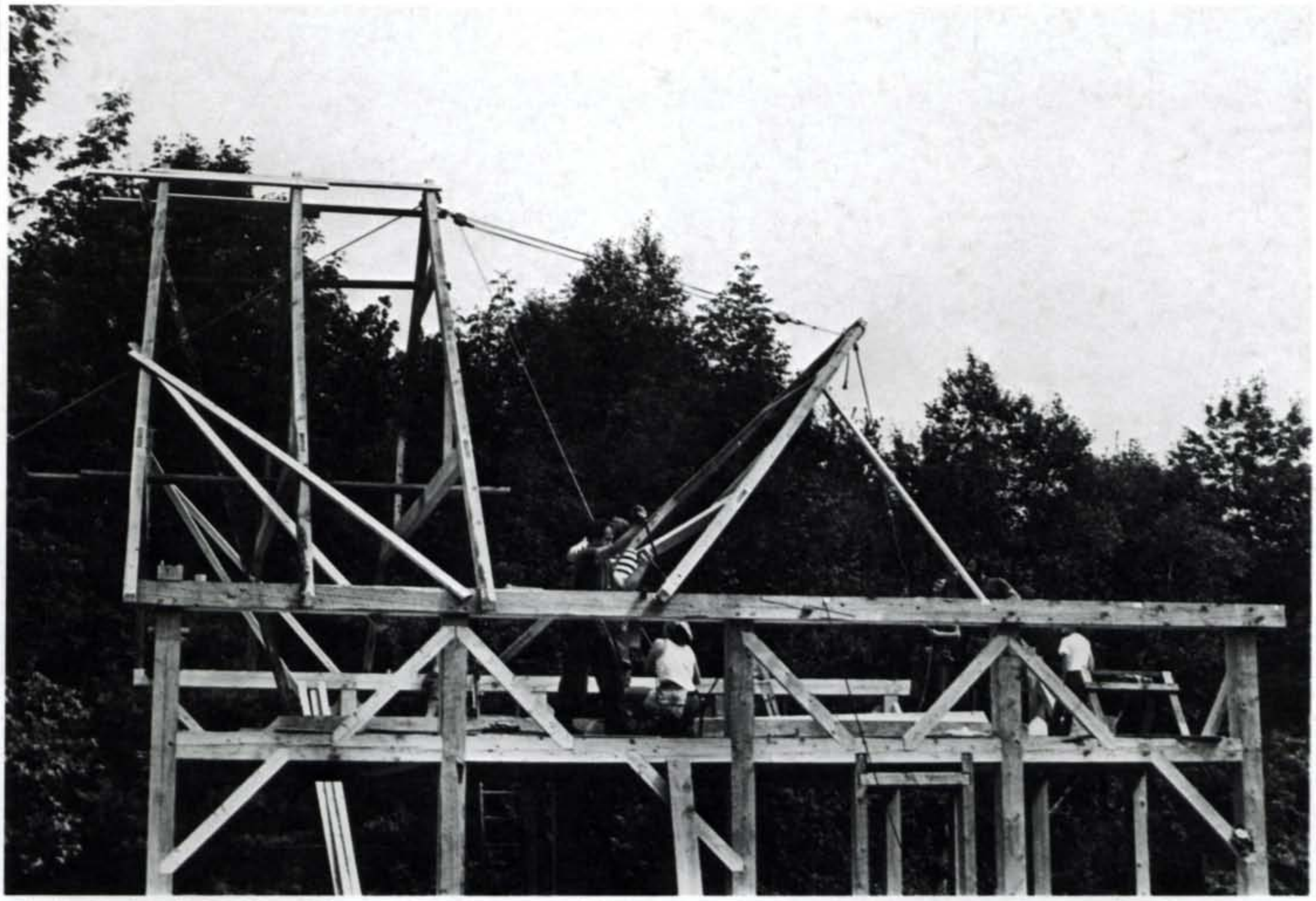
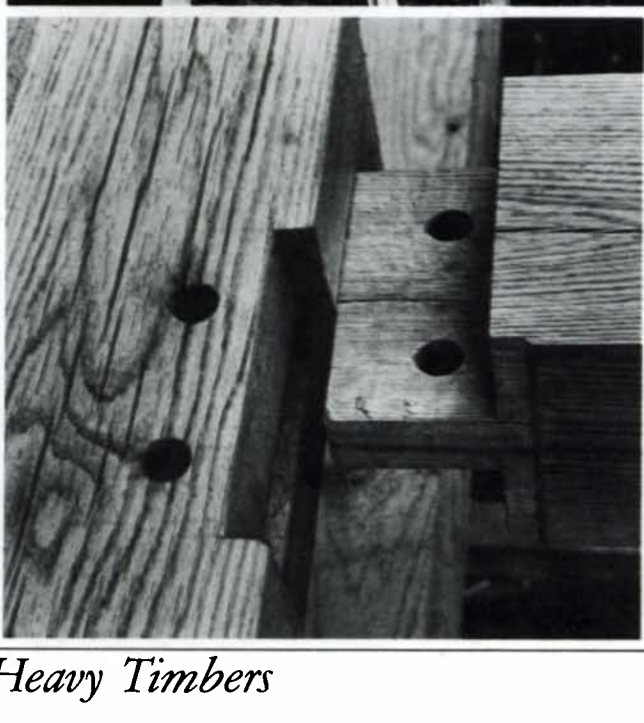
Fine WoodWorking

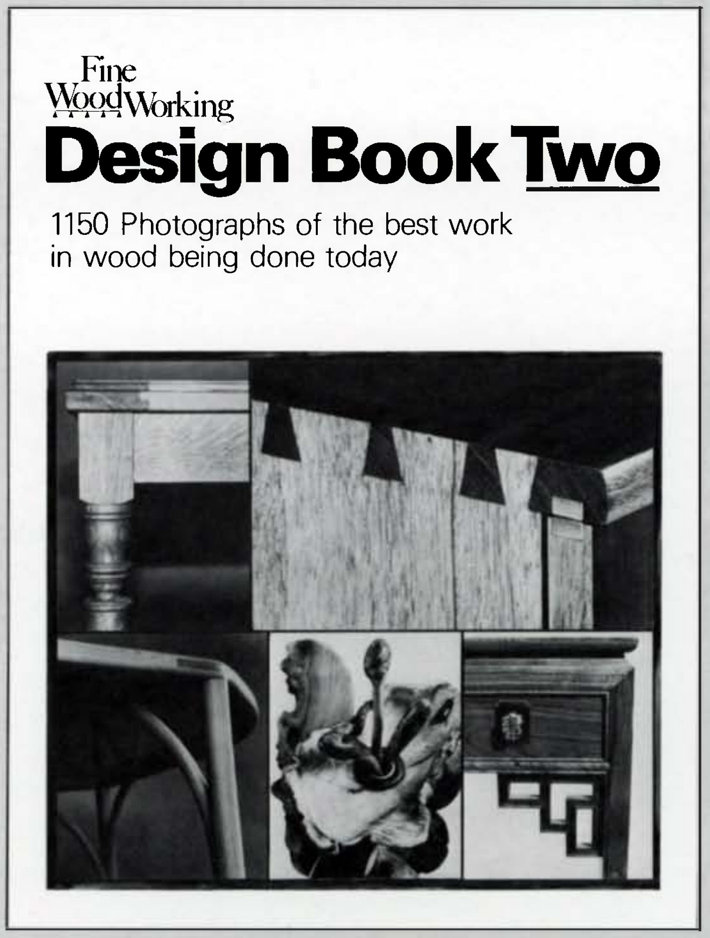




Heavy Timbers

JULY/AUGUST 1979, NO. 17 $2.50

The best work in wood from the woodworkers of America



Now offered only to *Fine Woodworking* readers at a prepublication price of $10, a saving of $2.

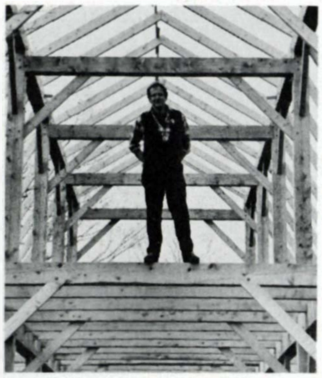
Chairs, beds and stools; tables, desks and bureaus; tools, instruments and toys; cabinets, cupboards and houses; sculpture, carving and marquetry—and even a couple of canoes. *Fine Woodworking* Design Book Two is a lavish treasury of 1,150 photographs of the best work in wood by 1,000 present-day craftsmen. It covers a breathtaking range, from traditional favorites to contemporary wonders. If you like wood, you'll love Design Book Two. *Fine Woodworking's* original Biennial Design Book (1977) was such a smashing success that the editors invited *Fine Woodworking* magazine's 130,000 readers to send in photographs of the best work they had done since then. The response was overwhelming. The editors pored over thousands of entries to choose the very best photos of the very best woodworking. Design Book Two is the result—a unique record of the state of the woodworker's art in all its inspiring diversity.

Each photograph is accompanied by the dimensions of the work, and a list of the woods and principal techniques used. There also are informative remarks by the craftsmen themselves—on how they work and why they work. The book includes a directory of woodworkers, giving the business name, address and shop specialties of the professional craftsmen represented.

Design Book Two is 288 pages long, printed on the same quality and size paper as this magazine, and bound in both soft and hard covers. It goes on sale Sept. 30 at $12 a copy soft-cover or $16 hard-cover, postpaid. *Fine Woodworking* readers may reserve a copy now at the special prepublication price of $10 soft-cover or $14 hard-cover. Simply fill out and return the coupon bound inside the back cover of this magazine. This prepublication offer expires Sept. 15, 1979.

The Taunton Press

52 Church Hill Road, Box 355D1, Newtown, CT 06470



Cover: Raising the rafters and some joinery details from heavy timber frames made by housewright Ed Levin of Canaan, N.H. (above). Levin discusses the elements of timber framing, tools, layout strategies and the basic mortise-and-tenon joint, on page 43. Cover photos: Richard Starr.

Fine WoodWorking®

JULY/AUGUST 1979, NUMBER 17

DEPARTMENTS

ARTICLES

Fine Woodworking (ISSN0361-3453) is published bimonthly, January, March, May, July, September and November, by The Taunton Press, Inc., Newtown, CT 06470, Telephone (203) 426-8171. Second-class postage paid at Newtown, CT 06470 and additional mailing offices. Subscription rates: United States and possessions, $12 for one year, $22 for two years; Canada, $14 for one year, $26 for two years (in U.S. dollars, please); other countries, $15 for one year, $28 for two years (in U.S. dollars, please). Single copy, $2.50. For single copies outside U.S. and possessions, add 25¢ postage per issue. Send to Subscription Dept., The Taunton Press, PO Box 355, Newtown, CT 06470. Address all correspondence to the appropriate department (Subscription, Editorial or Advertising), The Taunton Press, 52 Church Hill Road, PO Box 355, Newtown, CT 06470. Postmaster: Send notice of undelivered copies on Form 3579 to The Taunton Press, PO Box 355, Newtown, CT 06470.

Letters

In reference to a letter from a "group of people" from the Huron, Ohio area represented by Mel Bird (May '79), until a year ago I would have shared Bird's opinion. I am a furniture maker. I produce only those of the period type. However, I am now in contact with woodworkers of all kinds, be they professional or amateur. I have learned that their so-called art is produced with the same meticulous expertise as period pieces. They have just as much respect for wood and the craft of woodworking as you do. . . they merely express it in their own way. —*Paul C. Hardy, Jr., Malden, Mass.*

I would like to second the letter from Mel Bird and add some of my thoughts. I own a small short-run production shop in which I do woodwork for other manufacturers. Occasionally, I do things which you might respect. My subscription began with your first issue and I'm astonished at how little you have taught me. I'm about to file you under *craftsy-poo* and be done with it. . . . Your emphasis seems to me a strange marriage of hippie and elitist. You focus on the impractical, the outlandish, the outdated and all too often, the petty, to the near exclusion of anything practical. I am so tired of wooden planes, goofy turnings, and useless and uninformative advertising that I could scream. There is a real place in the culture—in these times—for affordable, well designed and proudly made wood products. You publish precious little that I would care to own. Never mind whether or not I could afford it. You seem to insist that a craftsman is someone who belligerently clings to outdated techniques, scorns work that the man on the street can afford, has no interest in the social ramifications of his craft and derives his income either by toadying to the rich and bored or by playing the guru. Well, I claim that there is a crying need for woodworkers whose heads are suspended somewhere between the clouds and their butts, and I think you do the craft a severe disservice in ignoring this need.

Having vented the preceding spleen, I sat down to read the May issue and I want to note some encouraging signs. I've entered the vacuum press in my list of projects. The chair comments are sensible. Please put Lelon Traylor's work out and don't waste his efforts answering twinky questions. —*Bob McKelvey, Canoga Park, Calif.*

I disagree strongly with Mel Bird. . . . The element that sets *Fine Woodworking* apart is its emphasis on both the craft and the art of designing for, and working with wood. Most of us are regularly involved in the rather mundane process of making items that are popular, or that will sell. Certainly there are plenty of magazines and books dealing with that aspect of the craft. It is a joy to feed on one periodical that challenges the mind and ignites the imagination in the very medium we love the most. Please continue to challenge and ignite even in the face of constant and sometimes overwhelming pressure for mediocrity. —*Max Peterson, Library, Pa.*

I wholeheartedly agree with Mel Bird. Your magazine is great if you want to build some avant-garde project but lacking if you are interested in becoming a fine craftsman. —*Les Foster, Puyallup, Wash.*

In reference to Mel Bird's comments, it would seem necessary to point out the obvious which apparently escapes him, i.e., mankind has, for centuries, striven to combine art with func-

Workbench Price Breakthrough!

At Last! A Full-Featured Workbench At An Affordable Price

Until now, quality workbenches have usually been too expensive or too small. This huge 225 lb. Garden Way Home Workbench offers a 30″ x 60″, 2″ thick laminated work surface and is available direct from the factory at an incredibly low price. Made of solid rock maple, the Garden Way Workbench not only offers a spacious 12½ sq. ft. of work area, extraordinary sturdiness and clamping versatility, but is a fine precision tool itself that can be as useful as having an extra "pair of hands" helping you in your shop.

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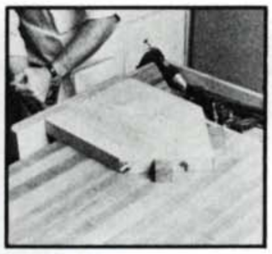
1 "Flip-over" vises provide a solid workstop—yet turn over so top of vise is flush with bench surface for regular vise use.



2 Round dog holes with rotating bench blocks will grip odd-shaped work pieces and eliminate most jigs and fixtures.

3 12½ sq. ft. (30″x60″) of work surface interacting with vises and rotating bench dogs lets you hold large boards and planks — even a 4′x8′ sheet of plywood.

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tion. Perhaps Bird's ancestors scoffed at a Thomas Affleck highboy as being "too modernistic and gaudy." The fact remains, however, that to see such examples of "period" furniture, one must go to the art museums.

Although I cannot claim to represent any contingent of readers. . .I hope that you continue to include articles about contemporary design along with classical design. I too may not always like the modern but I feel it is important to see what is being done.

—John E. Morgan, Louisville, Ky.

In recent issues I have read too many complaints (from the likes of Mel Bird) from people who fail to submit articles or even substantial and specific suggestions for the editors to pursue; let us read more praise, or at least constructive suggestions. Additionally, I wonder whether what he calls "art" projects aren't the contemporary displays of our craft? I, too, enjoy (building) period pieces, but I have had (and I'll immodestly add caused) a great pleasure approximating duplications of many of the artsy items. . . .

Dr. Albert Ritterson (May '79, page 36) is an amazing human being. Would that many of the rest of us could overcome the emotional and attitudinal handicaps that limit productivity more seriously than Ritterson's physical handicap limits his! I believe these articles about the attitude of the craftsman (Ritterson, Krenov, Nakashima, Barnsley, to name only the ones that come immediately to mind) are your most important contribution. . . . *—Hugh Foster, Manitowoc, Wis.*

Re "Sheet Metal Screws" (May '79, page 17). The furniture industry, in fact most cabinet shops I know, have for years been using an improved version of the standard sheet metal screw called the Twinfast Thread which is superior in wood holding power to the old wood screw. There also exists a grip-it thread screw which has superior holding power in particle board. The Equality Screw Company, Inc., Box 292, El Cajon, Calif. 92022, will supply large and mini-pack orders, in hardwood, softwood, cabinet installation, cabinet assembly, hinge and particle board styles and each in assorted thicknesses and lengths and in pan head or bugle head. . . .When I run out of Twinfast screws and need some screws in a hurry, I use common Sheetrock screws purchased from my local building-supply house. They aren't quite as strong and do not come in too many sizes but they are less expensive. *—Willy C. Dittmar, Fairfield, N.J.*

. . .Here is the reason why sheet metal screws are not a standard in woodworking procedure. If you want to draw together two boards you can not do it with sheet metal screws, unless you clamp the boards first. Such is not the case with a wood screw because for a wood screw you drill a hole in one of the boards for the screw shank and driving the screw home brings the boards together. *—Wm. V. del Solar, Westmont, Ill.*

Contrary to Kent McDonnell's "problem of setting a saw fence" (May '79, page 17) I have never found it to be a problem. First adjust the edge of the saw blade to the fence for the exact width of cut needed, temporarily locking the fence in this position. Then on the opposite side of the fence place the inside "heel" of a combination square in the table miter groove at a point opposite the saw blade, slide the blade of the combination square to the fence and tighten the combination square blade at this measurement. Then adjust the front of the fence and the rear of the fence to this measurement. If the width of the board to be cut exceeds the length of a combination square placed in the miter groove, then use

the edge of the table as a reference point instead. . . .

On the subject of table saws, one should periodically check the alignment of the saw blade with the table by placing a carpenter's square against the full width of a saw blade (on the mandrel). The right-angle leg of the square should be parallel to the front of the table. If it is not square you will never be able to get a true right-angle cut using a miter gauge in the miter grooves, unless you compensate for the error. Depending on the model and make of your saw it is much better to fix the problem by loosening the screws holding the arbor, aligning with a carpenter's square and retightening the mechanism securely. —*Curtis McDowell, Bessemer, Ala.*

Maybe Robert DeFuccio ("Five More Chairs," May '79) doesn't realize that there are still people who live and sit in the ways people did historically, in the times from which the design of these chairs come. There's a lot more to the reasons for such chairs than esthetics and craftspersonship. Perhaps it's true that humans weren't the same size in those times, but one of the greatest differences in physiology has probably more to do with muscle tone than with body size. It hasn't been that long, after all. Aside from that, every person has different physiological and psychological needs.

I've sat in Dave Sawyer's thumb-back chairs quite a lot. It is, as DeFuccio says, visually a very fine chair. Traditional chairs weren't built as lounge chairs and this particular chair is quite comfortable if one doesn't try to go to sleep in it. It feels, to sit in it, as though it were made to keep one's body strong and supple, and as much as possible, bearing its own weight. . . . I have been able to forget that there was a chair there at all, which seems to me to be the purpose of a chair. . . . Maybe "modern" people should just stay in bed with the TV set. —*Loy McWhirter, Burnsville, N.C.*

Thank you for your article on air-powered tools (Jan. '79). You covered a complex subject in a careful but concise manner. I have two comments: In the caption for the pneumatic panel saw, you say there is no pneumatic chain saw. My employer's grounds crew has a 24-in. chain saw, made by Remington Arms, which is powered by air; it has fittings similar to the fittings on their jackhammers/pavement breakers. . . . Secondly, I would strongly recommend the use of a respirator with some of the high-speed pneumatic rotary woodcarvers. The fine dust generated with some of these is sometimes literally overwhelming; the worker's breathing passages should be protected.

—*Paul R. Burnett, Temple Hills, Md.*

EDITOR'S NOTE: Remington makes two air-powered chain saws: model 1P, with 14-in. bar, for general work, and the heavy-duty model 6P, with interchangeable bars ranging from 18 in. to 39 in., which can be operated underwater. One distributor is Desa Industries, 25000 South Western Ave., Park Forest, Ill. 60466.

It was interesting to read of the crushed amber finish used by Harry Wake (March '79) on his violins. In *Bee World* no. 4, 1978, a British quarterly, there is a summary of evidence that the finish used by such Italian masters as Stradivarius may have contained similar resins collected by honeybees. Propolis is essentially fresh, sticky, unfossilized amber used by bees to varnish and waterproof their hollow trees. When extracted with alcohol the balsam and resin contents dissolve. Pollen, hairs and cuticle matter of the bees settle out. The article cites evidence of such characteristic impurities present in a violin finish to suggest that the extract was not even filtered. It also cites research on the resin/balsam ratio of most propolis to be from 90/10 to 75/25. But in the area of Cremona, Italy, the

ratio from the Canadian poplar is as high as 99/1. A high nondrying balsam content may be the reason for the lack of success by subsequent makers from other areas. Their propolis varnish remained tacky. It is interesting to presume that as the sticky balsam does eventually, over many, many years, dry, the resins become what we call fossilized; Wake may be using something similar to that of the old Italian masters.

—Nason Donahue, Cockeysville, Md.

. . . Harry Wake's description of finishing techniques is quite cryptic. Readers might be interested to know that it is desirable to prevent the varnish from penetrating the softwood face of a stringed instrument. Such penetration adversely affects the Young's modulus, and therefore the resonance of this major acoustic element. The most effective way of accomplishing this that I know of is to seal the face with skim milk prior to the application of varnish. There is some evidence that Stradivarius used this strategem.

I mix ordinary powdered skim milk with water to the consistency of cream and brush a single coat onto the instrument face. When it is completely dry, the instrument is ready to varnish. Care must be taken when rubbing the coats of varnish not to cut through the finish, since this will abrade the casein layer and cause penetration of the subsequent coat of varnish into the wood, resulting in a dark blotch.

—Evan Fales, West Branch, Iowa

. . . Re James Ralston's method for getting an invisible edge joint (March '79). I am a violin-maker's apprentice and have found that carbon paper has too hard (slick) a surface to transfer well. I use ordinary artist's chalk rubbed onto one of the two surfaces. It is a little messier but for repair work such as re-edging soundpost patches and fitting in bassbars it is quick and efficient. Also, with all of the little traditional planes available in the trade I find a single-cut file is more precise. For long, straight joints I use a plane.

—Kevin Flannery, Grand Rapids, Mich.

Regarding Michael Lynch's beam compass ("Methods," March '79) the problem of the blind spot caused by the center spacer can easily be overcome by offsetting the center spacer by at least one-half its width, and providing an opening for the pencil on each end of the beam. This eliminates the need for screwing the pencil through the handle.

—Jim Stewart, Petersburg, Va.

Lawrence Churchill's suggestions in his letter of May '79 that new wood machines are unsatisfactory, and that used machine tools offer a better value to the woodworker, deserve comment.

Although his frustrations with new machines are understandable, the conclusion that all new wood machines are unsatisfactory is mistaken. Powermatic machines, the brand he discusses, are not "top-of-the-line" by any means. Tennewitz, Northfield and Whitney come to mind as more likely candidates, along with table-saw prices in the $4,000 to $10,000 range. These 16-in. saws weigh in excess of 1,600 lb., compared to 800 lb. for the 14-in. Powermatic, and have ground surfaces on rack-and-pinion controlled rip fences as well as on the tables. The price may be high, but machine tool quality in wood machines *is* available.

Second, wood and metal machines are designed differently not only because wood and metal have different properties, but also because the sizes and shapes of the things generally made from the two materials are different. There is some overlap, of course. Machine lathes do everything that wood lathes do, and more; therefore, if the spindle speed is high enough, machine lathes make fine tools for wood. But it is hard to imagine that machine tools can replace saws, jointers and planers. True, a milling machine with the proper cutter can do almost anything, but surfacing a hundred feet of wood on a milling machine would try the patience of a statue.

Let me suggest that a better solution to Churchill's problem is found in used wood machines of the highest quality, rather than in metal machines.

—*Charles R. Lawrence, Cambridge, Mass.*

I'd like to further a point made in Larry Churchill's letter (May '79) on power tools. Without becoming the Consumer Reports of power tools, could you encourage articles, a column or a listing of subscribers willing to share their experiences on this subject? Mine must be a common problem: Without trying or buying, how do I compare saws with aluminum-alloy, die-cast and cast-iron tables? How might I judge the capabilities of an Inca or a Shopsmith, with their advantages to a space-poor shop, to those of a Rockwell or Powermatic, with their mass? What things might a hobbyist, seduced by the thought of sometime spending more than 10 hours a week with wood, want to consider when planning a major tool purchase? —*John Hiltebeitel, S. Burlington, Vt.*

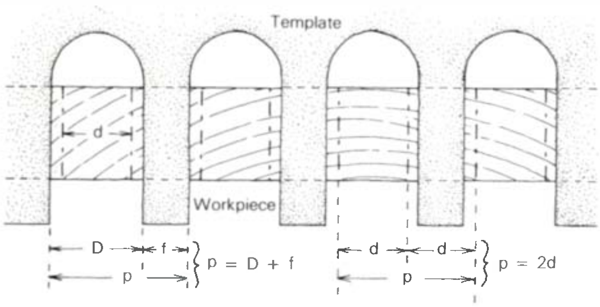
EDITOR'S NOTE: See page 18 of this issue for a report on small thickness planers. We're working on reports about combination machines, table saws and band saws, and will be grateful for readers' experience and opinions, both on woodworking machinery in general and on specific machines.

Many thanks for Patrick Warner's article, "Box-Joint Jig" (Jan. '70). I had recently purchased a router and a variety of bits to make just this kind of joint, so I read the article with great interest. However, I was a little confused about the relationships between the cutting diameter of the bit, the widths of the template finger and template slot, and the outside diameter of the template guide. Being an amateur woodworker and a professional mathematician I decided to apply a little elementary algebra. What is apparently obvious to Warner then became obvious to me—the width of a template finger added to that of the slot must be twice the diameter of the bit, and of course the width of the template slot must be the same as the outside diameter of the template guide. Perhaps the algebra will help others design templates to suit the particular box joints they wish to make.

The pattern (fingers and slots) of the template repeats itself over the same distance as that of the box joint. If this distance is represented by p, and the cutting diameter of the bit by d, then $p = 2d$ for a perfect fit. If the outside diameter of the guide is D, and the template finger width is f, then $p = D + f$. Hence, $f = 2d - D$.

For box joints with ½-in. fingers and slots and a template guide with ⅝-in. outside diameter, $d = \frac{1}{2}$ in. and $D = \frac{5}{8}$ in. Hence, $f = \frac{3}{8}$ in. Warner's template is designed for $D = \frac{5}{16}$ in. and $d = \frac{1}{4}$ in. In this case, $f = \frac{3}{16}$ in.

—*N.J. Gillespie, Toronto, Ont.*

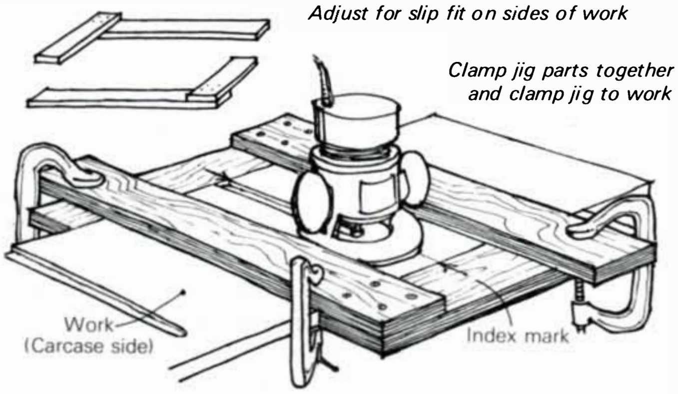


Methods of Work

Jig for cross-grain routing

The concept is simple, but this jig is indispensable for routing dadoes in carcase sides, especially when several dadoes are to be made in one board. Once the jig is clamped together you can slide it quickly into position for the next cut.

Make up two *L*-shaped pieces with 4-in. wide plywood strips. Cut the shorter pieces of the *L* 16 in. to 18 in. long (router base plus 8 in.) and the longer pieces 20 in. to 30 in. long (widest carcase plus 8 in.). Face-glue and screw the pieces together taking care to maintain a 90° angle.



To use, place one *L* on the front edge of the board to be routed and one on the back edge so that the two *L*'s form a woven rectangle as shown. Adjust both directions to give a slip fit against the router base and against the sides of the board. Then clamp at the intersections of the two *L*'s. Pencil in an index mark on both sides of the jig to simplify lining up for a cut. Clamp the jig to the board before routing the dado.

—Roger Deatherage, Houston, Tex.

Tin-can drying oven

If you have a stack of wood air-drying in the shop, chances are you have used this test to determine the moisture content of the wood: Cut a small sample from the wood, weigh the sample (I use a caloric scale), then dry the sample in the kitchen stove (until it doesn't change weight). Percent moisture is then calculated by dividing weight loss by final weight.

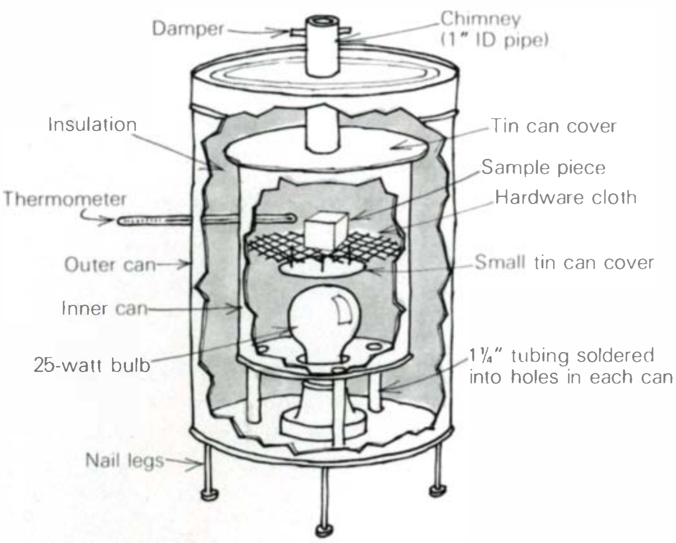
Unfortunately, the procedure ties up the oven for a day and, depending on the species being dried, fills the house with a disagreeable odor. These problems can be eliminated by a simple and inexpensive oven made from tin cans and heated by a 25-watt light bulb.

The model shows a 2-lb. coffee can (5 in. dia. by 6½ in. tall) as the inner container, and a large photographic-film container (7 in. dia. by 12 in. tall) as the outer container. The size and shape of the cans are not important—just so there's enough room for the wood samples and at least 1 in. of space between the inner and outer cans. Fill this space with fiberglass wool to retain the heat.

In operation, the heated, moist air rises through the chimney and is replaced by outside air drawn through the three tubes at the bottom. After a 20-minute heat-up period, adjust the temperature to about 112°F to 120°F by opening or closing the damper in the chimney. If the outside air temperature does not change drastically, the temperature inside the oven will remain relatively constant over the 24-hr. drying period with no need for a thermostat.

To solder the parts together, first file the surfaces clean,

Methods of Work *is a forum for readers to swap tips, jigs and tricks. Send details, sketches (we'll redraw them) and negatives with photos to Methods, Fine Woodworking, Box 355, Newtown, Conn. 06470.*



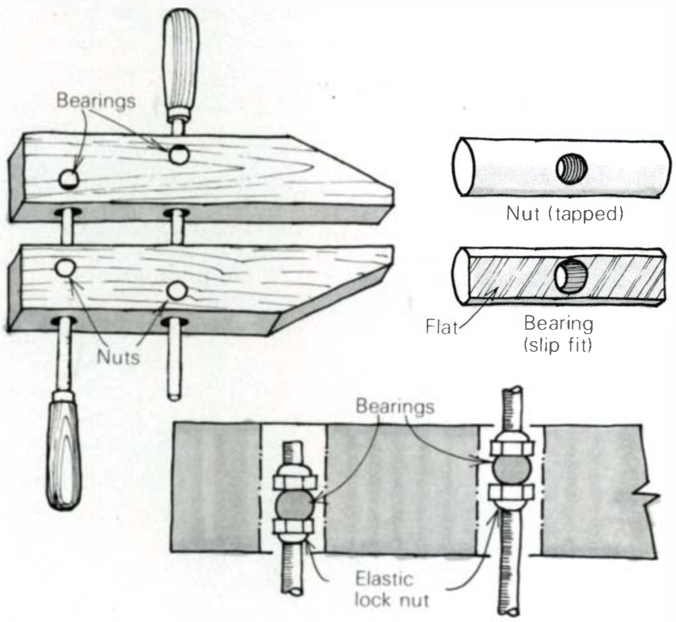
and tin with solder. Use soldering paste or acid as flux. Since tin cans are already tinned, soldering is easy.

The illustrated oven is designed for rather small wood samples. If you want to dry larger samples, the same design can be scaled up to a larger oven requiring, perhaps, a 40-watt or larger light bulb.

—*H. Norman Capen, Granada Hills, Calif.*

Toolmaker's clamp

I've seen several wooden clamp designs presented in the "Methods of Work" column—but none similar to what machinists know as a toolmaker's clamp. It is constructed like a standard wooden clamp but uses fixed bearing surfaces in place of the left-handed threaded rods and barrel-nuts. Because the toolmaker's clamp uses standard hardware-store threaded rod, it is much easier to build. Only a right-hand tap and drill bits are needed to complete the metal work.



Although the barrel-nuts can be made from either brass or steel, make the bearings out of brass (steel would soon gall the thrust surfaces). File a flat on each of the two bearings and turn the flat toward the side that takes the thrust. The thrust-nuts that bear up against the bearings must be locked into position on the threaded rod. I have found that elastic lock-nuts work well, but a pair of jam-nuts or a single nut brazed to the threaded rod could be substituted.

Both barrel-nuts must be located in one jaw and both bearings in the other jaw to get the standard tightening and loosening rotation. It will take twice as many turns to close the toolmaker's clamp, but you get twice the clamping force for the same tightening torque.

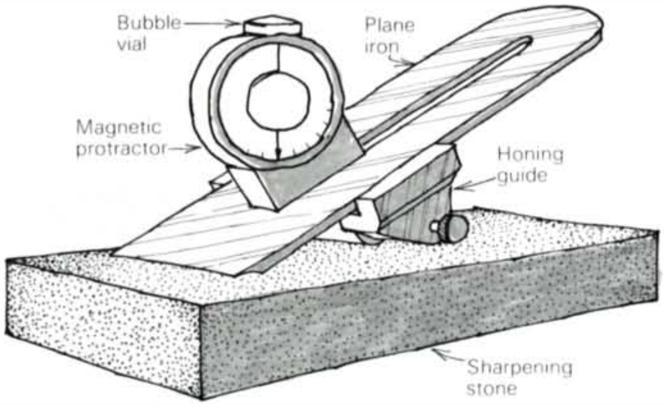
—*Larry Pagendarm, Santa Clara, Calif.*

Reproducing honing angles

Honing chisels and plane irons is facilitated by using a honing guide that clamps the tool and maintains the right sharpening angle between the tool and the stone. But it is difficult to set the tool in the guide at the same angle time after time.

I solve this problem by using a "magnetic protractor" (also called an "angle finder"). In its simplest form, the tool consists of a magnetic base and a movable part containing a bubble-level vial. A pointer on the movable part indicates the angle (from horizontal) on a protractor scale in the base. A similar (but more expensive) version is based on a spring-mounted pendulum that keeps the pointer vertical. Magnetic protractors are not commonly found in hardware stores but are available through Sears, Silvo Hardware and others.

To use, set the pointer to the desired angle and attach the magnetic base to the tool to be honed. Then, with the tool in the honing guide, adjust the angle between the tool and the stone until the level bubble is horizontal.

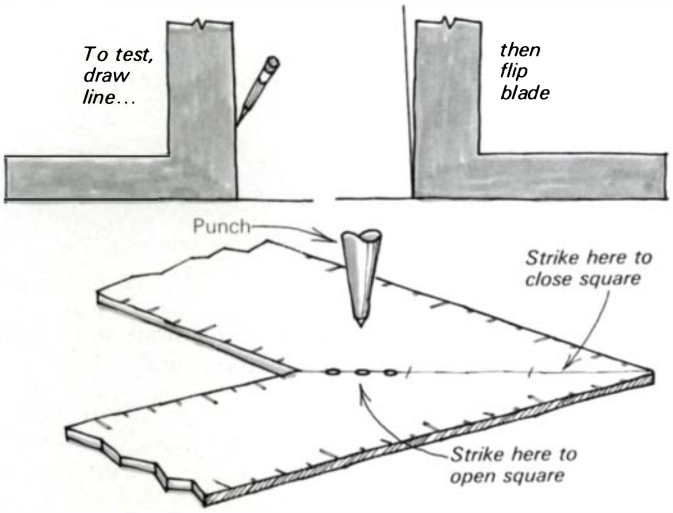


The honing surface should be flat and level for the above procedure to work. If the honing surface is not level, use the magnetic protractor to level it.

—*H.E. Brandmaier, Harrington Park, N.J.*

Trueing framing squares

Here's a method for trueing a framing square using just a hammer and center-punch. First test to determine if your square is true by drawing a straight line three to four feet long. Then, with the tongue on the line, draw a pencil line alongside the blade. Flip the tongue over and bring the square into the corner of the two lines just drawn. If the square is true, the lines will be right alongside both tongue and blade.



But if the lines don't coincide, here's how to regain a true 90°. At the heel, draw a line from the inside corner to the outside corner and divide the line into thirds. Place a center-punch on the line in the center of either the inner third or the outer third. By striking the punch in the outer third you spread the metal and cause the square to close (decreasing the angle). By striking the punch in the inner third you will open the square (increasing the angle). Rap the punch smartly with a hammer, as you would to leave a starting hole for a drill. Naturally, check the square after each adjustment is made.

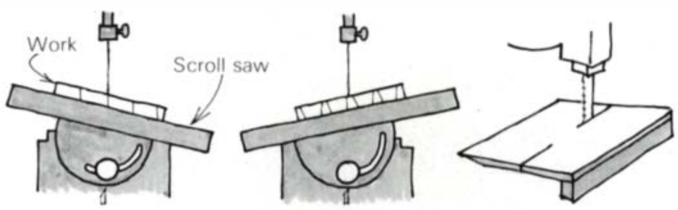
—Robert C. Amirault, South Thomaston, Maine

Cutting dovetails on the scroll saw

Traditional "hand" dovetails can be cut quickly and accurately on the scroll saw or band saw. The scroll saw gives a finer, more accurate cut than the band saw—especially if a thin, 32-point blade is used.

First, lay out the pins following the traditional method. Cut one side of the pins by tilting the scroll-saw table to the proper angle (8° to 14°). Then tilt the table the other way, cut the other sides of the pins and chop out the waste between pins with a chisel.

Some saw tables (especially on band saws) don't tilt in both directions. This problem is easily solved by building a clamp-



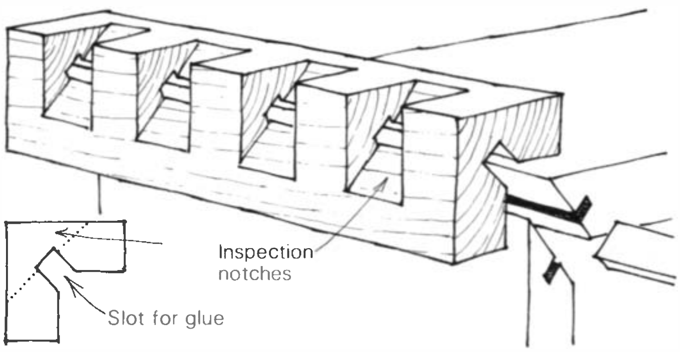
Tilt and cut one side of pins — *Tilt other direction and complete* — Auxiliary table for band saw on auxiliary table that can be reversed to get both angles.

The tails, scribed from the pins, are easily cut by returning the saw table to the horizontal position. By sawing away most of the waste between the tails, only a bit of chisel work is needed to complete the joint.

—*Gustave Kotting & David Haber, Grantsville, Md.*

Clamping splined miters

Here's an improved clamping block for spline-miter joints. My set has been used to make at least a hundred joints.



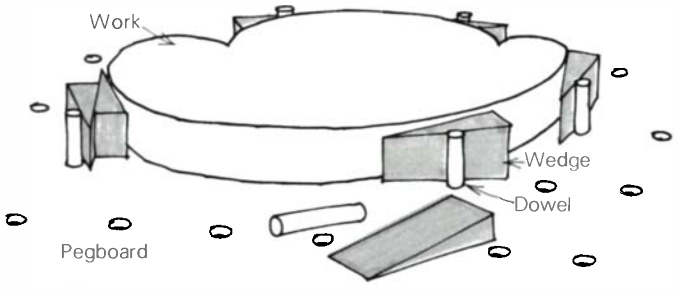
The glue block is basically an *L*-profile block with two additions—a channel cut in the inside corner to allow for exuded glue and a series of inspection slots cut into the outside corner of the block to see if the joint is pulled together evenly. The blocks can be used with strap or bar clamps.

—*R.H. Norton, Shalimar, Fla.*

Holding irregular shapes

A simple pegboard table will help hold irregular shapes in place. All you need is a sheet of ¼-in. pegboard for the top, a can of ¼-in. dowels in various lengths and a can of softwood wedges. Put the work anywhere on the pegboard, press in the dowels around the piece and take up the slack with the wedges.

—*Dennis J. Teepe, Lawrence, Kan.*



Shine, Mister?

When a finish is just "not quite right" I've found that a good stiff shoe brush used with fine abrasive powder can work wonders. Sprinkle a small quantity of either pumice, rottenstone or tripoli (depending on the desired effect) on the piece and brush vigorously with the grain. The sheen of a finish can be blended and evened out—light scratches and imperfections can be erased. Select finer abrasives for a glossy finish and coarser abrasives for a satin sheen. I have obtained better results faster with this method than with steel wool, oil or water hand-rubbing, and so forth. The technique can be used on oil, wax, lacquer or even French-polish finishes.

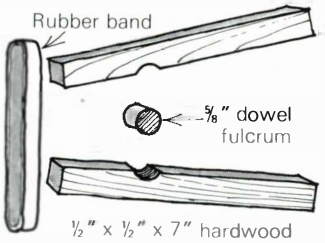
A shoe brush can also be used to embed grain accents such as red and white lead, Prussian blue, lampblack or malachite. Brush the accent in, wipe off the excess with the grain and seal—that's all that's necessary.

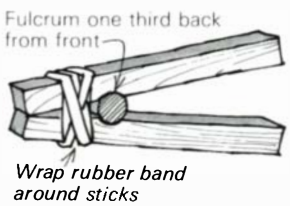
It's important, however, to use a natural-bristle, thick, clean brush of the highest quality. I use an old pure badger brush that I wouldn't trade for anything—well, maybe for some walnut or rosewood or. . . .

—Christian Albrecht, Allentown, Pa.

Clothespin clamps

I make heavy-duty clothespin clamps from two hardwood sticks (½ in. square by 7 in. long), a short ⅝-in. dowel fulcrum, and a heavy rubber band (about ¼ in. by 4 in. long). The dowel fulcrum fits in slight hollows filed in the sticks about one-third the way from the front. Dull the sharp edges of the sticks, then double the rubber band around the two sticks in front of the fulcrum as many times as possible.





I use this clamp as described for gluing the linings onto the sides of musical instruments. But by making a few changes the same basic clamp can be used for other applications. For example, different jaw capacities or parallel-jaw clamping can be achieved by using different sized fulcrums. The weight of the rubber band can be varied for more or less clamping pressure. The jaws can be notched to clamp unusually shaped work.

I also have some commercial steel-spring clamps but my homemade clothespins clamp with more pressure.

—Bart Brush, Cherry Valley, N.Y.

Q & A

Thickness planers for the small cabinet and home shop, in the 10-in. to 14-in. range, fall into two basic groups. One consists of scaled-down models of planers designed for industry, and is represented by Powermatic, Rockwell, Parks, General and Poitras. The second group consists of machines designed from the start for smaller shops, often according to quite different principles. This group includes highly engineered combination planer/jointers such as the Inca and Makita, Williams & Hussey's open-sided planer/molder and Belsaw's planer/molder/ripsaw. It also includes the Astro, which like the Williams & Hussey, offers a low-priced, hand-feed model.

Our first report on thickness planers (Q&A, March '79) generated a large number of requests for more information as well as considerable argument. Thus an expanded comparison chart appears below, incorporating more machines, additional data, and corrected specifications for Parks. It is followed by excerpts from reader mail, with comment by consulting editor Lelon Traylor. If you'd care to add your experience to the discussion, write us about the factors you consider important, which machine you own and why.

I read with consternation your opinion of Powermatic's 12-in. planer. To dismiss it because it has only one feed rate and then to mention the Astro planer which also has one feed would not appear to be a valid argument. Having more than one speed may increase the productivity of the machine but it has nothing to do with the best obtainable quality of the planed surface. Our feed rolls, cutterhead and bed rolls are larger in diameter than Rockwell's to minimize deflection under the heaviest cuts. We also can ship our planer with a quiet cutterhead to reduce noise, a feature no one else offers. We also offer a machine-mounted knife grinder and jointer to resharpen knives in the planer. You gave no discussion on maintenance. Isn't that important? In fact, wouldn't it be better to give your readers all the facts and let them make up their minds as to which are most important....

—Richard J. Flanigan, vice president, engineering, Powermatic Houdaille, Inc.

Traylor's comparisons left out many things to consider when buying a planer. First, one does not buy equipment by the pound as one does meat. The buyer must make decisions based on needs and finances rather than on a per-pound basis.

Traylor makes his recommendation on rate of feed and his opinion of the workmanship. He does not comment on the workmanship of all the machines nor does he list rate of feed for all. Rate of feed correlates to the quality of the planed surface. The slower the material passes under the cutterhead, the more cuts per minute, consequently a better finish. If time is of concern, a multiple feed might be considered. However, if quality is the primary concern then all the machines appear to provide a feed rate to produce a suitable surface finish....

—C.L. Michaelis, Lincoln, Neb.

One must first determine the use to which the planer will be put. For home-shop, nonproduction use, one slow feed is fine. Figured woods must be planed at a slow feed rate or the surface will be splintered and torn. But in school shops and cabinet shops a faster speed is necessary because time is money. Thus a machine with variable speeds meets a variety of planing conditions. Another feature not found on small planers is powered lower feed rollers. Large planers normally have

Planer manufacturers and/or major distributors: Astro, 58 Jerome Ave., Bristol, Conn. 06010; Belsaw Power Tools Co., 3725 Field Building, Kansas City, Mo. 64111; General, CAE, Box 12261, Omaha, Neb. 68112, and General Manufacturing Co., 855 Cherrier, Drummondville, Quebec, Canada; Inca, Garrett Wade, 302 Fifth Ave., New York, N.Y. 10001, and Anson Industries Inc., 4115 San Fernando Rd., Glendale, Calif. 91204; Makita U.S.A., 650 Hadley Rd., S. Plainfield, N.J. 07080, and local distributors; Parks Woodworking Machine Co., 1501 Knowlton St., Cincinnati, Ohio 45223; Poitras, Danckaert Woodworking Machinery Co., 891 Howell Mill Rd. NW, Atlanta, Ga. 30318 and Jos. Poitras and Sons, 70 5e Ave., L'Islet, Quebec, Canada; Powermatic, Houdaille Industries Inc., Morrison Rd., Box 70, McMinnville, Tenn. 37110, and local distributors; Rockwell International, Power Tools Division, 400 N. Lexington Ave., Pittsburgh, Pa. 15208, local distributors; Williams & Hussey, Elm St., Milford, N.H. 03055.

Thickness Planer Model	Max. width (in.)	Max. thick. (in.)	Feed rate (ft./min.)	Cutter-head dia. (in.)	No. of knives	Cutter-head RPM	Cuts per min.	Cuts per in.	Max. depth of cut (in.)	Feed roller dia. (in.)	Bed length (in.)	Motor (HP)	Weight (lbs.)	Base price	Price w/motor & stand	Price/lb. (incl. motor)	Special Features
Astro A 2000	10½	2¾	12	2	3	3,600	10,800	75	⅛	1⅞	14½	¾	125 (no motor)	$529.95 (hand feed)	$787.45 (power feed)	$4.80	
Belsaw 912	12¼	6	12 (22 opt.)	3¼	3	4,000	12,000	83 or 45	3/16	1½	18	3 or 5	300 (no motor)	$688. (incl. stand)	$958. or $1,079.	$2.56	Combination planer/molder (bed ext. to 42 in.) Model 910 incl. np saw ($748).
General 130	14	6	15	3	3	4,500	13,500	75	⅛	2	21½	2 or 3	520 (no motor)	$1,499.50 (incl. stand)	$1,759. or $1,809	$3.02	
Inca 510	10¼	6¼	11½/16½	2 7/16	2	6,000	12,000	87/60½	⅛	1	15½	1½	77 (no motor)	$1,185.	$1,400	$10.22	Combination planer/jointer (10¼ in. x 31½ in.). 2 feed rates. High cuts/in.
Makita 2030	11¾	6¼	28	3⅜	2	7,000	14,000	41½	⅛	2⅜	23½	2	275 (w/motor)	$1,580. (incl. stand)	$1,580.	$5.75	Combination planer/jointer (6⅛ in. x 59 in.). High feed rate.
Parks 95 (97)	12	4	16	3	3	4,000	12,000	62½	⅛	1¾	20	2	220 (no motor)	$865.	$1,274.	$4.51	
Parks 130	13	5	16/25	3	4	4,200	16,800	87½/56	¼	1⅞	22	3	370 (no motor)	$1,940. (incl. stand)	$2,267.	$5.03	2 feed rates. High cuts/in.
Poitras 6000	12	6	18	4⅜	3	4,100	12,300	57	⅛	2¼	36	5	700 (w/motor)	$2,640. (incl. stand)	$2,640.	$3.77	Large cutting circle.
Powermatic 100	12	5	18	2⅞	3	5,300	15,900	74	¼	2	24	2	378 (no motor)	$1,532. (incl. stand)	$1,670.	$3.79	Lever clutch. Optional: Staggered-knife cutterhead; Machine mount sharpener.
Rockwell 22-432	13	6	15–25 variable	2 23/64	3	4,500	13,500	73–45	¼	1¾	26	3	578 (w/motor)	$2,246. (incl. stand)	$2,246.	$3.89	Variable feed, removable cutterhead. Knife grinding attach. ($328.25 extra).
Williams & Hussey W7(S)	14 (7⅛ in. knives)	8¼	15	2⅜ (square arbor)	2	7,000	14,000	78	¼	1½	14	1½	83 (no motor)	$315. (hand feed)	$630. (power feed)	$5.38	Combination planer/molder. Open sided (cuts raised panels).

power on all four rollers, which prevents the lumber from hanging up.

It's difficult to acquire direct experience with a wide variety of planers. Yet when shopping for a planer, one must be sure of getting value. Planers made for industry are not the same as toasters made for retail—manufacturers who make shoddy or impractical goods do not stay in business. So, when evaluating a planer, I would look first at performance factors—size, feed, cutter style and cutterhead diameter, horsepower, table length. Most likely, I would end up with two comparable machines. I would then compare weights, giving preference to the heavier. Finally, I would want to know whether I was geting value. So I would figure the price per pound. You would not buy a machine on this basis alone.

A used industrial planer is wonderful. But most of these machines require a 10-HP or larger motor, and this means three-phase electrical current. I paid $25 for a used car, junked it and now use its engine to power the 30-in., three-feed planer that I built.

—*Lelon Traylor*

...My 12-in. Powermatic had a feed rate of about 21 FPM *and produced a quite decent surface. However, a slower feed rate ought to yield an even better surface, so I decided to see what could be done. It turns out to be fairly simple. For $2.69 I reduced the feed rate by 20%, to about 17* FPM. *This required replacing a 2½-in. sheave on the gear side of the cutterhead with a 2-in. sheave. The operation is done without disturbing the position of the cutterhead relative to the table, so there is no problem of cutterhead realignment. The 2½-in. sheave could probably also be replaced with a 3-in., if one wanted to increase the feed rate to about 25* FPM. *I prefer the slower feed rate now that I have it. A friend who owns a 16-in. Powermatic, with variable feed, eventually set it for the slowest rate and has not changed it since....*

—Ernest C. Tsivoglou, Atlanta, Ga.

You did not mention the Belsaw 12-in. planer. Since this planer is in the low end of the price range, I would appreciate an opinion. It isn't every day that we spend $1,000.

—Bill Martin, Mesa, Ariz.

The Belsaw is a no-frills basic machine. It is designed without the pressure bar that normally presses down on the stock between the cutterhead and the outfeed roller. The chip breaker appears to be more of a chip deflector—a chip breaker is supposed to press down on the lumber right up close to the knives, preventing splintering and also holding the stock against the table. The table feed rate is 12 FPM, although a pulley change permits a faster speed. The feed rolls are rubber-covered and are guaranteed for a year. The amateur should get several years from a set of rollers, which cost $12.65 each.

The basic Belsaw 912 weighs 300 lb. and costs $688. Considering price, construction and versatility, it should fit the needs of many hobbyists and small-shop operators. To compare it with the Rockwell is like comparing a pick-up truck to a Cadillac—the design approach is different, for a different market. But you get your money's worth with either. Belsaw also offers a model 910 planer which planes, rips and molds in one operation.

—*Lelon Traylor*

You overlooked what may be the best bet for a hobby-shop operation, the Williams & Hussey planer, which can be bought for about a third of the price of the more elaborate machines provided one forgoes power feed. This machine can be purchased with power feed if desired, but for those of us who just need a workable planer it's the best game in town.

—*John Black, Camarillo, Calif.*

For small work it does a good job. Difficulties arise on boards with considerable variation in thickness. The board will probably hang up, requiring you to change the thickness setting and start over. To surface a board that is wider than the cutterhead, you are in the same situation as running a 12-in. plank over a 6-in. jointer. Because it's open on one side, wide stock can be fed through, but it is difficult to get the two cuts to match—providing the grain run-out even permits surfacing from either end. If the board was pretty flat and true to start with, you'd get reasonable success. —*Lelon Traylor*

• • •

For outside use of mahogany (such as a boat's superstructure), why is it not acceptable to oil with tung oil by hand, as one would oil teak, instead of the conventional and time-consuming hard-varnish coating used on mahogany. I realize that tung oil is used in varnishes. However, my experience of oiling mahogany instead of varnishing it

Aluminum vs. cast iron

A principal disagreement among machine builders and users concerns the material for tables, trunnions and housings. One group swears by cast iron and it alone, the other prefers modern aluminum alloys. Consulting editor Lelon Traylor represents the cast-iron school of thought. In the aluminum corner is Garretson W. Chinn, president of Garrett Wade Co., importers of Inca woodworking machines, which are among the industry leaders in Europe.

First, Traylor: "Two critical requirements in machine design are no deflection under load and resistance to vibration. For me these translate into mass, and the way to get mass is to design and build with cast iron. Cast iron is heavy, damps vibration, threads cut in it don't strip, and a machine made of it won't wobble around the room. I am prejudiced against aluminum machinery components (except in a few cases such as band-saw wheels where lightness is important), because it is light, it vibrates, threads strip in it and it wobbles around. Some aluminum machines are well engineered and balanced, and some aluminum alloys are very strong. But wood is a variable material, cutting it exerts unpredictable forces and you need the mass of cast iron. I realize this is an issue among engineers, and knowledgeable people will hold the opposite opinion. They are welcome both to their opinion and to their aluminum machines."

Now Chinn: "Historically, thick sections were needed for machine castings and fittings because the only material available was cast iron, which gave the weight needed to damp vibrations from rotating parts that were not dynamically balanced. As structural steels and aluminums were developed, it became possible to build lighter components utilizing ribbed sections with rigidity equal to heavy iron castings. Occasionally designs in newer materials failed because of poor stress analysis or lack of knowledge about fatigue failure from cyclically imposed loads. However, new technology in metals has made possible tall buildings, portable power tools, aircraft and space exploration. Therefore, while sheer weight is a time-honored way to achieve rigidity and strength, the same ends can be achieved by more scientific means. Still, much of today's woodworking-machine design continues to be founded more on tradition than on accurate analysis of machine stresses based on working loads. When the Inca engineers designed their first saws 35 years ago they had several advantages: Having never built woodworking machines, they had no preconceived design ideas or old tooling to incorporate into new models. Equally important was the emergence of tough aluminum alloys as a structural material during and after World War II. The aluminum alloys used in the Inca table castings, for example, are similar to those used in high-performance auto engine blocks. However, when analysis indicated mass was important, it was added. . . . In summary, it's not just weight but performance that counts."

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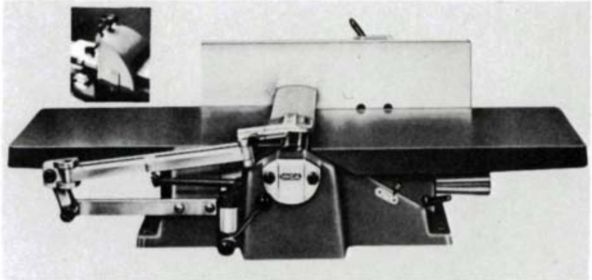

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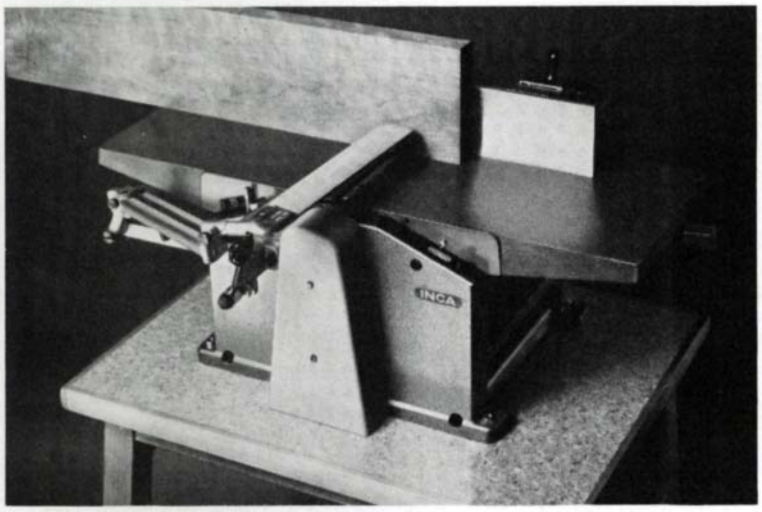

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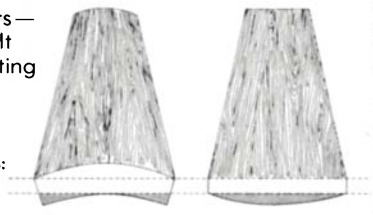

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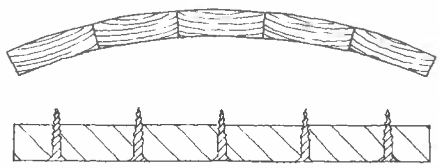
has been unsatisfactory. Are mahogany and teak inherently different?
—DonaldGuy Ross, Marblehead, Mass.

Teak has a natural oil in the wood that prevents moisture from getting into the fibers. Mahogany does not. Consequently, mahogany, when exposed to alternate wetting and drying, will begin to check, which allows more water to get into the grain. This process continues until the wood has become quite gray with weathering, and can be prevented only by a surface coating like varnish. Teak will also weather eventually but the process is much slower and the bright wood can be brought back easily by a light scraping.
—Simon Watts

"Textbook Mistakes" (Spring '76) has resulted in confusion about gluing boards together long grain without alternating the cup. This may be fine for tabletops where one would never see the underside, but, if screwed to a board, I assume that large cracks and splits will occur underneath. What if



one is making a cabinet door with both sides showing and no cross board to keep it straight? Although more difficult to hand-plane, it seems that the opposite cup direction would result in less exaggerated surface difference.
—Tom Thompson, Jefferson City, Mo.

When boards are glued together without alternating the cup, you don't have to screw each board down. The wood works together to form an arch, easy to tie down and keep straight with a few screws. In your drawing the cleat on the back is screwed on with all screws fitting snugly into the holes, which definitely will make the board split. To do it right, make one of the screws fit snugly and make the rest of the holes slots, so when the wood moves the screw is able to slide. Making a cabinet door with both sides exposed and no cross board to keep it straight? I would never make a cabinet door without something to keep it straight. How to make solid wood doors? See my article on page 78.
—Tage Frid

My local sawmill supplied me with some knot-free, 1-in. white pine, 24 in. wide. The wood was then air-dried for about a year indoors. Last month I used the first piece in making a headboard.

During planing, I noticed that woodworms had invaded the timber under the bark and had penetrated about 2 in. into the log. I cut out with gouges all of the punky wood and was satisfied the wood was worm-free. Last night, about 3:30 A.M., *I realized I had not completed the job. A distinct but barely audible scratch, scratch, scratch emanated from the headboard. I don't know how many there are, but woodworms are still in there.*

—Douglas W. Larson, Guelph, Ont.

Your symptoms sound like the larvae of a long-horned beetle called the white-spotted sawyer. These large white grubs tunnel along the cambium but they will also penetrate the sapwood, leaving large bore holes. The larvae will eventually emerge as adults and seek dying trees, sawn logs and freshly cut lumber in which to lay their eggs. Eventually they should disappear, but inspect your remaining lumber carefully and cull any infected pieces. I'd spray any active adults that appeared.

—R. Bruce Hoadley

I recently purchased a set of heavy-duty socket firmer chisels. I am bothered that the chisel blades, all of them, have been ground on the flat side. That is to say, the back of the blade is not perfectly flat—each has a 4° or 5° bevel toward the front of the blade. The front edge is ground correctly—at about 30°—if you don't count the 5° bevel on the flat. Is this normal and correct? —Fred Silva, Santiago, Chile

This is not correct, but it is normal. Some factories finish such tools on belt sanders, which unavoidably dub over what ought to be a flat surface. You can correct the condition by lapping the back of the chisels on a coarse oilstone, or on carborundum cloth taped to a flat surface such as a saw table. Use plenty of oil.

I recently constructed a headboard of veneer plywood with solid cherry trim. The finish is Deft. The problem is the veneer seems to have soaked up more finish than the trim, resulting in a darker shade. How can I get a consistent hue?

—Don Carbhoff, Plainfield, Ill.

If you use solid wood next to veneer made of the same wood, the veneered area will nearly always be darker. When veneer is made, the wood is submitted to intense heat and moisture. The fibers of the wood are broken, and they will absorb any coloring more readily than solid wood. I do not know any easy remedy. You could stain the solid parts with more concentrated stain or repeat the staining, until solid matches veneer. —*George Frank*

I am building a woodworking shop and am about to begin wiring. The room is 20 ft. by 18 ft. and has a cathedral ceiling with exposed cross beams. The height to the top of the ceiling peak is 14 ft. The windows located on three sides of the building let in a fair amount of indirect sunlight, but not enough. I've been considering direct lighting located on the cross beams to reflect off the Sheetrock ceiling, or a hanging semidome fixture.
—Stewart Wurtz, New Gloucester, Me.

Dr. Robert Brown, author of *Industrial Education Facilities: A Handbook for Organization and Management* (Allyn and Bacon, Inc., 470 Atlantic Ave., Boston, Mass. 02210, 267 pp., $16.95) replies: "You will need 16 dual 40-watt fluorescent fixtures suspended at approximately 8 ft. high to produce the necessary 150-foot-candle intensity at benchtop height. The fixtures should be equipped with opaque reflectors so that the lighting will be direct. Diffusers are not needed. The fixtures should be arranged in four rows of four fixtures each with even spacing. Rows 1 and 3 should be on one switch-activated circuit, and rows 2 and 4 should be on a second circuit, for economical daytime operation when the sunlight is intense. Windows are not considered in intensity calculations because many shops are most frequently used at night. Local lighting of machines such as drill presses, jigsaws and lathes is always desirable."

Follow-up

Re the reader who couldn't find blades for the Hook scraper (March '79). I shared his frustration for the last three years—the best scraper I ever used and no blades. Last summer, while traveling in Holland, I found them at a local hardware store. They are manufactured in England by Skarsten Mfg. Co., Garden City, Herts., England. Ask for #62 Skarsten scraping hooks.
—*Frank Rohloff, Sebastopol, Calif.*

I was surprised to see that someone is searching for plans for a master-craftsman tool chest (May '79).... Anyone contemplating the creation of such a chest should realize that most of them were strictly utilitarian and therefore contained a minimum of fittings and compartments. Others were obviously a labor of love, perhaps made at the time the cabinetmaker completed his apprenticeship and moved out into the world to make his own way. Externally, such chests tended to fairly standard dimensions [about 25 in. by 38 in. by 22 in.] and methods of construction [through dovetailed]. Internally, they were limited only by the imagination and patience of their creators. Some are complex and ingenious. The exterior was almost always plain, usually painted drab black, gray or blue, and old specimens tend to be beat up, apparently as a result of being pressed into at least occasional use as a workbench or sawhorse. My personal inclination is to search for an old tool chest lacking an interior and then design one to fit one's own tool collection and taste. I like the idea of a plain, painted exterior hiding an elaborate, finely constructed interior. I suspect the old-timers liked that idea also....
—*Lewis C. Cooper, Chester, N.J.*

I would like to add something to the answer given by Marlow to Morian (March '79), on how thin-line inlays found on antique furniture were made. This type of inlay is a lost art and, to my knowledge, has never been done on a large scale, but there are some pieces of antique furniture around—mostly in European museums—that have silver or tin amalgamations embedded in a groove cut wider at its bottom. It is much more time-consuming to cut out the grooves than it is to cut a normal wood inlay of the same intricacy. It is also more expensive because of the silver and mercury used, not to mention the health hazard involved. That might explain why this technique has been used very little. Designs of such silver inlay are naturally very different and the appearance is strikingly beautiful. Many years ago I successfully made a silver inlay while an apprentice in Switzerland.
—*Alois von Matt, Gladwin, Mich.*

George Frank's answer to the question on removing dark-colored dust from the pores of light-colored wood (May '79) will not solve the problem. ... The dust and rubbing of sandpaper impregnates, stains and marks the lighter veneers, especially holly, and no amount of vacuuming or air pressure will clean up this light wood. When dealing with this problem in marquetry, it is recommended to apply one or two washcoats of white shellac

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

(about a 50% mixture of alcohol and fresh white shellac) to seal the pores before sanding is started.

—Peter L. Rose, Marquetry Society of America, Saddle Brook, N.J.

Readers want to know...

As a professional woodworker with a limited budget, I am looking for the all-in-one machine. Specifically, a drill press, shaper, router, mortiser, slotter and horizontal mortiser. From the advertisement of the Toolkraft drill press router, model 452, one may surmise that with a few modifications it may fill the bill. I have yet to find an outlet in my area that sells this machine, much less demonstrates it. Does anyone know its capabilities? Can it be modified and used in a heavy-duty enterprise?

—Chip Jacobs, Newberne, W. Va.

Does anyone know which finishes are, and are not, safe for children's furniture and toys where the wood may be chewed on?

—James L. La Combe, Kamloops, B.C.

Supplies

Finding exotic materials and supplies is a constant headache for the woodworker. Here are new leads to inquiries from previous issues:

—Interlocking compression rivets: Indian Ridge Traders, P.O. Box 869, Royal Oak, Mich. 48068; Dixie Gun Works, Union City, Tenn. 38261; Atlanta Cutlery Corp., Box 839, Conyers, Ga. 30207.

—Potassium dichromate in small quantities: C. Napper, 32 McCord Rd., Toronto, Ontario, M4S 2T6, Canada.

—Wooden-wheel casters: Paxton, Upper Falls, Md. 21156.

—Leather seats for antique chairs: Rustic Renaissance, P.O. Box 93, Lake City, Colo. 81235.

—Plans for a master-craftsman tool chest: Woodcraft Supply Corp., 313 Montvale Ave., Woburn, Mass. 01801.

—Traditional inlays in the Hepplewhite style: Alois von Matt, 1118 W. Cedar Ave., Gladwin, Mich. 48624.

—Machine oil: Sears, Roebuck and Co. lists this for $1.97 per quart.

—Desk-chair hardware that swivels and tilts back: MLG Enterprises, P.O. Box 68, Lakeland, Minn. 55043 sells reconditioned sets for $30/set.

Readers can't find:

—Hardware for the adjustable tray on a highchair.
—Unfigured boxwood veneer.
—Ash splints.
—Swing-rocker castings. □

Books

Manual of Traditional Wood Carving edited by Paul N. Hasluck, a republication of *Cassell's Wood Carving. Dover Publications, Inc., 180 Varick St., New York, N.Y. 10014, 1977. $7.95 paper, 558 pp.*

Wood Carving by William Wheeler and Charles Hayward. *Sterling Publishers, Inc., 2 Park Ave., New York, N.Y. 10016, 1972. $7.95 paper, 127 pp.*

Manual of Wood Carving and Wood Sculpture I and II by Frederick A. Brunner. *Frederick A. Brunner, 369 High St., Westwood, Mass. 02090, 1972 and 1978. Each $12.50 paper, 148 pp. and 142 pp.*

The Book of Wood Carving by Charles Marshall Sayers. *Dover Publications, Inc., 1978. $3.00 paper, 118 pp.*

Wood Carving and Whittling for Everyone by Franklin N. Gottshall. *Charles Scribner's Sons, 597 Fifth Ave., New York, N.Y. 10017, 1977. $12.95 cloth, 142 pp.*

Design and Figure Carving by E.J. Tangerman. *Dover Publications, Inc., 1964. $3.00 paper, 289 pp.*

The Modern Book of Whittling and Woodcarving by E.J. Tangerman. *McGraw-Hill, Inc., 1221 6th Ave., New York, N.Y. 10020, 1976. $9.95 paper, $14.95 cloth, 185 pp.*

Woodcarving has as wide a range of perfection as any other art or craft—from chipcarving, punch and scratch work and whittling to the complexities of the *acanthus rinceau*. Numerous books approach the subject with an "everyone-can-carve" philosophy. Unfortunately, there is so little fine woodcarving being done today that the different forms of carving are quite unknown to the general public.

I have apprenticed myself to these eight books and, like different teachers, I have come to know them as personalities. Hasluck's *Manual of Traditional Wood Carving* is the best book on the subject. It is authoritative not only because it is historical but because it is basic, uncluttered and replete with drawings and photos. "Woodcarving calls for the exercise of manual skill and artistic feeling," maintains Hasluck in his introduction, and this integration of artist and craftsman attended to throughout separates this book, plus Wheeler-Hayward and Brunner, from the rest. Hasluck advocates preliminary drawings, illustrates the advantage of models, and then discusses the suitability of a carving to its environment.

The first chapter begins with a discussion of woods most suitable for carving. Though the Wheeler-Hayward description of gouges is a little better, Hasluck's coverage of "appliances" is complete. A chapter on design reminds us of the creativity necessary to use tools and technical knowledge. Clay modeling and sketching are subjects of a chapter almost a book in itself.

Wheeler and Hayward's *Wood Carving* is not as ambitious as Hasluck's book, but covers nearly the same material and also a few areas Hasluck doesn't—gilding, linen-fold panels and lettering. The traditional setting-in, grounding and modeling are explained clearly and demonstrated via drawings but the photo plates are dark and hard on the eyes. The occasional photographs of historical and contemporary work are inspiring but not numerous. From simple cuts, the reader advances through a series of illustrative projects. One must occasionally reread passages to understand the instructions, but this is not the sort of book to read in one sitting anyway.

I discovered Brunner's books after I had been carving for a while. His mechanical step-by-step method seems anything but creative to me. These are home-produced books but the line drawings, which are 99% of the contents, redeem the shortcomings of Brunner's attitude and literary ineptitude and emphasize the need for sketching and visualization. Brunner's two books should be combined into one, with emphasis on the material in the second. His illustrations on sharpening and technique are fairly good but his explanations are not. He categorically dismisses Gothic carving and never changes his attitude or instruction as the difficulty of projects increases. The clutter in his drawings increases in *Manual II* and becomes quite bothersome for anyone but the beginner who's desperate for a guiding hand. Brunner's books are spiral-bound and do lie flat on the bench.

Both Gottshall's and Sayers' books are polished and pleasant, but of limited usefulness and scope. Sayers' *The Book of Wood Carving* has a conversational introduction, not very enlightening. The book proper gets right into projects, but is too brief at times. Sayers' method is a bit too simple, relying on the *V*-tool for outlining—a difficult tool for a beginner. The strength of the volume is in the close-up photos of the simple yet effective projects, and it is a valuable book for this reason.

Gottshall's *Wood Carving and Whittling for Everyone* is a disappointment. Virtually nothing inspires the reader to creative thought, and there is no mention of design problems (each project has its own measured drawing). The book is slick and brief of explanation. One glaring example is Gottshall's indiscriminate use of the terms gouge and chisel. This book has the same format as Sayers', but the projects are more varied and cover more techniques. Though there is a nice 28-in. Indian figure, there are also a number of whittled animals. I suppose these are in keeping with the author's intention, but they water down the book's effectiveness. Gottshall has written a number of books on woodworking and seems to know his material, but he doesn't appear excited about it.

E.J. Tangerman, whose name has become synonymous with whittling, has produced an impressive stack of books on the subject. *Design and Figure Carving*, first published in 1940, continues to be a prominent book in the field. This is a source book best read through once and then referred to when needed, because its scope is quite large. It is the only book reviewed here which is not how-to, though the use of various tools is discussed. Tangerman begins with carving trends (naturally out of date today), but his comments on the adverse effects of mechanization still hold true. His explanation of design principles parallels those in Hasluck and should be carefully studied by the novice. The illustrations are wonderful, except where six or eight photos of furniture are squeezed onto a page. Tangerman knows his sources and his history is as good as Hasluck's, but trying to coordinate each of 1,298 figure references with the correct drawing or photo is a considerable strain on the reader.

The photographs, though mostly of diminutive objects, are bigger and better in Tangerman's *Modern Book of Whittling and Woodcarving*. Tangerman's range is nearly limitless: barnyard animals, curls and fans, breadboards, birds, caricatures, nativities, pierced work, carved ivory, *ad infinitum*. And the most pleasing thing is the feeling that he's vibrantly excited about every piece he shows—a grandpa rocking and chewing on a Sunday afternoon, whittling a horse for his granddaughter, a twinkle in his eye.

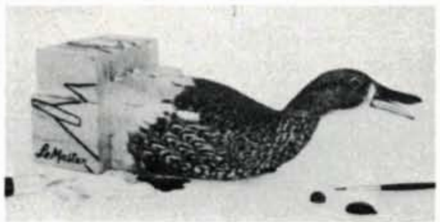
This review is not a definitive critical bibliography, but the books worth buying are here. No one becomes a master artisan without a continual application of the basics. These books are indeed the basics and more.

—Frederick Wilbur

Wildlife in Wood by Richard LeMaster. *Contemporary Books, Inc., 180 N. Michigan Ave., Chicago, Ill. 60601. $25.00 cloth, 244 pp.*

Some of the most contentious title fights never make the television screen or the sports pages. These are the controversies that frequently rage between authors and publishers over titles for their books. I don't know whether such a battle arose over *Wildlife in Wood*, but if so the winner lost the war. The title is a misnomer because the book only covers one form of wildlife—ducks. So if your ambition is to carve a basswood bass or a maple moose, you'll have to look elsewhere.

Physically, *Wildlife in Wood* appears to be a cocktail-table showpiece, with its large 9¼-in. by 12¼-in. format. But this book has more than a pretty face. It has a depth of intelligent information learned from years of hard work. The art director deserves praise for designing an exceptional full-color dust jacket, and the author deserves plaudits for his contribution. The mallard hen emerging from the partially carved block of wood is so realistic that you wish the carver would get on with the job of freeing her.



Richard LeMaster is indeed "the master" when it comes to carving realistic ducks. As a modelmaker with 30 years of professional experience, he is accustomed to meticulous detail and tedious perfection. One would think that a person who has worked so hard for so long would be reluctant to reveal his findings, but not LeMaster. He explains and reveals every detail and secret. Photos taken by him in a fenced-in environment show all angles of various ducks in flight, on land and water. Each part of the duck's anatomy is scrutinized under many conditions: fear, surprise, sleep, etc. As certain feelings come over a duck, some feathers will show more or less than normal, it will ride higher or lower in the water, and certain anatomical members will extend or contract.

LeMaster covers building a photographic set to confine the ducks for study, and how and where to obtain them. And he tells the reader how to use the tools and materials to create highly realistic prototypes. The information on painting techniques, where he tells how to achieve lifelike softness and iridescence, is especially enlightening. —*Bud Kronenberg*

Masterpieces of Furniture Making by Franklin H. Gottshall. *Stackpole Books, P.O. Box 1831, Harrisburg, Pa. 17105, 1979. $17.95 cloth, 224 pp.*

Franklin Gottshall's fans are legion, and with good reason. In a long career (he is past 70), Gottshall has produced 16 books of measured drawings and instructions for building furniture. His new book has been prepared with the same care his readers have come to expect, his drawings are extremely readable and his materials bills are exact. A plus is more photographs than usual of completed pieces, details and in some cases, work in progress.

The book begins with simple boxes and proceeds through a mirror, several desks and chests, beds and tables to the high point of the art, a Philadelphia Chippendale highboy. There is a plan for the corner cupboard that surrounds the large shell Gottshall described for *Fine Woodworking* (Sept. '78), several finely carved chairs and even an ambitious four-treadle loom he made for his wife. The text is not exhaustive, but it does give the general procedure for each piece as well as particular information about unusual details and procedures. A novice could use the book as a course of instruction, working his way through from basic to difficult.

Gottshall made many of the pieces in this book for his own home, and it's evident that his tastes lie firmly in the 18th century (although only a few are precise antique reproductions). The few modern pieces are less successful. Books such as this are always welcome additions to the woodworking literature, not only for their detailed plans, but also as a jumping-off point for work of the builder's own design.

—*John Kelsey*

Bud Kronenberg, 59, makes spinning wheels in Southbury, Conn. John Kelsey is editor of Fine Woodworking *magazine. Fred Wilbur specializes in woodcarving and owns Braintree Woodworks, Shipman, Va.*

A Little Help From My Friends

by Jim Haber

Early on in my woodworking endeavor I noticed an obvious correlation between a person's work and the tools he uses. I am speaking not only of the quality of work but also of the kind of work. Therefore, when I gained some insight into the work I wanted to pursue, I knew what machines would be helpful. I wanted a 12-in. jointer and a planer of approximately the same size, but, most importantly, I needed a good, tough, somewhat large band saw. One day while at the mill site of my favorite wood supplier (the man who owns the place is a story in himself) I noticed a large band saw standing in the middle of a field. Upon inquiry I found that it had stood there quite like a statue in a park for the last six years. Believing as we do, my wife and I had prayed that God would provide for us the machines I needed in my work. So as I walked toward the old saw I felt as if the answer to my prayers was standing before me. When I was within touching distance of the old machine I was impressed by several things, most notably its size and condition. They were huge and awful, respectively.

Later that week I enticed a friend to go down and see the old saw and help me decide if I should buy it. As we inspected it we learned the following: Rust covered it like frost, the trunnions supporting the 36-in. by 40-in. table were broken, and, worst of all, the shaft of the direct-drive motor had snapped at the shoulder of the Morse taper that held the lower wheel. With great enthusiasm I paid the paltry sum the mill owner was asking.

My first obstacle in what later turned out to be a seemingly endless list was to get it home. As my buddy, my wife and I began to dismantle the monster, I gained firsthand knowledge of another quality of this titan—its mass. The main table weighed approximately 320 lb. and proved to be quite sufficient to smash my friend's big toe. We loaded all that we could easily dismantle onto a trailer with some wood I had bought and drove the 60 miles home. It took two more trips to get all the pieces. On the first of these my brother-in-law, yet another friend and myself spent most of the time yanking the motor from the main casting, and on the subsequent trip my father-in-law, brother-in-law and myself managed to bring back the 1-ton main casting with the help of a whole slew of machine rollers, jacks, chains, blocks and a come-along.

Bob Reynolds

Jim and Kathy Haber (foreground) and friends gathered around the band saw. From left to right: Joe Reynolds (Haber's father-in-law), Tom Reynolds (brother-in-law), Frank Edwards and Dale Clark.

Once home, we deposited the casting in the prone position in the middle of my driveway. I now began to jump the long row of hurdles before me. With wire brushes and a wire wheel, my wife and I removed the layer of rust that covered everything. The tables were sent to the sandblaster and finished up beautifully. I took the trunnions to school and brazed them together. And finally, a machinist friend of mine bored the rotor, pressed in a new shaft, pinned it and then turned the appropriate taper and thread onto the end. This was all done after the motor had been rewound to fit the phase converter I needed to run the saw off of single-phase current. This process of cleaning, fixing and assembling it in my garage took the better part of six months.

After I had the machine basically together, I balanced both wheels as best I could, started up the motor and bottom wheel and sanded the tire to a crown. With the installation of the blade, tracking it and some other final adjustments, I was ready for the big moment. I pressed the starter. The saw emitted a groan that grew to a sound not unlike a galactic ship out of *Star Wars*. By the time the saw reached full speed (the blade travels at 120 mph) my 2-ton monster was shaking mildly, while the blade tracked unpredictably. With a crash the blade untracked and ripped into the custom-made stainless-steel blade guards. My heart sank. A lot of time, money and hopes had gone into this project; seething and frustrated I left the room.

I had too much invested at this point to give up. Upon analysis, I decided the saw needed modern blade guides and the 38-in. cast-aluminum rim of the upper wheel turned to a slight crown. After spending another $250, I had my saw back together, ready for another trial run. This time it ran beautifully and the tracking was solid. I tried the saw out on a flitch of oak perfect for the occasion. I was delighted with the cuts, though I did have to add a vacuum to eliminate the clouds of sawdust that the high speed of the blade produced.

The saw is used only once per piece but the fine resawn matched panels, stiles and sides it cuts make it indispensable. My work is richer because of this machine, but the help and friendship of friends and relatives is richer still. □

Fine Woodworking *pays $100 for readers' adventures; suitable length is 1,500 words or less—up to six typewritten pages, double-spaced. Send to Adventures, Box 355, Newtown, Conn. 06470.*

CLASSIFIED

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CARVING BLOCKS: KD Tupelo gum. Send SASE for sizes, prices. Kent Courtney, 1413 Texas Ave., Alexandria, LA 71301.

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26-in. band saw $500. 12-in. circular saw $300. Stationary gas-engine drive $100. Mrs. A. Rovery, 235 S. Ketcham, Amityville, NY 11701. (516) AM4-0444.

Large selection of AD and KD walnut and cherry flitches and boards, reasonably priced. Chris Focht, 112 Lafayette Dr., Norristown, PA 19403. (215) 666-6461 after 6 PM.

Parks planer, serial no. 37050, 4 x 12 1-PH 3-HP motor, switch, extra knives, like new. $1,000 FOB, C.E. Yancey, Rt. 4, Box 149, Marianna, AR 72360. (501) 295-3957.

Walnut boards with natural edges 10/4, 11/4, 12/4—up to 18 ft. long, varying widths, AD 3 to 5 yrs. 0-1M bd.ft., $2.50; 1M bd.ft. up, $2.25. Arthur Reed, PO Box 356, DeWitt, NY 13214. (315) 445-0244.

Stanley #45 plane like new, 22 cutters, $100. R. Miller, 211 B Woodbridge Dr., Ridge, NY 11961. (516) 744-8297.

Black walnut slabs, up to 2 ft. x 7 ft., $1.25/bd.ft. by the log. Average log 100 bd.ft. Quantity price $1/bd.ft. Will consider swaps for other woods or equipment. Brian Burns, 1263 Stanford Ave., Palo Alto, CA 94301. (415) 327-5335.

Two Richardson cast aluminum retorts for steam bending, 8-ft. capacity. Also jigs and bending press. (215) 777-7904.

Lignum Vitae log. 15 in. dia. 1 side 42 in. long, other 35 in. Dk. brown heartwood. No cracks or end checks. Wt. 340 lb. Best offer. A. Harshman, 321 Indiana, Dunkirk, IN 47336.

Complete set of fine hand planes (Primus, Record, etc.). C. Kadesch, PO Box 239, Romney, WV 26757.

Will trade for your favorite carving wood, my KD Louisiana Tupelo gum blocks of 4 in. x 6 in. x 18 in. Kent Courtney, 1413 Texas Ave., Alexandria, LA 71301.

Sale or trade: Logs, ½ logs, ¼ logs of apple, pear, walnut, cherry, wormy chestnut, almost any Eastern hardwood. Also some roots, crotches and burls. Call (304) 269-4108.

Zyliss Swiss vise system. List $100. Never used, $70. Millers Falls miter box, used but in top condition, 5 in. x 28 in. saw, Langdon Acme top-of-the-line. List $165. Sell for $75. Bill Muerdter, Rt. 3, Box 95, Waynesville, NC 28786.

Stanley #55 used but good, with 2 factory boxes of blades, $200. Also Stanley #45, very good with 20 factory blades, $175. George L. Lee, PO Box 315, Camp Verde, AZ 86322.

Black walnut burl slabs. Moving—must liquidate. Approx. 200 slabs, AD, 10 slab min. at $45 ea. Make offer on complete stock. R. Evans, 1935 Cambridge, Cardiff, CA 92007. (714) 942-1372.

Surplus edge-tool guards, sewn leather covers for planes, chisels, saws and axes—75¢ to $3.50. Photos, list, J. Lippitt, 9592 Onset Cir., Huntington Beach, CA 92646.

WOOD & TOOL EXCHANGE *cont.*

Three-drum sander, 42-in. throat, perfect condition, $800. MacPhail, Box 22, Strafford, VT 05070. (802) 785-4364.

Stanley #55 plane with 49 blades, $225. Set of 34 wood-molding planes, $300. Will sell either, not both. Don Crandall, Copake, NY 12516. (518) 329-3262.

SITUATIONS WANTED

Mature, self-taught, limited commercial experience. Desire position or association with established craftsman in NYC area. Willing to invest. MDS, 213-04 53rd Ave., Bayside, NY 11364.

Dependable skilled person seeking employment with craftsman/designer. Interested in traditional American furniture. New England area preferred. Chris Hopkins, Miller Rd., Chester Springs, PA 19425.

The CLASSIFIED RATE is $1.50 per word, minimum ad 15 words. Payment must accompany order. The WOOD & TOOL EXCHANGE and SITUATIONS WANTED rate is $1 per line, minimum three lines, maximum six lines, limit two insertions per year. Allow 30 letters or spaces per line, including name and address. The Wood & Tool Exchange and Situations are for private use by individuals only. Commercial accounts must use Classified. Please inquire for DISPLAY CLASSIFIED RATE. Send to: The Taunton Press, Advertising Dept., Box 355, Newtown, CT 06470.

Events

This column is for gallery shows, major craft fairs, lectures and exhibitions of general interest to woodworkers. To list your event, let us know at least three months in advance.

It's About Time—Handmade clocks and time-related objects, all media, Feb. 1 to March 14, 1980. Application deadline Oct. 15. Craft Center, 25 Sagamore Rd., Worcester, Mass. 01605.

Architectural Dimensions—All media with emphasis on furniture, Sept. 11 to Oct. 20. The Elements, 766 Madison Ave., New York, 10021.

Symposium West—Woodturning: design, materials and practice, Oct. 11-13. Contact Dale Nish, Department of Industrial Education, Brigham Young University, Provo, Utah 84602.

Third Canadian Agricultural International Wood Carving Exhibition—Aug. 15 to Sept. 3, Exhibition Place, Toronto, Ontario.

The Harmonious Craft: American musical instruments—through Aug. 5, Renwick Gallery, Smithsonian Institute, Washington, D.C.

Young Americans: Fiber, Wood, Plastic, Leather—through July 29, Brunnier Gallery, Sheman Bldg., Iowa State Center, Ames, Iowa.

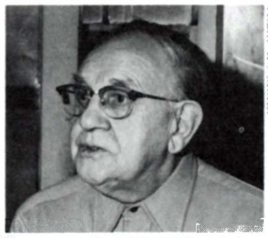
Pacific States Craft Fair—Open to trade Aug. 2, open to public Aug. 3-5, Fort Mason Facilities, San Francisco, Calif.

New Handmade Furniture: American Furniture Makers Working in Hardwood—Original work by 37 craftsmen, through July 15, American Crafts Museum, 44 W 53rd St., New York; July 23 to Oct. 21, Ontario Science Center, Toronto.

GIFTED HANDS

Frederick Brunner: Woodcarving personified

BY ROBERT L. BUYER



Alain W. Morin

Frederick A. Brunner

How do you distill the life and character, the skill and temperament of a man into black and white? Obviously, you can't. So how can I convey to you the respect and gratitude I feel for my teacher, Frederick A. Brunner? No mortal man has affected my past, present and future to the extent that he has, yet the best I can do is tell his story and hope that you will catch a glimpse of his spirit.

Alsace-Lorraine. The name conjures up images of medieval castles on the Rhine and Gothic cathedrals, revolution and political change. Frederick A. Brunner was born into this region in the city of Metz in 1901, the son of a respected woodturner. His early life story resembles a fairy tale from the pen of the Brothers Grimm.

Once upon a time (as all good stories begin) an eager young man of fifteen years entered the Apprentice Academy in Metz. For three-and-a-half years he attended classes in the morning and worked for a master craftsman the rest of the day. (Brunner points out that he received more education in that half-day at the academy than most full-time university students do today, and that a half-day on the job amounted to six hours.) Not being content with this long day, young Brunner also attended evening classes in freehand drawing, etching, clay modeling and watercolor painting at the Cathedral Academy of Arts. So skilled was he that he won two scholarships in drawing. Incidentally, Brunner is naturally left-handed. Kaiser Wilhelm II, however, had decreed that all students be taught to work right-handed. This hardship has become a tremendous blessing, for to this day Brunner can handle carving tools and drawing pencils equally well with either hand.

Brunner Archives

St. Joseph, carved by Brunner

Upon completing his formal education in 1918, Brunner took and passed the journeyman woodcarvers' examination in the city of Strasbourg. As a journeyman he worked in France, Germany and other countries. About this time our young hero met and fell in love with Rose Weiss. Our fairy tale does not, however, end with the traditional "happy ever after," for the storm clouds of World War I had intervened. In a clever and fortunate plan, our hero made a storybook escape, boarding a ship for New York with his bride of only three days.

Life in America was not easy for young Brunner. Yes, he had an uncle in Providence, R.I., to call for assistance, but how much could anyone help a recent graduate of Germanic background? The newlyweds settled in Boston, where more jobs were available. For a year and a half Brunner worked as a dirt digger, a waste pusher and a laborer on a spinning mule. Finally, the assistant plant manager of the woolen mill where Brunner worked learned of his training and contacted Irving and Casson, the noted church architects and builders of ecclesiastical furnishings, located in East Cambridge. I use the word builders here because "manufacturers" is inappropriate to the almost total use of manual labor in 1920. This company had a staff of 49 hand-carvers, mostly European-trained artisans, in addition to architects and sculptors in plaster.

Irving and Casson had a strict apprenticeship program and required that Brunner prove his ability as a woodcarver in a one-week test—carving two lions for a synagogue being built in Waltham. In a few days Brunner's drawings for the lions proved his capability. Salary during this test was $1.00 an hour. The beginning salary for "The Kid" was an unheard-of $1.15 an hour. At the ripe old age of 26, Brunner was recognized by Bullfinch and Chapeley and other famous architects as an unusually skilled craftsman. Still, back at the shop he was "The Kid."

In the early 1920s, Boston was the woodcarving center of the United States. Historically, the period from the end of the Civil War to the Great Depression is considered a reconstruction era. However, for the artistically inclined it was a romantic era in which furniture and buildings alike were highly decorated in various traditional European styles. Brunner had the knowledge and skills to produce the needed carvings—he participated in the construction of the Riverside Chapel, the Cathedral of St. John the Divine and St. Patrick's Cathedral, in New York City, and Harvard University.

As economic conditions in the United States began to collapse in 1929, Brunner left Irving and Casson to work for W.S. Ross and Co., also in East Cambridge. One of the principal contracts at Ross was for a ceiling carved in English oak for the Princeton University library, a work that encompassed three years. Brunner remained employed at Ross until 1932, when work was no longer available. Then, during the WPA era, Brunner was assigned to the federal art project.

In 1936, Brunner opened his own studio in a loft over a blacksmith's shop in Cambridge. In 1950, the Brunners moved to Westwood, Mass., where he still maintains his studio/workshop—

Robert Buyer, of Norton, Mass., teaches woodcarving and runs a sawmill/lumberyard.

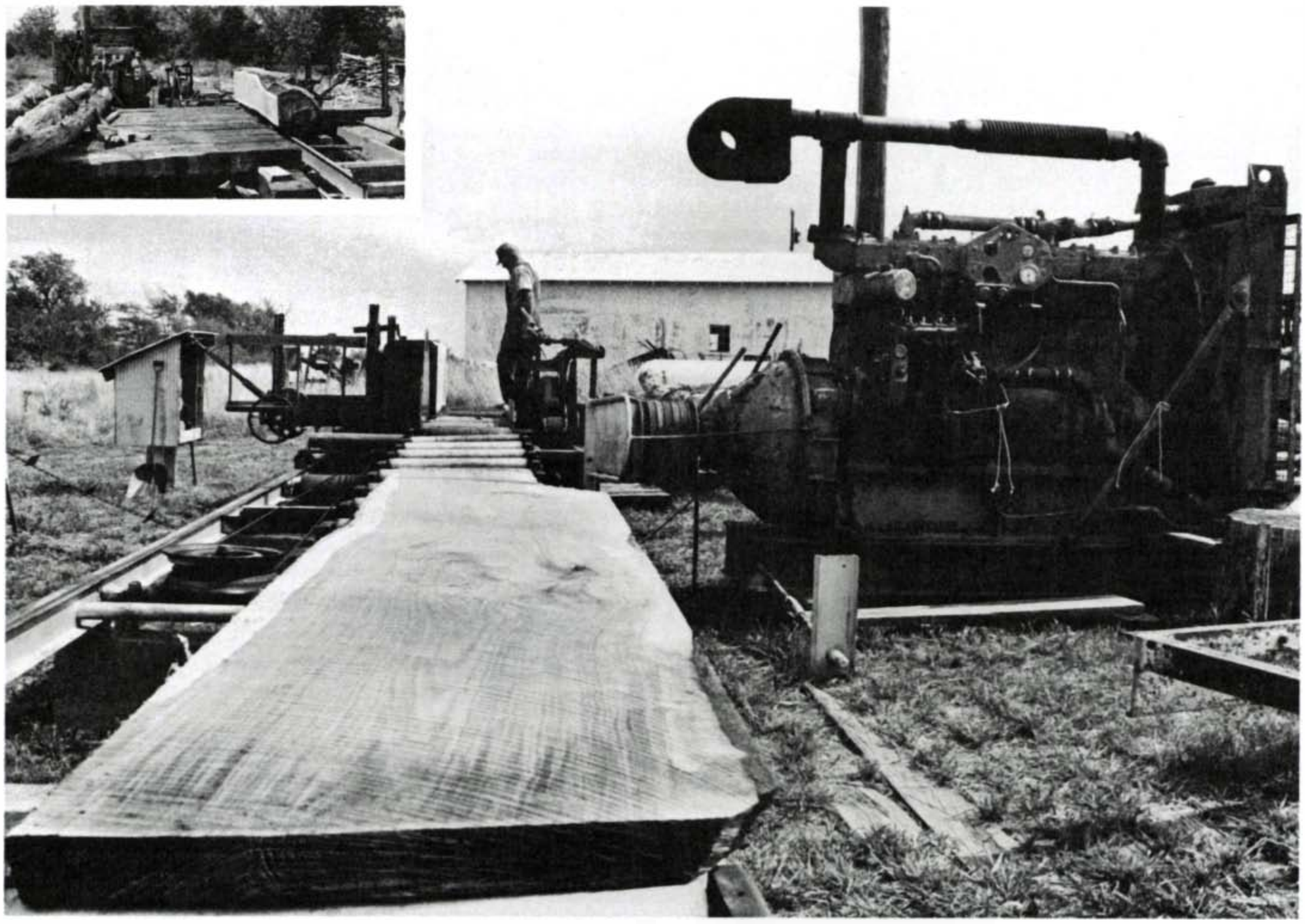
here he continues his collaboration with church architects.

To me, Brunner is the embodiment of everything that means traditional woodcarving; from drawing through construction into carving and finishing. Brunner's knowledge does not end with creating art, but extends into the related fields of tool design and construction, as well as sharpening. In his later years, with the construction of smaller and more modestly decorated churches, Brunner turned his attention to teaching a select few carvers in his shop. This experience led him to an increased desire to document his knowledge of woodcarving, and hence to the publication of *Manual of Wood Carving and Sculpture*, volumes I and II, picture books of intense woodcarving instruction.

Now, with Brunner's career continuing for over 60 years, what are his greatest pleasures? "Doing carvings, although the quantity is small now. Next to that my students are my greatest joy." What does he think of young carvers today? "Well, the older I get the more I think I owe these people something. . . that's why I wrote the books." What advice does he give to new woodcarvers? "First of all, and most important, learn to draw. Second, learn to sharpen your tools properly. Third, take the time to learn the basic cuts before tackling an intricate carving, and don't jump into a project that's beyond your ability. Also, ask a fair price for your carvings, and don't reduce the price just to make a sale."

Brunner is a robust man who has not slowed down with age—he's just mellowed. He works in his shop every day, swims in his backyard pool, and grows many of his own vegetables. Having been one of the privileged few to study under him, I have found his approach to carving simple and direct, and his methods based on knowing what works and what doesn't. To me, Frederick Brunner is more than a woodcarver, he is woodcarving personified. □

AUTHOR'S NOTE: *Manual of Wood Carving and Sculpture*, volumes I and II ($12.50 each) are available from Frederick A. Brunner, 369 High St., Westwood, Mass. 02090. Each has approximately 150 pp. and is spiral-bound to lie flat on the workbench. The pressures of business and providing for his family did not allow Brunner to attend formal English classes so, as you work your way through his books, look beyond the words to the meaning, and most of all, studiously examine the illustrations. Brunner's books are reviewed by Frederick Wilbur on page 26 of this issue.



Mounted on the side of the diesel power unit is the mill's 4-cylinder starting engine, itself started by pull rope. On the conveyor is the dog board from a 12-ft. walnut log. Deck at feed end (inset) can hold 10,000 ft. of timber, enough to keep two men busy for several days.

Sawmilling

How one small mill works

by Dwight G. Gorrell

My father Gordon and I operate our own sawmill on our farm outside of Centerville, Kansas. I've been sawyer on this mill for over ten years, sawing logs harvested from our own stands. Most people don't think of Kansas as having trees, but eastern Kansas is about 40% woodland, with sycamore, cottonwood, ash and walnut predominating, along with hackberry, oak and our native evergreen, aromatic red cedar. The reward of having your own sawmill is that you can use timber that usually just gets wasted. Since 1963 when we first got the mill running, we have sawed mainly damaged, culled and thinned trees, having more than enough lumber for our shop and some specialty sales, all the while improving the timber stands on our land.

Our sawmill is located on a gentle slope, which makes it easy to roll logs toward it and provides good drainage. It's different from other mills mainly because we built several of its major components from scrap iron and parts from highway vehicles and old farm machinery. We bought the blade, mandrel bearings and pulley, husk, dogs, setworks, headblocks, sawguides and part of the feedworks from an old sawyer. For the rest we learned to be make-do millwrights. Foresters and millwrights who have seen our mill tell us it compares well with others. When well tuned it does an excellent job.

The forerunner of the sawmill is the pit saw, powered by human muscle. The first true sawmill in the United States was the sash or up-and-down saw, powered by waterwheel. Then came steam power and the circular saw. Band headsaws next appeared, and at some large mills today double-cut band headsaws, with teeth on both edges of the blade, have increased production. Portable sawmills, both circular-headsaw-carriage and chain-saw types, are also available and useful where transporting logs is a problem.

Photos: Staff; Illustrations: Christopher Clapp

We use a single, circular headsaw, a 52-in. 8-gauge (5/32-in.), 38-tooth, right-hand blade hammered for 600 RPM. The power unit is a Waukesha Hesselman multi-fuel spark diesel engine, 6 cylinders with 7-in. bore and 8½-in. stroke, whose governed speed is 950 RPM, loaded. It has a 4-cylinder starting engine. The carriage is 18 ft. long and has two movable headblocks, one movable bolster, and a stationary tail bolster with dog. A plate-feedworks provides variable speed, forward and reverse.

The saw will clean a 23-in. cant face, and we have sawed stock 25 ft. long, but it is rather difficult. We don't like to saw logs larger than 33 in. in diameter. Some sawmills have a smaller circular blade, positioned in the same plane above and slightly ahead of the headsaw. This topsaw is activated by a clutch and is used when the headsaw will not reach through a log. To square up a large log on our mill, however, we have to saw with the saw buried, which necessitates slow carriage speed and caution. A chain saw finishes the cut.

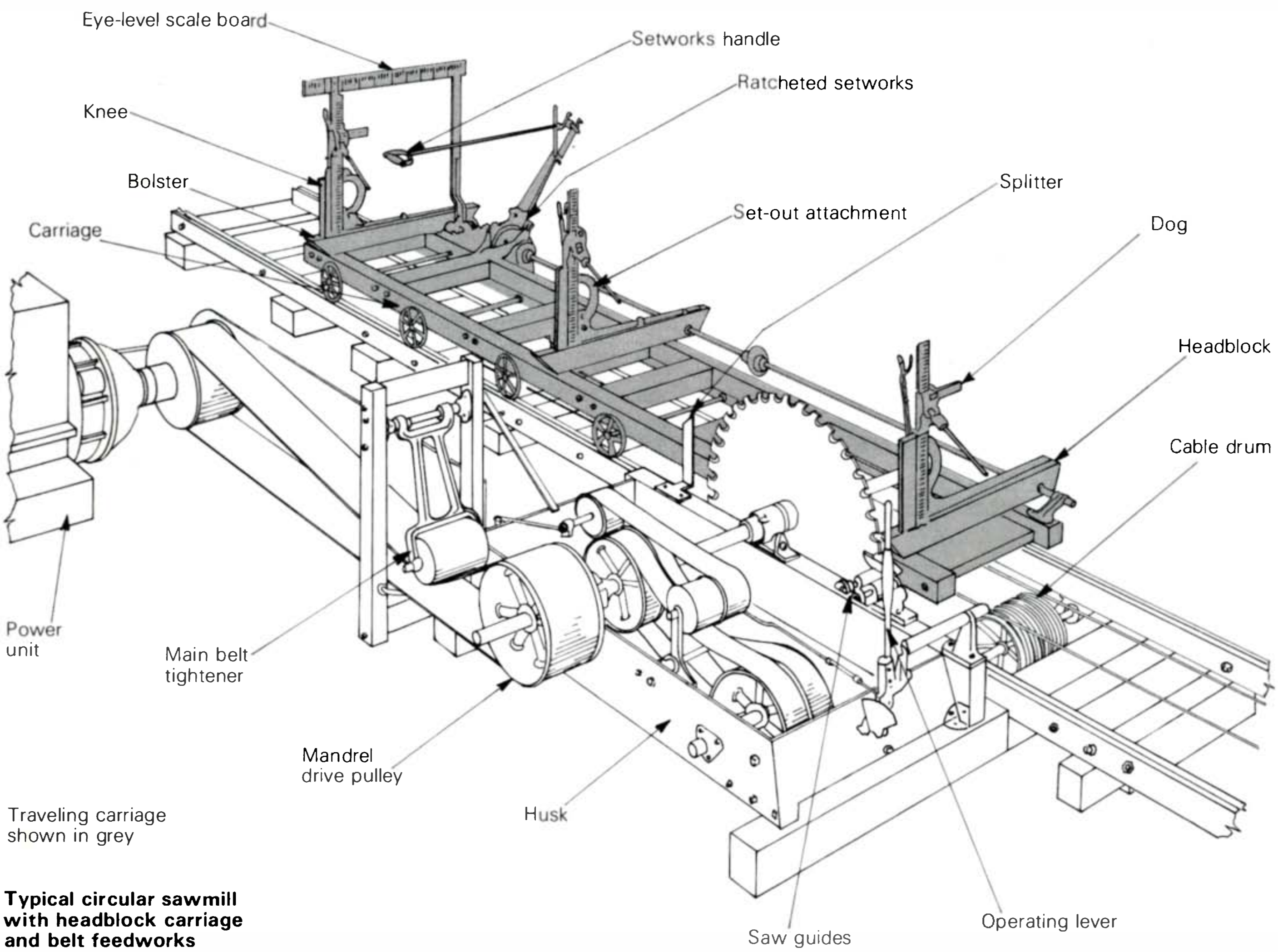
Except for an electric winch to turn large logs, we do all turning by hand. Small logs may be turned on the carriage against the knees, but large cants must be turned on the deck by rolling them off the carriage onto the face most recently cut, then sliding them back onto the carriage. This prevents damaging the headblocks and carriage.

Two men can get along quite well on a mill like ours. The sawyer and off-bearer (tail sawyer) are busy all the time, but under ideal conditions can saw several thousand board feet in a day. The sawyer makes decisions concerning actual sawing of logs, turns (or helps turn) the cant, controls carriage speed and direction, and operates setworks and dogs. Removing slabs and lumber, and helping to turn cants are the major responsibilities of the off-bearer.

In most large sawmills, the functions of dogging, setting and turning are automated. In older mills, before these jobs gave way to mechanization, they were done by men. One of them, called the setterman (setter), was responsible for operating the setworks. The setterman usually rode right on the carriage with the log, taking directions from the head sawyer through a system of hand and finger signals. Noise levels and distance made oral communication impractical. This sawmill sign language enabled the setterman and sawyer to make lumber and sawdust all day long without speaking a single word to each other.

Sawmilling actually begins in the timber. Trees must be properly felled to avoid splitting. When the trees are cut and bucked into logs, they should be cleaned as much as possible. Limbs, protruding knots, slivers, etc., should be removed flush with the surface of the log. Each end of the log should be a single, flat surface, cut square across. If the log has a large butt, this should be reduced. Final cleanup can be done at the mill, but it adds to the waste-disposal problem, which can be considerable because in mills like ours, bark, slab and sawdust are not burned for power. We do burn as firewood what waste we can, and bed livestock with the sawdust.

We avoid skidding logs through mud, gravel or rocks. These materials become embedded in the bark and wreak



Typical circular sawmill with headblock carriage and belt feedworks

Glossary of terms

Bolster—Base of headblock on which log rests.
Buck—To cut log into shorter lengths.
Butt—Log end that grew nearest stump.
Cant—Log that has been slabbed on one or more sides.
Carriage—Movable frame plus headblocks and setworks that carries logs into sawblade.
Deck—Holding platform for logs before they go onto carriage.
Dog—Adjustable device for holding log firmly onto carriage.
Dog board—Last board in the cant, which dogs bit into.
Feedworks—Mechanism that moves carriage past headsaw, consisting of drive train and clutch.
Flitch—Lengthwise slice of log with wane.
Gig—To run carriage back after cut.
Gullet—Open space or cavity between two adjacent sawteeth.
Gumming—The deepening of the gullet, usually by grinding, to lengthen sawteeth that have been shortened by repeated sharpenings. Only solid-tooth, not inserted-tooth, blades require gumming.
Headblock—Upper part of carriage, consisting of bolster and knees.
Headsaw—Main or primary saw.
Holder (shank)—Holds sawtooth in recess of inserted-tooth blade.
Husk—Frame that supports mandrel and other working parts of sawmill.
Jointing—Bringing points of teeth on a circular saw into the same cutting circle.
Knee—Vertical extension of headblock that supports outside of log or cant; with setworks, it moves stock into sawline.
Lead—Slight misalignment of saw plate and carriage to keep cant away from trailing edge of blade.
Leveling—Hammering of saw plate to remove high spots and kinks when tensioning.
Mandrel (arbor)—Shaft that sawblade is mounted on.
Saw guides—Two wooden pins positioned one on each side of blade, ½ in. behind gullet, to restrain saw from being forced off line.
Sawing on the shares—Form of custom sawing in which the sawmiller keeps a share of the lumber as payment.
Setworks—Ratcheted mechanism that moves log out into sawline and regulates thickness of cut.
Slab—Outside chunk that comes off log when squaring up; there can be four slab cuts.
Slash—Parts of a tree remaining after log has been cut out (limbs and tops).
Splitter—Bladelike bar at trailing edge of blade to open kerf and keep boards and pieces away from saw.
Swage—*n*, Die or stamp for shaping metal by hammering; *v*, To spread the tips of sawteeth and provide clearance in the cut.
Tensioning—Creating internal stress in a sawblade by hammering.
Topsaw—Auxiliary saw that permits wider logs to be sawed.
Turning—Rotating log on its long axis for further sawing.
Wane—Bark or lack of wood at edges of a piece of stock.
Wind shake—Separation of annual rings within a tree, caused by twisting force of winds. (Wind is the largest single cause of timber damage in our area.)

havoc on the headsaw. One of the advantages of a mill pond, which unfortunately we do not have, is that logs may be floated. This not only makes work easier and soaks off dirt, but prevents checking and worm and insect infestation too.

Trees should be inspected for obvious signs of hardware, which is the bane of the sawmiller. It's a good plan to mark logs that come out of fence rows, yards and other localities where hardware can have grown into the tree. Even so, wire, nails, insulators, rocks, gate latches and once in a while Indian arrowheads find themselves in the path of the headsaw. We commonly hit bullets, but the nonjacketed ones don't cause any damage. When we hit hardware, we shut down, swage and file the damaged teeth (or replace them), cut or pull the hardware out of the log, and then it's back to work. We have a system that reduces the incidence of such delays. We yard all logs suspected of containing hardware—a metal detector helps in the determination—and saw these logs when the teeth are well used. It saves damaging new teeth.

Another hazard is wind-shaken logs and logs that have internal stress (reaction wood). They're not much good for lumber anyway. It is difficult to determine the extent of wind shake until after the log has been opened up on the mill. Logs with reaction wood, such as hackberry, will warp and twist while being sawed. In extreme cases, it is not worthwhile to finish sawing the log—and it can be dangerous.

Knowing where to buck a crooked or a severely tapered tree comes from experience and common sense. Species of wood, size of logs and handling equipment determine whether logs are transported tree-length or bucked to their final length at the stump. The less cutting is done in the woods, the fewer pieces there are to handle and the more footage can be hauled per load. Smaller trees are usually easier to measure and buck in the mill yard or even on the deck than in a slash pile.

With the log on the deck, butt toward the front, we make a final cleanup, removing mud, gravel and loose bark with a garden hoe. Then we roll the log onto the carriage.

The opening face of a log affects the grade, grain pattern and yield of stock. Sawing for a particular grain pattern requires the opening face to be oriented just right, especially for crotch cuts. Knowing where to make the BOF (best opening face) requires observation, experience and luck. The two objectives of a sawyer are to obtain maximum-grade lumber and good volume production per hour. The principal objective in specialty sawing is to achieve maximum exposure of desirable figure, which militates against sawing for volume. It is not possible to succeed by any one method. Either the frequent turning required to recover the maximum-grade values reduces volume, or the minimum turning necessary to get high production sacrifices grade. Turning procedure must be varied in accordance with log qualities, sizes and headsaw capacity. In specialty sawing, each log must be sawed on an individual basis. During a typical day of sawing, a sawyer makes many quick, irreversible decisions.

Having decided on the opening face, the front dog is set and the log moved over into the sawline by the setworks, a ratcheted crank at the front of the carriage. If the log is appreciably tapered, I set out the small end so that a uniform face can be cut from end to end. Because our headblocks do not have set-out attachments, I block out with a wooden wedge between knee and log, and then set the tail dog. I'm now ready to feed the carriage past the saw for the first cut.


Dog bites log.

The feedworks of our mill deserves some explanation; it is unlike any other I have seen. It consists of a drive plate on a horizontal axis in contact with a friction wheel on a vertical axis. Plate and wheel are controlled by two levers: The right moves the drive plate to and fro; the left moves the friction wheel up and down. Together, through a system of cables and pulleys, they control both the speed and direction of the carriage. To move the carriage forward for the cut, the right-hand lever is pushed to the left. This moves the drive plate into contact with the friction wheel, gradually, much like the clutch of a car engages. To increase the speed of the carriage, the left-hand lever is pushed down, which raises the friction wheel on the drive plate, increasing the circumference in contact, and thus the speed. To reverse carriage direction, the right-hand lever is eased back, and the left-hand lever is raised. This lowers the friction wheel below center, where the drive plate rotates it in the opposite direction. The higher the handle (or the lower), the closer to the edge of the drive plate is the friction wheel, and the faster it moves. At any point, up or down, the drive plate can be withdrawn from contact with

The plate-feedworks, above, is the ideal transmission. Right-hand lever moves feed plate in and out to start and stop carriage; left-hand lever moves friction wheel up and down to control carriage speed and direction.

Sawyer and off-bearer are a team. Here board is held away from contact with trailing edge of blade and pulled down as carriage is gigged.

the friction wheel, thus stopping the carriage. The beauty of this arrangement is in the subtle control of speed and direction it affords. It gives me the control to slow up as I see a knot approaching the blade, and to back off if the blade begins to hog into or dodge out of the log. By controlling the load on the saw I can maintain optimum blade speed, critical for clean sawing and long blade life.

Sawing is a matter of attending with all your senses. I watch the teeth as they enter the log, wary for any deviation from the sawline. I listen to the blade. When it's cutting well, it's quiet; if it grows loud, something's wrong: the teeth are dull, the saw guides not properly set, the tension off or the speed wrong. And the two feedworks levers, whose solid brass handles warm to brilliance after a day's sawing, are my connection with the mill.

With the opening cut made, the carriage is gigged, the cant turned, the face positioned on the bottom side, resting squarely on the bolsters, and the same procedure makes the second cut, blocking out if necessary. Cuts one and two are the only cuts that can be blocked out. Most of the time I square the cant on all four sides before sawing it, taking just enough off each face to give a flat surface so the cant will rest firmly on all bolsters. By opening all four faces on the cant, I can choose the high and low-grade faces and saw accordingly.

With the cant squared up, it is now ready to be sawed into boards. Pulling the handle on the setworks moves the log across the sawline a regulated distance. This distance, minus the kerf, equals the thickness of stock that will be ripped off. Shrinkage rates of green material must be considered when sawing within close tolerances; no sawmill produces lumber without some variation among boards.

There are a few general principles that can be applied when sawing logs. Highest lumber grades (clearest boards) are most often found immediately under the bark. The procedure for grade-sawing lumber should be first to take high-grade material from the better faces by taper sawing (sawing parallel to the bark) and then to turn to a different face as the grade drops below that offered by adjoining faces. Low-grade faces can be sawed by the most convenient method. Knots should be near the center of a board instead of along the edge and cut across rather than with their grain—round knots are better than spike knots. Thin stock should be taken from the outside of the log, while larger pieces should be taken from near the center. Sawing around the log, or "boxing the heart," produces a single, large timber containing the pith of the log in its center. Production sawing requires that a sawyer be familiar with lumber grades and grading methods ("Lumber Grading," *Fine Woodworking*, Nov. '78).

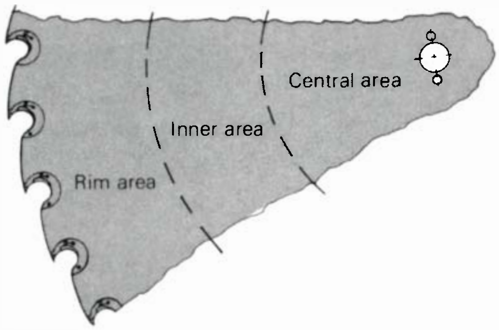
After sawing, the headsaw edges flitches and rips wide boards. Stack the flitches onto the carriage with bark edges clearing sawline. Make the cut, gig the carriage, turn the flitches over, placing sawed edges against knees, and saw off the other bark edge. To rip boards, measure over from the best edge at leading end and mark. Line up saw and cut.

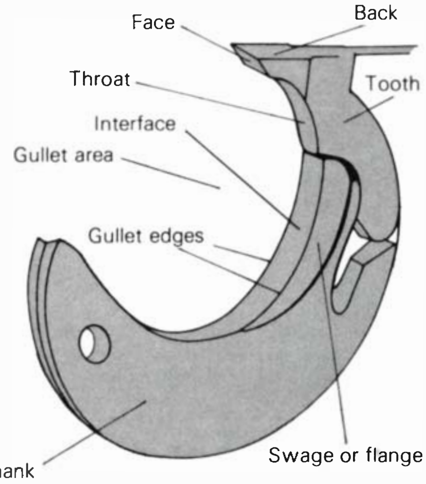
Sawmilling like this involves lots of hard work, but I never tire of watching that big blade make cut after cut. It's a pleasure to see and hear a well-tuned saw whisper through a log, and to savor the aroma of freshly sawed wood. The thrill and anticipation of what the next cut will bring is even greater when visions of fine furniture that the log could be crafted into fill my mind.

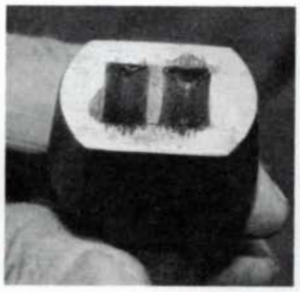
Sawmill technology — The nucleus of any sawmill is the headsaw itself. Like any woodworking tool, in order to perform well, it should be understood, used properly and maintained. Headsaws are designed to do a specific job under widely varying conditions, including hardness of wood, size of logs, knots, pitch or sap content, grain variation, feed rate, ambient air temperature and angle of tooth attack through the log. Blade diameters range from 32 in. to 72 in., with 48 in. to 52 in. most common. Blade gauge, the thickness of the blade at the rim, ranges on the Birmingham scale from 10 (1/8 in.) on thinner saws to 5 (7/32 in.) on heavy blades, common gauges being 7, 8 and 9. Most sawmill blades are thicker at the center than at the rim by one or more gauges.

Teeth are almost exclusively the swage-set, inserted type;

The three areas of a saw plate.
Detail shows parts of an inserted sawtooth.

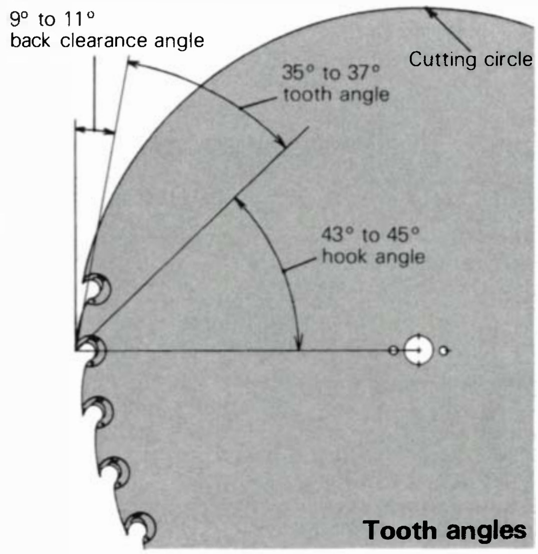






Tooth wrench (left) removes and installs teeth and holders. Swage (above) has two slots: convex-faced for forming points and flat-faced for shaping cutting edge. It is struck (right) with short, sharp blows.

After swaging, sharpen the tooth by first dressing the sides with a bastard file supported by the plate (left). Then file straight across the face of the tooth (above) at the correct angle (right). One light stroke on the back of the tooth removes any burr.



hardly any spring-set or solid-tooth blades are used anymore. Carbide-tipped teeth are available for inserted-tooth blades. Special tooth styles are made for sawing frozen timber. The parts of an inserted-tooth blade include the plate, the teeth (bits) and the holders (shanks). The plate is a large, circular piece of high-grade steel, at the center of which is the mandrel (arbor) hole, or eye, usually flanked by two smaller holes for lug pins to keep the mandrel from slipping in the saw. At the periphery of the plate are circular recesses (sockets) to accept the teeth and holders. A *V*-groove in the outer edge of the holder fits over a way in each socket on the plate. Compression of the holder against the socket keeps the tooth and holder tightly in place. The most obvious advantage of an inserted-tooth blade is that, as teeth become worn-out or damaged, they can easily be replaced. Also, this type of blade does not require gumming or jointing. There are several styles of teeth for headsaws and the number of teeth in blades of the same diameter may vary considerably.

Proper maintenance of the headsaw is by far the most important single task involved in efficient sawmill operation. Maintaining the saw includes keeping a close check on the condition of the plate and keeping the teeth sharp and in shape. Sawteeth should be sharpened correctly at least once a day or more often as necessary. When sawing large, dry hardwood, it is not unusual to sharpen up after each log. Experienced sawyers can tell when the saw is getting dull by the sound it makes.

There is nothing really difficult about swaging and sharpening the teeth ("Circular Saws," *Fine Woodworking*, Spring '78). As sawteeth wear or become damaged, they usually need swaging to restore the cutting edge to its original width. Swaging is spreading the point of a tooth to provide clearance for the saw plate while in the kerf. There are two types of swages available, the lever type (rolling swage) and the upset swage (hammer swage); the upset swage is the handier. In the working end of the upset swage there are two slots (dies). One slot has convex faces: It forms the tooth points; the other slot has flat faces: It shapes the cutting edge. The swage is struck with short, sharp blows using a 1-lb. hammer. It is recommended that the tooth first be shaped with a file, which is okay for routine swaging, but for reshaping a tooth that has hit hardware, it is not practical.

When the tooth is properly swaged, it is ready to be filed. Use an 8-in. mill bastard file with two round edges, and dress the sides to bring each tooth down to its final cutting width. This is done by allowing the point of the file to ride lightly on the saw plate while filing the corners of the tooth. File both corners evenly until the cutting edge of the tooth is the correct width and centered with the plate. You can make a small gauge to check finished tooth angles and dimensions, or use a new tooth for comparison.

The cutting edge is now ready to be sharpened. This is accomplished by filing the face of the bit in a single plane, parallel to the original face. Grasp the file securely, gripping the tang with one hand and the point with the other. To keep it from chattering, steady the sawblade by pressing against it with your body. Push the file full length straight from the shoulder without dropping your elbows. The file should move straight across the tooth. Avoid notching the throat. (This is the reason for using a file with round edges.) Keep the throat rounded as the tooth is sharpened back. Do not try to sharpen a tooth by filing on the back of it. It is important to keep the cutting edges of the teeth as far from the center of the saw as possible. Sawteeth should be uniform in length so that cutting edges travel in the same cutting circle. After side dressing and sharpening, a light stroke on the back of the tooth will remove the burr.

Holders require maintenance also. Besides holding teeth in place, they trap and remove sawdust from the cut. They are manufactured with a flange, or swage, about 1½ to 2 gauges thicker than the saw plate to reduce the amount of sawdust slipping out of the gullet and to reduce contact with the wood. Holders with worn flanges and rounded edges will allow sawdust to leak out of the gullet, which hastens wear on the gullet edges and saw plate, and causes the rim area to heat. Holders with rounded edges but in otherwise good condition can be restored to their original condition by sharpening straight across the interface. Loose holders can be tightened by peening, but it is best to replace badly worn or loose holders with new ones. They are removed and installed using a special inserting (tooth) wrench. Holes in the shank allow pins in the tooth wrench to engage the shank and the shank is rotated into or out of the socket.

Sawmill blades are not symmetrical in section, but crowned on one side. Thus blades are identified as right or left-hand to indicate on which side the log runs. The shape allows for a thicker center section to sustain the high torque of the mandrel, and a flat face to run on the log side. But to maintain this flat face at operating speed, a sawblade must be properly tensioned. The inner area between the center and the rim must be hammered into concavity, prestretched or made to "fall away" from plane to compensate for the centrifugal force and friction-caused heat at the tooth zone that expands the rim more than the adjacent inner metal. If the stress in these two areas is not equal at operating speed, the saw tends to buckle and weave and will neither stand up straight nor cut a straight line. But the tension of a properly maintained sawblade can remain correct for years. The secret is in keeping the teeth sharp. Dull teeth and worn holders cause the blade to heat up, warp and lose tension. But these problems can produce the symptoms of lost tension before tension is actually lost. Only after checking all mill adjustments and making sure that teeth are properly shaped and sharpened and that holders are not defective can it be assumed that a blade that continues to cut unevenly is in need of retensioning. Specialists must attend to tensioning along with leveling (the hammering free of high spots, kinks or twists)—most mills do not retension their own blades.

Cross section of a sawmill blade: Fall away varies from 1/75 in. to 1/12 in., depending on diameter, gauge, saw speed, number of teeth, kind of wood sawed, horsepower available, carriage speed.

When mounted on the sawmill mandrel, the blade needs to be plumb and have the correct amount of "lead" before it will operate satisfactorily. Lead refers to the slightly nonparallel alignment of the guide track and saw plate, the leading edge of the headsaw being slightly closer to the carriage than the trailing edge. Lead counteracts the natural tendency for the saw to run out of the log, especially on the slab cut, and also provides clearance for the trailing edge of the saw, preventing contact with the cant while sawing. Standard lead for most headsaws is 1/32 in. to 1/16 in. Lead is adjusted by shifting the mandrel bearings and should not be forced into the saw by sharpening the teeth with a high side or by adjusting the saw guide to one side.

Saw speed and carriage speed must be in the proper relationship for a mill to operate correctly; this is largely a matter of seeing and hearing and feeling what the saw is doing. For each sawmill blade there is an optimum speed, which should be maintained while in the cut, regardless of variable sawing conditions encountered. A common speed for headsaws is 600 RPM (8,000 ft. to 9,000 ft. per minute at the rim). Carriage speed, on the other hand, varies from log to log, depending upon the hardness of the wood and cant-face width. A faster carriage speed can be used to saw a small basswood log, for example, than can be used for a large burr oak.

Bite is the distance the log or cant advances into the saw between successive teeth. Interaction of the saw speed and carriage speed determines the bite. In order to calculate horsepower requirements for sawmills, bite must have an established value. Sawtooth manufacturers have advocated standardizing a bite of 1/8 in. for softwoods and 1/10 in. for hardwoods. A standard bite value of 1/9 (.11) in., halfway between, has been adopted by some people. Under actual sawing conditions bite fluctuates, but good saw performance requires that bite be held as nearly as possible between 1/8 in. and

$\frac{1}{10}$ in. Maintaining the standard bite of .11 in. with a 40-tooth blade at 600 RPM, it should take approximately four seconds to produce a 12-ft. flitch.

It is important to have plenty of steady, dependable power to turn the headsaw. Because sawmill blades are tensioned to turn at a constant speed, the speed of the power unit should be fairly constant under widely fluctuating loads, producing high torque at low shaft speeds. Large-bore, long-stroke, industrial diesel engines and large electric motors make ideal power units for sawmills. A few mills still use steam engines. As late as 1904, 10% of U.S. sawmills were powered by waterwheels, some reaching the colossal diameter of 35 ft. Some mills produced as much as 20,000 board feet per day using water power.

Dealing with a sawmill — Buying lumber directly from a sawmill can be quite different from preconceived notions that woodworkers may have. Unawareness on the part of the buyer as to what is involved in logging and lumbering, or in producing a specialty product, often causes misunderstanding, especially in pricing. By examining what brings a board from the stump to the consumer, the woodworker can better appreciate the wood and how its price is arrived at.

Availability and desirability determine lumber pricing. Mill-run lumber is usually less expensive than lumber the buyer picks through and selects. When we do specialty sawing, each piece is evaluated and priced individually. Width of stock is probably the single most important factor, followed closely by species, unusual figure or grain, then thickness, length and dryness. Customers who want a certain size piece of a particular species are often unable to find what they need. Their next thought is to have it sawed out. Most of the time this can be done, but having a large, special piece cut out of a log can be expensive because it often requires sacrificing the rest of the log.

An example of a sawmill product that is quite special, largely because of the species that it is cut from, is the osage orange bow stave, from which the English long bow is made. Because the osage orange tree is short and bushy, it is difficult to find a tree that will produce any staves at all. Staves, which are about 1½ in. square by 6 ft. long, must have straight grain and no defects. Some bowyers even specify the desired curvature and orientation of the annual rings in each stave. Even from a good tree, most potential staves are rejected because of the exacting requirements of the bowyer.

We used to do custom sawing, sawing logs to the owner's specifications. There are two ways that a sawyer can charge on a custom-sawing job: by the board foot or by an hourly rate. Determining which payment method to use is the privilege of the sawyer, because he judges if the logs are good, poor, large or small. When charged by the board foot, the customer pays according to the amount sawed. The content of irregularly shaped and waned pieces must be averaged. Usually, only those jobs that have good-quality, average-size logs are paid for by the board foot. If the logs are small, or of low yield, a sawmiller may charge on an hourly basis. It costs just as much to operate a sawmill for a small log as it does for a large one, though the yield is less. The same applies to sawing logs that are rotten, hollow, wind shaken or otherwise defective. Some people, upon finding out the log they brought in was not good, think they shouldn't have to pay for having the log sawed. The sawyer is forced to explain that it costs as much to saw a bad log as it does to saw a good one.

During our custom sawing days, it was not uncommon to have customers bring in logs with large, protruding knots, limb stubs that were too long, logs that were too crooked, logs that were too long for the amount of taper and logs with jagged or uneven ends. Whenever the sawmiller must do chainsawing or cleanup work on these logs, there is usually a cleanup fee added to the bill.

Some sawyers charge a flat fee for each piece of hardware or foreign material that is struck and causes damage to the saw teeth. This is to cover shut-down time of the mill and cost of repairs. If the logs have been skidded through mud or gravel, an additional charge may be assessed to compensate for the more frequently required saw sharpenings.

Once in a while, a wood enthusiast will come to our mill, bubbling with excitement about getting a big this-or-that kind of tree sawed into lumber. "It must be at least this big around!" he exclaims, gesturing to indicate a tree that would be much too large for our mill. Although there are ways to saw oversize logs, we have learned that most of the time it's not worth doing. It is time-consuming, wasteful and risky. Even though these monarchs contain unusual figure, they will often be defective—hollow, rotten in the center or shaken.

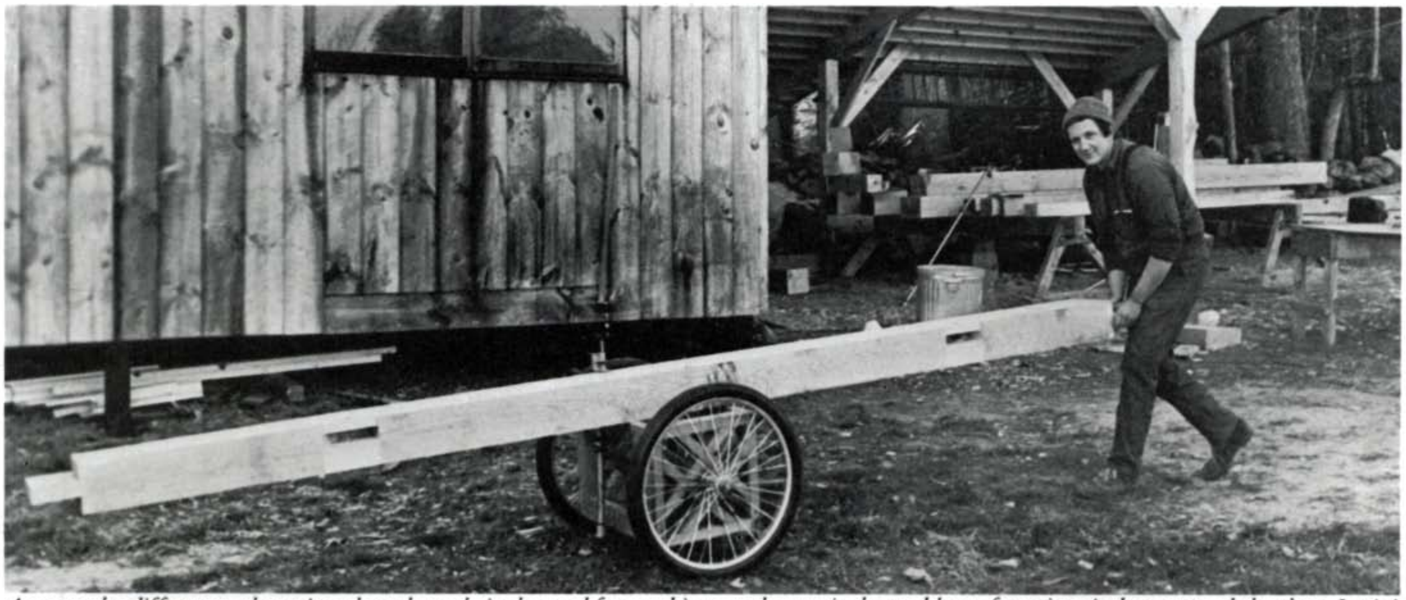
A sawmiller likes (as do most people) to be paid when the job is completed. Besides, fresh-sawed lumber should be properly stacked and stickered as promptly as possible.

We have done custom sawing "on the shares" and the lumber was divided according to who did what. Usually, if we cut the trees, loaded and hauled the logs and sawed the lumber, the owner received one quarter and we kept three quarters. If the owner cut the logs and hauled them to the mill, the lumber was divided half-and-half. Actual division of the lumber can be accomplished by separating it into four equivalent piles and allowing the tree owner first choice. This system has been used for a long time and seems to work well.

Once in a while, people will ask if they can help saw their logs or just help around the mill. Statistics show that sawmilling is a hazardous occupation. More than once, though not at our mill, an off-bearer has inadvertently placed a board in contact with the trailing edge of the headsaw, which promptly fired it through the mill-house wall like a giant arrow. Unless they are experienced, we strongly discourage people from helping around the mill. □

Loading walnut planks.

Dwight Gorrell, 32, and his father, Gordon, operate their home-built sawmill and a woodworking shop on the family farm near Centerville, Kansas.



Among the differences that arise when the scale is changed from cabinets to houses is the problem of moving timbers around the shop. Levin's solution is a four-sided truss of 2x4s pierced by the axle and wheels from a garden cart.

Working with Heavy Timbers

Woods, tools, layout and joinery of the housewright's trade

by Ed Levin

Traditional frame carpentry is something most woodworkers know little about, although its principles can be applied to any project where wood is joined to wood on a large scale. Timber framing, already in decline by the time this country was colonized, was superseded early in this century by the 2x4 balloon frame and its derivatives. The ancient art is only now coming back, albeit on a small scale. Modern timber-framing practice suffers dearly from this break with continuous tradition, to the extent that many self-taught practitioners—myself included—have to expend considerable energy rediscovering the craft. The methods I will describe are merely one man's solution to some of the problems of working with large, heavy timbers. Why timber frame? What is it in these days of balloon framing with prepackaged popsicle-stick studs that makes someone wrest whole living trees from the forest and laboriously shape them into a dwelling place? I have no simple answer. Timber framing is slow, difficult and expensive. It's also strong, durable, beautiful and righteous.

The frame — Timber framing can serve the structural needs of almost any kind of building—from traditional Japanese houses to modern fancies, as well as the classic colonial American house and barn. The frame shown in the diagram on the next page is of a typical late 18th-century New England house—still the most popular style among timber framers.

Sills sit over the masonry foundation and engage the first floor joists and the feet of all exterior posts. The sills are the first timbers laid down in a building, and often the first to be replaced—being close to the ground and in contact with masonry makes them prone to rot. The sills should be large enough to keep the ends of posts and joists clear of the masonry. Typical sizes are 6x6, 6x8 and 8x8.

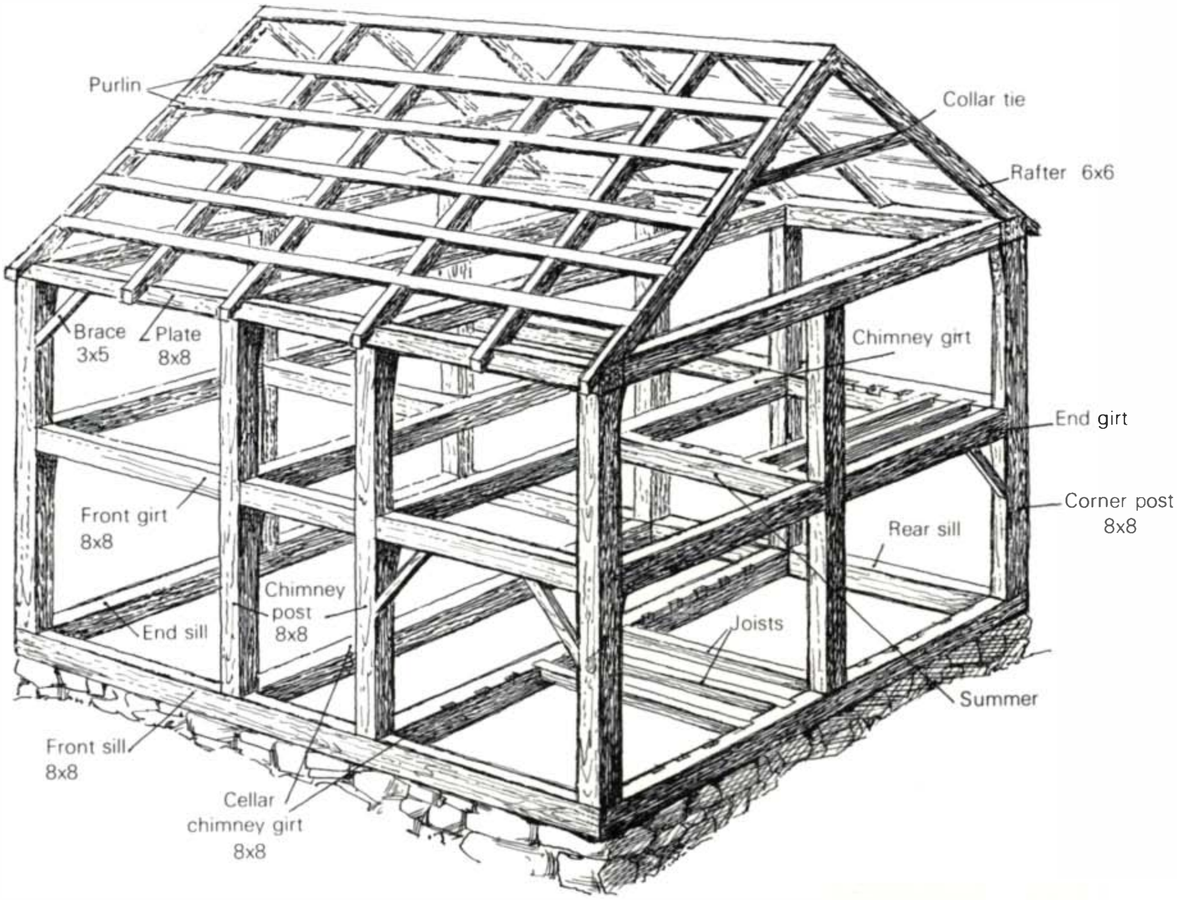
Major horizontal timbers above the sills are called girts and plates (the plate is usually the beam that supports the roof rafters). Their dimensions vary, but girts should be as deep or deeper than the joists they hold, and no wider than the posts they tenon into. Diagonal sway bracing stiffens the frame against wind, impact, resonant vibration, earthquake and internal moving loads—an extreme case of the latter would be holding a dance on an upper story. Summer beams break up long floor spans into manageable lengths. Because the summer beam has a long unsupported span and is heavily loaded, it is often the largest timber in the frame.

There are two kinds of roofs in the traditional frame. The common rafter roof has rafters on 3-ft. to 5-ft. centers with sheathing laid across the rafters. In the principal-rafter-and-purlin roof, rafters are spaced farther apart (7 ft. to 9 ft.) with purlins framed into them at 3-ft. to 4-ft. intervals and roof boards running with the rafters. Some typical dimensions for common rafters: 3x6, 3x7, 4x6, 4x7 and 4x8; for principal rafters: 6x6, 6x7 and 6x8; and for purlins: 3x4, 3x5 and 4x4. Collar ties often join rafters near the center of their spans. Tie is a misnomer as it is not in tension but in compression, and keeps rafters from sagging at midspan. Finally, roofs with a purlin system sometimes have a true ridgepole. This is a member closer in size to the rafters than to the purlins, into which the tops of the rafters are tenoned.

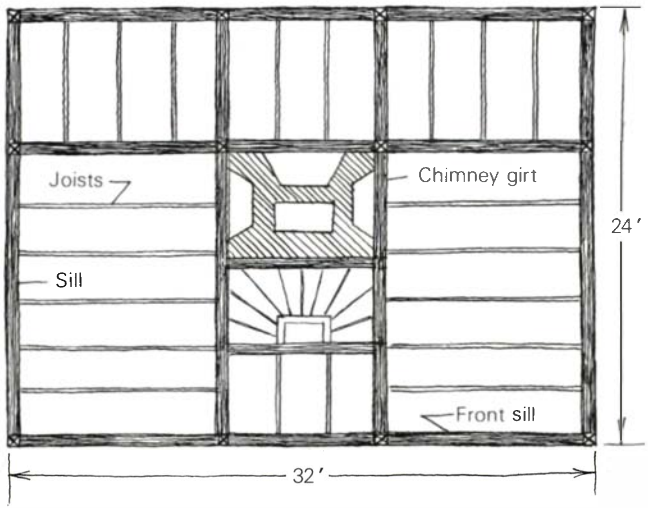
Wood — Strong, beautiful and durable oak is the premier framing material in the Anglo-American tradition. However,

Photos: Richard Starr

Framing diagram



First floor framing plan



Framing diagram (above) and first floor plan (left) of a typical two-story house in New England of the late 18th century. The contemporary frame in the photo follows the same scheme, except that its second story posts are reduced to a knee wall. This permits almost as much usable space, with considerably less timber.

oak is unyielding, heavy and slow to dry, and the availability of other suitable species caused Americans to diversify timber usage. The Northeast abounds in old frames of spruce, maple, pine, beech, hemlock, chestnut, fir, and even basswood, butternut and poplar, although current usage in New England favors oak, pine, spruce and hemlock.

Choice of a framing material depends on taste, availability and price. Hardwoods are stronger, cut cleaner and finish well, but are expensive and prone to greater shrinkage. Softwoods are lighter and cheaper and they work more easily, but they are weaker and don't cut as cleanly. Softwoods with high moisture content (pine and hemlock) are weaker when used green, and care must be taken that timbers do not sag while drying. I prefer oak (red oak in my vicinity) in houses and good clear spruce in utility buildings.

Hand hewing was the method of converting logs to timbers before machine sawing took over, and remained common into the early 20th century. The shift to sawn timber was gradual, happening earlier in cities and later in rural areas. In many places the transition to sawn beams never took place, since timber framing was supplanted by balloon framing.

The bulk of mortise-and-tenon timber construction going on today uses native lumber sawn at local mills. But dressed Douglas fir and southern pine beams are available in a vast array of sizes and lengths (it's not difficult to procure a 40 ft. long fir 12 in. by 16 in.). At the other extreme, hand hewing continues among a select group of owner-builders. Many local mills can't handle logs longer than 16 ft. so using a broadaxe or chainsaw mill may be your only alternative to imported fir for long girts, plates and rafters.

Should you frame with green wood or dry? Nowadays, most framers use unseasoned timber. The schedules of both builders and homeowners don't permit waiting for beams to dry. With a drying rate of roughly a year to the inch, it can take a decade for a large oak timber to air dry. I know of no place where you can purchase dry beams. Historically, there is evidence both ways. Because it is next to impossible to hew dry wood, beams were probably shaped while green and then seasoned before the joiner started his work. Rapid seasoning and shrinkage of timber can cause checking, but coating the ends of the beams with paint, varnish, paraffin or a commercial end sealer guards against this.

Whether you work green or dry, shrinkage is inevitable. Even air-dried timber (of say 15% moisture content) is going to move when placed in an enclosed, heated space where low relative humidity in winter may cause an equilibrium moisture content of 6% or less. So, to prevent disastrous cracking during that first winter, maintain humidity with a humidifier or by placing shallow pans of water on heaters or woodstoves. All the same, as the new frame settles into the drier interior environment, shrinkage will cause additional checking, usually accompanied by loud and eerie cracks and groans. The timber framer's primary concern is not checking however, but rather the effect of shrinkage on the joinery.

Tools of the trade

Measuring and marking tools —The power-return tape is hardly a specialized tool, but it is unbeatable for locating joints in the length of the timber. Try to use the same tape throughout the framing. I recommend the 25-ft. long, 1-in. wide variety. The steel (nowadays aluminum) rafter square takes over after the tape for marking lines across and around timbers, as well as for laying out roof angles. It can also be used to mark mortises and tenons and many other joints.

Use a knife for marking across the grain and a scribe for marking along the grain, following the edge of square, bevel or template. I prefer knives and scribes to pencils. Even when they're adequately sharpened, pencils break easily on rough timber. Cut and scribed lines can also be split cleanly—you can set the edge of your chisel right *in* the line when chopping or paring a joint. When crosscutting with a power saw, the grain will not chip up beside a cut line. This not only makes for neater work, but it also signals when you are cutting off the line because the saw starts to raise up flecks of wood. I use an ordinary utility knife for marking, and make scribes by grinding points on hardened 16d twist nails.

The combination square is better than the traditional try square for timber work. It is used to check for square inside mortises and notched or lapped joints, and on the shoulders of tenons. It also doubles as a depth gauge and as a handy straightedge to check surface flatness.

We use marking gauges to lay out mortises and tenons and in all applications calling for a straight line parallel to an edge. Ordinary gauges work well up to about 4 in. from the edge. Beyond this you need something larger. The home-made gauges in the photo are really just heavy-duty panel gauges with a couple of modifications. The stem (sliding part) of the gauge is wedge-shaped and fits tightly in a wedge-shaped mortise, eliminating annoying slop. The stem carries three spurs and scribes three parallel lines, one for each edge of the mortise plus a centerline. For points I use hardened (Sheetrock) screws that have been chucked in an electric drill and pointed while spinning against a grinding wheel. The screw thread allows you to adjust the heights of the spurs to get all three to mark evenly on erratic surfaces.

Templates are handy for laying out frequently repeated joints. Aluminum templates hold up best, but are tedious to make. Wood templates are easier, but move with the weather, get nicked and rounded over by the knife and scribe. Newsboard (heavy cardboard) templates are quickest and hold up well, but the difficulty of assembling two pieces rigidly at right angles restricts its use to flat templates.

Aside from layout for hewing, the chalk line is used primarily in those few cases when a timber must be laid out from a centerline rather than an edge. Of greater utility is an unchalked line in a reel, to check beams and assemblies for straightness, and also to measure the crown in bowed pieces.

The race knife or timber scribe was used by the carpenter to inscribe identifying marks on timbers to ensure proper assembly of a frame. It consists of a handle with one or more hook-shaped blades sharpened like gouges, which were drawn across the beam and scooped out a small trough in their wake. Such specialized marking tools have largely been supplanted by their distant relative, the lumber crayon.

Cutting tools — We rely mostly on 4-pt. crosscut saws and ripsaws with the standard tooth pattern. These cut well and are easy to sharpen, although it's hard to find saws with such coarse teeth. A pruning or docking saw can serve as a crosscut, and, for a ripsaw, either refile a docking saw or have a reliable saw doctor retooth a good saw for you. Its edge should be straight or slightly bellied to counter the tendency to leave a high spot in the center when sawing down to a line.

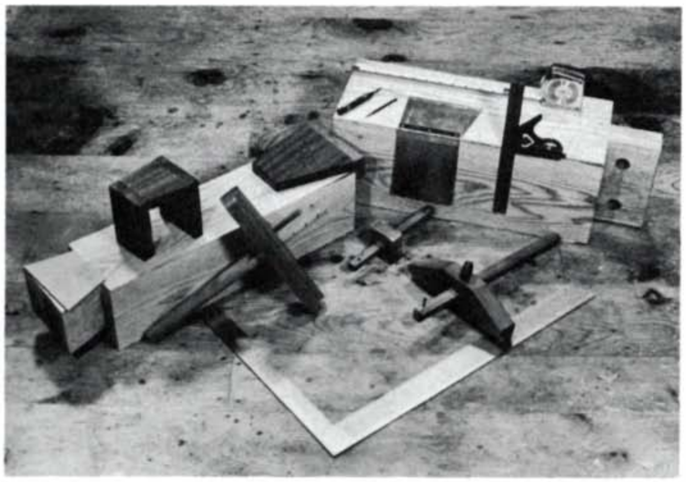
A mallet is for striking chisels when chopping joints, also for driving pegs and pounding joints home. We use 3-lb. mallets, with a cylindrical iron head filled with renewable rawhide inserts. Wooden mallets don't stand up to steel-hooped chisels.

A variety of chisels is useful, starting with the slick: a big 3-in. to 4-in. wide paring chisel with a long handle offset to clear the work. The slick is used to surface large areas, and is pushed (never struck). Framing chisels are standard. We cut mostly 2-in. and 1½-in. mortises, and employ 2-in., 1½-in. and 1¼-in. chisels. A chisel of slightly smaller than nominal dimensions is useful when chopping the ends of mortises, lest the tool become inextricably wedged in the joint. If you're like me and rely on the flatness of the backs (unbeveled side) of chisels, you'll probably have to resort to imported tools.

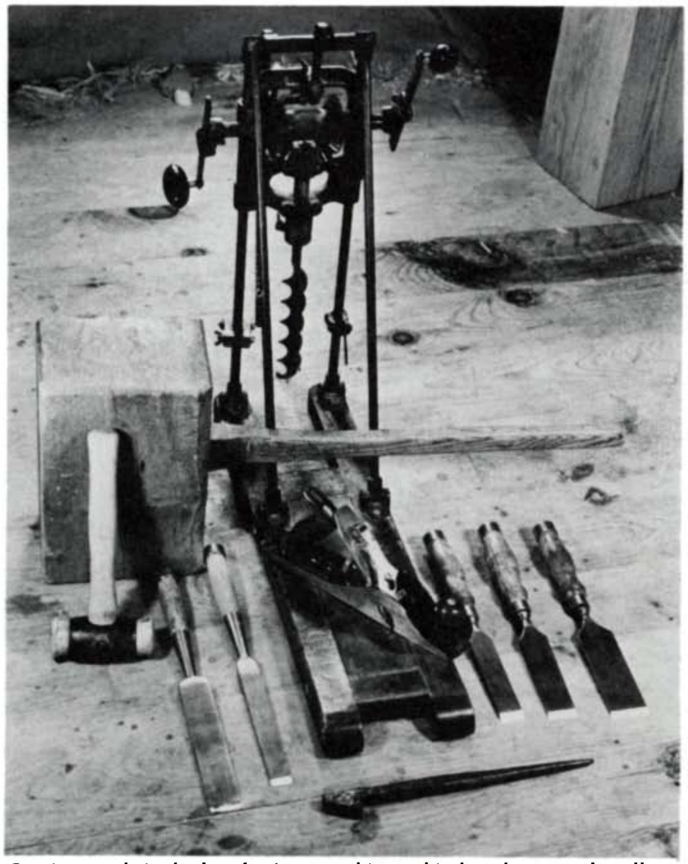
The corner chisel is currently out of favor in my shop—when using it you are cutting two surfaces at once and so need twice the concentration. They're also a nuisance to sharpen. I find a sharp framing chisel perfectly adequate.

A large (1-in., 1½-in.) bevel-edged chisel is useful for cleaning up in acute angles (inside dovetails) along with a small (¼-in., ⅜-in.) cabinetmaker's chisel for getting into even more restricted areas. I should mention that green oak corrodes steel almost instantaneously. Never leave a chisel in a mortise, and oil your tools after use. A hatchet is invaluable for roughing-out if you work by hand.

The plane is the unsung hero among timber-framing tools. A bench-rabbet plane (Stanley #10, Record #010, also known as a coachmaker's rabbet or jack rabbet) is a versatile tool for cleaning up and flattening out surfaces in timber work. We use a plane to knock off discontinuities around knots and



Measuring and marking tools include (clockwise) a power-return tape, combination square, marking gauges, steel rafter square, templates and scribes.



Cutting tools include a boring machine, chisels, planes and mallets. The large mallet (called a commander, beetle or persuader) weighs 30 lb., and is used to drive parts of the framework together. The drawbore, or drift pin (forefront) is used to align drawbored holes in mortises and tenons prior to inserting a wooden pin.

checks, to level crowned surfaces before marking out, as well as to dress housings and finish cheeks (and sometimes shoulders) of tenons.

A drawknife is used to remove bark from waney corners and, with a spokeshave, to cut decorative chamfers on beams.

The pre-19th-century tool used for boring out waste before chopping mortises was the *T*-auger. The modern carpenter has recourse to a ½-in. electric drill or drill press. Historically sandwiched in between, the boring machine had a brief but glorious career. The machine is placed on the timber and sat on by the workman. The coffee-grinder handles give tremendous leverage, and when the desired depth is reached (indicated by a scale on the side of the machine or by a built-in depth stop) a set of gears is engaged to retract the bit and most of the chips. Boring machines are also used to drill peg holes. They are a joy to use, a good alternative to electricity.

If you do your drilling electrically, use a powerful (6 amps or more), slow-spinning reversible ½-in. (or larger) electric drill with long handles, and take care when you run into knots or other dense places in the wood that the bit continues to spin rather than the drill. Locating large (2-in.) bits is a problem. The shank of 2-in. Scotch pattern augers can be cut short and chucked. Multispur and other brad-point bits can be used in a drill press, although bits without a twist may have trouble clearing chips in green wood. If you use a drill press, you want to have either the machine or the beam on wheels, and both should be leveled up.

Both drill and drill press have handicaps: With a portable drill, the bit must be squared to the timber surface and held square while drilling. The immobility of a drill press (wheels notwithstanding) makes locating bits over centers tedious.

The circular saw is the most useful power tool in timber framing. Try to find a saw that will cut at least halfway through the stock you are using. This is invaluable for long rip cuts (for scarf joints, flared posts, etc.).

The power plane is for surfacing timbers. Far and away the best machine on the market is a Japanese import (Makita) which planes a 6⅛-in. swath and (when sharp) leaves a glassy surface. You can contact Makita at 650 Hadley Rd., S. Plainfield, N.J. 07080, for distributors.

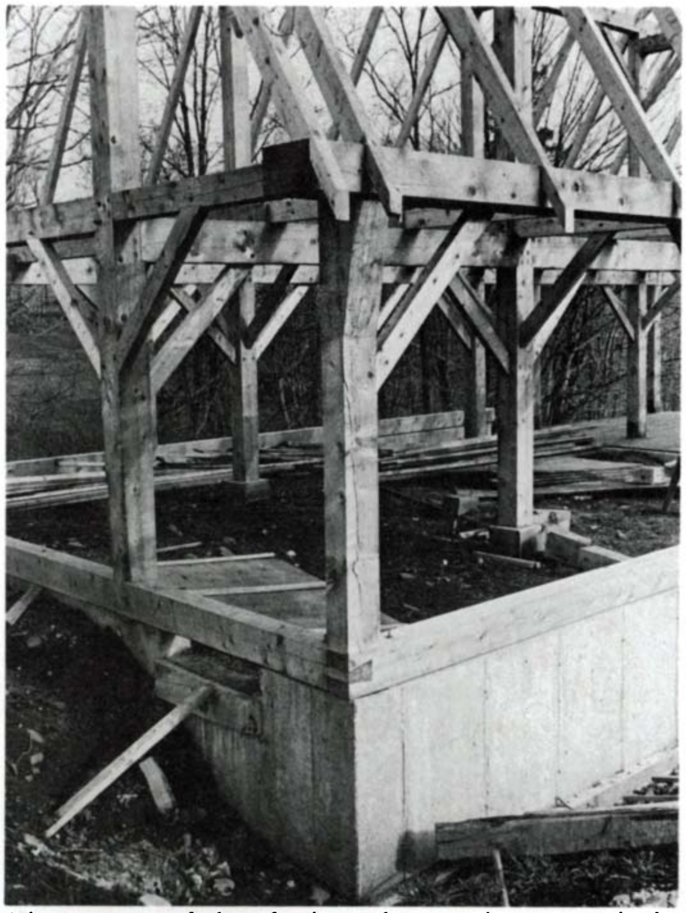
Layout — Layout is the art and science of setting out joints on timber surfaces, and accurate layout is the foundation of workmanlike timber framing. If you can't lay out a joint correctly, then it doesn't matter how carefully it is cut. But if you can, then in nine out of ten cases the cutting will follow almost automatically. The principles of layout in timber joinery are basically the same as those in furniture joinery, with one important difference. The cabinetmaker can overcome most of the spatial orientation problems that are the bane of accurate layout simply by trueing up the stock before marking it out. This is out of the question when working with heavy timber. So, unless you have exceptional skill with adze or broadaxe, or know of a mill which can provide beams that are uniformly straight in length, flat in width, free of twist, square, cut exactly to nominal size and free of defects, you will have to learn to cope somehow with the irregularities in the timber. Even if you have a timber sizer, a massive four-sided thickness planer capable of dressing beams to dimension, you will still have to deal with dimensional instability, knots, checks and twisting. Here are some of the anomalies that make timber layout difficult:

Bow (or sweep) in length—This is probably due to stresses locked into the tree during its growth. When the slabs that reinforce the tree against internal bending stress are removed, the remaining timber, sufficiently weakened, bends or bows.

Crown in width (the same as cup in boards)—Shrinkage in boxed-heart timbers usually causes initially flat surfaces of beams to become convex.

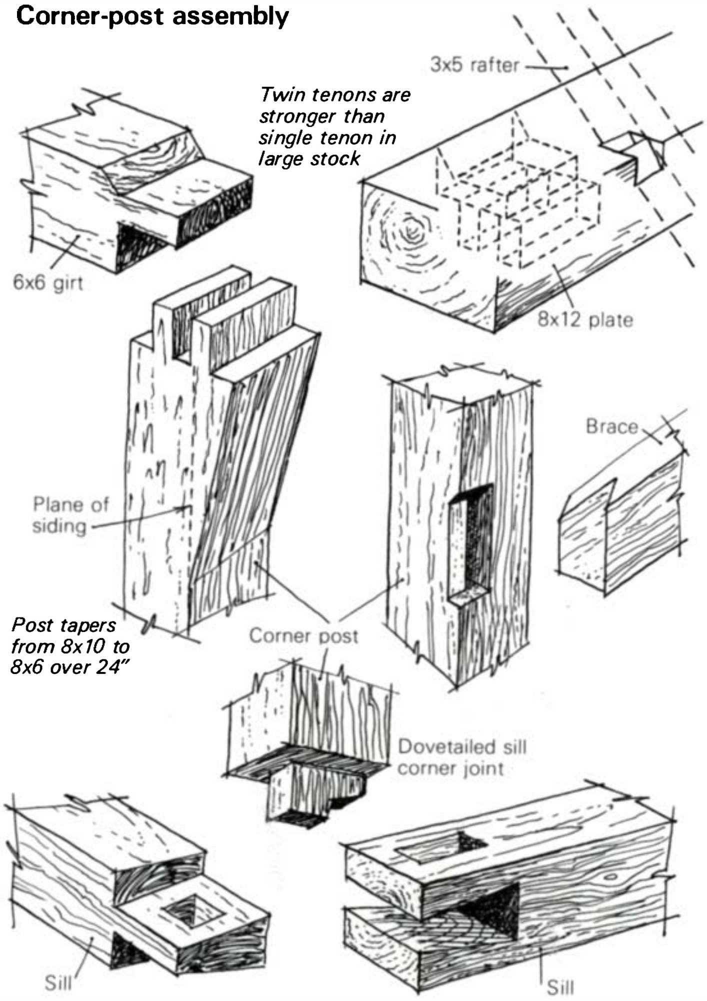
Twist—Again due to internal tensions in the wood. In some species timbers twist as they come off the saw, while in others they may twist as the timber dries.

Taper in length—This may be uniform from end to end or irregular, and is probably due to a milling fault.



The corner post of a barn for sheep (above) is taken apart in the diagram at right. Author used the tapered post to support an unusually wide plate, in order to increase eave overhang from the steeply sloping gambrel rafters.

Corner-post assembly



Faults—Wane, knots, checks, shakes, seams (ingrowths of bark), pitch pockets or decay may not affect the shape of the beam, but they will affect its structural adequacy.

Dimension—The size of roughsawn beams rarely corresponds exactly to nominal dimensions. Variations of ¼ in. to ⅜ in. are not unusual.

Square—Most timbers are sawn out of square. Departures from square of ⅛ in. to ¼ in. are not uncommon—in fact, it is unusual to find a timber in which all four angles are within 1/16 in. of square.

Many of these obstacles to precise layout can be overcome by careful selection of wood for a given job. Some pointers:

Measure beams in length carefully, and avoid locating defects in joints. Checks and shakes should be kept away from the ends of beams where shear stress is greatest. Serious faults should be avoided altogether.

Concentrate knots in the upward (or compression) side of beams and joists, and avoid using bowed timber in posts. Traditional wisdom prescribes laying out bowed beams from a chalk centerline. The bow, however, puts the middle portion of the beam off in left field, causing problems with joints in that area (too much wood on one side, not enough on the other). Better to cut such pieces up into shorter lengths, or discard them. Best of all, use them crown-up as joists or girts, where some upward camber is desirable to offset eventual deflection under load.

A small amount of twist is okay in timbers whose surfaces are not functional (such as interior posts). Use winding sticks plus chisel and/or plane cross grain to bring the surfaces of different joints into alignment. Pieces of small cross section (especially joists) with a slight twist will flex and straighten out when driven home. Serious twist, however, is an almost impossible problem. Some badly twisted beams may be usable for framing when cut into shorter lengths, otherwise cut them up for cribbing or blocking.

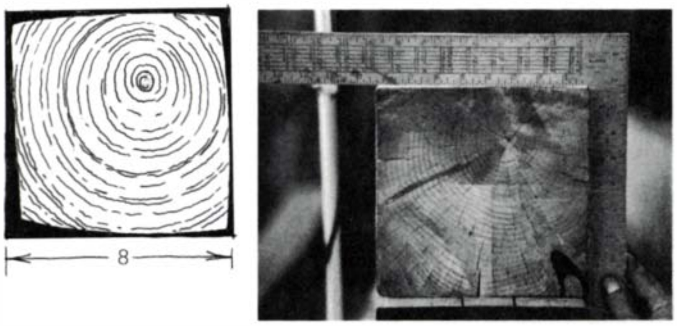
After you have given the timbers their job assignments, you can cope with the layout. The fundamental differences in layout methods are not so much in how layout is performed, but rather in how you prepare the stock. One approach is essentially to ignore irregularities and to mark the beams as if they were cut perfectly or had already been trued up. Accommodate imperfections during a trial assembly by trimming or kerfing the joints where necessary. Each joint must then be numbered so that it may be reassembled correctly.

The opposite of this approach, and the one I prefer, is mass production, using standardized dimensions and interchangeable parts. Some preliminary work must be done on parts of a timber *before* it is laid out to ensure uniformity of size and shape, but preassembly and numbering are unnecessary. For each particular set of joints, create a model timber, that is, an imaginary true beam that will fit entirely within any of the actual timbers you have to work with. I usually establish a dressed dimension of ¼ in. less than nominal. For instance, I find that a nominal 6x8 measures at least 5¾ in. by 7¾ in. and no more than 6¼ in. by 8¼ in. 99% of the time. Thus, I dress 8-in. beams down to 7¾ in. at joints (and make accommodation for pieces up to 8¼ in.).

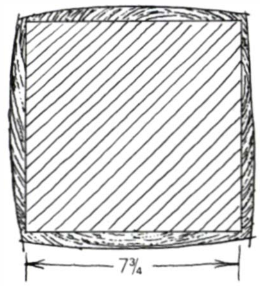
Once the working size is determined, you need only dress

Layout example

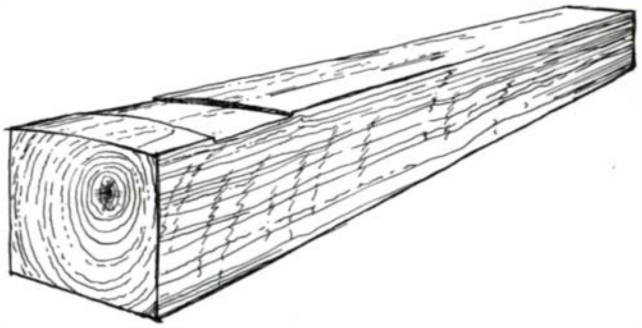
1. Upon close examination, a nominal 8x8 timber rarely measures 8 in. on a side. The faces usually are not flat, nor is it square in cross section.



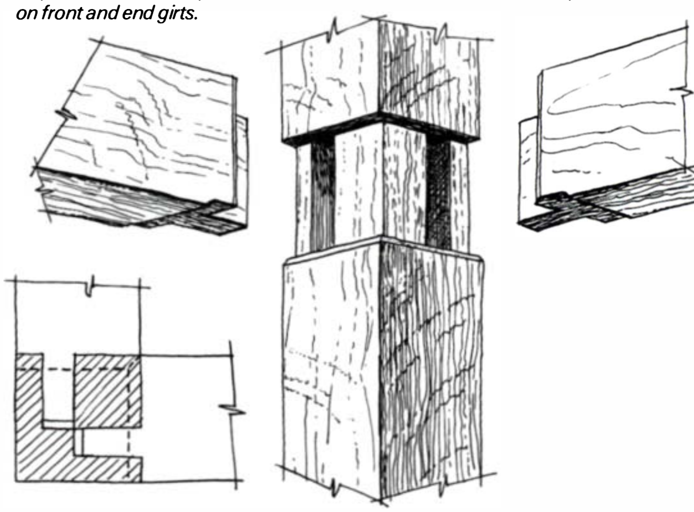
2. At the start of a framing job, survey the timbers and choose a working dimension that will fit inside all the real beams—for example, 7¾ in. by 7¾ in.



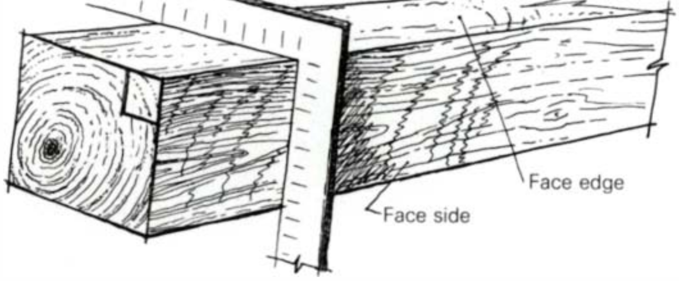
3. To avoid laborious surfacing without resorting to cut-and-try for each joint, dress all the timbers to working size, but only in the area of each joint. For many joints, this means merely planing a shallow flat.



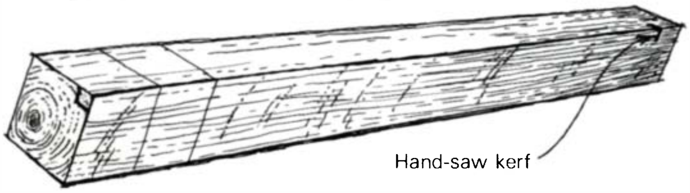
4. However, where a major beam joins a post, it is good practice to house it fully within the post, lest all the weight be borne by the tenon alone. For example, an 8x8 corner post is to be mortised on two sides, to accept the tenons on front and end girts.



5. Find the corner closest to 90°. This will become the outside corner of the building and the sides meeting here will be designated as face side and edge. If no corner is 90°, choose the one that is closest but greater.



6. Measure to locate the top of the finished post. Because there is no square end to measure from, make a small hand-saw kerf at the zero point in the arris (corner) where face side and edge meet, and set the end of the tape in the kerf. Square across and gauge the depth of the housing from the face side or edge. If the face side and edge are crowned, plane them flat in the area of the joint.



the timber down to size *right at the location of the joint*. By setting joints in shallow housings or gains you avoid the impossible and unnecessary task of trueing up the entire beam. In timber framing, the surface of the beam doesn't play an active role except in floors and outside walls, where the timber surface should be more or less correct to accommodate finish flooring and sheathing.

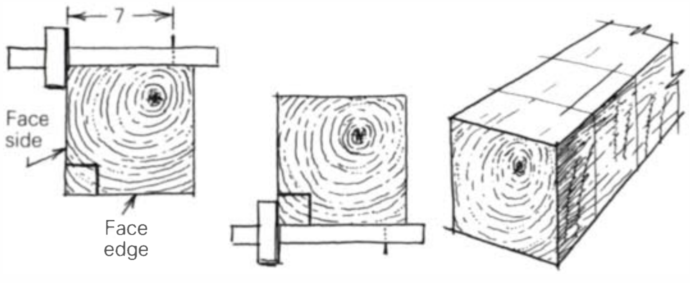
As in furniture joinery, choose a face edge and side, and mark the timber in relation to these surfaces. Floor and roof beams are ordinarily laid out from their top sides to provide an even surface for nailing floor and roof boards. Likewise, timbers set in outside walls should be gauged from the outside for a smooth surface for sheathing. In other locations, the face side or edge can be chosen arbitrarily, although it's wise to lay out all members in a given bent or wall of a building from the same side.

Beams are laid out from arris to arris (corner to corner). Because most timbers are sawn from the heart of the tree, the differential between radial and tangential shrinkage causes the surfaces of beams to become convex during seasoning. Therefore, it is necessary to flatten the surface in joint areas with a plane before laying out a joint.

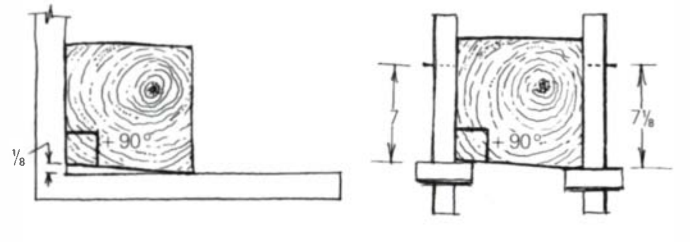
Knots (and checks) in the surface of a timber often cause a slight ripple on the face of the sawn beam, which can throw the steel square off. Check beams for straightness in length before squaring across and plane off any bumps. Always square from the face edge and side of the piece in question.

Corrective surgery is required only on two, or at most three, sides of any timber. First of all, in all applications (within the limits set by knots, bow, etc.) the carpenter should select as the face edge and side of any timber the two most nearly perpendicular adjacent surfaces. This is especially important in corner posts. When the face side/edge angle is square, only the joints in the two off-sides need be housed. When this happy situation does not occur, then one face surface (side or edge) must be selected as primary, and the other squared to it. Thus a corollary principle: If a face edge/side angle of 90° does not occur in the timber, select an angle of greater than 90° and dress down to square. Angles of less than 90° should not be used because they cannot be corrected without causing

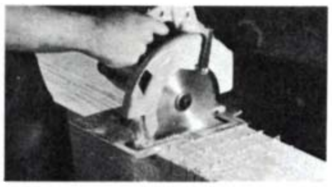
7. The housing in which the beam fits will be between ¾" and 1" deep, depending on the actual size of the post. Set a gauge at 7", and from the face side mark the surface of the housing for the mortise opposite.

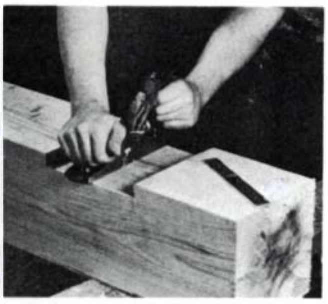


If the reference corner is not 90°, use the framing square to determine how much compensation is necessary and set the marking gauge accordingly.

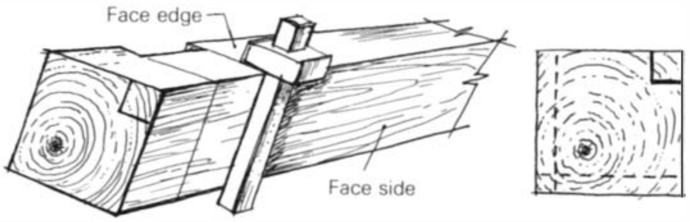


8. Use a crosscut saw or a circular saw to cut shy of the line and make a series of parallel cuts at intervals a little wider than your chisel. Only the end cuts are necessary, but the others ensure against sloping grain and make it easier to chop out waste. Be careful if you use a circular saw: When the housing depth is gauged from the side opposite the mortise, the surface on which the saw rides may not be parallel with the plane of the housing. Check housing depth on both sides and set the saw for the shallower. Then chisel out the waste from the edges inward, to avoid splitting below the line on the far side. Pare or plane cross-grain down to the line, from the edges into the middle.

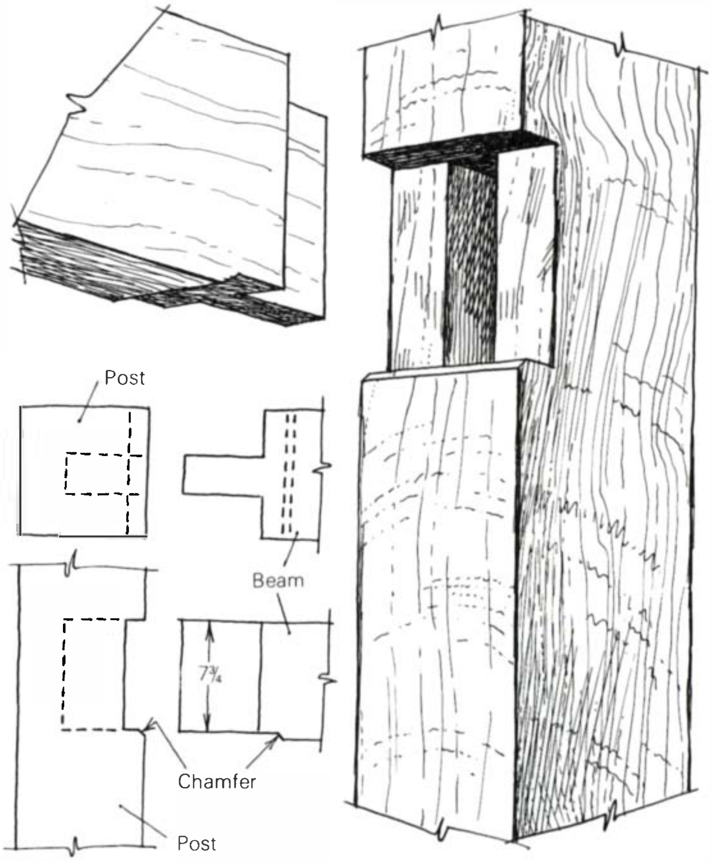




9. Rotate the beam and from the face edge lay out and cut the gain for the opposite mortise. Now add mortise and tenon (next page).



10. Notice that in this situation the depth of the tenon must be reduced to 7¾", and the resulting shoulder on both the tenon and the housing must be chamfered for a neat fit.
When two beams intersect in the same post, their inside vertical shoulders must also be chamfered to avoid interference. (See fig. 4)



discontinuities (at the corner where face edge and side meet) that make accurate measurement impossible. In beams (joists, girts, plates, etc.) this primary surface is normally the top, while in exterior wall posts it is the outside.

In practice in our shop, pieces 4 in. by 6 in. or smaller are usually run through a thickness planer and then worked up with stationary tools as much as possible. The bulk of beams 6 in. by 6 in. and larger makes it easier to use portable tools. It depends on personal preference and your equipment. The basic rule is obvious: When it's easier to move the tool than the wood, portable tools are called for. When you get to the point where pieces are light and holding them down becomes a problem, then stationary tools are helpful.

Of course, in a hand-tool shop this is a moot point. My sympathies lie in both directions. My earliest work was done entirely by hand, with the exception of a chain saw to fell the trees and a tractor to drag them out of the woods. I peeled, hewed, sawed, drilled and chiseled with the traditional tools of the housewright, 1800s vintage. And while sawn beams and power saws have supplanted tradition, all of our mortises (as well as most peg holes) are still drilled out with the boring machine and chiseled by hand.

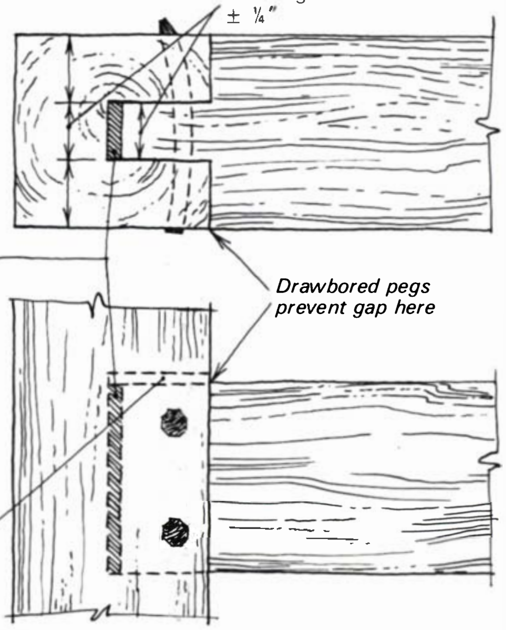
To those who see this layout scheme as excessively laborious, I would point out some mitigating conditions. First of all, joinery in any building is concentrated in posts. And it is always prudent framing practice to house beams into posts in any case, lest all of the weight carried by a girder rest on its tenon alone. Housings also restrain timbers from twisting. In addition, trimming male members (tenons, lap tongues) to size is a minor matter. Finally, recall that the standardizing of parts eliminates the need for trial assembly.

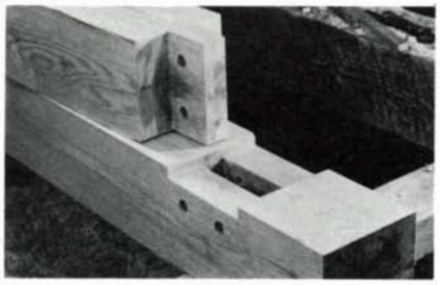
Cutting the mortise and tenon

Consider a tenoned girt joining a mortised post. In plan view (next page, top right), you can see that two boxed-heart pieces of equivalent species and moisture content tend to move together—as the tenon shrinks (or swells) so does the mortise. If the joint is cut well, the cheeks of the tenon remain snug in the mortise.

Things don't look so good in section. The tenon shrinks in height, but the mortise, being long grain, does not, which leaves a gap. The shoulder also tends to pull away as the post shrinks. The remedy for this situation is drawboring and pegging the joint, which causes the post to shrink toward the beam instead of away from it. Drawboring also slightly offsets the loss of rigidity, but the real answer to that is integral diagonal bracing of the whole frame. The tenon only withdraws when it is on a beam. When the tenon is at either end of a post or rafter, gravity prevails. Shrinkage also causes slop in the lap joints used for joists. Using dovetail joinery is one way to counteract this problem. As the male dovetail shrinks in width, the female dovetail shrinks at right angles across it. The net result is, the two shrink together. If the joint is properly proportioned, this action compensates for the shrinkage almost perfectly. Even if the joint does happen to become loose, the male dovetail can only withdraw slightly before it tightens up again.

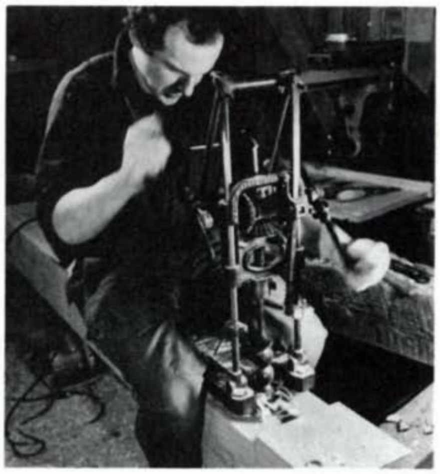
I will illustrate cutting the basic joint between post and girt, and then describe other joints that can be made with similar procedures.

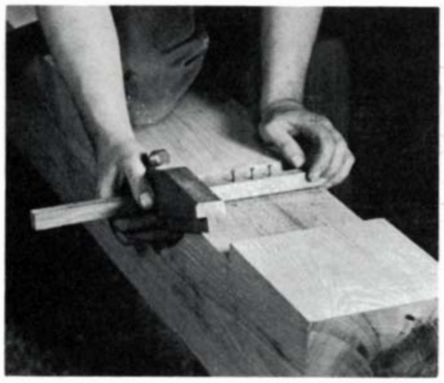




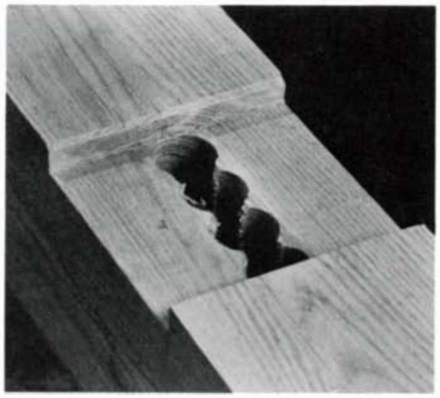
1. Here, an 8x8 oak post is mortised for a central tenon 2 in. thick and 4 in. long on the end of a 8x8 girt. The girt is housed ¾ in. into the post, and secured with two 1-in. octagonal pegs. For photographic purposes, we planed the timber clean. Normally, we cut the joints in rough timber and plane just before raising.

2. Gauge the mortise from the face edge (or side). Mark the centers for drilling out waste (and mark for the peg holes at the same time). Our mortise gauges have three spurs—one for the centerline—so it's merely a matter of measuring lengthwise and ticking off the centers. I deepen these marks with an automatic center-punch so the worm on the auger drops right on. The wedge-shaped worm on a boring-machine auger tends to close up checks, shifting the bit sideways so where there is a surface check within the mortise, adjust the drilling center to compensate. Once you've started the drill you're committed.

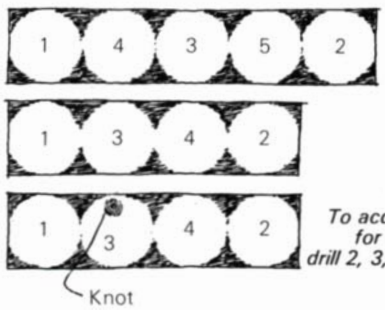


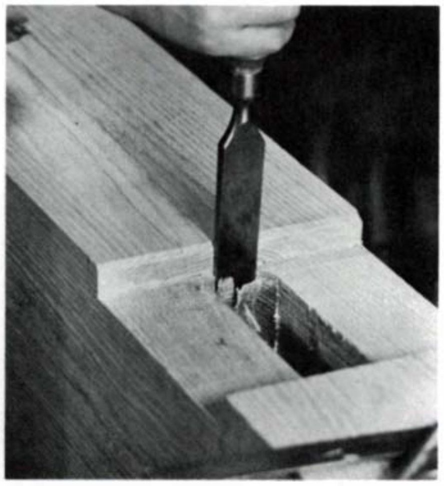


3. Bits should equal or be slightly smaller than the width of the mortise. I drill out as much waste as possible, and bore as many holes as will fit just touching or slightly overlapping. Make sure the bit is square to the surface of the housing. The end holes should always be flush with the end of the mortise, regardless of the spacing in between. Boring machines often have a depth scale engraved on their sides, but it's better to make a stop. When all the holes are bored to the same depth (about 4¼ in. here), the mortise will have a clean, flat bottom, leaving no uncertainty as to clearance for the tenon.



4. I usually bore the end holes first. Then, I hopscotch around so as to drill holes neither or both of whose neighbors have already been bored, possible in mortises with odd numbers of holes. This is easier on the machinery and least conducive to the bit slowly falling into an adjacent hole. Knots are the greatest cause of this problem, and are best not included within the joint in the first place. Where unavoidable, anticipate how the knot will affect the bit and switch around the drilling order. In the drawing, uneven resistance to the drill caused by the knot in hole number 3 might push the bit into the end hole. Drill number 3 first, leaving solid wood instead of empty space to resist displacement.



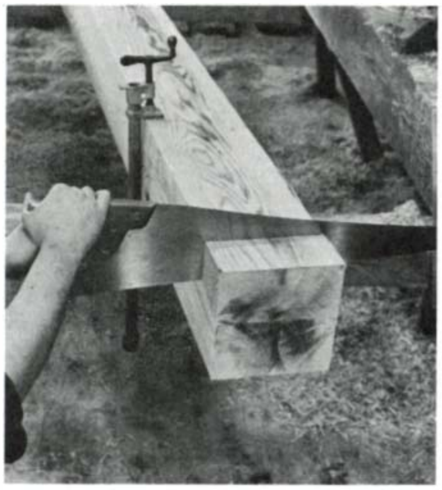


5. Chop and then pare out the sides of the mortise (left). Then chop the ends (right), checking with a combination square. For the final passes, the chisel can be set right in the layout lines. In a 2-in. mortise, I usually use a 2-in. chisel for the sides and a 1½-in. of 1¼-in. chisel for the ends. A 2-in. chisel in a 2-in. mortise is liable to get caught in end grain. After the mortise is completed, drill the peg holes, making sure the drill runs parallel to the surface of the housing.

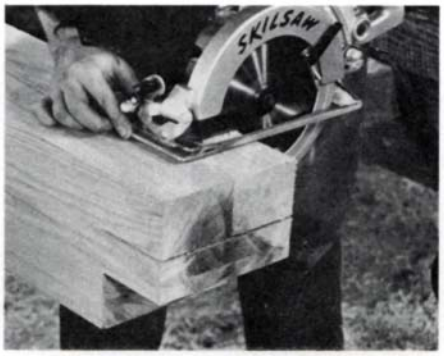
6. Locate the tenon in the length of the girt and, working from the face edge and side, square around for both the end and the shoulders. You will have two parallel lines 4 in. apart running around the beam. Squaring around the timber is like surveying land — you want to end up where you began. If the last line doesn't link up, something is wrong. Cut the waste off the end of the beam by sawing around all four sides rather than straight across. With a hand saw, this means starting a kerf all around and then cutting from corner to corner. With a circular saw, set it to cut halfway through the smaller dimension and work around in one direction, cutting on three sides. If the blade won't reach this far, cut all four sides and finish with a hand saw. These procedures minimize error. Most circular saws don't hold an angle in heavy work, so check frequently for square. If the angle setting has a plastic knob, replace it with a nut and tighten with a wrench.

Cut on the wrong side of the line. This enhances visibility when using a circular saw and adds clearance for the end of the tenon. Clearance allows for shrinkage of the post—a green oak 8x8 may shrink as much as 7/16 in. along a side. Allow at least ¼ in. between the tenon and the bottom of the mortise. In joints with opposed in-line tenons, the combined length of the tenons should be ½ in. less than the distance between shoulders. If you plan to use a circular saw to cut the tenon cheeks, chisel and plane the end of the beam flat and square.

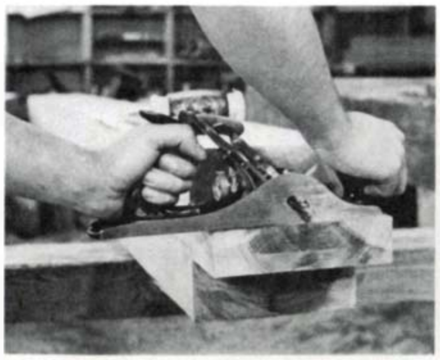
7. The layout may now be completed. Because girts are floor beams, the primary reference surface is usually the top and the secondary one the outside. Flatten these face surfaces with the plane. If they are square to one another, the tenon may be marked with the gauge at the same setting as for the mortise. If the angle is slightly greater than 90°, dress the side down to square and then gauge. In the unhappy event that the angle is less (or substantially greater) than 90°, gauge the top surface and square down across the end (right). Then gauge the bottom of the tenon with the gauge, resetting so that it lines up with the marks on the end of the beam.

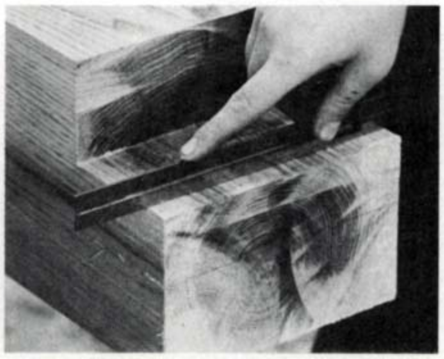


8. When using hand tools, saw the shoulders first. I use a 7-point crosscut saw. In the absence of large knots and if the grain is straight or slopes uphill toward the shoulder, the cheeks can be chopped out with a mallet and chisel (or hatchet). Leave 1/32 in. to 1/16 in. to pare or plane away. If the grain surprises you and starts to run downhill, chop the cheeks carefully across the grain, always working into the center. Where there are knots or difficult grain, saw the cheeks with a coarse ripsaw. Again, it's wise to leave a little bit to clean up with chisel, slick or rabbet plane.



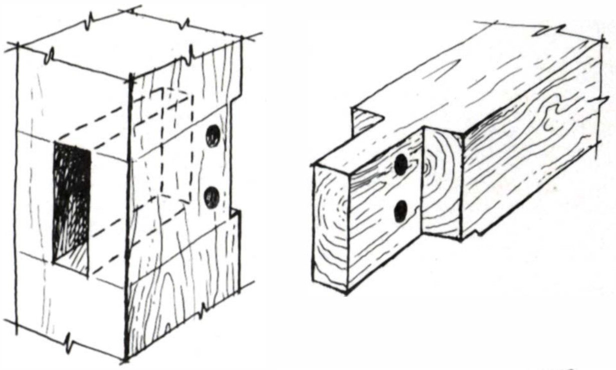
9. When using a circular saw, the order is reversed. First saw the cheeks close to but not on the line. As you can see from the picture, the saw table rides on the end of the timber. When sawing the shoulders, at least one cheek is liable to be out of line with the surface of the timber, so check the depth of cut on both sides and saw shallow rather than deep. The shoe of the saw must ride on the inboard side of the shoulder because waste will move at the end of the cut.



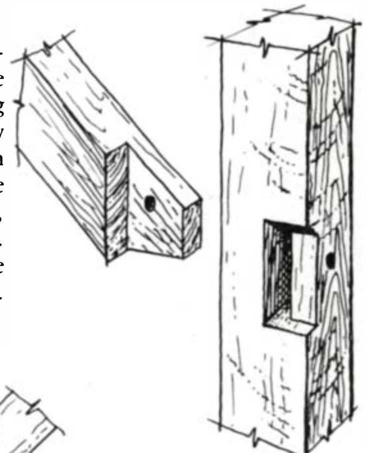


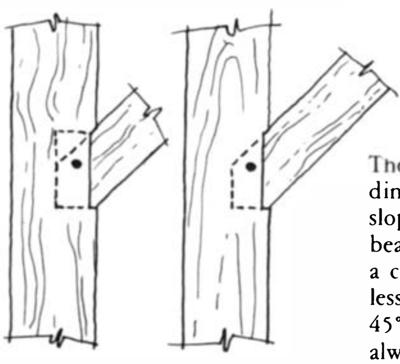
10. After the waste is removed, finish the cheeks by paring or planing. Check cheeks and shoulders for flatness and square, and correct where necessary. If you are not planning to preassemble your framework, mark and drill offset peg holes. In assembly, the shoulders of the tenon will be pulled home as the pegs are driven in.

There are several common variations on the mortise and tenon. For a through mortise, mark both sides and drill and chisel halfway from each side.

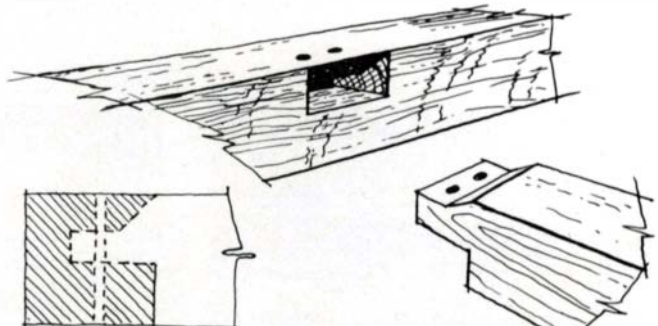


Diagonal braces are usually anchored with the chase mortise and brace tenon. When making the tenon with power tools, saw the end of the brace at 45°, then saw the single cheek, saw the shoulder, saw the square end, and finally drill the peg hole. With hand tools, saw the shoulder before chopping cheek.

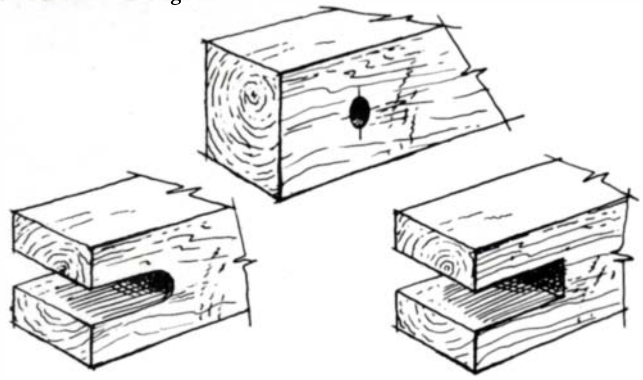




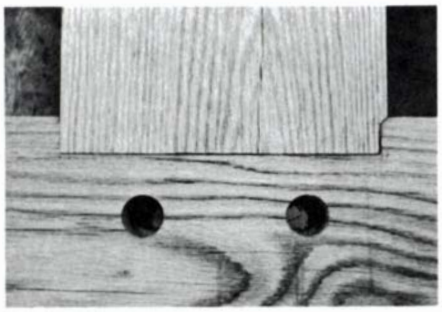
The tenon can go into an ordinary square mortise, since the sloping top of the tenon is not a bearing surface. Or, you can cut a chase mortise by drilling one less hole and chopping back at 45° or more to the beam surface, always checking for clearance.



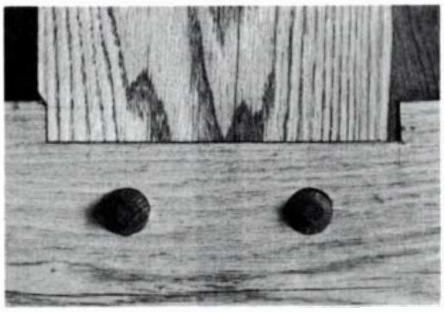
When working in the horizontal plane, the tenon usually has an undersquinted (sloping) entrant shoulder. Gauge from the flattened upper surface of the summer beam or girt. Cut the mortise in the usual way, then scribe or gauge a depth line on its inside surface. Saw down to this line at either end and at several intermediate points, using a hand saw. Chop out the waste, pare and check with a sliding bevel. You'll have to adjust the location of the peg holes to allow for the housing.



The tenon is unchanged when the mortise is open except for the location of the single peg. Lay out the mortise as if it were a tenon, then drill one full-width hole at the closed end (drill halfway from either side). Saw the sides of the mortise as if they were tenon cheeks, except the kerf is on the other side of the line. Paring is difficult and planing impossible inside an open mortise, so saw right up to the line. Knock out the waste and chop the end square, again working from both sides.

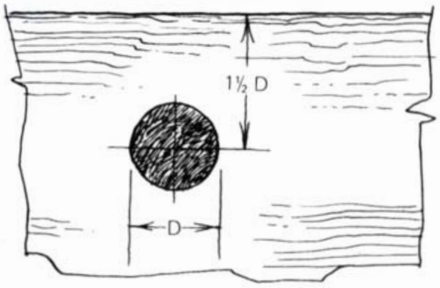


Holes in tenon are offset...



...so pegs will draw joint tight.

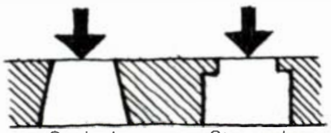
Locate pegs 1½ diameters from surface



Pegs — Wooden pins or trunnels (treenails) are the primary fastening devices in timber construction. Wood for pegs should be strong and decay resistant. I like white oak pins in softwood frames and locust pegs in oak frames. Green pegs are easy to work and limber enough to snake through a drawbored joint. The peg seasons with the bend dried in, preventing withdrawal. I use dry wood which swells as it takes on moisture from the green framework, locking into place. Pins can be square, hexagonal, octagonal or round, either parallel-sided or tapered. Hexagonal or octagonal pegs drive more easily than square with less distortion of the wood, yet their corners still bite in the walls of the hole. Round pegs should be dry and 1/32 in. or 1/16 in. oversize. Tapered pegs start easily in drawbored holes, but fit tightly when pounded home. Untapered pegs should be pointed to ease entry. If a peg is too blunt it will catch and damage itself and the joint.

Peg size is expressed as the diameter of the hole bored, and ranges between ¾ in. and 1 in. for light and heavy house framing, 1⅜ in. for ship planking and 2 in. for covered-bridge framing. There are many procedures for making wooden pins. Here are several:

Split and shave blocks of wood with a froe and work up the rough pegs with drawknife and spokeshave. Shaved pins can be of any shape and may be tapered or parallel-sided. Shaving works well in straight grain, but is trying and tedious in wavy wood, which is best worked up by turning or sawing.



Peg-forming holes drilled through steel plate

Drive split or sawn blanks through progressively smaller holes in a steel plate. The holes are all relieved on their bottom sides. Another type of peg-former is a hollow iron tube sharpened on its upper end and fixed above a hole in the bench. Rough-hewn blanks are driven through the tube.

Straight or tapered round pegs can be turned on a lathe. Or you can produce round pegs with a witchet or rounding plane. Flat-sided pegs can be machined from sawn lumber. Cut boards into square strips with a table saw and knock the corners off with the saw or jointer. When shaving or sawing, the blank should be left two to four pegs long and cut to length and pointed after shaping. Pegs should be long enough for the pointed part to protrude from the joint.

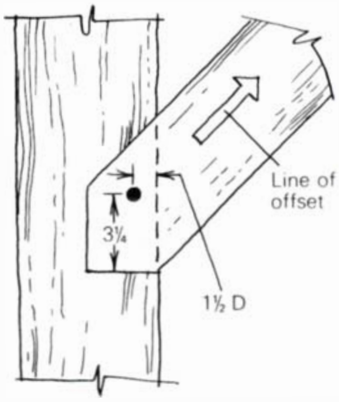
Drawboring — Drawboring is the technique of offsetting peg holes in mortised-and-tenoned pieces so the joint will be pulled home as the peg is driven in. You can do this by drilling the hole in the mortised piece, assembling the joint and marking the tenon through the hole. Or offset the holes by careful measurement and layout. Either way, make sure that the hole in the tenon is offset *toward* the shoulder.

Amounts of offset vary with size and species of timber and peg, type of joint and carpenter. Best is to make up some sample joints and try out different amounts. For reference, here are some of our latest recipes using 1-in. pegs.

The basic rule of thumb for locating pegs is to center them 1½ peg diameters away from the mortised surface.

Use a single, centered peg in 4-in. wide mortises. For 6-in. to 10-in. wide joints, divide the width of the tenon by four and use two pegs at the ¼ and ¾ points as measured from the face side or edge (for an 8-in. joint pins would be set at 2 in. and 6 in.). In very wide tenons three pegs can be used. In the other direction, center holes 1½ in. from the edge of the mortised piece and offset around 3/16 in. in the tenon.

To resist tension, peg holes in chase mortises should be set where they have as much wood behind the pegs as possible. For 3x5 braces with 4-in. deep tenons this is about 3¼ in. from the square end of the tenon. Keep centers 1½ in. in from the edge of mortises and offset about ⅛ in., but at 45° to the shoulder of the tenon—along the line of the brace. In open mortises a 1-in. pin should be set 1½ in. from both the shoulder of the tenon and the closed end of the mortise. Offset ⅛ in. or less along a line perpendicular to the miter angle between the two pieces (in rafters this miter angle is a plumb line).



Before pounding in pegs, check alignment by looking through the peg holes. If you don't see mostly daylight, the joint must be tightened. Knock it home or clamp up if the persuader does not avail. The traditional tool for pulling joints together is the drift or drawbore pin—a long tapered rod of metal that is tapped into the peg hole and then withdrawn. If none of these methods closes the joint, the peg hole can be partially or totally redrilled in place.

When pounding pegs use a mallet, not a hammer. Steel may mushroom or split the end. A little wax or oil on the surface of the pins should ease their entry, but if one does start to mushroom, tighten a hose clamp around its end. This will hold the fibers together while you pound the peg in. □

Ed Levin, 32, of Canaan, N.H., has been a housewright for eight years. He plans to discuss some of the more complex framing joints in a subsequent article.

Portfolio: Woodworking Women

The common denominator is hard work

by Laura Cehanowicz

More and more women are taking woodworking tools in hand. They are more often seen than heard, these women, but they can't be ignored. This was not always so, for there is no solid historical evidence of women woodworkers. While women were recorded in the guild registers of the Middle Ages, scholars suggest they probably were widows managing the family business until remarriage or until a son came of age. Frequently, the widow was transferred along with the shop to the next man in line, the new master craftsman. And while isolated cases of woman woodworkers and toolmakers appear throughout history, they were exceptions. Even as late as the 1960s, women were rare in school shop classes.

The less restrictive atmosphere of schools today is one reason for the recent influx of women into professional woodworking, and there are more women enrolled in school shops now than ever before. Programs in woodworking and furniture design, such as offered by the School for American Craftsmen at Rochester (N.Y.) Institute of Technology and Boston University's Program in Artisanry, are producing highly skilled women who are serious cabinetmakers. Many women, however, go the basement route and learn the way woodworkers have always learned, through books, their fathers' advice, and, mostly by trial and error.

Yet because their numbers, while growing, still remain relatively small, women have their own problems both in the school shop and in the working world. Suppliers may not be as cooperative. For example, when one woman attempted to purchase wood at a major lumberyard, the yardsmen ignored her and went on drinking their coffee. She waited so long that her husband, languishing in the car, came in to see what was wrong. Almost immediately, he was surrounded by attentive help.

Teachers, fellow students and potential employers also may not take women seriously. Sometimes work is hard to find. Perhaps more important, it's hard to establish credibility in a field dominated by men—most of the women interviewed here feel they have to prove their skills constantly. Still, as with men, the common denominator is countless hours of hard work, and the consensus among these women is that the woodworking is what's important.

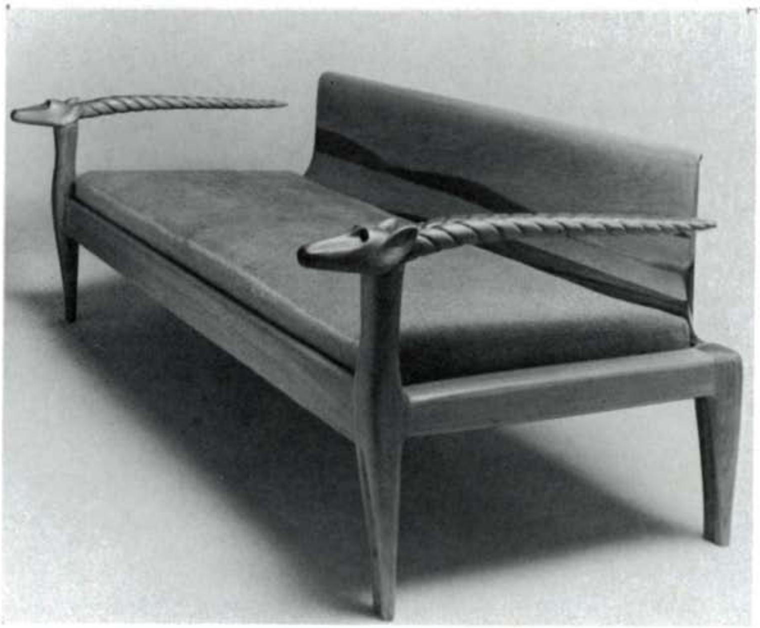
EDITOR'S NOTE: The women interviewed for this article were chosen from *Fine Woodworking's Design Book Two,* to be published in September by The Taunton Press. For more details, see page 2.

Judith Clark Bowie

Judith Clark Bowie

Bowie, 33, of Madison, Wis., designs multipurpose furniture with built-in flexibility. Her pieces can adapt to many different environments, an advantage since most people move every few years. Bowie's "Wall Piece/Stool #1" is a decorative hanging that becomes extra seating when necessary. To assemble the stool, a cross-piece is fitted into small holes in each of the two ends. The rope that runs through the key pin and around knobs on the legs is twisted to tension the stool. Each of the legs was carved separately, then splined into the center piece, then the knobs were turned and plugged into small holes. The wood is walnut finished with oil, and the stool measures 54 in. high by 15 in. wide when open to a hanging position. Bowie wove the goat-yarn tapestry herself and backed it with canvas so it won't stretch. It can be removed for cleaning. The price is $425.

Bowie is the first woman to graduate from the University of Wisconsin, Madison, with a master of fine arts degree in woodworking and furniture design. She currently teaches a class in beginning woodworking at the university, and also teaches woodworking in an adult-education program she started five years ago. She feels that little encouragement usually is given to beginning woodworkers who are women, so her role as teacher is important to her. Bowie would like to design for industry while continuing to teach part-time, which she sees as dovetailing nicely with designing and building one-of-a-kind furniture.



John Marshall

Judy Kensley McKie

McKie, 35, of Cambridge, Mass., started woodworking in the family garage about 11 years ago. Her first projects were simple, slab-like pieces joined with giant dovetails, dowels or tenons—a dining table, couch and coffee table. The carved furniture she now makes is a reaction against this butcher-block school, the output of which continues to fill Cambridge shops. To McKie it is highly depersonalized, and in her work she tries to suggest qualities of mystery and magic, and express a certain humanity. She draws heavily upon animal and bird imagery, much of it primitive in appearance.

Characteristics of wood such as spectacular figure and striking color don't interest McKie. She prefers bland woods that won't distract from her carving. She works with both hand and power tools and sometimes carves with a belt sander using a 36-grit belt. The couch with gazelles, right, is made from poplar and Baltic-birch plywood and measures 27 in. high, 82 in. wide and 35 in. deep. The armrests were carved, then doweled to the frame—McKie frequently joins with dowels because they give her the freedom of interchangeable parts. Complex joinery is unexciting to her and she prefers to find the simplest and most direct construction possible. The chest with birds, left, is made of limewood (basswood) and is 31 in. high, 36 in. wide and 22 in. deep. The inset handles are carved through the panels into small blocks of wood which are attached to the inside, then shaped. Both pieces are on display at the American Craft Museum's New Handmade Furniture show (44 W. 53rd St., New York, N.Y.) through July 15. McKie has had her own custom furniture shop (part of the Cambridgeport cooperative) since 1971. She graduated from Rhode Island School of Design with a bachelor of fine arts degree in 1966.

Scott McCue

Blake Emerson

Emerson, 30, of Berkeley, Calif., has been working in wood for the past six years, though her first taste of cabinetmaking was in grade school. She shares a shop, Open Hand Woodshop, with two other woodworkers, and her work consists mostly of custom cabinets and furniture of her own design. Emerson is also interested in house construction. She designed and built a house/workshop, with the aid of an experienced carpenter, in 1975. Her woodworking efforts now are part-time—she's also studying for a master's degree in clinical psychology.

Emerson's wall-hung spice cabinet/toiletry chest is made of bird's-eye maple, cherry burl and purpleheart inlay. It is 17⅞ in. long, 14½ in. wide and 4 in. deep. The panels are rabbeted into the frame, glued with white glue. The four dowels on each end of the case are decorative, and the handles are carved.

Judi R. Bartholomew

Hans Keel

Bartholomew, 44, of Milwaukee, Wis., started carving 15 years ago, when her Cub Scout son needed a neckerchief slide. Until then she had been working mostly in leather, but she has been carving wood ever since.

The rhea chick, called "I Am, What I Am. . .Today" (11 in. tall), is thornapple on a black walnut base. Bartholomew frequently portrays animals and birds because, she says, their instincts are where they're supposed to be. This one took her about three weeks to carve. She prefers working with hand tools (which she finds fastest for roughing out) but uses delicate power tools for fragile areas. The chick is finished with Danish and lemon oils. Bartholomew travels the gallery route to sell her carvings, and also has a small gallery set up in her home.

Bartholomew is certified as a master carver with the American Shipcarvers' Guild in New York City. Her most recent commission is a set of carved doors of her own design for the United Church of Christ in Sheboygan, Wis.

(please turn page)

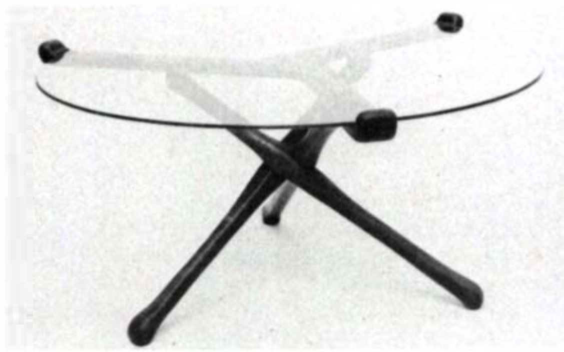
Marsha Vander Heyden

Stan Fellerman

Vander Heyden's jewelry box, right, is made for love, not money, and is not representative of the work she turns out at Vander Heyden Woodworking in Manhattan. Vander Heyden, 36, contracts most of her work from architects, and basic case goods are her bread and butter. She says that running a registered business is quite different from being a free-lance furniture maker—jobs don't necessarily go to the most skilled workers, and she's had to learn to present herself as a businesswoman, not a craftswoman, first. She's currently making a kitchen in ash, though she has done dry-wall construction, loft renovation, and, last winter, an office renovation.

Vander Heyden has a master's degree in painting from Cornell University, and a diploma in cabinetmaking from the Manhattan Evening Trade School. She's taught woodworking to children in New York and set up a woodworking program for children at The Cloisters, a branch of the Metropolitan Museum of Art. This box, of cherry and whitewood, measures 21¾ in. long, 7½ in. wide and 5½ in. deep. It's lined with black velvet and finished with oil.

Ann Ross



Ann Ross

Ross, 25, of Keaau, Hawaii, makes custom furniture mostly out of native koa, a hardwood comparable to walnut. Occasionally she is commissioned by clients on the mainland, but Ross hesitates to ship there because the move from warm, wet Hawaii to colder and drier areas plays havoc with the wood. Ross has been working for about two and a half years at Kalanikoa Studios, a shop she shares with her partner. She came to Hawaii after graduating from Chico State University in California with a degree in design. Because business is good now, she can afford to turn away work that doesn't intrigue her.

Ross's coffee table with glass top is made of koa and measures 16 in. by 32 in. Each leg was cut with a 90° notch into which its neighbor fits. The assembly was glued with plastic resin glue, then doweled. The three supports that retain the tabletop are blind-doweled; the wood is finished with Watco.

Three Students

Sandy Brenner, Wendy Maruyama and Lauren McDermott, all of the woodworking and furniture design program at Rochester Institute of Technology, find the school-shop situation ideal, though all are concerned with life after the classroom. A particular benefit of the program, Brenner says, is the opportunity to give and get support from other women—enough support, she hopes, to keep her going later on. Brenner, 28, is a recent graduate who plans to open her own custom shop in Philadelphia next year. She's prepared to do plenty of kitchen cabinets, restoration work and small production pieces to keep bread on the table.

To Brenner, the cherry chair at left embodies elements of dance—fluidity and movement. After stacking, it was chainsawn to shape with an 18-in. electric saw, then disc-sanded smooth. The top of the chair is built on piece by piece, each cut to fit from previously laminated stock, then the edge was shaped with a disc sander. The finish is Watco, and the price is $750.

Although she had been barred from the high-school woodshop, Wendy Maruyama, 26, completed a degree in furniture design at San Diego State College. After graduation she came East to learn more woodworking skills, and studied at Boston University before enrolling at RIT, where she is in the master of fine arts program. Surprising to her are the differences in East and West Coast attitudes toward women in the shop. People on the East Coast, she says, are less ready to accept serious women, but she's learned to ignore trivia such as bulletin-board pin-ups. After graduation Maruyama would like to make custom furniture and teach college-level woodworking, a field, like woodworking itself, underpopulated by women. Her table (center), a bubinga top with birch framing, measures 3½ ft. by 30 in. by 15 in. The legs are tapered laminations.

To Lauren McDermott woodworking is a practical outlet for new ideas. She came to RIT with a strong interest in graphic arts and crafts, and some experience in the high-school woodshop. McDermott works nights and weekends at a local production shop, Exotic Wood Designs, and expects to take the production and craft fair route after graduation next year. She hopes to make her living designing and building custom furniture. McDermott's white oak occasional chair (right) is designed to provide comfort for at least an hour's sitting. The slightly shaped slats are tenoned into the seat rails, which are single pieces of wood carved to look like two. The frame is held together with mitered finger joints. □

Woody Packard

Wendy Maruyama

Lauren McDermott

Bending Compound Curves

Laminated staves make bulging cabinets

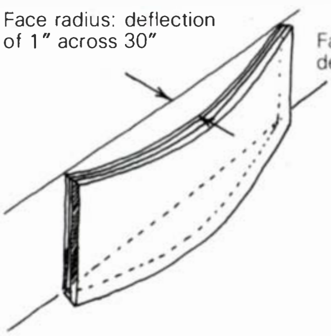
by Jere Osgood

Sides of this chest curve from front to back and bow outward toward the middle.

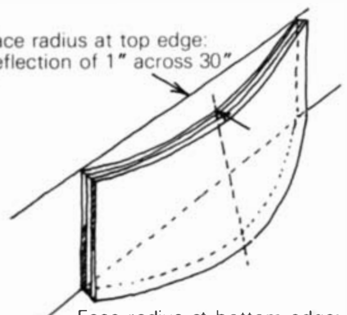
Thin layers of wood are easy to bend into a variety of simple curves—that is, surfaces that bend in only one plane. The basic techniques of layout, stock preparation, making press forms and gluing up are described in my earlier *Fine Woodworking* articles ("Bent Laminations," Spring '77 and "Tapered Laminations," January '78). The same approach can be used to create thin-walled panels that curve in two planes, for use as cabinet fronts, doors or sides, for drawer fronts, or for any other application requiring a compound-curved form. It is done by gluing layers of wood face to face into relatively narrow staves, making each stave take the shape of a different but related curve, and then joining the staves edge to edge. The key to the compound-staved lamination system is realizing that flat layers of wood can be bent to one radius at one edge, and to a different radius at the opposite edge.

Keep in mind that the surface of each stave is a portion of the surface of a cone, straight across its width. A single stave cannot take the shape of a section of a sphere or of any other surface that curves in two directions. Wood is not normally elastic and it will bend in only one plane at a time. However, a number of staves, each bent to a different radius, can be edge-joined together to produce an approximately spherical form (like a barrel or even a pumpkin) or almost any other three-dimensional surface. This assembly will be made up of a number of flats, like the outside of a barrel, but as long as the radius of curvature is not too sharp and the outer laminate is thick enough, you can plane, spokeshave, scrape and sand the surface to a smooth, continuous curve.

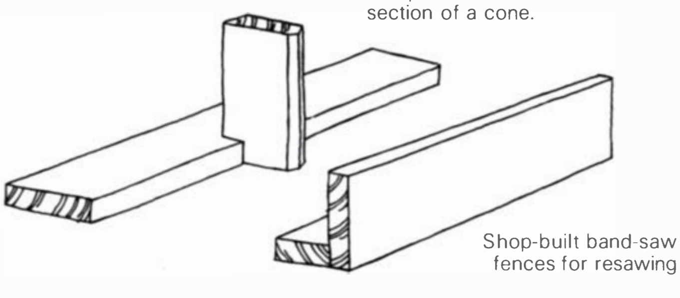
When I want a slightly convex stave, there is a little trick that is helpful, although fallible. I resaw and plane the lamination stock and sticker it overnight. The thin layers usually cup slightly as the moisture gradient within the original board reaches atmospheric equilibrium. I then mark the convex face of each laminate, and when gluing up the stave I stack all the convex cups in one direction. When the press form is opened after the usual glue-curing period, the stave will be perfectly flat across its width. But within 24 hours it usually resumes the cup.



Drawer front, 30" long, is simple curved lamination of three 1/4" layers—a section of a cylinder.



Drawer front, 30" long, is a compound-staved lamination—a section of a cone.



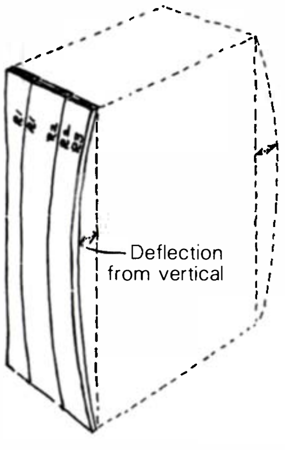
Shop-built band-saw fences for resawing

Compound-curved lamination is a forming process. Panels for cabinetry can be manufactured either as solid-wood laminates or by the veneer-plywood technique. In the former, the thickness of the layers is arbitrary and usually ranges from about 1/16 in. to 3/8 in. or more. A thin layer will bend around a smaller radius than will a thicker layer, but the thinner you resaw the stock, the more good wood you waste in the kerf. When using solid wood the grain of each layer is oriented in the same direction, and the laminated stave behaves and moves just like solid wood. In the veneer-plywood approach layers of thin veneer are cross-banded within each stave, or fancy face veneers are glued to multiple layers of 1/8-in. or 1/4-in. plywood. The alternation of grain direction stabilizes the unit and there is little or no movement across the grain. But springback errors can be disastrous and the need for accuracy is acute.

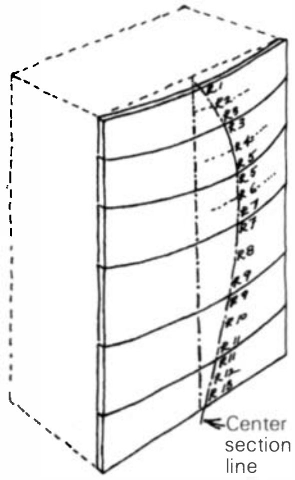
I usually prefer a subtle curve and therefore find using solid wood laminates more congenial. For example, drawer fronts with a gentle curve might be made from two 3/8-in. thick layers glued together. Carcase sides to accommodate a slightly greater bulge might be made of three 1/4-in. layers, the outer layer resawn and bookmatched from some sacred old stock, the two inner layers from a more common unmatched stock.

When resawing planks on the band saw, best results come from a new blade, preferably no finer than four or five teeth to the inch, and 3/4 in. or 1 in. wide. Make sure the blade guides are firm and tight both above and below the table, and that the blade is tensioned to specifications. Most band-saw blades lead to one side or the other, especially when they get dull, so you can't use the rip fence that comes with the saw. Instead, you have to make a wooden equivalent that you can clamp to the table, as in the drawing at left, and angle it one way or the other to compensate for the blade's lead. Or, you can use a vertical *V*-block or rod set in line with the teeth, swinging the end of the stock to compensate for lead. In either case, set the fence for the thickness of the laminate you want, and saw all the stock at this one setting.

If the wood is plain and straight-grained, I usually just resaw it thick enough to run both sides through the thickness

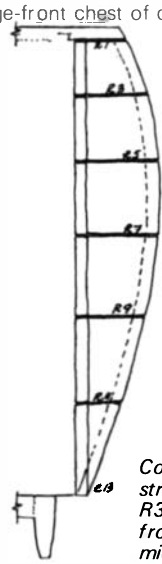


Curved cabinet sides, using compound-staved laminations

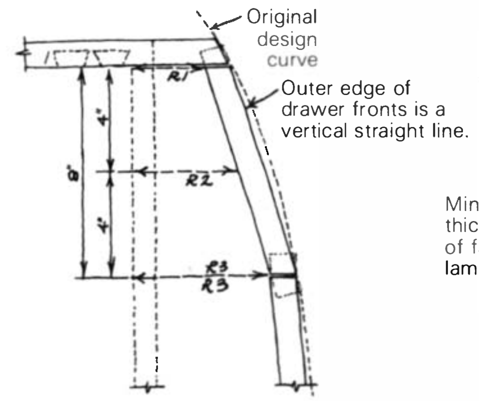


Bulging drawer fronts, using compound-staved laminations

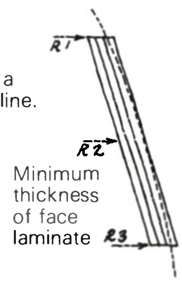
Partial side view of bulge-front chest of drawers.



Enlarged sectional side view. A full-size shop drawing is the key to making forms for bending.



Convert design curve to a series of straight lines. Dimensions R1, R2 and R3 represent the outward deflection from vertical on the centerline, at top, middle and bottom of this drawer front.



To duplicate exactly the design curve, draw the straight line outside it, and shape face laminate back to design curve.

planer. If it is highly figured, it is better to joint the face of the board before each cut. Use a stand or roller to support the wood as it leaves the band-saw table, and always have a push-stick handy for the last few inches of cut. The wood is liable to split suddenly near the end of the cut, and without a push-stick your thumb would plunge into the blade. Most small band saws are underpowered for resawing wide boards. I solve this problem by table-sawing a deep kerf on each edge of the plank. The remaining wood separating the two kerfs will be within the band saw's capacity. No fence is necessary because the band-saw blade tracks in the kerfs.

Most of the time I make bending forms from particle board because it is cheap and strong. I face the forms with layers of Masonite (hardboard) to distribute the pressure evenly, and clamp up with either quick-set clamps or a single five-screw unit from a veneer press. A vacuum press (*Fine Woodworking*, May '79) is ideal for this application, especially when using the veneer-plywood process. When bending solid wood, avoid white glue because it suffers badly from cold-creep under the stress of the wood attempting to straighten out. Yellow glue is better, although it is still subject to some cold-creep, but a urea-formaldehyde such as Weldwood, Cascamite or Urac 185 is best of all. In all lamination processes, good gluing habits are critical. There are four trouble areas: wood moisture content, oily woods, temperature and dull thickness-planer blades. The wood should be uniformly dried to about 8% moisture content—below 6% is risky, and so is above 12%. The curing time of most glues is sensitive to temperature, and many won't cure in a cold shop. But a drop-cloth tent over the work, with a light bulb suspended inside, usually solves the problem. Oily woods should be carefully tested before proceeding to the real thing, and here yellow glue will hold beter than urea. Dull planer blades mash the wood fibers, while sharp ones cut them cleanly. A clean, newly machined surface always yields the best glueline. The surface of stock that is resawn and planed and then left sitting around the workshop for months oxidizes slightly, jeopardizing the glue bond.

The first drawing above shows a cabinet whose side is straight at the back edge and bows gently toward the front. The back stave is straight along its rear edge, with the curve (R1) beginning along its front edge. The next stave has the same curve R1 along its back edge, but continues the outward movement toward curve R2 at its front edge. The third stave matches the second along curve R2, and goes a final bit further outward to R3. A variation on this would be returning the front curve R3 to a straight line, although with straights that move to a curve you must take care to avoid too great a change too quickly. In this example, to have a straight vertical at the back and front edges might require one or two more staves. There is no limit to the number of staves, and return curves or *S*-curves can also be used, although the more surfaces you have curving in and out, the harder it becomes to keep all the parts in phase with one another.

The next sketch illustrates a set of drawer fronts designed to bulge outward toward the middle. The top edge of the top drawer is slightly curved, while the bottom drawer line is straight. The carcase sides are shown vertical and straight, but they need not be so. Here each drawer front would be a single stave, with the curve of its top edge matching the bottom edge of the drawer above, and the curve of its bottom edge matching the one below. The intermediate radii shown (R2, R4, etc.) designate the curvature of spacing ribs for the bending forms. In the sketches and photographs to follow, I will describe the procedure for making a cabinet whose drawer fronts bulge outward like the one shown here.

Any project involving compound-staved laminations absolutely requires a good, full-size shop drawing. Front, side, top and sectional views are usually needed. The shop drawing makes it possible to visualize accurately the curves, and measurements for bending forms can be taken directly from it.

In this example, start with the usual front and side elevations and plan view, and construct an accurate side sectional view at the part of the curve furthest forward (on the centerline, in this case). Because the wood will bend in only one plane at a time, you have to convert the vertical curve of each drawer front into a straight line. I draw the straight line just inside the design curve, and leave the drawer fronts flat on the finished piece. But if you want to duplicate the design curve exactly, draw the straight line tangent to, but outside, the design curve. The largest variation between the curve you want and the straight face of the bent stave is the minimum thickness of the face laminate, since you will want to shape the wood back to the true curve without encountering an ugly glue line. If this thickness is too great for the bend you have in mind, you will have to redesign the curve or divide the drawer front into two (or more) staves.

From this sectional drawing, you can measure the deflection at the center of each drawer front, with respect to a vertical line on the plane of its straight outer edges. On this drawing, these measurements are R1, R2 and R3. This is the information you need to lay out and construct the forms for bending each drawer front.

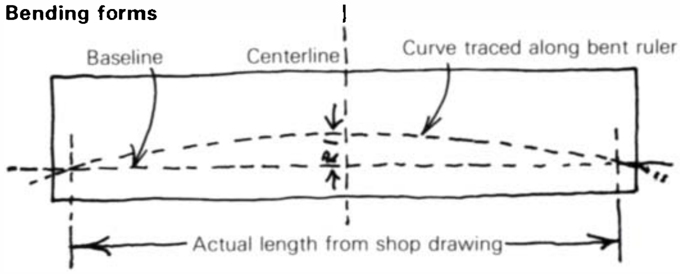
Drawers are often of different heights within a carcase. You can make a different bending form for each drawer front, or you can devise a modular form base to receive at the correct spacing the ribs for all the drawers. Drawer-front heights in multiples of 1½ in. or 2 in. will fit this concept nicely. The form ribs can be on any convenient spacing, as long as the base form is made to accept them all at the correct distance. The maximum distance is about 4 in., as shown at right. Beyond that, the gluing pressure might become spotty.

The sections R1, R2 and R3 need to be converted precisely to particle board or plywood ribs for the bending forms. There are only two measurements needed for this: the length of the drawer front (or of the cabinet side stave) and the amount of deflection in the curve. The bending forms should be made slightly overlong, and the resawn stock should be both overlong and overwide. The extra width in the form is gained by extending the Masonite form liners because the distance between sections R1, R2 and R3 cannot be changed. A typical two-part form would use a Masonite liner on each side: two or three layers of ⅛-in. tempered Masonite, or a single layer of ¼-in. tempered or untempered, depending on the sharpness of the curve.

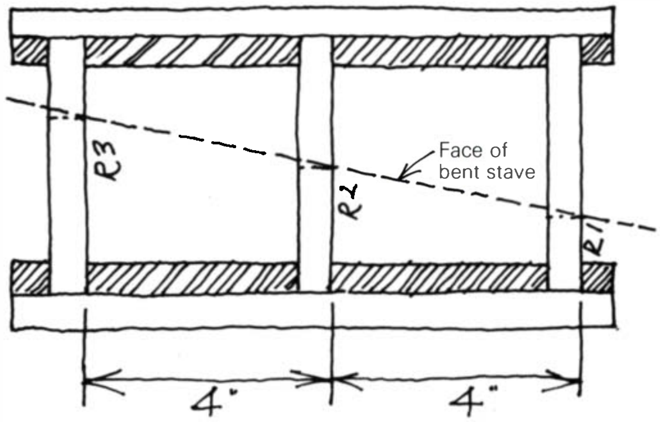
In this example, prepare some pieces of particle board 2 in. longer than the finished length of the drawer front, and about 3 in. wider than the greatest deflection of the curve. That is, if R3 is 2 in., cut the particle board 5 in. wide.

For press-form rib R1, draw a base line and a vertical centerline on the particle board. At the actual length of the drawer front, drive two brads into the base line. Transfer the bulge height (R1) to the vertical centerline. Find a steel, plastic or straight-grained wood straightedge (aluminum does not bend evenly). Rest the straightedge against the nails and bend it up to the limit of R1. Then bend it a little more, say ¼ in. for a deflection of 2 in., for springback. The exact amount to allow depends on the wood species, the severity of the curve, and the number and thickness of the laminates—you need experience with this technique to judge. Trace the curve of the straightedge onto the particle board. I suggest

Bending forms

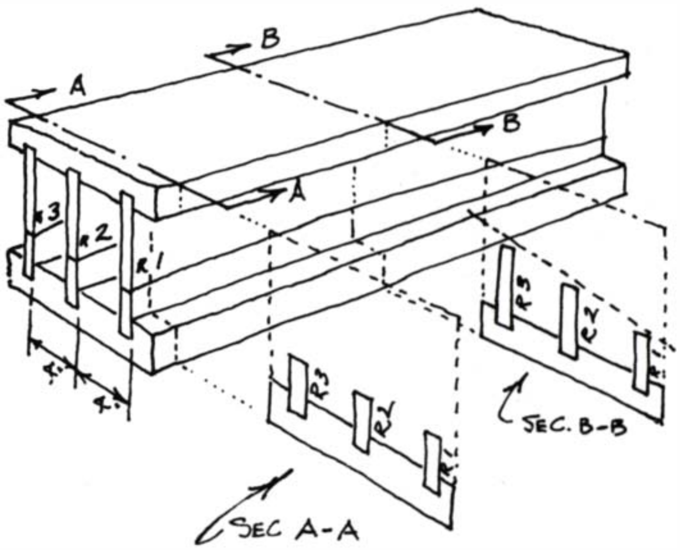


Example: press-form rib R1

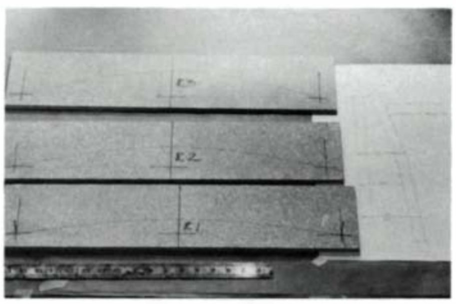
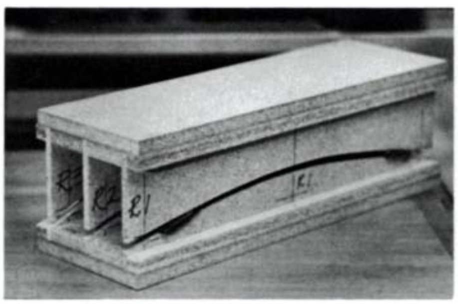


End view of typical form. Note construction for removable ribs.

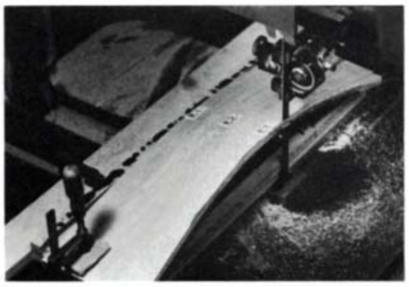
Spacing is measured from the front face of the form ribs. Be sure to keep all the ribs oriented the same way.



The sections A-A and B-B show deflection from the edges toward the center of the drawer front.

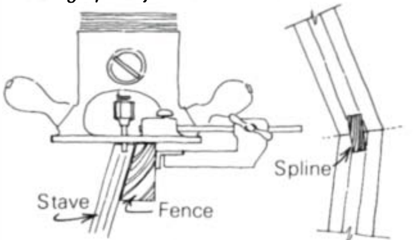




Full-size shop drawing (left) and resulting press-form ribs for drawer-front sections R1, R2 and R3. The press form (center) with ribs in place. These ribs are removable, so the same base pieces can be used with the ribs for the other drawers in the carcase. One section of a veneer press is used to bend the drawer-front laminates (right). The wood and the form are separated by a layer of Masonite to distribute the pressure.

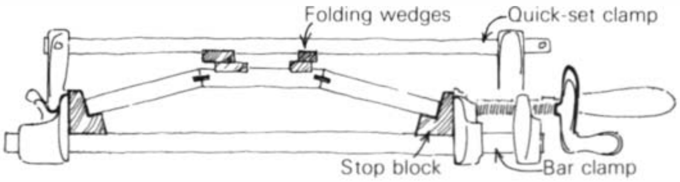


Use the bending form base as a jig to trim drawer fronts to width. The curve can often be freehanded over the jointer.

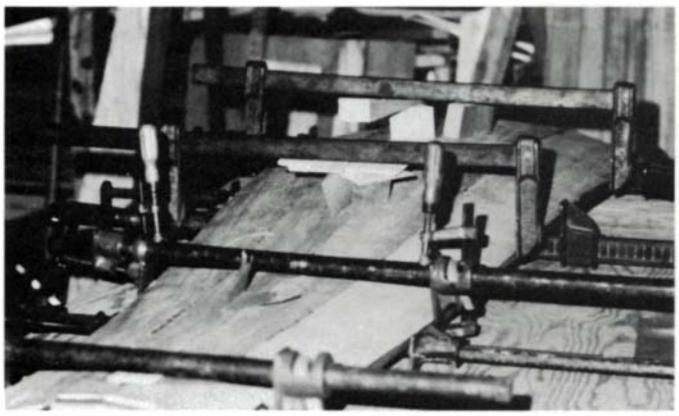
Joint line bisects angle between staves. Set locating spline just back of center.



To rout slots for locating splines in staved cabinet sides, use a ¼-in. straight bit and fence blocks beveled to the appropriate angle. A straight fence will follow a convex curve, but a concave curve requires a shaped fence. Always work from the outside face of the staves, to keep them in the same plane.



A combination of clamps, folding wedges and end blocks makes it possible to glue up a staved assembly. The wedges can be driven in and out, and the clamps tightened or released, to manipulate the curve. Always make a full-size cardboard template to check the curve during glue-up.



drawing all of the curves for all of the form ribs in the same session. This ensures that you use the same straightedge, and that the same face is bent outward (or inward). It is particularly important to draw everything at once if the design calls for a return *(S)* curve.

When bandsawing the form ribs, it is not a good idea to tilt the band-saw table. The staves do twist from end to end, and accurate sectional contact might be lost. The square edge in conjunction with the Masonite form liner will distribute the pressure adequately. Note that top and bottom form ribs are cut on the same line. In work like this I would not attempt to make true two-part forms, bandsawing to a different radius for each half. It would be too confusing, and if the curves are so tight that it is necessary, you are probably leading to distortion problems anyway. Such a design is stretching the limits of this procedure.

After the laminates are glued to shape, they need to be trimmed to width at the correct angle, on the section line. An easy way to do this is to use the base of the press form as a jig. Clamp the piece to the form so it overhangs (you'll have to cut a notch in the base so the clamp can clear the table) and feed it into the band saw or table saw. Because these pieces are curved, they can usually be freehanded over the jointer for a clean and true edge.

The angles that compound-curved laminations generate need to be understood. For drawer fronts, all the edges would be cut perpendicular to a real or imagined vertical, because the drawers need to slide straight in and out without interference. For cabinet doors or sides, I prefer a joint that bisects the average angle of the staves to each other. It is easier to glue and also easier to rout slots for splines.

A cross-grain spline is not needed for strength because the mating stave edges are all long grain and glue together well. The spline is only a locator, so it can be ripped from the edge of a board. The twist imparted by the compound curve makes the width of the stave edges vary, and the splines keep flush the face side of the staved assembly. The back side will need to be scraped down level, or the stave edges chamfered to disguise discrepancies.

Gluing up the staves that form curved panels often seems an impossible task, but it yields to experience. The method I have found best is to presand the insides of the panels and chamfer the mating edges slightly. To make clean-up easier I rub a little paraffin on the chamfer so the squeezed-out glue that collects there will pop right off after it dries. Then I use two stop blocks resting on pipe clamps to establish and control the overall width of the staved assembly, and a large quick-set clamp over the top to provide downward pressure, tightened with wedges. The drawing shows what I mean. It's very important to make a cardboard or Masonite template to check the angles between staves when gluing. This arrangement permits you to manipulate closely the pressure and the angle at which the staves meet when gluing up all sorts of curved or coopered panels.

These methods will seem to be fussy and confusing to people accustomed to roughing out curves from solid stock on the band saw. It will appeal to assemblers and to those who like complicated joinery. Here the time is spent on conceptualization, on accurate planning and drawing, instead of on carving off large amounts of waste from heavy unformed stock.

As I've said before in this series of articles, you must use discretion when designing for bent lamination. Consider the overall design appearance first and have the technique evolve from it. Once you master the basic techniques, it is all too easy to conceive of a piece that could be executed in theory, but that in practice would be simply too hard to handle. Such a piece would probably be disorienting as well, so busy that one couldn't bear to be in the same room with it. I have found it best to stay with one design experiment in one piece of furniture, and to keep the rest of the piece restrained. Being able to build a piece of furniture that bulges wildly in all directions at once is not a good enough reason for doing so. □

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Furniture from Photographs

For the right moldings, you'll also need to make a shaper

by Lelon Traylor

Early American furniture represents a substantial contribution to an artistic period. American craftsmen took the best designs of European styles and adapted them to meet American tastes and needs. From this came a style superior to anything Europe ever produced. The Goddard block-fronts, with their subtle gracefulness, the so-called Chippendale highboys, and Duncan Phyfe's chairs, tables and sofas are all works of art and craftsmanship at its finest.

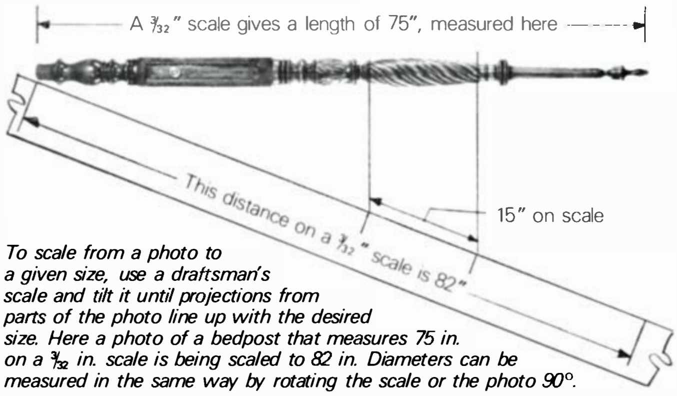
To reproduce one of these masterpieces is a challenge of the highest order, requiring a full understanding of all phases of design and craftsmanship. One advantage the amateur craftsman has is that time usually is not pressing, and he can determine to do the job perfectly; if a mistake is made, he does it over. Only by working in this manner can one hope to obtain the results achieved by our ancestors.

In this article I will examine how a museum-quality piece may be reproduced from the limited exposure to such pieces most of us have, which necessitates taking dimensions and detailing from photographs. The oftentimes large and intricate moldings called for in reproductions of period furniture make building your own shaper and grinding your own knives an integral part of building the piece. Directions for accomplishing these tasks are therefore included herein.

Scaling from photographs — The first step is to select the piece to copy or design. Access to a number of the best volumes on antiques is important, and the bibliography on page 67 should help. Overall dimensions of early pieces, often given in books, vary in height, especially for highboys. Tables are more or less standard: 29 in. to 31 in. for dining and writing, 25 in. to 26 in. for lamp and bedside tables. If the piece you are copying lists the overall dimensions you may not need to alter them, but you will need to determine all the other dimensions. This necessitates scaling.

If we take a photograph of a bedpost, for instance, and wish to make the post 82 in. high, regardless of its original height, the post must be scaled. First see if you can locate 82 divisions on a draftsman's scale that equal the height of the post in the photo. If so, you can start measuring the post. If not, and this is usually the case, slant the scale and drop perpendicular lines from the post to it. This will do the job.

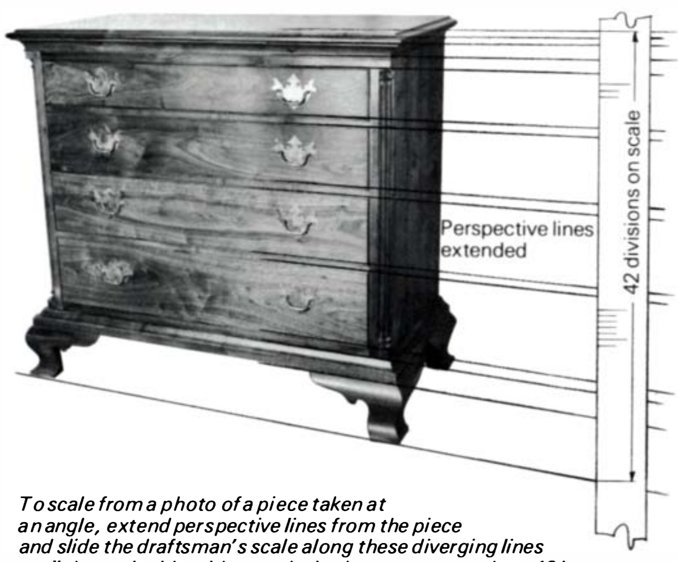
A method to use on a piece photographed at an angle is to extend lines from the piece until they converge or diverge



To scale from a photo to a given size, use a draftsman's scale and tilt it until projections from parts of the photo line up with the desired size. Here a photo of a bedpost that measures 75 in. on a 7/32 in. scale is being scaled to 82 in. Diameters can be measured in the same way by rotating the scale or the photo 90°.

Reproduction of a Goddard secretary in cherry, 44 x 22 x 94, displayed by John S. Walton, Inc., N.Y. The broken pediment, including the Chinese fretwork, was taken from a photograph in Nutting's Furniture Treasury *(fig. 717). Finials and a carved head at top with flames have yet to be mounted. The drawer-pull bails were made commercially by Ball Brass in West Chester, Pa.; the posts, plates and hinges were blanked from dies made at the School of Technical Careers, Southern Illinois University. The writing compartment was assembled first, then slipped into place. Locks, keys and round drawer pulls were machined from solid brass.*

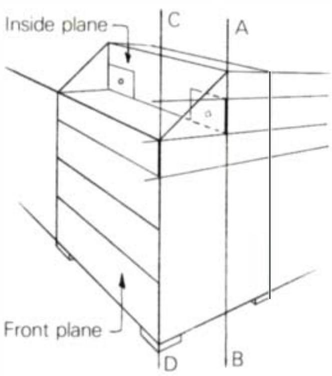
Photos: Robert K. Raben; Illustrations: B. Mastelli



To scale from a photo of a piece taken at an angle, extend perspective lines from the piece and slide the draftsman's scale along these diverging lines until they coincide with your desired measurement, here 42 in.

enough to match the scale you are using. The value of the scale does not matter. If a chest is to be 42 in. high, move the scale right and left until 42 divisions fit exactly between the top and bottom extension lines. Draw a vertical line at this point and pick off such dimensions as drawer heights.

Sometimes none of these methods works and you have to make your own scale. Let us take for example the block-front secretary with raised-panel doors and broken pediment, on page 61. The amount of detail, especially in the writing compartment, makes the use of a scale custom-made for this photograph attractive. A word of caution: When scaling a slant-top secretary, or any piece with detailing in more than one plane, keep in mind that a perspective photo has more than one vanishing point. Measurements on the drawer fronts will therefore be out of proportion to measurements on parts farther away from you, as in the case of the inside drawers of the writing compartment. You will have to extend the lines either backward or forward to get everything in the same plane.



Take into account the two vanishing points when scaling from perspective photos of pieces like secretaries with details in more than one plane. To measure drawers on the front and inside planes, for example, scale along line AB, which is on a plane common to both, or project inside plane to front plane and scale there, along line CD.

To construct the scale, measure the height of the piece as it appears in the photograph, say 6½ in., and divide that number by the height you desire to make the piece, say 89 in. The resulting .073 in. is the size of each division on your scale. The problem now is accurately laying out 89 lines .073 in. apart. It can be done by stepping with a divider, which is trial and mostly error, or you can use a vernier caliper with fine points for inside measurements. Set the points at .073 in., transfer the divisions to a piece of stiff paper, and you are ready to take dimensions directly from the photograph.

An opaque projector is useful for details such as broken pediments, as well as for overall dimensions. Cover a section of a wall with paper (white, brown or tracing), and mark the desired height of the piece, top and bottom, on the paper. Project the image of the piece onto the paper, and move the projector forward or backward until the image fits exactly between top and bottom lines on the paper. Focus and take dimensions, or outline the piece directly. You can project quarter, half or full size, and adjust your dimensions accordingly.

If the piece has been photographed from an angle, the image will be foreshortened and compensations will have to be made before you can take dimensions. One way is to estimate the camera angle used to photograph the piece, and shift the projector to a similar angle. When you have it right, the front of the piece will appear about head-on and square. Again move the projector in and out until the overall height matches your top and bottom lines. Now measure overall widths only. Take vertical measurements on the centerline or on a single vertical line. Don't skip around. I reproduced the VanPelt Highboy (opposite page) using the projector in this way to pick up carving details as well as dimensions.

Recently, while attempting to establish dimensions from the picture of a block-front secretary, nothing would come out right. Scaling, projecting from every angle, researching every old piece and cross-checking dimensions, nothing checked out. I would quit, study about it some more and come back determined to get it this time—no luck. Our daughter came by and said, "Why don't you write to them for the dimensions." My reply: "Never." This went on for some time, and I got to thinking about her solution. I finally wrote the letter, and learned that the writing surface was 34 in. from the floor, not 30 in. or 32 in. as was standard. The piece must have been built for a tall person. It didn't appear amusing at the time, but it points out what can happen when you are copying old pieces. This is what makes it interesting.

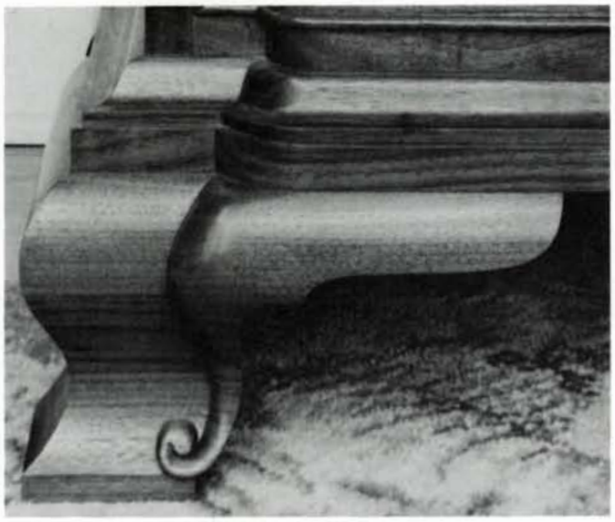
A second approach to the problem of reproducing antiques is to work up your own design from photographs of several pieces, choosing the best points of each piece where applicable. For instance, a block-front secretary may be perfect with the exception of its pediment or finials. Combining features from several pieces is fine, so long as the features fit the rest of the design and so long as you don't switch periods. This can be abominable.

Make the first drawing about 14 in. to 16 in. high. From 36 in. to 48 in. away, the eye can take in all the details of a drawing this size without shifting about, allowing the uninterrupted studying and sensing of proportion that is essential to good design. I have used this technique for years with excellent results, having tossed aside my books on design and proportion years ago. Books cannot substitute for what your own eyes can tell you.

One quick study of a drawing in this manner will not do the job. Tape the drawing to a wall at eye level and leave it there for four to six weeks. Study it daily but do not change it unless some point really starts to stand out. Drawings can be reduced or expanded by cutting and sliding the two pieces together or apart. Make sketches of any point in question, such as a foot or a pediment. Tape these sketches over the first drawing. Continue until you are satisfied, one way or another, and then redraw your composite to the same scale. This sounds like a lot of time and trouble, but compared to making a mistake on a major piece it is of small concern.

Sometimes it is best to make a full-size drawing of a piece from the small-scale drawing, or it may be sufficient to make full-size drawings of only the highly detailed areas such as corners, moldings or pediments. Naturally it depends on

Reproduction of the VanPelt highboy, 96⅜ by 48 by 22, in cherry. The bases of highboys present special problems of strength in relation to weight, which can amount to several hundred pounds with the drawers full. Cracked sides are not uncommon. A strong lower frame cannot be used because usually the lower center drawer cuts the frame in two. Frame-and-panel construction of the sides of the piece would not be in keeping with the single-board style. Traylor's solution was to use solid wood, 2 in. thick before carving, reinforced by a steel rod embedded on the inside. No problems have developed in the 25 years since it was put together. All carvings are from the solid, not applied. Moldings were cut on home-built shaper.



An exact copy of the Goddard chest, 42 by 21 by 38, on p. 94 of John T. Kirk's Early American Furniture. *A special spoon-shaped tool was forged to cut the groove around the concave shell. The beaded molding around the drawers was cut with a scraper ground from a power-hacksaw blade. Wallace Nutting states that the bracket foot on a block-front is more difficult to execute than a ball and claw. Traylor agrees.*

whether the piece is simple, like some chests of drawers, or complex, as highboys, secretaries and the like.

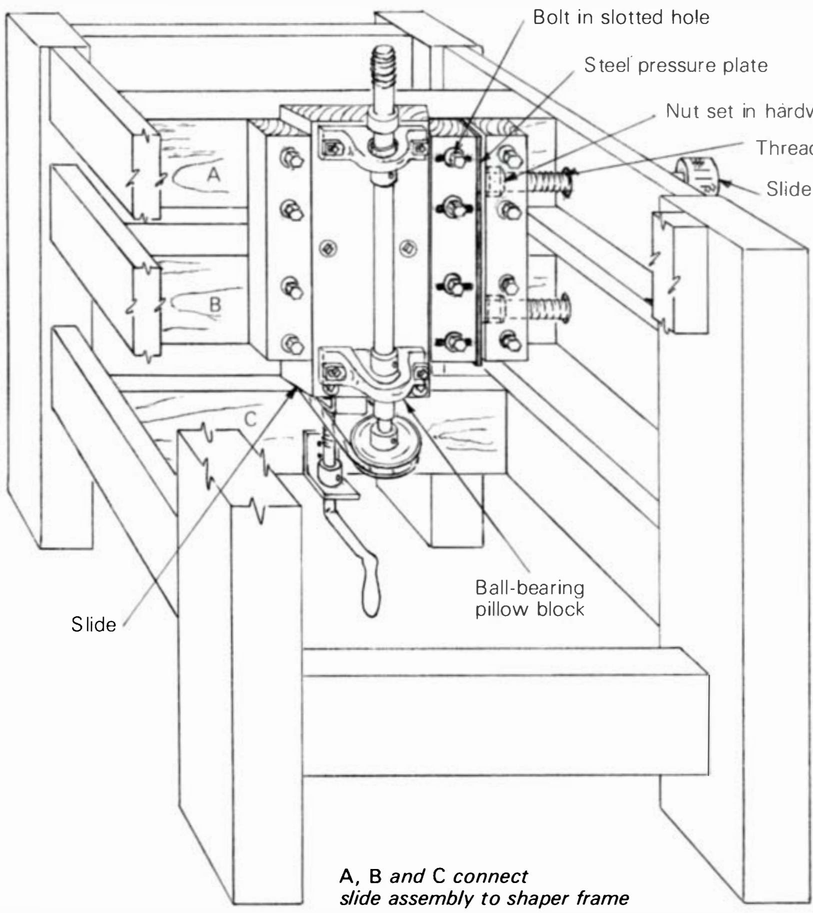
Draw interior construction details full size. A cutaway drawing of a corner section is of great help. Many times it will reveal what could cause problems later if not worked into the design from the beginning. Do all planning, designing and detailing before starting construction. It is much less trouble to correct mistakes on paper than on the piece itself.

Making a shaper — Moldings either make or break a design. They must be well done and appropriate for the piece being built. Don't feel restricted to available cutters. If you design around your in-stock cutters or from catalog cutters, the result will suffer. Sketch ideas for moldings full size, and let your eye be the judge. A molding that is the wrong size or shape can ruin an otherwise fine piece of furniture. A good molding will tie the piece together, smoothing out what would otherwise be an abrupt transition between sections.

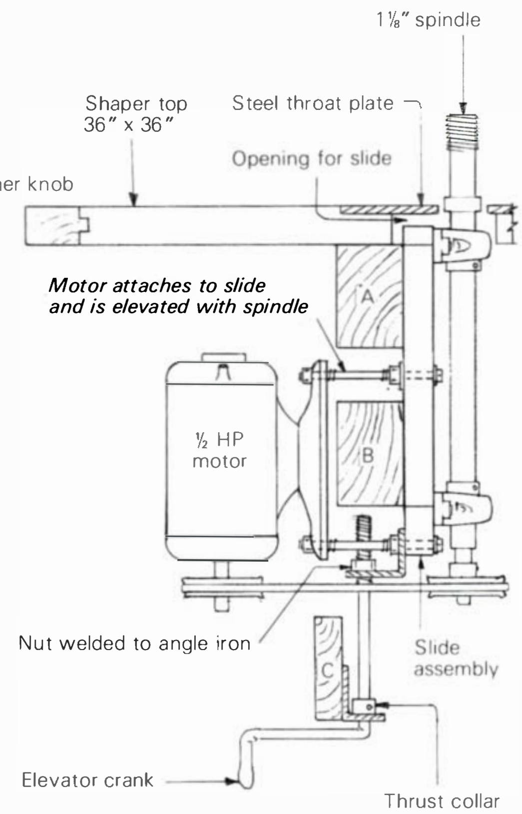
To exercise full choice and execution of design you need some basic equipment, most of which you can make yourself. A heavy-duty shaper with a spindle diameter no less than 1 in. is the first piece. You may feel a ¾-in. diameter spindle is okay, but I wouldn't want to be in the same room as a shaper with cutters extending 2½ in. from the head, running at 5,200 RPM. Weight and rigidity are important in damping vibration. A frame built of 4x4 or 4x6 stock with 2x6 rails is fine; 3-in. angle iron or 2-in. iron pipe will work too. The top may be laminated and draw-bolted as workbenches are, or made of two thicknesses of ¾-in. plywood covered with Formica, or of ¼-in. steel plate. Whatever the thickness of the rest of the top, a ¼-in. steel throat plate is necessary so the spindle can be raised close to the work surface.

Commercial shaper housings complete with ball bearings and elevating screw are available (with some delay at present in supply) from Woodworkers Tool Works (222 S. Jefferson St., Chicago, Ill. 60604). If you choose to make the spindle and elevator yourself, ball-bearing pillow blocks of industrial medium-duty capacity are adequate. Pillow blocks are designed to run at 3,600 RPM under load, but a shaper sustains very light loads and by using the proper grease the pillow blocks can be run at 5,200 RPM for years, eight hours a day. Use what is commonly called cup or axle grease, an inexpensive, low-heat grease which thins when it gets hot. Don't use chassis lube (it will overheat in minutes), and don't use wheel-bearing grease (it is for low speed and greater load). I have designed and built high-speed oscillating mortisers to run at 5,200 RPM in industrial situations; they haven't had a bearing failure in more than 20 years.

If you are not equipped to machine the spindle and fit the bearings yourself, take a plan of your shaper to a competent machinist who will lathe-turn the spindle using in the headstock a soft center that has been trued with a light cut. Have him turn the spindle from oversize bar stock to include a section about ½ in. long by at least 1¼ in. in diameter to tighten the cutterhead against. This cutterhead stop should not be built up by pressing, threading or welding a collar in place; it should be part of the original stock. Spindle runout should not be more than .0005 in. when the spindle is rotated by hand between centers and checked with a dial indicator. The bearing fit you want is close—the spindle's final diameter should be only .0001 in. smaller than the inside diameter of the bearings, so the bearings will slide on with no play at all. To get this close a fit, turn the spindle .001 in. to .0015 in. oversize, slip the bearing over the tailstock center, and lightly



A, B and C connect slide assembly to shaper frame



A heavy-duty shaper designed by author

file the spindle until the bearing just goes on. Continue filing toward the headstock, sliding the bearing along as you bring the spindle down to size. The bearing is in effect its own gauge, producing a perfect fit.

The spindle may be threaded with square threads, acme threads, national fine *V*-threads or national coarse *V*-threads. I have used all kinds. On the last shaper I built I used a 1-in. national coarse, 8-threads-per-inch, commercial nut. The face on a commercial nut isn't very true as to wobble or runout and should be faced off while screwed on the spindle, using a second nut as a jam. Cut the spindle threads on a lathe—a hand-held threading die is not accurate enough. The knives and collars will wobble and be dangerous to operate if the threads aren't true. Commercial nuts give a no. 2 fit. Ask for a no. 3 fit, which has no play.

The bearing slide may be made from hardwood, or from two pieces of ¾-in. plywood glued together. The assembly is a sliding dovetail, the contact areas of which may be faced with metal strips, plastic, or left as is. If you use plywood, treat the edges with hot paraffin. The elevator crank is made of ¾-in. threaded steel rod, heated and bent to form the handle. It is mounted to a 2x6 in the frame through a thrust collar attached to an angle iron. A nut fixed to another piece of angle iron mounted on the spindle slide receives the thread in the elevator crank. Rotating the crank moves the spindle slide up and down. The slide is released to move and locked in position by two bolts through nuts set in wood mounted to the frame. These bolts are adjusted to press or release a beveled block against the beveled slide. The motor is mounted directly to the slide and moves up and down with the spindle.

It is best to have cutterheads 1¾ in. and 2½ in. in diameter. The smaller one allows stock of a tighter radius to be shaped, and the larger one gives the "beef" necessary to hold the long, heavy knives necessary for moldings commonly found on highboys, secretaries and clocks. You won't be able to switch cutters back and forth, though, because on the small heads the distance from the center of the cutter out to the knife groove is less than on the larger heads. The knives require a different grind to produce the same molding. I would suggest, as the easiest solution to this problem, that you lay out two diameters and check it out.

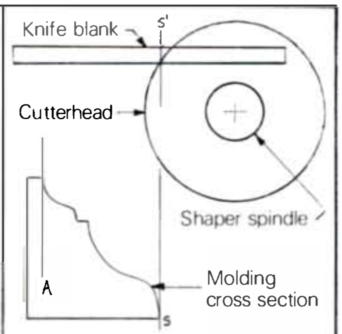
Shaper knife collars and knife-steel blanks with notches to prevent slipping of the cutters are available from Woodworkers Tool Works. This equipment is more expensive than plain knife steel and smooth 60° *V*-groove collars, but safer.

Shaper knives — Before you make the cutter knives, it is important to understand that because they are mounted in the cutterhead along a chord of the cutter circle, and not along a radius, the knife profile will not be identical to the molding profile it cuts. Instead, the knife profile will be an elongated version of the molding profile, the amount of elongation depending on the depth of the cut. There are several ways to lay out knife profiles; the method I find most convenient relies upon a strip of paper as the principal measuring tool. This procedure is detailed in the panel at right. Note that the deepest cut (*A'* on the diagram) plus the length of the blade inside the cutterhead is the length of the whole blade. Once you have drawn the correct profile on stiff paper, carefully cut it out for use as a pattern.

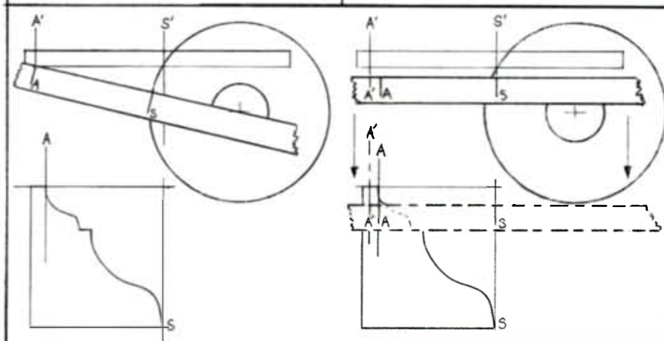
Now apply layout ink (Dykem Steel Blue is available from industrial suppliers) to the knife blank and let it dry. A con-

Designing shaper knives

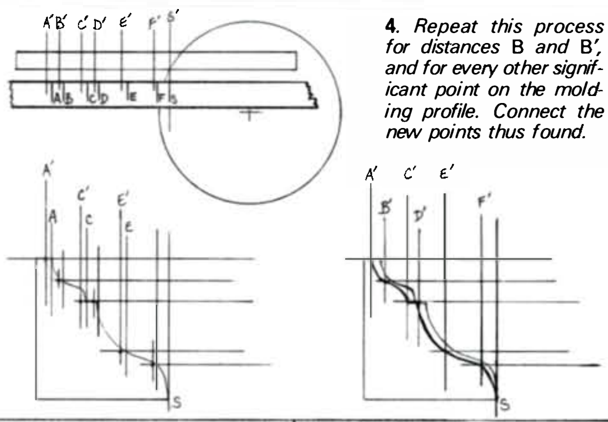
Because a molding knife is set on a chord across the cutterhead, and not on a radius, its profile is not quite the same as the cross section of the molding it will produce. To find the knife shape that will make a given molding:



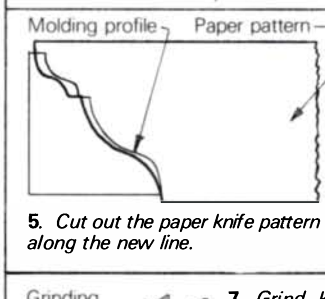
1. *Draw full size a molding cross section and a plan of the shaper head. Extend vertical line* S *from the shallowest part of the profile, and vertical* S' *where the knife enters the cutterhead.* S *and* S' *are base lines for subsequent measurements. Label also* A*, the profile's deepest point.*



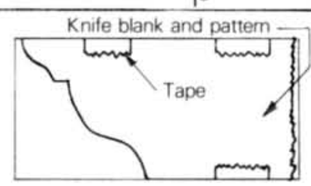
2. *Mark distance* AS *on a strip of paper and transfer this distance to the cutterhead plan, placing the edge of the strip across the spindle center with point* S *on the cutterhead circumference. Mark* A' *where* A *intersects the knife, left.*
3. *Align the paper strip with the knife so that* S *coincides with* S'*. Transfer distance* A' *to the strip, then to the molding profile, right.*



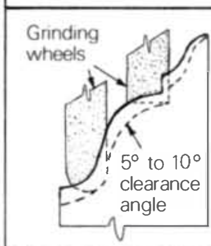
4. *Repeat this process for distances* B *and* B'*, and for every other significant point on the molding profile. Connect the new points thus found.*



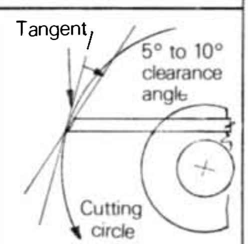
5. *Cut out the paper knife pattern along the new line.*



6. *Apply layout ink to the knife blank, tape knife pattern to knife blank, and scribe contour.*



7. *Grind knife, using wheels of various shapes, to provide 5° to 10° clearance angle. This angle is measured between the bevel and the tangent to the cutting circle, and will vary with the radius of the cutting circle.*



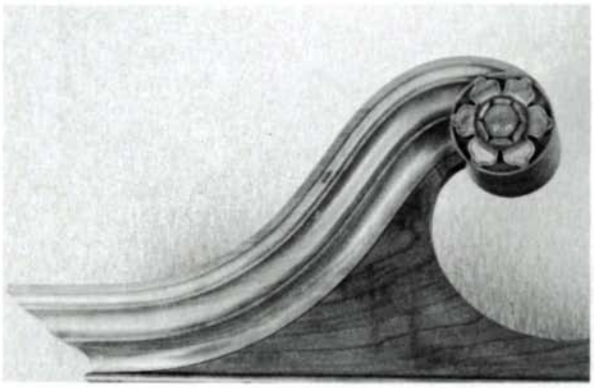
centrated solution of copper sulfate (bluestone) makes an excellent layout dye, but this chemical has become difficult to buy. Tape the pattern to the knife blank and scribe around it.

To grind molding cutters you need grinding wheels of various shapes. Grinding wheels should therefore be dressed with a diamond nib, a short rod with an industrial diamond set in the end by brazing, available from mill suppliers. It is important to proceed properly because the diamond can be dislodged. First pre-dress the wheel with a conventional dresser. Then, holding the nib in your hand (don't rest it on the tool rest) point it slightly downward and swing it in an arc around the edge of the wheel. Keep the nib pointed downward to prevent it from digging into the wheel and jarring the diamond loose. A diamond can be reset by holding it down with a small steel welding rod, while brazing it in place. Completely cover the diamond, let cool and carefully grind the rod to barely expose the diamond.

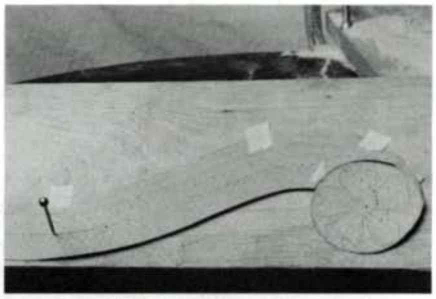
When grinding the cutter, don't overheat the blank or you will lose your layout line. I find it easier to control the grinding process if the tool rest is removed from the grinder. Try it both ways and use the method that is easiest. More clearance is necessary in some places than in others. The side clearance doesn't need to be as great as the clearance on the periphery of the cutter. To prevent the heel of the cutter from dragging, more metal must be removed from small-diameter cutters than from larger ones. This makes the included angle of the knife steel less on the smaller cutters. Always turn the spindle by hand after mounting cutters to see if the heel clears a piece of stock held against the table. When tightening the main spindle nut to lock the knives in, I run it up as tight as it will go and give it another quarter-turn. I place on edge a 3-ft. piece of 2x8 on the table, which is about buckle height, before I turn on the machine. If the knives are going to come out, the 2x8 should stop them.

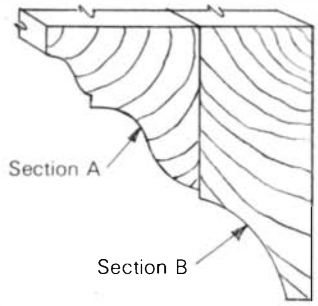
Several types of guides are used to make shaper cuts on contoured pieces, the most common being a depth collar mounted directly on the spindle. If the cut does not span the entire thickness of the stock, the unmolded portion can run directly on the depth collar. Apply paraffin to the edge that will be in contact with the collar, and after the cut, scrape the paraffin off with a pocket knife. Ball-bearing collars are also available, but they can seize and paraffin is easier to clean off than a burned edge. Whatever the collar, be sure to use a starting pin mounted in the tabletop to rest the stock against while feeding it into the cutter.

If the entire thickness of the stock is to be molded, a

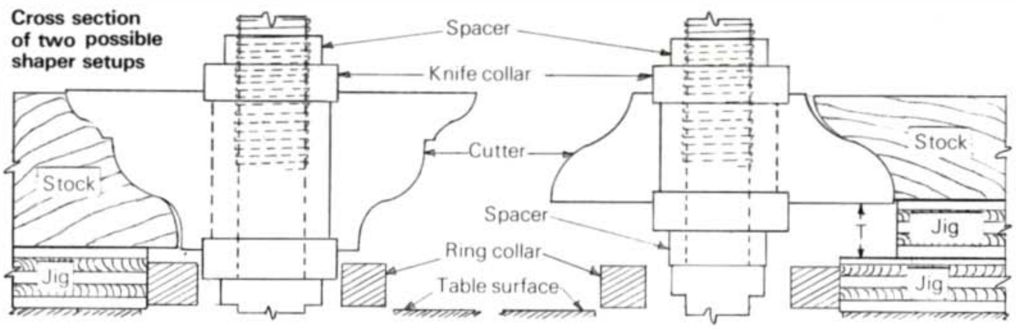


The finished molding, forming the pediment of the Goddard secretary (on page 61).





Large moldings are best made in two sections. Here, pattern is taped to molding stock with scriber marking dividing line between sections A *and* B *into which blank will be bandsawn. Piercing the pattern and connecting the points in this way saves cutting the pattern apart. Second row of pinpoints (½ in. back) is line used to cut jig that will run against ring collar. Because collar follows jig rather than work, only edge of jig need be smoothed.*



Cutters can be mounted to cut from the top or from the bottom of stock. Cutting from the bottom is safer because blades will not dig in if stock is lifted from table, especially important for long pieces. It's a good idea on large cuts to make more than one pass, raising or lowering the cutter into the stock between passes. Cutting from the bottom requires a thicker fixture because in its lowest position blades must turn clear of most of the stock. T *is available travel to allow for shallow starting cuts.*

First and final cuts, as cutter is lowered into work over several passes. Notice that the jig contour is set back from stock contour because ring collar extends past shallowest part of cut. The guard has been removed for photograph.

spindle-mounted depth collar can not be used; the stock will have to be mounted on a jig to be run against a fixed ring collar mounted concentric to the cutterhead, but not attached to it. The contour of the jig can be taken directly from the original molding pattern, except that the ring collar is usually larger than the smallest diameter of the cutter. The jig must therefore be cut down to allow the whole molding profile to reach the knife.

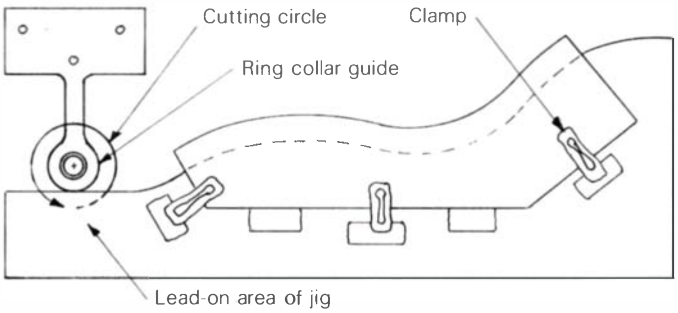
To do this, tape the pattern of the molding to the blank from which the jig is to be cut. Say the ring collar extends ½ in. beyond the smallest diameter of the cutter. Measure back ½ in. on the paper pattern and draw a contour parallel to the edge of the full length of the pattern. With the point of a compass or scriber, pierce the paper at intervals along this contour, and connect the points made on the jig, free-hand or with a French curve. Bandsaw outside this line and carefully work down to the line using a curved sanding block or a drum sander on a drill press. Remember that this surface determines the finished contour of your molding. A careless job here will be transferred by the jig to your finished piece. Use paraffin on the edge of the jig to facilitate feeding.

Heavy cuts are impossible to make in one pass. To get around this and to allow the molding to be produced in several passes, the cutter can be mounted to cut from the bottom side of the stock, and the cutter raised at each pass. You may need to use a jig with a fixture made from a second piece of ¾-in. plywood to raise the work adequately for shallow first cuts. When cutting against the grain, several light cuts with freshly honed cutters are in order.

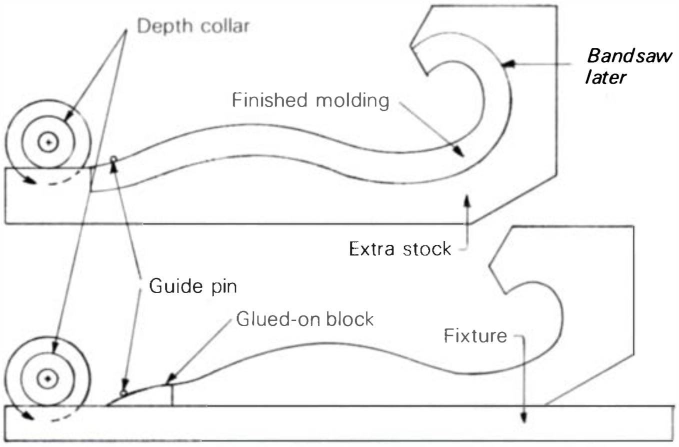
As you are about to shape your stock, ask yourself if the material being machined were suddenly and at any time removed from your grasp, would your hand or fingers go into the cutter. If the answer is maybe, you are not 100% safe, which means that on a lot of work you are going to have to mount your stock on a fixture. The fixture may be nothing more than a 2x4 attached to the stock by glue, screws or clamps. If the stock is large and can be safely held, a fixture isn't necessary—shape first and with a band saw remove the extra stock afterward. Either way, safety first and caution always is the motto when operating a shaper.

Building your own shaper assures you of having a machine that fits your own needs at a vastly reduced price. A shaper is an important part of any complete shop. It is a satisfying experience to build your own furniture with machines and knives that you have designed and built. □

Lelon Traylor has been reproducing museum pieces for 30 years. He teaches tool and manufacturing technology at Southern Illinois University, Carbondale.

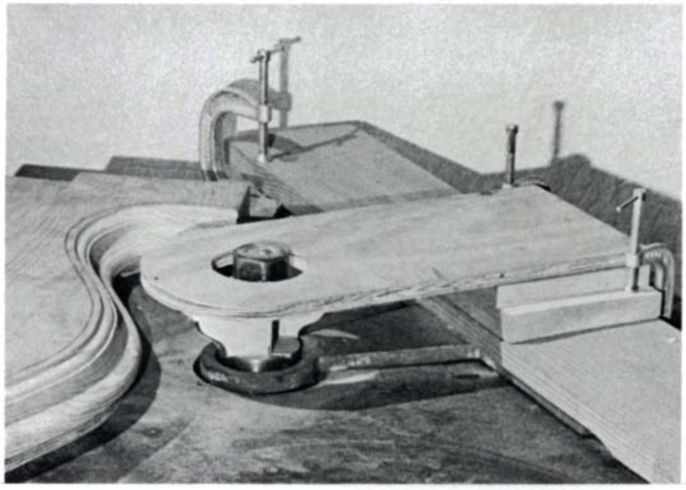


Use a jig with lead-on area to guide contoured stock past cutter that spans entire thickness of stock.



Fixture is 2x4 glued, screwed or clamped onto stock.

Extra stock or a fixture added on—either way be sure you have enough to hold on to to keep your fingers away from the cutter. If stock is squared off at the end, glue a block in place to lead cutter into stock.



Machine guards must do two things: protect the operator from injury and stay out of his way. The shaper guard shown is constructed from plywood rather than metal for two reasons: It is quick and easy to make, and it is safe; if the cutter grabs and the guard touches the knives, shavings rather than knife pieces are thrown about.

Further reading

These books contain pieces completely dimensioned and are excellent guides to furniture design.

Construction of American Furniture Treasures, Lester Margon, Architectural Book Publishing Co., New York.

How to Design Period Furniture, Franklin Gottshall (presently out of print but in my opinion the best book on furniture design ever published).

Masterpieces of American Furniture, Lester Margon, Architectural Book Publishing Co., New York.

These books have overall dimensions only:

American Furniture, Queen Anne and Chippendale Periods, a Winterthur Museum book, Bonanza Books, New York.

Furniture Treasury, Two Volumes in One, Wallace Nutting, Macmillan, New York.

These books contain no dimensions but contain excellent examples of period furniture and rooms of furniture:

Antiques Magazine, Straight Enterprises, Inc., New York.

Early American Furniture, John T. Kirk, Alfred Knopf, New York.

Fine Points of Furniture—Early American, Albert Sack (introduction by John Graham II, Curator, Colonial Williamsburg).

The Golden Treasury of Early American Houses, Richard Pratt, Harrison House, New York. (Completely in color, 279 pp. Excellent for rooms of furniture and close-ups of individual pieces.)

Living with Antiques, Alice Winchester and the staff of *Antiques Magazine,* E.P. Dutton and Co., New York.

Routing for Inlays

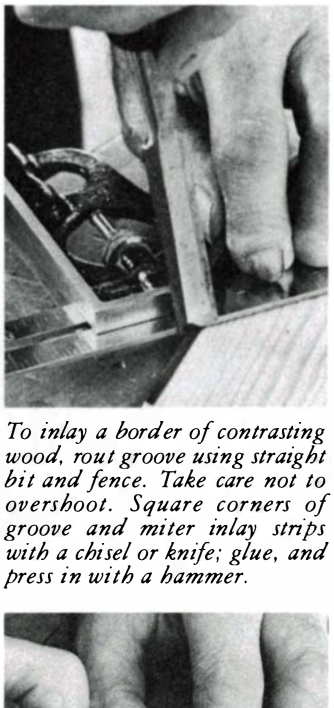
Template guides match inlay and recess

by Eric Schramm

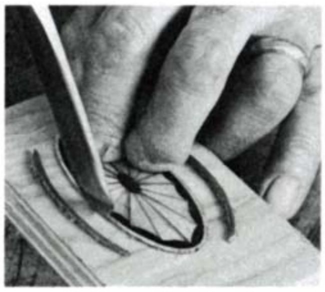
Inlaying is often regarded as a difficult process requiring a great deal of skill. However, with a portable electric router and a fence, thin strips of contrasting wood can easily be inlaid to form the border on tabletops, drawer fronts, cabinet doors and straight-tapered legs. With suitable template guides, or with just a steady hand, the router can inlay marquetry inserts and pieces of burl, butt or crotch veneer. Inlays enhance the beauty as well as the intrinsic value of pieces of furniture, serving trays and jewelry boxes.

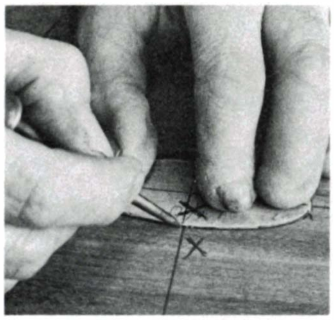
To cut a straight groove for an inlaid border strip, insert a straight bit of the proper diameter in the router and adjust it to a depth slightly less than the thickness of the strip. Fasten the fence at the desired distance (or if your router is not equipped with a fence, clamp a straight piece of wood to the base), and hold it against the edge of the piece to be bordered. Rout counterclockwise around the work, opposite to the rotation of the bit, to keep the fence pressed against the edge. With a sharp knife or chisel, square the corners of the groove and miter the inlay strips to the correct length. Brush the strips with glue and force them into the grooves by running the face of a hammer along their length, pressing carefully so as not to damage the wood. When dry, scrape the surface flush and clean off excess glue. Then sand and finish.

Photos: Robert Schramm



To inlay a border of contrasting wood, rout groove using straight bit and fence. Take care not to overshoot. Square corners of groove and miter inlay strips with a chisel or knife; glue, and press in with a hammer.



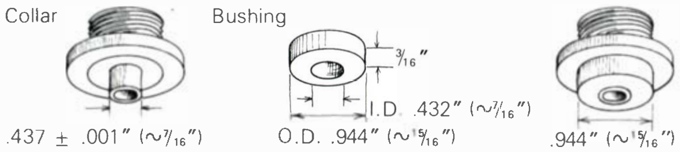


To freehand rout a recess for a marquetry insert, first trim insert of background veneer, and use it as pattern to scribe outline onto ground stock. Centerlines and X's assure proper positioning. Rout to within 1/16 in. of outline and clean edge with gouges. Glue insert in place and clamp, using wax paper between insert and clamping block.

There are two methods for inlaying a marquetry insert, one freehand and one involving the use of a template. As received from the distributor, these inserts are glued to a piece of brown paper and set in the center of a piece of veneer, which protects their delicate edges. The background veneer should be removed to the outline of the insert. First cut with the band saw to about 1/4 in. from the insert itself, then remove the remainder with a sharp knife, chisel or gouge. If bits of the paper backing project around the edges of the insert, file or sand lightly. Place the insert face down on the surface where it is to be inlaid. Draw two centerlines crossing each other at right angles on the project and on the insert, and position the insert so the centerlines coincide. Trace its outline on the surface with a hard, sharp pencil or with a scriber. Before removing the insert, mark it and the surface with an *X* so they can be realigned. Set up the router with a 1/4-in. straight bit, and remove wood to the proper depth, usually a little less than the standard veneer thickness of 1/28 in., cutting to within 1/16 in. of the line. Now use various carving gouges of the proper curvature to remove the thin line of wood that remains after routing. Apply glue to the recess, press the inlay into it with the brown paper backing facing up and the *X*'s corresponding, and force out the surplus glue by rubbing the head of a hammer over the surface. Use one or two pieces of masking tape to be sure the insert stays in position. Then cover with a piece of wax paper so glue will not adhere to the clamping block, lay down a block of wood close to the size of the insert, and clamp overnight. After the glue has dried, hand-sand with 60-grit to remove the paper backing, then fine-sand the entire surface to 150-grit.

Another method of routing in inserts is to use a template. This procedure requires a 1/2-in. and a 1-in. outside-diameter template guide, and a 1/4-in. straight bit. The idea is to use the smaller template guide to cut an opening in a piece of plywood larger than the insert to be inlaid, and then to use this oversize template with the larger template guide to cut a recess the exact size of the insert. Only Rockwell makes

EDITOR'S NOTE: You can purchase marquetry inserts from Constantine, 2050 Eastchester Rd., Bronx, N.Y. 10461; Woodcraft Supply Corp., 313 Montvale Ave., Woburn, Mass. 01801; Minnesota Woodworkers Supply Corp., Industrial Blvd., Rogers, Minn. 55374; and Craftsman, 2727 S. Mary St., Chicago, Ill. 60608.



To make template guide collars for Stanley routers, use two standard 7/16-in. Stanley template collars, and machine a bushing, as shown above, to press fit on to one of the collars. Individual routers will vary in tolerance, so test cut the template and recess. If the inlay fits too tightly, use emery cloth to remove one or two thousandths of an inch from the outside diameter of the bushing. If the inlay is loose, remove one or two thousandths of an inch from the 7/16-in. collar used to cut the template.

template guides of the correct diameter, but Stanley template guides can be refashioned to work. In order to use a 1/4-in. thick template, as will be done here, the length of the guides must be machined to 3/16 in.

The first step in making the template is to make a pattern the exact size and shape of the insert to be inlaid. On a piece of 1/4-in. hardboard or solid-core plywood, scribe the outline of the insert, bandsaw, then sand to split the line. Draw a horizontal and a vertical centerline on this pattern and also on a piece of hardboard or plywood 4 in. to 5 in. larger all around than the pattern. Secure the pattern in the center of this larger piece with wire brads. Set up the router with a 1/4-in. straight bit and attach the 1/2-in. template guide to the router base. Adjust the router so the bit projects just enough to cut through the template stock. Fasten the pattern and template stock on another piece of plywood so that when the router cuts through, it will not damage the workbench. With the router running, lower the bit into the template stock, being careful to keep the edge of the template guide touching the pattern. Move in a counterclockwise direction, guiding against the pattern, to cut out the template.

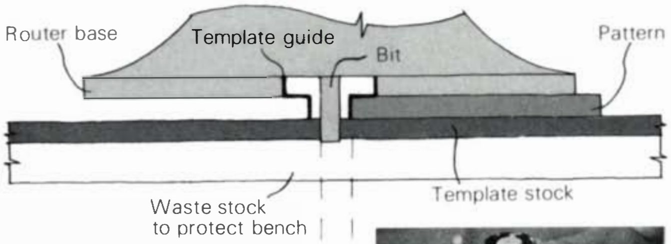
Now position the template on the ground stock to be inlaid, aligning the centerlines. Replace the 1/2-in. template guide with the 1-in. guide, and adjust the depth of the cut to a little less than the thickness of the insert. Again with the router running, lower the base onto the template so the template guide will run on the inside edge of the template. Rout around the template (in a clockwise direction because now the fence is on the opposite side) to cut the outline of the inlay, then run the router back and forth within the template opening to remove the waste. Be careful to keep the router base resting on the template at all times. If the inlay is so large that the recess cannot be cleaned out with the router resting on the template, remove the template and place the router over the recess on two equally thick parallel strips of wood. Reset the depth of cut to the thickness of the strips plus the inlay, and remove the remaining material. Clean out the recess with a chisel, and glue the inlay as before.

An advantage of this method of inlaying is that inlays of burl, crotch or contrasting veneer can be made with the same template. Draw centerlines on the veneer to be inlaid so that the template can be lined up. Hold the template to the veneer with brads into the waste part of the veneer. Then with the 1/2-in. template guide, and the 1/4-in. straight bit set to the proper depth, carefully lower the router so that the guide rests against the inside edge of the template. Guide the router around the template until the inlay is cut out.

Inlaying with a template

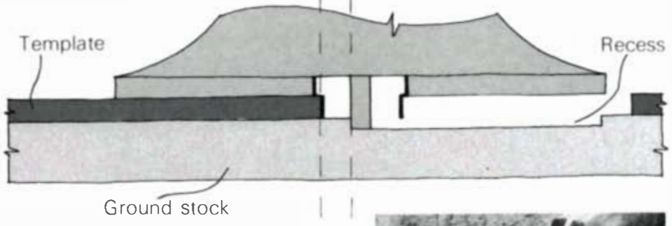
1. Making template

Secure pattern from marquetry insert to 1/4-in. plywood and rout template with 1/4-in. straight bit and 1/2-in. template guide. Note that this setup cuts template opening 3/4 in. larger than pattern: 3/8-in. margin on each edge.



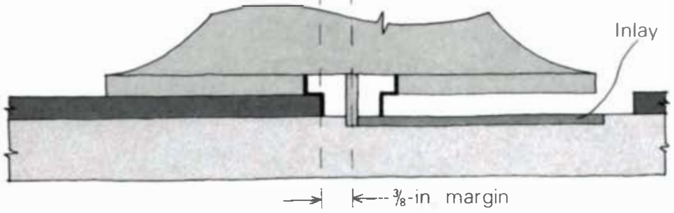
2. Cutting recess

Change to 1-in. guide, reset depth and follow template. Note that this setup establishes 3/8-in. margin and cuts recess same size as original pattern.



3. Routing border

Change to 3/4-in. guide and 1/8-in. bit, using same template. Note that groove spans edge between inlay and ground stock. Press border strip in with a hammer.



A border of 1/16-in. or 1/8-in. holly, satinwood or black-dyed maple strips may be set in to frame the inlay. To do this, align the template over the inlay. Change to a 3/4-in. guide and a 1/16-in. or 1/8-in. straight bit, depending upon the size of the strip to be inlaid, and adjust for the correct depth of cut. Move the router around the template with the guide held against the inside edge of the template. Clean out the groove, apply glue and press in the strip, carefully bending it to conform to the curve. Normally no clamping is necessary because the strip will hold well in the groove while the glue dries.

Template routing can also be used for setting in hinges, chest and wardrobe locks, and recessed draw pulls. □

Eric Schramm, 57, of Los Gatos, Calif., designs and builds custom furniture.

Precision

Tips from the die-making trade

by Fred J. Johnson

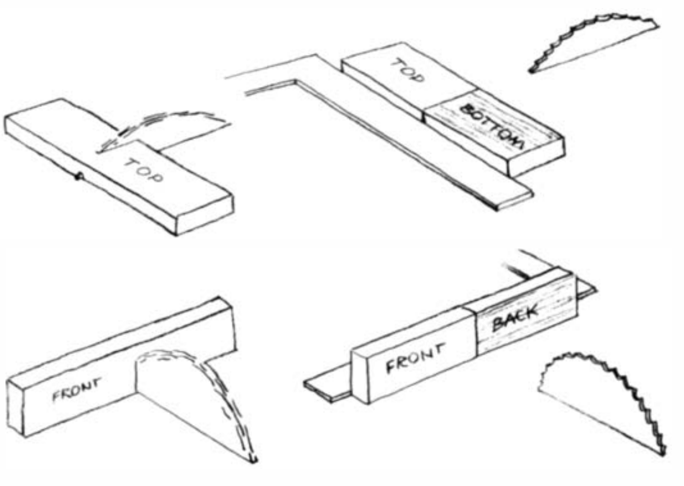
As a package designer, I am fortunate to be associated with some extremely skilled woodworkers—the steel-rule die makers who make the cutting dies used to produce folding cartons out of boxboard. Many of these cartons, beverage carriers for instance, require incredibly complex cutting dies made to tolerances usually associated with metal work. The dies are made from ¾-in. thick hardwood-plywood blocks, which separate the steel cutting and scoring rules. Solid birch is used for the really tiny pieces of wood. I have discovered that it pays to watch others at work. Each craft and each woodworker has distinctive methods of getting the job done. Having learned from die makers a number of ways to be safer and more accurate in my own woodworking, I would like to share some of them here.

Proving a table saw

It is so easy to be a good craftsman when all of your sawn pieces are perfectly rectangular—every edge an exact 90°. Achieving this state sometimes seems difficult, but here is an easy way to check your saw to see if it is cutting squarely.

Take a piece of scrap with parallel edges and crosscut with the board flat on the saw table. Turn one of the pieces over and put the sawn edges back together. Align one side against a straightedge and examine the cut. Any error will be doubled. When you have set the miter gauge or sliding table so that only a line shows, the saw will be cutting truly square.

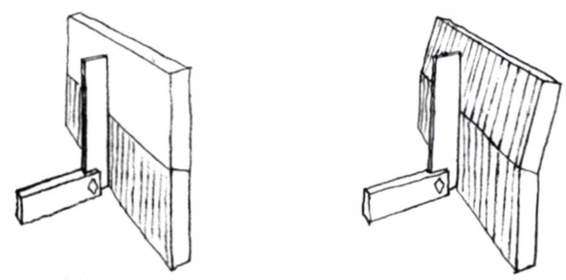
To see whether the blade is set at 90° to the table, crosscut with the scrap on edge. Crank the sawblade to its maximum height and make a cut, then check as before.



Proving a jointer

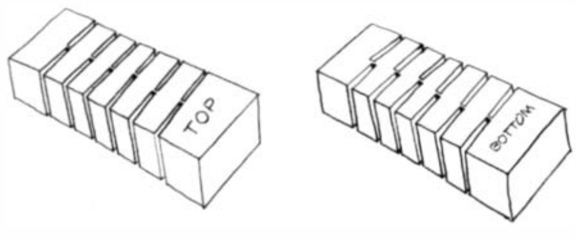
To prove that the jointer fence is set exactly at 90° to the table, joint two pieces of scrap and mark the machined edges. Stack them with jointed edges together and check their faces with a straightedge. Then turn the top piece around, keeping the same edges together, and recheck the faces. If they are not flat, then what you see is twice the error.

When edge-gluing stock, it is not imperative to have the jointer set at 90°. Anything close will do—providing the boards have relatively straight grain. Mark their faces and run alternate faces against the fence. They will edge-join flat; the error cancels.



Adjusting band saws and jigsaws

Here is a simple way to ensure that the blades of band saws and jigsaws are cutting at a true 90° to the table. Set the top blade guides at the height that you are going to cut. Then take a scrap of wood an inch or so wide and cut across the width to its center. Turn it around and make another cut up to the first, stopping about $\frac{1}{32}$ in. short of cutting through. Turn the block over and examine the two kerfs. Any offset will be double the error—adjust the table and try again. It pays to recheck after changing the height of the blade guides.



Accurate measurement

To measure really accurately you need a good ruler and a draftsman's pricker, or else one made from a dowel and needle. I use an 18-in. Starrett adjustable square blade in satin chrome. Stand the ruler on edge and slide the pricker down the ruler's engraved grooves at the desired dimension, being careful to hold the pricker perpendicular to the face of the ruler. Using this technique, you can accurately space lines one hundredth of an inch apart, if your ruler is so graduated.

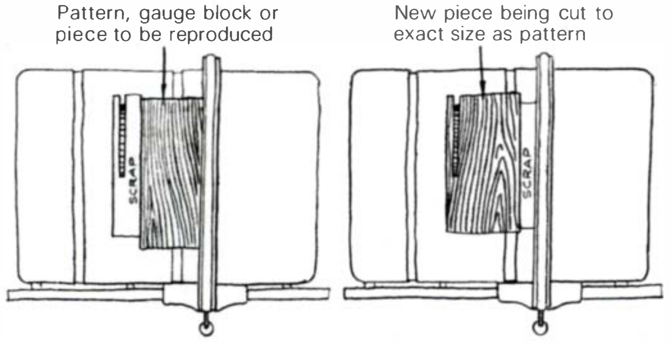
Draftsman's pricker

Illustrations: Fred J. Johnson

Cutting to precise dimensions

Here is a technique for sawing wood to precise dimensions, invaluable when reproducing a previously sawn piece. Place the piece to be reproduced against the rip fence of the table saw. Leave enough space between it and the blade for a safe cut. Hold some scrap wood against the piece and run the scrap through the saw. Then replace the piece with the scrap. Now the distance between the blade and the scrap is the same as the piece to be reproduced.

Steel-rule die makers use this technique to saw blocks of plywood to precise dimensions. They keep precut and marked blocks and strips, usually made of Micarta, aluminum or precision-ground steel. If they want to cut a block to 3¹³⁄₁₆ in. wide, they will stack pieces measuring 3 in. and ¾ in. and also a ¹⁄₁₆-in. steel strip against the rip fence and then cut the scrap block. This technique also saves setup time.



Precision crosscutting

The mark of precision crosscutting on a table saw is perfect edges that are smooth and straight all the way around. Some blades (carbide and dado blades are the worst offenders) chip splinters off the trailing edge of the cut. To prevent this, always place a solid backup behind and under the workpiece. Stand a piece of straight scrap on edge and screw it to the miter gauge so that it extends beyond the sawblade, for good support. The saw kerf in the scrap is also a precise way to align your cutoff mark because it represents exactly where the saw is cutting, even if there is a slight wobble to the blade.

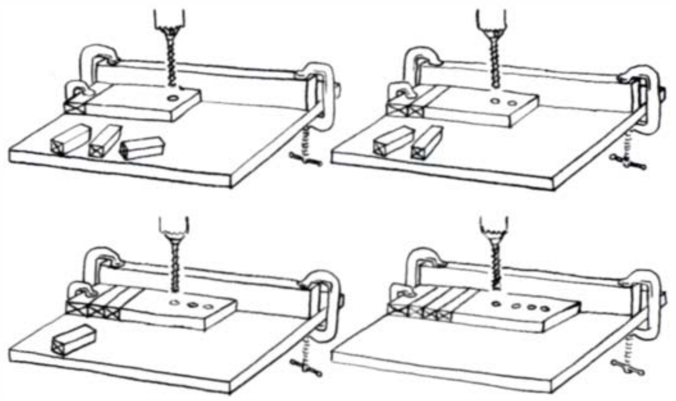
The same principle holds true for the saw slot in the table. For super-precise cutting where you cannot tolerate any splintering, the sawblade should fit the slot exactly. Make a wooden table insert and hold it firmly in place with a stick. Then crank the blade through the insert to the depth of your cut. Now the edges of the work will be supported right at the tabletop—especially important in dado work.

The same techniques apply to other tools. Shaper cutters, even if sharp, often tear giant splinters off the end grain. If you can't leave enough scrap on the work to trim later, glue a piece of scrap to the edge and trim it off afterwards.

Step-and-repeat

Step-and-repeat is what die makers call the process of accurately spacing holes or cuts. It is ideal for doweling. The basic setup consists of spacing blocks cut equal to the desired spacing, and stop blocks that define the end spaces. The work is held against a stop block and is then drilled or cut. The work is moved away from the stop block, and spacers are put between stop block and work, one at a time.

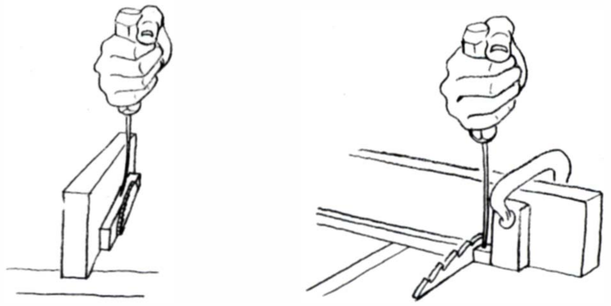
This technique has three advantages: It will space as accurately as you make your spacing blocks, you can make any number of pieces exactly the same, and you can make mating parts with exactly the same spacing. Be careful not to get sawdust between the blocks or inaccurate spacing will result.



Ice-pick technology

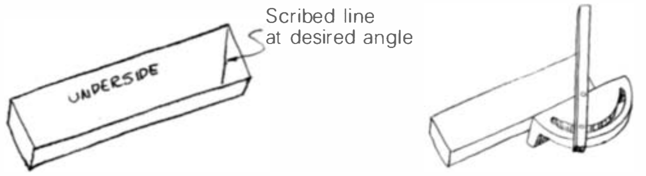
One of the more difficult things to do on a table saw is to cut small pieces of wood precisely and safely, especially when using the rip fence. The die makers solve this problem with ice picks. They hold the workpiece securely in the jig or fixture, or firmly against the rip fence, with the point of an ice pick. They use the pick to guide it carefully past the blade.

On rare occasions an accident chews the end off an ice pick and sends a blade or cutterhead to the sharpening shop. But consider the alternatives. Ice picks are made of excellent steel that can withstand the pressure needed to control the workpiece. Square-handled picks are best because they don't roll.



Miter gauges

The play of the miter-gauge bar in its slot can be annoying as well as contribute to inaccuracy by causing wide, long planks to jerk through the blade. To cure this, remove the bar from the protractor part. Put it on an anvil or stout piece of steel, and peen the top edges slightly with a hammer. Go lightly over both top edges, being careful not to hit it at much of an angle. Check the fit and peen until it fits the way you want it to. If you overshoot, file the fat parts. To set a miter gauge, mark the required angle on the underside of the board to be cut. This can often be scribed directly from the work. Set the miter gauge against the same edge that will be used when cutting. Now swing the bar to align exactly with the scribed line and lock it. It is now set perfectly. □



Fred Johnson, 50, of Long Beach, Calif., is filling his house with his reproductions of 18th-century antiques.

Finishing Materials

What you always wanted to know...

by Arthur D. Newell

Choosing a correct finish for your woodworking project is really quite simple, despite the confusing array of types and brands on the market. The key to selection is compatibility—the finish must be chosen with the physical requirements of the particular piece in mind. For example, where the surface will be subjected to wear or abrasion, the finish must be as tough and flexible as possible, with maximum adhesion to the wood substrate or the sealer coat. Where the surface will be exposed to liquids, moisture resistance is important. Where the piece is decorative, clarity and appearance are the deciding factors.

All finishing materials can be categorized as one of two basic types: solvent-release or chemically reactive. In simplest terms, solvent-release finishes (shellac, lacquer) form a solid film upon evaporation of the solvent or thinner. Chemically, the film is not changed. Reactive finishes, however, such as tung oil, linseed oil and varnish, harden by means of a complex chemical reaction. The wet film first absorbs oxygen from the air. This starts a reaction that proceeds through the film, changing it from liquid to solid. Solvent-release finishes can be reliquefied simply by applying the correct solvent or thinner to the surface. Reactive materials usually cannot be brought back to their original fluidity. This is one reason why shellac and lacquer are easier than varnish to spot-repair.

Solvent-release materials

Shellac — Shellac is a natural resin made from the secretion of the *Laccifer lacca* insect. It is available in flakes or buttons ready to be dissolved in alcohol by the user, or in ready-to-use alcoholic solution as either orange or white shellac. As the name implies, orange shellac is colored and will impart some color to the wood. White shellac has no color. If the shellac is fresh, there is little difference in performance between them. However, orange shellac will keep longer in the can without losing its ability to dry. Another difference is that orange shellac is substantially more moisture resistant. For interior use, shellac of either color is much more moisture resistant than lacquer and many varnishes.

By itself, shellac is extremely brittle. But when applied either as a penetrating sealer coat or as a finish *in* the surface of properly sanded wood, it can take abuse and wear without chipping. Because shellac is an alcohol-based, solvent-release material, the dry surface is easily softened by alcohol. Thus, additional coats of shellac bond strongly to shellac undercoats, as does lacquer (because of its solvent content). However, finishes such as drying oils and varnishes, neither of which contain alcohol, won't adhere to shellac films. For good adhesion of these over shellac, the surface must first be sanded thoroughly with medium-grit paper, permitting a mechanical bond between the films.

Shellac has excellent moisture and wear resistance, dries quickly and can be rubbed or French polished to almost any degree of gloss or sheen. However, it can be easily softened or disfigured by alcohol or alcoholic liquids. It also has limited shelf life (about six months) when dissolved, and almost no exterior durability.

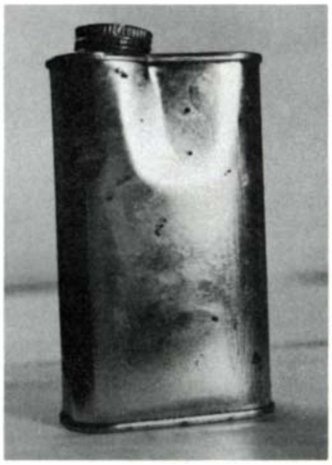
Lacquer — Despite certain variations, clear lacquer for wood finishing is generally composed of nitrocellulose dissolved in solvents, plus a small amount of a plasticizing ingredient that helps reduce the brittleness of the film upon drying. Spraying and brushing lacquers are essentially the same. In spraying lacquer, however, the solvent/thinner mixture evaporates quickly, giving the wet film only enough time to flow out evenly before it begins to harden. In brushing lacquer, a different solvent/thinner mix evaporates more slowly so that brush marks can level out before the surface hardens.

Brushing lacquer is seldom thinned before use, but spraying lacquer always is. If you're fortunate enough to have a spray outfit, the type of thinner you use to reduce the lacquer for spraying can make the difference between good and bad results. When lacquer dries, heat is carried away from the surface as the thinners evaporate. If the humidity in your shop is high and you use "fast" thinners to cut drying time, moisture in the air will often condense onto the surface, producing a cloudiness called "blushing." Other things being equal, you're better off using a slower, richer thinner. Among other things, you'll get better flow and gloss.

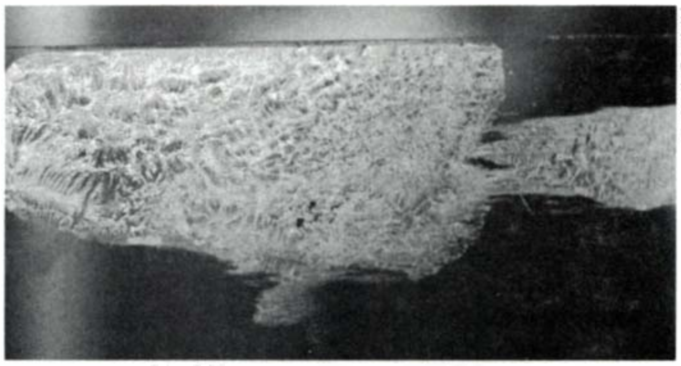
Lacquer dries faster than oils or varnish, often permitting the application of three or more coats in the same period of time. It produces a good, durable film resistant to wear and abrasion, and can be rubbed out or polished to almost any degree of gloss or sheen. However, it requires many more coats than varnish to produce the same film build, because lacquer has a lower percentage of solids. It is more susceptible than varnish to retaining brush marks in the dried film, and is not as moisture resistant as shellac or some varnishes. Nonetheless, it is quick-drying and produces an attractive, good-quality finish with good interior durability.

Sanding sealers — These are fast-drying, solvent-release materials used on bare wood to fill the pores and level the surface prior to applying the final finish. As the name implies, a sanding sealer is designed to be sanded down to a smooth, even surface. It usually sands so easily that the surface comes away in a cloud of white powder.

Most sanding sealers are based on either nitrocellulose or vinyl, to which is added a large quantity of stearates. The stearates act as a lubricant to make sanding easy, but because they are literally a kind of soap, shellac, varnish and drying oils should never be used over a sanding sealer. Sooner or later, the top coat will simply strip away in sheets. Only lacquer should be used over a sanding sealer, because the solvents in lacquer will bond well to the lacquer base of the



A graphic example of the degree to which a reactive material absorbs oxygen from the air. This can contains a popular brand of rubbing oil (a thin solution of drying oil and varnish). It was stored half-full, but capped. For several months the varnish absorbed oxygen from the air in the top of the can, thus creating a vacuum that sucked the can's sides inward. The reaction also jellied the contents. Conclusion: Varnish remaining from a job should be poured into a smaller container, filling it completely, to keep it usable for any length of time.



Closeup of a dried film of pure tung oil, rubbed out on glass. The thicker the coat, the more evident the wrinkling. Very thin coats, well rubbed into the wood, will not wrinkle to this extent, but will produce a definite matte or flat appearance.

Photos: Don Newell

sealer. Sanding sealer is a good base on small-pored woods, but is not designed to replace filler on coarse-grained wood such as oak.

Reactive materials

Drying oils — Linseed oil is available raw and boiled. Raw linseed oil has nothing to offer the finisher except trouble. Among other things, it contains substantial amounts of what are called "foots," nondrying portions of oil which no amount of heating or aging will harden. Foots are removed during refining by filtering and refrigerating the raw oil, prior to producing boiled oil, but the home brewer cannot make raw oil into boiled oil simply by boiling it.

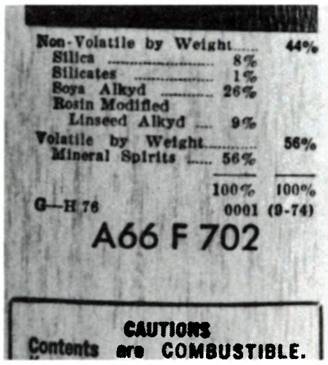
Boiled linseed oil has the foots refined out, then it is steam-heated and held at a high temperature with the addition of metallic drier compounds. It is a true drying oil and reacts with oxygen to become a solid film. However, solid doesn't necessarily mean hard. Even aged linseed-oil films remain comparatively soft, though thin films will solidify to a dry-feeling surface. Because boiled linseed is usually applied in thin coats and rubbed in well by hand, the finisher may think he has a good, durable finish. However, because oil that has penetrated down into the wood structure will remain semisoft, linseed films should never be overcoated with lacquer or shellac. The top coat will adhere badly or not at all.

Linseed oil was a favorite old-time finish because it was readily available, easy to apply and repair, and looked good if not subjected to wear. Linseed films have poor moisture resistance, which is one reason old-time paint made from linseed oil seldom blistered or peeled. Moisture in the wood beneath the paint simply passed out through the paint without hindrance. Compared to tung-oil films, boiled linseed oil will pass about twice the amount of moisture.

Tung oil — This is more properly called China wood oil, and is much more reactive than boiled linseed. Tung dries to a harder film and is twice as moisture resistant. It dries through more quickly and completely than boiled linseed. In

How to read the label

Except on the smallest of containers, the label on the can usually tells the amount of oil/resin solids in the mix and the nature of the materials in the finish.



Satin-type finishes invariably contain a certain amount of silica and/or silicates, which make the film dry to a low luster. Since these contribute nothing to the film properties, ignore them. You'll not find such flattening agents in a gloss-finish formulation.

What you should look for are the amounts or percents of oils and resins in the formulation. These will generally be referred to as the nonvolatile part of the finish. Because the nonvolatile materials are what will be left after the thinner evaporates, they are what constitute the ultimate finish on or in the wood. In the example shown in the photo above, under nonvolatiles by weight, you'll see soya alkyd and rosin-modified linseed alkyd, totaling 35%. This means that whatever the amount of wet material you brush onto the surface, about a third of it will be left as a film when it dries. This particular finish happens to be a varnish.

A typical lacquer would list its nonvolatiles as nitrocellulose, and, possibly, an oil or oil alkyd (used as a plasticizer). In the case of a satin or flat lacquer you may find figures for stearates. If the stearate figure is listed separately, ignore it.

The nonvolatile percentage figure is most helpful in comparing one finish with another. The formulation with the highest percentage of solids will leave the thickest film. A few percentage points mean nothing for practical purposes. But if one formulation indicates 50% solids and another 35% solids, the former will leave a film half again as thick as the latter. Which means that it will require three coats of the second to give you the same finish thickness as two coats of the first.

Where the label lists the nonvolatiles by name, you can determine whether you have a tung or other type of oil base, and what resins are present. This is sometimes helpful where the product name is ambiguous. For example, one popular finish carries a name that strongly implies it is a polyurethane varnish. Yet, on reading the ingredients on the label, it is obvious that the varnish is really an oil-modified phenolic type. If you want a polyurethane varnish, you will not use this one by mistake. Or, if you don't want a poly varnish, you could conclude that this material is just what you have been searching for.

The other most helpful information on the label is in the instructions panel. For example, polyurethanes generally have a sensitive period within which recoating must occur, assuming you intend to use a second coat. If you exceed this time period before recoating, adhesion will suffer. *Always read the instructions.* If you don't follow them, at least you'll know what it is you've done wrong.

my view at least, tung oil has a major shortcoming when used as a final finish. It tends to dry nonglossy, even in thin coats. In heavy coats it wrinkles badly. According to one manufacturer, thinning the oil by half with mineral spirits, followed by steel-wooling after it dries, will reduce the flatness. To me tung oil seems more suitable as a utility finish than as a beauty treatment. If you must have tung oil's moisture resistance while insisting on a decent degree of luster, select a good varnish made from tung oil.

Varnish — The old-time spirit varnishes made from natural resins dissolved in alcohol have largely disappeared. Today's varnishes are reactive materials composed of synthetic resins and oils combined together under heat and pressure, with driers added to speed the hardening process. Thinners are then added, making the varnish fluid enough to brush out.

Alkyd resin varnish — An alkyd resin is a synthetic resin made by reacting a type of alcohol, such as glycerol, with an acidic ingredient, such as phthalic acid. The resulting resin is then combined with or modified by unsaturated oil such as tung, linseed or soya, and driers and thinners are added.

A large percentage of today's varnishes are based on soya or linseed-oil alkyd resin. These produce workable, durable finishes, which generally are not as hard as polyurethane varnish. As a class, alkyd resin varnish is comparatively flexible and can accommodate expansion and contraction of wood in normal interior service. It can also be recoated easily without encountering problems of poor adhesion.

Alkyd varnish produces an easily applied, attractive finish that is highly durable on interior surfaces. Generally, it can be rubbed to the desired degree of luster. For maximum moisture resistance, select an alkyd varnish whose label lists tung oil as an ingredient.

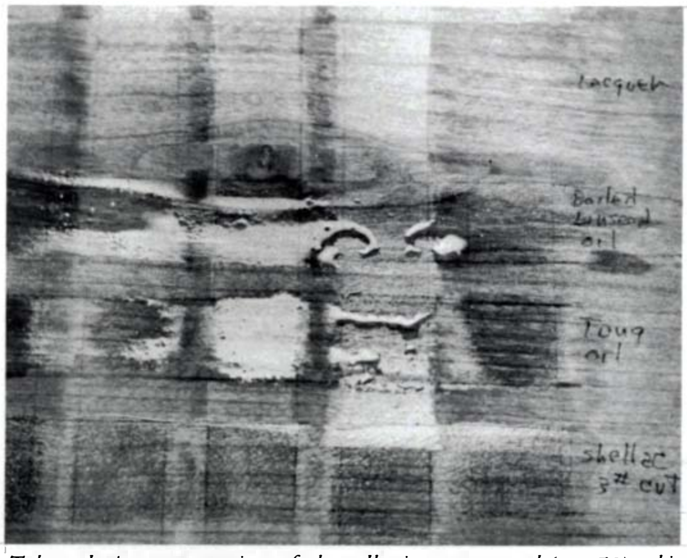
Rosin/ester gum alkyd varnish —The label on some cans lists such ingredients as "rosin-modified" or "ester-gum modified" alkyd. Generally, this type of varnish will dry to a harder film than regular alkyds, and consequently may rub out and withstand wear better. In fact, some gym-floor varnishes are ester-gum formulations.

Phenolic-resin varnish — This varnish is made from a special synthetic resin that dries to a tougher, more moisture-resistant film than alkyd varnish. The phenolic varnishes are primarily for exterior use because of their weather resistance and their ability to withstand the dimensional changes in wood without splitting or cracking. These varnishes are usually labeled spar varnish, super-spar varnish or the like. They're softer than most polyurethane varnishes, which makes the phenolics more flexible and permits recoating without adhesion problems.

Phenolics are notorious for darkening or yellowing, sometimes even when kept in the dark. Some modern phenolic varnishes contain an ultraviolet-absorbing element to help reduce this tendency.

Phenolic resin varnish is not the ideal choice for interior furniture work, but it is a superb utility finish for exterior wood furniture and trim exposed to weather and sunlight.

Polyurethane varnish — "Polyurethane" really refers to a class of material closer to a true plastic than an alkyd resin,



Taken during preparation of the adhesion test panel (pg. 75), this photo is proof that neither tung oil nor boiled linseed oil should ever be used over a base or sealer coat of polyurethane varnish. Both of these drying oils refuse to 'wet out' the polyurethane surface, actually crawling together rather than spreading out over the surface. While their dried films might hold mechanically on a well-sanded polyurethane surface, almost no chemical bond will be established.

rather than a specific formulation. Consequently, a pure polyurethane varnish will be hard, tough and comparatively brittle. To recoat, sanding down to bare wood and starting over is required.

However, the usual polyurethane varnish you find on the shelf of your hardware store will most likely be modified with a drying oil or alkyd resin. This supposedly makes the varnish less brittle and more recoatable, but your only chance for good adhesion is to follow label instructions to the letter when applying a second or third coat. Actual adhesion tests using a typical brand-name polyurethane varnish sold for furniture indicated some problems, whether in applying it over other types of finishes, under other types of finishes or even over itself. This is not my preferred choice as a finish for my better work for interior use, but some people may like it.

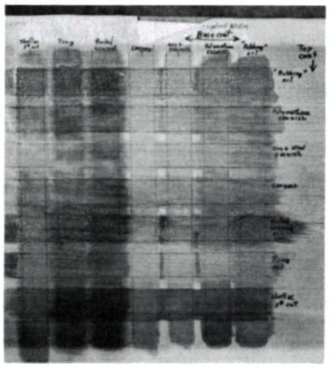
Rubbing oils — This is more a description of a class of finishing formulations than a specific material. The name on the label may imply that it is used by Danes or Swedes or will produce an antique finish (whatever that may be), but it is usually just a dilute varnish containing a substantial amount of oil. Nevertheless, brand-name rubbing oils are excellent products. They penetrate well, dry hard and produce attractive finishes if you work with them enough to really learn how to make them perform. Because they are comparatively thin-bodied, don't expect a great deal of surface buildup. But then, that isn't necessarily a major criterion for a fine finish.

Finishing materials compatibility

When two different materials are used in finishing, they must be able to bond together permanently. Wear, handling, accidental impacts and normal expansion and contraction of the wood substrate place great stress on any finish, and the better the bond the longer the finish will last without chipping, peeling or crazing.

Generally, maximum compatibility is achieved by using a single type of finish. For example, in finishing with a varnish, the first coat may be thinned down for greater penetration as

The Adhesion Test



I used seven different materials to test the adhesion and flaking potential of various finishes over and under themselves as well as other finishes. First, each was applied in vertical strips on bare cherry veneer, using three good, wet coats with 24 hours of drying time between. Then, the same materials were applied in horizontal strips over the first set. Once again, three good coats were applied with 24 hours of drying time between.

After allowing a week's drying time for the composite panel, each finish-on-finish square was lightly punched through from the back with a roundnosed, ¼-in. punch. By examining the torn edges of each punched hole, it was easy to determine how well the top coats adhered to the undercoats.

Where the top-coat finish broke away from the undercoat cleanly, adhesion obviously was at a maximum, and these samples were rated good or better, depending on the degree. Where some peeling was found, the sample was rated fair. Where the top coat appeared to be stripping away in sheets, it was rated poor. Very poor means almost no adhesion.

Any undercoat/top coat combination rated good or better in such a test will probably have sufficient adhesion and durability to be used with confidence on furniture or cabinet work to be subjected to wear or handling abuse.

If nothing else, this test illustrates two points. One, that nothing adheres as well to a base material (used as a sealer coat) as the same material itself—except for polyurethane. And two, that to the degree that the particular brand of polyurethane used represents all polyurethanes (and there's no guarantee that it does), a poly varnish must be recoated within its sensitive period or it shouldn't be recoated at all.

The same seven finishes used in the adhesion test were also tested for flexibility and film integrity. The seven were painted heavily on a sheet of Teflon as shown in the photo, and allowed to dry thoroughly. The dried films were then carefully stripped off the Teflon and bent, twisted and torn to determine film strength. Here are the results:

Shellac: glass-like, brittle, no film strength.

Tung oil: tough, coherent, fair film strength, but it dried cloudy and wrinkled.

This section of a typical punched hole from the adhesion test shows some minor flaking or stripping off of the top coat from the undercoat at the edge of the break, and would be classified as fair adhesion. The materials are rubbing-oil film over alkyd-varnish film base. Photo was taken through a low-power microscope.

Materials applied as top coat (final finish)	Materials applied as base coat on cherry veneer: Shellac 3 lb. cut	Tung oil (unthinned)	Boiled linseed oil	Lacquer (satin)	Alkyd (soya) varnish	Polyurethane gloss varnish	Rubbing oil
Rubbing oil finish *Over*	Poor	Fair	Good	Fair	Fair	Fair	Good
Polyurethane gloss varnish *Over*	Very poor	Poor	Poor	Very poor	Very poor	Very poor	Very poor
Alkyd (soya) varnish *Over*	Poor	Fair	Good	Poor	Good	Poor	Fair
Lacquer (satin) *Over*	Excellent	Good	Good	Excellent	Good	Very poor	Good
Boiled linseed oil *Over*	Fair	Excellent	Excellent	Fair	Fair	Fair	Good
Tung oil (unthinned) *Over*	Poor	Good	Good	Poor	Poor	Poor	Good
Shellac, 3 lb. cut, *Over*	Very good	Very poor	Poor	Fair	Fair	Poor	Good

Boiled linseed: softer than the tung-oil film, but fairly coherent and strong. It can remain semisoft even after a full week of drying.

Polyurethane varnish: very tough, strong and coherent.

Alkyd varnish: somewhat softer but otherwise equal to polyurethane varnish.

Lacquer: similar to shellac in brittleness. Poor film strength.

Rubbing oil: very strong, clear and coherent film. —*D.N.*

a sealer coat, followed by one or more top coats of the same varnish used for the final finish. Because the sealer coat and top coats are soluble in the same thinner, each coat will bond well with the preceding coat. The one exception is a material such as polyurethane varnish which generally has a so-called sensitive period, after which the surface becomes so hard or inert that following coats will not adhere well. However, if the finisher follows instructions on the label, this should not be a problem.

But compatibility, or the lack thereof, can be a real problem when using one material for the sealer coat and a different material for the finish coat: Varnish top coats over a shellac sealer coat, for example. Because varnish is a reactive material dissolved in a hydrocarbon thinner such as mineral spirits, and shellac is a solvent-release material dissolved in alcohol, the bond between them tends to be weak. The chemical bond, that is. A good mechanical bond can be achieved by sanding the shellac/wood surface with medium-grit paper to give it "tooth."

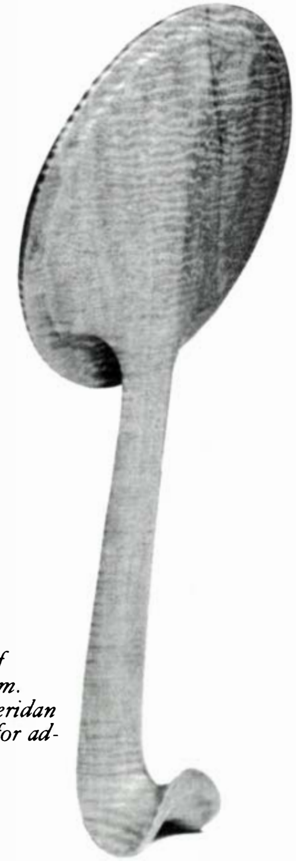
In addition, because the shellac sealer coat obviously will not have filled the porous wood completely to surface level, a certain degree of porosity will remain. Consequently, even though the wood has been "sealed" by shellac, the varnish can still penetrate the surface somewhat, further enhancing the mechanical bond.

The more chemically compatible two finishing materials are, the greater the probability that the resulting finish will be strong, coherent and resistant to separation or finish failure in the long run. The less compatible, the more the finisher has to depend upon a good mechanical bond. A good rule of thumb is to use reactive materials over reactive undercoats, and solvent-release materials over solvent-release sealers. Drying oils such as boiled linseed can be used over almost anything, since they are generally applied in such thin coats that film strength is not a factor. □

Don Newell, of Farmington, Mich., is an amateur furniture maker and a paint and varnish chemist.

Out of the Woods

Touring show features designer-craftsmen of Ontario



Out of the Woods is the first juried show of contemporary woodworking to be organized in the Canadian province of Ontario, and it may be the first such show in Canada. Juror Wendell Castle received slides of 89 works, and chose 34 pieces by 20 craftsmen for display. Rather than attempt to rank the work by awarding first through fifth prizes, Castle wisely divided the available money into five equal prizes.

Eric Dewdney of the Cambridge Public Library staff, himself an expert woodworker, coordinated the exhibition and prepared its catalog. In it he points out that the purpose was to promote and encourage the art of design in wood by giving craftsmen an opportunity to show, and to bring good work to the public by putting it on tour throughout Ontario for the rest of this year. Dewdney adds, "It was also conceived to focus on original design and only works exhibiting originality in a contemporary idiom were considered. By creating this focus, we did not in any way intend to diminish the importance of the work of many exceedingly fine woodworkers producing period reproductions and traditional carvings. We were trying to encourage the creative efforts of a smaller minority of designer-craftsmen."

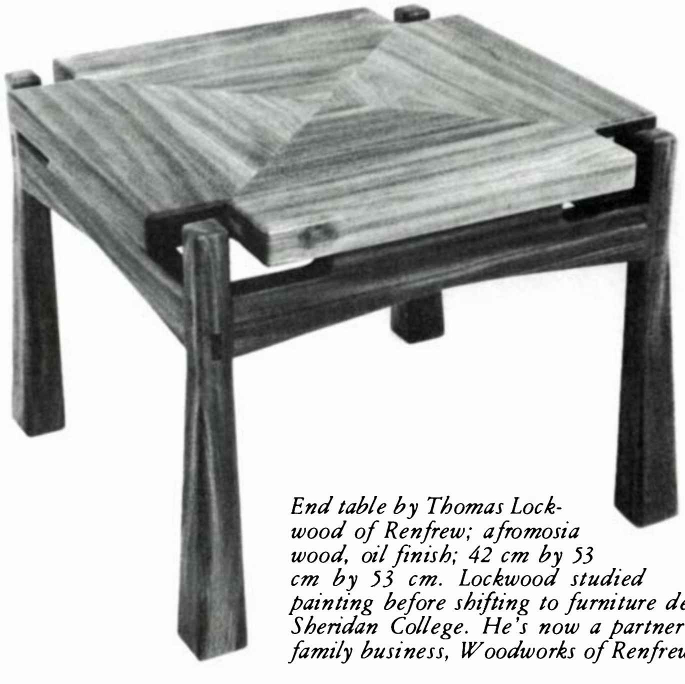
Dewdney might have added that this show demonstrates the close relationship between high-caliber art woodworking and a school where craftsmen can be trained. Ontario had no such place until 1967 when the School of Design was founded at Sheridan College near Toronto. The majority of the 20 craftsmen represented in *Out of the Woods* came out of the woodshop at Sheridan.

You can see *Out of the Woods* July 6 to 29 at Thames Art Center in Chatham; Aug. 8 to 26 at Timmins Museum in Timmins; Sept. 4 to 26 at Macdonald Gallery in Toronto; Oct. 2 to 21 at Art Gallery of Peterborough in Peterborough; and Nov. 2 to 5 at Gallery/Stratford in Stratford. *J.K.* □

Mirror frame by Michael Fortune of Toronto; koa wood; 24 cm by 10 cm. Prize winner. Fortune attended Sheridan College and later received a grant for advanced study in Sweden. He now operates a custom-furniture studio.

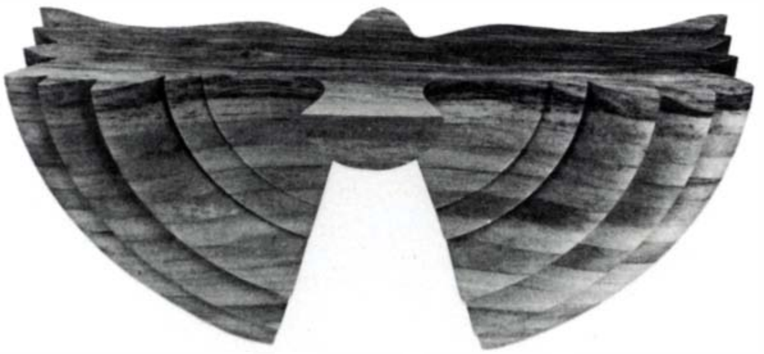
Michael Fortune

Transportable tool cabinet by Tom Carnahan of Kemble; elm wood, oil and varnish finish; 163 cm by 61 cm by 46 cm. Carnahan is a recent Sheridan graduate now working to establish a custom-furniture business.



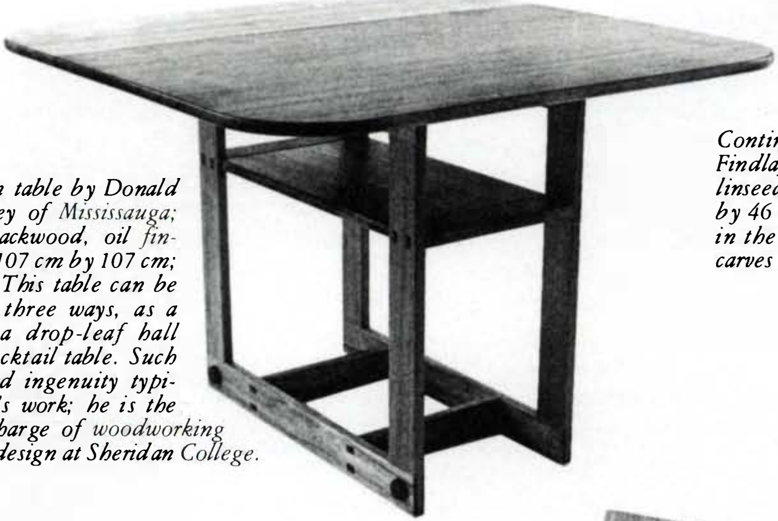
End table by Thomas Lockwood of Renfrew; afromosia wood, oil finish; 42 cm by 53 cm by 53 cm. Lockwood studied painting before shifting to furniture design at Sheridan College. He's now a partner in the family business, Woodworks of Renfrew Ltd.

All photos, except where noted: Henry Vanderdraay

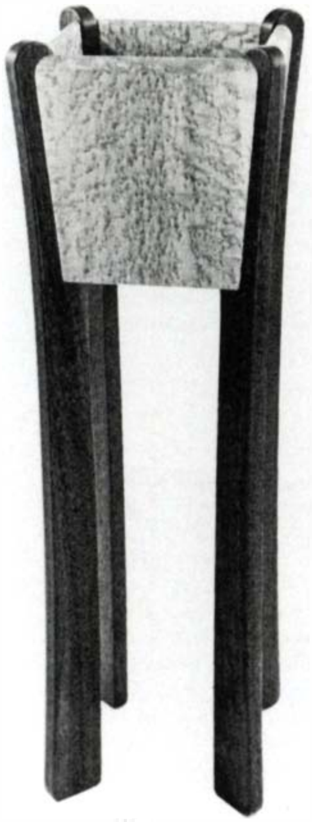


Bird table by Stephen Hogbin of Caledon East; yellow walnut, oil and wax finish; 90 cm by 27 cm; prize winner. Hogbin studied in England and taught at Sheridan College before opening his own studio. This table is a large, sectioned turning—his specialty.

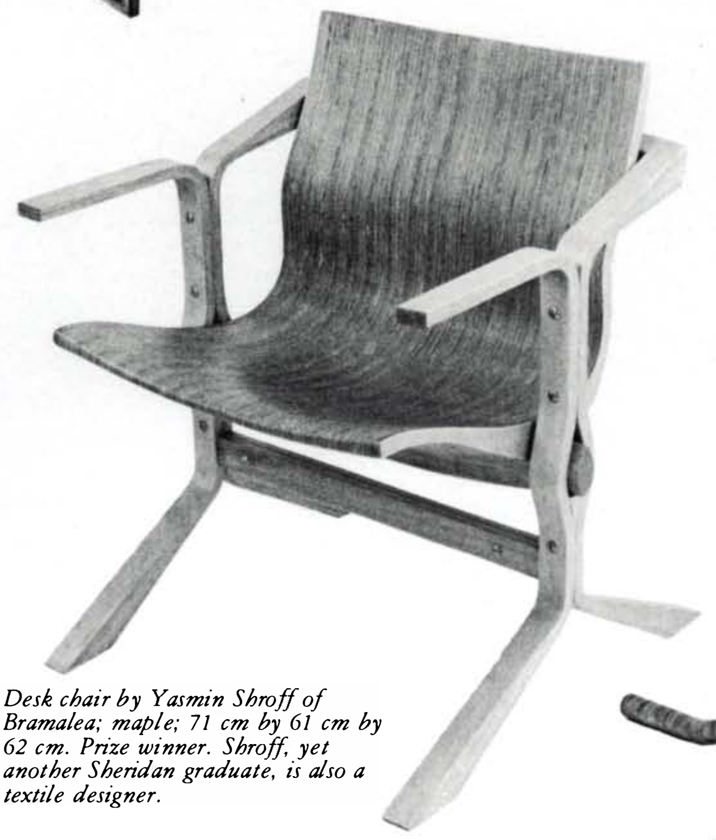
Continuity sculpture by Peter Findlay of Mississauga; maple, linseed oil finish; 48 cm by 38 cm by 46 cm. Findlay is a supervisor in the furniture industry who carves and sculpts after hours.



Triple position table by Donald Lloyd McKinley of Mississauga; Tasmanian blackwood, oil finish; 74 cm by 107 cm by 107 cm; prize winner. This table can be assembled in three ways, as a game table, a drop-leaf hall table and a cocktail table. Such well-considered ingenuity typifies McKinley's work; he is the professor in charge of woodworking and furniture design at Sheridan College.



Plant stand by Kathy Cherney of Cambridge; bird's-eye maple, walnut, oil finish; 91.5 cm by 28 cm by 28 cm. Cherney, a Sheridan graduate, now works as a cabinetmaker.



Desk chair by Yasmin Shroff of Bramalea; maple; 71 cm by 61 cm by 62 cm. Prize winner. Shroff, yet another Sheridan graduate, is also a textile designer.

Cactus coat tree by Andrew Poynter of Cambridge; curly maple, cherry, zebrawood, oil finish; 170 cm by 71 cm by 71 cm. Prize winner. Poynter studied mechanical engineering and turned to making furniture for a living in 1971.

TAGE FRID

How to make solid wood doors and keep them flat

There is no way to stop solid wood from moving, except to make it into plywood or to treat it chemically, which kills its color and beauty. When making anything out of solid wood, you must be sure to control which way the wood moves, and leave room for it to do so. I have seen a ½-in. thick parquet floor, when the roof started leaking and the floor got wet, push out all four brick walls about six inches.

The problem of wood movement is complicated when we want to make doors out of solid wood for houses or cabinets. We want the door to stay flat, and to always fill its opening. But not only does the wood expand and contract across the grain, it also tends to bow. This is because the humidity on each side of the door is usually different, especially when the door separates the outdoors from the inside of a house. Even a cabinet door is exposed on its outside to various temperature and humidity changes in the room, while very little changes inside the cabinet. If the door is not constructed to stay straight it will bow out when humidity is high in the room, like during the summer, and cave in during the winter when the heat is on. Usually the door will also try to twist.

Although a cabinet door is seen on both sides, it is usually closed and the inside exposed only when it is opened. Thus I would put the more beautiful side of the wood toward the outside. There is no need to alternate the cup of the annual rings as some textbooks suggest (see "Textbook Mistakes," *Fine Woodworking*, Spring '76). The wood can be kept straight with one of the methods I am about to describe. Whatever way you choose, if it is done right and made well, it will add to the design. Anything that is constructed and designed right is beautiful because it makes sense. The outside of an airplane was never designed to be beautiful, but because of the way it slips through the air, it is beautiful.

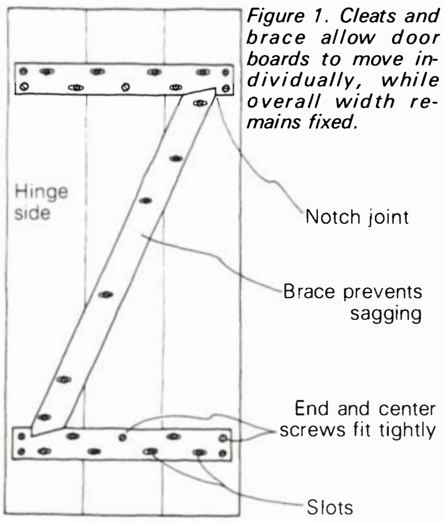


Figure 1. Cleats and brace allow door boards to move individually, while overall width remains fixed.

When you are making a solid wood door for a house, especially an outside door, don't glue the boards together. Construct the door so that its two outside edges are tied down. The individual boards will be able to move, but the overall width of the door won't be able to change. There are several good ways to do this; the oldest and best-known method is shown in figure 1. This is the way most people would make a solid wood door and there is nothing wrong with this construction.

The diagonal brace and cleats are what keep the door together. It is important to fit the brace into the top and bottom cleats with a notch joint, as shown, so it cannot move. Also be sure that the brace is anchored to the bottom cleat on the hinge side, and to the top cleat on the lock side. This arrangement prevents the door from sagging. If you change the hinges to the other side, turn the door upside down.

The brace and cleats are held to the door with screws. The screws at the ends of the cleats should fit snugly into their holes, so the total width of the door cannot change. In this example the center board is also tied down in its center, so the wood can move an equal amount on each side. All the other screw holes in the cleats and brace are horizontal slots. When the boards move, the screws can move back and forth with them. If you don't do this the boards will split. The length of the slots depends on the width of the board. Using a drill a little larger then the screws, drill three holes side by side. Remove the waste with a chisel or keyhole saw.

Figure 2A. Nailed batten can cover the gap in tongue-and-groove doors, which work best when the boards are narrow.

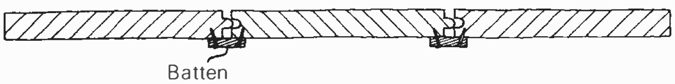


Figure 2B. Lap joint can accommodate movement of wider boards. Slots in cleats permit screws to slide.

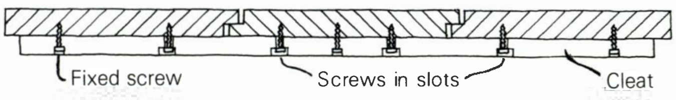
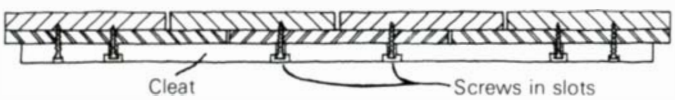


Figure 2C. Two layers of wood nailed or screwed together with staggered joints make a tighter door.



The door must also be wind and rainproof. The most common way to do this is tongue-and-groove. This is fine with narrow boards, but the door won't stay airtight if the boards are wide. The tongue usually isn't very big, its edges are often rounded and sometimes the tongue is tapered so the joint will slide together easily. The result is that when the boards shrink, wind and rain come right through. You could nail batten strips over the joint (figure 2A). With wide boards, a lap joint (figure 2B) can be quite successful, but I prefer to use two layers of wood (figure 2C) for a tighter door. The boards can be screwed together, or if the wood is not too hard, nailed together and the ends of the nails bent over. Just be sure the ends of the cleat are screwed down tight, as before.

When using strap hinges, the back of the door is exactly as in figure 1, but the cleats and brace are welded steel. The hinges are bolted to the front of the door, through the wood and the steel on the back side. Usually there is only one bolt through each board. If the boards are not too wide, being bolted between the two pieces of steel overcomes warping. If more than one bolt has to go through each board, some of the holes in the wood have to become slots.

Figure 3. Steel rod through boards can overcome wood movement.

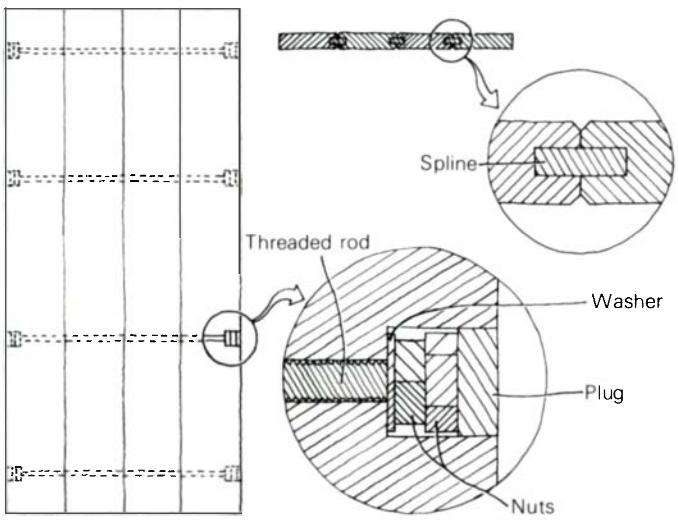


Figure 3 shows a door without cleats or strap hinges, but with metal rods right through the width of the boards. The best way to make a door like this is to use cold-rolled steel threaded at both ends, or threaded rods. To make the door as tight as possible, put the boards together using splines, but don't glue them together. The bolt holes through each board have to line up. First, drill the big holes for the nuts and plugs in the outside edge of board no. 1. Then use a long drill of the same diameter as the rod and continue the holes all the way through. Be sure the holes are centered and straight. Drill only a little at a time then pull out the bit and clean it, or else the drill will start wandering. Most hardware stores stock 12-in. and 18-in. bits that electricians use, called bell-hanger's bits. The most common size is ⅜ in., and this is a good size for the rod too. For a larger door, or an outside door, use ½-in. or bigger rod. With all the holes drilled in the first board, put the spline in and clamp the first and second boards together. Use the long bit and the hole in the first board as a guide to drill partway into the second, then remove no. 1 and continue drilling all the way through. Proceed in the same way through nos. 3 and 4. Now to accommodate the nuts and plugs on the outside edge of no. 4, plug the rod hole with a dowel (don't glue it) and drill the big holes.

With all the holes drilled, assemble the door and insert the rods, then put the washer and one nut on each end. Tighten them up with a socket wrench so they are good and tight, but don't overdo it by compressing the wood. It will compress anyway, when the wood expands, but if you do it right the boards will stay about the same width after the wood shrinks again. Any small gap will remain airtight because of the spline. Put a second nut on to lock the assembly, then glue in the plug. Square one end of the door and cut it to length. With the rods in, the width of the door will always be the same even though each board can move a little bit. Be sure not to put the rods where the lock and hinges are going to be.

Figure 4. Breadboard ends allow wood to move both ways—remember to allow for expansion as well as contraction.

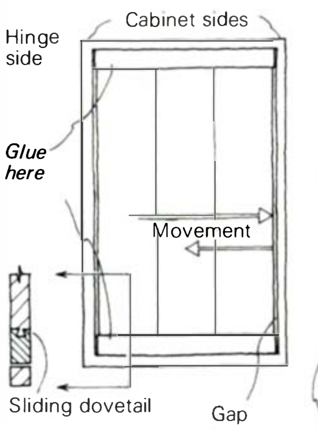
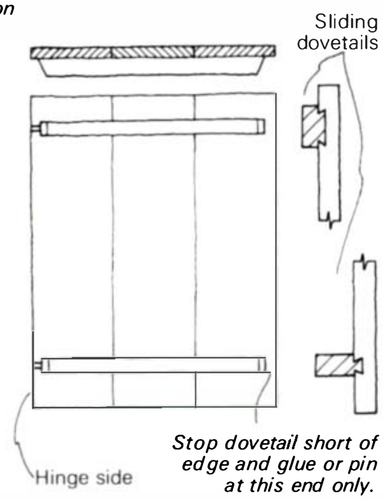


Figure 5. Cleat with sliding dovetail will hold a cabinet door flat.



Attaching two pieces of wood to the top and bottom of a cabinet door (figure 4) is another way to keep a door straight. The end pieces should be fastened with sliding dovetails and should be secured toward the hinge side. This way, all the expansion will take place in the opposite direction, but you have to remember to allow for it. If you were to secure the sliding dovetails at the center, like a breadboard, the hinges would be pushed out when the door shrinks while it is enclosed between the two sides of the cabinet. I try to avoid this construction for solid wood doors whenever possible because it looks like half of a frame-and-panel without any of the advantages of a frame-and-panel.

For a cabinet door or the top for a chest where the boards are glued together, cleats could be slot-screwed on the inside. But for a piece of furniture, I would attach the cleat with a sliding dovetail instead. The wood for the cleats should be on edge against the door—for stiffness—but it also could be on its face to be less obtrusive. Stop the female dovetail housing near the handle side, so it doesn't show on the edge when the door is open, and glue the dovetail only toward this end. Thus the wood will be free to move. This is shown in figure 5.

Figure 6. Deep cleats can become the top and bottom of shelves mounted inside the cabinet door, like a refrigerator. Dovetail the vertical sides of the door shelves to the cleats, and add a front rail to keep things from falling out when the door is opened.

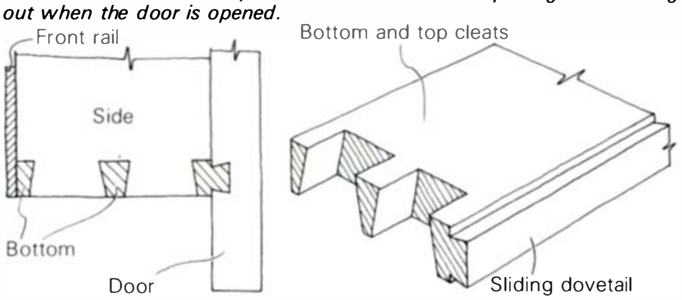
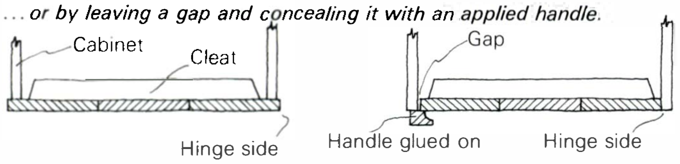


Figure 7. Movement can be concealed by letting the door overhang the cabinet...
...or by leaving a gap and concealing it with an applied handle.



When you use a cleat with a sliding dovetail on a cabinet, the inside of the door can become a shelf, like on a refrigerator door. Make the cleats wide enough for what you want to store, and dovetail their ends to vertical side pieces, as shown. Be sure that you glue a piece of wood in front of the door shelves, or join on a railing, to prevent what is stored there from falling off when the door is opened (figure 6).

Because such a door will always move in width, you have to make allowance for movement when putting the hinges on (figure 7). One way is to mount the door outside the cabinet, with an overhang all around. If the door is set inside the cabinet opening, you must leave space for expansion along the edge opposite the hinges. One way to conceal the gap is to glue a piece of wood onto the front edge of the door, and shape it into a handle.

Today you have to be lucky to find a board that is wide enough to make a door by itself. But if you are so lucky, treat the board just as if it were several boards glued together. Always allow solid wood room to move. □

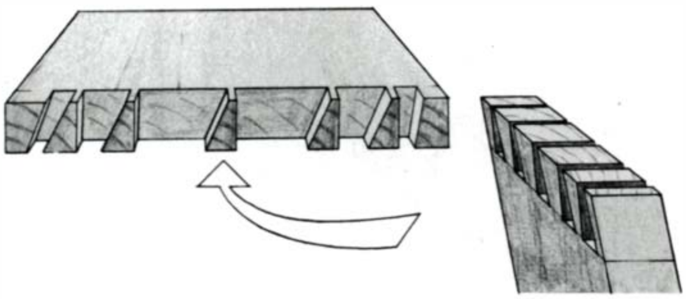
Library Steps
Exacting design and complex joinery

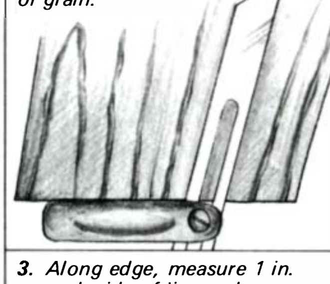
by Simon Watts

Several years ago some people from St. Louis stopped by the shop and asked if I would make them some library steps. I had never been asked to make any before so I had no immediate image of what they should look like. I was familiar with the steps the Shakers made for reaching their high storage drawers. I also remembered the marvelous three-tread spiral that the Pennsylvania woodworker, Wharton Esherick, had made.

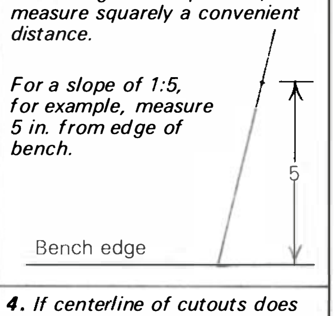
The requirements were straightforward: The steps had to be 27 in. high, which suggested three treads. They also had to be easily moved, sturdy and handsome. After looking at various woods we decided on cherry for its strength and the beauty of its grain. It also seemed an appropriate wood for a library. We considered adding a post as a handhold for people standing on the top tread, but finally left it off because the piece had to travel cross-country in the trunk of a car.

I had an able student at the time, Bruce Beeken, who was itching to try his hand at a complex piece of joinery. He and I worked on the design together, but the steps were made entirely by him. After deciding on the number of treads and the overall arrangement, we drew out various full-size profiles for the side pieces. I usually work out designs full size and always keep a roll of brown paper and a crayon for this purpose. I have never been able to make the mental transfer from a scale drawing to the actual piece.



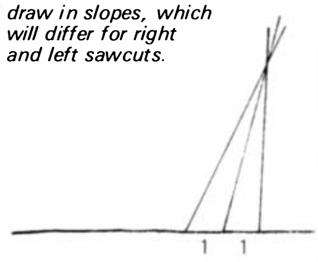


1. To determine slopes for pins and tails, first align bevel gauge with direction of grain.



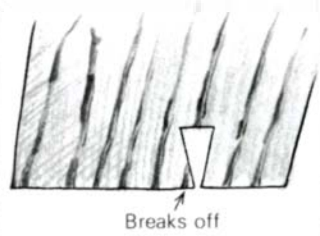
2. Transfer angle of grain line to bench edge or scrap wood, and measure squarely a convenient distance.

For a slope of 1:5, for example, measure 5 in. from edge of bench.



3. Along edge, measure 1 in. to each side of line and draw in slopes, which will differ for right and left sawcuts.

Measurements given in inches



4. If centerline of cutouts does not follow grain, consequent short grain risks weakness and breakage.

Things look different when enlarged or reduced, and I have often had to explain to my customers that you cannot take an existing design, change the scale and expect the proportions to look the same. The few times I have done this the result has been an awkward compromise. The reason is that we see everything in relation to our own size. We also see furniture in relation to rooms, door heights, knives and forks, books, etc. Walking into a room and finding a chair twice as large as normal would make most of us uneasy, while the same chair of average size might pass unnoticed.

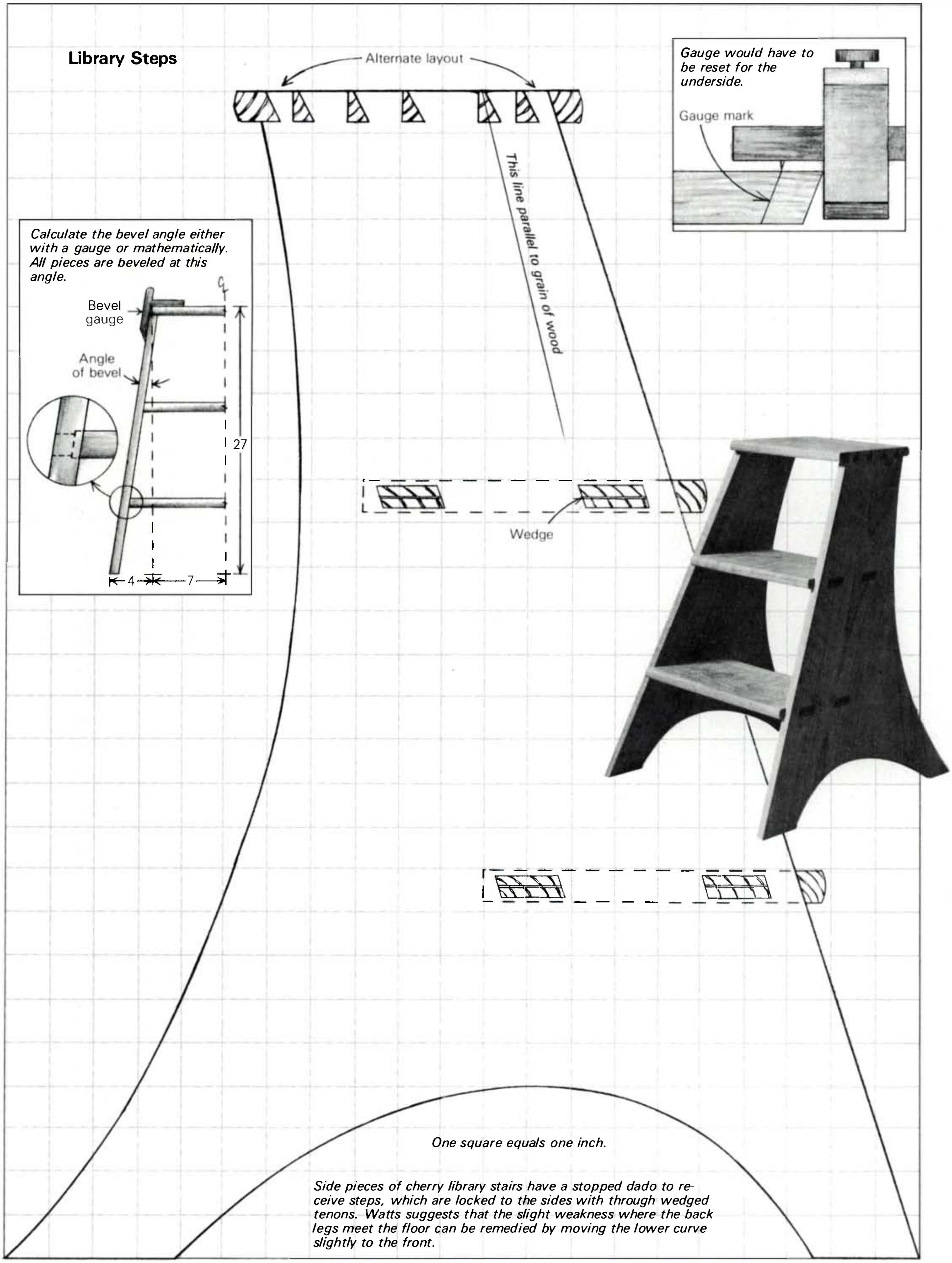
After the piece of furniture is finished I make a drawing to scale so that it can be made again, incorporating small changes that the experience of making has shown to be necessary. If a second piece is made from the drawing, further refinements are made. Eventually there are no more significant changes to make. It is important to recognize this point and not tamper with the design further, or the force of the original idea will be diminished.

Patterns on paper don't keep very long around a busy shop and if they are worth keeping it is a good idea to transfer them to Masonite or cardboard. I like to write on the pattern the name of the customer, the date and the number of the drawing, if there is one. Then all the relevant information can readily be found in one place.

When Beeken and I had a shape that we both liked and that satisfied the requirements, we cut the two sides out of cardboard and set them up in the shop where we could look at them. We then adjusted the slope and the distance between them until they looked right. This matter of "looking right" is difficult to explain and is best understood by the analogy of focusing a camera. You try an extreme position that is obviously wrong and then an extreme in the other direction. You gradually narrow the range of possible positions until you find one that looks right, or, in the case of a camera, focuses the subject. With furniture it is much better to do this with two people, one to do the moving and the other to watch what happens. It finally becomes a matter of quite delicate adjustment, but there *is* a point and it *can* be found. Here there were only two variables—slope and horizontal distance. In some instances, finding the proper spacing for the supports of a trestle table, for example, there is only one variable. In other cases there may be many more.

The whole business of when things look right and when

Cabinetmaker Simon Watts, of Putney, Vt., is a contributing editor of this magazine.



One square equals one inch.

Side pieces of cherry library stairs have a stopped dado to receive steps, which are locked to the sides with through wedged tenons. Watts suggests that the slight weakness where the back legs meet the floor can be remedied by moving the lower curve slightly to the front.

Photo: Bruce Beeken

they do not is something that a student has to learn for himself. It means developing the ability to observe things intelligently and for this reason cannot be taught.

As can be seen from the photo and drawings, the dovetails do not meet at a right angle. They are also skewed. Marking out and cutting skewed dovetails is similar to cutting regular through dovetails (*Fine Woodworking*, Spring '76). I usually start by cutting the ends of the boards to the correct angle and bevel—in this case, only the two side pieces are cut at an angle and the ends are beveled. The top tread is left square but its ends are beveled to the same angle as the side pieces. The bevel angle is the angle at which the pieces meet when the step is seen from the front, and can be obtained from a full-scale drawing. A gauge mark the thickness of the board or slightly more is then made on one side and two edges of the beveled end of each board. The remaining side is cut in with a knife or by resetting the gauge.

Dovetails can be laid out in different ways to achieve the same results. Ideally, the pins should be more closely spaced near the corners and the spacing increased toward the center of the joint. Anyone wishing to complicate this piece further could try angling the treads in toward the back.

Skewed dovetails are just like straight dovetails in that the centerline of the pins and tails is parallel to the long fibers of the wood. If this is not done you get short grain and consequent weakness. Because the end of the piece carrying the tails is not cut square, the centerline also must slope. The result is that the right and left cuts that form each socket are not at the same angle, and two different settings of the bevel gauge are necessary.

The next step is marking out the tails on the face side of one of the boards. In this case the tails are cut in the vertical boards and the pins in the horizontal piece. They could equally well have been cut the other way around, with the advantage that the piece could have been glued up in two stages. I didn't do this because the angles might have made it impossible to assemble. I was particularly aware of this possibility because not long before I had made a small cabinet where the joints interlocked in such a way that the piece could not be put together. When sawing the tails, complete the cut at the bevel angle and take care not to overshoot. Then scribe the pins from the tails in the usual way.

Once you have conquered skewed dovetails, the dadoes and housed mortises that join the treads to the side pieces should be no problem. The walls of the housing are cut at the same angle as the dovetails, and its floor is parallel to the face of the wood—it is therefore best to hand-cut it. When the housings and mortises are cut, the shoulder-to-shoulder tread length can be measured and the tenons sawn to fit.

On looking at the photo of the library steps five years later, I see a slight weakness where the back legs meet the floor. This is especially noticeable because one sees them in contrast to the front legs, which could support an elephant and do, in fact, carry most of the weight. I would correct this by moving the lower curve slightly to the front and choosing a board with enough natural sweep to reduce the danger of short grain breakage. I would also add a handhold and perhaps use slightly thinner stock.

I still find the piece pleasing to the eye. I like the contrast between the rear curve and the straight front edge, and the way all the structural elements are locked together. Its sturdiness is obvious even to people who are not woodworkers. □

EDITOR'S NOTEBOOK

Of accidents and doors

The three-fingered or short-fingered handshake is all too common when woodworkers get together. When I meet such a craftsman I ask what happened, and usually I am told about an accident, years ago, that could have been avoided. Constant vigilance around machinery and scrupulous attention to safety are still the best ways to prevent mishaps. But nowadays, surgeons working with microscopes may be able to repair damaged fingers that a few years ago would have had to be amputated. You have to know what to do right away, and you have to know where to find a surgeon with the necessary skills and equipment. Woodworkers should keep this information by the telephone—just in case.

Reader Rod Goettelmann of Vincentown, N.J., had this bad experience. He writes, "On Dec. 22, after nearly 20 years in the trade and an excellent safety record, the unspeakable happened to my left hand when it was pulled back through a dado blade. I now know there was a BB-sized particle under the work, which allowed the work to flatten as the particle reached the edge of the table, resulting in a violent kickback when the work wedged on the dado blade."

Goettelmann happened to know that a skilled team of microsurgeons was working in Philadelphia, 50 miles away, and he went directly there. "I expected to lose the middle finger and maybe the end of the ring finger," he says. "But they reconnected the nerves and tendons and in a few more

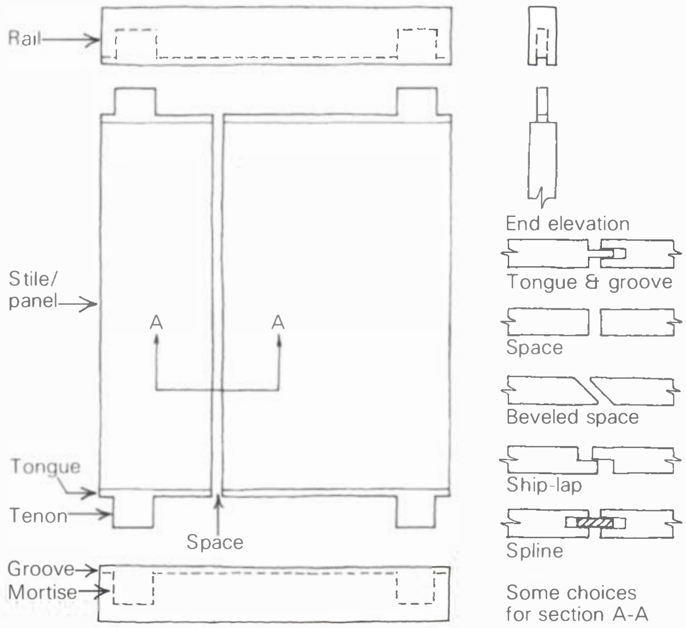
Photo: Rosanne Somerson

Sterling Johnson King of Leucadia, Calif., has found this showcase a superb way to sell his one-of-a-kind furniture. The aluminum and glass case sits on the mall at a fancy shopping center near San Diego. It puts King's current work directly in front of potential clients, yet requires only minimum attention from him—he changes the display once a month. When he came up with the idea, King had little difficulty persuading the shopping-center management to lease him the space, but he's met some opposition from the other merchants, who have to tend their stores every day. King pays according to the square footage occupied by the base of the case, at the same rate other merchants pay for their stores. It comes to less than $40 a month. Says he, "Next I plan to install a request button that will trigger a tape and slides."

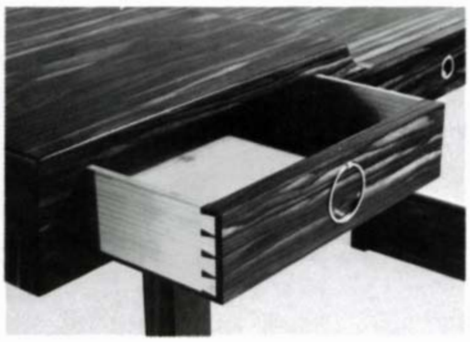
weeks I expect 98% function and feeling. All readers should be aware of these now available medical skills. . . ."

Following Goettelmann's lead, I wrote to Dr. Mark Nissenbaum of the Hand Rehabilitation Center in Philadelphia for advice. He replied: "There is no doubt that prevention remains not only the best, but the only 'cure.' Once a hand or finger is injured no surgery, no matter how skillful, can restore the original capacities. In addition, microsurgical replantation of severed portions of a hand, although possible even far out on the fingers, does not always produce the best result. In other words, not all amputated parts should be put back. Certainly, with multiple finger amputations, amputation of the thumb, or loss of the entire hand, an attempt should be made to replant the amputated portion.

"As far as first aid at the time of the injury, minimizing bleeding is the most important. Elevation and direct pressure should be sufficient to stop bleeding from most wounds. Tourniquets are rarely necessary, and if left in place too long, do more damage than good. If a portion of the hand is completely amputated, it should be retrieved and placed in a clean towel. If immediately available, regular ice (not dry ice) should be placed around the part. The best course then would be to proceed to the nearest appropriately equipped hospital emergency room. If a hand surgery center is immediately available, go directly there." Nissenbaum adds that you should have the address and telephone number of the nearest emergency room pasted to the wall beside the telephone. You should also check with a local orthopedic surgeon or plastic surgeon to find the names and numbers of any hand specialists working in your area, and paste that to the wall too. Should you draw a blank, you can get a list of members from the American Society for Surgery of the Hand (3 Parker Place, Suite 233, 2600 South Parker Rd., Aurora, Colo. 80232). However, there are many qualified hand surgeons who do not belong to this society.



Tage Frid's remark (page 79) about a door that is neither solid wood nor frame-and-panel reminded me of a successful hybrid door for a cabinet that I saw last year at George Nakashima's shop. It is two rails mortised and grooved to accept stiles and a panel in the usual way. But the stiles themselves are also the panel, extending to almost meet at some agreeable place in the middle of the door. The tenons are glued but the tongue is not. The wood is free to move into the central space while the overall width remains constant. The space can be left as space, concealed by ship-lap or tongue-and-groove construction, or filled with a loose spline. A figured board can be crosscut to make the stile/panels for a single door, or it can be resawn and bookmatched for the inner stiles of two doors that meet in the middle. □



Furnituremaker Alan Peters won Britain's Windsor and Newton Craft Award for this handsome desk, in a juried show of work by 150 artisans in all media. The desk, inspired by a trip to Japan, is made of Macassar ebony veneer on a solid ground of Spanish mahogany, with solid ebony edging and legs. The drawer sides and bottoms are cedar of Lebanon, and the handles (which Peters also made) are aluminum. Peters, 46, apprenticed and worked for seven years with Edward Barnsley (Fine Woodworking, *May '79), then studied design for five years before opening his own shop in 1962 at Cullompton Devon, about 160 miles west of London. The craft award was presented in association with the Guild of Master Craftsmen, of which Peters has been made an honorary member. The guild is a voluntary association of professional craftsmen who have banded together to promote high standards of workmanship as well as good business practices. It publishes a quarterly journal and an annual directory of members. It has no counterpart in America, but American craftsmen may become associate members. For information, write the Guild at 10 Dover St., London W1X 3PH, England.*

Cabinetmaker Robert Whitley (right) shows his replica of the Oval Office desk to Patricia Lawford Kennedy and two of her assistants, at his shop in Solebury, Pa. Whitley made the desk (without finish in this photo) for the John F. Kennedy Memorial Library being built in Boston. The original, now being used by President Carter, was made at Queen Victoria's order with English oak timbers from the HMS Resolute, salvaged by an American whaling ship after it was lost in the ice in 1845 during an attempt to find the fabled North-West Passage. Cabinetmakers Ervin Hart and Edward Vogel, with apprentice Renate Kells, helped Whitley make the desk. Carvers Albert Cooper, Edward Ciurczak and Frank Hastings worked with him on the ornamentation.

Norwegian Woods

Wood sculptor Floyd Lien of Aptos, Calif., doesn't usually make scale models. His more typical contemporary sculpture may be seen in galleries or at the National Carvers' Museum in Monument, Colo., but if you happened to visit the California Carvers' Guild show in San Jose this April, you may have been lucky enough to see this blue-ribbon exception to the rule. A photo of one of the striking Norwegian stave churches inspired Lien. The resourceful carver wished to see a stave church in person, but rather than hop a flight to Trondheim he spent a few productive months in his shop. With all seven stories, the result of his labors notably resembles the 12th-century church at Borgund. Most time consuming were the 12,000 yellow cedar shingles. These were not laboriously cut one by one, however, but gang sawn from prenotched boards. Siding, trim and fascias are also yellow cedar and doors and hinges are red oak, all untreated. Fascia boards and other details were engraved with a parting tool. The model stands 61 in. high, 32 in. wide and 40 in. long.

—Alan Marks