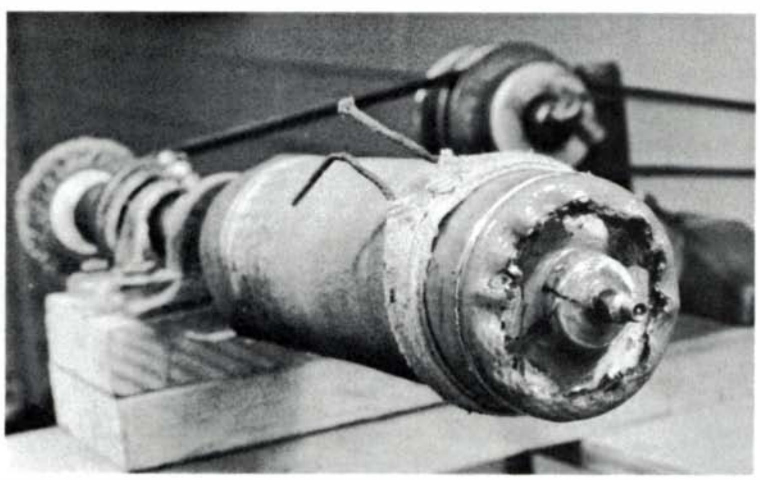
The next step is to mount the shaft adapter to the opposite end of the pipe. First drill and tap a set-key hole in the pipe approximately ¼ in. from the end to keep the pipe from slipping on the shaft adapter. It's a good idea to use a threaded shaft adapter and to tap a thread in the pipe to fit it.

Before attaching the adapter, insert in the pipe a tight-fitting rubber stopper liberally coated with silicone rubber sealant to form an airtight seal ahead of the shaft adapter. A ⅛-in. hole drilled through the pipe between the stopper and the valve end permits air to enter the drum chamber.

Next construct the ends of the drum. First ream the four ¾-in. bushings to fit over the pipe, which will be approximately $\frac{27}{32}$ in. Also drill and ream the center holes of the discs. Place the bushings and the discs on the pipe as shown in the drawing. Before tightening be sure to apply liberal amounts of silicone rubber sealant on each side of the discs next to the bushings; position and tighten the bushings to hold the discs in place 9 in. apart outside to outside.

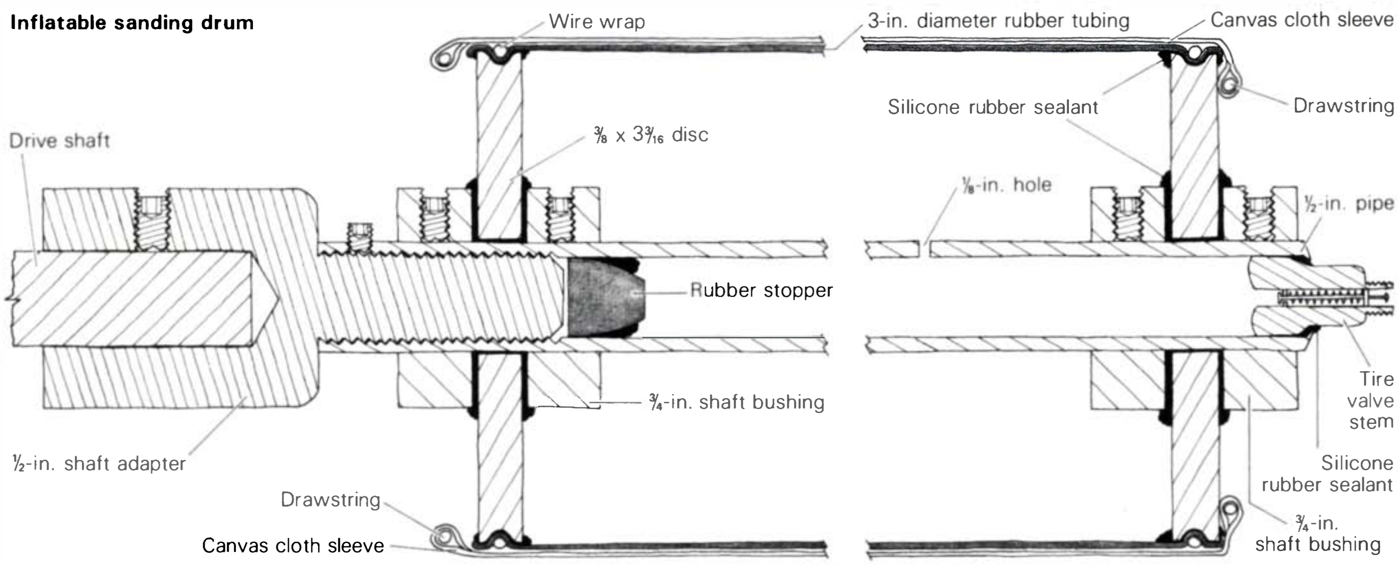
After the silicone rubber sealant is dry, place the assembly on your drive and turn down the two discs to a 3$\frac{3}{16}$-in. diameter. This corrects for any wobble in your shaft or off-centering of the hole drilled in the discs. Next turn a groove in the center of each disc for gluing the diaphragm. This groove should be deep enough to permit the wire or cord windings to be pulled below the surface of the completed drum. This will

Sheets of cloth-backed sandpaper with a strip of sand removed and glued over on the back form sleeves for the sander.



The drum, showing tire valve stem (sealed with silicone), wire wrap, canvas sleeve with drawstring, and pillow blocks bearing the belted shaft.

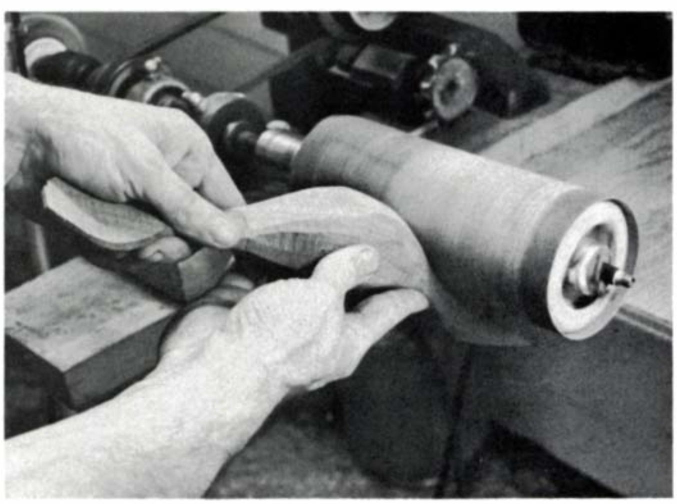
Photos: Milton Fanta; Illustration: Christopher Clapp



protect the windings and the protective cover from damage.

Now comes perhaps the most difficult step, that of attaching the diaphragm and obtaining an air-tight seal. The 3-in. diameter rubber tubing should be longer than the drum in order to be able to hold it in place while wrapping and gluing the binding wire or cord. Silicone rubber sealant applied liberally on the inside of each disc will aid in forming an air-tight seal. Pull the wire or cord tight so that it bites into the rubber, pressing it tight against the discs. Let the sealant dry thoroughly before testing. If you detect minor air leaks, these may be sealed using bicycle-tire sealing materials. The diaphragm is then covered with a canvas cloth stitched and tied with a drawstring down over the ends.

The last step is to prepare the sanding sleeves to be placed over the drum. First wrap the 9-in. by 11-in. sheet around the drum and mark the sheet at the point of overlap. Scrape a strip of abrasive off one end of the paper, apply glue and then clamp until set. Once the glue is dry, place the sleeve over the deflated drum, inflate and use. For dust collection, I have mounted a 3-in. by 6-in. vacuum nozzle (not shown in the photos) behind the drum. A Sears Shop-vac takes care of most of the dust. My drum rotates counter-clockwise, and I hold work sometimes above, sometimes below it. Try using different pressures and see how it affects your work; you will be amazed at the fine, smooth finish you can achieve on irregularly shaped pieces of wood without leaving flat spots, ridges and sanding marks.



Drum sander smooths irregular contours of a bandsawn bird.

Hand-held adaptations — I am sure that by extending the length of the water pipe to accommodate two handles slipped over the ends, with bearings between the inside diameter of the handles and the outside diameter of the pipe, you would have the beginnings of a rolling-pin sander. The handles could be turned-and-bored wood or plastic or metal pipe. The tire-valve stem would remain protruding from one end of the spindle pipe. To power the unit, a shaft adapter or a plug fixed to the other end of the pipe could be turned to fit a flexible-drive-shaft or portable-drill chuck.

The hand-held adaptations I have actually made are single-handle designs made from nylon bar stock. Efficient use of standard 9x11 sheet sandpaper determined the various drum sizes, all smaller than the original design and ideal for sanding holes and tight curves. To use a 5½-in. by 9-in. half-sheet, the drum must measure 9 in. by 1⁵⁄₁₆ in. in diameter. Taking into consideration ¹⁄₁₆ in. for the inflatable sleeve and ¹⁄₁₆ in. for the canvas covering, the disc has to be turned to 1³⁄₁₆ in. To use a 5½-in. by 4½-in. quarter-sheet, the drum measures 5½ in. by 1³⁄₁₆ in. in diameter and the discs must be turned to 1¹⁄₁₆ in. And to use a 4½-in. by 2¾ in. eighth-sheet, the drum measures 4½ in. by ¾ in. in diameter and the discs must be turned to ⅝ in. These drums were constructed similarly to the large one, however the spindle and discs are one unit turned from 2-in., 1½-in. and 1-in. nylon bar stock, respectively. For a drive shaft I drilled and tapped a hole in the end of the bar stock and screwed in a ⅜-in. bolt, then cut the head off. This shaft can be mounted on any ⅜-in. chuck drive (flex-shaft or portable drill). To attach the tire-valve stem to the opposite end of the shaft, first remove the rubber from the metal portion of the valve stem. Then drill a hole in the end of the spindle, into which the valve stem can be driven for a tight fit. This hole should be deep enough to go past the disc portion of the spindle in order that the ⅛-in. hole that permits air to flow into the chamber can be drilled across the spindle to meet it. The diaphragms for these smaller drums were made from thin-wall latex rubber tubing, attached, sealed and covered as on the larger drum. □

Bob Pavey, a research scientist, lives in Western Springs, Ill.

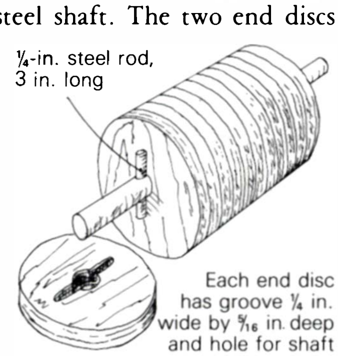
A Low-Tech Thickness Sander

Homebuilt machine is accurate and cheap

by T.R. Warbey

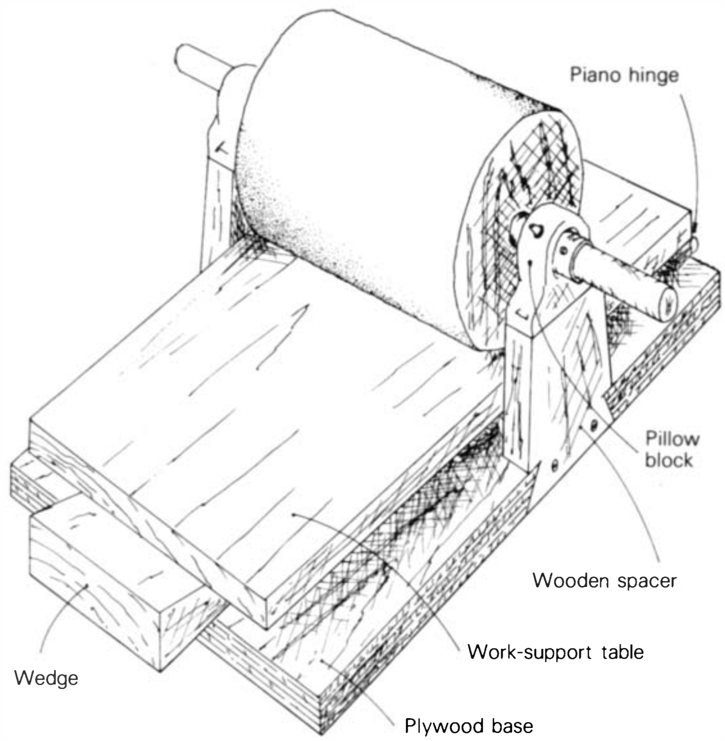
I make dulcimers, so I need thin pieces of wood sanded to fine tolerances after resawing. Last summer I made an abrasive thicknesser that handles stock down to 0.040 in. The machine cost me less than $20.

My thicknesser uses a drum made of plywood discs glued together and mounted on a steel shaft. The two end discs have ¼-in. grooves routed in them, and the steel shaft is drilled through with two ¼-in. holes to coincide with these grooves. Insert 3-in. lengths of steel rod into the holes when all the discs but the end ones are glued and in position on the shaft. Apply glue to the end discs and position them over the two rods. Clamping the assembly locks the drum onto the shaft. When it's dry, I take it to the local machinist to be turned true.



Next mount the drum/shaft in pillow blocks on wooden spacers on a heavy plywood base. On my machine, the base is the top of a stand to support the machine and to house the motor. For the work-support table under the drum I used 1-in. maple only about 15 in. long, to minimize flexing. The table is hinged at one end (a full-length piano hinge is best) and sits on a wedge at the other.

I glue sanding-belt material to the drum using contact cement, but I use white glue for the joint at the belt ends. Dip the ends in boiling water to remove the abrasive, and dry prior to gluing. Lap the ends at an angle to the axis, a standard belt-gluing procedure.

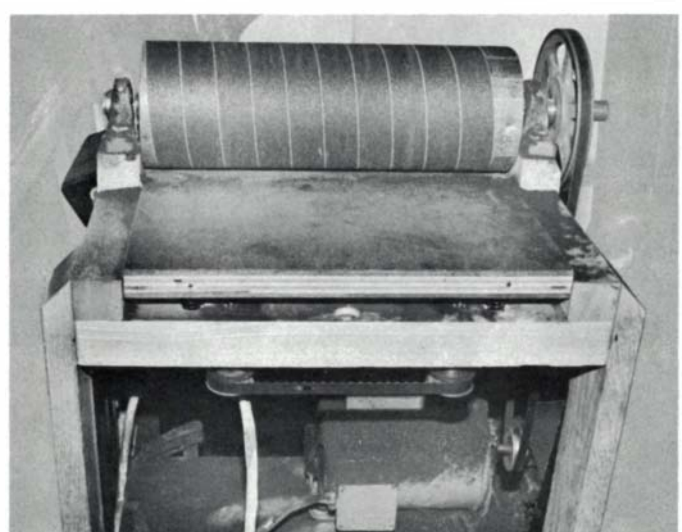


I sand both softwoods and hardwoods using 50-grit closed-coat aluminum-oxide belting. My machine is driven by a ¾-HP motor; the 6-in. diameter drum turns bottom toward me at 1600 RPM. I stand at the wedged end, place the work on the table and gently push it in under the drum, which sands and thicknesses at the same time. When one side is done, turn the work over, shift the wedge in a little and sand the other side until your stock is the desired thickness.

The machine is light enough to carry outside; this way I don't have a dust problem. Even so, I wear a mask. My next problem is how to change grits and keep it simple. □

EDITOR'S NOTE: We've come across a number of machines similar to Warbey's thickness sander. One made by Bob Meadow (a lutemaker and resident woodworker at Peters Valley Craftsmen, Layton, N.J.) is shown at right. It has a screw adjustment instead of a wedge to raise and lower the table. Two threaded rods are pinned to two timing pulleys and synchronized by a toothed rubber (timing) belt, which ensures even support. To true his drum, Meadow slid coarse sandpaper under the rotating, roughcut drum. (It is even possible to turn round an octagonal blank, already in the pillow blocks, from a tool rest mounted on the frame.) This both trues the drum and corrects any slight misalignment to the table.

According to R.E. Brune, of Evanston, Ill., another maker, the drum-type thickness sander has been around for several centuries as a luthier's *filertier*. Other variations can be found in the data sheets compiled by the Guild of American Luthiers (8222 S. Park Ave., Tacoma, Wash. 98408). Among the refinements is an answer to Warbey's problem of changing grits simply. *GAL Quarterly* editor Tim Olsen recommends using a steel drum (see data sheet 48). Not only is this more stable than a wooden one, but the sanding strip can be applied with a light, spray-on rubber cement (Olsen uses Weldwood Spray 'n' Glue), which bonds weakly with the steel and is easily removed. Wrapping the strip helically and securing the ends with masking tape provide an adequate hold.



Thickness sander by Bob Meadow uses a pair of synchronized machine screws to raise and lower the table. The machine is powered by a 1½-HP *motor that turns the cylinder 1150* RPM.

Some Abrasive Facts

by Lyle Laske

Abrasives fall into two categories: natural mineral and synthetic mineral. Natural minerals include flint, garnet and emery. Since 1900 the synthetic minerals aluminum oxide and silicon carbide have become more and more popular, both in industry and in the home shop. Because of the superior qualities of synthetics and also as a result of the development of power tools, sanding has become a shaping method as well as a finishing method.

Abrasive hardness is routinely measured on two scales. The Mohs scale runs from 1 (talc) to 10 (diamond). Ratings are determined by abrading a soft mineral with a harder one; they do not indicate equal or proportional differences. The Knoop scale, which goes from 1 to 8500, determines hardness with a pressure indenter, and more accurately measures the proportional hardness of minerals. Toughness, which differs from hardness, is determined by a ball-mill test: rotating a given grit in a steel drum with steel balls for a standard period of time and noting how much of the grit survives at the original size.

Each abrasive has advantages and disadvantages, and comparing them will help you choose the right one for the job at hand.

Flint *(quartz)*
Color: buff
Mohs: 6.8 to 7.0
Knoop: 820
Toughness: 20%

Garnet *(almandite)*
Color: reddish-brown
Mohs: 7.5 to 8.5
Knoop: 1360
Toughness: 60%

Emery *(corundum and magnetite)*
Color: grey to black
Mohs: 8.5 to 9.0
Knoop: 1750
Toughness: 80%

Aluminum oxide
Color: tan or white
Mohs: 9.4
Knoop: 2050
Toughness: 75%

Silicon carbide
Color: greenish-black
Mohs: 9.6
Knoop: 2480
Toughness: 55%

Flint is used in an inexpensive sandpaper. Because its sharp edges break down quickly, it is not used in production work, but is good for sanding resinous and waxy surfaces and for removing paint and sealers, which clog sandpaper quickly.

Garnet abrasive is obtained by crushing semiprecious garnet jewel stock and heat-treating it to increase its natural hardness and toughness. It is used for production woodwork and sanding between coats of paint and sealers. In use, garnet fractures, generating new cutting edges (see p. 53). The furniture industry prefers garnet because it is less expensive than aluminum oxide and because garnet's cutting edges scrape rather than scratch the wood. This promotes finish consistency and resistance to burning on most end-grain sanding operations. Garnet is manufactured in grits from 12 to 320. It is not recommended for metal.

Emery, the second hardest natural mineral after diamond, is the toughest abrasive listed here. However, because it has round, blocky, heat-generating cutting edges, it is usually used with lubricants to polish metal. The dull fracture and lack of chip clearance make it unsuitable for woodworking.

Aluminum oxide is made of heat-treated bauxite and lesser amounts of titania. There are only four minerals harder (three synthetic and diamond). Its heavy, wedge-shaped cutting edge is the reason for its toughness. Aluminum oxide is well suited to high-speed sanding machines working hardwoods and hard metals; its higher cost is offset by its durability. However, when sanding resinous softwoods which clog the cutting edges, thus shortening the work life, and where burning is a problem, garnet is a more economical abrasive.

Silicon carbide is made from heat-treated silica sand and petroleum coke. Only boron carbide and diamond are harder. Of all abrasives, silicon carbide has the longest cutting edges and the best concave sides for chip clearance. Unfortunately it breaks down rapidly on hard metals and reacts chemically with ferrous metals. Because of this it is commonly marketed in finer grits—from 180 to 600, although grits as coarse as 24 are useful on particle board and plywood. The best uses for silicon carbide are in sanding soft materials, hardwoods and low tensile-strength materials such as stone, plastic and glass. Silicon carbide abrasive is also used for sanding hard lacquers, varnish and baked-enamel finishes.

Abrasives are sold by grit size, a measure of how coarse or fine they are. Three grading systems are commonly used. The *grit symbol*, the oldest, is an arbitrary system. Number 4½ is the coarsest and 10/0 is the finest. The grit symbol is being de-emphasized by manufacturers. The *mesh number* or *grit number* indicates the approximate number of apertures per running inch in the vibrating silk or wire screen that sorts that grade of stock. Thus 120 grit means there are 14,400 (120 × 120) openings per square inch; discounting the size of the silk thread, each opening (and each grit that falls through it) is about 0.0052 in. across. *Simplified labels* used on flint sheet and emery cloth are Extra Fine, Fine, Medium, Coarse, and Extra Coarse. (For a comparison of grit gradings, see "Sanding," *FWW* #12, Sept. '78.)

Abrasives are applied to their backing either by gravity or electrostatically. First the backing is given a *make coat* of glue (either hide or resin, the latter being stronger). In the electrostatic process, the glued backing is conveyed in a strip above a belt conveying the sorted grit through a high-voltage field. This causes the grit to lift off the conveyor and adhere, with maximum evenness and with their sharp points (least mass) outward, to the glued backing. After the make coat has dried, a second, thinner *size coat* (again of either hide or resin glue) is applied over the abrasive surface. Resin-over-resin bonds are used for heavy-duty grinding and in waterproof papers for rubbing out finishes.

The grit can be applied to cover the complete surface *(closed coat)*, or to cover 50% to 70% of the surface *(open coat)*. The spaces in the open coat promote self-cleaning when sanding gummy or resinous materials, and extreme flexibility when bonded to cloth. For fast cutting, use light pressure to avoid heating. A closed coat has more abrading points per square inch, will last longer and produce a smoother surface. It is best for hardwoods and other hard materials that will not clog; it can be put to the work with heavy, constant pressure.

There are four types of abrasive backing: paper, cloth, fiber and combination. Paper backing is manufactured in four weights. *A*-weight paper, or finishing paper, is used mainly for light hand and vibration sanding. Its flexibility allows the operator to feel defects, and it conforms to small contours and narrow openings without breaking. *C*-weight and *D*-weight (cabinet) paper backings are heavier, stronger and less flexible than finishing paper. They are used for hand or vibration sanding with coarse grits and greater pressure. These papers are strong enough not to buckle, yet flexible enough to conform to irregular contours. *E*-weight paper (roll stock cylinder paper) is strong and durable. It is used on belt, disc and drum sanders. This paper withstands heavy pressures without becoming soft or raggy.

Cloth backings are of two types. *J*-weight, or "jeans," is lightweight and flexible. It is used in roll form for sanding irregular shapes, especially with pneumatic drums. *X*-weight, or "drills," is medium-weight, strong cloth backing. It lacks flexibility, hence it is used for mechanical sanders in high-pressure and high-tension operations.

Fiber backing—mainly for disc and drum sanding—is made from vulcanized or hardened rag-stock paper. Combination backing is sturdy and shock-resistant. Laminated paper and cloth is used for high-speed drum sanders. Laminated fiber and cloth is used for discs.

Three abrasives used in surfacing finishes should be mentioned here. Steel wool in pad or roll form is sold in grades from 0000 (very fine) to no. 3 (coarse). Pumice, made from lava, is a white powder that is combined with rubbing oil or water and rubbed with a felt pad. The common grades for woodworking are FF and FFF. Rottenstone, a brown or dark grey substance made from decayed limestone, is finer and softer than pumice and is used in the same way. □

Lyle Laske, a sculptor, of Moorhead, Minn., prepared this article with help from 3M Company and from Norton Company.

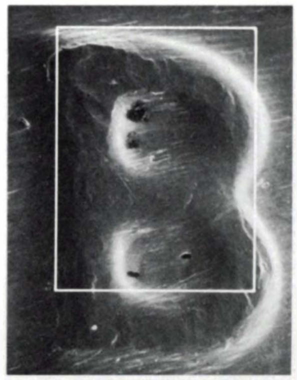
A Close Look

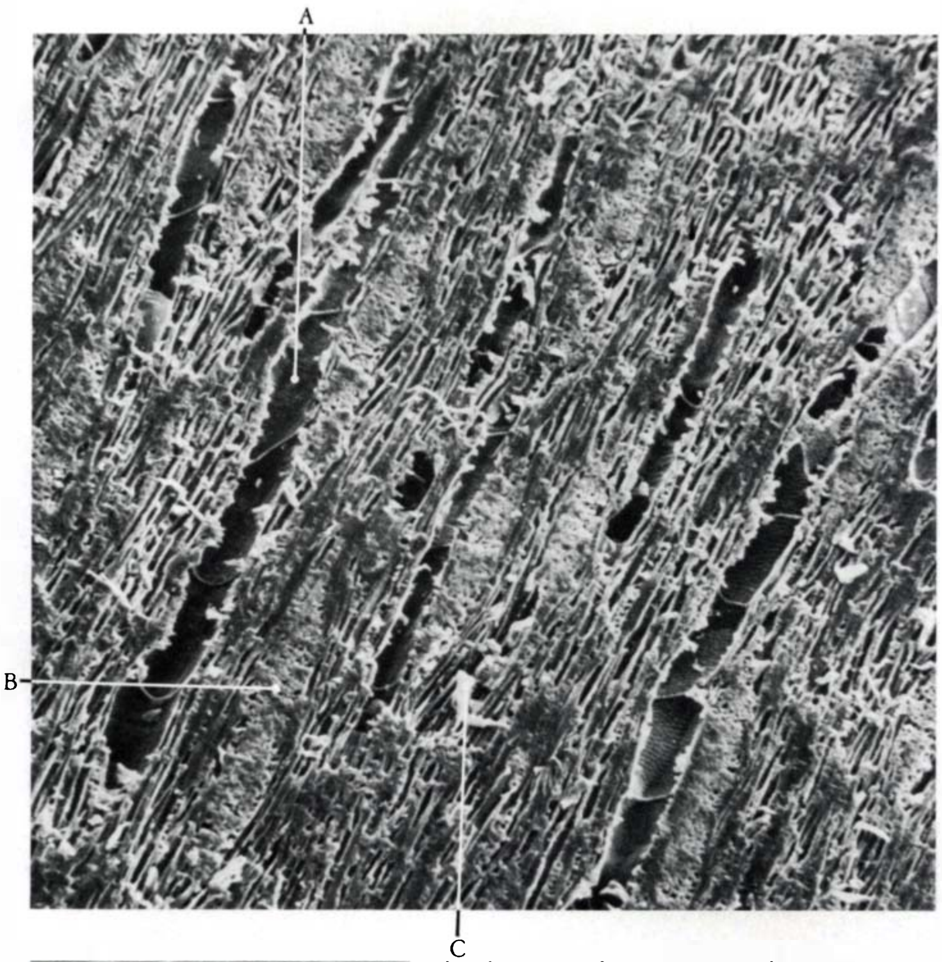
Micrographs illuminate sanding, scraping and planing

Photos by Stephen Smulski

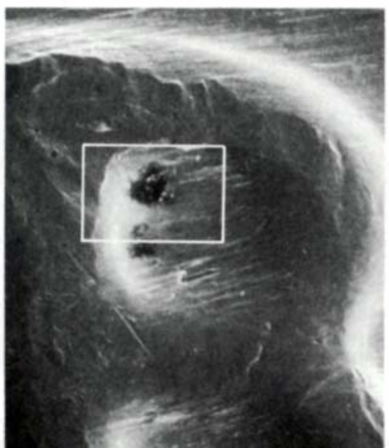
The photomicrographs on these two pages show the surfaces left on hard maple *(Acer saccharum)* by various woodworking tools, along with the cutting edges of some of the tools themselves. The wood samples are all tangential surfaces from a plainsawn board, and the grain runs from lower left to upper right. The micrographs were made on Polaroid positive-negative film with an ETEC Autoscan scanning electron microscope. All but the last photo were taken at 50 × magnification, although the first one, of planed wood, has been photographically enlarged to about 100 × . For comparison we've reproduced at right the *B* from the word LIBERTY on the face of a Lincoln penny, also at 50 × . The first and last photos are accompanied by further enlargements of the boxed portions of the *B*, at matching scales. To get the full impact of these photos, find yourself a penny before reading further.

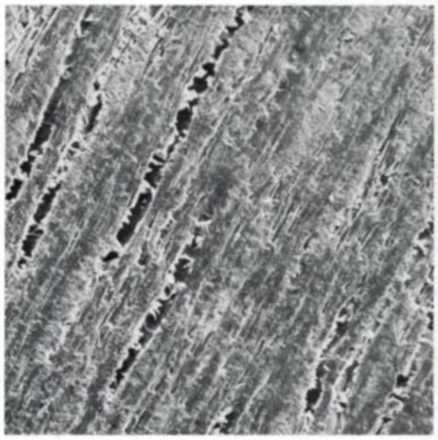
Stephen Smulski, a graduate student in wood science, took these photographs at the University of Massachusetts, Amherst.





The cleanest surface, as you might expect, comes from a well-tuned smoothing plane. The long openings are vessel elements (cells) of various kinds (A), *some of them divided by cross-walls. The lighter, more densely structured areas are ray cells in cross section* (B). *It's possible to see minute details of the wood's fiber structure, and most of the fibers are cleanly severed. White flecks* (C) *are small shavings.*



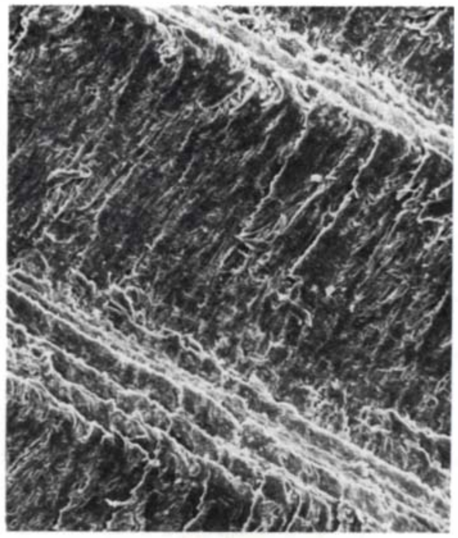


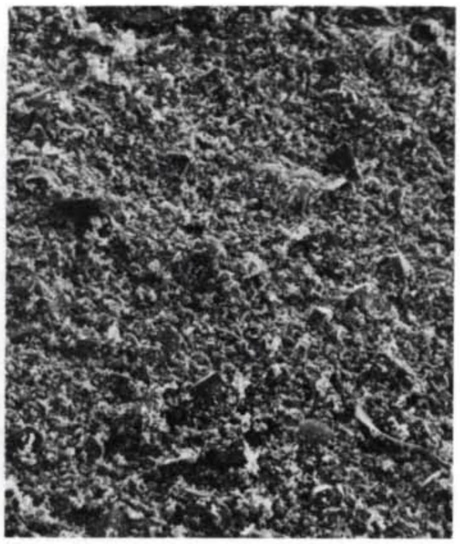
Machine-planed maple still shows open vessel elements, but the smaller features are obscured by torn and pounded fibers. The knife has moved across the surface from lower left to upper right, burnishing the fibers over onto one another. The jointer that did the work is routinely kept in good shape, and nothing special was done to it for this job.

The machined surface has been worked with a cabinet scraper. Most of the wood vessels are filled in by torn and rolled tissue, and the surface is scratched by the minute raggedness of the scraper's edge.

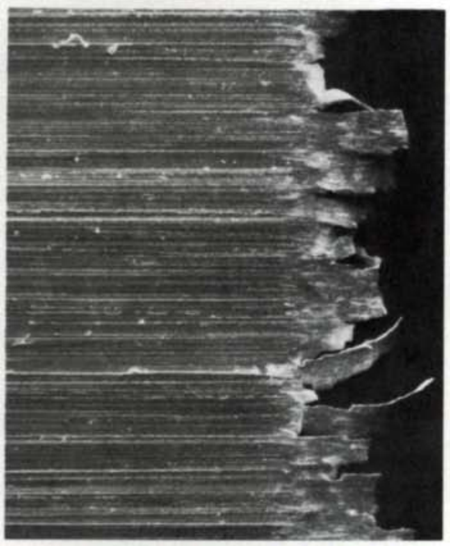
Maple hand-sanded with 220-grit sandpaper (Norton open-coat garnet) is just about as clean as the scraped surface, but there are more scratches. Dust (the white specks), rather than torn fibers, seems to have filled the vessel elements.

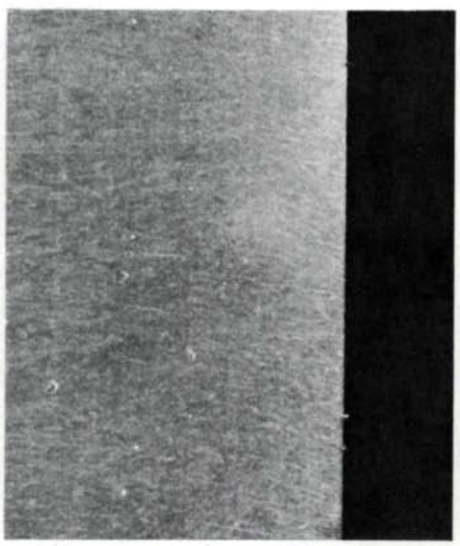
For comparison, here is maple bandsawn with a 5-tooth-per-inch blade. The two broad bands of bright lines are the tracks left by two band-saw teeth, both set in the same direction. The dark zone between the bands represents a tooth set in the opposite direction. It's still possible to locate a couple of open vessels, but torn fibers obscure most of them.





Sandpaper (Norton 220-A Openkote garnet finishing paper), new (far left) and after sanding the maple (left). What makes garnet good for sandpaper is its crystalline structure—the grit fractures into smaller, similarly angular particles. The used paper is littered with broken bits of garnet, maple dust and a few stringy wood fibers.





How sharp is a sharp edge? This section of a planer knife (small enough to fit in the vacuum chamber of the electron microscope) was sharpened using the same techniques as for the smoothing-plane iron that cut the wood so cleanly. All three photos are of the beveled side of the iron. Left, the blade has been ground on a Mark II belt-type sharpening machine, using a Norton 100X aluminum-oxide closed-coat belt. Center, contributing editor Bruce Hoadley whetted and honed both sides of the blade, using light machine oil and moving it always in the direction of cut, progressing from a fine India to a Washita stone, then to a white hard Arkansas. He finished by stropping on mimeograph paper, as if he were going to use the blade to clean up a carving. Hoadley swore it was perfectly clean, and at 50 × it does look pretty good, but the microscope reveals two tiny blips projecting from the edge. Right, at 500 × (the bit of B below is at the same scale), they seem to be tiny curls of metal clinging to the now jagged-looking cutting edge, not much bigger than the grain structure of the steel itself.

The Bowlmaker

The turner's art in Ethiopia

by Chuck and Nancy Boothby

The Bowlmaker spent several weeks each year in Mendi, a town in western Ethiopia near the Sudan, where we taught English during 1968 and 1969. Mendi, three days drive from the capital, was the last town in this direction with an ample supply of cordia—most of these trees closer to the capital had been cut into doors and window shutters. This was his preferred wood—easy to carve, with a beautiful, dark, rich, wavy grain.

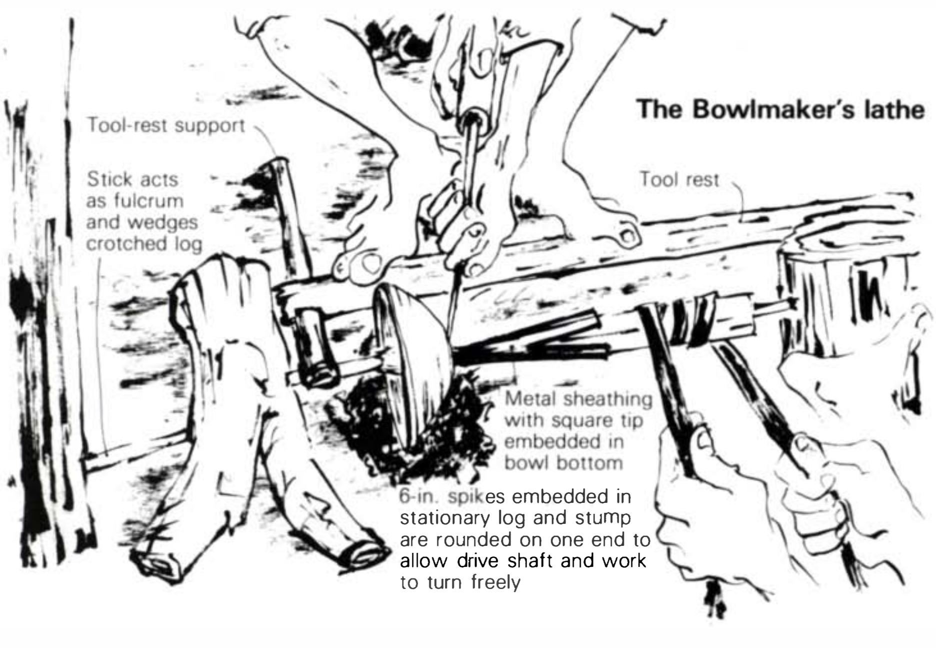
The Bowlmaker would come to our town in the dry season, buy a large tree, cut it into logs and turn the wood in the shade of a nearby front porch. The green wood turned easily. When a piece was completed, the Bowlmaker would finish it with animal fat mixed, intentionally or accidentally, with red clay. When we first saw the Bowlmaker, we were fascinated with the simple beauty of his work. Later on, while taking the photographs that appear here, we were captivated by how his body, his equipment and the natural environment all fit together into an aesthetic unity—quite unlike that of an erect, modern electrical lathe wobbling on an irregular concrete floor inside a stark, dusty building.

In his work, the Bowlmaker used ax/adzes, turning tools and drills—all made by a local blacksmith using primitive leather bellows with cow-horn nozzles. He had three ax/adzes: a large one for chopping and roughing out, a smaller one for fine shaping and one with a curved blade for rough-hollowing the bowls. All three blades had hollow, tapered throats for the pointed end of a crooked handle. While this is probably the easiest way to attach a blade to a wooden handle, it is also the most practical—the blade is easily removed to change ax into adze as the job requires. Hitting the curved part of the handle on its side loosens the blade; hitting the handle with the blade up tightens it.

His turning tools were long metal shafts embedded in handles made from sticks that were 1 ft. long and 2 in. wide. Unlike our precise, machine-made tools, the blades were shaped to the curves useful in his work. The drill, which was worked by rubbing it rapidly between the palms of the hands, was a ⅝-in. diameter stick, its bit a piece of metal ⅛ in. in diameter with the point flattened on the sides to form the cutting edge. The Bowlmaker used two sizes, one about ⅛ in. and the other about ¼ in.

Many of the Bowlmaker's designs were influenced by foreigners, especially missionaries. For example, his magnificent candlesticks had a definite cross shape. Similarly, his lidded bowl/table (for family sharing of a spicy stew served on large sourdough pancakes) collapsed so ingeniously that it seemed to have been designed specifically for the suitcases of foreign visitors, though it was an integral part of local custom. The Bowlmaker first approached us with his usual product line, but when we described a set of salad bowls instead, he eagerly took on the challenge. The idea of a set of bowls all exactly the same size, however, was a strange concept to his way of thinking. He turned bowls in the same style, but their dimensions were determined by the width of the portion of tree limb used for the stock, as well as by the Bowlmaker's varying aesthetic energy. He used no standard measuring tools, but gracefully measured with fingers or forearm, then remembered the results. More precise measurements were made by breaking the nearest straight twig to the proper length, and pocketing it for later reference. □

Chuck and Nancy Boothby teach at Moorestown Friends School, Moorestown, N.J. They built their own summer home in Sedgwick, Maine.



The Bowlmaker's specialty—a collapsible lidded bowl/table for the family meal.

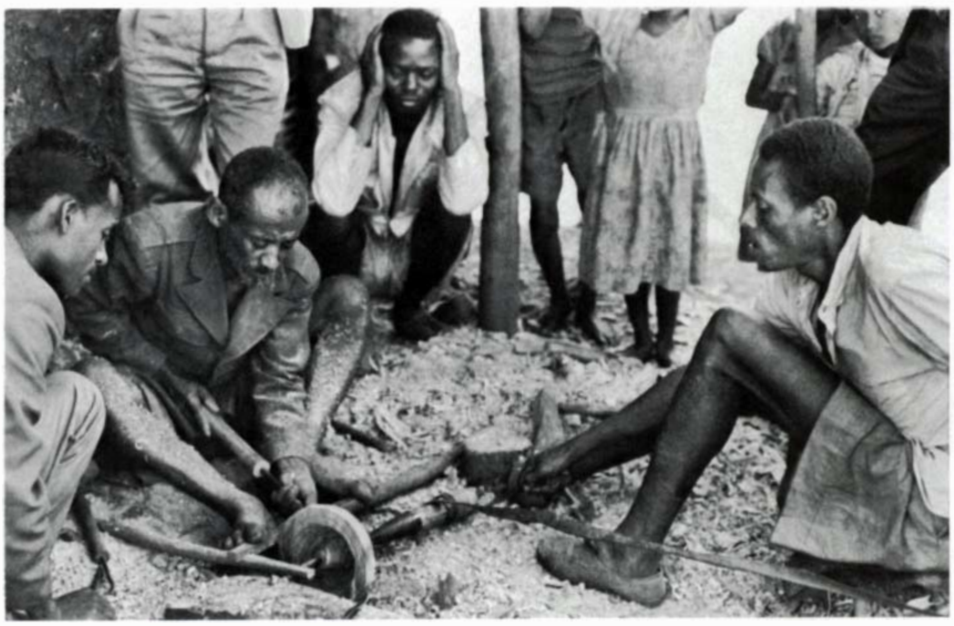
Photos: Nancy Boothby

The Bowlmaker splits a large green log in half lengthwise with an ax/adze, then cuts it to length. Rounding the ends completes external shaping.

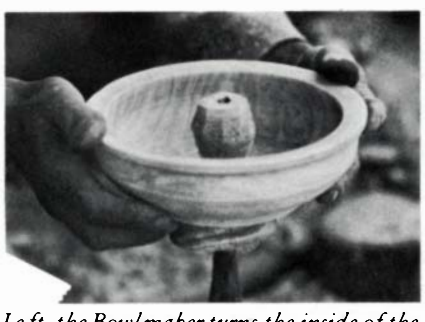
The next step is rough-shaping the inside of the bowl with a concave-bladed ax/adze. The knob in the center is left intact for attaching to the headstock of the lathe.

Next he drills a center hole in the bottom of the bowl—the drill is turned by rolling between the hands, while the Bowlmaker steadies the bowl with his feet.

The headstock, a stick with a cone-shaped end wrapped in metal and square at the tip, is banged securely into the center hole with a mallet. Then he marks the tailstock center with a smaller drill.



The lathe is powered by a strong assistant pulling forward and back on a long leather strap wrapped around the headstock. For symmetrical cutting, the strap must be pulled rhythmically.



Left, the Bowlmaker turns the inside of the bowl—little sanding is necessary because of the smoothness of the cuts. To sand, the Bowlmaker uses local abrasive leaves—fig leaves, according to a botanist in Addis Ababa. When the turning is complete, above, the bowl is taken off the lathe, with the center knob still intact. Knobs on both top and bottom will be removed with a small ax/adze.

Rough areas are smoothed with a few strokes of the turning tool, and the bowl is done.

Turning Full Circle

An exploration of segmented forms

by Stephen Hogbin

The woodturner works with a geometry of circles, spheres, cylinders and spirals. All these forms are built upon the circle, the symbol for unity, totality and eternity. The variety of forms that can be produced with the lathe seems to have no beginning or end. Also, the number of refinements to forms once they have been turned is limitless. My personal exploration of the potential in cutting apart and reassembling turned forms illustrates one neglected aspect of the possibilities in turning wood.

I was trained as a designer for industry, which quickly became an incomplete experience. I felt the need to take greater control of the whole process—the making and marketing of the object as well as its design. The lathe enables me to develop and fabricate a number of ideas in rapid succession—a freedom approaching that of the potter at his wheel. I prefer this speed to the tedious joined-stick-and-panel construction of furniture. I am also interested in questions of creativity: How do ideas happen?

After turning three or four plates, I studied their forms to isolate characteristics. The dominant feature of a lathe-turned plate is its circular outline. Cutting into that circle seemed the most likely way of developing new forms. Since the wood is attached to the lathe with a "face plate," I first cut the profiles of two human faces into the edge of a plate, a metaphor about technique. Then I cut into a plate along the graphic lines of the wood figure, removing some sections that related to its pattern (figure 1, facing page). I was trying to consider the material, the form and the function of the plate in relationship to the techniques of turning wood. What transpired was the fundamental idea of interrupting the primary characteristic of all turned forms—the circle. To direct my progress from that point, I first adopted the questioning attitude of "what happens if," and then tried to observe all related possibilities.

Before I had made ten plates, a honeycomb check opened in the center of one. I had not then read *The Unknown Craftsman* by Yanagi, and if I had I would probably have seen the check in a different way. The Korean woodturners Yanagi describes live in a world of "thusness," not of "must or must not." When something breaks or has a check in it, they simply mend it.

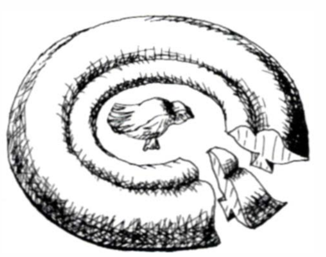
I recall seeing three alternatives for dealing with the fault in my plate: throw it away and start again; fill the check; or cut the check out and rejoin the pieces, thereby changing the circle into an eye-shaped profile.

This last possibility supported my idea of interrupting the circle. After removing the check and studying the half-plate, I realized that cutting a form in half may visually enrich it. When I placed the two halves of the plate together in various ways, the resulting forms presented themselves not as solutions but as new points of departure. If I joined the rims of the half-plates, for example, they became a deeply hollow bowl form, a wooden pocket. If I attached them at the foot, the two halves presented a butterfly or Rorschach cross section, as shown in figure 1.

At that time I was preoccupied with containers. I made my next plate with an unusually deep foot and, when I cut it in half and joined it, a more practical bowl form developed. The finished piece still looked like a plate halved and joined at the foot, so I looked for another line of development by which to pursue the form. It is difficult to recall my exact thinking, but the cutting in half and the revelation that the cross section could be more interesting than the whole certainly relates back to my art-school training. One design exercise was to cut into fruit, vegetables and other organic materials to reveal the mysteries of inner growth. I began thinking about gourds and fruit as possible sources of form. The black walnut bowl shown in figure 2 is one result of that approach. I worked through many variations related to the mechanical and sculptural concerns of the 1960s, with varying success in terms of form and function.

A plate cut in half and joined may take on new life, but it has the severe appearance of half of something. If its top edge or face is cut down further along a curved line, the form becomes gentler, more integrated. The curve cut tends to hide the method by which the form was made. In the same pursuit, I next jointed two turned plates, removed a wedge to reveal the inner volume, and thereby built the form back up into the circle, an approach opposite to that of cutting down. The idea of cutting turned forms had matured into a new completion of the circle, as shown in figure 3. Many other approaches to segmenting turnings followed, and the pieces illustrated here represent only part of this exploration. In any exploration the idea or plan of action is more important than the solution. One's first solutions are hesitant; indeed, they are not really solutions at all, only expressions of process, not fully matured objects.

There is historical precedent for the segmented forms I make. The earliest example I have seen is a traditional technique from Central Europe, whereby a doughnut of wood is



turned such that it can be sliced into a large number of blanks for carving into toy animal figures. More recent examples are seen in design curricula; some segmented turnings appear in the book *Creating Modern Sculpture* by Dona Z. Meilach (Crown, 1978). I learned of these and other segmented forms after I was well into my own investigations; I did not initially understand the lathe's rich heritage or its potential as a tool for developing new forms. I use the word "new" advisedly; precedence invariably grins at the inventor from museum collections and libraries, and from

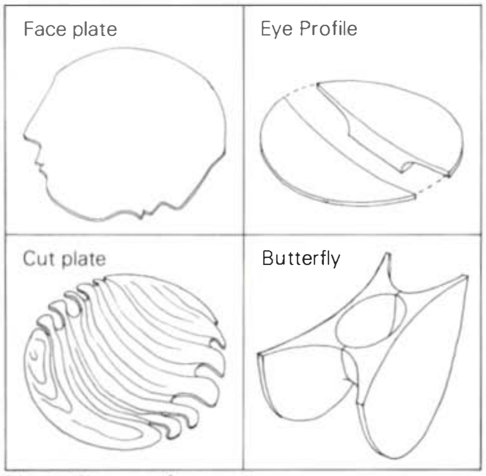


Fig. 1: Some early experiments.

Fig. 2: Bowl, black walnut, 11 in. dia., 1972.

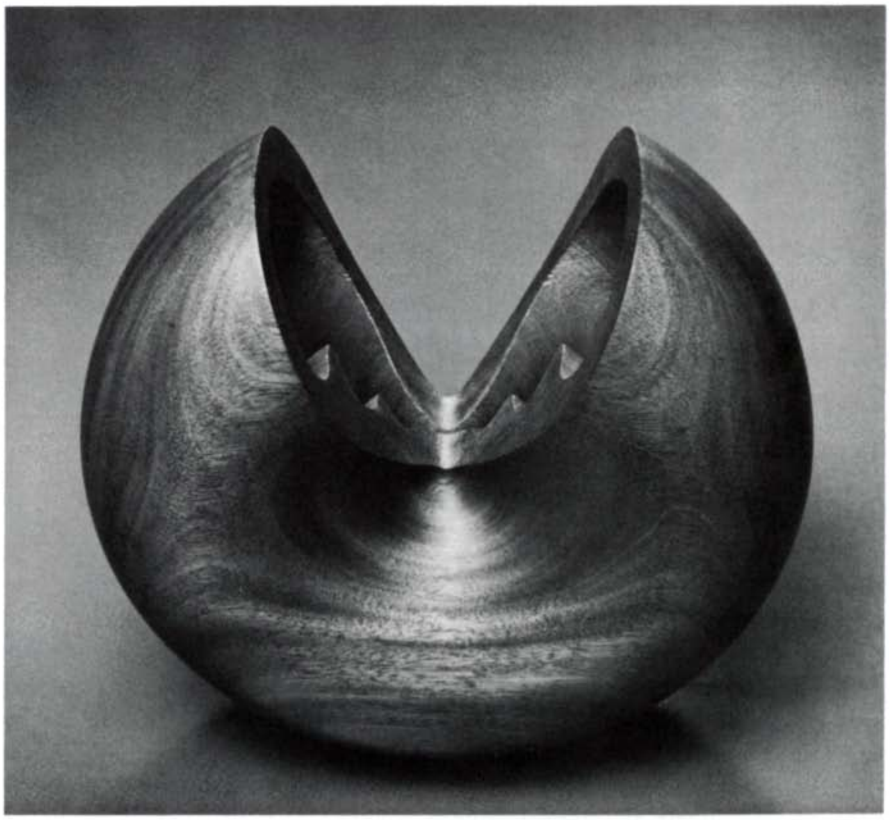


Fig. 3: Form exploration, Honduras mahogany, 13 in. dia., 1972.

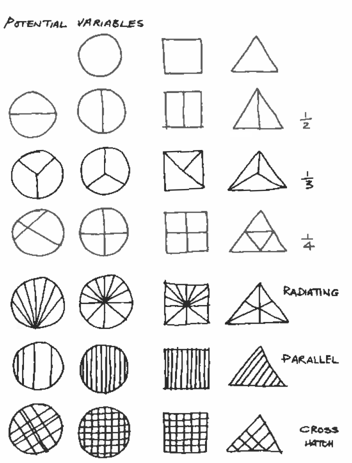
standard industrial practices, relegating investigations such as mine to rediscoveries.

Discovery (or rediscovery) of forms can only come as a response to a situation not dealt with before. If a dogmatic attitude is taken, then the hand is guided into forms already known. No information or collected experience can be considered irrelevant; everything is fascinatingly connected and anything can become a point of departure. But new relationships invariably derive from some specific concept, and the creativity on the part of the inquiring individual happens in spurts around or along the line of inquiry: there has to be a concept, a line of inquiry. A concept is developed out of personal experience and knowledge, and finally the solution is tested against that.

Having started to work in an empirical manner, it became necessary for me to organize my progress. I used diagrams and word associations to make a clean sweep of some obvious variations in form, regardless of whether I could see a way of making them, or of putting the results to use. Suspending judgment allowed the mental juices to flow. The diagram below (figure 4) illustrates a simplified scheme of appraisal. At first I concentrated on the circle, but later wondered, "why not other shapes?" I added the square and the triangle to the diagram. So far I have not explored even these few geometric possibilities.

I have been describing each segmented turning singly. If more than one turning is put together the variables multiply dramatically into modular patterns capable of considerable size. Illustrated (figure 5) is a bowl form where two identical turnings were halved and assembled, then a section of the interior was carved. As I shall discuss later on, this could become a bowl, a planter or something else, and need not remain made of wood.

I did not see the pie shape that was removed from the form in figure 3 as a significant leap forward until long after making the piece. Then the diagonal presented itself as yet



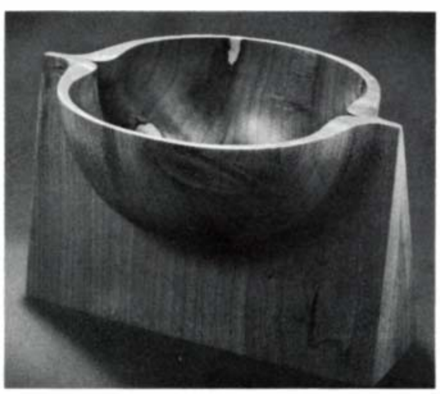


Fig. 4: Some geometric possibilities (left) and a bowl (black cherry, 8 in. long) turned on the square, cut and rejoined.

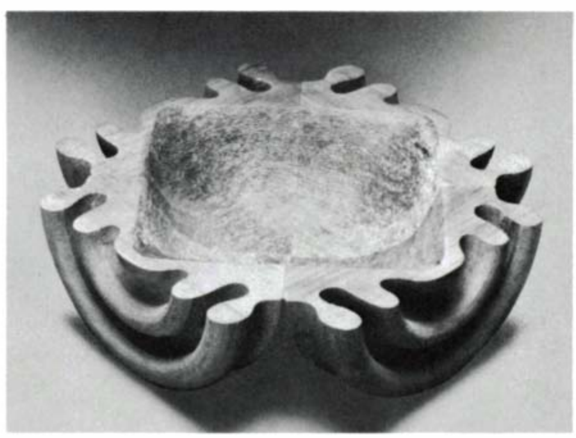


Fig. 5: Bowl, western red cedar, 10 in. square, 1973.

Photos: Rudi Christl

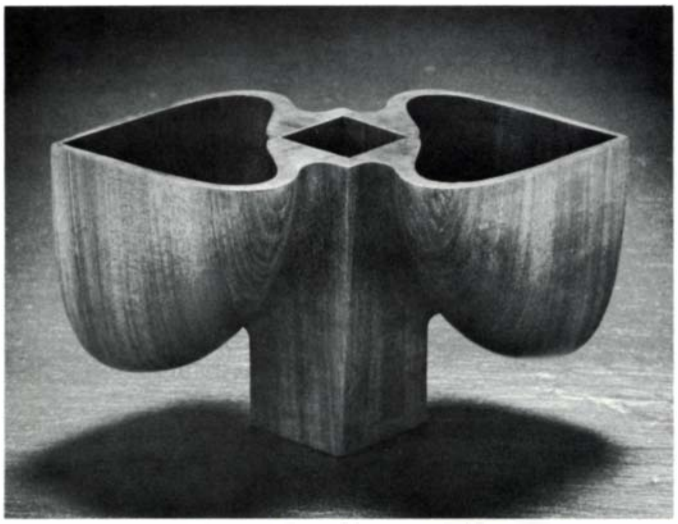


Fig. 6: Bowl, Australian black walnut, 10 in. long, 1979.

Fig. 7: Chair, western red cedar, 34 in. high, 1974.

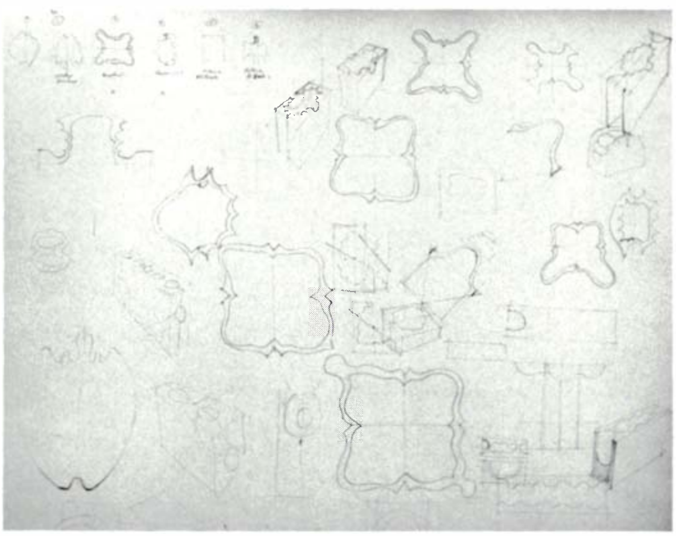


Fig. 8: Page from author's sketchbook.

another point of departure. This diagonal cut or wedge shape removed from the inside of the bowl made it asymmetric. This cut was internal. The next step was to use the cut to develop forms that leaned into, or projected from, the base of the piece; or, conversely, that presented the diagonal cut on their top surfaces. The piece illustrated (figure 6), which began as a square of wood on the faceplate, turned both sides, represents another idea made just last year, thus separating the first idea and this one by nine years.

As suggested by these examples, the system imposed by a diagrammatic analysis does not close other avenues. An apparently rational equation can be transcended by an intuitive leap into a fresh perception. The chair (figure 7) was made from a 6-ft. disc, flat on one side, turned on the other, with a hole in its middle. This wrinkled toroid was cut into quarters and reglued flat-to-flat, making blanks for two chairs. The cuts for the seat and back released two blocks of wood that I made into a small table; the scrap I had to remove to make the tabletop horizontal left me with two elements that suggested shelves. The sequence required quartering the circle plus additional diagonal cuts to unfold the suite—two chairs, a table and two shelves from a single large turning. This kind of complexity can easily obscure the original turned form.

Clearly developed forms that do not conceal their technical origins seem to have a sense to them. When the form also carries symbolic meaning, then process and form both become subservient to another cultural force. The sense or expression of any object may feature its structure, construction, material, shape, function, purpose or meaning, with each aspect responding to economic considerations as well. By "economic" I mean the expedient solution to a design problem, compared to the extravagant solution—understated or overstated, understructured to overstructured. An example might be a shooting stick compared to a pilot's chair. The former is an expedient solution to the problem of sitting, with minimal comfort; the latter is extravagant, maximum comfort. A design that works is an optimum solution to some particular set of circumstances and requirements.

All objects, however, record the motivations of the maker, and motivation can also be understood (interpreted) in terms of the criteria listed above. Usually one aspect of motivation is dominant, and this becomes the expression of the designer's intent. All design is a compromise—I am clear about the disadvantages within my chair design (for example, its weight), but I endeavor to understand its primary purpose: the application of forms of this kind to architectural spaces.

Along with this study of geometric possibilities, I inquired into the cross sections of these segmented turnings—that is, the ribbon of shape surrounding their volume, like the clear meat surrounding the heart of fruits and vegetables. The skin, shell or outer casing of organic material is often simple, consistent and even, with the visual pattern developing toward the center. The crimped edges of shells, the wrinkled edge of nuts, and the fluid lines of oil on water suggest a dynamic relationship to the regular curve of the circle. These articulated edges of energetic growth add mystery to the totality of the circle (figure 3).

Ideas seem to present themselves in three basic ways: through seeing, drawing and imagining. We all look but how often do we see? Making connections between two apparently unrelated situations is "seeing" in the way I use it here. For one table design I remember seeing a bird taking off; it appeared unmistakably as a turned form. The rapid motion of the wings appeared to be the outline of a rotating disc (*FWW* #17, July '79, p. 77). Drawing and sketching evolve shapes and relationships on paper that may be too complex to juggle mentally. Imagining is discovering relationships within one's own mind. Designers use all three approaches to idea generation, and switch comfortably from one to another. I find that whatever method seems to be working best at the time, I still end up drawing my ideas before I actually make them (figure 8). Drawing also has the advantage of freezing an idea for extended scrutiny, and it is a quick way for a woodworker to test a form without investing wood and work. It also develops sensitivity to the proportions, feeling and sense that a design will carry.

To conclude, I would like to introduce my concern for the purpose of making forms like these. As investigations of technique suggest ways of making new forms, the questions of why this or that shape, and to what use in daily living these forms can be put, become paramount. There is not space here to debate the whole hierarchy of economics, structure, construction, material, form, function, purpose and meaning.

Wood is an amazing material, but metal and plastics also have properties that make them superior for some uses. While I work primarily in wood, I do not like to see it wantonly misused in inappropriate ways. Some of my designs (e.g., figure 5) were intended to contain soil for plants, perhaps outdoors. Concrete or aluminum would be more suitable than wood, but I could not turn them on my lathe. I therefore turned a blank of expanded polystyrene, then had a foundry cast it in aluminum using the burn-out method, similar to the lost-wax technique of the jeweler. The concrete forms were never cast, even though I did develop a plug that would generate a bicycle rack. Lack of knowledge, time and resources stopped that development at an early stage.

I have also made a number of small sculptures in limited editions. First I turned the form in wood, then had it translated into aluminum by sand-casting, and then into polyester resin by casting into a mold prepared from the wood blank. It is very useful to see the same form in different materials, colors, textures, weights, etc., as the form can thus be studied independently from the seductive nature of wood. It is too easy to rest on the naturally beautiful qualities of wood.

Another aspect of my inquiry was the relationship of these forms to architecture. Contemporary public architecture is often technically superb and beautifully proportioned, yet lacking the human qualities of texture, diversity and the responsive hand and spirit of the craftsman. Rather than agitate for a total change in building technology, I advocate adding an overlay of decorative elements that display texture and diversity, to enrich, embellish and bring accents of human meaning to the urban environment. This meant increasing considerably the size of the designs on which I had been working. I built a lathe that could swing a 7-ft. diameter. I also felt that to fit contemporary architecture, my turnings would require verticals and horizontals. Squares and rectangles are eminently easier to work with if they are to be a part of the building, not just additions hung on the walls at random intervals. The turned face of a square, without being segmented, can make a tile for floor, wall or ceiling. Segmented in halves or quarters and reassembled, face-turned squares suggest many more variations for surface patterns.

Figure 9 shows a square that was turned on both sides, then cut into uniformly thin strips, with the cross section of each strip facing the camera. This solution could become a small grill; turned through 90° it becomes a speaker cabinet or a garden gate. Increase the scale and it might be an 8-ft. screen dividing two spaces; hung horizontally it becomes a false ceiling or the pattern in a terrazzo floor. The potential of such forms can be seen through this example; the precise use will determine the materials, scale and finish.

These speculations relate to faceplate turning and divisions of the square. It is easy to achieve a square from spindle turning as well, by cutting the form through its long axis and rotating the pieces. The piece shown in figure 10 could become a table, or, by increasing the scale, an archway. The form is actually a 6-in. cube set on a reflecting surface, and is from the first generation of this kind of segmenting. The leg is too heavy and the top too thick, but that kind of refinement comes with familiarity.

This essay and the forms that illustrate it document more

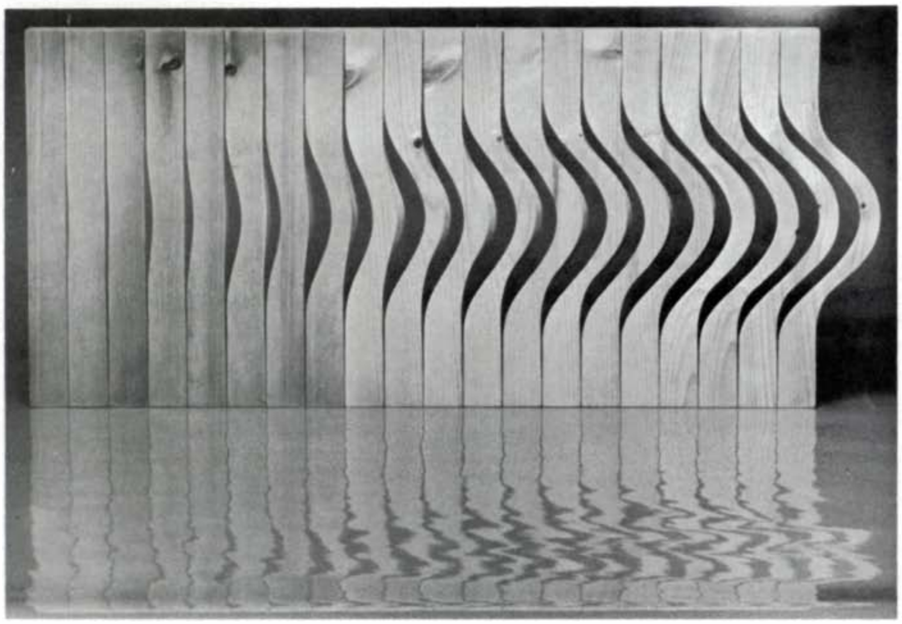


Fig. 9: Form exploration, white pine, 13 in. by 29 in., 1974.

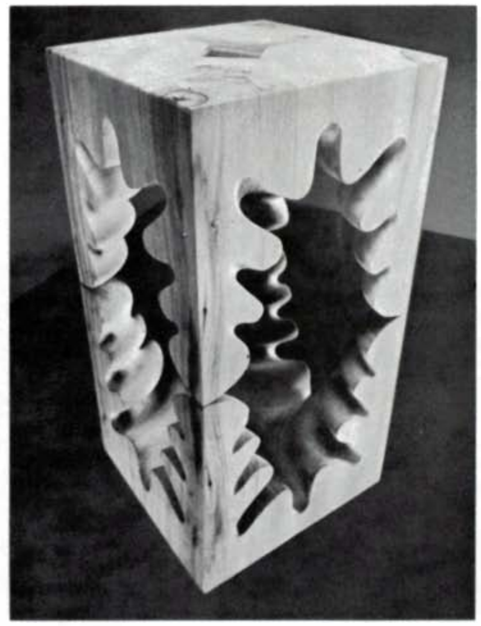


Fig. 10: Form, poplar, 6 in. cube, 1974.

than eight years of inquiry. They represent an inescapable curiosity about experience and perception, insight and differentiation. These aspects of creating seem concentric and interwoven, like the annual rings of the tree, which grows to maturity from the center out, from the earth to the sky, taking nourishment from above and below, outside and inside. The ecology of creativity is a delicate balance, usually confusing, often exhausting, but never dull and sometimes exhilarating, for the maker and (one hopes) for the viewer as well. □

Stephen Hogbin has written a book, Wood Turning, *about his experiments during a year's study in Australia. It contains photographs and drawings of the 7-ft.-swing lathe he built and will be published this spring by Van Nostrand Reinhold (Dept. RB, 135 W. 50th St., New York, N.Y. 10020).* The Unknown Craftsman *can be purchased from Books about Wood (RR3, Owen Sound, Ontario, Canada N4K 5N5), a mail-order book service operated by Hogbin's wife, Maryann. Hogbin sells his woodturnings through Aggregation Gallery in Toronto.*

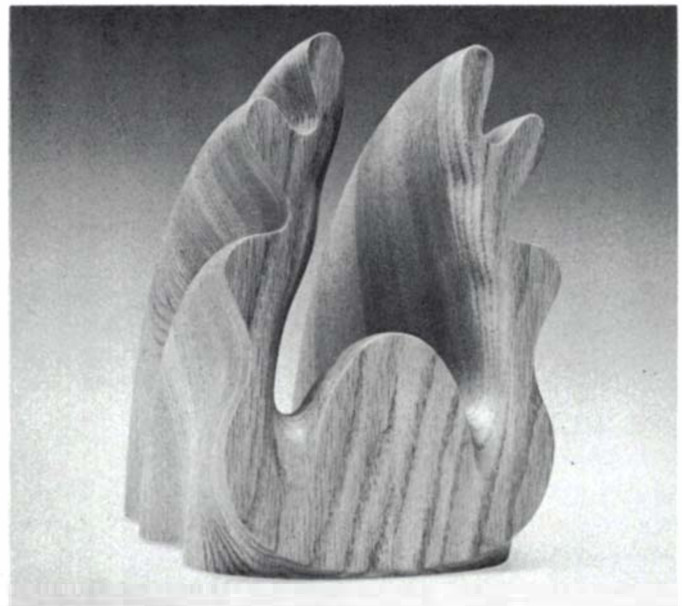


Fig. 11: Untitled, red oak, 11-in. radius.

The Sketchbook as a Design Tool

by Leo G. Doyle

There is more to woodturning than mere operation of the lathe. Most books and courses deal mainly with technique, devoting little time, if any, to design. The serious woodturner should seek a more equitable balance between designing and actually working on the lathe. I can design many more pieces than I have time to make, so when I do decide to make a thing, I can be very selective. I have accumulated through my own research and teaching a number of approaches to design, which may help other turners develop a more professional design sense. Very few people seem to have a natural ability to design—most of us must learn design techniques just as we learn turning techniques.

The heart of my method is my sketchbook/journal. I treat this book with the same respect as a sharp tool. A way to get started is to sketch the turnings you feel have been most successful. It is best to do this in chronological order, so you can look for consistency or signs of maturity, and evaluate your own progress.

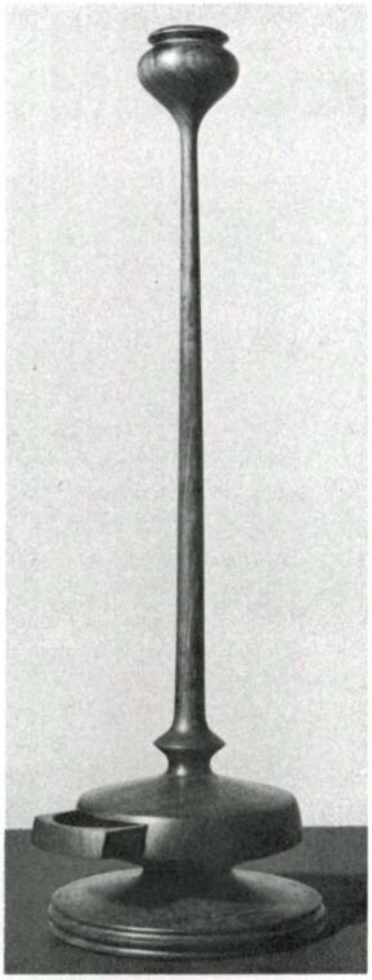
The journal is more than sketches of completed work. It quickly becomes a personal diary of your thoughts and observations. It helps if you can draw well (and to learn I would recommend a course in figure drawing, not mechanical drawing), but good drawing is not a necessity. It is more important just to understand what you commit to paper. A sketch can be redrawn and cleaned up later on; its real value is the development of new ideas. I keep one book at home and one at my shop, because many ideas come while I am turning and I want to document them immediately.

Another helpful procedure is to write lists of turnable projects. These lists should not be just single words, but each idea should be expanded to a variety of applications. For example, think about a turned lamp as a problem in lighting. Soon you would list table lamps, desk lamps, chandeliers, wall lights, reading lights, and so on. Expand the lists and make notes about possible constructions with the woodturning process in mind, then you'll be able to extract a practical list of possibilities for further development.

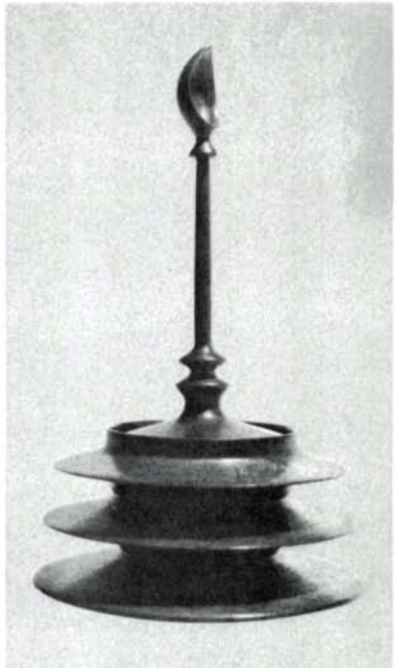
You will also discover that the popular view of the lathe as a machine with narrow limitations is quite unfounded. You can, for example, beat the size limitation by turning a piece in sections to be joined together. Any limitations that seem dictated by the lathe itself should be taken as a challenge to discover new ways and ideas.

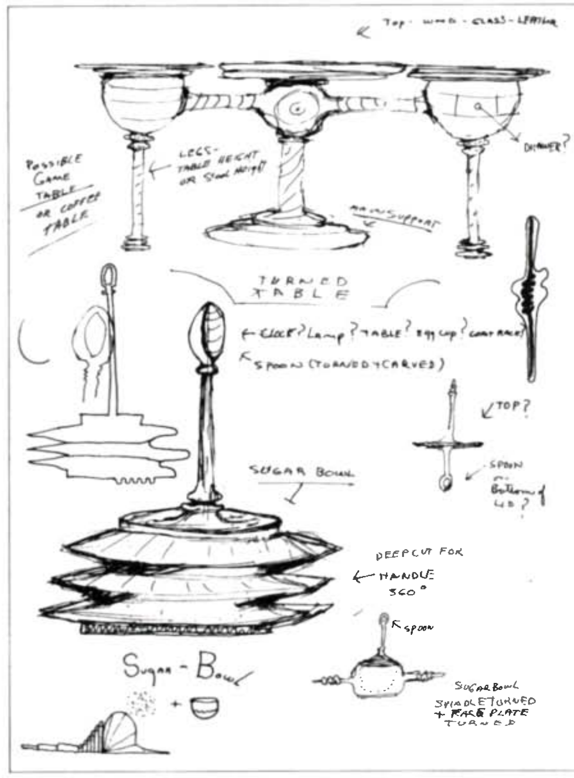
If you are serious about learning to design, there are more exercises to try. We get information about form from our eyes. Train yourself to see the round shapes in nature as well as those made by man. Everywhere you look you can find round shapes that can increase your understanding of form, line and proportion. Pay attention to work in other media with round forms; in particular, to books on ceramics. Pay attention to sculptural possibilities and practice drawing by sketching nonfunctional forms. Many times this approach can loosen up new directions, because the shapes can be used for functional pieces as well. Try to design multi-functional forms and bring your findings back to traditional turnings.

The woodturning process is a perfect model maker. You can quickly try an idea at small scale in whatever wood is handy. This allows the close study of forms for larger projects, as well as plain development of ideas. Look at your models from different angles, on the floor, walls, ceiling, upside-down. Elongate shapes you like, or compress them. Cut the shapes apart and reassemble them, keeping track of your thoughts in the sketchbook. Try adding bits of other materials, or colors. Learn to see the negative space around the ob-



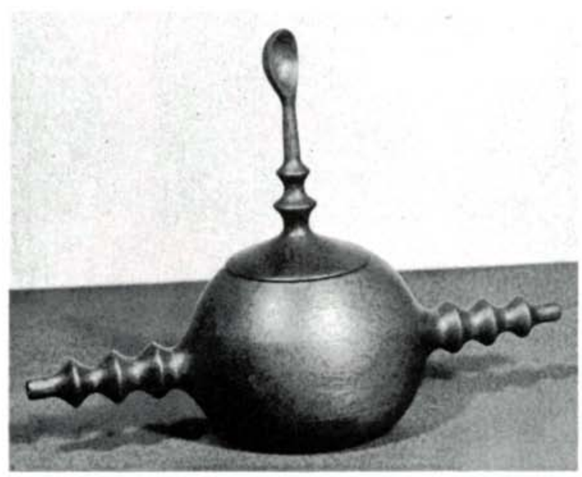
Candlestand with match drawer stacked into blank before turning, padauk, 5 in. by 18 in.





Sugar bowl, purpleheart, 3½ in. by 7 in. high. Spoon is carved into lid. Sketchbook page documents author's idea.

Vanity, purpleheart, 5 in. by 10 in., is designed for a desk. Inverted, the mirror becomes a lid.



Sugar bowl, purpleheart, about 7 in. high.

ject as well as the positive space which is the object itself, to be sure they are working together. Woodturning is a process of removing wood—think also in terms of what could be added to a piece.

Many beginners tend to overdesign. I try to simplify shapes. I try to use the basic concave and convex shapes the turning tools make as part of the function of a piece. More intricate shapes will come in time, with experience. We seldom hear the word "delicate" applied to woodturning. This quality should be examined closely—the work of many beginners appears heavy, overdone. How thin a spindle can one turn in various woods, and still maintain functional strength?

There often doesn't seem to be much gap between hand-turned work today and good mass-produced work. Yet there are many techniques a hand-turner can use that will separate his product from industrial production, especially in the areas of split and off-center turning. Does it really make sense to do twist-turning when that process has been mastered by machines? I feel there are too many other possibilities to explore.

Turning can also be a way of highlighting the grain of carefully selected wood. But turners should be careful when combining different woods, because the color contrast can distract from the form. Successful combinations of different woods can require as much thought as the actual design of the object. Many times projects would be much stronger if the turner had used just one type of wood, or added a second variety only for subtle changes.

Woodturning is usually considered an adjunct to other methods of woodworking. I have made it the basis of all my work, and I try to approach every commission I receive in terms of turning it on the lathe. Other methods of woodworking then come into play to support the woodturning, not the other way around. I like to think my work could easily fit in with all periods of furniture—I do not design to conform to any particular style. I would like my work not only to be used, but also to be appreciated for its own existence. □

Leo Doyle, 38, is chairman of the art department at California State College San Bernardino, and associate professor of woodworking and furniture design.

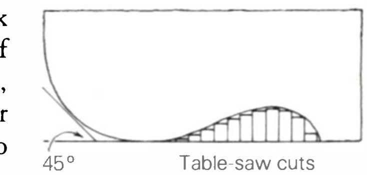
Photos: Leo G. Doyle

Ogee Bracket Feet—Another Way

Glue up first, shape afterward

by Eric Schramm

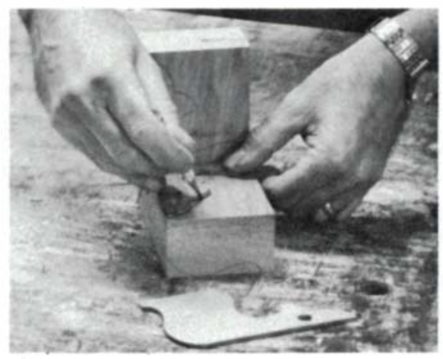
Ogee bracket feet, widely used during the Chippendale period of the early to middle 18th century, form a beautiful base for chests, tall clocks, desks and many other pieces. However, to many beginning woodworkers, they appear difficult to construct. The traditional way involves shaping a long board of the required thickness, using molding planes. The instructions I have found for making ogee bracket feet have the ogee molding cut on the table saw. The ogee shape is laid out on the end of the stock to serve as a guide for adjusting the sawblade to the correct depth of cut. Then repeated cuts at various heights rough out the shape. After cutting on the saw comes the laborious task of cleaning-up the molding with carving gouges, gooseneck scrapers and various grits of sandpaper (see *FWW* #12, Sept. '78, Methods). After cleanup, the molding is cut to the desired length, mitered, dadoed across the miter for the spline, assembled and finally cut to shape. For most home craftsmen or small shops this is the way to make continuous ogee molding bases. But there is another method, based on the band saw, for making ogee bracket feet up to 6 in. or 7 in. long. It is faster, and I think simpler, than the usual methods.

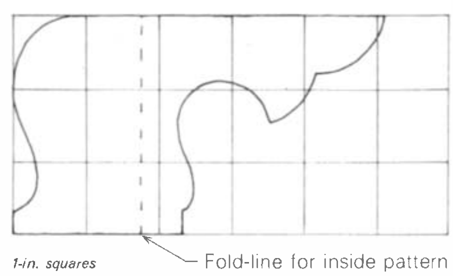


Photos: Robert Schramm

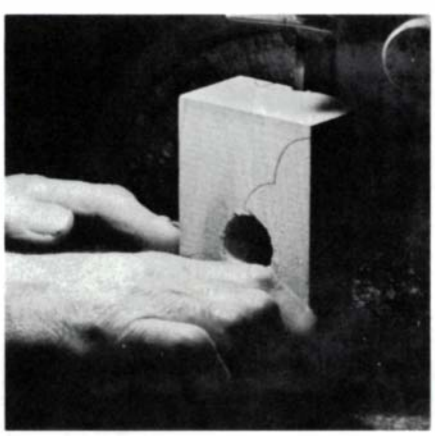
Begin by cutting blocks 1¾ in. by 3 in. by 6 in., mitered at one end. With the sawblade set at 45°, move the rip fence to the left of the blade and set the fence so that the blade will cut a slot for the spline close to the heel of the miter. Set the blade to cut ½ in. deep across the miter. After making the cut on all the blocks, move the fence ⅛ in. farther to the left, raise the blade a fraction and make the second cut to provide a ¼-in. wide dado. The spline may be made of ¼-in. hardwood plywood with the face and back veneer grain running lengthwise for maximum strength, or from the same material used for the feet. The grain of a solid spline should cross the line of the miter, also for maximum strength. Cut the spline ¼ in. thick by 3 in. wide by 1 in. long.

In preparation for assembling the blocks, I glue-size the end grain first with a thin coating of glue. This will preclude a starved joint by keeping the glue from being forced into the pores of the wood under clamping pressure. After the glue-size has dried, apply more glue and assemble, positioning clamps to bring pressure from both directions.

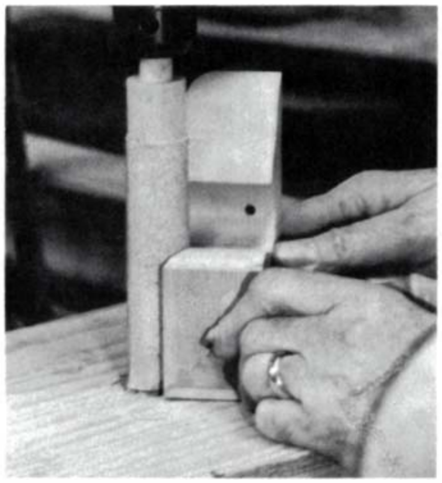




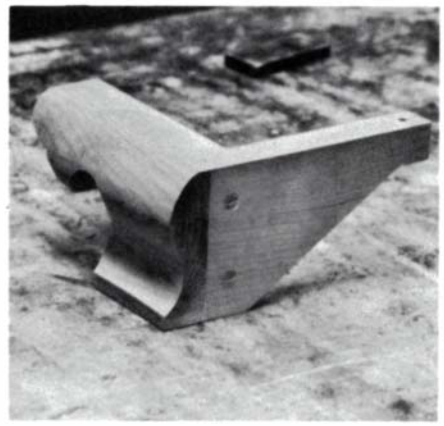
Using templates made from the pattern, above, lay out the ogee shape on the ends and inside faces of the assembled bracket.



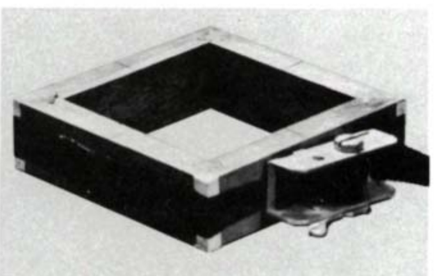
Drill a 1¼-in. hole at the tightest part of the outline curve. This should be done before cutting the ogee shape to prevent any splintering on the face side of the foot. Then, to cut the ogee shape, a sharp ¼-in. or ⅜-in. band-saw blade, properly adjusted, will ensure a straight cut with no drifting. Set the upper guide about ¼ in. above the work. If you use a ⅜-in. blade, make one or two relief cuts in the concave part of the ogee shape to prevent the blade from binding. Cut the second side of the bracket in the same manner. Now cut the outline shape.



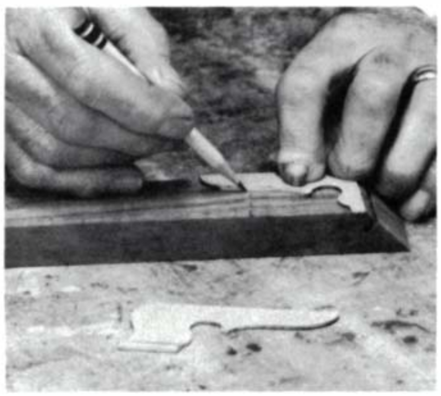
Sand the convex part of the ogee on a belt or disc sander, or by hand using 60-grit sandpaper. The concavity can be sanded easily with a shop-made spindle on the drill press, or on the lathe. Final sanding is done by hand with 100-grit sandpaper, followed by 220. Drill ³⁄₁₆-in. holes, countersunk for flathead screws, to mount the completed foot.

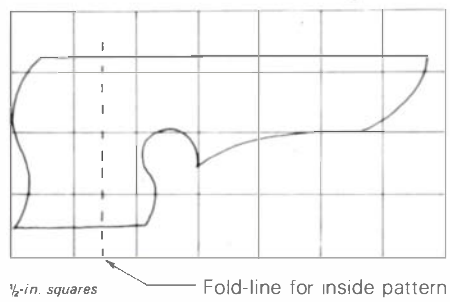


Furniture that will stand against a wall does not require the ogee shaping on the back. In such cases it's necessary to shape only the side of the foot. A plain wooden brace, cut on the diagonal and attached with glue and screws, will provide the necessary support.

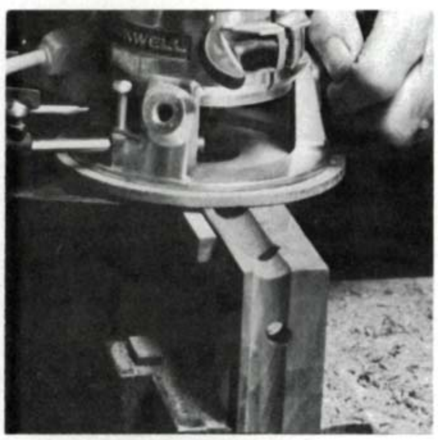


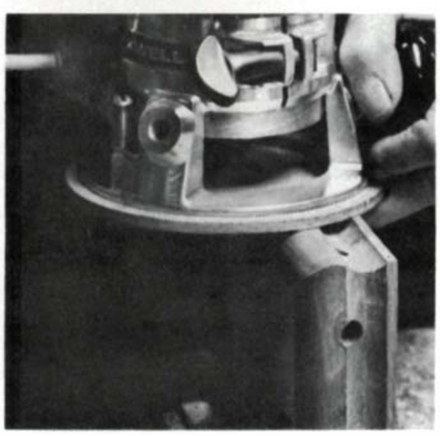
Small bracket feet, suitable for boxes, lamp bases or mantel clocks, can be made similarly. They are easier to handle however, if glued-up into a frame.



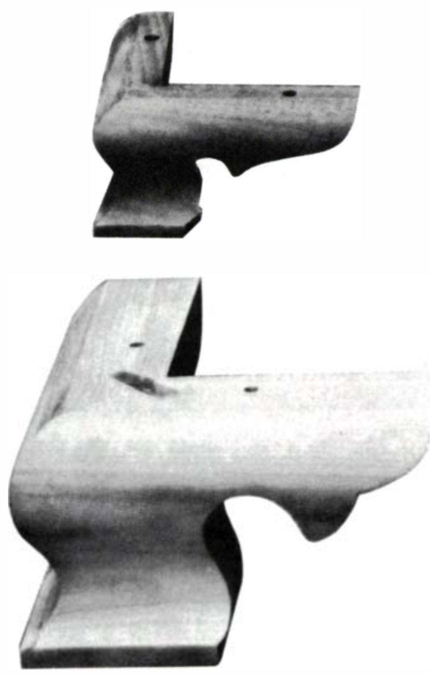


Before assembling, lay out the outline pattern on the inside and drill the hole for the tightest part of the curve.





After the frame has been assembled, a router with a ¾-in. core box bit, top left, cuts the concave part of the ogee shape. Be careful not to cut too deep. Next rout the convex shape with a ⅜-in. rounding-over bit, left. The ridge left by the core box bit can be removed with a block plane, above. The feet are then cut out on the band saw, sanded and drilled for mounting.



The completed bracket feet, both sizes. □

Eric Schramm designs and builds custom furniture in Los Gatos, Calif.

Hewing

Axwork shapes log directly

by Drew Langsner

There are three basic types of axwork: chopping, where the axman works diagonally to the grain, as in felling trees and bucking logs; splitting, where the wood is cut with the grain, as for firewood; and hewing, the most sophisticated of the three, in which the woodworker combines techniques of chopping and splitting. Hewing used to be common practice, and still has a place in the modern woodworker's repertoire. Craftsmen who traditionally hewed wood include post-and-beam carpenters, turners, furniture makers, coopers, boatbuilders, carvers of woodenware, wheelwrights and makers of tool handles and agricultural implements. Wood sculptors have also used hewing techniques to advantage. Hewing is perhaps the fastest and certainly the most direct way of bringing a log to approximate size, shape and flatness.

Axes — There are two basic types of hewing axes. Symmetrically beveled axes are shaped and sharpened on both sides of the blade. These may be similar to woodpile axes, except that the blade is usually slimmer and more perfectly maintained. Many have specially shaped handles, and there is a wide variety of ax-head patterns—the result of local traditions, different needs, and available materials. Symmetrically beveled axes permit a scooping action, good for concave cuts. They are also excellent for convex cuts, rough and complex shaping, and fine carpentry.

Broad axes (named after the massive axes used to hew timbers for buildings, railroad ties and bridges) have a bevel on only one side of the head. The other side is flat from the eye straight down to the cutting edge. These axes work like superbroad chisels, and generally are used to create smooth or moderately convex planes. The flat side allows the ax to work at a close angle, skimming the surface in a straight line.

Symmetrically beveled axes and broad axes are also available as hand hatchets—handle length, not head weight, is the determining factor here. Hatchets have shorter handles, and while they are generally lighter (1½ lb. to 2 lb.), some hewing hatchets weigh upward of 5 lb. Axes weigh from 2 lb. to 12 lb.

The evolution of axes probably reached a peak in the Middle Ages, when a wide variety of special types were made for various trades. Though industrialization resulted in the large production of a limited variety, it is still possible to find some special styles of axes in junk and antique shops.

Almost any hatchet or ax can be reshaped or sharpened for use in woodworking, but common hardware-store hatchets tend to be too thick in cross section. The short bevel necessitates chopping at a wide, unwieldy angle, and the thick head has more of a wedging effect, which means the wood is more likely to slip out of control. You can more easily slice into wood at a close angle with greater precision using a hatchet of thin cross section.

Woodworkers' hatchets and axes also tend to have a longer cutting length than common camp axes. Many craftsmen prefer a shape that flares back from the eye to allow gripping close to the cutting edge, which makes the cut easier to control. An ax or hatchet with a straight cutting edge can be used on thin stock like a chair post. However, a curved edge facilitates severing the grain and is therefore easier to use for hewing wider pieces, shaping the exterior of a large bowl, for instance, or hewing a beam.

The handle of a woodsman's chopping or splitting ax is generally made as thin as possible for a slight whiplike effect and to help absorb shock. Woodlot ax handles require a smooth finish so that the user's forehand can slide freely with each swing. In hewing, the craftsman generally uses a much shorter stroke, keeping both hands in one position—a comfortable grip therefore results from a thicker handle and a rippled or whittled surface.

Handle length and shape are matters of taste. The handle on a heavy broad hatchet may be shorter than a foot, while the handle on a Japanese broad ax may exceed 4 ft. I prefer a handle that gives good leverage, but which is not awkward—about 28 in. long. The axis from eye to handle foot should be straight except in broad axes, where a single or double bend ensures the knuckles will clear the work during each swing.

Ax handles should be split from clear, straight-grained hickory, ash, birch, maple or oak. Green handles are shaped about 10% oversize, then seasoned for at least one month before fitting. Handles made from preseasoned rough blanks can be fitted to the ax eye early on, which allows testing for feel and alignment as shaping progresses.

Broad-ax handles can be bent green immediately after fashioning or after fitting to an ax head. I boil the fitted handle for a half hour, then bend it in a jig (photo facing page, bottom right) and let it set for two to four weeks. After it has cured, I touch up the handle with a knife or rasp, sand it a little, and finish with linseed oil.

Hatchet hewing — Hatchets can be used on stable massive timbers, such as in post-and-beam construction and boatbuilding, but they are generally used for much finer work that must be held in place by hand. For this kind of work, you'll need a support to prop the stock against. A waist-high hardwood stump set in the ground or on the shop floor is ideal. You can also make a small chopping block from a slice of a log and place it directly over a leg on top of your workbench, handy in shops with limited space or where hewing is only an occasional undertaking. A shallow depression on one side of the chopping surface, made with a hatchet or chain saw, keeps the wood from slipping, especially when you're hewing at an angle. The edge of the stump or slab can also be

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used for support. Keep the striking surface clean—dirt and grit will dull a hatchet fast.

Hatchet weight and shape and your strength and speed will determine the effectiveness of your hewing strokes. Fine hewing is easier if you hold the hatchet at an angle, thereby slicing into the wood. For delicate work I sometimes wrap thumb and index finger around the hatchet head. In hatchet work both hands are busy, as you must also pay attention to the non-hewing hand that holds the work. All axes and hatchets are easier to control in vertical strokes, so it is constantly necessary to invent ways of holding the wood.

In most cases, begin hewing a few inches above the end set against the stump. Progress upward with succeeding strokes. You can start at the upper end and work down, but there will be more risk of the wood splitting or going out of control. Hew notches and concave shapes with conventional hatchets and axes, beveled on both sides. Place the wood on the stump, end grain down, and hew toward the center of the desired shape. Work from both sides to make a *V* or *C* shape with small, easy strokes to avoid splitting. Making a sawcut down the center of a concave shape to full depth also helps prevent splitting.

Hewing a spoon blank.

Any hatchet is effective for hewing close to the grain angle. But you can chop a steep angle only with a sharp hatchet and the work well supported (hold the work over the edge of the stump), taking small shavings with each stroke.

Hewing a beam — Most areas grow at least one timber species that is suitable for log work. Some typical hewing woods include the pines, fir, spruce, redwood, tulip poplar and oak, but you can also hew other woods such as black locust or maple. Within a species, certain trees will be more suitable than others. Knots add to the work involved, and the butt section of a tree is often much tougher than wood a few feet farther up the trunk. Most projects call for relatively straight trees. In North America, logs are generally worked green, but most European craftsmen prefer to hew seasoned logs, which are less likely to check, split or warp.

Before beginning, it's important to be aware of the problems in dealing with a material as heavy as logs, which weigh green between 40 lb. and 70 lb. per cubic foot. It's often difficult to get a log moving, but when gravity takes over, the log becomes hard to stop. Always be careful when lifting or moving logs. Learn to use leg muscles, which strain less easily than the back. Make use of levers, fulcrums, block and tackle, and rollers. Large and small peaveys and cant hooks are almost indispensable. I like to lift and haul logs with a partner on the other side of a timber carrier (photo top left, p.67). It consists of a pair of grab hooks that hang from a swivel in the center of a 4-ft. or 5-ft. pole. Each person lifts an end of the pole; the front end of the log is in the grab hooks between them, the far end is supported by a pair of wheels in a wooden truss.

Most log hewing is done with broad axes, but though they're wonderful tools, you don't need one to try hewing. In fact, some beginners find a 7-lb. to 10-lb. broad ax intimidating, awkward and backbreaking.

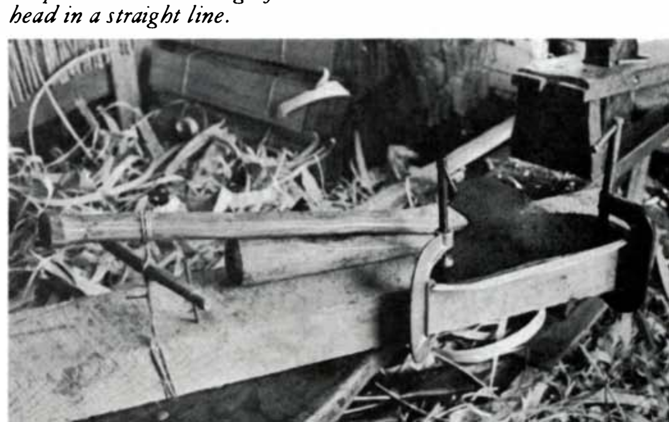
The broad ax that I use has a 9-lb. head with a 13-in. cutting edge. An important feature of this ax, often not understood, is that the inside face of the head is not flat. The side curves along a horizontal line, forming an arc about 3/16 in. deep. This causes the ax to cut with a slight scooping effect. Vertically, the inner face is perfectly flat from the cutting edge to the poll. Broad-ax handles vary in length from 15 in. to 30 in. For most hewing techniques, the handle must take a radical bend immediately behind the head where the lead hand is positioned. This provides the necessary clearance between the hewer's fingers and the log.

The method of hewing I use was developed by Peter Gott, an accomplished craftsman who has refined his hewing technique and style during 18 years of log-building. Many axmen hew by eye, snapping one or two chalk lines down a log, and then hewing. This can be tricky because logs taper, bend and bulge, making it difficult to eyeball a flat plane. Gott's technique, which practically guarantees good results, uses a series of accurate pencil and chalk guidelines that are all perpendicular or parallel to one another, and can be used for hewing one, two, three or four surfaces. Flat planes facilitate notch work, mortise-and-tenon joints and other detailed refinements. You can also adapt Gott's technique to carving and sculptural projects.

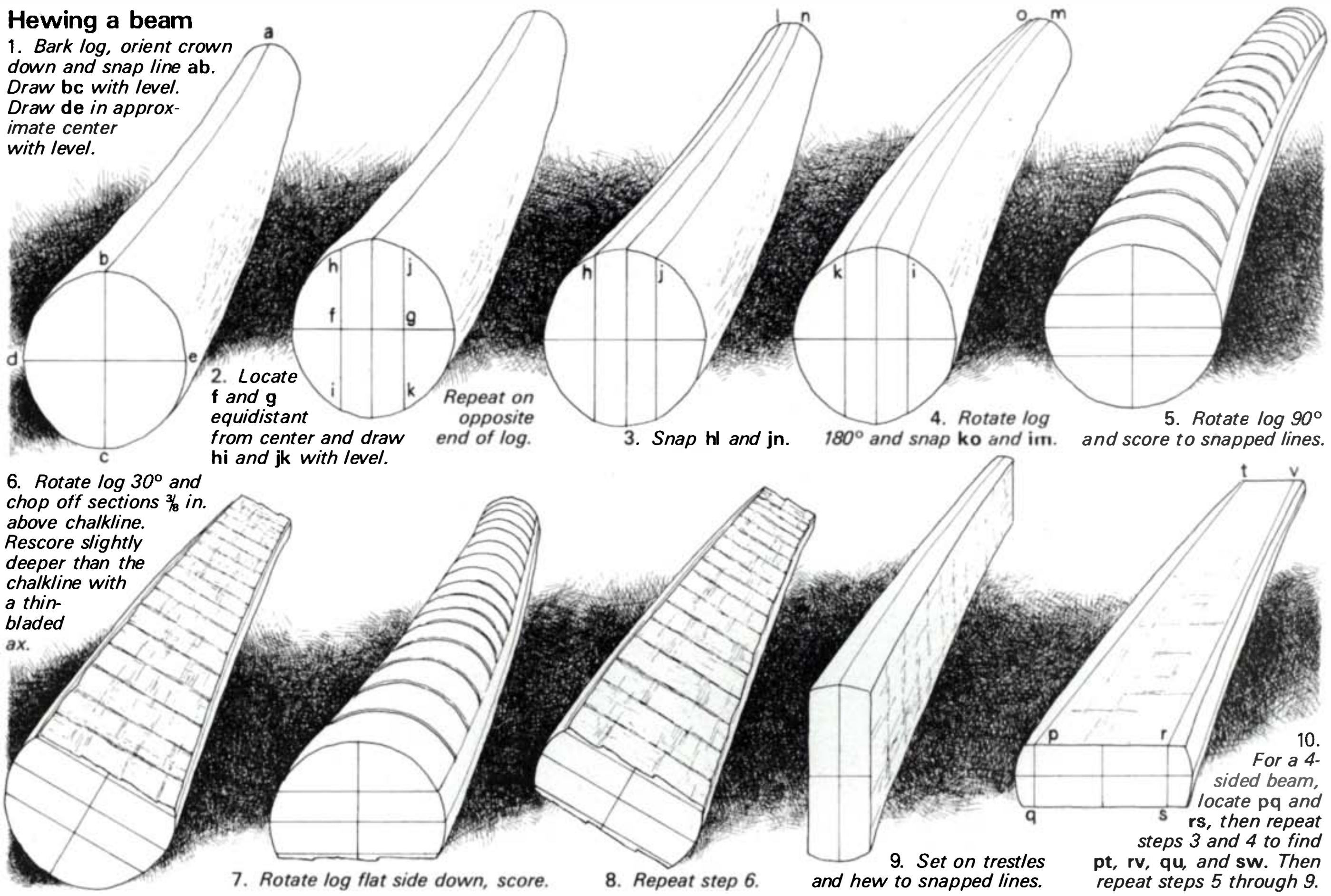
Begin hewing by barking the log. Some trees (such as tulip poplar) peel in large slabs, others require more work. Slash a narrow strip with an ax, then try to peel by inserting a barking

At left, hatchets (top to bottom): A symmetrically beveled Kent hatchet, characterized by a diamond-shaped flange around the eye, a well-defined poll and symmetrically flared shoulders; a German broad hatchet; a Japanese daiko ono, *whose light head (less than 1 lb.) and extremely back-flared blade (you can hold the hatchet directly above the blade) make it maneuverable enough for making furniture and chopping bowl exteriors; and a reproduction of a 12th-century Viking hatchet, probably an all-purpose tool used for woodworking, butchering and self defense. Axes and hatchets are of two basic shapes. The broad ax (center photo, left) is flat on one side and ideal for smoothing plane surfaces. The symmetrically beveled ax (center right) cuts with a scooping action and is best for roughing out and for concave cuts.*

Handle-bending jig (for broad axes) is made from 1-in. thick board, two C-clamps, a wooden wedge and a piece of twine. Heat the handle in boiling water, clamp the head to the board and bend the handle up, by hand, to an angle slightly more than is needed (to allow for springback). Slip the wedge between plank and handle, and tighten the twine with a winding stick to pull the handle into a reverse curve. Shape the handle to align your two hands and the ax head in a straight line.



Hewing a beam



spud or garden spade at the cambium. You can also ax off bark or use an extra-large barking drawknife.

Move the clean log onto a pair of cribs (3-ft. to 4-ft. cross logs with center notches to prevent rolling). Sight the log from each end to determine dominant swag or crown, and, with a short peavey or cant hook, rotate the log so that it is crown down. Put an awl through the loop of a chalkline and stick the point into the approximate center of one end of the log. Reel out the line and stick a second awl into the other center, pulling the string taut. A chalk line snapped on a rounded surface can easily result in a curve—avoid this by locating the angle for snapping the line with a vertically held carpenter's level. This is particularly important when working on nonlevel ground, as it's difficult to judge plumb by eye.

Draw a vertical line down the end of the log, using the level as a straightedge. Then draw a perpendicular line somewhere near the middle. Locate the edge(s) to be hewn by drawing vertical lines across the perpendicular line. (On a log to be hewn on two sides, these lines are equidistant on either side from the original vertical line.) Use your level.

When your lines are drawn, knife a small *V*-notch where they meet the side of the log. Repeat this procedure at the other end of the log. Snap new chalklines along the length of the log to locate the hewing lines, using the *V*-notches to hold the chalkline in place. Rotate the log 180° (crown up) and snap parallel hewing lines along the crown.

Rotate the log 90° so the side to be hewed faces up. Remove bulk waste by first scoring to the hewing line every 8 in. to 24 in. on center, using a symmetrically beveled ax, a handsaw or a chain saw. Then rotate the log 30° and remove the end chunk, placing the ax edge ⅜ in. to the waste side of the chalkline and striking the poll with a mallet. Continue down the log, splitting wood off and leaving the same ⅜-in. margin above the chalkline so the broad ax, which will be used to finish the surface, will have something to bite into. After you have removed most of the waste, chop another series of vertical scoring marks slightly deeper than the chalk hewing lines with a sharp, thin-bladed ax. These cuts should be about 4 in. apart; their pattern will show slightly after hewing is finished. Deep scoring prevents fiber from tearing inward, especially around knots, and is also more attractive than rough saw kerfs. Then flip the log and repeat the entire process on the obverse face.

Set the log on a pair of trestles about 30 in. high—diameter of log, size of craftsman and personal preference dictate different trestle heights. Place the log on edge, and temporarily hold it steady with makeshift wedges placed underneath. Use the level and a vertical guideline on one end of the log to adjust for plumb. A variance of a few degrees makes hewing considerably more difficult.

One traditional way to hold a log steady on edge is with hewing dogs—iron staples with one end driven into the log and the other into the trestle or crib log. Some large logs can be wedged upright, or you can wrap a chain with a light load binder (a lever and cam device used to tighten the chain) around the log and trestle. You can also improvise excellent bracing using 1x1s cut to various lengths and secured to the log and the trestles with box nails. With this system it's possible to make any number of lightweight staples in dimensions as needed. They're virtually free and have the advantage of being mainly wood—there is little chance of dulling an edge tool. I generally begin with two staples on either side of

Photos: Tad Stamm. Illustration: Christopher Clapp

Two-person timber carrier and trolley, left, bring log to where it can be scored with a symmetrically beveled ax, hand saw or chain saw, center. Then log is rotated 30° and waste wood chopped with a symmetrically beveled ax to within ⅜ in. of the chalkline, right.

With both sides roughed out and rescored with a thin-bladed ax, log is steadied on trestles with 1x1 staples. Finish hewing can then begin.

Broad ax, left and below, leaves a smooth surface in plane.

the far end of the log, and one nailed on the opposite side from where I begin hewing. On a long wobbly log I'll set a fourth staple after I've hewn past the first trestle.

The hand grasps used in hewing are different from those used for chopping wood. The best hewing grasp consists of holding one's accustomed hand immediately behind the ax head (thumb extended forward and fingers tucked close to the handle), with the unaccustomed hand somewhere near the handle end. Rather than lean over the log, I prefer to bend both legs, keeping my right leg well forward (something like an advance position in fencing, but not as extreme). I like to stand close to the log, so that my vision is straight ahead along the hewing line. I take short and deliberate strokes.

Carefully hew down the right-hand vertical guideline on the log end, with the length of the log in front of you. Start with short, careful strokes. Hold the ax slightly askew (outward) so that you chop a shallow bevel, trying to split the upper line, but stop after about 2½ ft. Go back and hew straight down, concentrating on the area between the log and the inner side of your ax blade.

I hew about half to two-thirds through from the upper line, then move on. It's easy otherwise to break off wood along the bottom edge, or to go off plumb. Another advantage of not hewing straight through is that I'm continually hewing into waste wood, so the ax doesn't fly free, throwing me off balance or out of rhythm.

Hewing is a skill that combines muscular exertion with subtle accuracy. It's important to find a steady rhythm. Hewing through knots takes extra muscle—extra scoring across and around them minimizes excessive tearing. Sliding your forward hand toward the middle of the ax handle results in more power. Try to remove thin shavings.

When I get to the far trestle I remove the staple and renail it at the first trestle, if one isn't already in place. I carefully hew down the vertical end, stopping often to glance down the line. (It's not visible from the hewing posture.)

In hewing two surfaces of the log, switch staples and work down the other side. Turn the log over, restaple and finish hewing. For hewing a three or four-sided beam, continue the same procedures. Chalklines for each side of the log can be taken from the original horizontal pencil line made when the log was round. Scoring the third and fourth sides is awkward, because it's necessary to see both hewn edges while sawing. If you're using a chain saw, I recommend stationing a friend on the opposite side who can signal just as the cutters approach the chalkline.

Once you develop a feel, it becomes possible to hew fairly large slabs and to move along at a steady pace. In cool weather I hew one side of a 15-ft. log 15 in. in diameter in about half an hour. Seasoned experts are considerably faster. However, the total time needed to hew two sides of the same log, from initial barking and layout to final hewing, adds up to several hours. The job should be virtually perfect, requiring no touchups with an adze or slick. □

AUTHOR'S NOTE: Woodcraft Supply Corp., 311 Montvale Ave., Woburn, Mass. 01888, sells a fairly nice Kent hatchet imported from England. Modified Kent broad hatchets are currently made by Blue Grass and True Temper, available in hardware stores. Some fine broad hatchets are being imported from Germany and Austria by Woodcraft, The Garrett Wade Co., 302 Fifth Ave., New York, N.Y. 10001, and Frog Tool Co., 541 N. Franklin St., Chicago, Ill. 60610.

The Dowel Joint

Why round tenons fall out of round holes, and the elastomer compromise

by R. Bruce Hoadley

Dowel joints must surely be among the oldest methods of joining wood. What could be more basic than a cylindrical tenon fitting a drilled-round mortise, locked forever with good glue? The image of perfection.

But not quite. For our experience suggests that if anything is as old as dowel joints, it is loose dowel joints. We have become resigned to loose and wobbly chairs, and to our mothers warning us not to tilt back at table. Accepting this has always seemed unreasonable to me, so some years ago I set out to study the traditional dowel joint, to find out why they fail and especially to discover the recipe for a joint that would not fail. After many experiments I arrived at the troubling conclusion that no matter how well the joint is made, the conflicting dimensional behavior of the mortise and the tenon in response to humidity variations in our everyday environment can cause self-induced loosening. The very nature of wood ensures that it eventually can come loose. However, some recent research encourages me to believe that soon we will have a dowel joint that is successful, virtually indestructible. In this article I will explore the self-destructive effect of moisture variation on the traditional dowel joint, and I will suggest some remedies and some lines for further exploration.

A plain round tenon in its simplest form, such as an unshouldered rung inserted into a chair leg, responds to external loading differently from a shouldered tenon, a dowel in a rail/stile frame joint, or a grooved, serrated or precompressed tenon. This article makes no attempt to address such special cases, but focuses on the individual dowel or tenon insertion.

Obviously, the species of wood and the dimensions of a successful joint will accommodate the loads it must sustain. In a typical chair (figure 1), analysis can determine the dimensions and proportions of the joint so that axial stresses along the mating surfaces are safely within the strength properties of the wood. Adding glue provides shear resistance to whatever minor withdrawal load might be imposed. And the commonly used dimensions, which have evolved by experience and tradition, are more than adequate to resist loads imposed by use—or even moderate abuse. Chair rungs are rarely so small in diameter that they fail simply because of excess bending stress and break off at the joint. When they do break here, it is usually because the other end has fallen out of its socket, and someone then steps on the rung. Likewise, as long as the joint remains tight, its bearing areas are usually large enough to distribute the racking loads.

But two common shortcomings lead to problems. First, the mortise may be too shallow in proportion to its diameter. In a Windsor chair, for example, the thickness of the seat limits the mortise to a shallow hole compared with the rather large tenon diameter at the top of the leg. Second, the mating surfaces may be of poor quality. Poor turning or shaping of tenons is not nearly as common as badly bored holes. If the spurs of the auger aren't in top condition, the surface of the hole is liable to be lined with damaged cells, which can neither support the bearing loads nor develop a successful glue bond. Proper fit is also critical. With water-based emulsion glues (white or yellow), highest withdrawal resistance develops when the dowel diameter is several thousandths of an inch less than the mortise diameter. If the tenon is oversized, the joint will be scraped dry upon assembly; if undersized, the glue line will be excessively thick.

Moisture variation is to blame — If a joint is properly designed and well made, it will carry any reasonable load at the time of assembly. The mystery is why an apparently successful joint loosens due to nothing more than humidity change. The humidity variation in typical indoor situations is wide. In Northern states, humidity in the 80% to 90% range may prevail through August and September, only to plummet to 15% to 20% relative humidity in the subzero days of January and February. This may cause the average equilibrium moisture content of wood to cycle from as low as 4% in winter to as high as 15% in the summer. Even greater extremes occur in such areas as basement rooms, with condensation dampness in summer and a nearby furnace causing excess dryness in winter. Furniture assembled in Scottsdale, Arizona, later moved to New Orleans, and ultimately back to Scottsdale, would go through a similarly drastic moisture cycle. An unfinished wooden ladder, stored flat on the ground and covered with a tarp in summer, then returned to a heated shop for winter storage, would suffer likewise. As a result of moisture cycling, the dimension of wood perpendicular to its

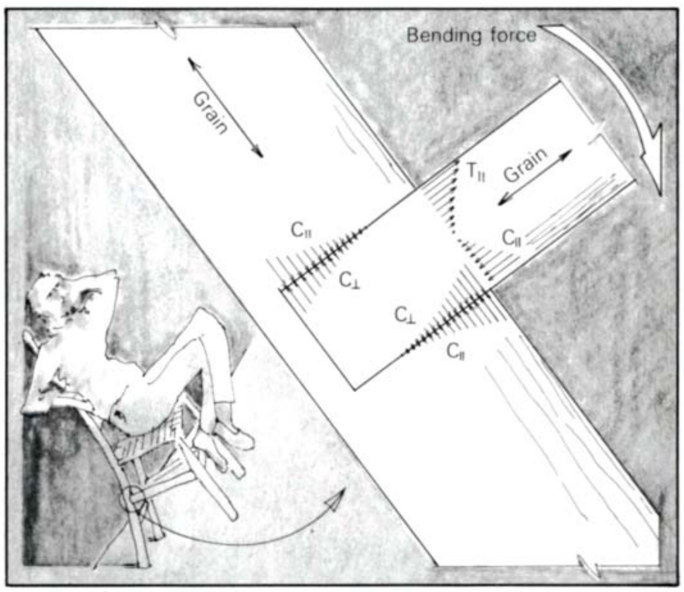


Fig. 1: Tilting back in a chair racks the joints. The rung tends to bend, causing axial stresses (tension, $T_{\parallel}$ and compression, $C_{\parallel}$). In turn the rung tenon bears against the mortise walls, compressing the rung perpendicular to the grain ($C_{\perp}$) and the mortise parallel to the grain ($C_{\parallel}$).

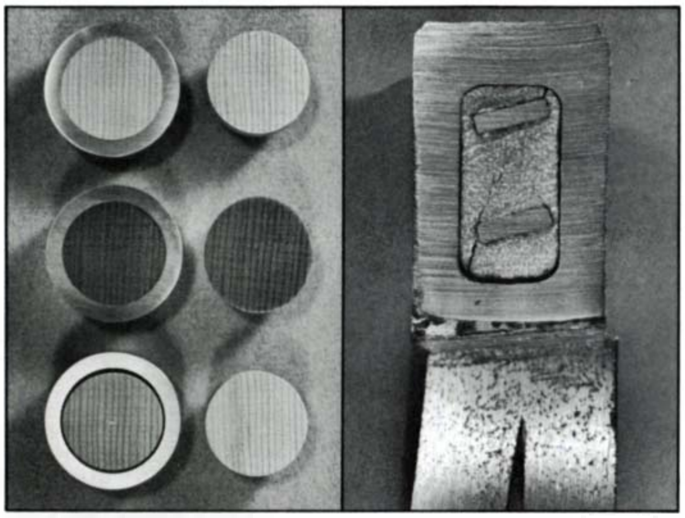


Fig. 2: Paired discs of American beech, left, dramatize the effect of cyclic moisture variation. The top two are as originally turned at 7% moisture content—the wood tightly fits its steel sleeve. The central pair has been moistened to the fiber saturation point (about 30% MC). The lower two were moistened to fiber saturation, then dried to their initial 7% MC. Compression set makes the restrained disc smaller than it started out, whereas the unrestrained disc has returned to about its original size. Right, the handle was tight when this hammer head was sectioned by hacksaw. Then it was stored in a damp place and later redried—the hickory shows severe compression shrinkage, and moisture variation, not the pounding of use, is to blame. This is why soaking a tool in water to tighten a loose handle is a temporary solution at best.

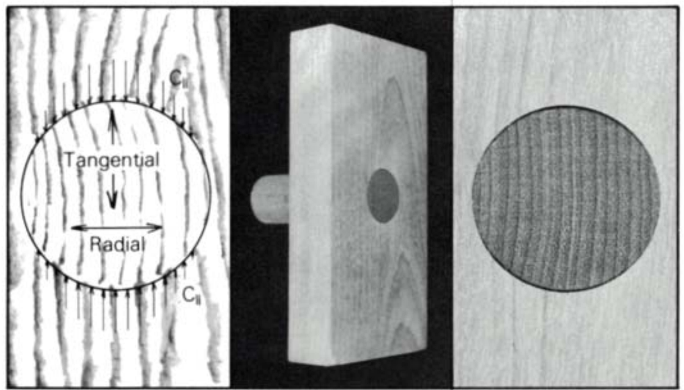


Fig. 3: Increased moisture swells the mortise across the grain by about the same amount as the tenon swells radially. But the mortise doesn't change in height (parallel to the grain). Thus, like the steel sleeve, the end-grain surfaces of the mortise restrain the tangential swelling of the tenon (diagram, left). When the unglued birch joint shown in the photographs was cycled from dry to wet to dry, compression set made the redried tenon smaller tangentially than it originally was, yet still a snug fit radially. Since most woods move more tangentially (in the plane of the annual rings) than radially (perpendicular to the rings), the orientation shown here is not optimum. Turning the tenon 90° in the mortise would be better.

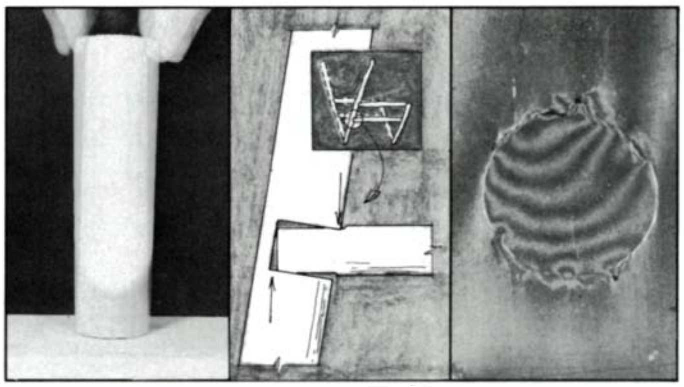


Fig. 4: This white ash ladder rung, left, was driven tightly into a western hemlock rail, then put through a severe moisture cycle. The double exposure shows how loose the joint has become. The diagram shows that once looseness develops in a joint, racking results in concentrated load that may further crush the wood: The worse it is, the worse it gets. Right, a birch dowel in ponderosa pine was coated with moire strain-analysis material and photographed through a grill of undistorted lines. The light-dark patterns show that compression damage extends well into the end grain of the mortise.

grain direction can change by up to 4% of its original dimension. This amounts to a change of ⅓₂ in. across a 1-in. diameter tenon.

First, consider a wooden dowel confined in a metal socket, such as a hammer handle tightly fitting into its steel head. For our experiments, we simplified this to a dowel of wood fit snugly into a stainless-steel sleeve, then cycled from low to high and back to low moisture content. An unconfined dowel would simply swell and reshrink to approximately its original diameter. However, the restrained dowel crushes itself, and upon redrying to its original moisture content, assumes a smaller-than-original size. Confining a piece of wood to prevent it from swelling by 4% is essentially the same as allowing the piece of wood to swell and then squeezing it back to its original dimension. The trouble is that in confining wood perpendicular to the grain, the limit of elastic behavior (that is, its ability to spring back) is less than 1%. Any additional squeeze will cause permanent deformation, or "set," as in figure 2. In addition, the wood surfaces, already somewhat damaged by machining, do not behave elastically, and seem simply to crush. The result is a concentrated surface layer of crushed and mangled cells.

The wood-to-wood mortise-and-tenon joint is a special situation in that the restraint is unidirectional. The diameter of the mortise does not change parallel to the grain, but its diameter perpendicular to the grain varies right along with the diameter of the tenon. It becomes ovoid during moisture cycling (figure 3). After a dry-wet-dry cycle, compression set is greatest against the end-grain surface of the mortise, while the tenon remains snug at the side-grain surfaces of the mortise. The tenon will therefore be looser in a plane parallel to the grain direction of the mortise.

Such looseness in the side rungs of a post-and-rung chair will allow the chair to rock forward and back. As soon as this looseness begins, the joint-surface load is no longer distributed evenly, but is concentrated at specific points. The concentrated loads may now exceed the strength of the wood at these points, further crushing the surfaces. So the joint gets looser—the worse it is, the worse it gets (figure 4). With woods of equal density, most of the damage will turn up as crushed tenon because of the lower strength of wood in compression perpendicular to the grain. However, where the mortise is in a lower-density wood than the tenon, such as a hard maple leg tenoned into a white-pine seat, the crushing may be worse on the end-grain walls of the mortise. This bad situation is compounded if the end grain was damaged when the mortise was bored, especially in fragile woods like pine.

Now consider glue. If a good glue bond develops between the tenon and the end grain of the mortise, the shrinking of the compression-set tenon during the drying cycle can be significantly retarded. This is apparent when we make matched samples with and without glue. The unglued joint will open with even the slightest cycle. Glued joints resist moderate moisture variation without failure. With exposure to more

Photos: R. Bruce Hoadley

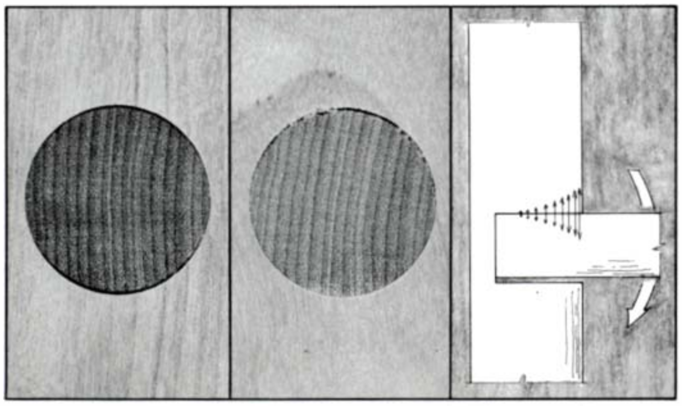


Fig. 5: Dowel joints without glue (left) and with glue, after severe moisture cycling. Once one side of the joint has opened, the other glue line is no match for racking stresses and usually fails in tension. If the mortise was badly drilled, a layer of wood may pull away with the glue.

severe cycles, the joint eventually fails, at first along only one of the end-grain surfaces. The remaining glue bond is now no match for even moderate racking, for the critical stress has become the tensile loading of the glue line (figure 5). When a joint loosens, we assume that "the glue has let go." Close examination may show, however, that a layer of wood tissue has been pulled from the inside of the mortise. This is common where a high-density tenon is glued into a lower-density mortise—the maple leg in the pine seat.

One more point bears elaboration: the behavior of wood in tension perpendicular to the grain. As we have seen, if wood is compressed perpendicular to the grain to well beyond its elastic limit (that is, by several percent of its original dimension), the cell structure is permanently crushed but it remains intact. However, in tension perpendicular to the grain, the strain limit is 1% or 2% of the original dimension, whereupon the wood pulls apart. Therefore if the moisture cycle develops between 1% and 2% compression shrinkage, a glued tenon may be pulled apart during the drying cycle, no matter how perfectly the joint was machined and glued. The tenon actually splits near the glue line. So one way or another, the joint will fail if the moisture cycle is severe.

What to do? — I really didn't appreciate how destructive moisture cycling could be until I ran some experiments. I had arrived at a standard test assembly consisting of a 4-in. by 1-in. dowel inserted into a 1-in.-dia. hole, 1⅛ in. deep, in a 3-in. by 5-in. by 1¼-in. block. In one series, I made 20 similar maple-tenon-in-pine-block joints, using wood that had been conditioned to 6% moisture content. I used a PVA adhesive (white glue). Ten of the joints were stored in sealed plastic bags; the other ten were conditioned up to 18% moisture content and down to original weight, over a period of several months. The cycled joints weren't wobbly, although visible fracture of the squeezed-out glue along one side of the joints suggested that compression set had developed. Then, by racking the joints with hand pressure, there was an audible snap and the joints became wobbly. When pulled apart in a testing machine, the average withdrawal load of the uncycled specimens was 1,550 lb., while the cycled specimens averaged only 42 lb. This was a terrible predicament, for under commonly encountered moisture variations, even well-made joints were destroying themselves. I didn't want to believe it, but further experiments confirmed this cold, hard truth. To minimize the problem, I arrived at a list of five checkpoints for making joints with the best chance of survival:

1. Proportions. Avoid shallow mortises. I try to make the mortise 1½ times as deep as it is wide. However, if the mortise depth approaches twice its diameter, a new set of problems make the situation worse again.

2. Original moisture content. The wood (especially the tenon) should be slightly drier, not wetter, than its eventual average equilibrium moisture content. Better a little compression than tension at the joint interface.

3. Mortise surface quality. Carefully bore the mortise. Sharpen the bit, especially the spurs, with extreme care to produce the cleanest possible surfaces. Using a drill press or boring guide will improve the hole.

4. Grain/growth-ring orientation. If possible, bore the mortise radially into the female member; orient the tenon with its growth rings perpendicular to the grain direction in the mortise (figure 6). This minimizes the stress by putting radial, rather than tangential, dimensional change in opposition to long-grain structure.

5. Finish the product. Completed work should be given a coat of finish selected to provide maximum protection against short-term, but potentially disastrous, extremes of humidity. Lacquer, varnish or paint is best. And remember to finish all over, especially end-grain surfaces.

All of the above conditions cannot always be optimum, and there will be situations where severe moisture variation cannot be avoided. What other solutions might be possible? For unidirectional stress problems (the chair leg and rung in figure 3), I tried providing stress relief by making a saw-kerf slot in the tenon, thinking that compression would be relieved during the swelling cycle. This helped, but it had the disadvantage of shearing the glue line adjacent to the kerf as each half swelled. Finally I split the tenon—a plane of failure that would relieve stress during the drying phase of the cycle. As compression shrinkage took place, the split could open rather than the glue line failing. In our initial tests with circu-

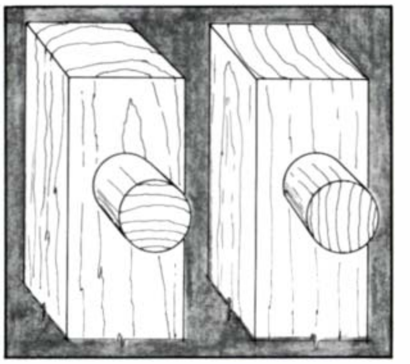


Fig. 6: The optimum condition (left): tangential movement coincides in both mortise and tenon, while the lesser radial dimensional change in the tenon opposes the stable long grain of the mortise. At right, tangential movement varies the depth of the mortise and may 'walk' the tenon out, while compression will cause the greater change in tenon height.

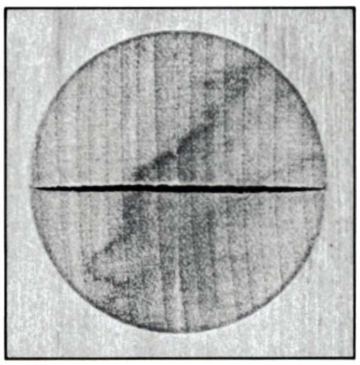


Fig. 7: Birch tenon was split both radially and tangentially before assembly. After moderate moisture cycling, compression shrinkage has developed entirely in one direction, opening the radial split, while the tangential split remains tight. The entire glue line remains intact. This may be what actually happens when tenons are wedged.

lar plugs in flat boards, the presplit tenon opened as predicted, and the glue line remained intact. In matched specimens without splits, the glue line failed. Analysis confirmed that in the compression-shrinkage phase the wood could actually distort itself by enough to relieve the strain. When I made regular, full-depth joints, splitting the tenon to the full depth of insertion, the joint stayed together under moderate moisture cycling (figure 7). I suspect that this mechanism is the real reason why wedged tenons work. Although the wedge is intended to supply lateral pressure to the glue surfaces and perhaps also to splay the tenon for a dovetail-style mechanical lock, it may actually do no more than provide a stress-release slot and thereby help the glue line survive.

Under moisture extremes, a new problem emerges: The mortise depth changes, and the glue line shears. After repeated cycling the tenon remains glued around the bottom of the hole, but shear and compression set develop near the outside junction, and racking eventually completes the break (figure 8). An especially tight fit, good gluing and finishing, and close control of moisture content at assembly can help prevent the mortise from changing depth relative to the tenon. The price is liable to be an unsightly bulge or a check on the back side of the chair leg. So the simple split has promise, but it is not the best solution.

Silicone adhesives — It has always intrigued me to see a heavy motor set into a base with rubber-sleeve motor mounts. Why not set tenons into some kind of rubber sleeves inside the mortise? The rubber might yield enough during the swelling and shrinking phase of the cycle for the glue joint to survive. First, I bonded rubber tubing 1/16 in. thick around a 1-in.-diameter dowel and glued it into the mortise. A tedious procedure, but I was encouraged when the joint survived severe moisture cycles without failure. Next I experimented with General Electric's RTV (room temperature vulcanizing) silicone elastomers. A translucent formulation, RTV-108 (in hardware stores the product name is Clear Glue and Seal) worked well. To keep the tenon centered and parallel to the mortise while the silicone cured, I glued thin splines onto it at 90° positions (figure 9). Later we figured out how to machine a four-spline tenon with its base diameter undersized by the thickness of the glue line. Hand-carving a dowel to leave four or six thin ribs also works. If the modified portion of the tenon is slightly shorter than the depth of the mortise, the elastomer sleeve can be fully hidden in the joint. Before gluing, slide the tenon into the mortise to be sure the ribs fit snugly. Then wipe a dab of silicone adhesive into all mating surfaces. Next, quickly squeeze a dab into the bottom of the mortise and firmly push the tenon home, allowing the silicone adhesive to flow back up along it. Within an hour it will skin over firmly and you'll soon discover the point at which the squeeze-out solidifies enough to be neatly peeled off. The joint cures within 24 hours but does not reach full strength for a week or more.

I have experimented with various dowel sizes, adhesive layer thicknesses and wood species, and compared the results with conventional assembly glues. Predictably, with fairly thick elastomer layers (0.060-in. layer in 1-in.-diameter mortise) the joints are able to withstand severe moisture cycles (6%-24%-6% MC) without losing withdrawal strength. The same cycle destroys a standard PVA (white glue) joint. For example, in oak joints with white glue, it took an average of 1,100 lb. to pull apart uncycled joints. But after a 6%-24%-6% moisture cycle the average withdrawal resistance was only 41 lb. (most joints were loose enough to be wiggled apart by hand). With RTV-108 (silicone), the original joint strength averages 264 lb.; after cycling, 262 lb. Even though the white-glued joint was stronger in withdrawal to begin with, the silicone-glued joint is strongest after cycling. The silicone joints that withstand the severest moisture cycling are not nearly as rigid as conventional glues and unmodified tenons, and the silicone-glue approach cannot be considered a direct substitute for traditionally made joints. In defense, I point out that after severe cycling, the white-glued joints were often far worse than the silicone joints. However, the rigidity of silicone joints can be improved by increasing the relative depth of the mortise and by making the adhesive layer thinner. It is best to keep the depth of the mortise at

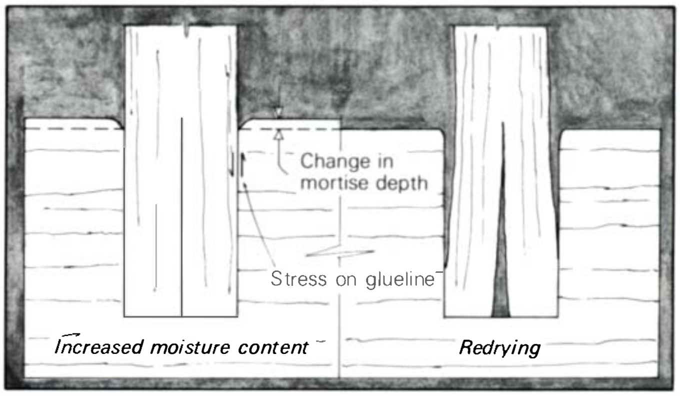


Fig. 8: In moisture extremes, typically high moisture content followed by redrying, the changing depth of the mortise and compression set near its mouth shear the glue line. The split tenon accommodates stress at the bottom of the hole, but racking will soon break it loose.

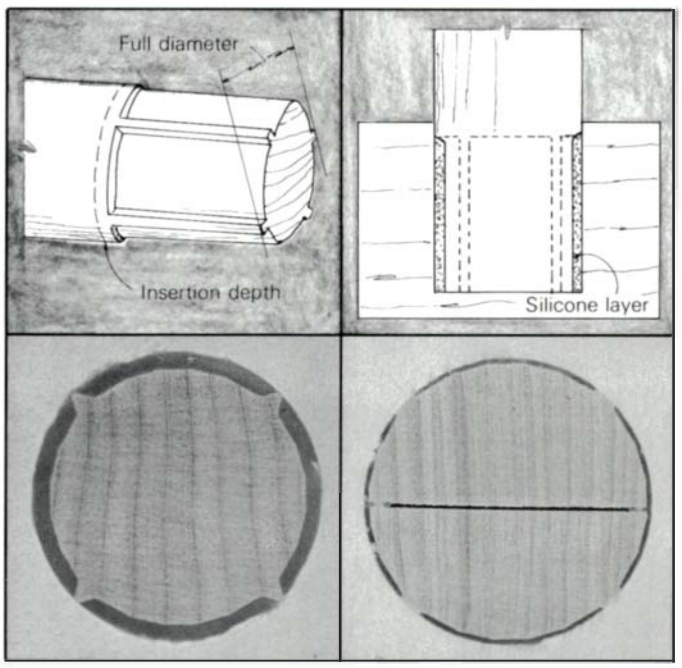


Fig. 9: The elastomer compromise. Four thin ribs are formed on the tenon, by machining, whittling or by gluing splines onto the tenon. The ribs should be 90° apart, and oriented at 45° to the grain of the mortise. The ribs keep the tenon centered and contribute to rigidity. Their depth determines the thickness of the silicone layer; their length can be short of full mortise depth, thereby concealing the modified portion of the tenon. A split in the tenon contributes to strain relief and allows the silicone layer to be quite thin. The silicone compounds with better adhesion to wood now being developed may solve the problem of wobbly chairs.

least 1½ times its diameter. With 1-in. tenons, as the glue layer is reduced to about 0.020 in., the joint stays rigid, will have reasonable withdrawal strength and will withstand fairly drastic moisture variation. Effecting this can be a problem in leg-to-seat joints for Windsor chairs, where the seat thickness limits the mortise depth. If the glue layer is too thin, compression will develop. A good point of departure for experiments with 1-in. dowels would be a silicone layer of about 1/32 in. or slightly less. This should give a good compromise between durability under moisture variation, and rigidity.

I have also tried assembling several different types of woods with silicone adhesives. One style of captain's chair, having a pine seat and arms and maple turnings, was assembled using nominal 0.020 in. silicone layers. After six years, all joints are still secure. While seated in the chair, by intentionally racking the frame, you can feel slight springiness due to its non-rigid joints. But nobody who hadn't been told about the special system of joinery has ever commented on the slight wobble. In a set of twelve thumb-back chairs, half the joints were assembled with silicone, half with white glue. The chairs were left in a library lounge for six months of student use. The only failure was in one white-glued joint.

In other items silicone joints seem to be the perfect solution—attaching the smokestack to toy tugboats for the bathtub, where alternate hot-soak and drying of unpainted wood is a most severe exposure. Bathtub toys assembled with conventional glues compression-set and fall apart easily, but silicone joints can take it. Another application is attaching laminated beech sculptor's mallets to their maple handles. Silicone not only solves the loosening problems, but the layer of elastomer seems to contribute to shock absorbancy. I have also used it to reassemble a few pieces of furniture whose tenons were woefully undersized and loose because of compression shrinkage as well as fist-pounding reassembly many times. Success was predictable according to joint proportions: Shallow mortises didn't work out, but where the tenons were long and the mortises deep, the silicone did a perfect job of filling the gaps and solving the looseness problem, perhaps forever.

Note that all of these remarks apply to rectangular structures, which rely on joinery for rigidity. A triangulated structure, on the other hand, is inherently stable, and silicone glues might be exactly right. I hope some craftsmen may be encouraged to experiment along these lines.

Combining silicone with a stress-relief split in the tenon also looks promising. I found that the glue layer can be held to a minimum (0.010 in. to 0.015 in.), since part of the problem is handled by the opening of the split tenon. Some typical values for direct withdrawal of a maple tenon from a pine mortise, before and after moisture cycling, are: with white glue, 1,553 lb. and a mere 42 lb.; with a layer of silicone 0.010 in. thick, 830 lb. and 290 lb.; and with silicone plus a slit in the tenon, 753 lb. and a surprising 580 lb. The limiting feature of silicone adhesives has been adhesion to the wood surface. Average tensile strengths perpendicular to the surface are only about 200 PSI. Recently, however, we have tested some formulations (not yet on the retail market) which have more than double this strength. I am confident that we will hear a lot more about silicone elastomers, and see them specifically incorporated into joinery work. □

Bruce Hoadley teaches wood science at the University of Massachusetts, in Amherst. For more on repairing wobbly chairs, see FWW *#20, Jan. '80, p. 79.*

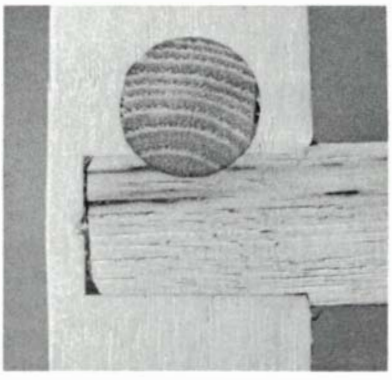
One Chairmaker's Answer

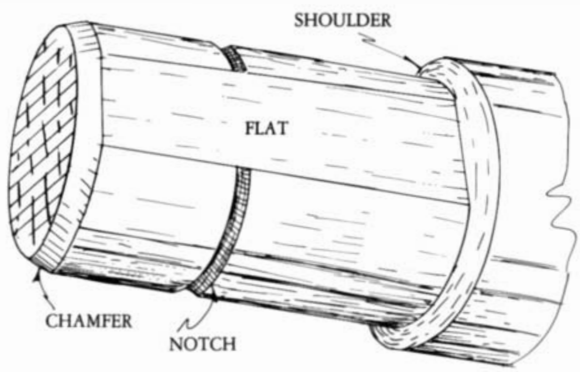
(EDITOR'S NOTE: The following is excerpted from *Make a Chair from a Tree: An Introduction to Working Green Wood,* by John D. Alexander, Jr., published by The Taunton Press, 1978.)

The goal is to employ the compressability of green wood without exceeding the elastic limit of the fibers in the tenon. When the moisture balance is right, we can drive in an oversized tenon and create a tight bond between the surface of the mortise and its tenon. . . . At the time of mortising and assembly, the post should contain about 15% to 20% moisture (air-dried outdoors) and the rung about 5% (dried indoors near the stove).

. . . I flatten the sides of all the tenons in my chair—slightly more so on the tenons of the rungs near the top of the front posts. Flats not only prevent posts from splitting during drying, but after drying they act as a lock that prevents the tenon from rotating in the mortise. . . . Taper the flats a mite so they are broader and deeper toward the shoulders. This makes them slightly dovetailed when viewed from above. If all goes well, the shrinking post locks the dovetailed tenon into its mortise. Last, notch the tops and bottoms of the tenons so that when the compressed end grain of the mortise dries and straightens, a ridge of post wood will be forced into this notch. . . .

When the chair is assembled, the wood rays in the tenon should be oriented vertically, in the same direction as the long axis of the post. This orientation aligns the direction of maximum rung movement (the tangential plane) with the direction of maximum pressure from post shrinkage. . . . Looking from the top of the post, bore the mortises so that the plane of the wood rays bisects the angle between the front and side rungs. This allows each tenon to be compressed equally as the wet wood shrinks. . . . Bore the bottoms of the side mortises about 3/32 in. lower than the tangent lines laid out earlier from the tops of the front and rear rung mortises. This locks the rungs together inside the post. . . I use glue. I use every technique I can that might help the chair hold together. —*J.D.A.*





Interlocking tenons secure the joint; tapered flats and notches also help.

On Dovetailing Carcases

Which to cut first, pins or tails?

by Ian J. Kirby

The through dovetail has become synonymous with quality woodworking, a hallmark of distinction. This is understandable because the joint must be handmade—we don't have a machine that can produce variations in the dimensions and angles of its tails and pins. I do wonder, however, why so many woodworkers see the joint as a standard of craftsmanship. In terms of skill it is considerably easier to make than the mortise and tenon or the secret mitered dovetail. Cutting the through dovetail is little more than sawing to a line. I make this point not to demean the work, but to encourage anyone who might feel inhibited about attempting dovetail joints. The through dovetail is not difficult, and it should not be thought of as the ultimate in woodworking skill.

The through joint was routinely used by 17th and 18th-century cabinetmakers to put a carcase together very quickly. It doesn't take much experience before you can lay out and cut the joint with the minimum of marking out. If you make the end of the board square and knife the depth-line around, the spacing of pins and tails is easy to eyeball *(FWW* #17, July '79). Lines may be penciled square across the end grain as an assist, but with practice even this is not necessary. It doesn't matter if the angle on the tails varies, since the pins will be marked and sawn from the tails; the interface will still be tight. It was usual 200 years ago to cover the through joint with an applied molding. The outlook and attitude of the times was to conceal structure behind some embellishment. Note the direct contrast with 20th-century attitudes—our urge is to expose structure as part of the dynamic of the object, and to read structural detail as the mark of quality. Figure 1 illustrates some layout possibilities.

The details of laying out and cutting the joint have been written about by other authors *(FWW* #2, Spring '76, and #8, Fall '77). What I have to say concerns the associated and attendant techniques. There is, however, one point about making the joint itself: whether you should cut the tails first and mark the pins from them, or whether you should start with the pins and mark the tails from them. Woodworkers disagree, and either way will achieve the result. If you understand both, then the answer to which is correct has to be, whichever method you are most comfortable with, and whichever gives the better result. The decision is often determined by which board in a carcase—the vertical or the horizontal—is to have the tails, and which board is the longer. For example, take the proportions of a carcase as shown in figure 2 and assume we want the tails on the longer piece. They will therefore show from the top. If the tails are made first it is simple to put the pins board upright in the vise, position the tails board on it, and mark the pins through the tails. If the pins were made first, then to mark the tails you would have to balance the pins board vertically on the tails board. This is usually done by clamping the pieces in place on the edge of the bench. If the pins board is in any way cupped or twisted, the problem is compounded by having to clamp straightening battens across it. When the tails are made first, a cupped or warped piece can be straightened by blocks or by clamps put across the bench. Having come this far, I should say that for through or lapped dovetails I make the tails first. It seems to give better control over the marking out and cutting, and better control of the boards themselves. On the other hand, when cutting a secret mitered dovetail, you must make the pins first and mark the tails from them—it can't be done the other way around.

The sawing of the joint also takes on different flavors depending on whether you cut the tails or the pins first. If you make the tails first, then the first thing is to get the sawblade at right angles to the face of the board, and the kerf is made just 1/32 in. or so deep right across the end grain, as shown in figure 3. Make this initial kerf by keeping the saw vertical and don't yet be concerned about the tail angle. The small amount of vertical cut will not affect the extreme tip of the tail. Right-angularity having been achieved, set the saw at the angle to which you wish to cut the tail.

Once started, the angle must not be adjusted or the result will be a bent line. This bent line cannot be "mirrored" on the pin—and anyway, if the angle varies a little from one tail to another, does it matter? The important thing is to have all the sawcuts at right angles to the face of the board. If you make the pins first, cutting them follows this same procedure. But once the tails have been marked from the pins, there is no room for any variation in sawing the angle. The kerf is made across the wood to about 1/32 in. deep, and the

Fig. 1: Dovetail layout

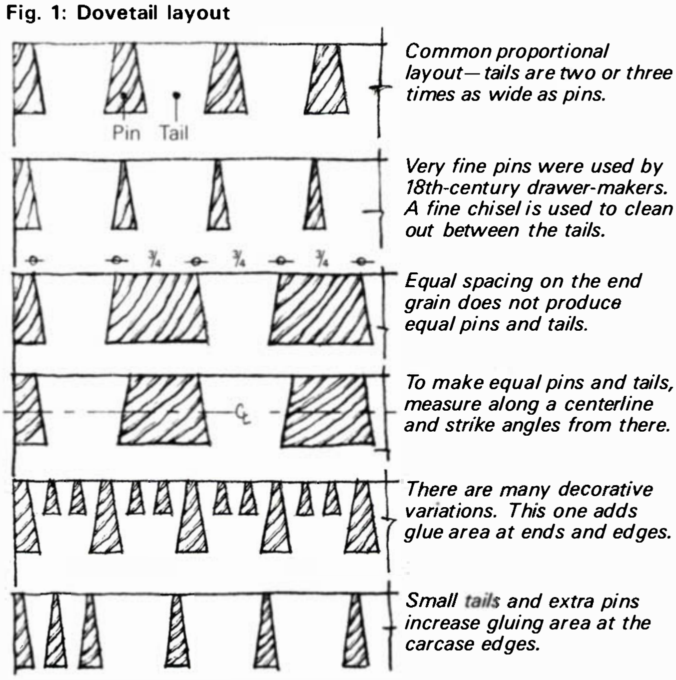
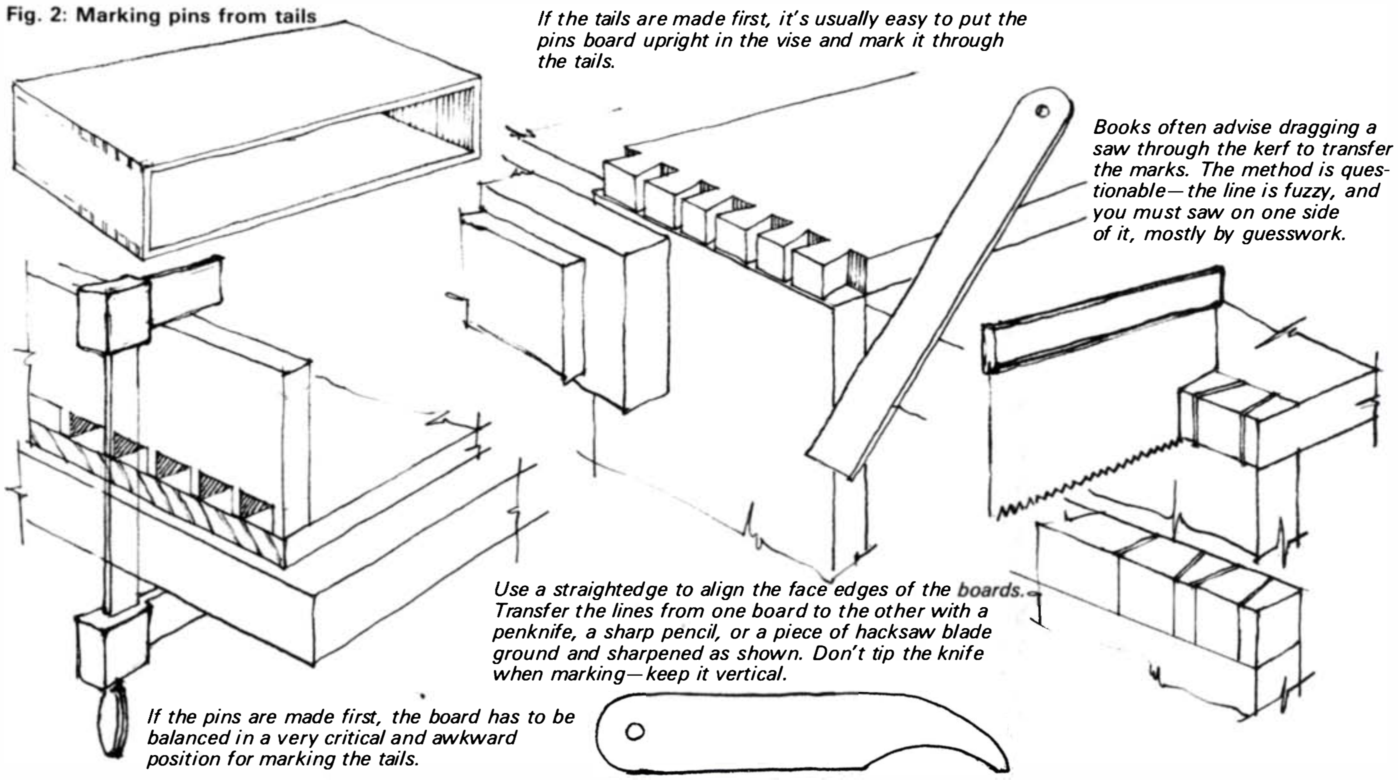


Fig. 2: Marking pins from tails



saw is sighted and set exactly at the angle which must be achieved to give a good interface.

Whatever the method, getting the saw into the correct angle is probably best achieved by beginning the cut on the far side of the wood—not, as one might expect, from the near side. Use light strokes to start, almost lifting the weight of the saw off the wood. Once the shallow cut is made and the saw will remain in the kerf, then saw across the line toward the near side—don't cut any further down the back side of the workpiece. You must concentrate on achieving the angle, not on reaching depth of cut, at this stage. Starting from the far side seems to give better vision into the workpiece—the saw does not hide the line, and the dust is easily blown away. All you have to accomplish is the shallowest kerf across the end grain, to give the saw teeth a register in which to work. If you lift the saw out, the kerf should be well defined across the board but too shallow to have direction downward. Now you can set the saw to the required direction—at an angle for a tail, or vertical for a pin. All of this assumes that you have placed the board vertically in the vise for sawing. If you want to become skilled with the saw, there is no virtue in tilting the wood in the vise. Keep the workpiece square to the bench and learn to saw at the required angle.

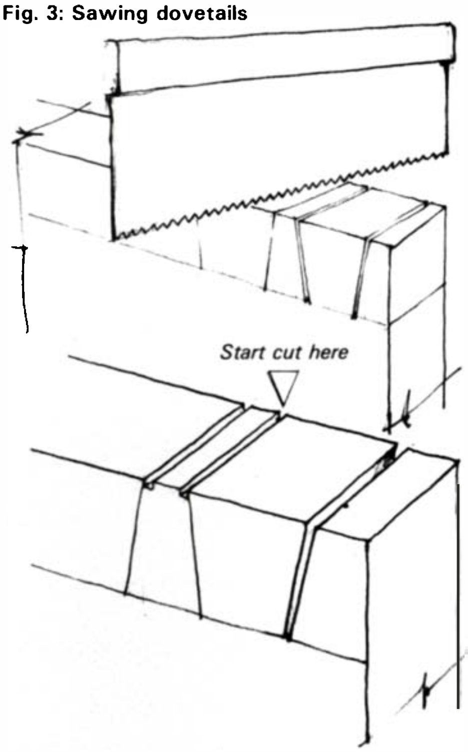
To gain skill, the amateur craftsman should look for and take every opportunity to practice. This often leads to experiments in softwood, for utility work around the home and shop, but it can be a disappointment. Generally, softwood tissue is alternately hard and soft, and the soft part readily crumbles if forced into too tight a joint. When cleaning out the bottoms of either pins or tails, that is, when paring across the grain, the wood will crumble badly unless the chisel is absolutely sharp. It helps to ease the under-edges of the tails when working in softwood (figure 3) or when you have made one or more pins a little too tight. With the sharpening bevel of a wide chisel toward the wood, remove a sliver of material from the corner of the tail which is going to come first into contact with the edge of the pin. Don't cut away any tissue that will be visible, and remove an absolute minimum only. It may seem wasteful to practice with good wood such as a mild-working mahogany, but the feedback of information through your tools and hands, plus success achieved at a critical learning time, makes it worth the expense.

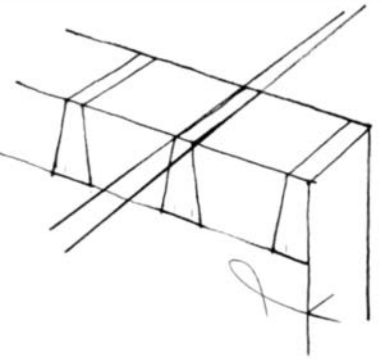
From the outset you should work toward making a through dovetail straight from the saw. The cross-grain surfaces must be chiseled flat, of course, but if the beginner thinks that long-grained surfaces should be sawn fat and chiseled back to the line, adequate results will be a long time coming. You can get the result you want directly from the saw, and to a very high standard, after only a few practice tries.

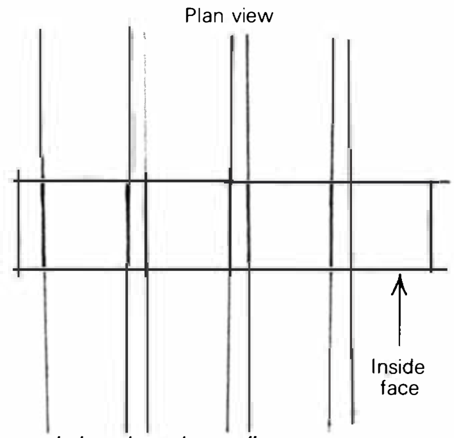
Having become skilled at making the joint, you may wish to try a mild variation: a very slight off-square cut when making the tails (figure 3). Mark out the joint as usual, with the face side of the board toward the inside of the finished piece. But instead of sawing the line of the tail square to the face, very slightly angle the saw so that the normally parallel gap on the end grain of the tails is wider toward the face side of the board. The gradient of the tail isn't altered, but the tails have a larger pin gap on the face side of the board than on the outside of the carcase. When the pin is subsequently marked from the larger profile, it will tighten as it is driven home and the top interface will be mildly crushed. Be cautious: Overdoing this can ruin an otherwise good joint. The angling of the saw is more an opinion than a visible amount off-square. At worst the outside edges of the pins will be crushed at the top and won't present a parallel line—you went too far.

Use a steel hammer to drive the tails into the pins. A mallet can't be directed at a single tail, if it hits the workpiece on the twist it very easily marks the wood, and its tone upon impact gives no clue as to the tightness of the joint. The hammer should be slightly domed on its face—most hammers are anyway—so that each tail can be struck individually. The hammer will do little damage to the tissue if each blow is

Fig. 3: Sawing dovetails

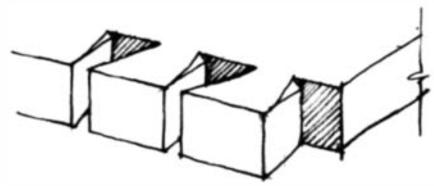






Here the line of the saw has been extended to show the small amount by which the cut can be angled. Be sure the wider part is toward the inside of the carcase.

Start the cut from the far side of the board, keeping the saw square to the face and end of the board. Make the initial kerf only $\frac{1}{32}$ in. deep, then set the saw to the required angle and proceed.



Removing a small sliver of wood where the tails will first contact the pins eases entry, especially in softwoods. It isn't essential and shouldn't be used constantly.

delivered squarely. Each tail can be driven independently, and you will hear a distinct change in tone if a tail is binding and getting too tight. As well as the change in tone, the hammer will now bounce, as though hitting solid end grain. If this makes you queasy, protect the work with a small block of wood. The alternative to a hammer is a bar clamp. It has its greatest effect at the very end of assembling the joint, when the tail should be sitting down tight on the end grain at the base of the pins. When driven with a hammer the tail will travel the last few thousandths of an inch and may then bounce back or simply absorb the shock. Either way you can be fooled into thinking the tail won't sit down tight. Try a clamp and it goes the final fraction without problem, giving a clean, gap-free interface.

One sometimes sees a woodworker making up a set of castellated clamping blocks for each dovetailed carcase—the idea being to put pressure only on the pins or tails on each side of each corner. To me, this practice reflects fundamental misunderstanding of sound cabinetmaking technique.

In a through dovetail, when determining the length of the tail and the pin, we have three options (assuming that the pieces of wood to be joined are all of the same thickness). We can make the tails and pins longer than, equal to or shorter than the thickness of the wood. The method that seems to be most common is to make the tails and pins longer than the thickness of the wood. When the joint is put together the ends of the tails and pins protrude, later to be planed or sanded flush with the carcase sides (see p. 13). Unless you feature this protrusion by carving in some way, there is no virtue here. This approach means you must saw to a greater depth than necessary, only to plane away the effort when cleaning up. In the process, you destroy a vital registered edge. Furthermore, clamping turns into a juggling act with all those little blocks, which tend to crush the tissue mercilessly, or you waste time making a set of special blocks.

Instead, I make the tails and pins fractionally shorter than the thickness of the stock. Considering this point takes us back to the initial selection of which faces are to go on the inside or the outside of the carcase. Assuming that the more handsome side is to face out, then the less handsome side or inside should be prepared as the face side, having all the normal properties of a face side—it should be flat in length, flat in width, and out of winding or twist *(FWW* #13, Nov. '78). It is likely that the boards will have been passed through a thickness planer after receiving their face side and face edge, but this is not necessary to the manufacture of the carcase. For the sake of argument, the outside of the boards could be left rough from the mill. But the ends of the boards must be cut to length and squared. The end grain should be clean and free of any tear-out. Do this by knifing round the ends fairly deeply (figure 4), then plane down to the knife line with one of the bench planes—the wider the boards, the larger the plane. A shooting board can be a big help here, since it allows you to lay a heavy plane on its side, gives good vision into the work, and with practice the plane can be made to cut almost like a bacon slicer.

Probably the most useful assist I have found when teaching this and other aspects of woodworking is a magnifying glass about 4 in. in diameter and of 4 × or 10 × magnification. The enlarged view of the work and the tools brings understanding not only of how and where one is cutting, but also of the quality and sharpness of what one is cutting with.

I am always surprised by how often I meet a woodworker who believes a block plane is the correct tool for end grain. This plane is a small thing, not easy to grasp firmly and push through end grain, where you need the heft and two-hand grip of a larger tool. The fact that the block-plane iron is set at a low angle is of little consequence. Since it is also mounted on the frog with its bevel uppermost, the cutting angle is the same as on a larger plane.

Having got the ends square they need to be knifed round. It is at this point that one has to settle the length of the tails

Fig. 4: Planing end grain

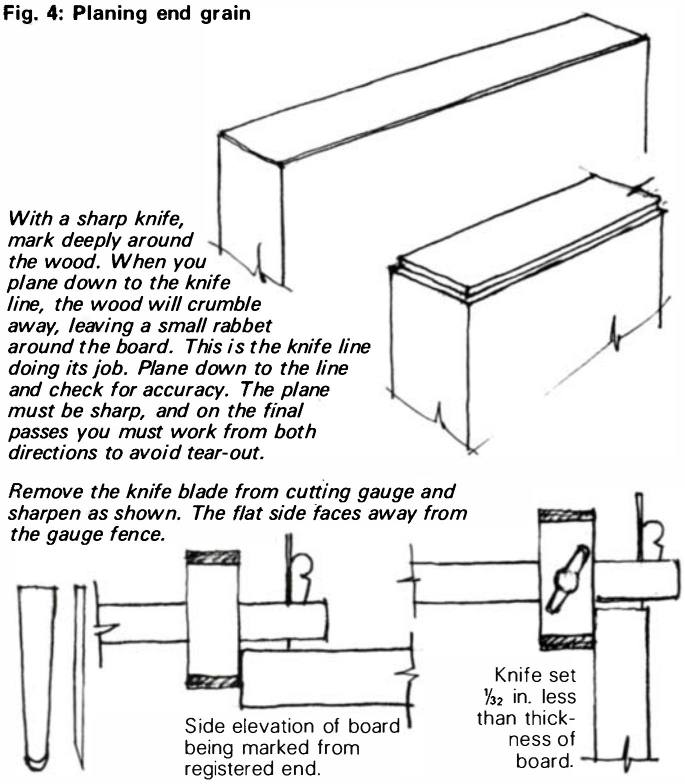


Fig. 5: Making drawers fit well

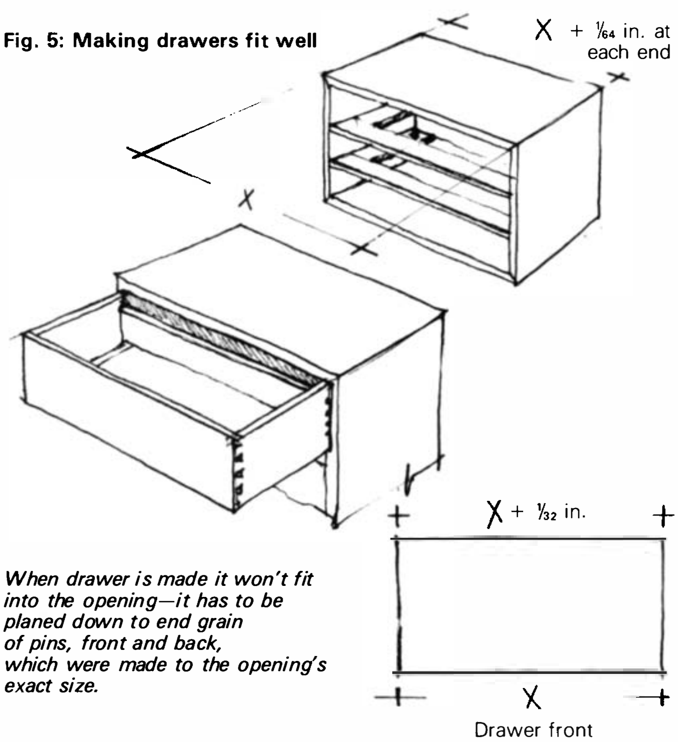
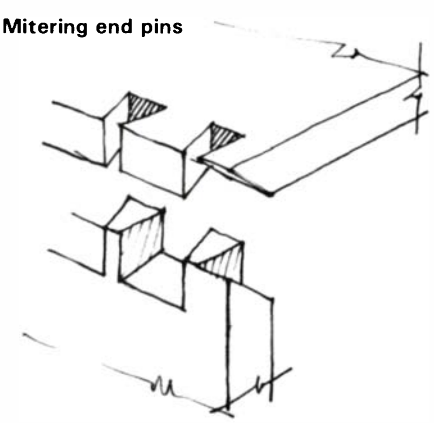


Fig. 6: Mitering end pins

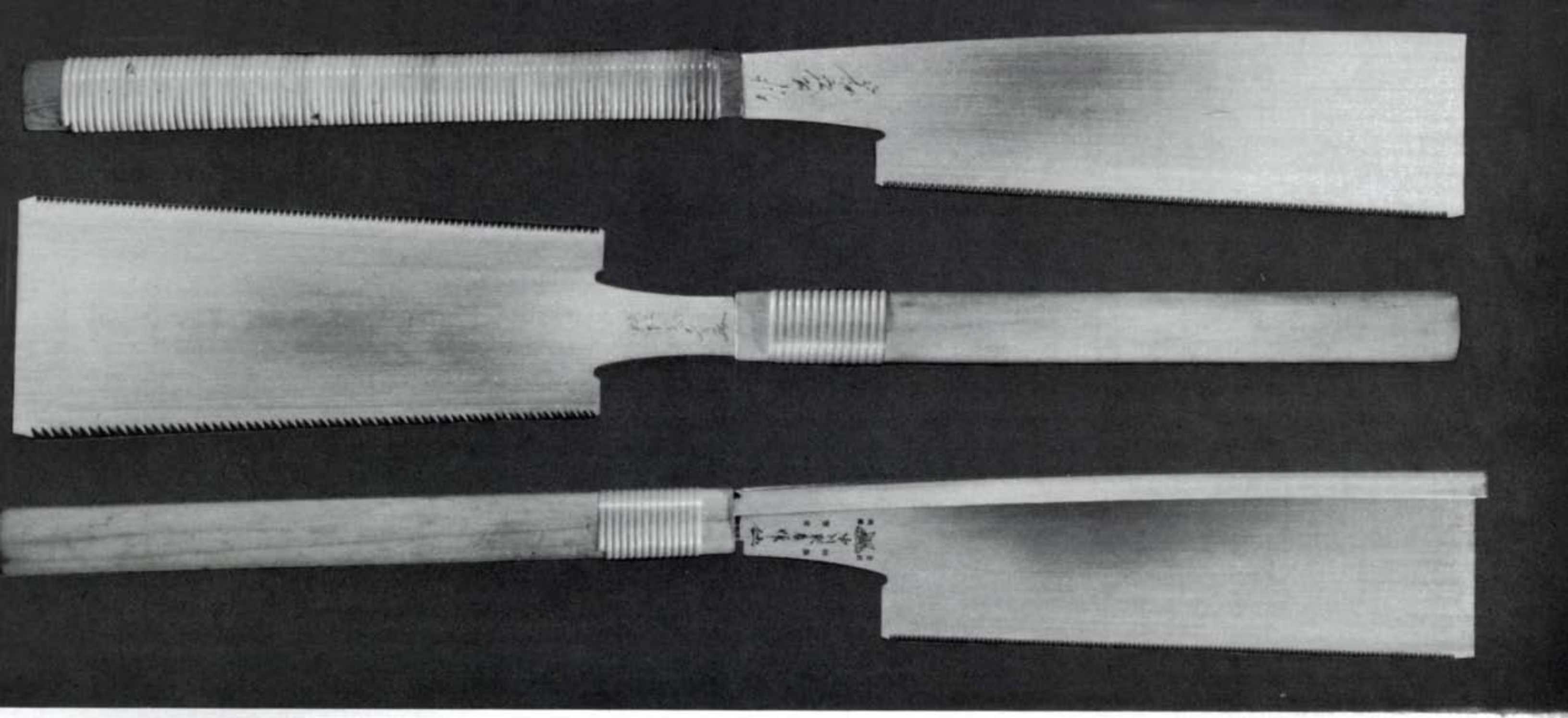


and pins. Set a cutting gauge a bare 1/32 in. less than the thinnest part on the boards. Knife a line round the ends of the boards, using the accurate end of the board as the face from which to gauge. The gauge knife should be sharpened to the profile shown in figure 4, flat side away from the gauge fence. This puts the beveled surface of the knife into the wood on the waste side of the line. Because the pins and tails are marginally short of the outside face of the carcase, during assembly there is no need for special clamping blocks. The clamp heads can be place directly on the tails to press them home, or a straight, simple clamping batten is all it takes. When cleaning up the carcase on the outside, one simply has to plane off the whole surface and come down just to the end grain on the tails and pins—the original end grain prepared by saw or plane. When we reach it and take the finest feather off, then the outside of the carcase is accurate to thickness and parallel to the inside, or face side. This method is not used for the sole purpose of achieving accuracy of carcase thickness—this is only a consequence. Another consequence is that the gauge line from marking out will be removed when cleaning up. Most importantly, carcase squareness was achieved long before the joints were made.

This procedure also permits a delightful refinement in fitting drawers (figure 5). Assume we are making a drawer or set of drawers as shown, and that the carcase is 18 in. deep (front to back). The ends of the top and bottom pieces are made deliberately not square. They are made with 1/64 in. extra on the back edge at each end. Thus the top and bottom pieces are 1/32 in. longer on their back edges than on their front edges. The end-grain edges are prepared as previously explained; the difference being that when one gauges from these edges the assembled carcase will be longer at the back than at the front. When the drawer is made, the boards for its front and back are cut and planed to fit exactly the carcase opening. Then the sides are joined to them with lap dovetails at the front and through dovetails at the back. The drawer sides are also made proud of the end grain of the front and back pieces, then planed down just to the end grain, front and back. Such a drawer will fit exactly into its opening, and will enter the carcase with a mild friction-fit left and right. Because the carcase gets fractionally wider toward the back, this friction does not increase significantly as the drawer goes farther into it. When the drawer is pulled out, the resistance increases as it approaches maximum opening—the action is very sweet. Making a traditional drawer in a traditional carcase relies on this technique of leaving long grain proud on the carcase sides and on the drawer sides. It cannot be done by having end-grain surfaces of tails and pins protrude.

In conclusion, there are two small points to consider when making a carcase with through dovetails. At the outer edges it is generally good to have two or three quite small dovetails, to increase the number of gluing surfaces. This helps if someone should be tempted to lift the piece by grasping the outer edges of the board, and it also increases resistance to cupping. The second consideration is to miter the outside joints, giving a more vital flow to the front edge of the carcase. Making this miter is not difficult—the common mistake is to saw down the line of the first pin, and you don't need to. Figure 6 should make this clear. □

Ian Kirby, a regular contributor to this magazine, teaches woodworking and makes furniture in Bennington, Vt.



Top to bottom: a kataba, ryoba *and* dozuki, *each approximately 22 in. long.*

Japanese Saws
Thin, flexible blades cut on the pull stroke

by Robert Ghelerter

The *kataba, ryoba* and *dozuki* are the three primary handsaws for the Japanese woodworker. The *kataba* and *ryoba* roughly correspond to the cabinet saw or carpenter's saw, and the *dozuki* is equivalent to the backsaw or dovetail saw. They differ from their Western counterparts in that all the teeth face back toward the user—they cut on the pull stroke rather than on the push. This allows the blades to be very thin and light. My *ryoba* weighs less than 6 oz. All in all, I find them less tiring to use and more accurate than Western saws.

In Japanese the words *"kataba," "ryoba"* and *"dozuki"* are often followed by the word *"nokogiri,"* which means "saw." *Kataba-nokogiri* is a saw with teeth on one side; *ryoba-nokogiri*, a saw with teeth on both sides (one edge for ripping and the other for crosscutting); and *dozuki-nokogiri*, a saw with guard adjoined.

The first saws came to Japan from China via Korea between the 14th and 15th centuries. The Japanese were never on friendly terms with the Chinese, and everything from China came via Korea. There is some evidence of saws before this time, but they weren't widely used. The first saws introduced were large, for felling and resawing trees. The other saws evolved from them.

The *ryoba* is relatively new, created about 100 years ago. Before this combination saw, woodworkers needed two *kataba*, a rip and a crosscut. Both *ryoba* and *kataba* are for rough cutting and can be used with one or two hands. The saws are versatile and can bend to get into difficult places. When cutting flush to a surface, I prefer the *kataba* because its back can be rested on the wood without scratching the surface. The blades of both *ryoba* and *kataba* are thinner in the center than at the edges to reduce friction in the kerf.

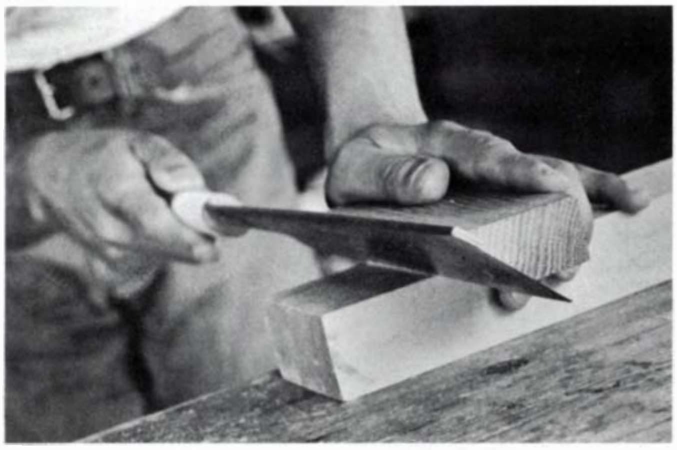
The *dozuki* is used for accurate work, and when cutting angles a guide block can be used. To trim a board to length, draw lines on four sides of the board with a square and a sharp pencil; a thin pencil line will be easier to see, especially on light wood, than a marking-gauge line. Begin the cut at the far corner of one side, gradually leveling the saw until the kerf is about ¼ in. deep. Then turn the board and do the next side. When all four sides have been started, the cut can easily be completed, the kerfs guiding the saw.

The *ryoba* and *kataba* can be used this way too, and the same method cuts shoulders on tenons. For crosscut work I find these saws superior to electric saws in that they leave no tear-out. They are especially handy for cutting 4x8 sheets of ¼-in. paneling. They can be every bit as accurate as a machine and often faster. Although *dozuki* are usually filed for crosscutting, their teeth can also be shaped for ripping.

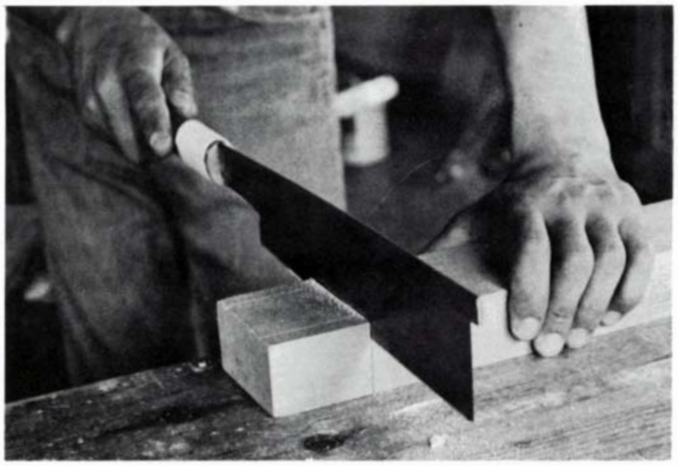
There are a few different styles of *kataba, ryoba* and *dozuki* to choose from. The *ryoba* and *kataba* usually come with the teeth in a straight line, but sometimes carpenters prefer a saw with a convex cutting edge (*anabiki*) to begin cuts in the middle of a board or panel. On *dozuki*, the teeth are always in a straight line but the amount of arch in the stiff back varies,

EDITOR'S NOTE: A 210-mm *ryoba* saw costs $46.50 at Woodline/The Japan Woodworker, 1004 Central Ave., Alameda, Calif. 94501; and $11.75 at Tashiro Hardware, 109 Prefontaine Pl., Seattle, Wash. 98104. Many mail-order catalog houses also sell these saws: Garrett-Wade, $17.50; Woodcraft Supply, $17.40; and Leichtung, $10.95.

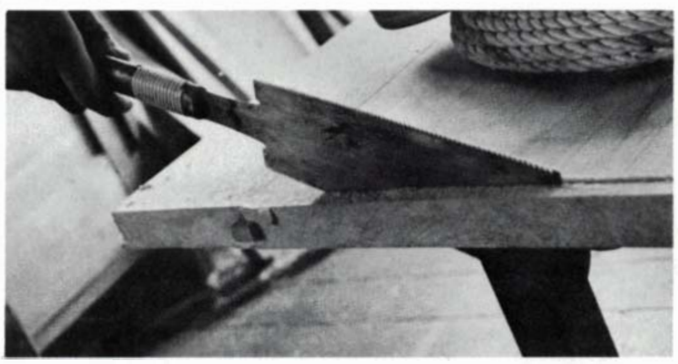
Photos: Robert Ghelerter



Dozuki *with guide block cuts the beveled shoulder for a beveled mortise-and-tenon joint.*



Board is cut to length by sawing in from each of the four sides in turn.



Ryoba *crosscut edge trims tabletop.*

changing the angle of the handle to the saw body. There is also a small version of *ryoba* known as *azibiki*. Its blade is usually no longer than 100mm (4 in.), is thick and will not flex much. The cutting edges are convex. I have seen these saws used only by carvers for roughing out, though I understand they are also used in joinery.

When choosing a saw, first consider usage. Carpentry and cabinetmaking saws differ in size, flexibility, hardness and thickness. Standard blade sizes are as follows:

	Cabinetmaking	Carpentry
Kataba and *ryoba* length	210mm to 240mm (8¼ in. to 9½ in.)	270mm to 420mm (10⅝ in. to 16½ in.)
Dozuki length	210mm to 240mm 8¼ in. to 9½ in.)	240mm to 315mm (9½ in. to 12⅜ in.)
Dozuki depth of cut	40mm to 55mm (1⅝ in. to 2 in.)	60mm to 95mm (2⅜ in. to 3¾ in.)

Carpenter's saws are bigger, thicker, harder and have fewer teeth per inch than cabinetmaker's saws. *Dozuki* usually have from 25 to 30 teeth per inch. *Kataba* and *ryoba* crosscut blades range from 15 to 20 teeth per inch, and ripsaws have from 6 to 8 teeth per inch. *Kataba* and *ryoba* teeth are slightly smaller near the handle, for starting the cut.

There are three grades of Japanese tools based on the quality of the steel: "Yellow" is the lowest, "white" the middle, and "blue" the highest quality. It is difficult in this country to distinguish these grades except by price. Saws of the yellow rank (their blades have a yellowish tinge) are cheap ($2 to $13) and not used by serious craftsmen. Most middle and high-grade tools are made from white steel and can cost from $20 to several hundred dollars. A few extremely expensive tools are made from blue or sword steel. Those that are handmade are easy to differentiate from machine-made saws; the surface is rough and they can cost several thousand dollars.

For general cabinetry, a good saw to start with would be a 220mm *ryoba*. For fine joinery you should also have a *dozuki*—240mm is standard. Beginners should stay away from the thinnest (paper-thin) *dozuki*, which, although more accurate, are harder to control and can easily break. A good saw maximizes hardness and flexibility; it will bend considerably (the *ryoba* and *kataba* into a half circle) and still return to its original shape. Yet because it is thin, it will break before it deforms. Cheap saws are thicker, softer, less flexible, and less likely to break.

Good saws generally come with the handles unattached. The handles are usually wrapped with bamboo cane, for strength. Some are wrapped only at the end where the saw fits in, others the entire length. Handles come with a hole for the tang, but the holes are usually too small and should be enlarged with a keyhole saw. Cut only a little at a time, trying the saw tang for fit. Push the tang into the handle and strike the handle end with a hammer. Never strike the saw itself.

In Japan most woodworkers send their saws to a shop for sharpening by hand. Saws can be sent back to the factory to be sharpened by machine, but hand-sharpening, which leaves the teeth rough from the file, is considered superior. It is not difficult and with a little practice can be done rapidly. If this is your first time sharpening a saw, before beginning, cut a kerf in a piece of wood so that the newly sharpened saw can be compared to how it was before.

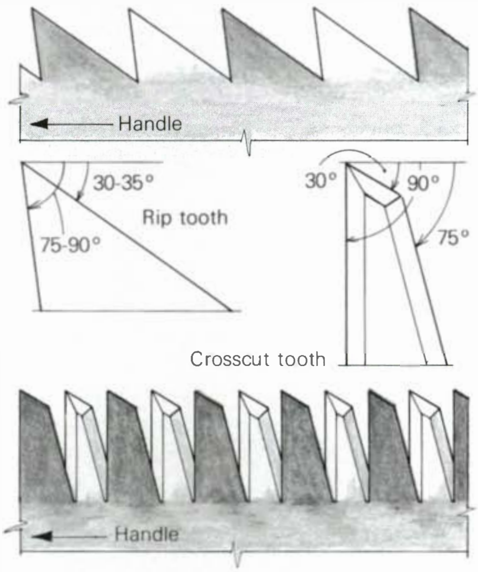
If the blade is warped or kinked, sometimes a result of friction-caused heat expanding the metal at the cutting edge, hammer it out with the same hammer that will be used to set the teeth. The saw is placed on a piece of iron, concave side of the warp down, and struck lightly to stretch the metal evenly. Never heat the blade; you can easily ruin its temper.

Sometimes the blade of the *dozuki* slips a little from the backing. It is held only by pressure and is not actually bonded. A loose blade can become badly kinked, but is easily remedied by tapping the saw's back on a piece of wood. After straightening, hold the blade in one hand, resting on a firm surface, and joint the teeth. The Japanese use a special tool, but a flat metal file serves the same purpose. Two or three strokes ensure that all the teeth are the same height. Now the saw is ready to sharpen.

Sharpening must be done with a special feather file (a thin diamond in cross section), which should be available where the saw is purchased. It is best used only once and comes unhandled, so it's a good idea to make a simple, reusable

Photos: Robert Ghelerter

A special tool, left, joints the teeth. The saw vise alongside the sharpener's knee is used with a diamond-profile featherfile, as at right, to sharpen the lead side of a rip tooth.



After filing, gentle tapping sets the teeth.

handle. The Japanese prefer a thin branch from a cherry tree, but a piece of dowel stock with a drilled hole to receive the tang will work as well. To hold the saw, the Japanese use a flat, wide vise whose two jaws, hinged in the middle, are driven together with a wedge at the bottom. The jaws are shaped so they grasp the saw only near the teeth. Two shaped boards held together with screws and wing nuts will suffice.

Rip teeth and crosscut teeth have different shapes and are filed differently, except that filing is always done on the push stroke and on teeth that point away from you. For the rip teeth, hold the file 90° to the saw body and file the lead side of every other tooth (the side closest to the handle), then turn the holder around and file the lead side of the remaining teeth. Push simultaneously sideways and down, to cut a little into the body of the blade. One or two strokes are adequate. Next file the trailing side, also 90° to the saw body, once again doing every other tooth, then turn the holder around to file the remaining teeth. File until a new point is formed.

Japanese crosscut teeth are quite unlike any Western saw teeth, in that each is sharpened with a bevel not only on the leading and trailing edges but also at the apex of each tooth. The leading and trailing edges of adjacent teeth are filed on the same stroke, then the top facet is filed. Start with the handle of the saw on the right. Hold the file at a 60° angle to the saw body, pointing toward the handle. One stroke, pushing down and toward the left, should cut the leading edge of the tooth set away from you, while the other side of the file rubs lightly on the trailing edge of the tooth to the right, set toward you. Next file the top of each tooth set away from you, trying to duplicate the existing angle, which is about 60° to the saw body, but slanted away from the handle. Again, one stroke is adequate. Then turn the holder and with the handle and file pointed to the left, and applying more pressure on the stroke to the right (on the leading edge of a tooth set away from you), file the other teeth.

Because the blade is so thin and sharpening can bend the teeth, they are set after filing. A hammer with a face no wider than a single tooth is used. Hold the edge of the saw on the rounded edge of a piece of flat iron so the tooth to be struck almost touches the iron. Bring the hammer down lightly, or allow it to fall of its own weight. The small crosscut teeth require considerable skill. Look down both sides of the saw to make sure the teeth are in line. *Dozuki* teeth need little set, although the amount can vary with personal preference. If in use the saw is difficult to guide, the teeth may need a little more set. After setting, deburr the saw by running a piece of metal along both sides of the teeth. Occasionally, rub a little oil into the blade to keep it from rusting. □

Robert Ghelerter, 26, has recently returned from a year and a half studying woodworking in Japan. He now builds furniture in Berkeley, Calif.

Editor's Notebook

Two schools in England, and a glimpse of skill

The British believe so strongly in education that they devote whole schools even to such arcane fields as furniture making. Among their newest is the School for Craftsmen in Wood, run by John Makepeace at Parnham House, a 15th-century manor in rural Dorset. The two-year intensive course has 18 students and a full-time staff of four, plus a dozen or more visiting lecturers each year, some for a day and some for a week. The threefold idea behind Parnham is perhaps best phrased in the school prospectus: "To put skill into the hands of young men and women of practical aptitude and creative intelligence; to provide an integrated training in design, woodworking, production and management including marketing; to foster the initiative, discipline and stamina required for self-employment." The students here practice not only joinery, but also photography, typing and accounting, for Makepeace believes it imperative to be as excellent in business as in workmanship.

The students live in dormitories attached to the manor house and can observe goings-on at Makepeace's own successful studio, which employs seven cabinetmakers. In the first year, the students are given drawings to build, thereby learning about materials and techniques; in the second, they develop their own designs. Ideally, a student graduates with a portfolio of good work he already knows how to make, and the savvy to survive when he opens his own shop. Applicants come from all over the world and are screened meticulously, and the tuition is steep. But the joint is jumping, and the students I met are clearly pleased to be there, working hard day and night. For information, write Makepeace at Parnham House, Beaminster, Dorset DT8 3NA, England.

As Parnham is an elite place, so the London College of Furniture caters to the rest of us. It was founded in 1889 to supplement apprenticeship training; today, it is a modern, six-story structure in the Shoreditch district where 600 full-time and as many part-time students go every day. The facilities—especially the machine rooms—are superb, although the atmosphere hasn't nearly the electricity of Parnham.

Courses of study can last from one to four years, with most students entering directly from seconday school. Programs range from furniture design and construction to industrial production, upholstering, antique restoration, finishing and interior design. A separate division of musical-instrument technology teaches the making and repair of pianos, harpsichords, violins, guitars, lutes and woodwinds. British students receive a variety of tuition subsidies, while overseas students must pay the full freight, from $1,000 to $2,000 a year. For a prospectus, the address is 41/71 Commercial Rd., London E1 1LA, England.

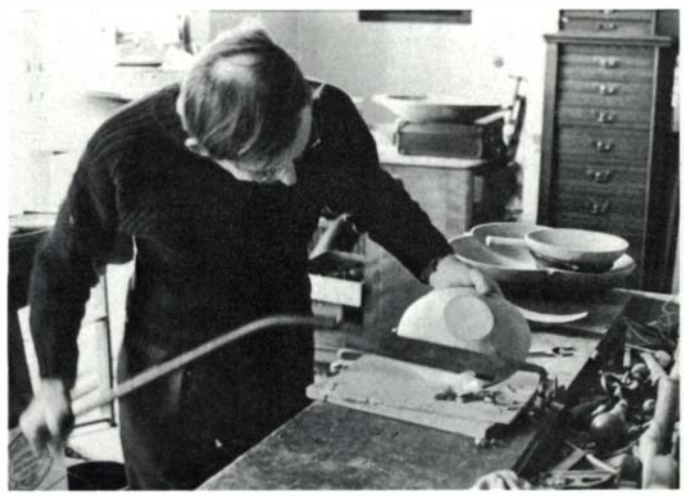
* * *

All the schooling in the world is no match for the intelligent application of skill and experience; the more seasoned the craftsman, the simpler his tools, and the more directly he can go to the result he desires.

Take David Pye, for many years professor of furniture design at London's Royal College of Art. Pye wrote two of the most insightful books we have, *The Nature and Aesthetics of Design* and *The Nature and Art of Workmanship* (for reviews and for photos of Pye's work, see *FWW* #13, Nov. '78). These days he lives in bucolic retirement south of London, augmenting his pension by turning delicate boxes and carving robust bowls. His shop is a single room on the ground floor, the clutter of many years surrounding two large benches and a foot-powered toolmaker's lathe. While turning, Pye commands a view through door-high glass of his gardens and the wooded hills beyond. Besides the lathe, and despite a career teaching in a very well-equipped shop, his only machine is a little band saw. He'd rather have the quiet, and find more cunning ways than brute force to avoid drudgery.

As theoretician, Pye makes the distinction between workmanship of risk (hand-dovetailing, for example) and workmanship of certainty (most mass production). He divides the results into a spectrum ranging from highly regulated work through free work to rough work—a light bulb is highly regu-

H. Triggs



Left, mahogany lowboy by Bennett Bacon won the London College of Furniture's craftsmanship award last year. Bacon is from Leesburg, Va. Above, David Pye demonstrates the bench knife.

lated, axwork is necessarily rough-hewn, most cabinet work is moderately free in that there are inevitable discrepancies between the drawn idea and the finished reality. As craftsman, Pye seems to be exploring techniques that fall into spaces between his careful categories, with subtle and startling results.

His large bowls are so regular they appear to be turned, even though many of them have handles or are double and triple circles wrought from a single plank. When I asked what faceplate could handle such shapes, Pye explained that the insides are wasted with an adze (very fast), then finished with carving gouges guided by jigs that leave tool marks in controlled, regular patterns. Then he bandsaws the outside close to the line and finishes with the little-known bench knife shown on the previous page. Knives like this were used by makers of wooden shoes, a trade long gone. Pye made his by bending one tang of a drawknife into a hook, which engages a staple driven into the bench (or the end of a stump). He straightened the other tang, drove it into an old bent rifle barrel and welded on an iron handle. With the simple knife and considerable skill, as I said, this most learned man goes directly to the shape and surface quality he wants—no fuss, no noise and no dust. *—John Kelsey*

New Japanese planers move wood against fixed knife

Although industrial leviathans dominated the 1979 Woodworking Machinery and Furniture Supply Fair, held at the Los Angeles Convention Center in early November, the show did not lack items of interest to the small shop. Japanese and European manufacturers continue to shine in design elegance, quality and performance. That this should be so worries me. American woodworking machinery seems unable to compete on the world market except by virtue of its low price. Foreign manufacturers of furniture intent on capturing the world market will not buy anything but the most efficient, up-to-date equipment, and are continually updating their plants. We, alas, nurture old isolationist tendencies, which may have made sense when our natural resources seemed endless. Our manufacturers of power tools still tout the same clumsily built and paleolithically designed planers, shapers, band saws and table saws they have been building for the last 30 years or more. In the meantime, the foreign machinery manufacturers capture the field, scrambling to come up with more efficient use of old materials, exploring new ones and devising innovative and creative techniques for improving versatility, precision and operating ease.

Japanese firms, for example, are investigating the potential of a new type of surface planer. The smallest of these, the Royal Sunday by Marunaka International, uses a single stationary knife that is raised or lowered in relation to an equally unconventional bed. The "bed," a broad conveyor platen made up of a continuous, resilient belt under power, propels the wood against the knife edge, peeling off a single, perfect shaving (I miked one at .003 in. thick) and leaving an absolutely flat, shimmering surface, free of sanding scratches and without the marks you get from conventional cutterheads. The knife angle with respect to direction of feed adjusts from 0° to 60°, to accommodate woods of different hardness and density. If you put a hand plane upside-down in a vise and ran a piece of wood against the sole, you'd have a fair representation of what these machines do. Why not just use a plane? It would take a plane with a 4-in. knife to duplicate the feat, and who'd be strong enough to push it?

These machines, ranging upward in capacity from 4 in. wide, do not replace the thickness planer. They will, however, surface better, more easily and more pleasantly (no dust or unbearable noise) than sanding surfacers or stroke sanders. Almost no piece is too short to surface. And because one side of the machine is open, if you reverse an 8-in. board on a machine of 4-in. capacity for a second pass, you have surfaced a full 8-in. width. Maximum thickness is 3⅛ in. The low knife angle permits surfacing against the grain. The Marunaka surfacer displayed at the show weighs only 110 lb. Marunaka machines are sold by Southwest Machinery Co., 9507 Santa Fe Springs Rd., Santa Fe Springs, Calif. 98670.

Elsewhere on the surfacing front, Makita (U.S. office is at 650 Hadley Rd., S. Plainfield, N.J. 07080) has a 15¾-in. planer of conventional cutterhead type, with a novel precision-pillar system for raising and lowering the table. It's more difficult to manufacture than the usual gibs-and-ways, but it uses fewer parts and keeps things undoubtedly parallel. The thickness capacity is 7⅞ in., yet the machine weighs only 254 lb. and is being marketed ($1,380 retail) as a semiportable. I wonder if, coupled with a portable circular saw, router and chain-saw mill, a tool of this type might not complete the foursome needed to tackle the most sophisticated on-site work, starting with the tree.

Lest this review seem biased in favor of Japanese products, I'd like also to mention the introduction into this country of a 10-in. Ulmia table saw manufactured by George Ott of West Germany. I believe this new saw, model 1710, is one of only two available here with mortising tables off the side. Ulmia is by reputation the top of the line in European table saws of small capacity. The price reflects it, though, so don't consider one unless you either are wealthy or cannot do without absolute reliability and precision. The saw has a 2½-HP single-phase motor enclosed in its stand, a 20-mm (about ¾-in.) arbor, and a sliding table off the left side. It also comes equipped with casters, lever-operated. The mortising table has a joystick like that of a helicopter, with which it maneuvers in, out and sideways. It is on display in California at the Cutting Edge stores in Beverly Hills and Berkeley, and costs in the neighborhood of $4,000. *—Alan Marks*

EDITOR'S NOTE: The Los Angeles machinery show is a regional version of the international furniture supply fair that used to be held every two years in Louisville, Ky. This year the sponsoring organizations have disagreed and two different shows will be held. The Woodworking Machinery Importers Association will show Aug. 23-27 at the Georgia World Congress Center in Atlanta. The Woodworking Machinery Manufacturers of America will show Sept. 13-17 at the Convention Center in Louisville. You can preregister for either show for free by mailing forms that will appear later this spring in woodworking trade magazines, or you can avoid forms and just pay $5 at the door.

Both of these shows are organized by and for the furniture and general woodworking industry, although they do include exhibits of interest to the small cabinet shop. In addition, a new trade show is being organized to serve the independent cabinetmaker and serious amateur woodworker. It will be held Oct. 2-5 at the Hyatt-Regency Hotel in Chicago, and success there will probably spawn similar events in other regional centers. Exhibitors will include tool and machinery manufacturers and distributors, hardwood, veneer and finishing suppliers, schools, plus craftsmen showing their work. For more information about exhibiting or attending, contact Marvin Park & Associates, 600 Talcott Rd., Park Ridge, Ill. 60068.

by Bjorn E. Loftfield

BRANDON CHAMBERS: Briar pipes and how they're carved

Before the briar pipe, clay, bone, stone and unknown woods were used as pipes. In the late 17th century, the smoking public discovered meerschaum (German for "sea foam") a fossilized sediment that carves like soap, is light in weight and breathes for a cool smoke. Meerschaum's only drawbacks are fragility and scarcity.

In the 1800s a wood substitute was found in the burl of the white heath tree *(Erica arborea)*. Briar (from the French *bruyere*, meaning burl) grows as a sphere between the roots and the tree base, and functions much as a camel's hump: It ensures survival throughout the dry season by storing moisture. The burl matures in 50 to 100 years, at which time the briar is harvested. Usually 1½ ft. to 2 ft. in diameter, it is then cut into blocks, and dried for five years.

The first craftsmen to work briar were the French carver/turners of St. Claude, a small mountain village. Their principal tool was the treadle lathe. The briar was turned green; a pipe smoker had to break in his pipe over several months to dry it out. If you know what a "sour pipe" is, then you can sympathize with these first users of briar pipes.

The industrial revolution mechanized the turning process and made pipes more affordable, which in turn increased the demand. Care was taken to dry the briar and to bake it clean of resins. Briar pipes became more accepted, even among the aristocratic meerschaum smokers. Today turning a pipe takes seconds; grading, polishing, and waxing take several more.

Some French carver/turners decorated their pipes with intricate carvings of heads and figures, but most work of this nature was done in meerschaum, and practically no intricate carving has been done on briar pipes since the 1880s. Brandon Chambers, 26, of Olympia, Wash., is reviving the craft.

Chambers has been working wood for 16 years. Some of his first tools were screwdrivers, which he sharpened into chisels. Chambers first dabbled in pipe-carving as an army private stationed in Germany eight years ago and continued doing commissioned pipes in meerschaum and ivory until 1977. That summer he came upon an exceptionally fine briar block and decided to use it in the Tinderbox national pipe-carving contest. His pipe won and is now in the Brotherhood of the Pipemakers Museum in St. Claude.

That pipe revealed to Chambers the niche available to a carver of briar pipes. His prize was a trip to St. Claude, the pipe capital of the world, where he stocked up on briar blocks. The machines of the modern pipe factories he saw there can not read grain as can a sensitive craftsman. "When I pick up a block I consider what 'piece' it contains," he says. "Almost invariably I am correct, or the wood is, down to the very flow of the grain."

Carving a briar pipe can begin with either a raw or a predrilled block, which comes with a finished stem. Briar is graded into categories, depending on the number and size of the flaws and on the part of the burl from which the block is cut. Pieces called "plateaux" are most desirable and are used for the finer freehand pipes because they include the outer layers of the burl where the grain is tightest and most attractive.

Drilling the bowl, draft and shank holes are the critical steps. A long narrow bit tends to follow the grain, and the draft hole must align perfectly with the bottom of the bowl: If it meets above the bottom, the pipe will not smoke dry and will sour rapidly; if it goes past the bottom and into the opposite side, it creates a pocket that will not draw properly. The bowl is bored first. Chambers has experimented with tapered machine bits, but now pilot-drills and turns the bowl on a lathe with a ¼-in skew. The shank hole is drilled next and, to ensure alignment, the draft hole is drilled on the same setup. For bent-stem pipes the shank and draft holes must be angled differently. The bowl and draft-hole sizes determine the smoking time and temperature. A ¾-in. diameter bowl 1¼ in. deep with a ⅛-in. draft hole is about a one-hour pipe. Altering the draft hole by 1/32 in. either way produces a shorter or faster draw. For the shank hole, a ¼-in. diameter to a depth of ½ in. to ¾ in. is standard.

After the pipe is drilled, shaping can begin. Chambers uses a band saw for roughing out, making sure the walls will be no less than ¼ in. and uniformly thick. On plain and freehand pipes the work after bandsawing can be completed with a patternmaker's rasp and sandpaper. But most of Chambers' pipes involve figure-carving. After bandsawing he uses a series of air-powered grinders with various bits ranging in shape and size from a 1-in. tree-shaped burr to a pinpoint with three blades. His tools include a 22,000-RPM heavy-duty die grinder, a 50,000-RPM dental-surgery handpiece and a 60,000-RPM pencil grinder for the tight places. The high speed allows him to cut smoothly across and against the grain.

Grinding goes much slower than bandsawing. An arc stroke works well up and down the outside of the bowl. The figures are carved from the top, down and in, leaving supports for delicate lacework and ropes. Smoothing is done with finishing burrs, rifflers and 400-grit sandpaper. Next he scrapes the surfaces with a burnished knife, using fine steel wool for the highlights. Then he goes to a 1-in. buffing wheel with pumice and water in the flex-shaft, followed by a 1¼-in. diameter stiff brush.

If a pipe is to be dyed, an aniline dye must be used, either water or alcohol based. Stains, oils, and many other wood-finish products would eventually be tasted in the bowl, and sealing the grain will result in a sour pipe. A pipe left unstained will assume a burgundy color with use. Wax will protect the pipe and allow the briar to breathe. Carnauba, the hardest wax, has a high luster but the high speed required to apply it can burn or damage the pipe. Chambers' mixture is one-third beeswax and two-thirds carnauba wax. It is hard enough to afford protection, yet soft enough to spread at a safe speed.

The pipe stem can be purchased rough-cast in many shapes and lengths of vulcanite, hard rubber or acrylic through most pipe shops. A dowel-cutter brings the stem shank down to size. Ornate turnings or figure and relief carvings can be added on the stem. It is then sanded to 400 grit and buffed with plastics compound and waxed. The stem can be bent after rotating it close to an electric coil; overheating can change its composition and color. □

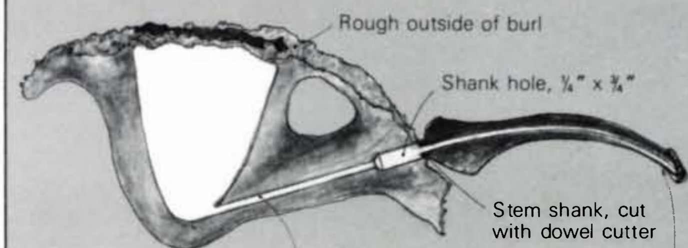
EDITOR'S NOTE: The only book we've found about making pipes is *Pimo's Guide to Pipe-Crafting at Home*, from Pimo, Box 59211, Chicago, Ill. 60659. Pimo also sells pipe tools and materials, as do most pipe shops and mail-order woodworking supply houses.

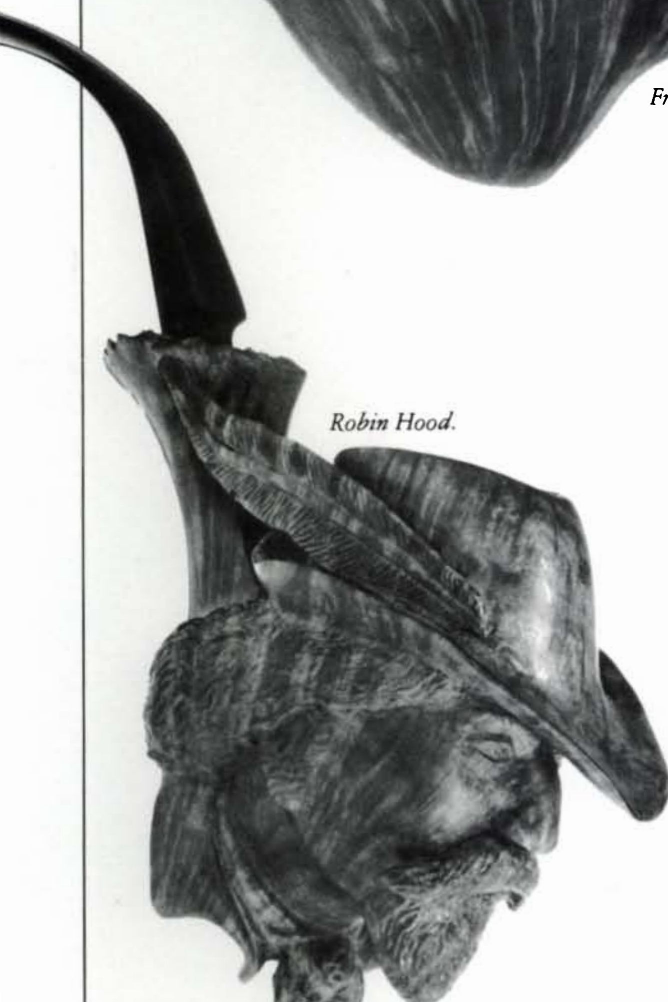
Photographer Bjorn Loftfield, 26, lives in Woods Hole, Mass.

Photos: Bjorn E. Loftfield

Freehand bridge.

Freehand-pipe construction





Robin Hood.

Freehand flower.

Neptune.

Woolly mammoth with attackers.

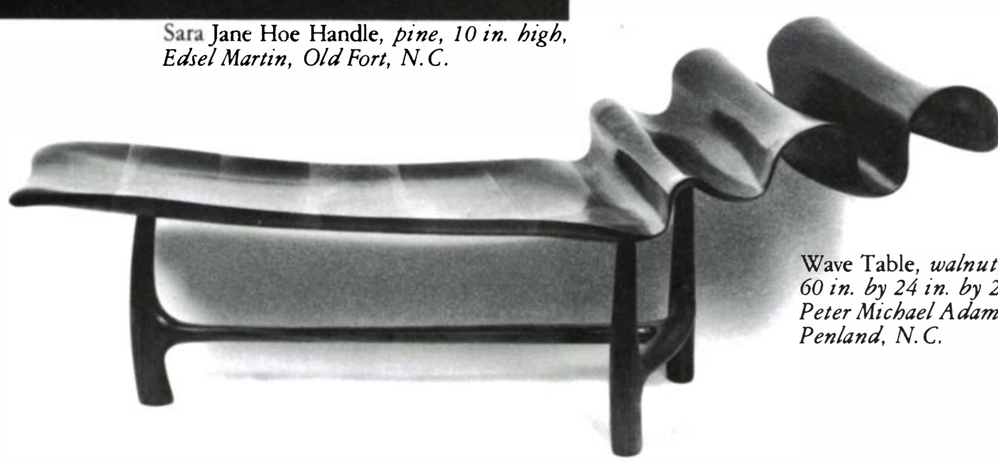
Appalachian Crafts/ Thirteen States

It used to be that to see several hundred pieces of fine craft in one showing, you'd have to be on one coast or the other. The woodworking on this page is a small taste of the 300 creations in all media drawn from the Appalachian states, from southern New York to eastern Mississippi, to inaugurate the Appalachian Center for Crafts near Smithville, Tenn. In New York or Los Angeles, you might find such a plentiful exhibit, but it would probably be either contemporary or traditional, rarely both at once. The magic of Appalachia is that in its blue hills the old ways have never faded, yet the new find fertile ground. Nobody hesitates to put one beside the other.

The center has been five years in the planning and building, with funding from the Appalachian Regional Commission. It promises to be a major professional training center and a reservoir for craft activities. Facilities include studios in each of the five major crafts (wood, fiber, metal, clay and glass), a research library, a supply store, housing, a cafeteria and a gallery, which is building a permanent collection. Besides local craftspeople, some of whom will be in residence, the center brings in teachers from throughout the country for seminars and workshops (See Events, p. 34). In development are programs for continuing education, apprenticeships and a crafts degree.

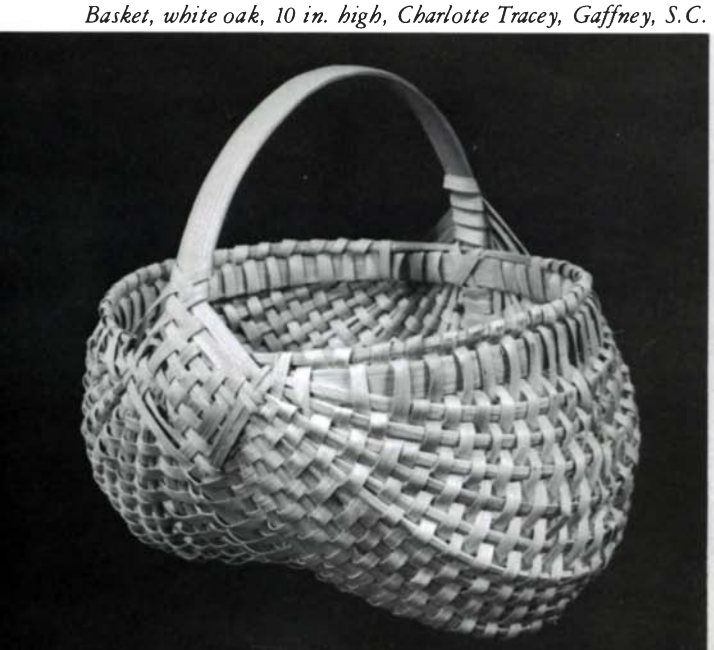
Sara Jane Hoe Handle, *pine, 10 in. high, Edsel Martin, Old Fort, N.C.*

Queen Anne side chair, walnut, 40 in. high, Eugene E. Landon, Montoursville, Pa.



Wave Table, *walnut, 60 in. by 24 in. by 28 in., Peter Michael Adams, Penland, N.C.*

Basket, white oak, 10 in. high, Charlotte Tracey, Gaffney, S.C.



Feline Table, *walnut, satinwood, deer antler, 20 in. by 36 in. by 18½ in., Craig Nutt, Northport, Ala.*

Fine WoodWorking® INDEX

This index covers the first twenty issues of *Fine Woodworking* magazine (Winter '75 through Jan./Feb. '80). It is divided into four sections: **Information, Photographs, Article Titles** and **Books Reviewed.** *Information*, the main section, is primarily technical references from articles, departments and letters. *Photographs* comprises only finished pieces of woodworking; pictures of people and of work in progress are not included. In these two sections many references are duplicated, in both their specific form and under such subject headings as Joinery, Finishing, Chairs, Tools, etc. For example, look for dovetails under both Dovetails and Joinery. *Article Titles* is arranged alphabetically by main headline, and corresponds to the tables of contents from each issue. *Books Reviewed* is also arranged alphabetically.

In all these listings the issue number is given first, followed by a colon and page numbers. Note that consecutive pages are separated by a hyphen, non-consecutive pages by a comma.

The first eleven issues of *Fine Woodworking* were designated by date, not issue number. The issue number has appeared on the front cover and contents page since No. 12, Sept. '78. This table correlates cover date and issue number for the first eleven issues:

No. 1 = Winter '75	No. 7 = Summer '77
No. 2 = Spring '76	No. 8 = Fall '77
No. 3 = Summer '76	No. 9 = Winter '77
No. 4 = Fall '76	No. 10 = Spring '78
No. 5 = Winter '76	No. 11 = Summer '78
No. 6 = Spring '77	

We've printed this index as a center insert so you can remove it, if you wish, for ready reference. Hold the magazine firmly on the table with one hand, and with the other grasp the index pages. Yank sharply straight up, the way you would remove a Band-Aid.

Index prepared by David J. Wanger, A.S.I.

INFORMATION

Photographs

Article Titles

Books Reviewed