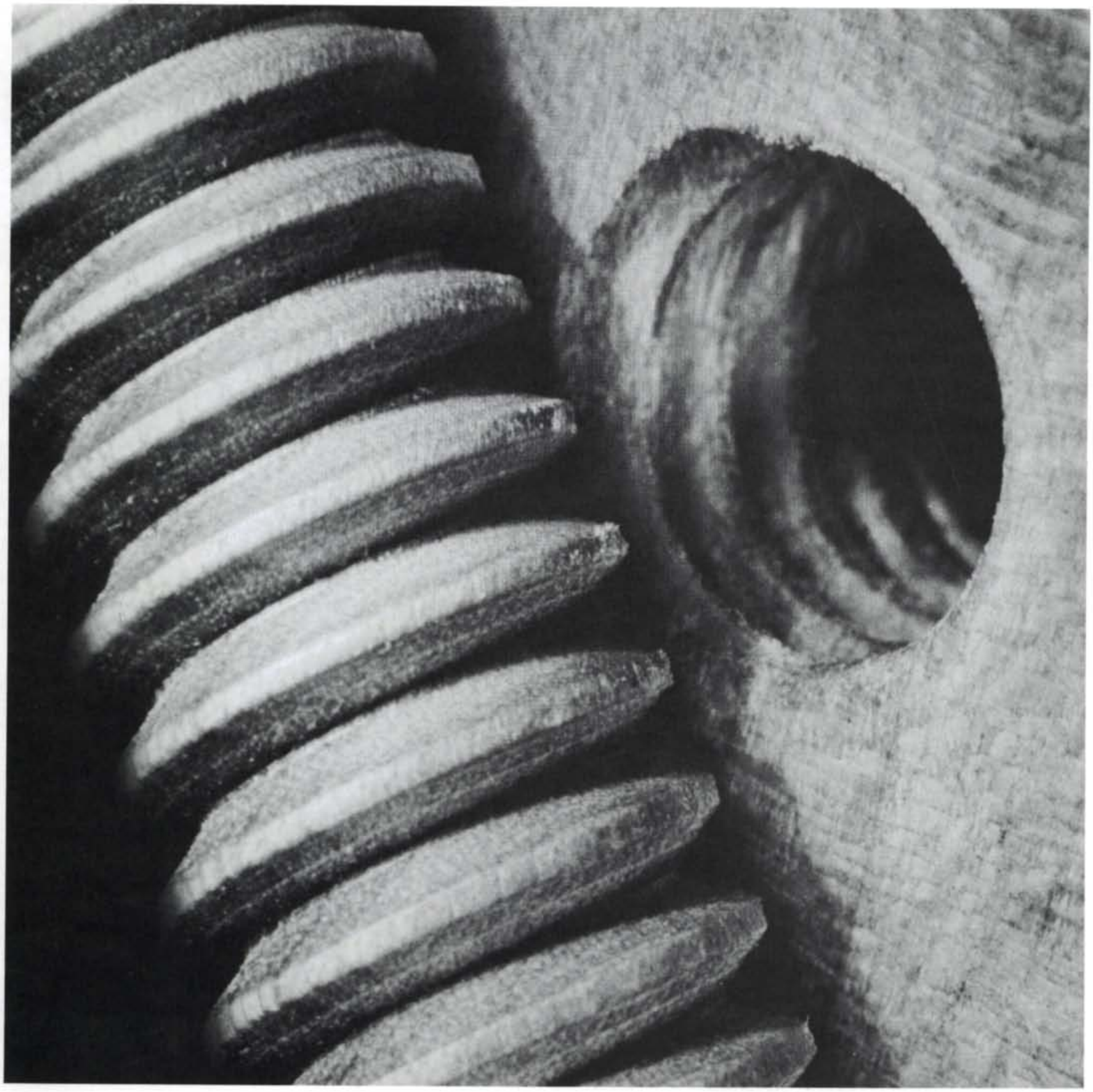
Fine WoodWorking



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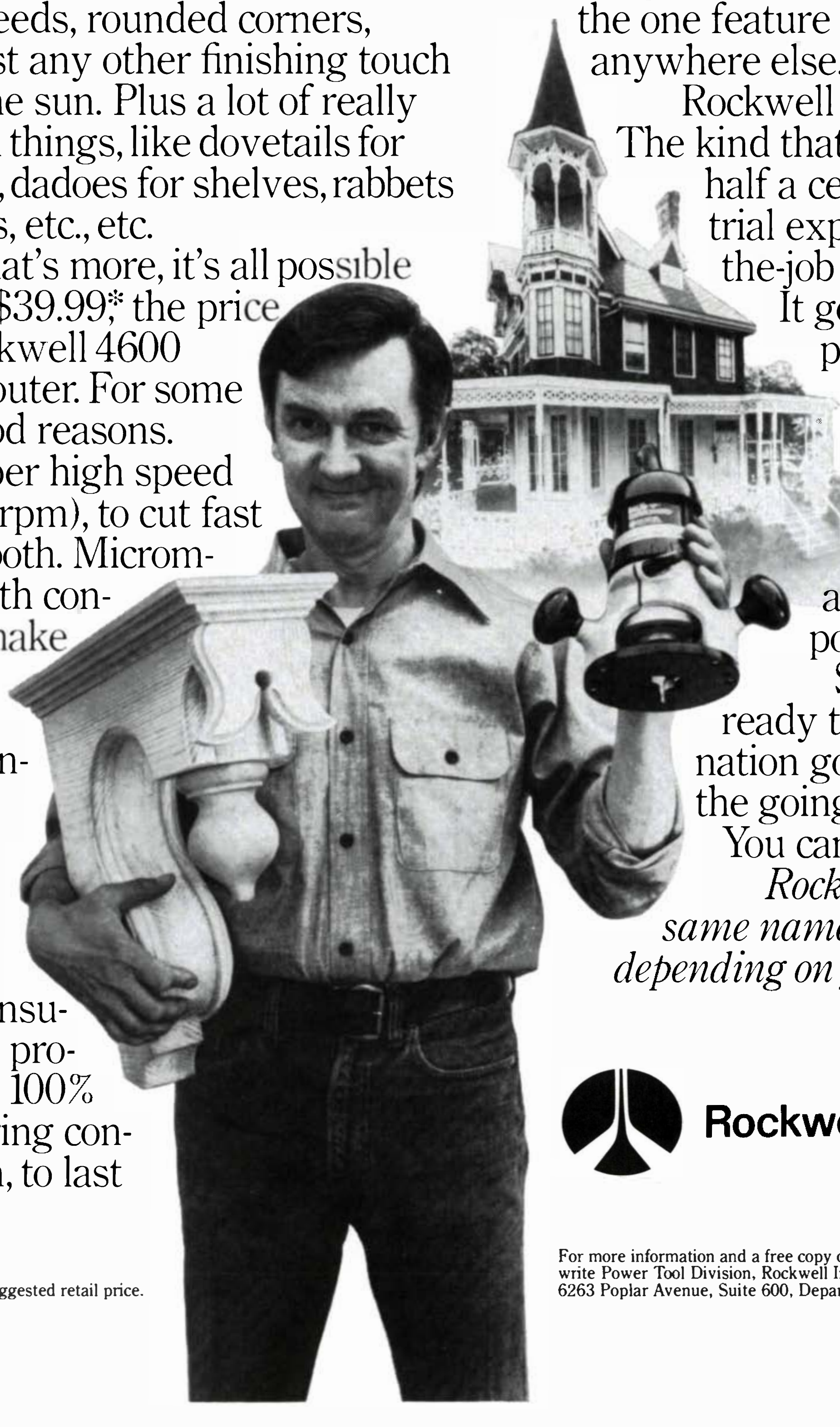

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Fine WoodWorking

Spring 1977, Volume 1, Number 6

CONTENTS

Cover: Three-quarter-inch wooden screw and nut, six threads to the inch, made with tools described on page 22. Nut is made of quartersawn cherry; screw is yellow birch.

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...referring to cutting the female portion of the sliding dovetail (Winter '76), you say: "...the tapered side is sawed at an angle, using the saw shoulder as the guide." Please describe how the shoulder may be used as a guide when it is not in contact with the work until the cut has been made to its full depth. It seems that a standard backsaw or dovetail saw used with a guide block cut to the desired angle and clamped to the work would serve much better.

Actually, the router plane appears to be the essential tool to hand-cutting the female portion of this joint.

—*Stephen B. Ringle, Somerville, Mass.*

[Editor's note: Tage Frid replies that because the handle of the saw is beveled at the correct angle where it meets the blade, you merely eyeball it. When the saw shoulder looks parallel to the work, the cut will be correct.]

Regarding the article by Bob Stocksdale (Fall '76), I am in no position to quarrel with a professional wood turner whose work is as fine as those pictured...What I don't understand is his sanding sequence. Starting with 16 grit seems incredible to me—I myself start with 50 grit and feel that much of the time this is too coarse...Ideally it seems to me no sanding other than a very fine grit should be required.

—*Alex R. Ross, Stillwater, Okla.*

Regarding Clarence Hill's question about an old drawer joint (Winter '76): During my days as a master pipe organ builder, we called this a pinned cove joint. As to its origins, it could have been either German, French or English. A larger version than that normally seen on drawers was used on wind chests and on reservoirs, as the joint is very strong and less likely to leak air under varying degrees of stress.

However the method of producing the joint is rather involved and cumbersome. Several special tools and fixtures must be made. Also needed would be a vertical boring machine or drill press. In the old days a breast drill and a reliable apprentice were used. The cove and pin were cut first, with a hollow mill shaped somewhat like a Forstner bit, whose center retracted into its shaft against a spring. The cutter formed the cove and pin in one operation.

The spacing is very critical and was achieved with a ratchet bar, precisely notched to 1/128 in. Ratchet bars were made to match each size mill. Next the pinholes were drilled (using brad point drills) in the end plates or drawer sides, and these matched the pins previously formed by the mill, because the same ratchet bar was used. The scriber is set down over a pin and set to the radius of the cove. Remove its bushing and replace it with the correct size scriber pin, and scribe an arc directly above each pin. The scriber must be set so that the scallops are *just* an interference fit when the joint is assembled. A fine saw cut is made down to the interstice of each arc. Next, a sharp half-round firmer gouge of a radius to match the cove is fitted with a pilot device equipped with a pin to match the pinhole.

The end plate is clamped down over a piece of hardwood (maple) that has a dado cut down its length, that falls directly below the pinholes to accept the guide pin. The guide pin is slipped into the pinhole, and the chisel is adjusted to fit between the sawn lines. Strike the chisel in the normal manner, two or three blows with the mallet. Do not cut the scallops in one "fell swoop." Make it in two cuts, just short of the scribed arc. Re-hone chisel and finish to scribed line.

After all the scallops have been made, the back of the plate must be rabbeted to fit the front. This will clean up that ragged back side of the scallops.

—Francis E. Olderr, St. Petersburg, Fla.

Gordon Harrison's article on heat treating (Fall'76) did not define the two common types of carbon tool steel. The two types we should be concerned with are the water-hardening steels and oil-hardening steels. It is quite easy to distinguish between them by a spark test on a grinding wheel. Water-hardening steel will give off a shower of "Fourth of July" type of white sparkly sparks while oil-hardening steels give off a lesser amount of streamers, red in color and fewer dead-looking sparks at the ends of the streamers.

If you attempt to harden oil-hardening steel in brine or water you are quite likely to damage the structure of the steel and in many cases there will be shock cracks large enough to destroy the tool. If, on the other hand, you quench many of the water-hardening types in oil, you may get no hardness at all or at best only a hardened skin on the thin sections of the tool. Usually files, springs, etc. are varieties of water-hardening steel and in general do not make a very good cutting tool because these steels are alloyed with small amounts of other materials to enhance their ability to do the best job for which they were intended. Oil-hardening or type 0-1 steel will give you that silky, velvet-smooth cutting edge desired by all craftsmen. This steel is readily available from any industrial supply house. This is probably the easiest steel with which to work, thereby making it a cinch for the amateur... Concerning the quenching oil, you should have a minimum of one gallon in a pan shaped like a bread baking pan. This allows ample oil to absorb the heat of several hardening attempts. Also, never use cold oil. It should be preheated to a warm temperature with a heated scrap of metal.

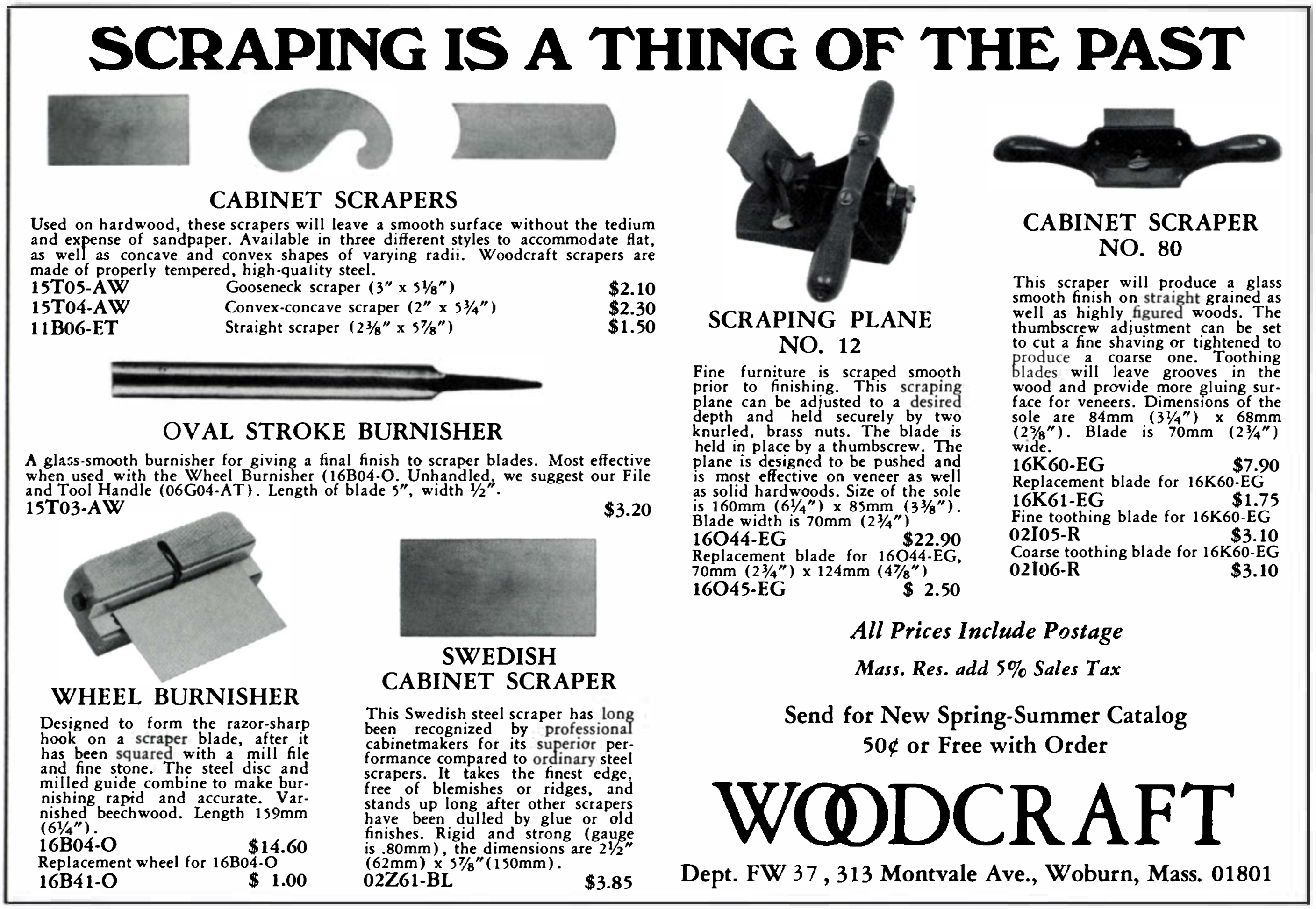
—R. Perry Mercurio, Kingfield, Maine

Sure hope the man in the photos in "Heat Treating" (Fall '76) isn't a teacher. His safety habits leave much to be desired: no gloves to protect from the heat, loose sleeves and shirttails, no safety glasses for pops and spatters.

—David Rose, Tokyo, Japan

Your article on heat treating (Fall '76) was a very informative item for the woodworker as it helps to remove some of the mystery from the steels that we all use.

When you soften steels you definitely anneal them, but there are a variety of procedures to utilize, to gain given properties. In the metalworking industries annealing means that after you have heated the steel past its critical temperature, you then slow-cool it in still air—in the furnace. This gives you soft steel with a fairly coarse grain structure. If you were to take this same piece of plain carbon or low-alloy steel and place it on a bed of ashes or sand in still air in the shop you would have a steel that was soft but with finer grain structure. In other words the more time that the steel spends in the



grain-forming temperature region, the coarser the grain.

If you take this piece of steel and pound it out cold to make a chisel, it will elongate just so much and then crack. So if you cold-work it, re-anneal it before it cracks.

Plain carbon steels aren't generally considered to have a great deal of toughness—when they're soft they're soft; when they're hard, they're fairly brittle.

A person who wants to heat-treat steel can make a piece of mild steel hardenable. You can buy at your local welding supply a can of case-hardening powder which will soak carbon into the steel.

—James Despard, Rochester, N.Y.

I want to present a suggestion to all wood users. We all consume wood, and that's fine. The wood is being put to good use. I think, though, that we ought to do some thinking about the renewing of our valuable resource. . . I propose that every person, household or business using wood for heat, every craftsperson or woodworker using wood in production, and every manufacturer or builder of wood items or structures take action to renew the resource by planting seedlings for future trees. . .

—Richard Esteb, Lacey, Wash.

As a woodcarver I have been less than enthused by the articles you have printed dealing with my profession. A case in point would be "Tackling Carving" by Robert Butler (Fall '76). The author's assertion that a carver, even the beginner, could get by with a few tools and a rasp is patently ridiculous. I myself have close to 200 tools in my set. This number will have to at least double before I can even begin to consider it close to complete. Even as a beginner with about 15 tools I found myself limited on very simple pieces. . .

The rasp, while a valuable aid, cannot be expected to take the place of a good tool assortment. The professional carver uses the rasp sparingly, and only in addition to, never instead of, carving tools. To encourage a novice to use a rasp in place of learning proper tool control is foolish.

—Donald R. Murphy, Wellesley Hills, Mass.

Invest in a sturdy strap clamp for pulling up spline miter joints (Winter '76). For drawing up one miter (which is rarely necessary) glue a piece of supermarket bag between the panel and the waste block. Part with a chisel, which splits the paper and leaves the wood fibers intact.

—A. W. Marlow, York, Pa.

To Mr. Conner, (Winter '76), who by and large agrees with me: I do not object to the use of lamination on the ground that it might delaminate. There are cases where lamination is indeed the best way to make something, if esthetics do not count. A laminated rifle stock, for example, is less satisfying esthetically than one carved from a perfect piece of walnut, with grain chosen to follow the lines of the stock. But it has been my experience, and the experience of others, that a rifle with a laminated stock shoots better most of the time.

Yes, you can hide the laminations with an opaque finish, but then why use wood? The beauty of wood is in its grain and texture; if you are going to cover this with enamel or lacquer, then you might as well make the object of plastic.

To Mr. Romary (Winter '76): No, I do not miss the point of the whole thing. I simply object to making pieces out of the wrong materials (as in the case of the library steps) or to waste fine workmanship on bad designs, as in the case of the clock, wine cellar and desk pointed out in my letter. I do not "condemn" glue in its place, which is to fasten pieces of joinery.

—John S. Carroll, Emlenton, Pa.

"Making Shaper Knives" (Winter '76) was particularly interesting to me as I also make knives for my Rockwell shaper.

I use oil-hardening tool steel or die steel that is not beveled. Die steel is about one tenth the cost of regular shaper steel, soft and easy to work and also simple to harden.

I don't know how Tommy Bargeron manages at 4000 rpm; I run my machine at 10,000. The old-timers ran their shapers at 15,000 to 20,000. They say the faster the better.

Wood shaping can be done on a circular saw. I know a man who has done all the mill work for many house restorations here in Ontario and he's never used a vertical spindle shaper.

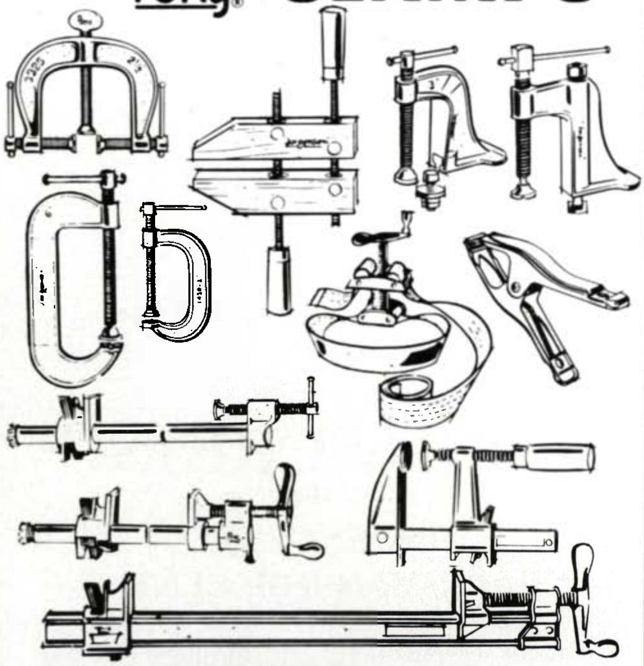
—D. B. Chambers, Barrie, Ontario

William Cumpiano's "Guitar Joinery" (Winter '76) omitted an increasingly popular method of making the neck/body joint which has implications for many areas of woodworking.

That method is butt-joining the neck directly to the outside of the guitar body using an epoxy glue. It is an unconventional but apparently successful method that is currently used by several professional guitar makers.

—Larry Stevens, Farmington, Mich.

"Jorgensen" and "Pony" CLAMPS



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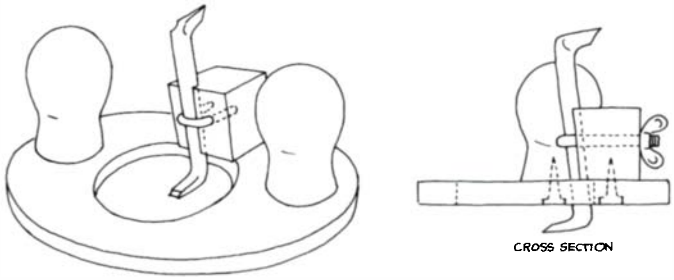
METHODS OF WORK

A router plane

You can build your own routing plane that will work as well as a commercial one for the cost of a cheap offset screwdriver and a U-bolt. The cutting irons are ground from the screwdriver bits, a blade about 1/4 in. wide at one end, and a narrow plow at the other. The blades sit almost flat to the work, like paring chisels. Relief under the heel of the blade is obtained by making the blade holder with a tilted face.



Dimensions and shape can be suited to the builder's fancy and to the materials at hand. The illustrated design is simple enough to be produced in a single evening at the workbench.

—Van Caldwell, Cincinnati, Ohio

Natural stains

All my stains are made from natural materials—nuts, wood and plants. They are very true in color. First you must gather material for the color you desire. The dry husks of black walnut shells give a deep brown tone. Dry beechnut husks make a deep yellow tan, plug tobacco an antique yellow, red swamp cedar chips a reddish-brown. I have used other nuts and woods; I suggest experimenting with whatever is available to you. My mother, part Indian, suggested many natural materials to use for stains, and so was a great help in my search. The Indians used a homemade lye, but I found an easier answer—non-sudsing ammonia.

Place the materials to be leached in a jar, pour in the ammonia until the material is covered, and let sit. Black walnuts absorb the liquid, so it may be necessary to add more ammonia to keep the husks saturated. How long you soak the material affects the deepness of the color. Tobacco leaches out in a week. Black walnut shells still have color after a month and can sometimes be washed and used for a second batch.

After the tone is right, strain the juice off through a nylon stocking into a clean jar. (Don't use cans, because they will rust.) Leave the jar open for several days until most of the ammonia smell has dissipated. It can be used right away, but is strong-smelling! For a lighter tone, dilute with water; for a darker stain, let the liquid evaporate. Because the stain is water-based, the wood will need light rubbing after application. The stain works well under oil or varnish finishes.

Be sure to use non-sudsing ammonia. Sudsing ammonia will carry the color to the top with the suds.

—C.H. Dimmick, Sparta, N.J.

Using chalk

When working the darker woods like walnut or rosewood, pencil lines and even scribe marks have a distressing way of fading into the vagaries of color and grain. The woodworker can waste a lot of time relocating his mark, or worse, cutting what he thought was his mark, only to discover it to be a color change inches from the desired point. A piece of chalk can be a great help. The faintest scribe mark, dusted with yellow or white chalk, jumps out dramatically and makes accurate cutting a certainty. One can also use chalk for setting out dimensions on lumber prior to rough-sizing. If you are like me, and indecision is a habit, you can easily brush off the chalk.

—Christopher Murray, Richmond, Va.

Darkening glue lines

Glue lines of polyvinyl and aliphatic resin glues (white and yellow) can be darkened with tincture of iodine. This turns the glue a dark purple, perfect for walnut and dark mahogany. It should be applied after wet-sanding as it does not penetrate deeply, but it does go through oil nicely. I have also had good results using it under lacquer.

—Richard S. Newman, Rochester, N.Y.

Raising dents

To eliminate or reduce dents in wood use a soldering iron, a natural-fiber, smooth-finish cloth folded to a point, water, and discretion.

Wet the dent, allowing the crushed fibers to soak up the water. Squeeze excess water out of the cloth. Bring the iron up to the boiling point, but not to full heat. Test the wet cloth until it steams. Press the wet cloth into the dent with

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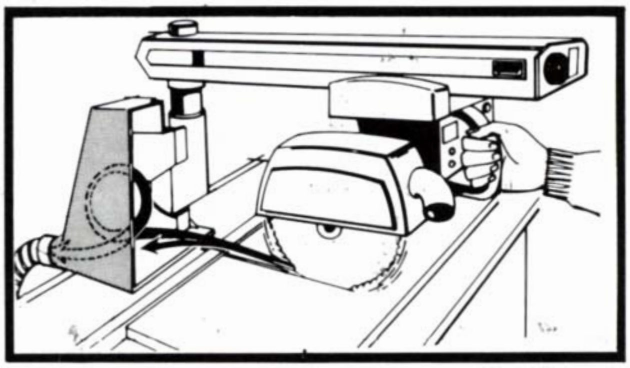

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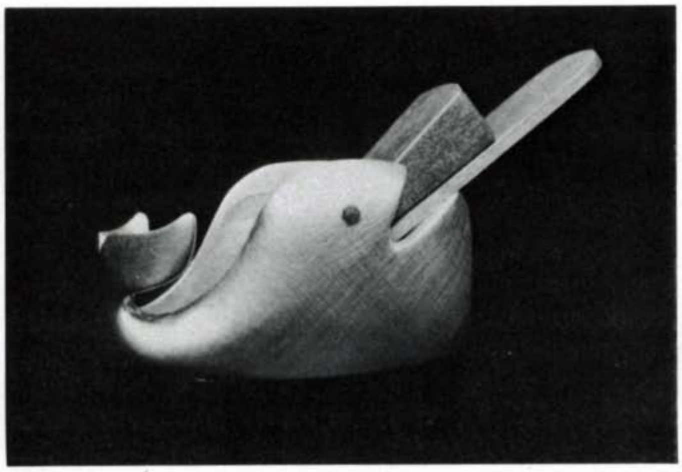

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the hot iron for as long as steam is still produced. Repeat, if necessary, until no further rising occurs. You cannot burn the wood as long as the cloth is wet, so press the iron for brief intervals and be sure the cloth is continually wet. This should be done only on raw wood; if there is finish on the piece, remove the finish first.

Raise the dent before final planing or scraping. Otherwise, the dent may rise above the planed surface. Make one or two passes with a plane at its finest setting after raising the dent. An older method is to use a household iron. This is cumbersome and also raises the grain in the undamaged wood around the dent.

This technique works as long as the dented fibers have been crushed and not torn.

—Henry T. Kramer, Rye, N.Y.

Cleaning saw blades

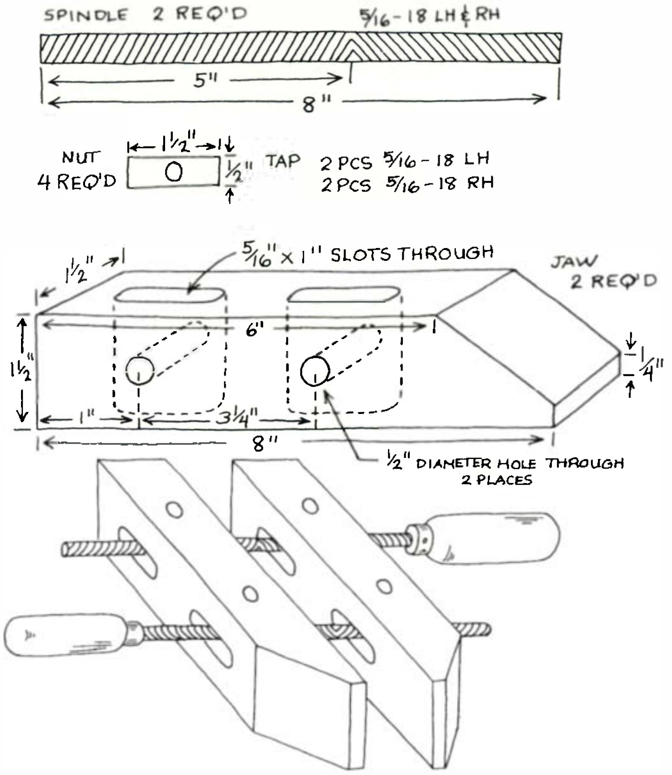
Oven cleaner works very well for removing pitch from bits and saw blades without harming the steel. A clean cutting surface stays sharp longer, gives better results, taxes the motor less and makes for safer use of the tool.

—Chuck Oliver, Fremont, N.H., and
George Eckhart, Kenosha, Wis.

Making clamps

For many people who aren't professional cabinetmakers, wooden clamps are in the luxury-tool class. Good commercially-made handscrews cost at least $10 in the 8-in. size. Materials to make one cost less than $2.

Make the jaws from maple or another dense hardwood. The 1/2-in. holes must be carefully drilled square to the jaw surface and the same distance apart. The spindles are 5/16-in. steel bar. Thread one end 5/16-18 right-handed, and the opposite end 5/16-18 left-handed. Make the 5-in. long

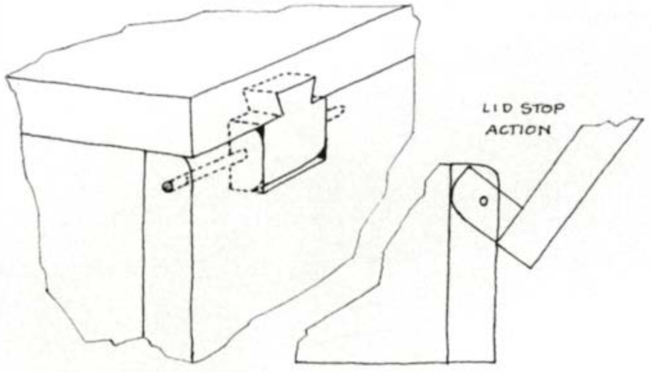


thread right-handed on one spindle, and left-handed on the other. The 3-in. thread is also reversed. Make the nuts from 1/2-in. round bar. Be sure the tapped holes are square to the axis of the bar. Small file handles will work well if you don't have a lathe. Drill through the ferrule and spindle and insert a small pin after assembly.

—Richard E. Price, Seattle, Wash.

Wooden box hinge

This box hinge is easy to make and provides a built-in lid stop. First fit the hinge pieces to the lid. A short sliding dovetail is probably the best joint. Set the lid on the box and scribe the outline of the hinge pieces on the back. Cut the slots in the back. After measuring pin location drill pinholes in from the side of the box with the lid in place. Redrill the



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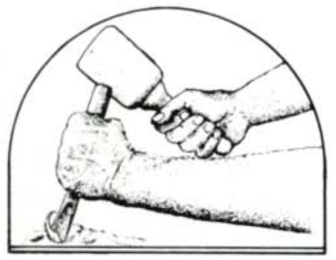

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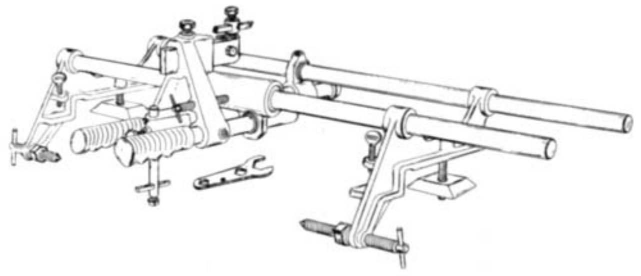

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Winter 1975: The Renwick Multiples, Checkered Bowls, Tramp Art, Hand Planes, Carving Design Decisions, Woodworking Thoughts, Marquetry Cutting, Which Three?, Library Ladders, A Serving Tray, Stamp Box, All in One, French Polishing, Birch Plywood, Bench Stones.

Spring 1976: Marquetry Today, Split Turnings, Eagle Carvings, Hand Dovetails, Mechanical Desks, Textbook Mistakes, Antique Tools, Spiral Steps, Gustav Stickley, Oil/Varnish Mix, Shaker Lap Desk, Back to School.

Summer 1976: Wood, Mortise and Tenon, The Christian Tradition, Hand Shaping, Yankee Diversity, Plane Speaking, Desert Cabinetry, Hidden Drawers, Green Bowls, Queen Anne, Gate-Leg Table, Turning Conference, Stroke Sander, Furniture Plans.

Fall 1976: Cabinetmaker's Notebook, Water and Wood, Hidden Beds, Exotic Woods, Veneer, Tackling Carving, Market Talk, Abstract Sculptures from Found Wood, Workbench, Ornamental Turning, Heat Treating, Mosaic Rosettes, Shaped Tambours, Buckeye Carvings, Hardwood Sources.

Winter 1976: Life Begins at..., Stacking, Design Considerations, Keystone Carvers, Carcase Construction, Dealing With Plywood, Patch-Pad Cutting, Drying Wood, Gothic Tracery, Measured Drawings, Wood Invitational, Guitar Joinery, The Bowl Gouge, English Treen, Shaper Knives.

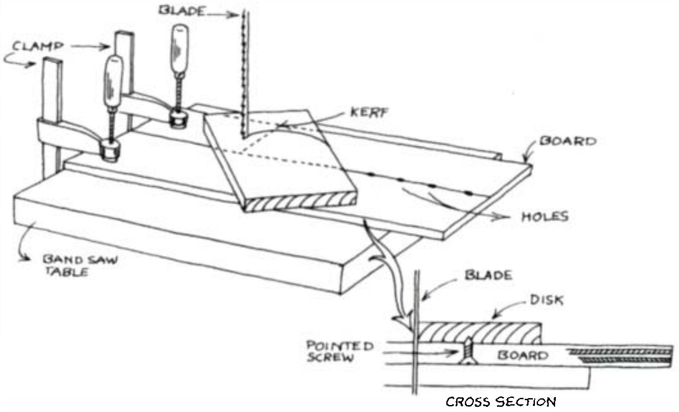
Fine Woodworking, Box 355, Newtown, CT 06470.

holes through the hinge pieces for easier operation. Install the pins. An ordinary nail works well. The hinge and the back edge of the box should be slightly rounded off.

—Jim Richey, Houston, Tex.

Cutting circles

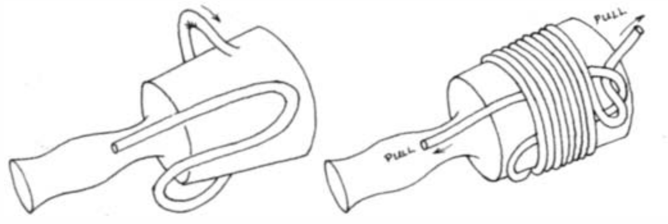
A good method for cutting perfect circles on a band saw: Take a strip of plywood or chipboard about a foot wide and several feet long. Divide it lengthwise with a line. Lay it on the band-saw table and cut a slot from one edge to the center line. Along the line from the slot, mark off the radii of the circles you wish to cut and drill pilot holes. Countersink these holes on the back of the board and insert a wood screw in any hole. Mark the screw, remove it and grind it so only a point protrudes. Now you can put the screw in the appropriate hole, clamp the board to the band-saw table, and pivot the blank you wish to cut on the protruding point. You can finish the edge of the circle with a similar setup on a disc or belt sander.



—Larry Green, Bethel, Conn.

Repairing mallets

Wooden carving mallets tend to check unless well cared for. I solve this annoying problem by whipping a line around the face of a badly checked mallet. I use heavyweight string and apply two coats of well-thinned white glue afterward. The glue soaks into the string and prevents it from fraying and unraveling.



—Riff Masteroff, Arlington, Va.

Restoring old tools

To restore old tools the process I generally follow is: Use Murphy oil soap with very little water to wash off excess dirt and grit, and let it dry thoroughly; sand with 6/0 wet-dry sandpaper or 4/0 steel wool; treat the wood with two coats of Minwax antique oil, which does a better job than linseed oil;

METHODS (continued)

apply paste wax and buff; soak all metal parts in a rust remover and then buff them on a wire wheel; coat the blades with clear lacquer to keep them from rusting again.

—R. K. Brunner, South Charleston, W. Va.

[Editor's note: While lacquer will protect metal parts, it will clog the stone when sharpening tools that are to be used.]

Polishing turnings

During the past fifteen years I have had considerable experience with lathe turning. I have found that after all the cutting has been completed and the turning is sanded to 220-grit and steel-wooled with 4/0, the wood is polished to a low lustre that still shows any small pits or striations remaining from sanding. Since these areas will not polish, they should again be sanded and steel-wooled. Polishing the turning with its own shavings will result in a satin lustre which can be left as is, or then lacquered, oiled, etc.

—Paul L. McClure, Denver, Colo.

Waxing saw tables

On all machine platens, such as saw tables and jointers, bottoms of planes and such: Use a good car wax such as Simonize, and you will be surprised how much better they perform. Wood will slide and not stick; rust will not form in wet weather. I use it on all of my chisels and any tool that comes in contact with the wood.

—Ellis Thaxton, Arlington, Tex.

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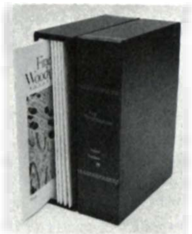

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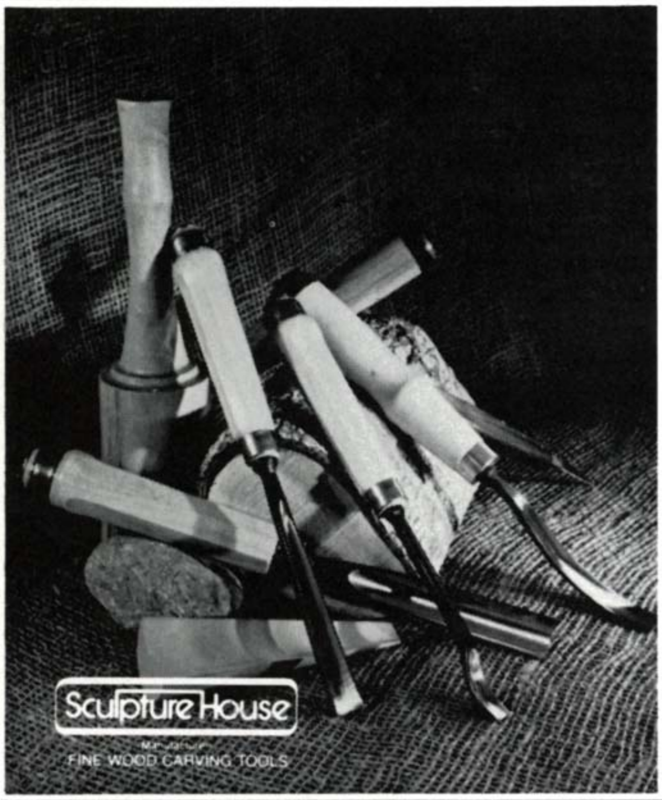

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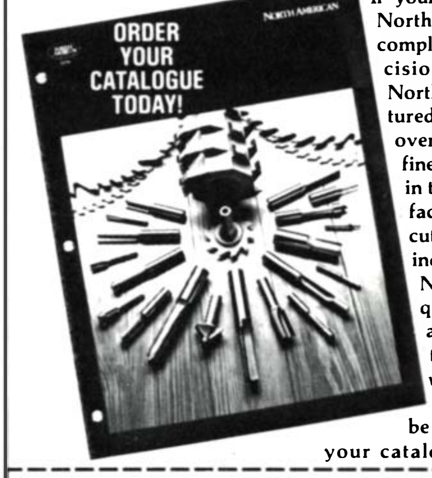

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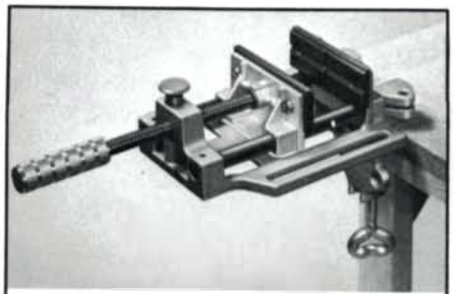

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Q & A

Please send questions or answers to Q/A, Fine Woodworking, Box 355, Newtown, Conn. 06470.

Q: What is the market price for walnut trees?

—G. Vande Kamp, Waupun, Wisc.

A: So much depends on the size and form of the tree, its proximity to the sawmill, the number and location of limbs, whether the tree is growing straight or leaning, etc. Forest-grown trees are less likely to contain hardware or metal fragments than backyard trees, another important consideration. Recently, an Ohio farmer sold a lot of 18 black walnut trees for $80,000. The price was inflated because the lot included a tree the industry coveted as the most perfect specimen in the nation, worth $30,000 by itself. This 100-year-old tree stood 57 ft. to the first limb, 130 ft. to the top, and its diameter was 38-1/2 in. at eye level.

—R. Bruce Hoadley

Q: How do I properly finish and care for salad bowls?

—Dan Lyneby

Q: How important is the weight of a table saw, say, for cutting 4 x 8 sheets of 3/4-in. plywood and heavier work as well? What are the relative merits of the Inca 10-in. deluxe cabinetmaker's saw and the Rockwell 10-in. contractor's saw?

—Peter Wade, Blauvelt, N.Y.

Q: Can you recommend a good book on woodcarving in bas relief, especially for portraits?

—Whiting Evans, Amityville, N.Y.

Q: Do you know of any chemical or solution that will soften old glue for removing old veneer?

—D.D. Dickey, Bloomington, Minn.

Q: Can anyone suggest a way of deep-drilling (2 in. or more) holes of at least 1-in. diameter in hardwoods that will ensure perpendicular holes? Can drill presses be slowed enough to allow the use of expansion bits?

—Richard G. Hawkins, O'Fallon, Ill.

Q: What is the best way to finish holly inlay strips prior to staining so that the strips won't absorb the stain

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and disappear? I tried brushing the strips with lacquer after they were glued in place and sanded. The results were splotchy. Next I tried sanding them in place, removing them, coating one side with lacquer and gluing them in. The results were worse.

—Thomas C. Parsons, Lake Forest, Ill.

Q: I have a maple tabletop that I stripped, sanded, stained and sealed. When I applied polyurethane, the wood repelled the varnish and caused craters in the finish. What can be done to correct this?

—James A. Smith, Birch Run, Mich.

Q: Can anyone tell me about a hone, inherited from my wife's grandfather, called an "Apart Hone," made in Marburg, Germany? It is the color of jeweler's rouge, reddish brown. How does it compare with the various grades of Arkansas stones?

—Thomas Russell, Indianapolis, Ind.

Q: I have a 60-year old walnut extension table with six solid wood leaves. All the pieces are cupped in an upward arc. Can anyone suggest how to straighten out old lumber?

—Warren Lawson, Rochelle, Ill·

Q: Is there an oil finish that resists water marks?

—Angelo Pallaria, New Hartford, N.Y.

Q: What finish do you recommend for the gears of a wooden gear clock?

—Roy Matthew, Marshall, Ill.

Q: I have attempted to buy a book devoted to the practical application of routers. As a novice woodworker I am eager to learn the uses and applications of this tool. Any sources?

—John M. Clement, Cassopolis, Mich.

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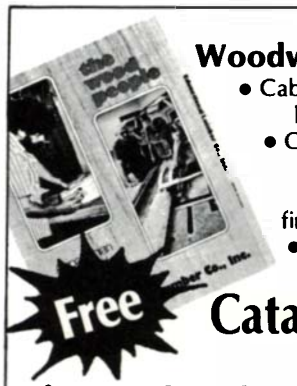

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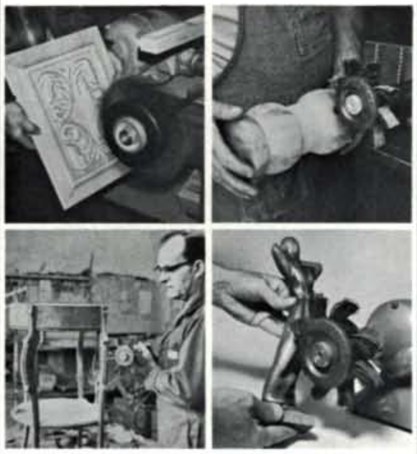

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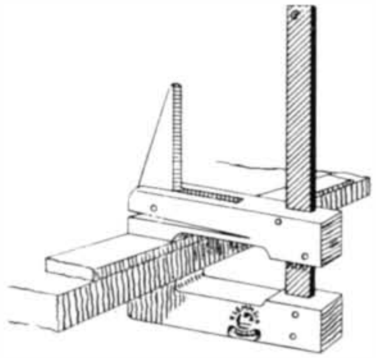

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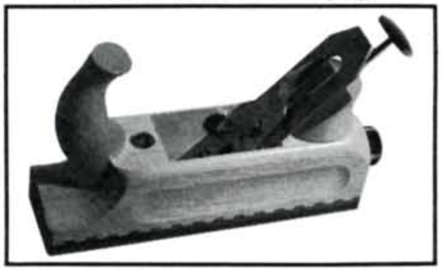

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BOOKS

Know Your Woods by Albert Constantine, Jr. (revised by Harry J. Hobbs). *Charles Scribner's Sons, 597 5th Ave., New York, N.Y. 10017, 1975. $10.00 hardcover, 360 pp.*

Handbook of Hardwoods revised by R. H. Farmer. *Printed in England for Her Majesty's Stationery Office, 49 High Holborn, London WC1V 6HB, 1976. $15.00 hardcover, 243 pp.*

Wood Structure and Identification by Harold A. Core, Wilfred A. Cote and Arnold C. Day. *Syracuse University Press, 1011 E. Water St., Syracuse, N.Y. 13210, 1976. $12.95 spiral-bound, $17.95 hardcover, 170 pp.*

Most of us are familiar with the commercial woods available in our area. But I'm always startled when a non-woodworker asks if the walnut piece I'm working on is cherry. Most of us know the difference but we are always learning. When we see another woodworker's project we look at the design and craftsmanship and we look at the wood. What is it? Is it strong? How workable is it?

Know Your Woods is now out in a revised edition and it's a fine introduction to wood identification and properties. The author's forty-year familiarity with the cabinet-wood business makes for a very readable book. The short early chapters cover wood structure, processing, appearance and modern propagation techniques. But the bulk of the book is the description of more than 300 woods.

Common and scientific names, sources and wood properties including shrinkage, workability and strength are all touched on lightly. There are photographs of wood grain and of tropical trees—an impressive sight. But the book is a popularization, one of several on the market. If you have a good idea of the name of the wood and its source you will learn something about it in the Constantine book. But it lacks the detailed data so necessary for design work and identification.

The *Handbook of Hardwoods* provides much more detailed information about the properties of 250 woods commercially available in England (most are available here as well). Strength, movement, stiffness and other proper-

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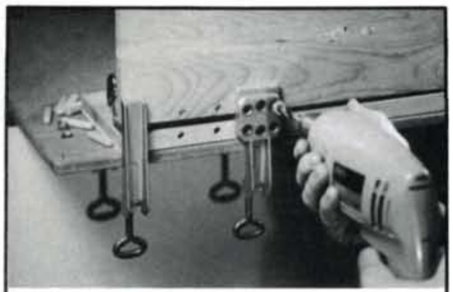

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ties are presented in numeric form when available and are also listed on a relative scale. Even the type of blade to use when cutting is specified. There are descriptions of grain, a detailed cross reference of popular names and drying schedules. This book aims to aid the hardwood user but its tacit assumption is that the wood is obtained commercially and thus is readily identifiable.

The really hard problem is to identify a piece of wood with little or misleading information. This often requires not only the general physical characteristics of the wood—such as color, grain, figure, taste and smell—but also a confusing array of properties detailing the structure of the wood itself. These include the presence and arrangement of wood rays and pores, the difference (if any) between early and latewood, and the presence and condition of intervessel pitting and thickenings in the cell wall. Even with detailed information, identification is difficult for the wood technologist or biologist.

Wood Structure and Identification is a short course in wood identification for the interested layman-woodworker or forester—not the biologist. It is the clearest presentation I've seen. Most popularizations present this material in five pages and then never refer to it in later chapters, while technical books require a scientific background. These authors discuss the properties of trees and wood, the microscopic arrangement of cells in wood (easily seen by eye or with a hand lens) and the microscopic structure of the cells themselves. They do this with the readable text and light- and electron-microscope photographs that show us the internal beauty of the wood. They discuss the preparation of samples for observation with microscope, hand lens or with the naked eye. This is important because they deal mainly with domestic woods (a key to American woods is included) but the techniques developed are applicable to all species. This book is good preparation for using more technical identification books.

Many books deal with wood properties. Of these Constantine's is a good introduction. *Handbook of Hardwoods* is helpful for choosing a wood to meet a specific need. The Syracuse book is best if you seriously want to learn about wood identification.

—*Irving Fischman*

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ADDENDA, ERRATA

On page 14 of this issue a new feature, Questions & Answers, begins. Each week we receive dozens of letters from readers asking questions about woodworking techniques. We have tried to answer many of them by mail, or we have passed them on to contributing editors and authors who might know the answers. Woodworking is not an exact science, however, and there are few correct answers. It is an endeavor of experience and judgment—and the woodworkers who know best are the ones who make their living working wood, not writing, editing or teaching. In Q&A, we'll publish the questions that seem to be of general interest and we invite readers to answer them. Thus this quarter's column is mostly questions. When we receive some answers we'll print them, along with more of your questions. . . We also invite readers to send us more substantial items for our Methods of Work column. We pay for material published in Methods at our regular rates of $100 per magazine page, prorated.

The International Society of Wood Collectors has published a booklet, "Wood Collecting," about types of collections and how to collect, process, label, index and store samples. It is free to society members and $2 to others. Write W. G. Cookman, 3155 Edsel Dr., Trenton, Mich. 48183. . . More than a thousand woodworkers have entered a superb collection of photographs for *Fine Woodworking's* Biennial Design Book. The book will be available in late spring, on schedule. . .

More bench business: In Fall '76, page 43: piece 3 should total 46 in. long, not 46-1/8 in.; the top of the bench-dog slot in piece 3 is 1-3/16 in. wide, not 15/16 in., (the bottom of the slot is 15/16 in.); on piece 7 the dado is 7-3/8 in. long, not 7 in.; piece 5 is 16-3/8 in. long, not 16-5/8 in.; the protruding tongue of piece 23 is 2-1/4 in., not 2-1/2 in.; bolts are shown as hex-head but mislabeled as carriage bolts. On page 45, piece 12, the dado slot is 1-1/4 in. wide, not 3/8 in. wide. . .

The Adam side table on page 48, Winter '76, should be 34 in. high in the front elevation, as in the side view. . . on page 15, Winter '76, the

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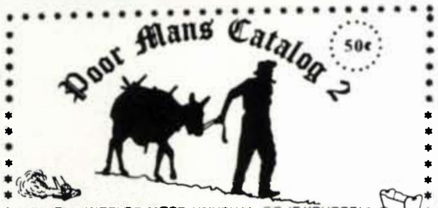

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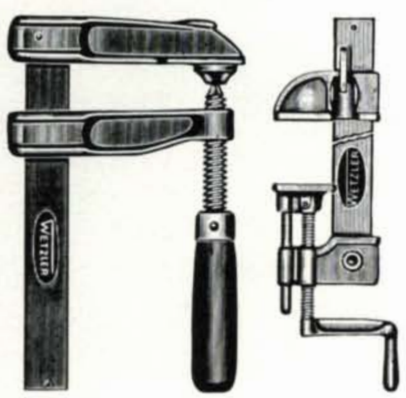

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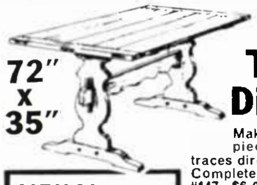

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iron of the ball plane, to cut a 5-foot sphere, is scribed to a 2-1/2-ft. arc...

Richard Starr ("Wood Threads," page 22) would like to hear other views on the story of the wooden tap from woodworkers who have made or used such tools...Ellen Swartz ("Stacked Plywood," page 50) would like to hear from people who are interested in exploring the social and political concerns of craftsmen. Her address is 237 Frost Ave., Rochester, N.Y. 14608.

Art credits: 8-12, 46-49, 53, Mathilde Anderson; 22-28, Roger Barnes; 42, 43, 60, Image Area.

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The Wood Butcher

'I *made* it, the whole thing'

by Cary H. Hall

There is a class of woodworkers who read *Fine Woodworking* with all the yearning of the village idiot hopelessly in love with the village beauty, who fondle those photographs of unbelievable masterpieces with longing despair. These are the wood butchers. The wood butcher embarks on projects that are too advanced for his abilities. He aims too high and teeters always on the brink of failure—when he is not already wallowing in disaster. He is not of the home improvement breed, those who saw weathervanes in the shape of camels and build lawn furniture from packing crates. His projects are Hepplewhite chairs and Goddard block fronts. He is like the high school art student who copies the Mona Lisa.

The wood butcher always chooses the most difficult way to go, disdaining the obvious shortcut. If he needs to take two inches off a plank he will plane with long, soul-satisfying strokes, glorying in the aromatic shavings that litter his workshop floor. He won't saw the piece in one pass through his table saw.

He reveres sharp tools. He has a collection of stones and special oils and gadgets to put the precise angle on plane irons. But he hates to sharpen tools. So he won't lend them, knowing, by looking into his own heart, that the borrower will dull them utterly—if he returns them at all. He is an insatiable tool collector, always hoping to find one that will cut cleanly forever without sharpening. He buys tools that he may use once, or not at all, and they litter his too-small workshop.

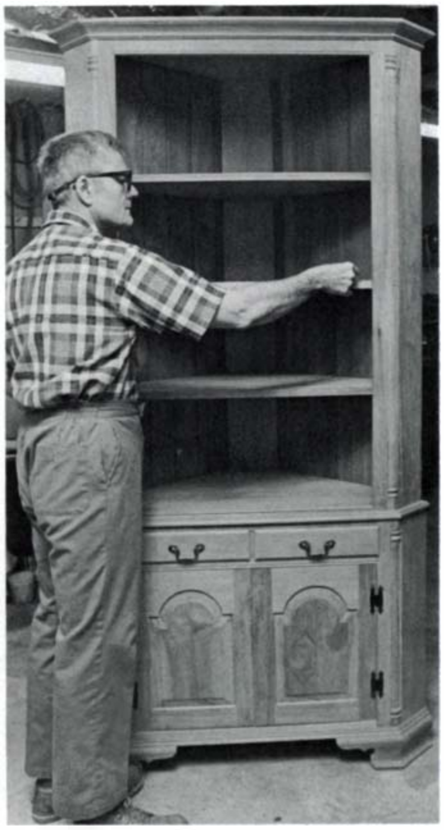
The most distinctive characteristic of the wood butcher is his cursing. When he saws a piece one inch short and it won't fit, he sincerely invokes the gods with a full and heartfelt desire for lightning to melt the ruler, vaporize the saw and singe the arm that ruined a beautiful piece of wood. Then he splices and patches to make the offending piece do. A wood butcher's work, once finished, has unexpected joints and unexplained pieces of wood inlaid in odd places.

Patching is an art in itself, not often discussed at the more expert levels of woodworking. If you ask the expert what he intends to do about a flaw he will respond, coolly, "sand it out." But there's no way, when making a fluted column, to sand out the flute that winds into the next slot because the fitting wasn't properly clamped down before the errant flute was run. So the column becomes an exercise in patching, with carefully cut blocks squeezed into carefully cut grooves. What about a rabbet on the wrong side of the board? Saw off a sizable hunk of wood, make a lap joint, glue on a new piece, and start over on the rabbet, or else throw away those dovetails cut with fearful expenditure of time at the other end.

Just about anything can be patched. The expert says, disdainfully, "Dumb amateurs. Ought to start over and make a new piece." Easy for you to say. The wood butcher knows that if he starts over he'll make a different error on the new piece—and have to patch that.

But to make up for it all there's the moment when the project is going together and it looks so good the wood butcher just can't believe his own two clumsy hands could possibly have turned out such beauty. He drags casual visitors into his shop where they stare dumbfounded at raw wood and comment, innocently, "I see you took all the finish off." His voice trembling, the wood butcher replies, "I *made* it, the whole thing."

The wood butcher is thankful that few people know where to look for evidence of his failures and can see only the sanded wood, the chair or chest of drawers with a shiny lacquer finish that most think could come only from a furniture store. They are amazed, as when seeing a monkey painting a picture—not so much that the picture is beautiful but that the monkey can paint at all.


Author patches his latest masterpiece.

The wood butcher delights in seeing thin shavings peel evenly from his workpiece and in the crisp sharpness of a carving in good stock. Of course, the grain is usually crazy and there's a knot in the panel right where it hurts the most and there's cursing. But the wood butcher only remembers the beautifully grained stuff that works true and smells wonderful.

After all the tribulations, the pieces that were off a fraction, the saw that slipped so the corners aren't quite square, the unexpected splits, the gouges in the surface that was to have been so lovely, the wood butcher remembers the tenon joints he tapped in oh-so-gently with his mallet, the sanded surface that felt so smooth, like the finest fabric, and the curves that flow just right. Everybody has to see the completed work and they are expected—maybe forced—to marvel and to compliment, in strained voices, this miracle of the cabinetmaker's art.

Cary Hall, 59, of Hampton, Ga., took up woodworking in 1953, because golf only made his ulcer worse.

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Wood Threads

A handmade tap and screwbox

by Richard Starr

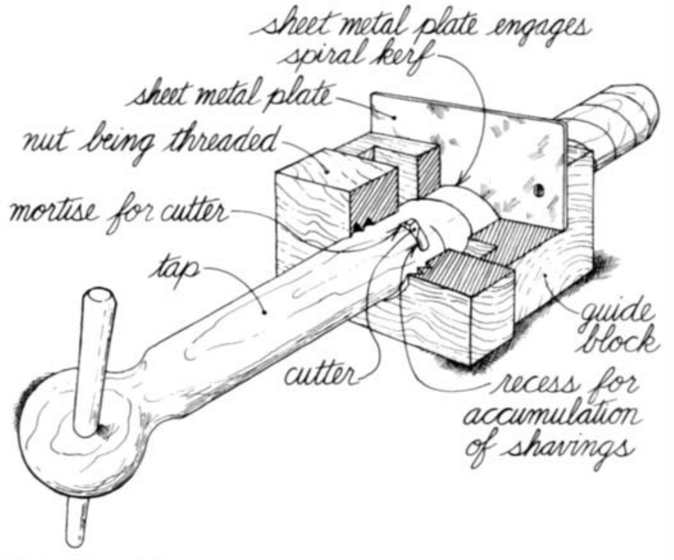
> *"In this remarkable and very simple and efficient tool of unknown antiquity, the great preliminary difficulty of making an original metal screw by hand with a file is escaped and nothing more precise is needed than a spiral saw kerf on a wooden cylinder, a steel point plugged therein, and a piece of sheet iron edged upon a hole."*
>
> Ancient Carpenters' Tools:
> *Henry C. Mercer, 1929*

Two tools are needed to make screws and nuts of wood. The screwbox, or die, cuts an outside thread on a dowel that becomes the screw, while the tap cuts a thread inside the hole to be used as a nut. Because the screwbox consists of a vee-shaped gouge cutter positioned ahead of a threaded hole, the tap must be made first. It is then used to thread the inside of the screwbox.

The most common wood taps are similar to the tools for tapping metal and are made on a machinist's lathe or perhaps cut by hand with a file, laboriously. A woodworker without a lathe, or wishing a thread coarser than four turns to the inch (the limit of most lathe lead screws), is left only with commercial taps for wood. But they must be purchased paired with a screwbox, and the sets are expensive, especially in large sizes.

The wooden tap described by Mercer in the quotation above offers a solution. It is a hand tool made with hand tools, of common materials. The design is awkward in diameters under an inch, where an all-metal tap would be better. It is particularly suited to cutting the large screws needed for vises, clamps and presses. Fractional pitches and left-hand threads are no problem, and Mercer cites diameters up to eight inches. The screwbox or die design is good for any size even less than one inch.

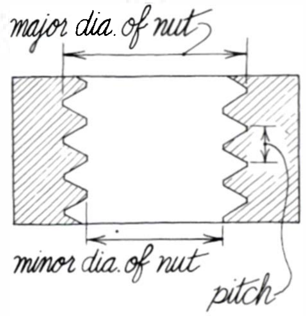
The wooden tap consists of a helically grooved cylinder with an adjustable single-tooth cutter, and a guide block that fits behind the nut to be threaded. The sheet metal guide plate engages the helical kerf and draws the rotating tap through the hole. The scraper cutter pushes its shavings ahead of itself, thus requiring several passes before it reaches full depth. Its adjustability, which allows nuts to be threaded slightly oversize or undersize, is essential for a close fit and to compensate for changes in humidity.



Richard Starr, 33, teaches hand woodworking to grades 6, 7 and 8 at Richmond School in Hanover, N.H. Starting with a clue provided by an old-time craftsman and references in musty books, he rediscovered this technology.

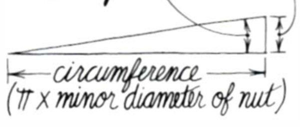
To make the cylinder for the tap, choose a square of wood about four times as long as the deepest hole you expect to thread, plus two or three inches for the handle. The material must be a close-grained hardwood that will wear well and resist chipping along the edge of the saw kerf. I have used cherry, yellow birch, and rock maple, but hornbeam might be better. Choose a piece that is straight-grained and well seasoned to minimize changes in dimensions.

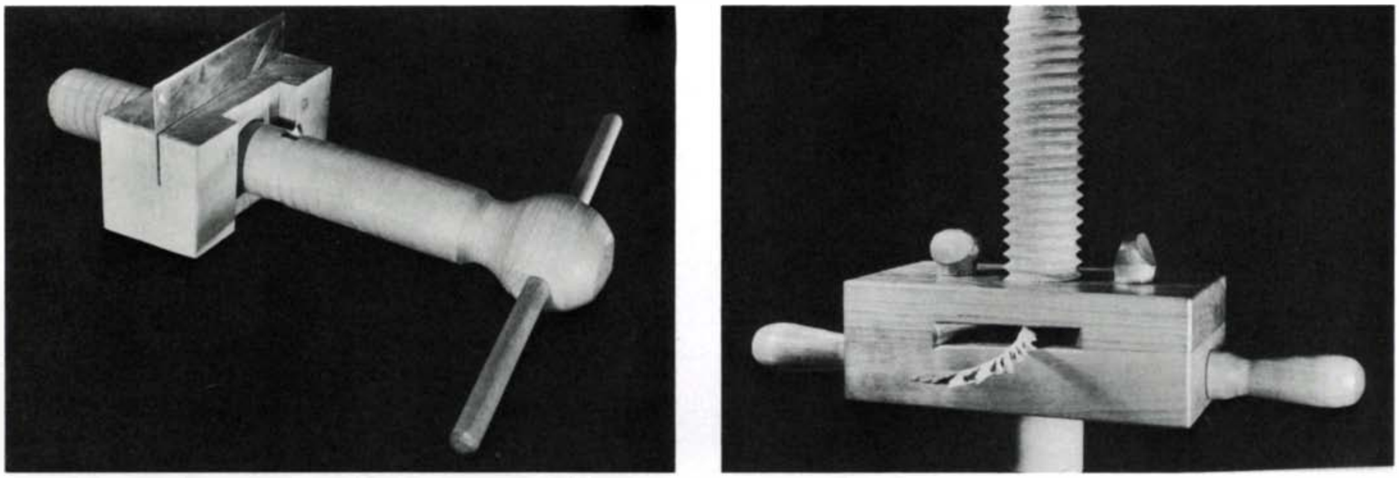
The shaft must be turned to the desired minor diameter of the nut. Use a vernier caliper rather than a pincer-type to measure accurately. Make the finish cuts with a large skew chisel, or a large gouge and a shearing cut, to leave the wood smooth and regular without using sandpaper. Sanding would leave grit in the wood, dulling tools used in later operations. A finish of hardening oil such as Watco, then wax, will help the wood wear longer.



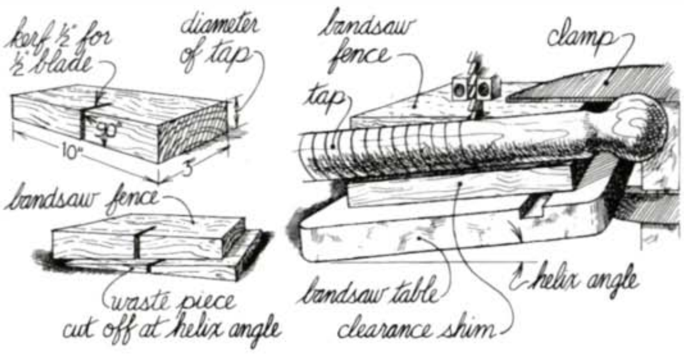
The helix cut into the cylinder determines the rate of advance of the tap, which is equal to the pitch of the screw. The cut must be shallow—around 3/16 in.—so it won't jam the guide plate or weaken the tap, but it should engage the plate snugly lest the tap widen the thread as it is backed out. The cut may be made on the band saw by tilting the table to the helix angle, holding the tap against a fence and rotating it into the blade. Or it may be cut by hand.

To make the kerf with a band saw, first determine the helix angle at the minor diameter of the nut and make a paper template. Choose a scrap board and cut a short kerf, as shown in the drawing. Use the template to lay out and slice off the bottom of the board at the helix angle. The apex of the angle should be at the left for right-hand threads, at the right for left-hand threads.





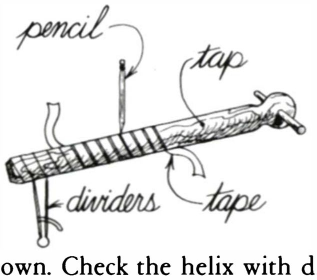
Two-inch tap (left) and die or screwbox (right) can be bootstrapped. Tap is made first, starting with a handmade helical kerf, then used to make thread inside the screwbox, which is shown here cutting a thread in yellow birch.



Now lay the cut surface of the board on the table and tilt until the blade lines up with the kerf. Mount the fence atop a shim for clearance, and clamp the assembly in place. Be sure the fence is square with the width of the blade.

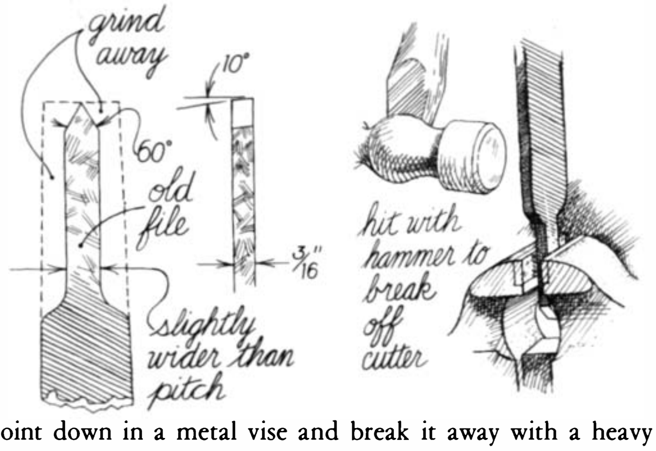
For best results use a new, sharp blade, adjust the guide blocks close to the blade and tap, and set the blade tension high. Place the blank tap firmly against the fence and rotate it slowly into the blade. It will advance itself, creating the helical kerf. Make a test cut and measure it to check the pitch. I always make the blank overlong and use the end for the test, cutting it off afterward. If successive turns of the helix are too far apart, the table angle is a little too great, and vice versa. Adjust accordingly.

This is one of those band-saw operations where the wood is unsupported directly below the cut. The blade may grab and draw the wood quickly down toward the table, which would mar the tap or break the blade. Avoid this by holding the tap firmly in both hands and rotating it slowly, allowing the blade to cut at its own speed.



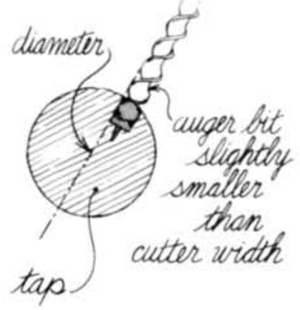
To cut the kerf by hand, prepare a ribbon of paper the width of which is a pencil line's thickness less than the pitch of the thread. Wrap this ribbon tightly around the tap, leaving the width of a pencil line between successive turns, and tape the ends down. Check the helix with dividers before marking it out. Score the pencil line with a chisel and make the 3/16-in. deep cut with a small backsaw or dovetail saw. Depth can be gauged with tape on the saw.

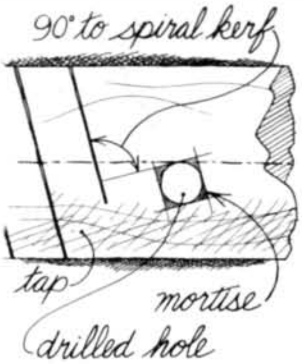
The cutter is ground from the business end of an old file, as shown in the drawings. Cool the metal frequently to preserve its temper. To separate the cutter from the waste, place it point down in a metal vise and break it away with a heavy hammer. Dub off all the edges except those that will be cutting, and sharpen on India and Arkansas stones.

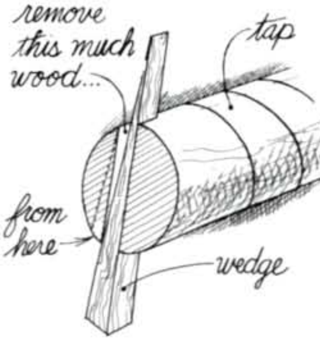


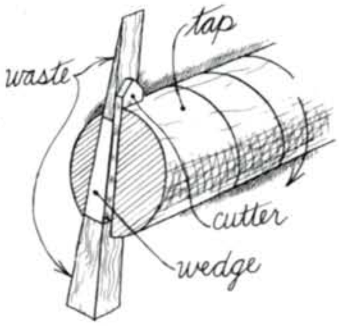
The cutter sits in a through mortise and is held by a small wedge. Center the mortise hole about a half-inch beyond the end of the kerf, with one edge following a diameter of the tap. This edge will accommodate the working face of the cutter. Lay out the square by marking a line tangent to the drilled hole at right angles to the helix, and chisel it out. Be sure the blade fits snugly.

Cut the wedge an 8° taper from scrap that is just thinner than the width of the cutter, and insert it in the mortise to gauge the amount of wood that must be removed from the back face. When the wedge fits tightly, insert the cutter and mark the wedge where it emerges from the tap. Trim at both



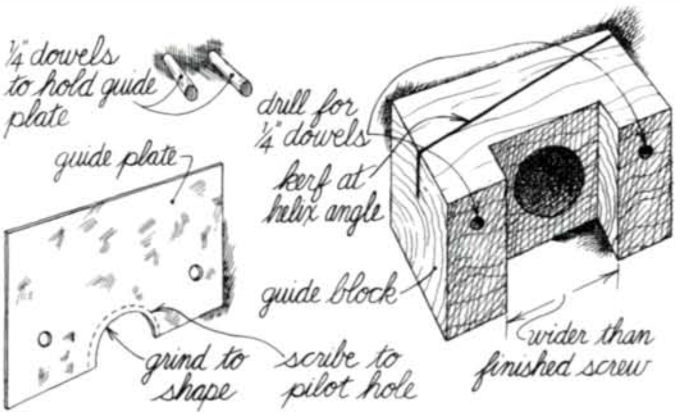






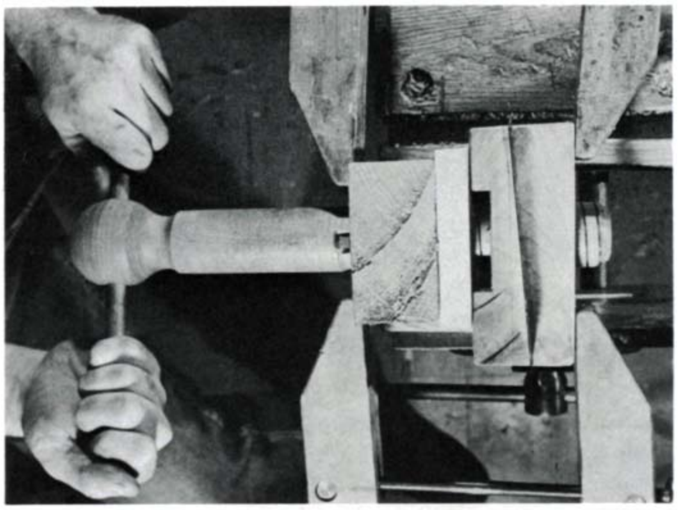
ends and chamfer all the edges to reduce the chance of splintering. Finally, gouge a shallow relief valley ahead of the cutter, to make room for shavings as the tool works.

The guide block has these important features: A pilot hole a hair larger than the tap so the tap will turn freely; a metal plate set in a kerf at the helix angle; a recess in front of the plate to allow shavings to drop out; and enough surface area for clamping to the nut. The notch must be wider than the major diameter of the thread and half again as deep as the pitch, to clear the cutter. For a 2-in. tap I have used a block about 3 in. by 6 in. by 2 in. thick. Center the hole and drill it; saw and chisel out the notch; then lay out the kerf at the helix angle. Drop perpendiculars on the ends of the block so the kerf will intersect about one-third of the hole, and cut it with a fine backsaw.



Any sturdy sheet of metal will do for the guide plate. I've used old saw blades and an old scraper blade. Drill two 1/4-in. holes in the block, insert the plate and mark it for drilling or punching. Two 1/4-in. pieces of dowel will secure it in place. Now use a pair of dividers to scratch an arc on the metal, gauged from the circumference of the hole to a little less than the depth of the helical kerf on the tap itself. Remove the guide plate and grind away the excess metal. Ease the corners of the arc so it won't catch in the wood, and remove any burrs. With the plate back in the block, the kerf in the tap should engage and turn freely. Drill a hole in the bulge of the tap for a tee handle, and the tool is ready to work.

Choose a sturdy hardwood to test the tap because strength is essential in most applications. Many woods won't take good external threads, but nearly any wood can be tapped as a nut—even pine. Drill a pilot hole in the stock the same size as the hole in the guide block. Clamp the guide block behind this stock, insert the tap and turn it a few times to ensure that everything is aligned. Adjust the block by tapping it gently with a mallet and draw some witness marks so the guide block can be removed and replaced if necessary.



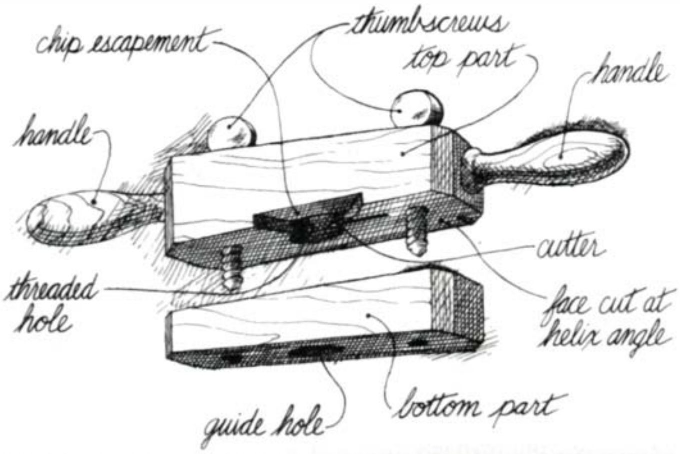
Up to now the cutter has a sharp vee point and at full depth will cut an ideal vee thread. In practice, the crest and the root of threads should be truncated to create a little flat that avoids sharp, fragile edges and provides clearance for smooth running. The truncation is obtained by dubbing off the point of the cutter, and by not setting it to full depth.

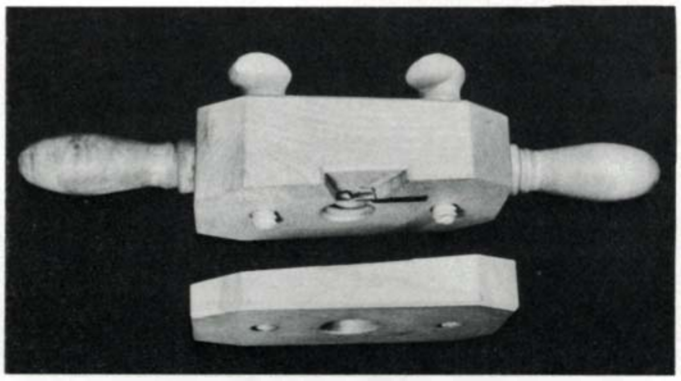
Set the cutter to project about a third of its final depth or about one quarter of the pitch. (At full depth, the cutter will be projecting about two-thirds of the pitch.) Drive the wedge in tight so the strain of cutting can't force it back in its mortise. Make the first pass through the hole and listen for the pleasant grinding sound as the cutter etches its helical path. When it emerges at the chip recess, see that it drops all the shavings before you wind it back. To adjust the cutter for the next pass, set a screwdriver or pin against its back end and gently tap it forward with a hammer. Make sure the wedge is tight after each adjustment.

It's important to take small bites, especially in very hard woods. Otherwise the tap will be difficult to turn, the thread will be rough, and the tap may be damaged. Consider that all the chips must be pushed ahead of the cutter—a 2-in. tap of 3/8-in. pitch, in a 3-in. nut, travels a linear distance of more than three feet. The little recess gouged ahead of the cutter increases chip-carrying capacity, but the tap can easily become overloaded and jam. Some roughness in the threads is normal, especially on the end-grain portions of the helix, and will occur with an all-metal tap too. Such tearing can usually be polished away by running the nut over a screw a few times with a little linseed oil or wax. I've tried to ease the cutting with beeswax or oil, but have found that any lubricant just glues the shavings together, jamming the cutter. The cutter functions as a scraper, and scrapers are most efficient on hard, dry wood. As the cutter emerges it is liable to cause some splitting and roughness, just as an auger bit would. A piece of scrap with the pilot hole drilled in it and sandwiched between the stock and the guide block will prevent this.

The screwbox cuts threads on the outside of a wooden cylinder. It consists of a vee-gouge positioned in front of a threaded hole, and the first real job of the wooden tap is to thread this hole. When the box is rotated onto a dowel, the cutter makes a notch that immediately catches the threads, drawing the cutter around in a helical path.

The tool is usually made in two parts, although in smaller sizes it can be cut from a single block. The top half contains the threaded hole and the cutter; the bottom contains the guide hole. The two halves meet at the helix angle of the screw (to be determined) and the cutter fits tightly into a mortise. This simplifies positioning the cutter and eliminates metal hold-downs for it. Metal bolts with wing nuts or wooden thumbscrews hold the two halves together. Once the thread is started the screwbox will cut with its bottom half removed, if a clamp is introduced to hold the cutter. This allows threading up flush to a shoulder.

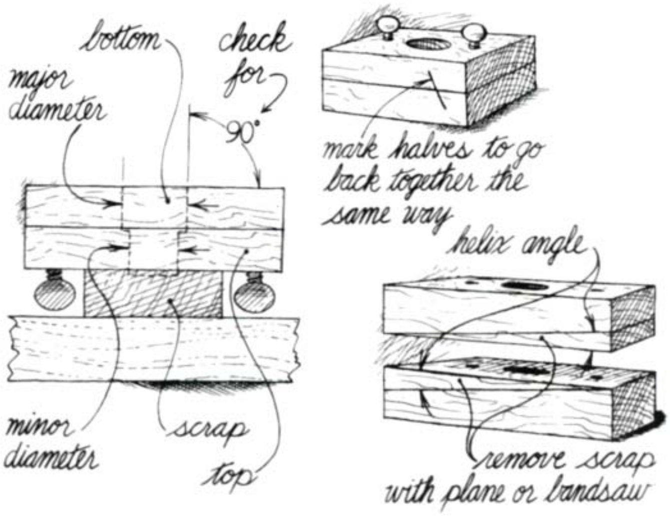




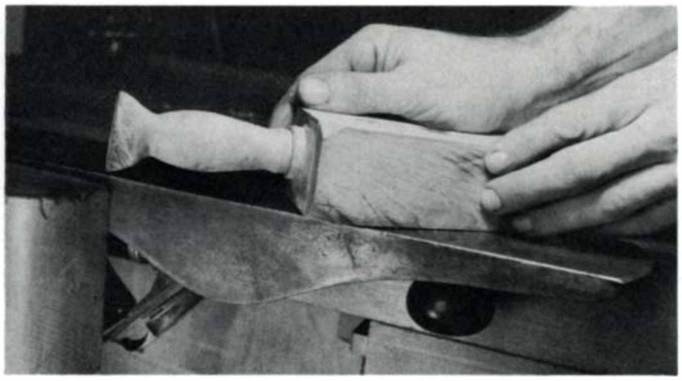
The proportions of the screwbox aren't critical as long as the top contains at least four turns of thread, and provision is made for the handles and thumbscrews to clear the finished screw. The handles may be made separately and mortised in, or turned in one piece with the top half of the box.

Choose a dense hardwood that has been well seasoned. I have used cherry, maple and yellow birch. Square both pieces on all four sides, align them carefully and clamp them to scrap atop the bench. Locate and drill holes for the bolts through the two halves into the scrap and fasten the halves together. (If you are using wooden thumbscrews, drill and tap a pilot hole in the bottom half of the box.)

Now turn the box over and drill a hole the size of the major diameter of the screw (which for clearance is a tad less than the major diameter of the nut) through the guide plate, setting the depth gauge so the hole intrudes slightly into the screwbox itself. Reset the bit to the minor diameter of the screw and drill through.

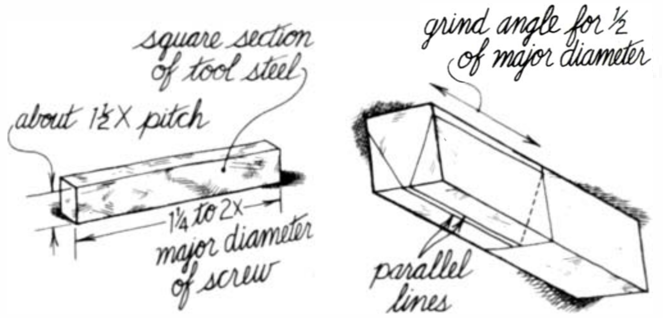


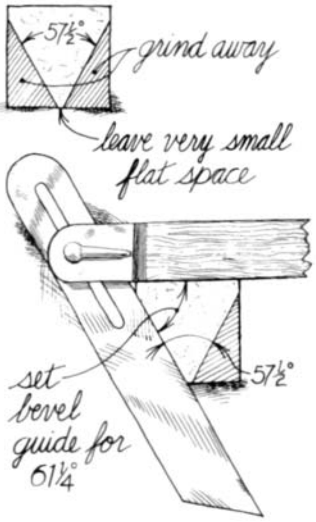
Mark the two halves so they will go back together the same way (there are four possibilities at this point), unclamp the assembly and tap the hole in the top half of the tool. Calculate the helix angle at the pitch diameter (the average of the major and minor diameters). Make a paper template and lay it out. You can plane away the waste or use the band saw, but in either case the surfaces must finish smooth and flat. The two halves should go back together with all the holes aligned and the top and bottom surfaces still parallel. I prefer to finish the surfaces by running them over a long jointer plane held upside down in the vise and set very fine.

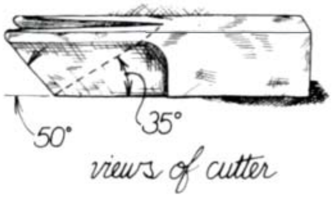


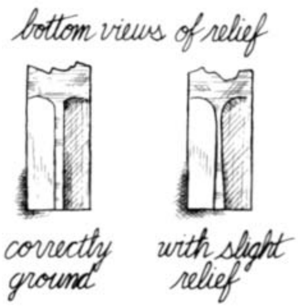
You may prefer, especially in small sizes, to make the screwbox from a single block of wood. Drill the holes and cut it apart at the helix angle. If you plan to turn integral handles, cut the box apart and saw away the excess wood before mounting it in the lathe. The turning axis should be rather close to the top surface, well clear of the angled cut.

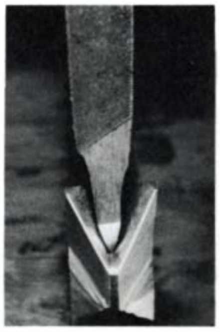
The screwbox cutter makes a 60° thread, but because of its position with respect to the minor diameter of the screw it is ground at an outside angle of only 57-1/2°. You can visualize this foreshortening by drawing a vee and squinting at it while tilting the paper. When your eye is at the plane of the page, the vee will appear to flatten out. The front of the cutter is

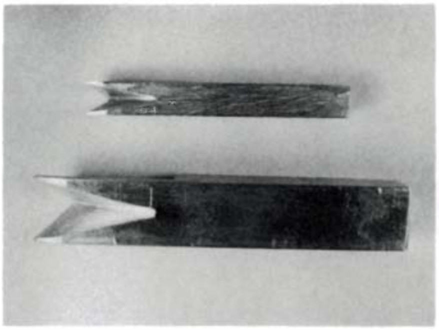












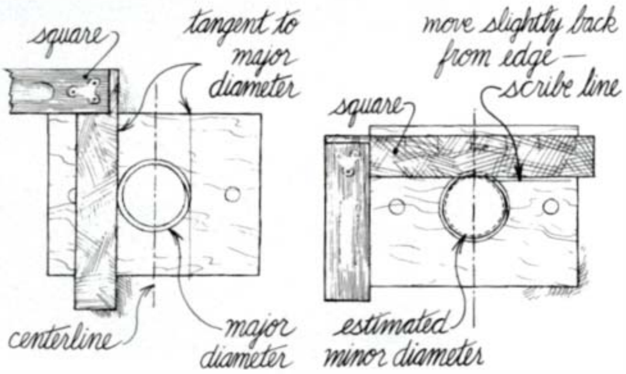
raked forward at an angle of 50° to the top of the shank. This allows the crest of the thread to be cut in advance of the root and prevents the wood from tearing.

Select a square section of tool steel and lay out the angle as shown, leaving a small flat at the apex. Grind to shape, dipping frequently to avoid burning the steel. Leave the surfaces a bit fat and clean off with a file, then file a slight relief behind the cutting edge. This allows the tool to cut smoothly. Grind the rake and hacksaw or file the inside notch. The length of the notch isn't critical; the idea is to make a sharp cutting edge without leaving the walls so fragile that they break. The notch is cleaned out with a narrow chisel made from the end of a triangular file. First grind two surfaces of the file to an angle sharper than the interior angle of the cutter, then rake the tip back about 70°. The sharp point that results is the chisel. Tap the file handle with a light hammer to pare metal from the bottom of the notch. Finally, grind the top of the cutter down to the filed facets, and harden and temper the steel (''Heat Treating,'' Fall '76).

Sharpen the inside bevels of the cutter with a narrow India slipstone until you can feel a burr on the outside. Stone off the burr, but do not allow any outside bevel to form. Finish with an Arkansas slip.

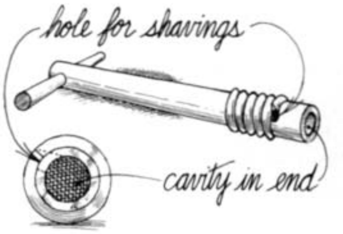
The position of the cutter on the inside face of the top half of the screwbox is critical. It must be at the helix angle of the screw; its apex must rest on, and in fact establishes, the minor diameter of the screw; its bottom edge must be parallel to the side of the box and on a line that is almost, but not quite, tangent to the minor diameter. (Set it too high and it lifts out of the work, too low and it digs in.)

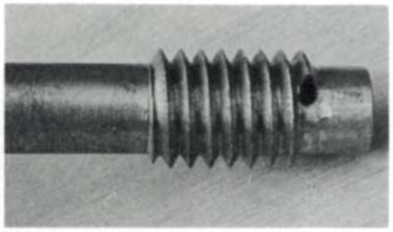
Having said all this, the cutter can best be positioned by eye. Draw lines tangent to the major diameter of the threaded



A small tap of metal

by Trevor Robinson





With access to a screw-cutting lathe, it's rather easy to make a small metal tap for threading wood. The tap is made from a piece of steel rod six to eight inches long and the major diameter of the nut to be threaded. For occasional use cold-rolled steel will take a sharp enough edge; a much-used tool would be made of tool steel or high-carbon steel. Common sizes are 3/4 in., 1 in. and 1-1/4 in. For all of these diameters six threads per inch is a satisfactory pitch, and a sharp 60° thread is cut for a distance of 1-1/2 in. or 2 in. from one end of the rod. From the same end about 1/2 in. of thread is then removed, just down to the minor diameter. The end is bored to a depth of 3/4 in. at a diameter sufficient to leave a wall thickness of about 1/16 in. The rod is then reversed in the lathe and turned down to the minor diameter from the far end to the start of the thread.

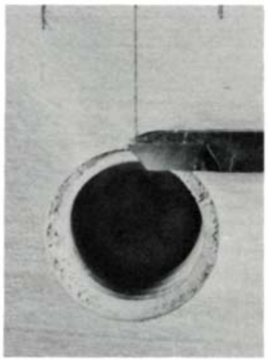
When this lathe work is done, a hole is drilled at the top end to take a tight-fitting tee handle, then the actual cutting edge is made by filing or grinding off the bottom end of the thread to make a face that is radial to the rod. Just in front of this face a 5/32-in. hole is drilled through into the cavity. The hole can be filed to make a triangular gouge at the end of the thread, with a sharp, inside bevel. This will direct the shavings into the cavity as the tool is twisted into the nut.

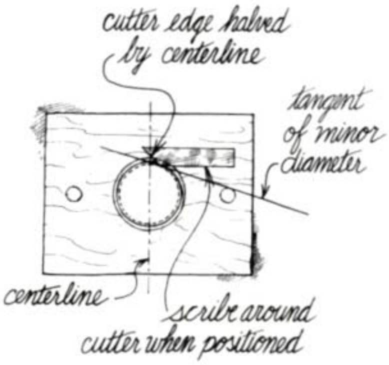
If very hard wood is to be tapped, it should be done in two steps with a starting and a finishing tap. Both have the same minor diameter, but the major diameter of the starting tap is about equal to the pitch diameter of the finished thread, or the average of the major and minor diameters. The starting tap is made with a flat-root thread, cut with a 60° bit whose end has been ground straight across for half the length of its vee. In using the two taps it is obviously essential to start the finishing tap exactly in the cut made by the starting tap.

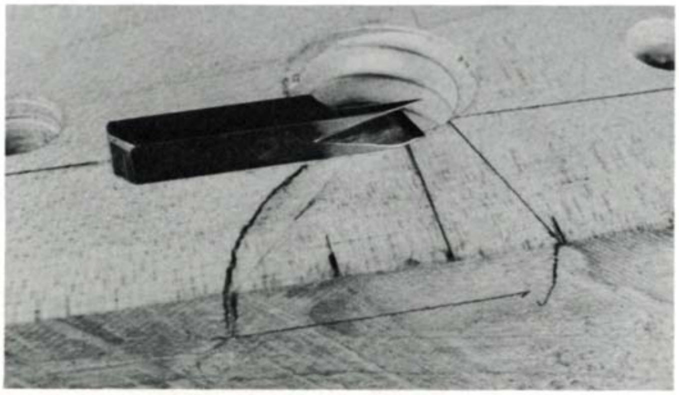
Trevor Robinson, author of The Amateur Wind Instrument Maker, *is a biochemist at the University of Massachusetts.*

hole on the angled face of the screwbox. The major diameter is the circle that was scored by the drill as it completed the pilot hole in the guide block. Measure midway between the lines, and square a center line across the hole.

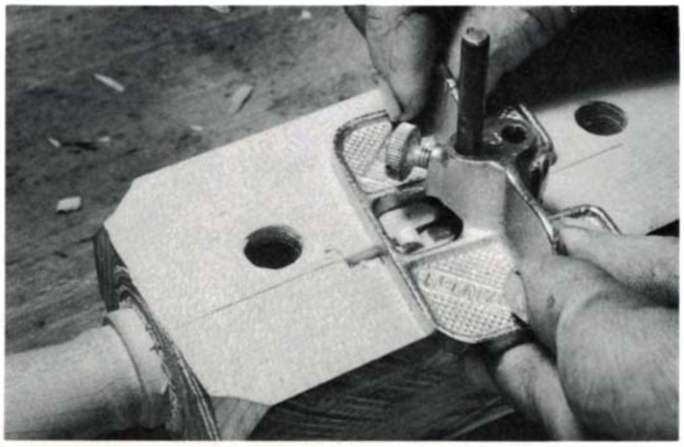
The minor diameter of the nut was established when the hole was tapped, and the minor diameter of the screw is a tad smaller for clearance. Lay a rule parallel to the edge of the screwbox at the minor diameter of the tapped hole and move the rule a little farther into the hole, to the estimated minor diameter of the screw. Scribe the line with a sharp knife. Set the cutter on the line so that the section of its edge between the apex and the major diameter is cut in half by the center line, and scribe closely around the shank.







Lay out and cut the chip escape channel as in the photo, making sure it clears the notch on top of the cutter, to a depth that equals the thickness of the cutter. Score the scribe marks for the cutter mortise and chop it to the same depth. Now the cutter must be sunk into the screwbox until the groove it will cut catches the threads in the screwbox. The little Stanley #271 hand router will do the job, but make sure its blade is sharp and square to the sole before you begin. Work the mortise and chip channel together, frequently testing the cutter to make sure the fit remains snug.



Use a narrow strip of cardboard as a depth gauge. Along its edge lay out four marks exactly a pitch distance apart. Align three of the marks with the crests of the thread inside the box, and rout until the flat on the cutter exactly centers on the fourth mark. When the depth is correct, the bottom of the cutter may appear to be higher than the last ridge of thread. This is a result of the peculiar helical geometry of screws.

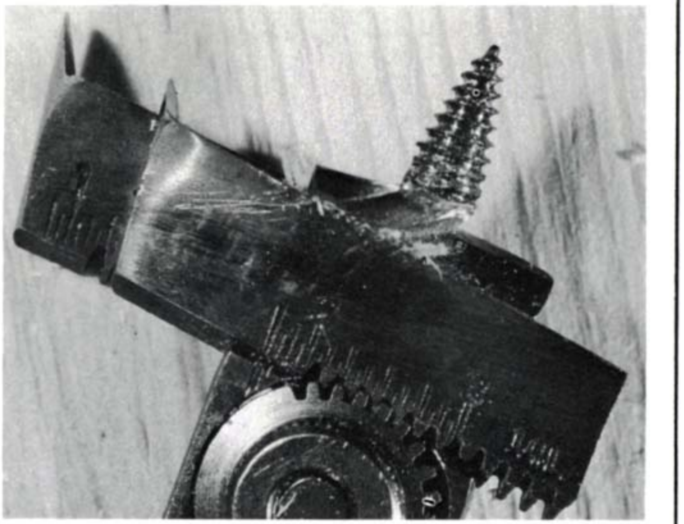
Finally, use the upside-down jointer to plane the surface of the box until the cutter is again flush. Since the bottom of the

Expansion bits

The expansion bit is the wooden screwmaker's cup of tea. It's an inexpensive tool that is continuously adjustable from an inch to more than three inches in diameter. Normal auger bits come in 1/16-inch increments and aren't commonly available larger than an inch and a half. Expansion bits are made for use in the drill press or the hand brace.

The most popular bits for hand use are the Irwin "Microdial" and "Lockhead." The adjustment on the "Lockhead" cannot be tightened enough to hold its setting in hardwood; the more expensive "Microdial" locks more securely. Even so, it sometimes slips to a larger size. I find it necessary to grip the drill head in a vise and bear down hard on the screwdriver.

These drills have a spur that tends to bend outward as the drilling progresses. This enlarges the hole and makes it hard to turn the brace. The cure is to file the spur to about half its original length. After the spur has been shortened it must be filed on the inside surface to reduce its thickness and to re-establish a sharp cutting edge at the top. Auger bits seldom arrive sharp enough to make a clean cut in hardwood. It pays to dress the cutter edges with a fine India stone, then an Arkansas slip.



The little scale printed on the drill is much too coarse for accuracy. I always test the setting in scrap wood, and may adjust it four or five times before arriving at the exact setting.

Auger bits will leave a rough exit hole unless you clamp a piece of scrap behind the stock and drill through into it. I like to clamp a piece of paper between the woods. When paper shavings emerge, the hole is through the stock. *—R.S.*

box is also surfaced at the helix angle, it may be used as a gauge. Then remove one shaving more so that when the box is closed tight the bottom plate bears upon the cutter shank and locks it in place. Use a small gouge or knife to pare away the threads in advance of the cutter right out to the major diameter, so the dowel can enter the box.

The dowel to be threaded must be sized to fit snugly but turn freely in the guide hole. Taper or chamfer the end for an easy start and dip the whole dowel in mineral or linseed oil for lubrication because this is now a cutting, rather than a scraping, operation. Set the dowel upright in the vise and start the box with some downward pressure. Once the cut is begun, no downward pressure is needed. The box should turn easily and cut a clean thread.

Most problems result from an improperly set cutter and can be corrected by enlarging the mortise and adding shims. If it won't cut at all, the cutter is probably riding too high on the thread and the mortise will have to be widened to relocate it. If it produces a screw but is difficult to turn, check the minor diameter—a deeper cut may be indicated. If the cutter is misaligned with the thread, it will be difficult to turn the tool and one flank of the thread will bind inside the box and emerge polished. If the bottom surface is polished, deepen the mortise; if the top is polished, add shims to raise the cutter. Such misalignments affect the pitch of the finished screw. A shallow mortise rushes the thread through and lengthens the pitch; when it is too deep it compresses the pitch. The accuracy of the pitch may be checked by comparing the thread with a sliced nut.

It isn't easy to describe the quality needed in a wood to help it accept the helix of a screw with grace and strength. The wood must be strong and hard, and resistant to the shearing forces that would separate the thread from the core of the screw. Yet it still must cut cleanly across the grain.

The most common problem of wood being cut into a screw is that chunks of thread break away. In extreme cases, the screwbox leaves a shaggy, undersized dowel with no threads at all. Chips usually fall from the same position on successive turns, indicating weakness along the length of the grain. I recently cut a large screw in green elm. It had sapwood for about a quarter of its circumference. Chips fell exactly at the boundary between heart and sap along its entire length.

The only consistently fine wood I know for making screws is yellow birch (or red birch, the older heartwood of the same tree). It drips long, continuous shavings from the screwbox. Hornbeam (also called ironwood, leverwood or remin) makes a beautiful, bone-hard screw. Dogwood, juneberry (shadbush or sugarplum) and some of the fruitwoods (especially apple) also work well. Exotics such as boxwood and lignum vitae should be excellent. Oak, ash, cherry and the white birches are sometimes very good and sometimes awful.

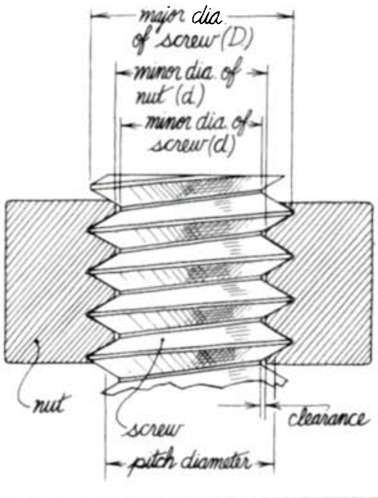
Woods that should not be considered for screws include walnut, butternut and beech. Many commercial dowels are beech. Look for the telltale ray flecks and avoid them.

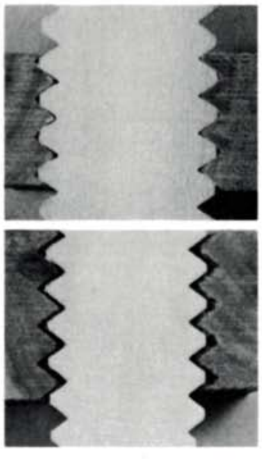
The same characteristics that make green wood cut so well on the lathe make it easy to cut in the screwbox. This is especially important when making large screws with a single-cutter tool. But green wood may check as it dries, and it will shrink. Polyethylene glycol (PEG) treatment may be an answer. But I prefer to rough out an oversize dowel and let it dry slowly until it is about half seasoned. Checking is minimized by avoiding the heart of the tree. Then turn it to size and cut the threads. Build an oversize screwbox or tap the nut undersize, and learn from experience what will work.

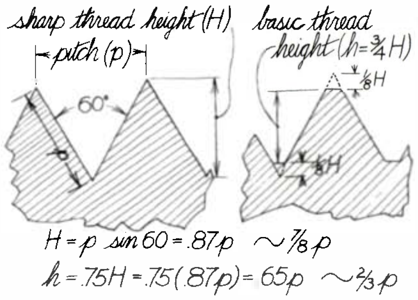
Sizing threads

The dimensions of threads in wood can be figured from the same basic relationships as threads in metal. However wood is not worked in increments of .001 in. and such calculations can yield only ballpark figures. For smooth running there must be slop.

In metal threads the tolerances are precise: Truncation is one-eighth of sharp thread height, and clearance is one-sixth of basic thread height. In wood, the amount of clearance also depends on the dryness. As the wood gains and loses moisture circles will become ovals and the pitch of the nut will actually change. The threads in the photo are an inch in diameter. One is a tight fit, the other is a loose, but still good, fit.







The maker of threading tools is likely to start with a bit with which he plans to drill pilot holes to be tapped for nuts. He chooses the pitch of the screw and calculates from there. Or he could start with some dowels which he plans to thread for screws, and calculate backward.

For example, starting from a 2-in. drill bit and pitch of 3/8 in.: The drill establishes the minor diameter of the nut. The shank of the tap is turned just a hair smaller so that it will work freely, and the cutter is set, step by step, until it protrudes about two-thirds of the pitch, or 1/4-in., from its mortise. The tool should then tap a nut with flats at crest and root.

The maker scribes this setting on the cutter and slices the test nut in half. He measures its actual major diameter to confirm that it is in the region of the minor diameter plus twice the basic thread height, or 2-1/2 in.

The major diameter of the screw, and thus of the dowel to be threaded, will be smaller than the measured major diameter of the nut by at least one-third of the basic thread height—in this example, more than 1/16 in. and less than 1/8 in.

The Scraper

A most versatile tool

by Tage Frid

The scraper is one of the most important and versatile tools for wood sculptors and cabinetmakers. It is available as a simple, rectangular piece of steel, called the scraper blade and as a blade mounted in a handle that looks like a large spokeshave called the cabinet scraper.

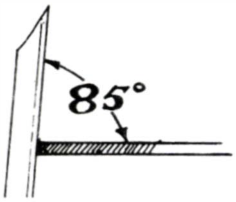
Sharpening and maintaining the scraper are simple, but do take practice to learn. Many people get frustrated and give up, but once you can maintain the proper edges you will wonder how you ever did without it. Whenever I lecture, people want me to demonstrate the care and use of the scraper because few are able to learn this on their own.

The same scraper blade can be used for crude and fine work, to scrape glue or to produce a high-gloss finish with lacquer or shellac. It is better than steel wool between coats of finish because it doesn't leave tiny shreds of metal embedded in the pores of the wood. And when an old scraper gets too narrow to use it can become a tool for making half-blind or hidden dovetails.

The cabinet scraper has many uses too. It can remove old finishes without the use of solvents. It is excellent for removing paper after veneering and, like the scraper blade, it removes excess glue. If sharpened correctly it will put a fine finish on burl woods or delicate veneers.

The working edge of a scraping tool is the burr which does the actual cutting. Magnified, the burr resembles a small hook running the length of the edge. The scraper blade is sharpened by first filing the edges square. Then a medium stone removes the file marks. I prefer a wet/dry carborundum stone without oil. Then I use a honing stone, and here I prefer a Belgian clay water-stone, used with water. I hate to use oil because it mixes with particles from the stone and gets on my hands and the bench. Before I know it, the work too gets oily. The edge a water-stone produces is just as good as with an oilstone and it cuts the metal much faster. And if the stone wears hollow you can redress it yourself with sandpaper, by hand or machine.

After the edges are honed square the scraper is ready to have its cutting edge or burr put on. This is done by stroking the edge with a burnisher held at an angle of 85° to the face of the blade. A burnisher is a piece of steel that is harder than a scraper blade. The back of a chisel works just as well—I think even better—and I don't have to buy another unnecessary tool. The whole sharpening procedure is explained in the photographs on the following pages. The biggest mistake people usually make is to get too excited and burnish too hard. The resulting big hook, which digs too far into the wood, is fine for rough work like glue scraping. But for fine finishing you need a light touch when burnishing the cutting edge. It is just like when you had your first date and touched the other person's hand for the first time—but this time you don't have to blush.



When the blade gets dull, you can burnish the old burr down and pull it back again five or six times before you must file and stone.

For rough work I simple file the edges and don't stone it. I keep the burr left by the filing, burnish it out flat, and pull it back again. This edge will cut as well as if it were stoned, but it will have microscopic nicks that won't matter much for rough work.

The cabinet scraper is sharpened almost the same way, except its blade has a bevel and the burr is slightly larger, so it is burnished at a slightly steeper angle. As you file it, knock the corners off the blade so they don't dig into the wood.

A scraper will cut sanding and finishing time in half, and the end result will be considerably better than if only sandpaper were used. Since the rate of tree growth depends on the season, some parts of a board are harder than others. Sandpaper will remove the softer wood more quickly and the result will be a very uneven surface—which may not become apparent until the finish is applied. I never use an orbital sander because it has a flexible rubber or felt pad that will make the surface even more uneven. The best finish surface is obtained by first using a smoothing plane or cabinet scraper, then a flat scraper blade which will keep the surface flat and remove the wood quickly and efficiently. Then sandpaper.

If the first steps have been done correctly, very little sanding will be required. I use only 80-grit and 120-grit paper before applying the finish. I feel that often too much time is wasted by going any further. I always use a piece of cork for a sanding block. It is rigid, but not too hard, and it is very inexpensive. And I save the sanding dust to mix with either shellac or lacquer, depending on the finish I am using. (For an oil finish I use shellac.) This makes an excellent paste for filling small imperfections. If stain is to be applied I mix sanding dust with half Titebond glue and half water. The sanding dust will fade and shade with the wood, and is better and cheaper than any plastic preparation.

A swan neck (also called a goose neck) scraper blade is sharpened and handled the same way as the straight scraper. It is used in curved places—mostly for carvings, moldings, sculpture or sculptured furniture.

You can buy scrapers for about $2. But I always use a Sandvik #475, which costs about $4 and is worth every penny. Its polished edges and high-quality steel produce a much cleaner burr without imperfections. You can look at various scrapers on the market and see the difference in the quality of the steel. Since most people buy only one or two blades in a lifetime, it is a good investment to buy the best.

After reading this and trying to sharpen a scraper several times, you might be the most frustrated person in the world. But don't give up. All of a sudden it will work out right, if you don't get too excited. Remember the light touch.

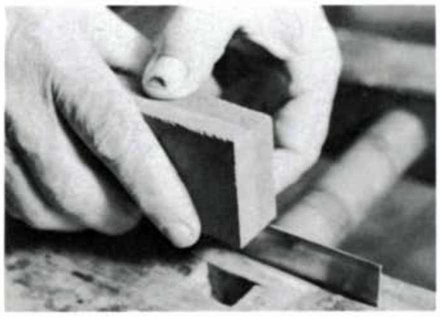
[Cork sanding blocks are available for $.75 from George Gordon, Box 144, Pittsford, N.Y. 14534, Sandvik scrapers from Woodcraft Supply.]

Tage Frid teaches furniture design and cabinetmaking at Rhode Island School of Design. He's been a professional woodworker for close to 50 years.

Sharpening the scraper blade

The first step in sharpening a scraper blade is to file the edges square. Clamp the blade in the vise; curl the fingers around the file for control.

Hold the file square to the edge and draw it along in long, even strokes.

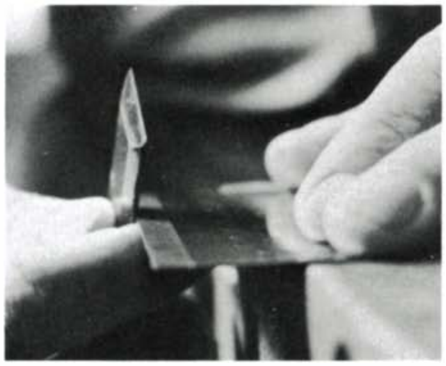


Remove file marks with a medium stone.

Then hone with a fine stone held askew to avoid wearing a groove in its face. The edge of the blade must remain flat and square—don't rock the stone.

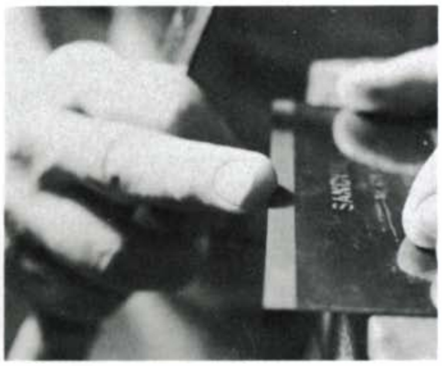
Finally, wipe the stone along both faces of the scraper to remove any remaining burr.

Put a drop of honing oil on all four edges of the blade to prevent the chatter of steel on steel and place the scraper on the bench with its edge extending over the side.



Use the back of a chisel as a burnisher. Hold it at an angle of about 85° to the face of the scraper and draw it back and forth until a small, even burr forms.

Two or three passes should do it, with light pressure (about four ounces).



Check the burr with a fingertip and repeat on all four long edges of the blade.

When the scraper gets dull you don't have to go through the whole process of filing and stoning. Lay the blade flat on the bench, add a drop of oil and slowly lay down the burr with the back of the chisel until you can't feel it on the top surface.

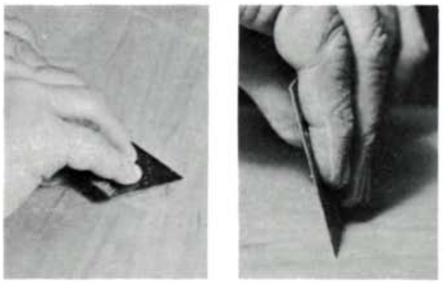
Lift one edge of the chisel to make sure you burnish the whole length of each edge and guide your finger along the bench to keep the chisel from slicing into your other hand. Then burnish to raise the burr as before.

When an old, much-sharpened scraper blade gets too narrow to use, it can become a tool for continuing the saw cut in half-blind and hidden dovetails. Set it in the kerf and tap it with the hammer. It saves a lot of chiseling.

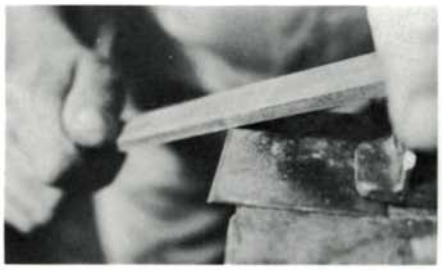
Using scrapers, sharpening cabinet scrapers

Now the scraper is ready to test on the top of the bench. Curl your fingers around its ends and bow it slightly with thumb pressure. Start with the blade vertical and tilt it until it just bites the wood, about a 70° angle, and push. If it is sharp it will make fine shavings, not dust. →

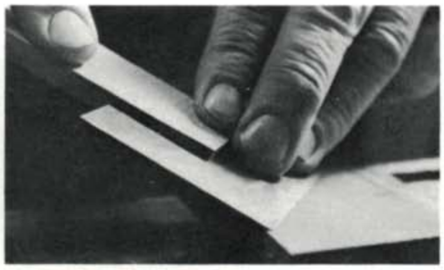
The scraper can also be pulled toward you—it will cut better and more evenly if it is held askew to the grain direction, but moved parallel to the grain. Don't scrape away at one spot; reverse direction and work the whole surface so it stays smooth and even.



It won't cut properly and the blade will get dull quickly if you hold it at too shallow an angle. The correct angle is at right. If the corners dig in, press harder at the center of the blade to bow it more.



To sharpen the cabinet scraper, clamp the blade to the bench with the bevel upward and overhanging the edge. Hold the file in both hands and draw it along the bevel, maintaining an angle of 25° to 30° so the bevel is twice the thickness of the blade.



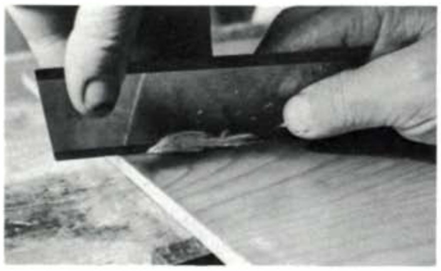
File until there is a burr on the back, then stone the edge and back on carborundum and hone with a fine stone until the burr is gone. The cabinet scraper is sharpened on both long edges—use a stick with a saw kerf as a holder so you don't cut yourself.

Then burnish the same way as the scraper blade but at a steeper angle, resulting in a slightly bigger burr. To set the cabinet scraper in its handle, remove the wing screw on the back of the handle and the two knurled screws on the front.

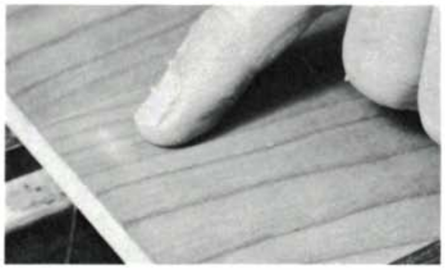
Place a piece of paper under the front of the sole to gauge the depth (double the paper for a deeper cut) and drop in the blade so it rests on the bench, with bevel facing upward and burr frontward. Hold the blade in place and tighten the knurled screws.

Set the wing screw until it just touches the blade and test the cut. For a deeper cut tighten the wing screw against the blade, making it bow. Always push the cabinet scraper with the blade leaning away from you. It, too, should make fine shavings.

To remove a finish, set a large burr on the cabinet scraper and tighten the wing screw so it bites between the finish and the wood. Scrape across the grain.



A scraper blade is the perfect tool for leveling a lacquer finish between coats. Just go lightly over the whole surface to remove bumps and dust. Start with the ends because they are the most difficult places.



After the pores are sealed, use the scraper to remove as much lacquer as possible without cutting through the surface. The change in color tells you you have gone too far. Work across and with the grain; be sure you don't miss any place, or the finish will streak.

After final scraping, for a glossy surface mix a pumice-and-oil paste and rub it on with a felt block. For a really high shine use rottenstone and oil. Then rub on sanding dust to absorb the oil. For a matte finish apply dry pumice with a shoe brush.

California Woodworking

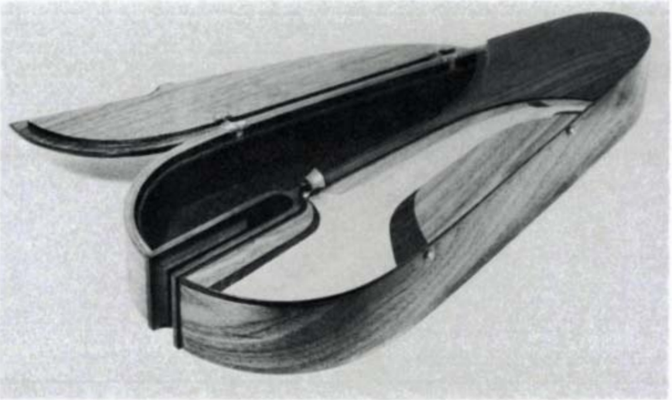
Intriguing solutions to traditional problems

by Alan C. Marks

A healthy cross section of contemporary work was on display during November at the "California Craftsman '76" show at the Monterey Peninsula Museum of Art. The wooden pieces in the show were on the whole well executed and displayed a number of intriguing approaches.

Wood is, of course, a living, breathing material, but we apply a tremendous amount of effort to turn it into dead, inanimate substance for our purposes. A plank of wood comes to us cut from a tree which weathered years of drought and storm, seasons of heat and cold, sheltering man and beast with its branches, and which died with a personal history recorded in its grain structure. Whatever we do with that plank should be done with respect. Wood possesses a natural dignity that we try to deprive it of; we impose upon it patterns foreign to its nature, abrade it, cook it, pulverize it with huge machines, and restructure it using plastic resins and great pressure. Today, we can manufacture plastic that looks like wood and wooden furniture which could as well be plastic.

We are impressed by the sheer amount of mechanical energy expended in transforming wood into a predetermined shape, but should we really be? Some feel a new era is dawning, an era in which man lives in harmonious interaction with the resources and materials of his world. Perhaps this attitude will make itself felt in design as well.



Jewelry box by Lawrence Jones: walnut, koa, rosewood; 12 inches.

This little jewelry box with a marquetry top reflects Larry Jones' background in metal (the silver hinges) and instrument building. The woods he chose for the marquetry complement each other in a subtle interplay of nuance, texture and form. The sides, back and portions of the top are walnut. The lighter wood is koa and dark accents are Brazilian rosewood. The sides are laminated of four 1/16-in. plies bent and glued in a plywood jig.

Rolltop desk by Espenet: walnut and genisaro; 40 inches high.

The desk by Art (Espenet) Carpenter, one of six in a production run, features integral side/leg construction, using edge-joined planks designed around an overhanging writing surface combined with a tamboured front. He uses what he calls "band-saw boxes" as storage for pencils, letters, etc. To make a band-saw box, Carpenter saws out a core from a solid chunk, exits his blade through the entry kerf, then glues and clamps together the halves of the cut. This renders the kerf invisible. Removed cores can then be used as drawers for the pigeon holes. Although the sides (made of the Guatemalan wood genisaro) are striking, it is questionable whether the front legs could stand up against accidental kicks or side stresses without snapping along the grain. Some kind of reinforcing seems required. An otherwise impressive piece.

Gary Upton, 22, has been working with wood for about five years. He has switched from wooden clocks to musical instruments and only recently turned to furniture. His desk in oiled walnut shows great potential. On the mechanism, Upton comments:

"That was an experiment I tried. I had seen it done before, on one of the Greene and Greene Bros. desks, only they had a mechanism where you pulled down the drop leaf and the runners slid out from underneath. But they were totally exposed. I wasn't really sure how they built it, so I built some small models. They worked, and I got the basic idea down. I wanted to conceal the movement and create a surprise when you open the desk."

He designed the drawer/storage console after finishing the case; it slides out as a unit—a fully acceptable solution to cleaning and dust problems. The pocket shelves are laminated around a removable core.

One weakness is the corner drawer trays, which pivot open. They drop down of their own weight when opened, bind when closed, and afford scanty storage space.

Desk by Gary Upton: walnut; 37 inches high...

Open the top...

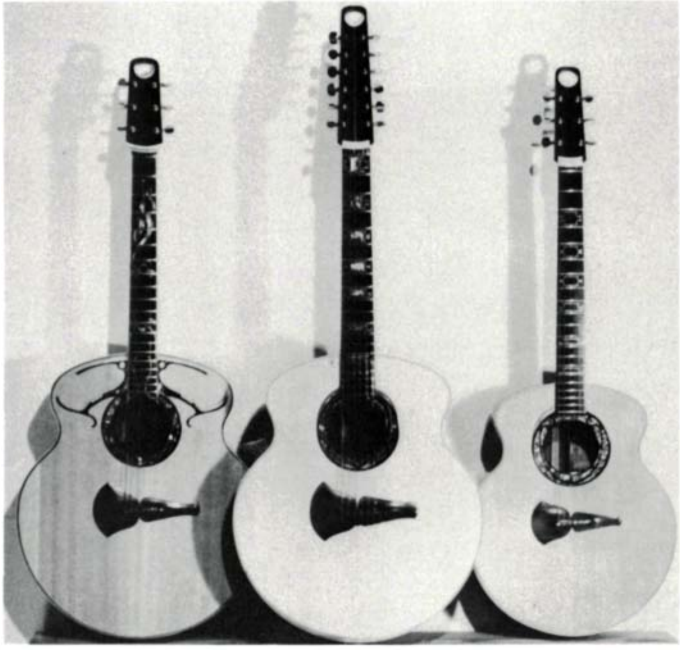
the door drops down...

the runners slide out.

Norm Tornheim's "Silver Ghost Cremation Urn," one of a series he has done, has ornamental accents of silver wire inlay, brass and copper that reflect his background in jewelry. Wheels are of rosewood sandwiching padouk. The body consists of three plies of padouk with two birch veneers as separation.

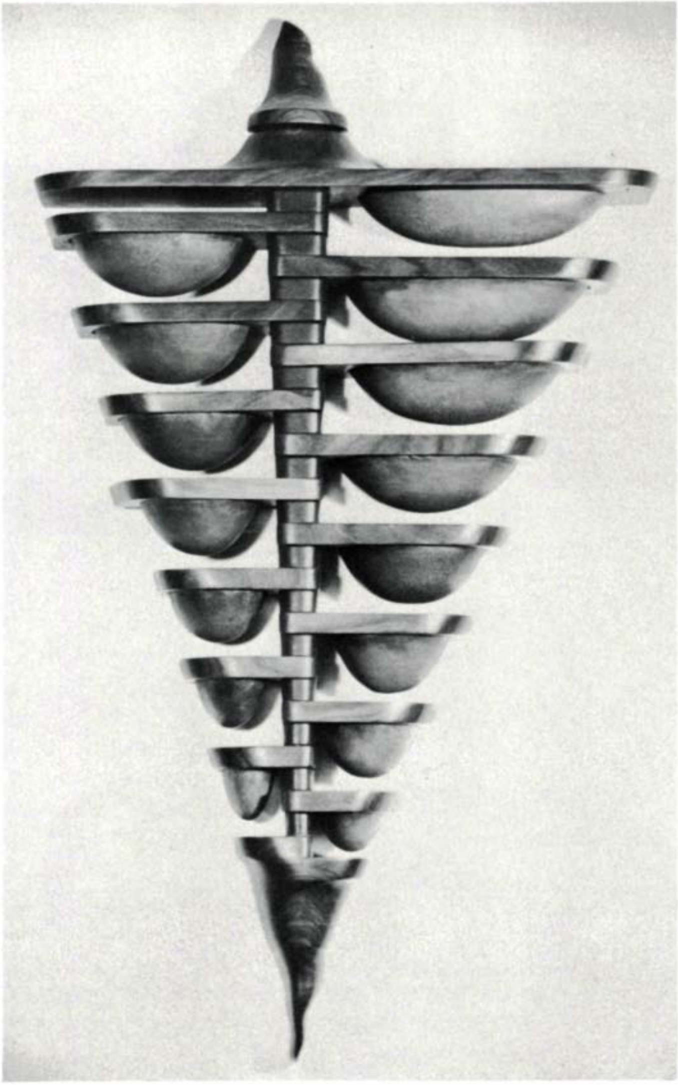
Ancient man considered the funeral urn a "vehicle" in which the soul is purified. This urn, inspired by the horse-drawn hearse, was named after the first armored tank, a converted Rolls Royce.

"Silver Ghost Cremation Urn" by Norm Tornheim: rosewood, padouk, birch; 17 inches.



Guitars by Steve Klein: rosewood and spruce; abalone and silver.

Walnut with leather pouches by John Cederquist; 31 inches. Pouches swivel from center column.



An unusual bridge was the major factor in determining the unconventional size and shape of Steven Klein's guitars. They were designed in accordance with principles evolved by Prof. Michael Kasha of the University of Florida. Klein adapted Kasha's theory to the steel-string guitar. Body size and bracing structure result from his own research. The patented bracing permits a relatively loose face of large size. A transverse bar runs directly under the bridge pieces, as in the traditional Bouchet system, but in front of the bridge Klein uses what he terms a ''flying brace'' attached to a rosewood plate. Two arms fly down at a slight angle and butt into the sides at the waist. Only a small triangular area in front of the bridge is supported, so the rest of the face remains loose. High tensions, necessary with steel strings, are transferred to the sides.

After experimenting with different woods, Klein settled on traditional rosewood backs and sides with spruce faces.

Another piece which could split apart is Sam Maloof's sculpted chair in walnut. A departure from the traditional chair seat, which is free to float in a frame, the seat of this chair is solid wood. As a result, its annual shrinkage and swelling (probably about 5/16 in.) will create stress where the rear legs are doweled into the cross-piece at the top of the back. The cross-piece itself will remain stable along its length. Probably the legs will flex, but the joint still is liable to crack. Perhaps the best way to eliminate the problem would be to bolt the leg to threaded metal inserts in the rungs.

Desk chair by Sam Maloof: walnut; 40 inches high.

Bent Laminations

Slice and glue the wood to make it curve

by Jere Osgood

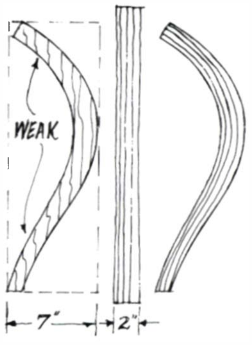
Samples of laminated wood have been found dating from the 15th century B.C. Lamination means a layering process. All the layers are aligned with the grain going in the same direction, and are held fast by a glue. Thin slices of wood can be laminated flat or to a curved form.

It is important to distinguish lamination from veneering. The grain of the laminate layers is always oriented in the same direction. In contrast, in veneering or plywood the grain directions alternate and an odd number of layers must be used. In lamination the layers, when glued together, will act like solid wood, expanding and contracting across the long grain. In veneering, grain alteration stabilizes the unit and there is no movement across or with the grain. Another form of lamination, stacking, is really a separate subject. (See "Stacking," *Fine Woodworking*, Winter '76.)

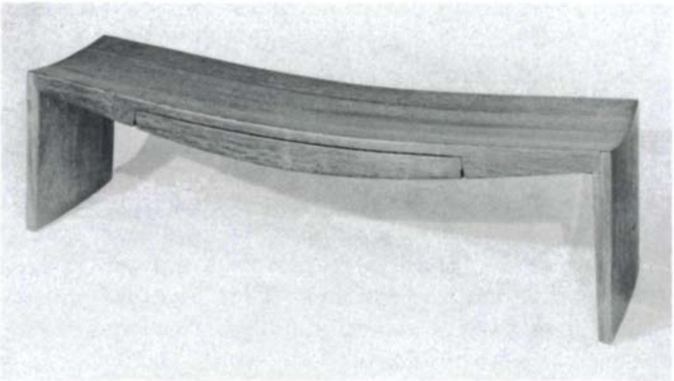
Furniture-related examples of lamination are flat or curved cabinet panels, tabletops, and curved leg blanks. The simplest lamination is the use of a fine figured wood as an outer layer on a tabletop or cabinet panel.

In many cases I find laminations more acceptable than solid construction. For example, one plank of an unusual figured wood could be resawn into many layers. These could perhaps cover all the sides of a cabinet, if backed up by layers of wood of lesser quality or rarity. If used at full thickness, many planks of this unusual wood would be needed to achieve the same effect.

Lamination is an economical way of obtaining curved forms. Members can be thinner when laminated as opposed to sawn because of the inherent strength of parallel grain direction. Steam bending is of course an alternative for curves and is an important process. However, lamination offers the advantage in many cases of more accurate reproduction of the desired curve. Modern glues have eliminated the bugaboo of delamination—the glue lines are as strong as the wood itself. An excellent use of laminated wood is in chair or table legs where short-grain weakness might inhibit design. It is important in some cases to make the layer stock thick enough so that any shaping or taper can be done in the outer two layers because going through the glue lines might be unsightly. In addition to counteracting short-grain weakness, laminating a curved leg also saves scarce wood, because a laminated leg can be cut from a much narrower plank than would be required for sawing the curved shape out of solid stock.



For flat panels such as a tabletop or a cabinet panel, a core of some stable wood (poplar or mahogany) is used. A face wood, which can be veneer or resawn stock, is glued on both sides with the grain directions the same. It is important to cover both sides to forestall warp and to use the same species



Dining table by James Schriber: Top is simple laminate faced with tamo veneer; apron and legs are laminated ash. Bench by Osgood: Curved ends, top and front are all bent laminates.

Jere Osgood teaches woodworking at Boston University. He lives in New Milford, Conn.

Chest of chair, laminated curly maple, by Jere Osgood.

on both sides. However, if the densities are kept the same, substitutions can be made. Typical veneer thicknesses are 1/30 in., 1/28 in., 1/16 in. and 1/8 in. Resawn stock is thicker—perhaps 1/8 in., 3/16 in., 1/4 in. or 3/8 in. The core thickness in a cabinet panel might be 1/2 in. and in a tabletop, 13/16 in. The core requirements disappear when laminating something like a drawer front, which might typically be two layers of 3/8-in. material or three layers of 1/4-in. stock.

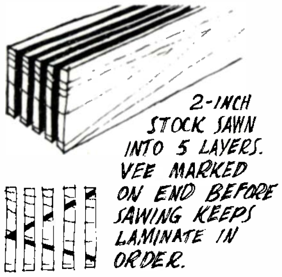
When panels are curved the thickness of the layers is important. A thick core might not be possible. Whatever size layers are used, they must each be able to take the desired curve. For example, 1/16-in. layers might be needed to bend a 3-in. radius, but for a lesser bend of, say 1-in. deflection over a 36-in. drawer front, 1/4 in. or 3/8 in. might be thin enough. The appearance of the visible edge of something like a drawer front is also a design factor to consider.

A general rule is to keep layers of the maximum thickness that will take the desired bend. This not only saves time and money (each time a lamination is cut, a slice the thickness of the saw blade turns into dust) but also aids in gluing evenly. A multitude of thin layers of, say, 1/28-in. veneers risks a surface unevenness from disparate clamp pressure marks resulting from a poorly bandsawn form or from unevenly spread glue. But you don't have any choice if you have 2000 square feet of very thin veneer that will fulfill the stock requirement for a specific piece of furniture.

First, determine the thickness needed by testing the bend with a sample. Narrow or simple cuts, say for chair legs, are usually possible with a single pass on a table saw, the limitation being the diameter of the saw blade. In many cases a carbide rip blade will give a good cut for gluing that will not need to be run through a thicknesser. Stock cut with a normal rip blade will need to be thickness-planed.

Wide laminations that can't be cut in one pass on the table saw can be cut on a band saw using a resaw jig. Another tablesaw method involves dressing stock normally, cutting from opposite sides of the board with the blade height set to cut halfway, and thicknessing the cut-away pieces. Because there is one smooth face they can be surfaced as is, ignoring warp if they are thin. The center portion of the board is left rough and should be resurfaced before repeating the operation.

Resawn stock may warp or cup. If this is not desirable the stock must be left thick enough to plane warp out. There is a tendency to overestimate the number of resawn layers available from a board. Therefore take careful account of kerf loss and warp. Be sure to laminate resawn stock in the same order it was cut. A vee marked on the ends of the laminate boards makes it easy to keep them in this order when they are glued to the curve. For wide laminations, the resawn pieces can be folded apart, or bookmatched, to keep the grain in a pattern.



2-INCH STOCK SAWN INTO 5 LAYERS. VEE MARKED ON END BEFORE SAWING KEEPS LAMINATE IN ORDER.

Almost any glue works for flat laminations where the only stress is the seasonal movement of the wood. However, I prefer a slow-setting glue for a lot of layers or a large surface area. I do not recommend white glue for fine furniture because of the variation in quality from one brand to another. A yellow glue such as Franklin Titebond (an aliphatic naphtha-based glue) is good for shallow bends or curves without a lot of stress. Cold creep (slippage after drying) occurs to a lesser extent with yellow glue than with white glue. A chair leg laminated with yellow glue will slip minutely and show the layers after about nine months. The layers are trying to become straight again—you can see and feel the unevenness.

If a lamination is sharply bent and under stress, a urea formaldehyde glue such as Weldwood or Cascamite is called for. I have had good results with Urac 185, made by American Cyanamid Co., Industrial Chemicals and Plastics Division, Wayne, N.J. 07470. Unfortunately, it is available only in 55-gallon drums. I recommend a two-part resorcinol formaldehyde where wetness is a problem, but the dark glue line may be objectionable. These glues don't suffer cold creep.

Springback is normal as the layers try to straighten out against the formed curve. It is slightly greater with yellow glue than with urea glue. But the amount of springback is usually small and can be estimated with practice. In many cabinet or chair parts it can be ignored. Joint angles should be checked after laminated parts are made. Where a precise curve is needed one could use thinner (and therefore more) layers, which will tend to reduce or eliminate springback, or test-glue the part and adjust the form before laminating the actual piece.

In lamination, as in all gluing, there are four potential trouble areas: moisture content of the wood, temperature, oily woods, and dull thickness-planer blades. Opinions may vary, but below 6% moisture content is risky.

Temperature is another important factor. While yellow glue can set at a lower temperature, 70° F is about the lowest for the urea type, and at that temperature about 12 hours of clamping time are required. For urea-resin glue a temperature of 90° F reduces the pressure period to about five hours. One easy way to increase temperature in a workshop is to throw a drop cloth over the clamped work and put a 150-watt bulb underneath. Be careful, because most glues don't reach maximum strength for 48 hours.

Oily woods such as teak or rosewood can be laminated in several ways. Titebond is more likely to succeed than a urea glue. Another way to achieve a bond is to roughen the glue surfaces with a toothing plane or 40-grit garnet paper. Narrow pieces cut with a carbide table-saw blade which are not cleaned up or jointed may glue better. Another method is to clean the surface with lacquer thinner or carbon tetrachloride before gluing. Oily stock should be tested first, before committing an expensive lot of wood.

Another area of potential trouble that is often overlooked is a dull thickness-planer blade. Dull knives beat and mash down the wood fibers; sharp knives slice them off cleanly. Microscropic differences in the surface greatly affect gluing.

A simple flat lamination can be done with two cover boards and a few quick-action clamps. An alternative to this is a veneer press. In addition to flat pressing, the veneer press can be used for curved parts with a two-part form.

For simple parts a one-piece form can be used. The layers are held in place under pressure with quick-action clamps.

Free clamping without a heavy back-up form can be done for parts requiring a spiral or otherwise impossible compound curve. A lamination of several layers can be held in place with 1/4-in. Masonite strips as cover pieces on either side of the layers of wood. Masonite of this thickness twists easily.

On a wide piece, a good rule is to begin clamping from the center out to the sides or from one side to another so that air or glue pockets aren't trapped between the layers.

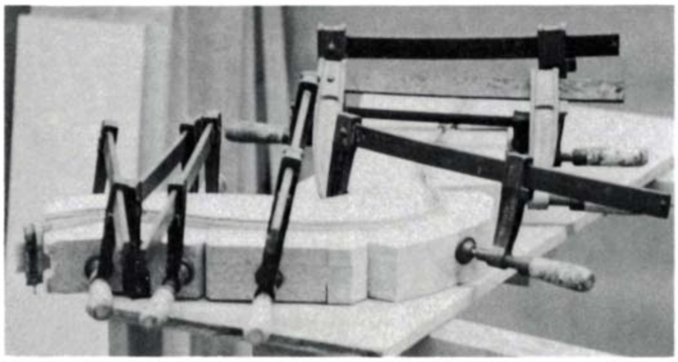
The cheapest material for making forms is particle board, chipboard or floor underlayment, all basically the same material. Fir plywood is the next most economical choice and should be used where strength is required. Particle board has an advantage over fir plywood in that the band saw won't track off the pencil line into some strong grain configuration.

I usually face my press or forms with Masonite to help obtain even gluing pressure and to compensate for slight irregularities in bandsawing. I use 1/8-in. or 1/4-in., depending on the severity of the curve. Masonite is cheap and its surface resists glue.

In determining the curve to be drawn on the form, the actual piece plus the thickness of the facing must be considered.

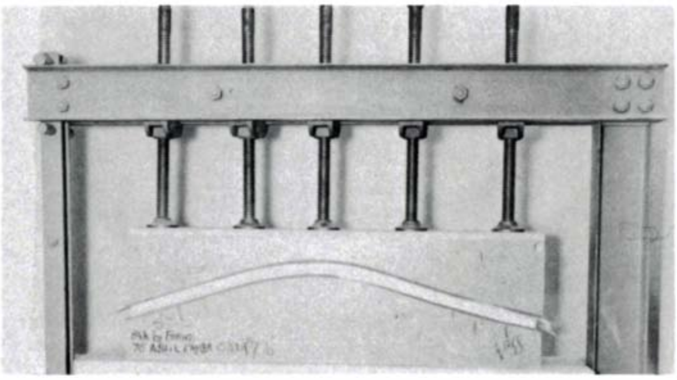
Forms five or six inches thick could be made from solid, but it is often more economical to make the form as a series of ribs with spacers in between each rib. The form can be made as a one-part, open-face jig or constructed as a two-part form. Usually the decision depends on the gluing process. Clamping pressure must be maintained approximately perpendicular to the work. While I prefer a two-part form that fits in a press for most work, there are many cases where the curve is too great or the piece is too large. For example, the semicircular apron for a round dining table can be made most easily with a one-piece form.

A two-part form with a shallow curve, such as for a drawer



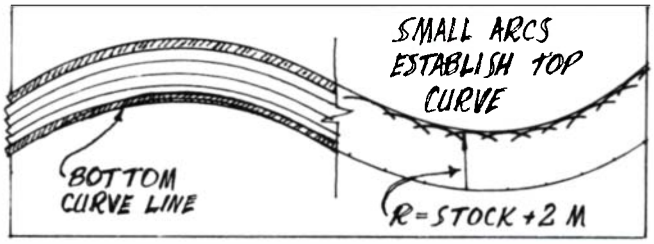
Chair by Tom Hucker: Quick-action clamps hold thin layers of maple in two-part chipboard form, above. Outer part of form is segmented for easier assembly. Then eight identical staves are joined and shaped to make seat of chair. Legs are also laminated.

Hardwood board under screws of veneer press distributes pressure and keeps form from crumbling at center.



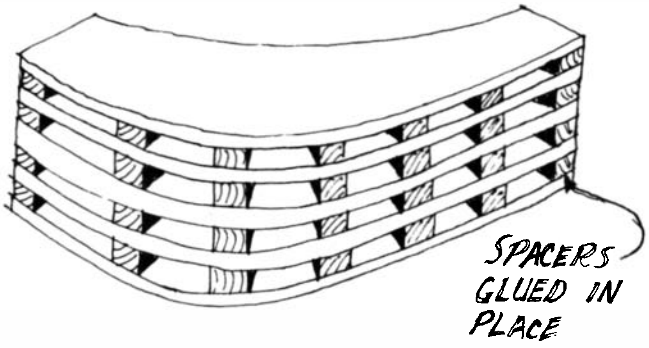
front with a one-inch deflection over a three-foot distance, requires bandsawing only along a single pencil line. The form will flex enough over that length to give even clamping pressure. For a drawer front of the same length but with a two-inch deflection, it would probably be necessary to calculate the various radii by the method described below.

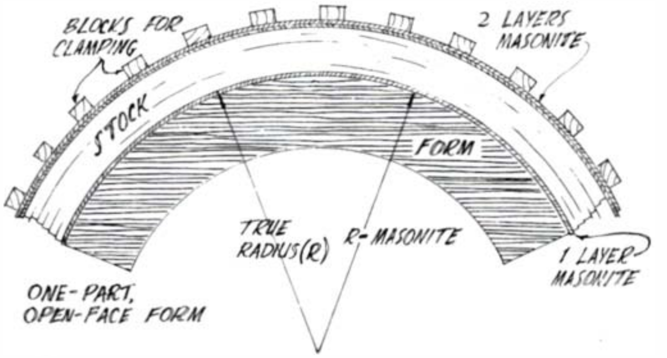
The first step is to thickness-plane the laminates to the desired thickness and check the true combined thickness with calipers. For example, four 1/4-in. layers might actually measure 1-1/16 in. together, and a one-inch form would be off. The form needs to be that precise. The two band-saw lines are established by taking the curves of each side of the desired piece, adding the facing thickness to each side and transferring the total dimensioned curve to the form. For a compound shape, the bottom curve line is taken from a full-size shop drawing. Then a compass is set to the total laminate thickness plus the two layers of Masonite. The compass is lined up with the bottom line and small arcs are swung at the correct distance from points all along the bottom line. The crests of these small arcs are connected using a flexible curve, to establish the correct top line.



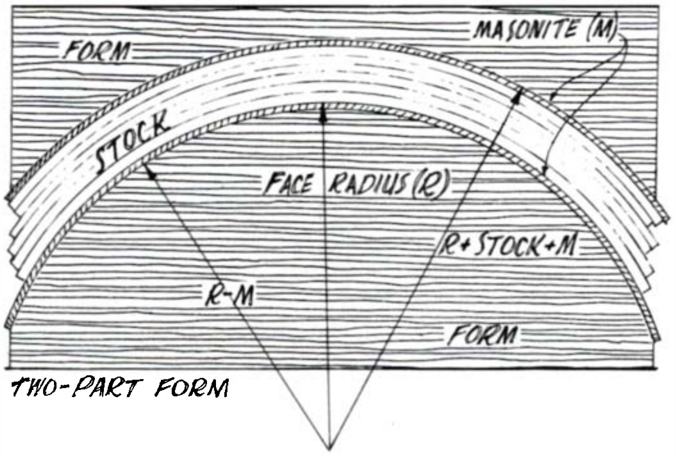
When laying out the curve onto the form, the normal inclination is to work from a vertical or horizontal reference on the drawing. This does not necessarily ensure perpendicular gluing pressure. Often the curve layout on the form must be tilted to center the curve.

Most of the directions so far have been for narrow furniture parts of up to five inches. Another method is suited to larger pieces such as door panels, cabinet ends and bench seats. The same method would be used to veneer the panels. After establishing the curve on the form, band-saw lines are drawn onto the end piece of a stack of ribs that have been carefully cut to the exact length and width and then dadoed. These ribs are not glued together, but held by four spacer strips press-fitted into the dadoes. The idea is to make a short, easy package to bandsaw. For example, a 20-in. form can be made of eleven 3/4-in. ribs which would make a stack 8-1/4 in. high to bandsaw. The stack can be kept uniform by inserting short, temporary spacer strips into the dadoes. After bandsawing, the short strips are replaced by strips of the total length. Masonite sheets are then used to line the form, and finally two sheets of particle board or plywood are cut for top and bottom plates.

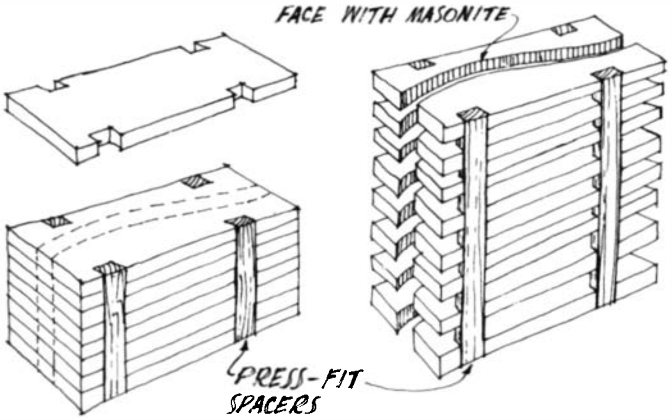




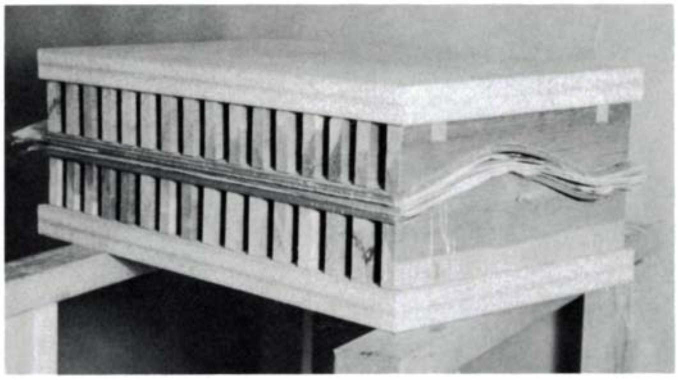
One-part, open-face form is used with quick-action clamps for parts that are too large for veneer press. Masonite regulates pressure, but must be accounted for in layout.



Two-part forms provide most even squeeze with either clamps or veneer press. Again, accurate layout is essential.



Rib-and-spacer forms bandsawn from a stack of boards are best for wide, curved panels. At left, an open-face ribbed form is made from chipboard with pine spacers.



Dry Kiln

A design to season 500 board feet

by William W. Rice

A number of years ago in a small New England town I met a man drying oak flooring. He cut the oak into 1 x 3-1/2-in. random-length strips while it was green. These were carefully stacked in his garage on sticks until the garage was full, except for a 3-foot space to the wall on one side and about 4 or 5 feet on the other. The lumber reached from the back wall to the doors. A thin partition extending down from the ceiling to the top of the load contained three 18-in. window fans spaced along the length of the lumber pile. On the wall hung two thermometers, one with a piece of wicking surrounding the bulb and dangling into a pan of water.

This man had a dry kiln. When he fired up his wood stove, he could heat the garage to about 100 degrees. The fans circulated the hot air through the lumber pile; when the humidity got too low he misted the pile with the garden hose. After a month, his flooring was flat, check-free and at a low moisture content.

The operation succeeded because the man knew what he was doing as he manipulated the heat and humidity to produce flooring that would machine, finish and perform well in service. For those of us who need small quantities of dry wood, a homemade kiln may be the answer.

Wood is a cellular material (*Fine Woodworking*, Summer '76 and Fall '76) that in the tree, log or freshly sawn board contains two forms of water. Free water is located in the cell cavities in a liquid state and can move by capillary action from cell to cell. Bound water is held in the cell walls by molecular attraction and moves by diffusion. During drying, the loss of free water does not change the dimensions of the cells and the effect can be likened to emptying a coffee cup. However, as bound water is released from the cell walls, the cellulosic strands move closer together and the wood shrinks. In very small pieces of wood, the free water leaves the wood first, followed by the bound water. But larger pieces dry from the surface towards the center and bound water evaporates at the surface while free water is still traveling from the interior. This creates moisture gradients in the wood, which cause drying stresses, and the result is checks, splits and warp.

The three factors to be controlled in drying wood are temperature, humidity and air movement through the pile. In that New England garage, the wood stove undoubtedly produced erratic temperatures. Control of humidity was probably minimal—the moisture evaporating from the wood maintained the necessary relative humidity, occasionally supplemented by the garden hose. Only the air circulation was constant throughout the kiln run. How fast the load dried depended on the way the man handled these factors, plus the characteristics of the species.

In general the higher the temperature, the faster the drying. Heating the wood also heats the water and water vapor it contains and reduces the molecular forces bonding the water to the wood. Thus water moves more easily through the wood to the surface where it can evaporate. Temperatures below 70° F do not promote drying; temperatures above 212° F are likely to cause structural damage, especially in hardwoods. High temperatures over periods longer than three days can reduce the strength of wood and make it brittle.

Most kilns operate between 100° and 180° F. The normal sequence is to maintain low to moderate temperatures (100° to 140° F) until the free water has been removed and then to raise the temperature to accelerate the process. As the wood becomes drier, it takes more energy to break the bound water loose from the cell walls.

In large commercial kilns the usual heat source is steam generated in a boiler and distributed by finned pipe similar to home baseboard convectors. While steam has proven to be the most economical, hot water, electricity, radio frequency and solar energy will also work. A steam system has the added advantage of easily furnishing vapor for humidification. An electric heating system is usually lower in initial cost and easy to control, but expensive to operate.

Relative humidity is the amount of moisture air contains, expressed as a percentage of the maximum amount it could contain at that temperature. Air at low relative humidity can absorb large amounts of water vapor before becoming saturated. Air at high humidity has little capacity for additional moisture. Heating air without admitting additional moisture reduces its relative humidity; cooling the air will reverse the process and increase the relative humidity. By manipulating the relative humidity of the air, we can control the drying of wood.

The hygroscopic property of wood allows us to predict how it will react to various combinations of temperature and relative humidity. A piece of wood will release or absorb moisture until its moisture content is in balance with that of the surrounding air. This is called equilibrium moisture content (EMC) and it is expressed as a percentage.

Thin pieces of wood arrive at equilibrium with the atmosphere in minutes and react quickly to fluctuations in relative humidity. The surfaces of thicker pieces of wood also arrive at equilibrium quickly. However it takes a long time, even years, for lumber to reach equilibrium throughout its mass. This "reaction time" results in moisture gradients during

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drying. Wet wood subjected to a low relative humidity (and therefore a low EMC) will dry quickly because the moisture gradient is steep. The differential between internal moisture content and surface moisture content causes water vapor to flow to the drier zone. The larger the differential, the faster the rate. The kiln operator adjusts the temperature and relative humidity to control the drying rate without excessive stress formation and consequent degrade.

Humidity is easily increased in the kiln by spraying steam into the chamber through a perforated pipe. Small kilns can be humidified by steam released from open, shallow water tanks equipped with immersion heaters. A third, and very economical, way of controlling humidity is to use the moisture evaporated from the wood by not venting it from the building. This sometimes retards drying since the exact humidity called for in the schedule may not be achieved, but it saves fuel because less outside air must be warmed and humidified. A skillful kiln operator can do an excellent job of drying and never use the steam spray until the end of the run, when it is needed for stress relief.

Air circulation is necessary to carry the evaporated moisture away from the lumber surface and to heat the lumber to accelerate evaporation. The air circulation system also vents wet air from the kiln and brings in fresh, dry air to aid in humidity control. The air is moved by fans. In modern kilns, velocities of 500 feet per minute through the load are desirable, although speeds as low as 200 fpm can be effective. Whatever the air speed, it is essential that the air move uniformly through the stack so that the lumber dries evenly. Thus baffles are used.

With regard to species characteristics, low-density woods give up moisture faster and with less stress development than do the high-density species. Part of the difference is due to the thickness of the cell walls and the resulting volume of free water. Structural characteristics that affect the permeability of wood, such as the formation of tyloses or other deposits within the cell, slow down the drying rate and increase the risk of degrade. This is why white oak takes longer to dry than red.

How a kiln operates

Briefly, a lumber dry kiln is operated as follows: The boards are carefully stacked in the kiln chamber with uniformly thick stickers between the layers. Stickers should be spaced on 16-in. or 24-in. centers along the pile and vertically aligned in successive courses of lumber. The ends of the boards should be supported because even a 10 or 12-inch overhang will droop during drying. Good stacking is critical to obtaining flat, dry lumber.

As the lumber is stacked, the operator selects and sets aside several boards that represent the wettest and the driest material in the load. He may be guided by a moisture meter, by weight (heavy generally means wet), or by other knowledge about the initial wetness of the load. A commercial kiln operator takes four to eight samples in 20,000 to 50,000 board-foot loads. Even with loads as small as 500 BF, two or more samples should be taken to ensure control.

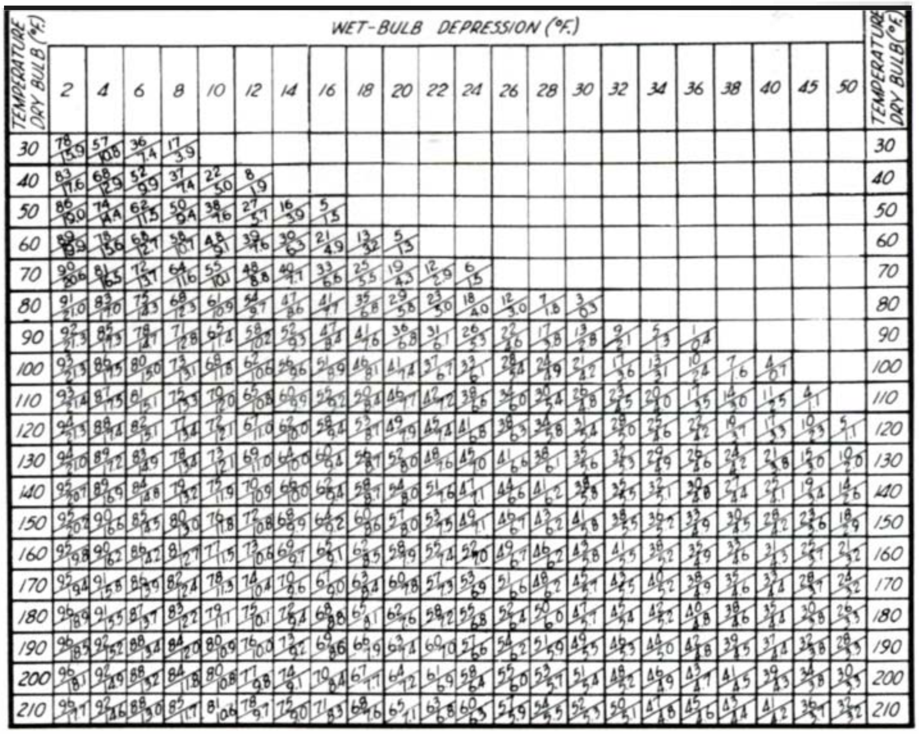
The operator cuts sections about 30 inches long from the centers of the sample boards, to avoid being misled by previ-

From wet-bulb and dry-bulb readings, operator uses large chart to find relative humidity (above diagonal line) and equilibrium moisture content. Chart below left gives typical kiln schedules; chart at right determines EMC values for stress relief at end of kiln run.

Final desired average moisture content	Moisture content to which driest sample should be dried	Equilibrium moisture content at which charge should be equalized	Desired moisture content of wettest sample at end of equalizing	Equilibrium moisture content values for conditioning treatment	
				Softwoods	Hardwoods
5%	3%	3%	5%	7- 8%	8- 9%
6	4	4	6	8- 9	9-10
7	5	5	7	9-10	10-11
8	6	6	8	10-11	11-12
9	7	7	9	11-12	12-13
10	8	8	10	12-13	13-14
11	9	9	11	13-14	14-15

CHERRY 4/4, 5/4 and 6/4

Moisture Content	DB	Dep.	WB	RH	EMC
Initial to 35%	130°	7°	123°	81%	14.0%
35 to 30	130	10	120	73	12.1
30 to 25	140	15	125	64	9.6
25 to 20	150	25	125	48	6.9
20 to 15	160	40	120	31	4.3
15 to Final	180	50	130	26	3.3
CHERRY 8/4					
Initial to 35%	120°	5°	115°	85%	16.2%
35 to 30	120	7	113	80	14.1
30 to 25	130	11	119	71	11.5
25 to 20	140	19	121	56	8.4
20 to 15	150	35	115	35	5.0
15 to Final	160	50	110	21	3.2
WALNUT (Black) 4/4, 5/4 and 6/4					
Initial to 50%	120°	7°	113°	80%	14.1%
50 to 40	120	10	110	72	12.1
40 to 35	120	15	105	60	9.7
35 to 30	120	25	95	40	6.6
30 to 25	130	40	90	21	3.8
25 to 20	140	50	90	14	2.6
20 to 15	150	50	100	18	2.9
15 to Final	180	50	130	26	3.3
WALNUT (Black) 8/4					
Initial to 50%	110°	5°	105°	84%	16.2%
50 to 40	110	7	103	78	14.1
40 to 35	110	11	99	67	11.4
35 to 30	110	19	91	48	8.1
30 to 25	120	35	85	23	4.4
25 to 20	130	50	80	10	2.0
20 to 15	140	50	90	14	2.6
15 to Final	160	50	110	21	3.2



ous end drying. Then he cuts 1-in. wafers from the ends of each sample, immediately weighs them, and dries them in an oven at 220° F until they stop losing weight. He calculates the moisture content of the wafers from the formula:

$$\text{moisture content (MC)} = \frac{\text{original wt.} - \text{oven-dry wt.}}{\text{oven-dry weight}} \text{ x } 100$$

While the wafers are drying he weighs each sample board to .01 lb. and seals the ends with paint or glue. The sample boards are assumed to contain the same percentage of moisture as did the oven-dried wafers. The boards go back into the kiln and stay there, to be retrieved periodically and weighed to gauge the progress of the drying. Based on these control samples, the operator manipulates temperature and humidity to dry the lumber as rapidly as possible with a minimum of degrade.

By calculation, the oven-dry weight of the sample board can be found. This value is used to determine current moisture content of the sample as the load dries. The formulas:

$$\text{calculated oven-dry wt.} = \frac{\text{original sample wt.}}{100 + \text{MC}} \text{ x } 100$$

$$\begin{array}{l}\text{current MC}\\ \text{of sample}\end{array} = \frac{\text{current wt.} - \text{calc. oven-dry wt.}}{\text{calculated oven-dry weight}} \text{ x } 100$$

Research and experience in the drying of various woods have resulted in kiln drying schedules which guide the operator in applying the right combinations of temperature and humidity. But only with a great deal of experience can a kiln be run on a rigid schedule. More information about kiln operation can be found in the *Dry Kiln Operator's Manual*· This manual also presents a wealth of information about wood-moisture relationships, degrade and storage.

The kiln load is started at the temperature and humidity corresponding to the moisture content as determined by sampling. It is held there, and the sample checked daily, until the moisture content has dropped to the next line on the schedule, when the kiln is adjusted accordingly.

All kiln schedules start with low temperature and moderate to high relative humidity, and become hotter and drier as the wood moisture content drops. Generally, hardwoods for furniture and other interior uses are dried to 6% to 8% MC. Softwoods such as white pine should also be dried to this level for furniture, although often softwood millwork is only dried to 10% MC.

At the end of the drying period the wood will contain drying stress (often misnomered as casehardening). This stress is normal but it should be relieved before the wood is machined, by raising the humidity in the kiln until moisture enters the surface fibers, swelling them slightly and relaxing the stresses. This is called equalizing and conditioning.

Total drying time in the kiln varies with the initial moisture content, species, thickness, and final moisture content. Low-density species dry quickly. Thick, dense woods dry slowly. Examples of comparative drying times from green to 7% MC are:

4/4 white pine	8- 9 days
4/4 red oak	21-28 days
8/4 white pine	25-30 days
8/4 red oak	56-72 days

While kiln drying green lumber has the advantage of placing the drying process under control from start to finish, thereby reducing degrade, it does cost more in terms of capital investment and energy consumption. Commercial operators much prefer to kiln dry most species after they have been air dried as low as possible. This cuts the kiln residence time in half.

Properly air-dried stock (well stickered, good pile foundation, roofed) can be started in the kiln at its current moisture content, partway through the drying schedule. The higher temperatures and lower humidities safely accelerate drying since the danger of checking was passed during air drying. A combination of air and kiln drying is especially desirable when seasoning 8/4 and thicker lumber.

Dry kiln construction

Basically, a dry kiln is a well-insulated box equipped with devices to control the environment inside. Size depends on how much lumber is to be dried in one charge and may range from a unit about the size of a garden shed to one 50 feet square by 30 feet high or larger. Kilns are usually sized by their holding capacity of 4/4 lumber, expressed in board feet. A 20,000-BF kiln would be about 15 feet wide by 50 feet long.

Kiln length to width ratio is often determined by the length of the lumber or by combinations of lengths. In small kilns, the length of the unit must be carefully considered. A kiln designed to hold 12-foot boards cannot accommodate 16-foot boards. On the other hand, a compartment designed for 16-foot stock and then operated most of the time with shorter lengths will be inefficient and, because air cannot circulate evenly, drying quality may be poor. In a well-loaded and properly run kiln, the drying time will not vary significantly with the volume of lumber.

Craftsmen using less than 5,000 BF at a time find it prohibitively expensive or impossible to obtain space in commercial kilns. But a craftsman can build and operate his own small kiln. The plan offered here is for a kiln of 500-BF capacity, in 8 ft.-2 in. lengths. This kiln should be sheltered inside a barn, garage or shop; if it is to be used in a small area such as the basement of a house, it should be vented to the outside like a clothes dryer.

Kiln structure

It is important that the kiln be well insulated to minimize heat loss, with a good vapor barrier on the inside of the insulation. This is to prevent the high humidity generated in the kiln from penetrating the insulation and destroying its effectiveness. The roof is especially vulnerable to moisture penetration. Wherever wires or pipes pass through the kiln wall or roof, they should be in a conduit that can be sealed. In this design the conduits pass through framing members rather than stud spaces and insulation. Doors and vents should fit snugly with gaskets to prevent leaks.

If masonry construction is used, the interior walls should be sealed with an asphalt-base sealer. Two coats of aluminum paint are also advisable for both a moisture barrier and reflective insulation. Our plan calls for conventional frame construction with studs and joists 16 in. on center. It is assumed that the unit will be located on a level floor and that the bottom plate will be sealed to the floor with caulking. A few anchor bolts tying the plates to the floor will ensure that the kiln stays put, but they are not essential. If a floor is poured specifically for the kiln, an inch of Styrofoam insulation under the concrete will reduce heat losses. It is also useful to install a floor drain for those times when the kiln is extra wet.

Apply kraft-backed or foil-backed fiberglass insulation to the framing with the backing to the inside of the kiln. Then install a continuous film of 6-mil plastic to the inside framing, to line the walls and ceiling completely. Fold the plastic at the corners rather than cutting it. If it is cut, caulk the joint.

The inside wall covering is 15/32 Homasote board. It has good moisture resistance and insulating properties. It is available in large sheets which minimize the risk of leakage through internal joints. Since Homasote swells slightly with moisture gain, carefully follow the manufacturer's installation instructions. Two coats of aluminum paint will improve moisture resistance.

Almost any material is satisfactory for the exterior of the kiln, as long as it protects the insulation. We recommend 1/2-in. plywood for general rigidity. Door construction is the same as for the walls.

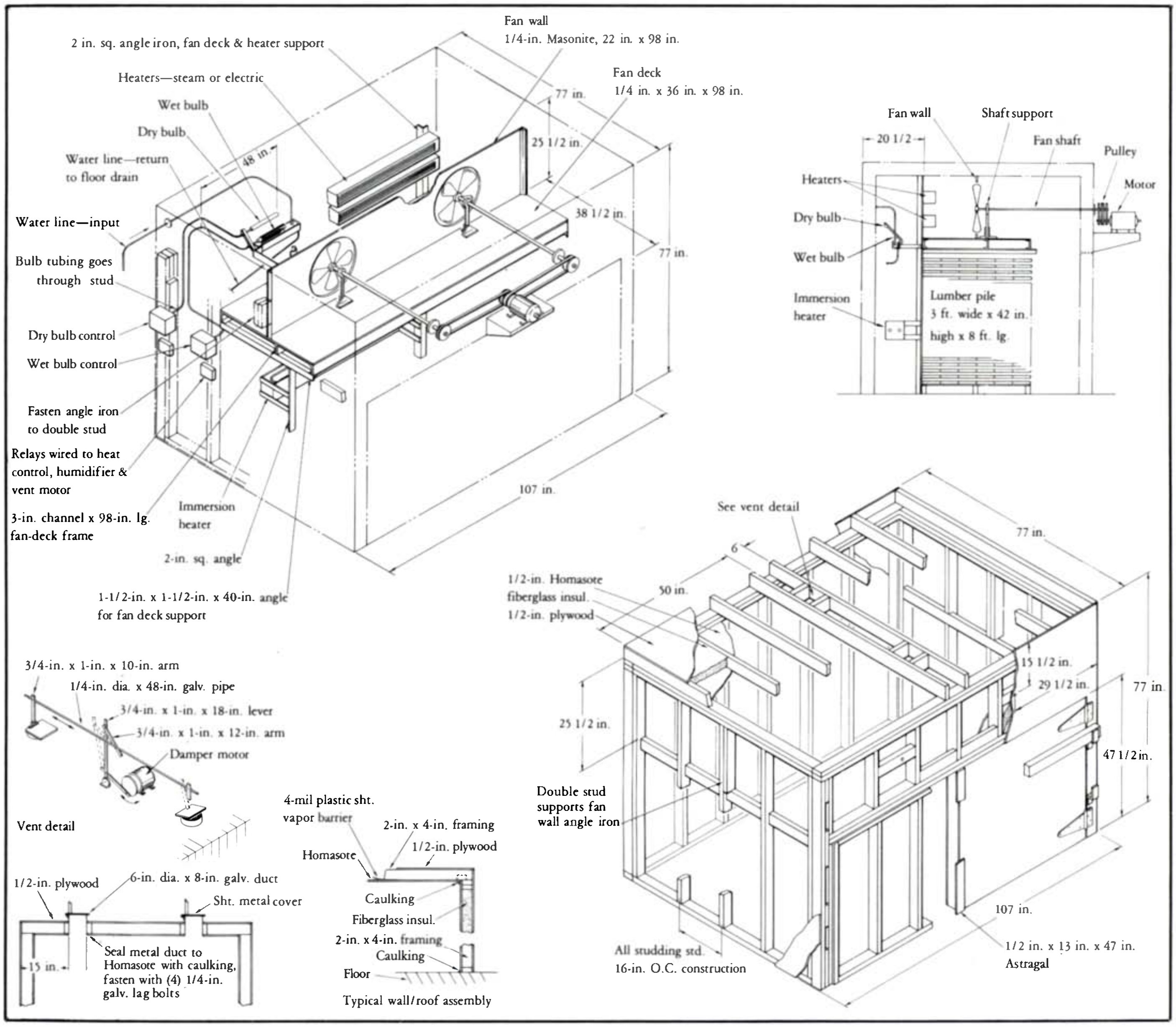
Air circulation

A single 1/2-horsepower motor drives the two fans that circulate the air. Flanged bearings (pillow blocks) can be bolted directly to the face of the kiln for the outside shaft bearing. Inside on the fan deck, the rigid-mount pillow blocks should be fastened to stands devised by the installer to align the fan in the fan wall. These internal bearing mounts must be braced to the fan deck and ceiling so they remain fixed. Install the fans so they blow in the same direction; the fans needn't be reversible because the load is small.

Heating/humidifying

The builder can adapt the heat and humidity system to available materials. Our kiln should be capable of temperatures from 80° to about 180° F. The heating system should be able to develop 15,000 BTU per hour although it will take, on the average, about 8,500 BTU per hour. This is about the amount of heat obtained by burning a pound of dry wood; it is also the heat an average room requires. Heating systems with less capacity will not generate the higher temperatures and drying time will be extended. Drying quality should not be affected, so if time is not critical less heating capacity is not a drawback. On the other hand, a system with a high heat output will give greater flexibility and somewhat faster drying. Also, it may permit the installation of additional kilns.

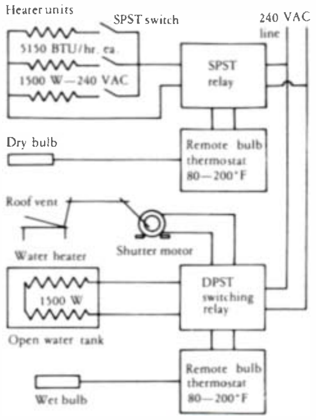
The electric baseboard type of heater is quite straightforward and easily controlled. Each heating coil has its own manual switch so that the kiln can be operated on only that energy actually required to hold the desired temperature. This results



in more uniform drying as well as energy conservation.

One drawback of electric heating is the need for an additional energy source for humidification. Our kiln uses an open water tank containing a conventional water-tank heating element. The immersion heater creates steam which is circulated by fans. A float valve keeps the tank filled.

A kiln builder can tap the steam system used to heat his residence or install a separate system. Again, a heating capacity of 15,000 BTU per hour is desirable. In place of the electric heaters, install 36 linear feet of 1-in. finned pipe (or 100 square feet of equivalent heating surface). This amount of pipe surface is based on the assumption that the boiler will operate at between 2 and 5 pounds per square inch pressure. Higher pressures require less heating surface to generate the same BTU output. As with the electric heaters, individual steam-coil control by means of hand valves is desirable.



Humidification with a steam system is accomplished by connecting six linear feet of 1/2-in. black pipe perforated 6 in. on center with 1/8-in. diameter holes. When called for by the controller, the steam will spray from the holes and circulate. Be sure to aim the spray away from the lumber to avoid staining the load.

Automatic heater and spray control valves can be solenoid-operated so the same remote-bulb thermostats and relays shown in the plan can be used. Depending on the solenoids, relays may not be needed. To conserve steam even on a 2-psi system, it would be advisable to install steam traps in the heating coils.

The kiln could also be heated by hot water (electric or oil-fired) or solar energy. Likewise, a hot-air furnace ducted to the kiln can be satisfactory. We have not worked out the details for these alternate systems but offer them as suggestions to trigger the imagination of the reader.

Ventilation

An experienced operator can run his kiln with practically no use of the vents, except when drying white pine green from the saw. However, vents are a desirable feature. For most schedules the vents can be set partially open for the entire run. Experience with various species and moisture contents will give the operator a feel for manual vent control.

Controllers

In the old days, dry kiln operators had only hand-valve control and glass-stemmed thermometers, and of course one can still do this. But a more accurate and convenient control system includes remote sensing bulbs that activate solenoid valves. The type of thermostat required for our kiln is relatively inexpensive and accurate to within 5° F. With experience the operator can set them quite closely to the desired temperatures.

The units should have a temperature range of about 80° to 200° F. Bulb capillary length of 5 ft. is sufficient. These thermostats do not indicate temperature except at the setting device. If the operator wants to see the actual temperature, we recommend he obtain some glass-stem thermometers with the scale etched in the glass. These are available at chemical supply houses for about $6.

BILL OF MATERIALS
(Approximate cost Dec. 1976)

Structure	
2 x 4 framing lumber for plates, joists, studs; 45 at 8 ft., 12 at 10 ft.	$ 77
6-mil plastic film vapor barrier, 400 sq. ft.	6
15/32-in. Homasote 400 for interior; 2 sheets at 8 x 6 ft., 3 at 8 x 10 ft.	76
Insulation, fiberglass, kraft-back; 3-1/2 in. x 15 ft.; 3 70-ft. rolls	24
Latex caulking, 4 tubes	8
1/2-in. AC plywood for exterior wall, roof, doors; 10 sheets at 4 x 8 ft.	125
1/4-in. Masonite for fan deck and walls, 2 sheets at 4 x 8 ft.	14
Hardware	
Heavy tee-hinges for doors, 2 pr. at 10 in.	16
Butt hinges with loose pin for vent covers, 2 pr. 1 x 2 in.	2
Brackets, 1/8-in., for door bars, 2 pr. 2 x 8 in.	1
16d common nails for framing, 10 lbs.	4
6 d galvanized nails for panels, 15 lbs.	9
Lag bolts, 1/4-in. galv. for deck, 50 at 2-1/2 in.	8
Machine bolts, 1/4-in. galv. for deck, 24 at 1 in.	1
Sheet metal, 22-ga. galv. for vents, water boxes; 1 sheet 30 x 30 in.	3
Flat steel, 1/8 x 2 in. for header door stop, 106 in.	3
Angle iron, 1-1/2-in. for door stops, fan wall, deck; 70 ft.	29
Channel iron, 3 in. for fan deck, 3 pieces at 98 in.	26
Rod, 1/4-in. for vent connector, 4 ft.	1
Copper tubing, 1/4-in. for water feed, 15 ft.	4
Fan system	
Two 3-blade fans, 18-in. dia., 2800 cfm at 1725 rpm	9
1/2-in. shaft for arbor, 2 at 42 in.	4
2 pillow blocks, 1/2-in. bore, flange mount	22
2 pillow blocks, 1/2-in. bore, rigid mount	10
2 sheaves, 1/2-in. bore x 3 in., 1-groove	6
1 sheave, 5/8-in. bore x 3 in., 2-groove	8
2 fan belts, size to sheaves	10
1 motor, 1/2-h.p., 1725 rpm	40
Heat and humidity system	
3 heaters, 1500-watt, 6-ft., elec. baseboard type, 5150 BTU/hr.	103
2 relays, SPST, for loads to 6000 watts	33
2 thermostats, remote-bulb, 5-ft. capillary, 80° to 200°	45
1 immersion heater, 1500-watt	5
1 float valve	3
1 shurter motor, 115 volts AC	24
TOTAL	$759

The wet-bulb temperature is controlled by having a second remote-bulb thermostat and on the bulb placing a wick which is constantly wet from a water reservoir. Do not use the humidification tank for a reservoir as this water is too hot and gives a false wet-bulb reading. Keep clean wicks on the bulb. Old undershirts or diapers make fine wicks.

The remote-bulb thermostats will trigger solenoid-operated heater and spray control valves in a steam system. In both electric and steam systems, the wet-bulb relay can energize a vent motor of the type normally used to open louvers for large exhaust fans. Enough differential should be set into the relay so that the spray and vents can never be open at the same time; trial and error will determine the differential setting.

Kiln modification

The capacity of the kiln can be increased to 1000 board feet simply by doubling its length and keeping its width and height the same. The heating units, humidification system and fans should also be doubled. The same temperature controllers will do, although they should be moved to the middle of the kiln length for accuracy.

Other modifications and improvements will occur to the operator as he builds and uses the kiln. In the meantime, we estimate that the 500-BF kiln will cost about $760 to build. Perhaps it will help some woodworkers get around the problem of finding wood. Dry it yourself.

[Author's note: The *Dry Kiln Operator's Manual* by E. F. Rasmussen (Ag. Hdbk. No. 188) is available at $2.65 from the Superintendent of Documents, U. S. Govt. Printing Office, Washington, D.C. 20402.]

Expanding Tables

500 years of making room to dine

by Alastair A. Stair

In the Middle Ages, when it was customary for the entire household to assemble for meals in the great hall, the usual dining table was of trestle construction, massive boards of oak or elm resting on central supports. Tops were detachable and the entire table was often removed after meals.

"Joyned" or "framed" tables came into general use in England, France and Italy around 1550. As these were not intended to be moved and the frames were of fixed size, a "draw top" was soon introduced. With this simple sliding mechanism the length of the table could be doubled. This style reached a height in Tudor England.

No less ingenious than draw-top tables are those of smaller size, arranged with gate legs and hinged flaps, meeting the need for expanding portable tables as rooms became smaller and special rooms set apart for dining came into general use after the 15th century.

The early tables are in the form of half an octagon or oval, with a flap hinged to the broad side. When not in use the table is pushed up against the wall with the flap folded over the top. The gates swing on oak pin pivots driven through the framing. In some examples a single gate pivoting on the central stretcher supports both flaps.

In the first half of the 18th century gate legs were made with a swing leg (most often cabriole), without stretchers. These tables display a new method of hinging the gates: a true hinge accurately formed in wood, generally of oak or beech, with a stout wire core. Instead of oak pins, metal screws hold the fixed portion of the top by passing obliquely through the underframe and into its undersurface.

Although the oak, elm and yew gate leg reached its greatest popularity about 1700 (sometimes in very large constructions with 12 legs), such tables were made in country districts until the end of the 18th century. Hardly any two tables are alike. For example, the early makers constructed the edge of the leaf where it is hinged to the table in three ways. One was to make a groove in the tabletop and a tongue in the edge of the leaf. The method generally used was to cut the edge of the leaf in a concave curve, with the reverse on the table edge, so that when the leaf is open the two fit snugly together—a rule joint. The third method has two short tenons on each leaf with corresponding mortises cut into the top of the table. About 1760 the gate-leg was revived in the guise of a small, light "spider-leg" table for the drawing room.

There was no notable advance in methods of enlargement until 1800, when Richard Gillow patented an improvement in the construction of dining tables "calculated to reduce the number of legs, pillar and claws and to facilitate their enlargement and reduction...by attaching wooden or metal sliders (which run in dovetail and square or cylindrical or other grooves) with or without wheels or rollers." These sliders are extended to the length required, and flaps are laid upon them. This is known as a "telescope" table. In 1805 Richard Brown patented a device by which "the two ends of the table frame are connected by pieces of wood, so joined together as to form what are commonly called lazy tongs."

The dining tables of the late 18th and early 19th centuries were generally made in sections held together by brass clips and supported on turned pedestals with three or four splayed

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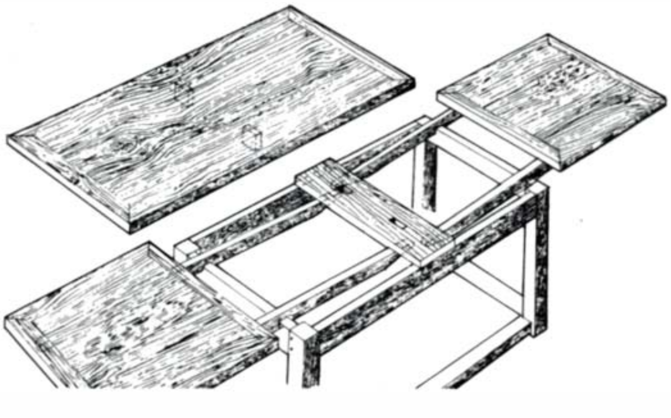
Alastair A. Stair is a transplanted Englishman and New York's leading dealer of 18th-century English furniture. All of these tables have passed through his showroom.

Leaves of Tudor-style draw-top table are fixed to raked runners, and center section is located by two horns that fit mortises in cross-rail. The leaves rise as they are pulled outward and the center rises along with them. When the leaves are just clear the center drops flush. Below, two legs are fixed and two legs pivot from wooden hinges at center of apron in gate-leg table. Early 18th-century tables more commonly had five or six legs. Note rule joint where leaf meets top.



Sheraton-style pedestal table extends, on interlocked sliders, to 90 in.

legs. These are referred to in the contemporary literature as "pillar and claws," because the curved legs often end in brass lion paws with casters. These tables were considered more elegant than their predecessors, partly because they have no legs to interfere with comfortable seating. A two-pedestal table can support one or two leaves; a three-pillar table can support more. In this fashion a dining table might stretch to 15 feet.

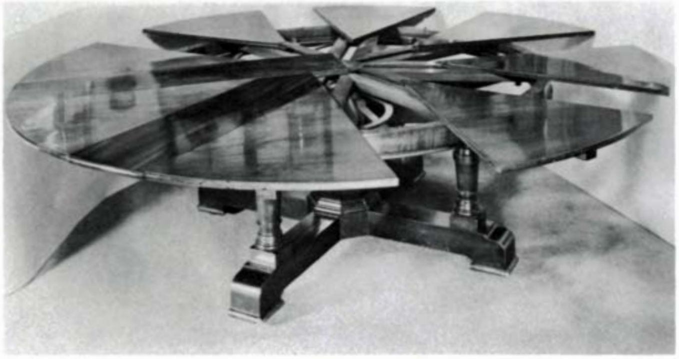
In the Regency period (1811 to 1820) a desire for ingenious constructions and novel forms encouraged the development of mechanical dining tables. A cabinetmaker named Pococks patented a rectangular table divided at the center into two leaves. When these are pulled away from each other, the extra leaf, stored beneath the top, snaps into place. The ends then push together and clip into place.

The large, circular table was fashionable and ingenious methods were devised for expanding it. Underframings became elaborate with all manner of rollers, sliders and hinges. Some examples have shaped sections added to form an outer border, fixed in position by long bearers and kept rigid by brackets. More commonly, the sections composing the surface were "caused to diverge from a common center (like a star, a pie or a medallion), and the spaces caused thereby filled up by inserting leaves."

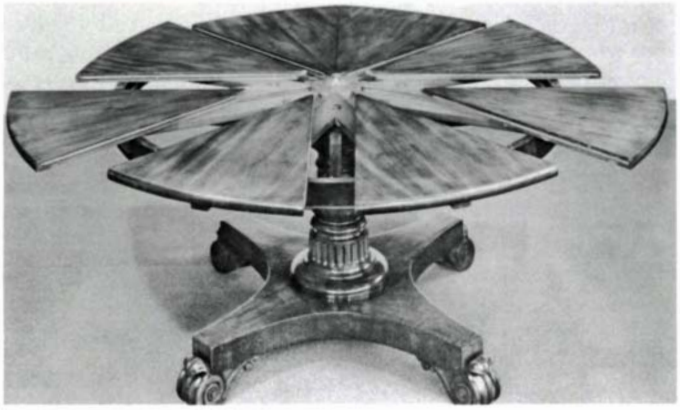
About 1835 Johnson and Jeans devised a method by which the pie-type top opens to add sections by twisting or cranking by hand. The spaces are filled with various numbers of spear-shaped leaves. Robert Jupe patented a similar table in 1835. These were made until 1900 and enjoyed a renaissance about 1920 when Schmeig-Kotzian reproduced them, winning first prize at the Chicago World's Fair. But they were too expensive to make and production was suspended around 1935.

Gate-leg variation consists of six-legged center table with rectangular flaps supported on swing legs. Semicircular end pieces, each with three legs, have independent existence as wall or side tables.

"Lazy-tongs" table folds tightly into apron at right, where hinged flap, left, conceals mechanism. Leaves are stored separately.



Mechanism of rare Johnson and Jeans table (1840) shifts wedges outward when top is rotated upon its pedestal, then leaves are dropped in. Wedges of octagonal table, below, pull out from the center and pointed slabs drop into the spaces, making it round.



Two Sticks

Ancient method simplifies layout of big jobs

by Hank Gilpin

The stick method of measuring and drawing is by no means new. I'm certain it predates all other methods used in designing furniture, since the availability of large pieces of paper is a relatively recent luxury. Prior to the introduction of S-curves in the late 17th century and the multiple-angle joinery of the Chippendale period, most furniture was joined very simply and readily adaptable to stick layout. The introduction of complex joinery and curved forms in furniture has not diminished this method's usefulness because even today most wooden objects are based on rectangles and squares. Contemporary English cabinetmakers use this method for nearly all construction except chairs, which are difficult to lay out on a stick. However, the simple Carver chairs of colonial America and the delicate chairs turned by the Shakers are obvious results of the stick method. In reproduction work the stick is very handy. If you are asked to duplicate a Sheraton bow-front chest, all you have to do is hold a stick to the front and scribe all the elements of the chest onto the sticks. Then you need only a full-scale drawing of the front curve.

I was introduced to the stick method by Tage Frid during the construction of a library circulation desk that measured 15 ft. by 18 ft. Frid grabbed the scale floor plan we'd drawn up, took a few measurements and covered two sticks with mysterious pencil lines. He made a cutting list, somehow related to those marks on the stick, attacked a 24-sheet pile of plywood, cutting, grooving and tonguing and in less time than it would have taken to execute a full-scale drawing (I'd still be hunting for an 18-ft. table) all the parts for the desk were cut to size, tongued and grooved, and ready to be glued together.

None of this really sank in until I had my own shop and was faced with my first big job. But, once I had adapted to the sticks as a substitute for full-scale drawings and devised my own method of marking, I wondered how I ever worked without them. Every element of a job can be drawn on just two sticks: doors, drawers, carcases and frames, drawer sides, bottoms, pulls, hinges, edge-banding and shelves.

In this article I'll use a kitchen to illustrate the stick method of layout, but everything I'm going to discuss can be applied to any large job that is to be constructed in your shop and installed elsewhere. I'm focusing on a kitchen because it is a job you are likely to obtain; everybody needs one. Undoubtedly this will be a larger job than you've ever done, possibly including fifty feet of cabinets. No problem. If proper attention is paid to measuring, layout and some standardization, things will progress with staggering swiftness.

The first step is careful measurement of the room with sticks, two pieces of wood 3/4 in. square (it's a handy size), each at least 18 in. longer than half the largest dimension of the room. In an 8-ft. by 12-ft. room with an 8-ft. ceiling, two sticks each 7-1/2 ft. long will suffice for all necessary measuring, with a face of the pair of sticks used per wall. For large or complicated rooms I use two sets of sticks, one for the horizontals and one for the verticals.

Assuming walls B and D are to receive cabinets we'll proceed to measure, or "stick off," the room. Facing B, hold the sticks horizontally at chest height and push them apart until they meet walls A and C. Mark the two sticks appropriately and check for variations at floor and ceiling level, noting any differences on the sticks. This noting of variations in length

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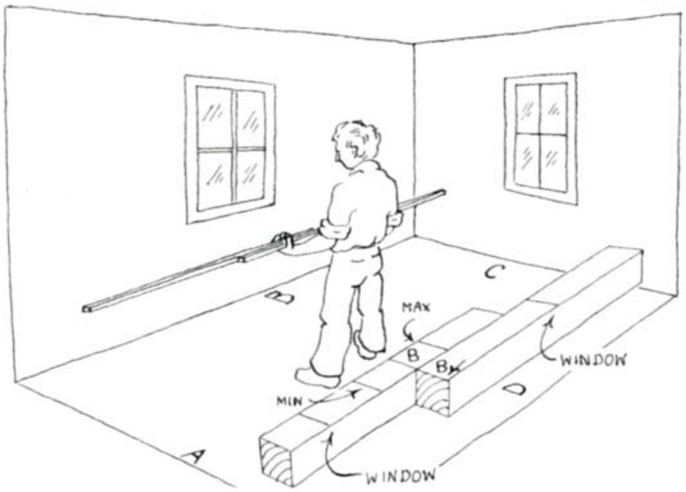
Hank Gilpin makes furniture in Lincoln, R.I., and teaches woodworking at Rhode Island School of Design.



Gilpin sticks off room, noting window position. Stick marks (left) establish scribing allowances for fitting cabinets.

will prepare you to make the necessary allowances for scribing the cabinets upon installation.

If there is a constant, such as the window in wall B, the sticks must be marked to indicate its extreme dimensions, including moldings. Use a straightedge to carry the window lines to the floor and ceiling and again check for variations in the length of wall B. Any other permanent elements in the room should also be marked on the sticks. This might include radiators, electrical outlets, pipes, doors, ducts, etc. This process, if carefully done, gives you an exact, full-scale horizontal cross section of wall B.

To obtain a vertical cross section follow the same basic procedure, but use one of the unmarked faces on the sticks or two new sticks and push them from floor to ceiling, once again marking windows and such. Check and mark variations in height by moving the sticks all along the wall. If the floor has a truly dramatic pitch, not unusual in older buildings, I like to set a level line on the wall 36 inches above the highest point in the floor's rock and roll. With this line acting as an imaginary counter top, and thus a necessary constant, I set my sticks accordingly. This is important for fitting the cabinets around appliances such as stoves and dishwashers, which require a specific counter height.

The process of sticking off should be repeated on all the walls and in any other areas, such as the middle of a large room, that are to receive cabinets. After measuring the whole room and returning to the shop I transfer all the information to clean sticks cut to length, and often to a new stick for each marked face of the old ones. Since a 16-foot stick isn't easy to come by, I use short lengths overlapped and nailed together.

Now you must design the kitchen around the available dimensions. It is at this point that you discuss entrances and approaches: cabinet styles, paint, light, heat, type of wood, sinks, tiles, floors, everything, but most importantly, appliances. A real nuisance these refrigerators, stoves, ovens and dishwashers, but these are the fixed elements in the evolving picture. So they are where you start. It is imperative that you have all the dimensions of each and every appliance your customer desires and that once a decision has been reached you state firmly but diplomatically that no changes can be allowed without increase in cost. When considering all the other aspects of the room, remember that the final appearance of your work, which will dominate the room and thus be most open for criticism, depends to a great extent on forethought and coordination of details. This usually means working with a number of subcontractors who may not be as concerned with esthetics as you are.

Once all of this preliminary discussion is completed you have to sit down and design the job. Referring to the sticks for overall dimensions, make a rough floor plan that includes all the appliances and various cabinet, drawer and counter combinations. Be careful to consider function with the esthetics.

It is helpful to make this floor plan to some scale, and 3/4 in. to the foot is easy to read and not overly cumbersome. Many cabinetmakers draw scale elevations to accompany the floor plan, but I find most customers just cannot project two-dimensional elevations into a vivid picture of the finished project. I've scrapped the elevations and instead present perspective sketches incorporating as much detail as possible. These sketches, along with the floor plan and a wood sample, give the customer a fairly good picture of what to expect. After you've done a few jobs it is always possible to take prospective customers to see a finished product, the best way of solving the problem of explaining ideas.

I know all this talk of appliances and plumbers seems contrary to the discussion of woodworking but I've learned that the preliminary planning, though time-consuming and a bore, is absolutely essential to a quick, trouble-free job.

Here is one of the basic structural approaches I use when building a kitchen. This is only *one* way of doing the job, and not *the* way.

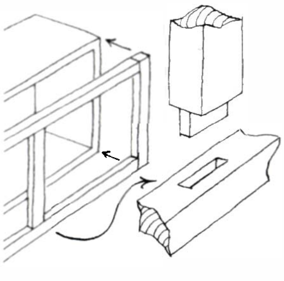
I use 3/4-in. veneer-core plywood for all carcases, usually birch for interiors and hardwood-veneered plywood for all visible exterior surfaces. It's wise to check the thickness of the plywood stock you buy as it often comes through a bit under 3/4 in. and this discrepancy might cause joinery problems. The carcases are joined by tongue and groove in two basic forms, each with a 1/4-in. tongue. One uses the standard centered tongue and the second uses an offset tongue. The offset joint is simply a way to add a small amount of strength to what is obviously a less than convincing corner joint. By setting the tongue to within 1/16 in. of the inside you gain enough strength in the vertical member to prevent the short grain from popping while gluing. Always leave a shoulder, no matter how small, as it adds a bit of strength and helps keep things square.

These joints can be cut in a number of ways, but I find it quickest and easiest to run the groove on the table saw with dado blades and the tongue on a shaper with two pattern bits coupled by a spacer made of long-grain wood that has been

This kitchen includes stove island, counters and wall cabinets. Complete layout was done on two sticks.

fitted to the groove. A new wood spacer should be made whenever you sharpen your blades because the kerf gets smaller each time. I generally find it a good practice to cut the groove first and fit the tongue to it. I also cut the groove about 1/64 in. deeper than the tongue, to allow for glue build-up and any slight inconsistencies in the cutting.

I make the carcases without backs, and the tops need not be solid pieces of plywood—a strip 4 in. or 6 in. wide at the front and back is enough to fasten the counter top to. I make my own counter tops of solid wood, usually 1-1/4 in. or 1-1/2 in. thick, with corners and edges carefully detailed. Sometimes I use floor tiles on the surface. After the carcases are glued up I face each with a solid wood frame that has been mortised and tenoned together. Remembering that any given edge of veneer-core plywood is at least 40% long grain, it becomes obvious that nothing more than glue and clamps is necessary to fasten the frame to the carcase. This frame adds the strength that was so menacingly deficient in the tongue-and-groove carcase.



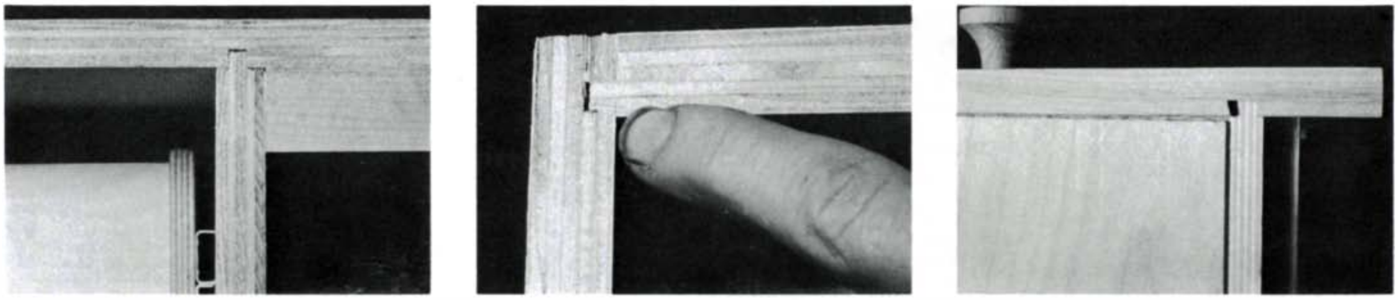
In any case, the weakness of the carcases will become inconsequential once they are screwed to the wall or floor at installation, even if the solid frame is omitted. To do this, I usually glue the edge of a 3/4-in. thick by 1-1/4-in. wide strip to the underside of the top of the carcase, at the back. I mark the location of this strip on the wall and drive nails until I hit a stud, then hold the cabinet in place and drill through for a No. 12 screw. I had a football player chin himself from an upper wall cabinet that was supported by screws into two studs; it held.

Remember that the frame is the element of the cabinet left oversize to allow for scribing as the carcase cannot be cut to match irregularities in the walls. Minor irregularities at floor level can be adjusted by scribing the lower cabinet kickboard supports before fitting the kickboard itself. Occasionally an independent base must be fitted to a room that is really out of kilter, but this does not occur very often.

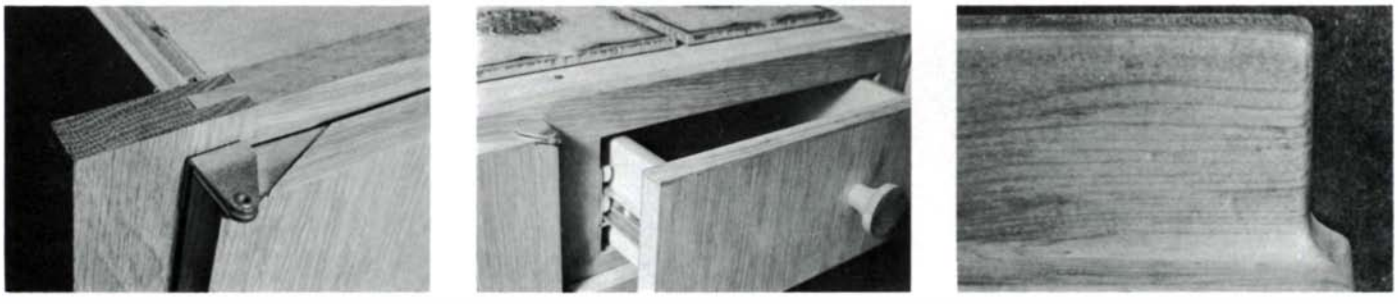
Our main concern now is transferring this information to the sticks, concentrating on the carcases, the frames, and the spaces necessary for fitting appliances. (Doors and drawers should also be laid out, but style preferences complicate matters and we'll ignore them at this point.) The depth of cabinets is predetermined in most cases, 24 inches or so for floor cabinets and 12 inches plus for upper cabinets. These are only average sizes, not absolutes, and thus, not directly related to the stick layout. As in any full-scale working drawing, the main functions provided are location of all joinery and full-scale measurements for the cutting list.

I'll discuss only the sink cabinet, since it is typical and straightforward, but remember that everything applies to the entire job. After locating the space necessary for the dishwasher, leaving no more than 1/8 in. on each side for fitting, you begin by marking the extreme dimensions of the plywood carcase on the width stick, the one carrying the horizontal cross section of the long wall. The cabinet is to be 36 in. wide so draw two lines, A and A-1, 36 in. apart. Then measure in 3/4 in., or whatever is the actual thickness of the plywood, from each and draw the next two lines. These represent vertical plywood sections. Now mark the height stick. If the height of the cabinet is 34-1/2 in. (without the counter top), draw a line on the stick 34-1/2 in. from the floor mark. Then simply measure down the thickness of the plywood and draw the next line. This represents the carcase top. Assuming a 4-in. kickspace, your next mark should be 4 in. up from the floor level. Again, measure in the thickness of the plywood and draw a line to indicate the carcase bottom. If you have plywood drawer dividers or permanent shelves, they too are marked out at this point. These lines on both sticks represent the carcase elements and locate the joints. I should add that I find it very helpful to color-code the various markings. I use black pencil for plywood elements, red for frames and green for doors and drawers.

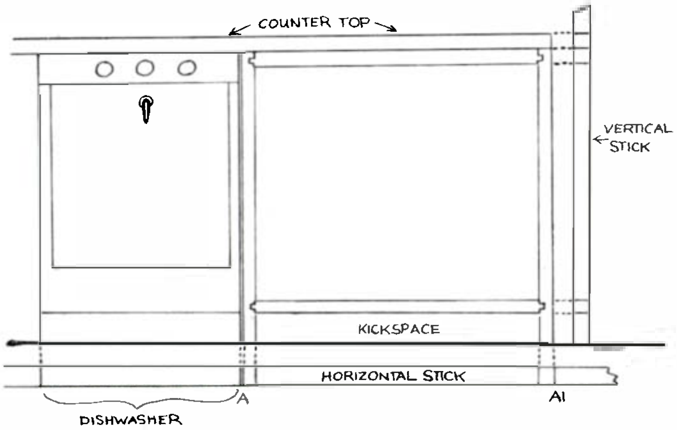
Once the carcase elements are laid out you turn to the

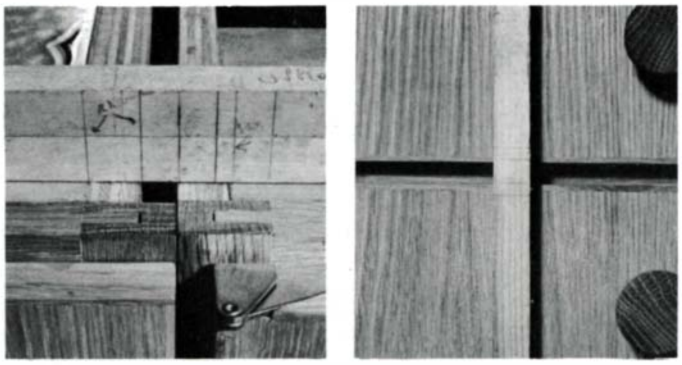


Centered and offset tongues join carcase elements, and sliding dovetails fit the sides of this drawer to an overhanging front.

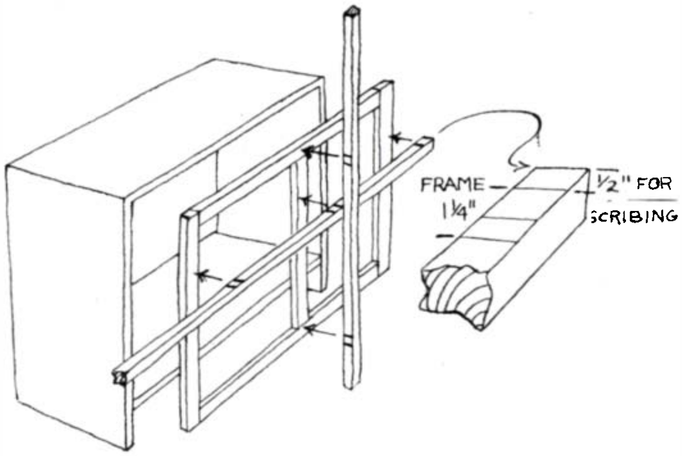


Cabinet at left has large allowance for scribing; it will be surfaced with ceramic tile. Splashboard, right, is carefully detailed.

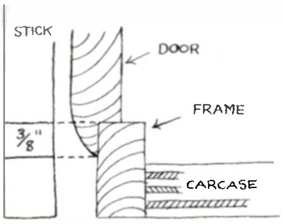




Sink cabinet, left, is marked out on horizontal and vertical sticks. Above, photo at left shows sticks atop finishing cabinet, with marks for plywood carcase and front framing; right, vertical stick locates drawer dividers and finished drawer fronts. Sticks and frames below include a 1/2-in. allowance for scribing to irregular wall.



frames that face the carcase. If your design calls for 1-1/4-in. frames throughout, simply measure in 1-1/4 in. from the extreme dimensions on the carcase and, using the red pencil, mark the sticks appropriately. If you are allowing for scribing, this is the time to mark it on the sticks. If the wall to which you are fitting is 1/2 in. off square over the 3 feet needed for the cabinet, mark the frame 1/2 in. beyond the line indicating the outside of the carcase on the length stick and then measure 1-1/4 in. inward from the same line, thus ensuring finished symmetry.



All vertical and horizontal stiles, integral parts of the frames necessary for the division of the doors and drawers, should also be drawn on the sticks. If you have decided to use lipped doors and drawers (3/8-in. square lip) they can be indicated on the sticks by simply measuring 3/8 in. out from the inside frame marks on both the length and height sticks. With face-mounted doors and drawers you must first determine the spacing that is desired between each and then mark each accordingly, remembering that these marks indicate finished sizes and might include edge-banding.

Now, with all the carcases, frames, doors and drawers marked on the sticks, your next step is to compile cutting lists. One will include all the plywood elements (carcases, shelves, and probably door and drawer fronts). The other will include all the frames. I always follow the same procedure to compile the cutting lists. On the plywood list I include a cabinet designation, what each piece is, the number of said pieces, type of wood and size. I indicate the pieces to be tongued and those to receive edge-banding.

You know the depth of the cabinets, so all the carcase pieces will be 23-7/8 in. deep (or 11-7/8 in. in the case of upper wall cabinets) and because all the floor cabinets stand 34-1/2 in., the vertical elements will be listed as such. In general, horizontal pieces have tongues, and verticals have grooves. The first pieces you must measure are the carcase top and bottom. Measure between the plywood marks on the length stick and add 1/4 in. for each tongue, noting same when you add the dimensions to the list. Example: If you have 37-1/2 in. between the plywood marks with two tongues, add 1/2 in., giving you a piece 38 in. long. This may seem academic but it is not often that the pieces will measure exactly 38 inches. You will more often have to fit the cabinet into a space 37-11/16 in. wide and careful measuring becomes imperative, lest you assume too much. Door sizes are simply measured and noted, although you must remember to subtract the thickness of the edge-banding if it is an element of the design because the marks on the sticks indicate finished dimensions. I make cabinet doors of solid ply, but they could be frame-and-panel for a more traditional appearance.

The frame list is compiled in the same way. All vertical end pieces will be 30-1/2 in. because all the kickspaces are 4 inches, all the cabinets are 34-1/2 in. high, and the frame does not extend to the floor. All other elements are determined by measuring between the frame sections drawn on the sticks, be they vertical or horizontal components, and adding the length of the tenons. In this case all the tenons are 3/4 in. long and shouldered on four sides (strictly personal choice—two shoulders satisfy many builders). Here again I note those pieces which will receive tenons. It is imperative to measure carefully because a 1/4-in. variation might not show up until you try and fit the frame to the carcase. Also, try to use the same ruler throughout the entire job as it is not unusual to find a 1/8-in. difference between two seemingly identical 6-ft. rules.

Once the cutting lists are complete and you have gathered the necessary stock you actually get to do some woodworking. One point I feel is helpful and hopefully obvious: When cutting plywood and lumber to size always start with the larger pieces and work to the smallest. This means you'll be cutting parts for different cabinets at the same time, which can get confusing, especially if you consider that an average-size kitchen might have 100 or more plywood parts and nearly as many frame parts. So this is not the time for casual conversation and extended coffee breaks. A few hours of uninterrupted concentration will prevent large headaches later.

Stacked Plywood

A fluid alternative to hardwood

by Ellen Swartz

Author with Surform

Making plywood furniture and understanding that process as a possible vehicle of social consciousness are primary concerns of mine. The material I use is secondary, although many people are struck by it first, foremost and finally. In 1970 I was searching for material to use in my simple shop and "found" plywood. It was easily available, inexpensive, strong when laminated, and could be worked with the basic tools I had. The more I used it, the more it appealed to me. I use it so there is very little waste (political appeal); it isn't rare or precious so my prices can reflect that (social appeal); I can scrounge plywood at construction sites for smaller works (economic appeal); and the simple and direct methods of construction allow me to concentrate more on concepts than technique (personal appeal; i.e., knowing your strong points and limitations). All said, we seem suited for each other.

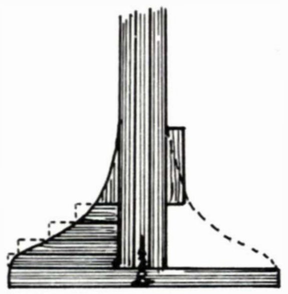
The technique of making plywood by fastening thin strips of wood together and alternating the direction of the grain to give greater strength has been known since the time of the ancient Egyptians. At the Step Pyramid at Saqqara (2700 B.C.), plywood was found in which six 1/4-inch layers with alternating grain directions were fastened with wooden pegs. However, it was the demand for plywood for building ships and planes for the First and Second World Wars that brought about the product we know today. Until that time, the impermanency of casein, animal and vegetable starch glues retarded the development of plywood. The improved casein glues of the 1920s and 30s were used in airplane construction, but repeated cycles of wetting and drying caused eventual deterioration. The development of resin glues in 1935 made available an adhesive which is waterproof and immune to bacterial attack. It is unaffected by wet-dry cycles or intense heat and makes a permanent weld. In plywood glued with phenol resins, the glue lines are stronger than the wood. From an engineering standpoint, the advantages of plywood are impressive. It is extremely strong in comparison to its weight. It is durable, and it is permanently cured so there is no checking or splitting as with solid wood.

There are many ways of putting plywood together to make furniture. For the past 40 years, molded plywood has been well developed by industrial furniture designers. Veneer-covered plywood is widely used in panel and carcase construction and in cabinetmaking. But plywood can also be glued together in layers, building up to almost any form by laminating thin, cross-sectional slices. A stack of "side-view slices" can be face-glued together to block out the form of a chair that is then shaped and finished. Pieces of ply can be glued edge-to-face to make a right-angle joint, as long as the joining surface is large enough. If the area of contact is small I use screws or lag bolts for strength, as where the arms of a chair join the back. Sections can be hinged together. Laminated plywood lends itself especially to fluid, bending shapes because no joints are needed at the bends. As long as the material is thick enough for the stress it has to take, it will be extremely strong.

Plywood isn't suitable for traditional joinery, although pinned finger joints, as at the back of a chair rocker, work

High chair, coffee table, side chair: plywood's horizons open wide when the designer's mind escapes from the 4x8 sheet.

well. They need to be rather large because there are no complete long-grain to long-grain glue surfaces. I make each section three layers of plywood thick and stagger the layers to form the finger joint itself. It's very strong. To make a transition from horizontal to vertical, as in a table pedestal, I start by gluing the three vertical layers that form the column itself. Then I measure up four or five layers and glue a vertical lozenge-shaped piece to each side to form the transition, with its bottom edge square to the side of the column. I usually shape the column and the transition piece next, because there is still room to work, then I cut the base plate and screw it to the bottom of the column. Last, I cut the four or five layers that will fit between the transition piece and the base plate and glue them in place. If the measuring didn't work out and they're too thick, I plane off a layer of ply. If they're too thin, I add a piece of veneer. Then I carve away the stair steps and shape the whole base.

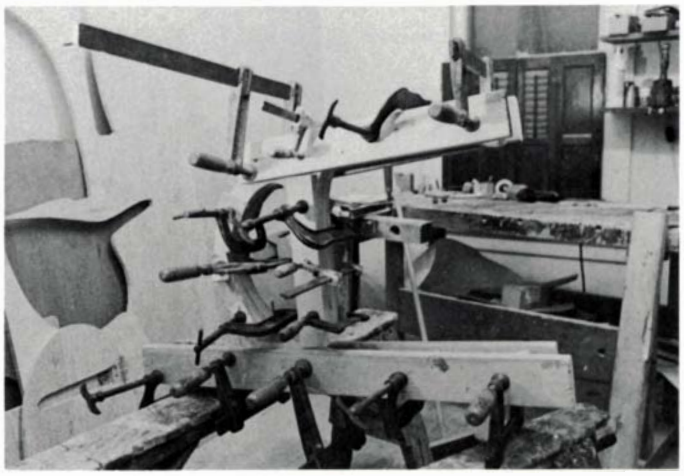


In terms of design, there are several ways I proceed. If an idea is quite clear, I make a small, three-dimensional and side-view sketch. Often I will ask the person I am working for whether he has any ideas to contribute, either verbally or through a drawing of his own. Other times I proceed with a rather vague idea and no sketch. This approach often evolves forms I'm sure I wouldn't ordinarily think up.

Once I determine the basic form I go directly to the plywood and draw up the first slice. This replaces the full-scale drawings many furniture makers use. The first and successive slices are cut out with a saber saw or band saw. The slices may be assembled from smaller pieces as long as the joints don't coincide from layer to layer. Usually I glue several slices at a time, sometimes as many as eight or ten. I use adjustable bar clamps and cee-clamps, placing one every 6 to 8 inches. I use Titebond yellow glue, which dries quickly, but 24 hours is still not too long to wait if much stress is going to be put on the joints.

For rough shaping I use a gouge and mallet, or a small electric chain saw. Then on larger pieces I use a high-speed sander—an auto body grinder, really—to take out the chain-

Sinuous bend of three layers of plywood is made first; it is very strong and needs no reinforcement. Two small lozenges are glued and shaped for the transition atop the base, then the bottom plate is screwed on, and the half-layers of the base itself fit in between. Similarly the tabletop, except the surface piece hides the screws into the upright section.



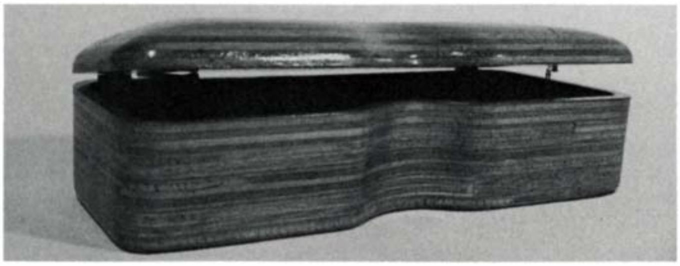
Chair begins with four side-view slices, clamped together without glue at the center.

When side has been shaped and four layers added to start the seat, gouge and Surform remove the stair-steps.

A wedge-shaped section will join the two halves, with dowels for reinforcement because the seat is supported only at the front.

saw marks. But I use the Surform and rasps to give all the shapes, curves and transitions their final form. Next I file to remove Surform marks. I fill checks, voids and splits in the plywood with oak-colored plastic wood and sand. I usually start with 30 grit, then finish with 50 or 60 grit.Sometimes I sand as fine as 80, but rarely. Because of the striations, plywood doesn't have to be sanded as finely as solid wood; because plywood doesn't expand and contract like solid, the plastic wood won't fall out as long as a sealing finish is used. I generally apply six coats of urethane varnish, sanding the second and fourth coats with worn 80-grit paper. The number of coats and the sanding builds a smooth finish on the rough-sanded ply.

The major difficulty in working with plywood is the chipping out caused by working your tools across layers going in different directions. Abrasive tools are better than sharp-edged ones for most operations because they cause less chip-out. And the abrasive nature of glue lines quickly dulls a sharp edge. Otherwise laminating plywood is a direct and easy method and a lot of technical background is not necessary before beginning.



Jewelry box is made of scrap. Cantilevered seat design of finished chair pushes material to its limits.

Rocking Chair with Message

Ellen Swartz made this rocking chair last year, when she was invited to show at a gallery of contemporary craft. Before applying the varnish, she wrote a message on the back:

In this society our responses to our work and to life in general are often conditioned by the cultural legacy of "rugged individualism," i.e. competitiveness. As a basic cultural tenet, competitiveness pits people against people and people against nature. A reordering of what we value which would place respect, equality and unity above divisiveness, could be a step toward re-establishing balance within society and within nature. I feel craftsmen/artists, as well as social thinkers, philosophers and doers, have a responsibility of evaluating their work and its relationship to the social, political and economic needs of society. If we remain on our ascribed pedestals and only feel we need to relate to the world of aesthetics, we remain part of the problem, not part of the solution.

Many viewers stopped cold, wondering why she had ruined the piece by writing all over it. But several inquired about the chair, and an art teacher eventually bought it—as much for the sentiment as for the chair itself. Swartz usually writes on the furniture she makes for invitational shows, aiming the messages at the audience such shows attract. "If I'm going to enter art shows," she says, "I want those people to listen to what I say, to react to it, even to say why did she ruin it."

Swartz, 31, is no raving revolutionary, but she believes American society needs some changes. She says that in traditional societies the artisan is an integral and necessary part of the culture, making the functional things everybody needs. In industrial society, mass production makes those things, often not very well, and only the rich can afford craftsmanship. As a result, she contends, the work becomes more sophisticated, elegant and technically elaborate—but also more hollow because its esthetic is "art for art's sake."

Thus she advocates using found materials and common construction plywood as a reaction against elegant, expensive rosewood or walnut. Her shop is simple; her only machine is a band saw, although she is a trained cabinetmaker.

The point of all this is to integrate her work as a craftsman with her life in the city. Her prices reflect the same ideas. When not bartering her work, she will build on commission for the same hourly rate that the buyer earns.

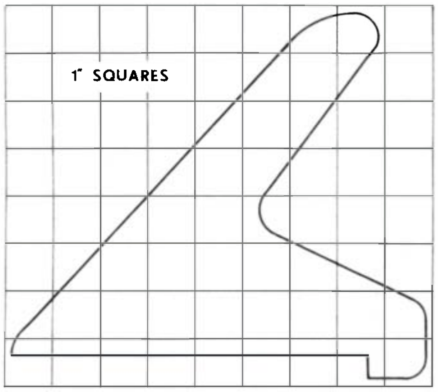
"I'd like to see craftsmen consider other ways of working," she says. "I'll try to use my work for good things, not all self-gain. Sure, I'm hooked into the system too, but it's a matter of degree. It's not to reject everything wholesale; it's small re-evaluations that may lead to bigger things." —J.K.

Two Tools

Push-stick; duckbill scriber

In ripping lumber on the table saw, the operator protects his fingers by using a saw guard and a push-stick. A push-stick feeds the stock forward and provides lateral force to guide the board firmly against the fence as well as hold-down force to keep the lumber on the saw table. The traditional push-stick is simply a stick with a notch in one end. This dangerous device has serious disadvantages. Boards (especially at the forward end) cannot be held firmly enough against the fence for accurate ripping. There is little control over the upward thrust of the lumber that results from the friction of the board against the rear edge of the saw blade. These shortcomings tempt the operator to use his free hand to help guide the board, to discard the push-stick entirely, or to decide that the saw guard is in the way and remove it. Here the guard has been removed to take photographs.

Improved push-sticks are safer.



Basic push-stick pattern

Careful analysis of the ripping requirements—feed, guide and hold-down—produces a safe, single-handed push-stick. This improved design applies force at a point well forward on the board to provide enough leverage for firm hold-down. The rear overhang ensures forward feed. The grip of the long bottom surface is enhanced by a covering of thin rubber, rubberized fabric, rug underlayment or abrasive paper, fastened with an adhesive such as silicone rubber or contact cement.

Although the improved push-stick will handle most routine ripping, no single push-stick design will cover all sawing situations, and therefore details of shape and size should be modified to suit the job at hand. Narrow models should be made for ripping narrow strips; wide ones provide greater lateral stability. A double-footed pusher offers maximum control; its two feet may straddle the saw blade and carry narrow cuts safely beyond. This style also is a perfect accessory for the jointer.

It is best to make push-sticks of hardwood plywood, because it resists splitting. I don't recommend softwoods and low-density hardwoods, except for wider models. One-piece push-sticks can be bandsawn to shape from plywood sheets by simply tracing or sketching the pattern on the stock.

—R. Bruce Hoadley

The duckbill scriber is easy to make and doesn't require a lot of tools or skill. It is used for scribing frames, moldings or anything that has to fit to an uneven surface such as plaster walls or anything else out of plumb. And I guarantee you, every house has some wall out of plumb. The tool is also handy when leveling the legs of a chair or table.

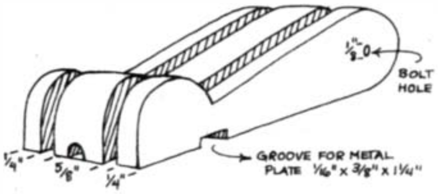
The only things needed are a piece of hardwood (preferably maple) 1-1/4 in. x 1-1/2 in. x 4-1/2 in., a piece of brass or steel 1/16 in. x 3/8 in. x 1-1/4 in. with two countersunk holes, two 3/8-in. No. 2 flathead screws, and one bolt at least 1/8 in. x 1-1/2 in. with a wing nut to fit.

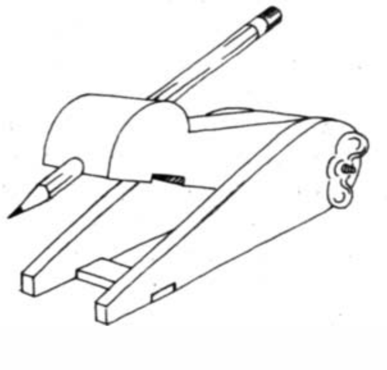
First shape the block, drill the holes for the bolt and pencil, and cut the groove in the bottom for the metal plate. Then cut off the two outside pieces at 1/4-in. thick and remove the half-round chunk from them.

To assemble it, bolt the three pieces together, then screw the metal plate to the two outside pieces. Be sure to drill pilot holes for the screws and put soap or wax on them before you insert them. File the plate until it is flush.

To scribe a cabinet to a wall, stand it in place or a little bit out. Place the brass plate side of the duckbill against the wall along the line the cabinet is to fit, and open it so the pencil touches the work. Tighten the wing nut. Now you merely run the duckbill along the wall, and the pencil reproduces all its hills and valleys. To level a chair, stand it on a flat surface and block up the legs until the seat is the way you want it and it doesn't wobble. Then lay the duckbill on the table and circle each leg, and you have your cutting lines.

—Tage Frid





Pricing Work

Keeping a small shop afloat

by Douglas Sigler

A woodworker who decides to make his living by making and selling production work at galleries, fairs and shows immediately runs into a most difficult problem: how to set prices. There are many variables and no particular formula will work for everyone. The common denominator, however, is that one must earn enough to survive.

Once a craftsman has determined what he wants his standard of living to be, or what he is willing to settle for, he should calculate an hourly rate. This is the safest and most widely applicable way to price work. But it depends on keeping accurate records of time, materials and overhead.

A craftsman who decides he needs $12,000 a year gross income should remember that 20% to 30% will go off the top to insurance and taxes (federal, state and local), leaving an annual net salary of $8,400 to $9,600. To break that down into an hourly figure, he first must realistically consider the maximum number of hours he can work in a year. While one may work a full eight-hour day, it is difficult to count on more than 45 weeks a year, figuring two weeks off for vacation, one for sickness, one for legal holidays, and at least three for selling the work. This includes time spent at craft fairs, shows, and with clients—all time that must be paid for. In 45 weeks, at 40 hours a week, one works 1,800 hours in a year. Some craftsmen set out planning to work 60 hours a week. This is fine, but one should not forget that if he were working for someone else at $12,000 a year, he would work only 40 hours a week.

Dividing 1,800 hours into $12,000 gross salary yields an hourly rate of $6.67. But this figure is based only on time—to it he must add overhead and some percentage for business profit. Overhead is probably the biggest variable in the pricing formula and the wise craftsman will keep it to a minimum. Overhead has ruined craft businesses that should have succeeded. When figuring overhead one must keep in mind that it does not stop for holidays and weekends—a business pays the same overhead whether the craftsman is working 365 days a year or 225. Here are some typical figures: rent or mortgage, $150 a month ($1,800 a year); electricity, $30 a month ($360 a year); heat, $50 a month ($600 a year); telephone, $20 a month ($240 a year); legal and clerical

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Doug Sigler teaches woodworking at Rochester Institute of Technology. He has shown at and sold at dozens of craft fairs and formerly owned Workbench gallery in Buffalo.

Going to Craft Fairs

Many woodworkers find craft fairs the best way to start selling the things they make. A booth or table at a local fair may rent for as little as $10, and a weekend of exposure to the public is at least educational—even if nothing sells. Some professionals make their entire living producing multiples of small designs to sell at such fairs.

One of the oldest and largest fairs in the country is held the last week in June at Rhinebeck, N.Y. Last year the Rhinebeck jury culled 500 exhibitors, 86 of them woodworkers, from 1,600 applicants for the five-day show. About 40,000 people attended the fair; its total retail and wholesale sales were about $2 million, or $4,000 per exhibitor.

The first two days of the Rhinebeck show are for wholesale buyers who stock gift stores for the following Christmas. The final three days are for retail sales—the fair draws from the lucrative New York City market. Craftsmen pay a booth rental ranging from $60 to $90 and must apply for admission about six months ahead to Northeast Craft Fair Ltd. (an arm of the American Craft Council—ACC) at 12 N. Chestnut St., New Paltz, N.Y. 12561.

The work a craftsman brings to such a fair will be sold at retail and should be priced accordingly. Wholesale buyers don't want to take the goods away with them—they study what is on display and order in quantity. The usual

Ritch Kelley's dulcimers are $75-$300. He averages 10 sales a fair, work for two months.

wages, $25 a month ($300 a year); miscellaneous, which includes the business share of one's car or truck payment and repair and maintenance of equipment, $70 a month ($840 a year).

These figures total $4,140 a year. Dividing by 1,800 working hours produces an overhead rate of $2.30 an hour. Thus a person must charge $8.97 ($2.30 plus $6.67 for wages) for every hour he works just to break even. On top of that still must come material costs, and a percentage for business profit. Profit is not the same as wages—the share put aside as business profit will be used to expand, to replace worn-out equipment or buy new machines, and so forth.

I personally use this formula for both retail and wholesale pricing. The hourly figure I come up with is my basis for pricing wholesale items, which are 70 percent of my business volume. The remaining 30 percent of my production I sell myself at retail, at double the wholesale price, so that an item bringing $20 wholesale sells for $40 retail. The difference, the retail markup, is my business profit. I have found that this 70:30 ratio works well for me and leaves enough capital in the business to keep it going. I would love to sell everything retail but I don't have the market for that or the time to find it.

After arriving at an hourly rate, pricing becomes a matter of keeping accurate records of raw materials and of hours in each crafted piece. The important thing is to make sure one works the hours that are recorded, and also to be sure those hours were on the particular piece being priced. Never guess at the number of hours already worked. The 80 hours that one might guess were in a finished piece, instead of the 60 actually worked, could make the difference between selling it or keeping it in one's own collection.

The time to start pricing is after an item is designed and jigged for production, not when it is still an idea or a prototype. This is also the time to settle on the number of pieces to be made. Making only five of an item does not cut the costs very much, but making 20 will probably bring the price down to what the market will bear. Thirty might not be as easy to sell, but the remainder can go into inventory and one will not have to rerun that piece for some time. This will help keep you sane.

Production items selling for less than $100 are impulse purchases. There is a fine line between what is profitable and what is not, what will sell and what won't. That is why it is so important to know exactly what each item costs to make. My formula has uncovered a couple of items on which I was actually losing money.

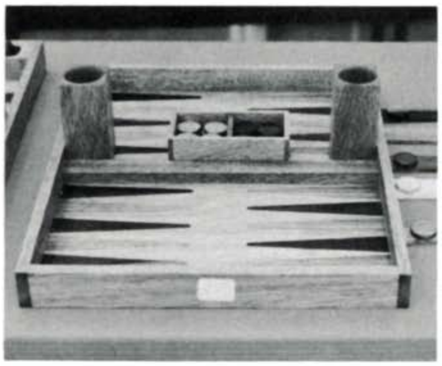
For wholesale craft fairs, I have found that a starter kit is an excellent way to get into new galleries. Before the show, I pack a selection of all my production items into a carton. The wholesale total might be $325, but I'll sell the whole kit to a gallery for $275. That way the gallery buyer can get samples of my whole line, and I don't have to work out dozens of complicated orders and go home with lists of this and that to pack up and ship. I save money and headaches because I can just hand them the box and send them a bill.

When a gallery buys my starter kit, I tell the buyer to return items that don't sell, and I'll exchange them for more of the things that do sell. I've found that what won't sell in one gallery will sell somewhere else. I've always exchanged goods for goods, but never for cash, and I've very rarely finished with unsold work.

A craftsman can apply the same pricing approach to individual commissions, if his records are complete enough to allow him to estimate his time accurately. Since the client is buying the design, he usually is not so concerned about price and the maker has a lot more flexibility—it often comes down to what the market will bear. Sometimes commissioned work sells for high prices because the craftsman is not eager to get rid of the piece. And sometimes the price is scaled down because, however much fun it was to make, it won't sell for what it cost. In any event, accurate records of time and materials are essential.

Wood-N'-Things sells toys through Rhinebeck and its own gallery. Car above is $15.

Geoff Miller makes about 95% of his living from fairs. He sells mostly wholesale.



Miller's backgammon sets sell better than the turned, laminated bowls.

wholesale discount is half the retail price. Most buyers expect to be billed when the goods are delivered, and the craftsman should guarantee a delivery date. Accurate order-taking is essential.

Some woodworkers at these fairs are furniture makers who don't want to produce multiples, but still need access to markets. They aim their displays at the retail public and use the fair as a showroom. Just one buyer wanting a complete living-dining room could provide work for six months.

The Rhinebeck fair accepts craftsmen from 12 Northeast states. The ACC also sponsors a February wholesale fair in Baltimore for craftsmen living east of the Mississippi and an August fair in San Francisco drawing from nine Pacific states. Other major annual fairs include the Ann Arbor (Mich.) street fair and the Old Town fair in Chicago.

The best way to find out about fairs in your state is to join the local craft organizations—you can track them down through the ACC at 44 West 53rd St., New York, N.Y. 10019, and

Colonial Costs

. . . and a guess for today

by R. E. Bushnell

Of the many questions asked by people visiting the cabinet shop at Old Sturbridge Village, the most common one is, "What would that have cost originally?" followed closely by "How much would that be in today's money?" Have you, as you made a reproduction or looked at an antique, asked yourself the same questions?

At Old Sturbridge Village we have a fine and comprehensive historical research library. The account books of many early New England cabinetmakers provide a wealth of information not only about what they charged, but also about what they made, the woods they used, the cost of the woods, how they made stains and varnishes, and their extracurricular activities.

In the outlying rural districts were men who called themselves cabinetmakers, but who actually were little more than carpenters. They made doors, window sashes, moldings and paneling, simple country furniture and household items, and mended wagons and sleighs. Because theirs was an agricultural society, most of these tradesmen were also farmers. A few owned taverns, sawmills or livery stables. They put their hand to anything to make a living.

On a higher level of competence were their urban cousins who worked in the larger, more prosperous communities. These men had undergone a specific apprenticeship—usually seven years long—and their main source of income was their trade. Most of these cabinetmakers were competent workmen who left us the majority of today's antique furniture.

At the apex of the profession were the men who worked in the cities (or near cities) and developed cabinetry to its highest level. The work and especially the designs of such men as the Goddards and Townsends of Newport, Frothingham and the Seymours of Boston, MacIntyre of Salem and the Chapins of Hartford has, in my opinion, never been surpassed.

Our records contain the account books of Lemuel Tobey of Dartmouth, Mass., an artisan who falls into the great "middle class" of cabinetmakers. The record begins in 1773 and continues through 1800. His accounts are in English pounds, shillings and pence—he never did convert to the American decimal system although it came into use during the middle 1790s. Mrs. Caroline Sloat, researcher at Old Sturbridge Village, has provided conversion figures: 12 pence (d) = 1 shilling (s); 20 shillings (s) = 1 pound (L). In New England, 6 shillings (s) = $1.00. Therefore, by using a little arithmetic, 1 penny (d) = $.0138; 1 shilling (s) = $.1666 and 1 pound (L) = $3.33. These represent average figures during Tobey's working life, since a mild depression and scarcity during the Revolution caused a rise in currency values. In spite of this, the prices of his various pieces remained quite constant during the entire 27 years, with variations apparently caused only by the amount of fancy work (carvings) and by the woods used. We must also assume that he was working mainly in the Chippendale style with occasional pieces of late Queen Anne and Hepplewhite.

Listed above right are the average prices of Tobey's furniture, 1773 to 1800.

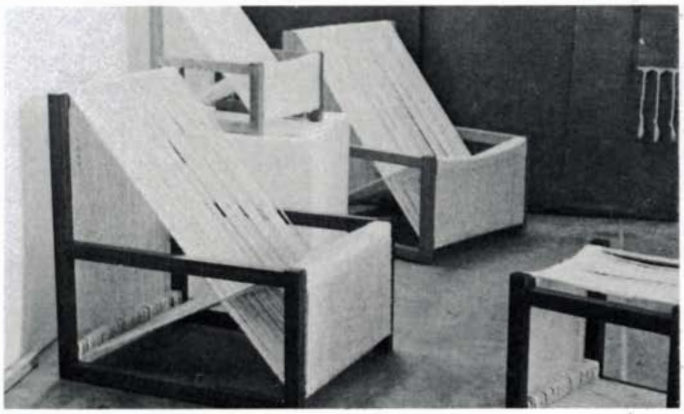
R. E. Bushnell is head cabinetmaker at Old Sturbridge, Mass., a restored Colonial town.

CRAFT FAIRS (continued)

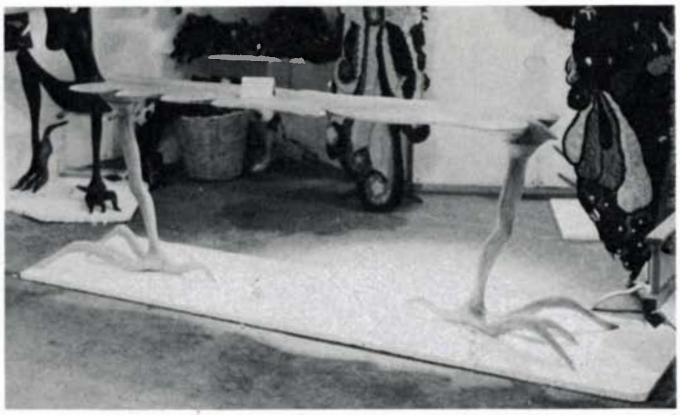
through local art museums, galleries and schools.

The major shows and some of the smaller ones are juried. Generally, the woodworker sends in five slides typical of the things he plans to sell and a panel of three professional craftsmen, usually including a woodworker, grades the slides to select the exhibitors. The important thing is a good, clean slide without distracting background.

Some of the woodworkers at Rhinebeck last June were there for the first time to test the water, and some make the rounds to a half-dozen annual fairs, year after year. Some were part-timers looking for spare change, and some expected to make their whole year's income from production for wholesale.



Daisy Schnepel's chairs sell for $190 in walnut, stools are $90. Fair's exposure generated later sales, but not enough for full-time work.



Andy Wilner's "Mortgage Table" in curly, wormy maple sold for $700. The fair yielded several sales and a few commissions.

Item	*$ then*	*$ now*
Maple desk	10.00	800
Walnut desk	14.00	1120
Mahogany desk	16.00	1280
Plain bedstead	2.00	160
Tea table	2.00	160
Mahogany tea table	4.00	320
Chest-on-chest	12.43	994
Mahogany table	9.33	746
Highboy chest	15.54	1243
Lowboy chest	6.67	534
Candle stand	1.00	80
Case of drawers	17.82	1426
Secretary	11.00	880
Large dining table	5.00	400
Round tea table	2.50	200
Chair	2.00	160
Drop-leaf table	4.00	320
Plank table	2.50	200
Cradle	2.00	160
Rolling pin	.07	6
3-ft.-square walnut table, ball & claw	6.00	480
Teapot handle	.17	14
Pipe box	.33	26
Cane	.20	16
Sea chest	2.00	160
Child's playpen	.42	34
Small child's coffin	1.00	80
Large child's coffin	1.33	106
Adult coffin	2.00	160

It is of interest to note that on the 23rd of April 1775 (shortly after the battle of Lexington and Concord) Tobey started making cartridge boxes for men of the Dartmouth area—a grand total of 41 at 1s each. Although he made a small variety of other items, the above list represents his main output—repeated year after year. As with all cabinetmakers, he also did a great deal of repair work.

Now we have a good idea of the original price of standard items made by the urban cabinetmaker, but what about the second question—the relationship to today's prices?

Well, sad to say, it is very difficult to relate accurately the price of an item made in 1776 to today's costs. The variables include the amount of apprentice labor (at little or no cost), the length of the workday (12 hours against 8 hours today), tax rates and the cost of materials. Today the employer must pay his share of workman's compensation, insurance, Social Security, retirement benefits, heat and power costs, machinery investment, upkeep and depreciation, few of which had equivalents in 1776. Perhaps a research economist could come close.

However, what's wrong with having a little fun by applying some reasonable conversion factor? Records indicate that the average pay of a journeyman cabinetmaker was 6s or $1.00 a day. If we assume a current wage of $10.00 per hour, his modern counterpart earns $80.00 a day, or 80 times more than in 1776. We will make a further assumption that the same factor will apply to prices. Therefore, the 1776 cost multiplied by 80 should put us somewhere in the ballpark. Let's try this theory out.

Tobey made maple desks for 3L or $10. Multiplying by 80 yields $800, not too far off. Tobey got 2L or $6.67 for a lowboy. 80 x $6.67 = $534. A little low perhaps, but still within reason. This approach seems to work reasonably well for the larger items, but not so well for smaller things such as pipe boxes, which he sold for 2s. According to our theory, today's cost would be $26.64. But one made in our cabinet shop just sold for $100, about 300 times Tobey's figure.

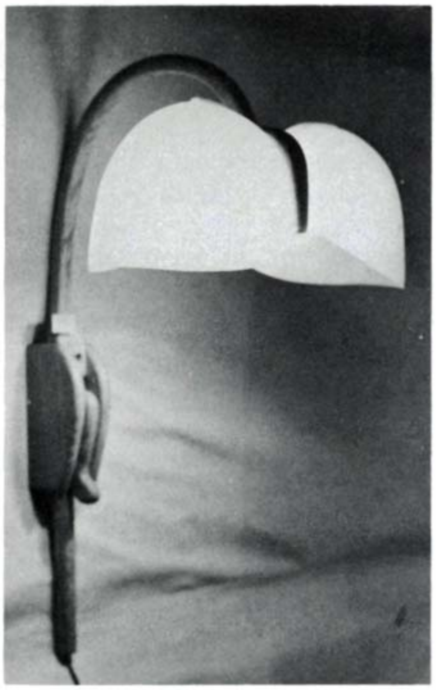
Tobey's books also contain the prices he paid for lumber, and we can compare them to today's costs. At first glance they are startlingly low: 190 board feet of maple cost him 5s 8d or $0.94. That's about a half-cent per board foot. He paid 14s or $2.33 for 42 board feet of walnut (about five cents per board foot) and 12s or $2 for 265 board feet of pine (about seven-tenths of a cent per board foot). For 114 board feet of mahogany, he paid 7s or $1.17 (about one cent per board foot). How would you like to buy lumber at those prices?

Of course if we apply the same factor of 80, maple would cost about $0.40 a board foot, the walnut about $4, the pine $0.56 and the mahogany $0.80. Except for the walnut, today's prices would be at least twice as high. Walnut in those days was scarce in Massachusetts. (It still is, especially around Dartmouth and Fall River.) Scarcity could have driven the price as high as it was, even by Tobey's standards, and the boards may have been of exceptional quality or size.

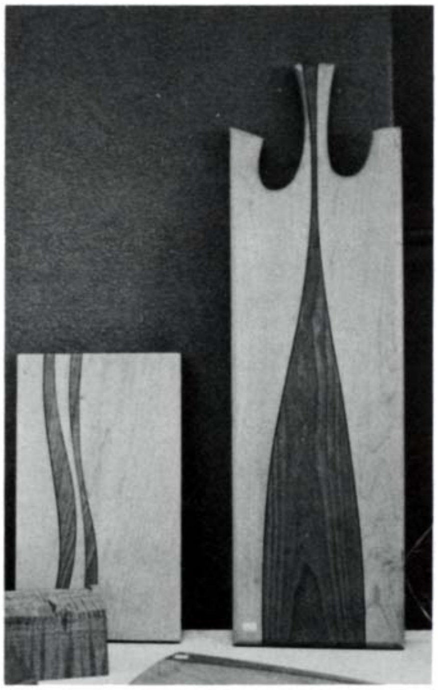
Well, despite all our conjectures and weak computations of comparative costs, it remains a most rewarding experience to examine old account books and see historic cabinetmaking come alive.

Generally, smaller items sold better at wholesale and larger, more expensive things at retail. Some craftsmen sold out and a few sold nothing. All complained about the size of the wholesale-retail price split, and of the difficulty of getting a fair return for an hour's work.

Briar pipes by Ed Shank were $25-$60. His income is earned from fairs and shows.



Peter Danko's wall lamp was $180. Although interest was high, sales were low.



Wayne Rabb sold many cutting boards at $10-$25, and also some furniture.

Serving Cart

Sliding top solves design problem

by Alan C. Marks

When first approached to design and build a serving cart, I was excited by the challenge. Most people who come to me have vague ideas of the function and other requirements their piece of furniture can or should fulfill. In this instance my instructions were specific, but rather than restricting the imagination, they liberated me from many critical decisions.

The height was to be 34 inches. The size of the table was to be 24 in. x 15 in., but it had to expand at least half again its length. Because space was limited, it was to take up as little room as possible when not in use. The cart was to roll equally well on linoleum and shag rugs. It had to have a drawer for potholders and carving utensils, which I measured to determine drawer dimensions. A carving board and a serving tray would be stored on a shelf below. Another shelf would carry used dishes and utensils to the dishwasher.

Dark walnut paneling and furniture decorated the room in which the cart would stand. The logical choice of wood was therefore walnut. I am used to designing for light woods, which I prefer, so I decided to make two carts, one of walnut for the client and one of close-grained Douglas fir for myself. I was afraid I would lose enthusiasm for the work if I couldn't look forward to a completed serving cart in a delicate wood like Douglas fir, and losing enthusiasm is the worst thing that can happen to me.

I think dark woods lend themselves best to sculptural pieces where overall shape or form is primary. With light woods small touches, color nuances and molded shapes stand out and enhance large wooden surfaces. This is because shadows produce greater contrast on light woods than on dark woods and describe small shapes well; details are emphasized rather than melting into an amorphous mass. Even details in shadow are light enough to be seen and to contribute to one's appreciation of the whole piece.

My biggest difficulty was how to increase the table surface. Everything else would depend on that decision—shelf placement, type of drawer, legs, everything. Usually some factors take sequential preference in a design problem; it is good to get the sequence right and avoid backtracking. It is best to make unpleasant discoveries on paper, so I do preliminary sketches first. While wildly drawing, I also consider whether it would be possible to build the piece as sketched. I mentally formulate assembly sequences and methods to determine whether or not it can be done.

Available hardware for drop-leaf mechanisms seemed ugly and poorly made. I wanted traditional handles to push the cart around with, and drop leaves on the ends would make this difficult. The leaves would conceal a large portion of the framework, and the hinged joint would not be attractive. So I discarded the idea.

Having two hinged leaves fold down from rest on top of the table seemed good. The table leaves would need support, and the handles might be able to perform this function. I would use a set of rails, front and back, and a drawer would slide on a frame on top of these.

Pleased with my preliminary sketch, I proceeded to a full-scale, head-on drawing that included construction details. I was confident I had a good solution. (Sometimes I can skip the working drawing for things easily kept in my head, but the cart was too complex.)

On the drawing, I spread the legs slightly to afford a wider base, because I feared that weight on the unfolded table leaves might tip the cart. This change also increased shelf space, as did tapering the legs, though the latter was mostly for esthetic reasons. Tall, parallel legs on a strict vertical appear to converge when viewed from a normal height, and the piece may look unstable. Tapered, slightly spread legs give a firm impression of stability.

The handle supports had to attach strongly to the legs, to provide enough meat for a cross-member to stabilize the frame and also be convenient to push on, and they had to complement the shape of the legs. There must be other ways of supporting the handles and achieving all this, but I was pleased with this shape and haven't come up with one I feel better about. The upper shelf rail echoes the curve of the handle supports. I didn't want to overdo this, so I left the lower rail straight, and I think it identifies with the floor and makes the cart appear anchored.

I let the tenons of all the bottom rails through the legs for extra strength and wedged them. This seemed unnecessary except where stress might break apart the joints. I didn't intend to join the side aprons atop the legs with this kind of joint, but when building the cart I accidentally mortised the first leg all the way through. Having no extra legs in reserve and being too impatient to start again on a new set, I bowed to fate and let the superfluous tenons protrude. I might pretend things turn out exactly as planned, but often they don't. The appearance didn't suffer too much from this mistake, although the cart in walnut escaped my clumsiness and looks better for it.

While drawing I worked for a general feeling of lightness and so chose spaced-slat shelves. The alternatives to slats would be either veneered and faced lumbercore, or frame-

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Alan Marks, 36, studied at Carl Malmstens Verkstadsskola in Sweden and apprenticed with Jim Krenov. He makes furniture in Pacific Grove, Calif.

and-panel construction. All would circumvent the problem of wood movement, but slats are airy and light. I ran them across the width of the cart to avoid the sag of longer lengths. I had planned to add rails on the sides of the bottom shelf for stability, and I set the slats below them so dishes couldn't slide off.

When my drawing was complete down to the minutest detail, I stood the drawing board against a wall to get a perspective on the cart.

It was awful. Top-heavy, thick and clumsy. I was annoyed with myself for assuming it would look right; experience teaches to look first and work out details later. The double top had to go. The drawer section looked much too heavy and box-like.

So I taped a fresh sheet on top and traced what could be salvaged—the legs, handles, shelves, and their placement. I mulled over it for some time, but the possibilities seemed to be exhausted. The top had to be made light and graceful, but how? A center leaf with pull-out table halves on extension slides suggested itself, but the slides would have occupied space under the table and made construction clumsy. Then everything popped into focus.

I could rout along the length of the front and back aprons with a dovetail bit and mount runners on the table halves. The halves would pull out and rest on the handles. I would use a veneered tabletop with a stable core to eliminate movement so the runners wouldn't bind. This left a cavity between the rails for storing the carving board/serving tray. The center leaf could store on the shelf. And I could hang the drawer in slots from L-shaped side aprons which also would support the carving board.

I hid the drawer runners behind an overhanging drawer front. Such a big overhang seemed unnecessary except at the top and so I felt free to curve the front at the sides to make the drawer less boxy; the curve was in tune with the handle style as well. There is a relationship between a serving cart and a carriage, and I emphasized the similarity by shaping the front and back of the drawer to give the impression of containing or carrying something. The simple pull accents the shape of the drawer front.

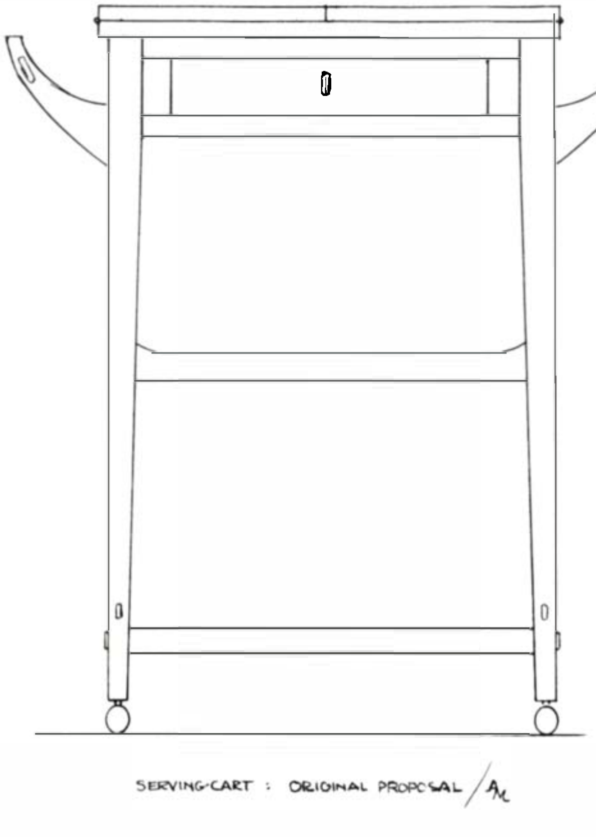
The tabletop, since it had to be veneered, required banding. I raised the banding to form a lip that would prevent things from sliding off. Usually I cut my own veneer with a band saw, so I can use wood of my choice, cut from the same planks as the rest of the piece. Color and grain structure remain harmonious this way, and I can get veneer of decent thickness, about 1/16 in. As a core, I used 1/2-in. Baltic birch plywood. I have not been able to locate a U.S. source of the 13-mm. lumbercore readily available in Sweden. The veneer grain runs lengthwise and the edge banding is narrow, to emphasize the length. The ends are capped with wider pieces that allow rounded corners and routed finger-grooves for pulling out the leaves.

The table assembly sequence was:

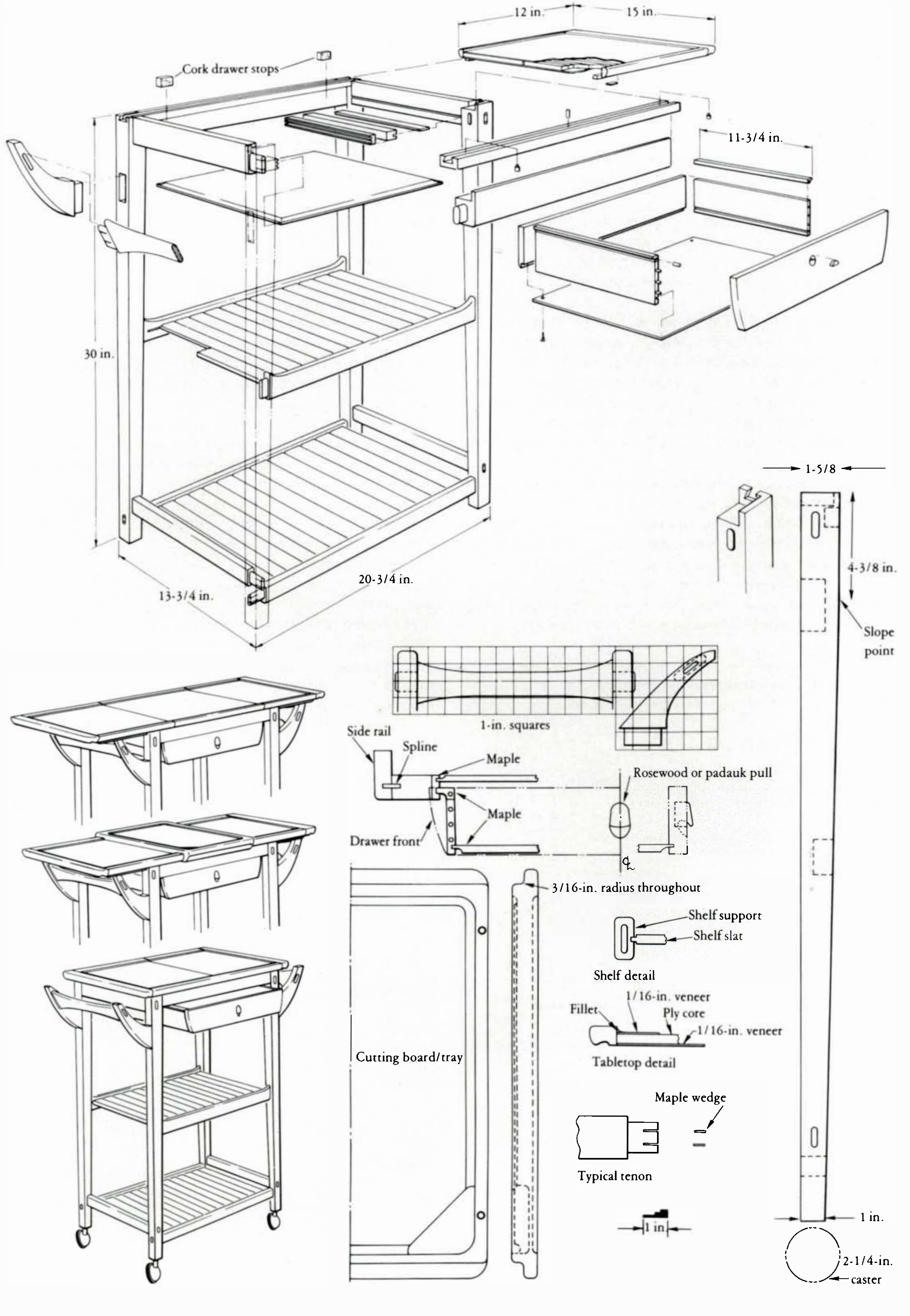
- glue and trim center bandings flush with plywood core;
- veneer (using white polyvinyl glue because it is not affected by moisture as Titebond);
- rout fillets on the inside of the banding;
- glue and trim the lengthwise bandings;
- glue and trim end bandings;
- rout finger grooves;
- shape bandings;
- round the corners.

Fitting the runners to the table halves was tricky. I made them of maple and inset pieces of maple in the aprons to dovetail through. Maple on maple glides beautifully and wears well. I predrilled the runners for screws and positioned them against stops in their dovetailed slots to protrude about

'It was top-heavy, thick and clumsy.'



Completed cart, 'made light and graceful,' in Douglas fir.


12 in.
15 in.
Cork drawer stops
11-3/4 in.
30 in.
13-3/4 in.
20-3/4 in.
1-5/8
4-3/8 in.
Slope point
1-in. squares
Side rail
Spline
Maple
Rosewood or padauk pull
Maple
Drawer front
℄
3/16-in. radius throughout
Shelf support
Shelf slat
Shelf detail
1/16-in. veneer
Fillet
Ply core
1/16-in. veneer
Tabletop detail
Cutting board/tray
Maple wedge
Typical tenon
1 in
1 in.
2-1/4-in.
caster

1/32 in. above the apron level. Then I glued and clamped the halves onto them and only then did I screw them in place. In spite of my efforts to be precise, the runners needed a lot of fitting before they would glide smoothly. This was partly because the plywood cores were slightly warped.

With the table halves gliding properly and in position, I glued the handle assemblies in place. I left the table supports a bit higher than needed and carefully filed them down until the runners slid out smoothly. The shape of the handles necessitated special clamping blocks with non-skid, sandpaper-covered surfaces which were themselves clamped to the handle supports.

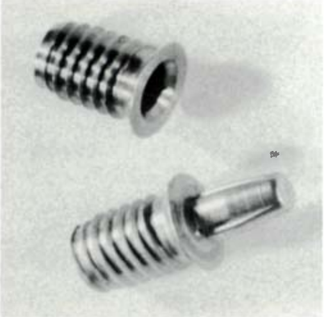
The steps in glue-up and assembly were:

- shape and mortise legs; assemble legs with front and back aprons and shelf rails; rout dovetails for the runners;
- glue these together with machined and fitted side aprons and side shelf rails with slats and compartment dividing panel in place;
- assemble table halves and center leaf; install runners and fit table halves; install locater for center leaf;
- glue handles into handle supports;
- with table halves in place, glue on handle assemblies;
- assemble and fit drawer, knob and carving board/tray.

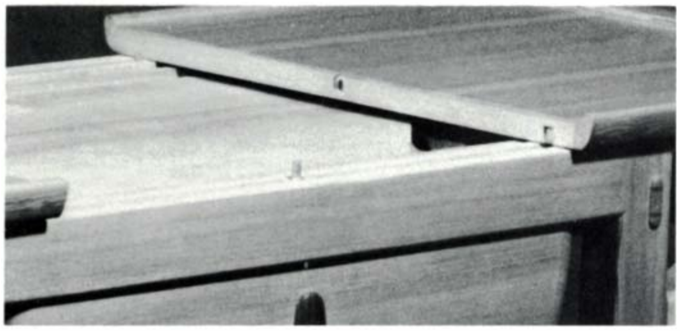
Three types of hardware were used, all where they'd hardly be noticed. I used click-stops to mark the table extension required to insert the center leaf. These are ball-bearing catches inset into the dovetail slots that pop into a brass detent plate set in the runners. To prevent the table halves from vibrating apart while the cart is rolling, I used two tiny button magnets oriented so their poles would attract. The center leaf has steel buttons on both sides. I used male and female brass locaters of the type patternmakers use to locate the carving board/tray.

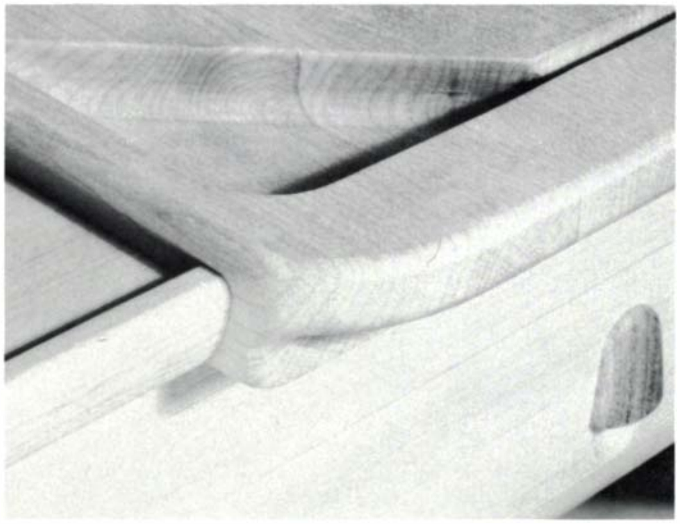
The client's walnut cart was finished with oil. The fir cart has an all but invisible coating of water-white flat lacquer.

I can't say how much time it took to construct my serving cart. I've found that the more attention I pay to passing hours, the less time is available for work. Solutions and decisions become forced, and mistakes occur. So I don't count hours.



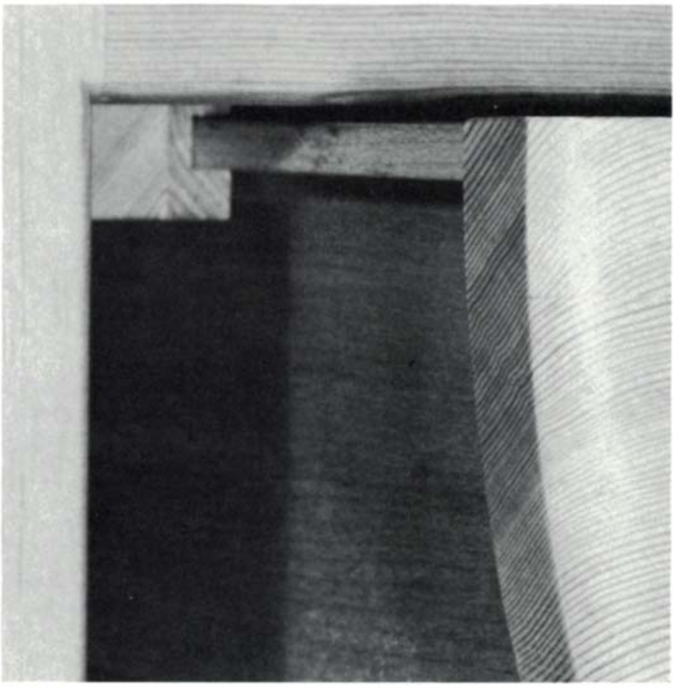
Patternmaker's locating pins, left, index cutting board and center leaf. Male pin, below, is set into center of front rail and a notch is cut into sliding leaves to conceal it. Button magnet at center of leaf edge keeps movable parts together. Bullet catches concealed in the ways control the extension of leaves.





Detail of serving cart shows cutting board/serving tray in place, and drawer pull.

Maple slide runs in dovetail way let through leg and rests atop handle support. Below, drawer hangs from slot in apron piece that also holds divider panel.



Woodworking Schools

Where they are, what they offer

Editor's note: This is a first listing of schools offering courses in various aspects of woodworking. The data were compiled from a mailed questionnaire; the survey will be updated from time to time as more responses come in and as readers inform us of unlisted schools.

The replies are summarized by type of school, length of program, degrees offered (if any), tuition, schedule and subjects offered. The information here is only a start—course offerings and fees are subject to change.

Woodworking instruction also is available through local art museums, YMCA programs, public night schools and city park and recreation departments. Our survey turned up a number of such programs, which are listed below. Undoubtedly there are many more.

Barnsdall Art & Craft Center, 4800 Hollywood Blvd., Los Angeles, CA; Craft Center, Iowa Memorial Union, Univ. of Iowa, Iowa City, IA; Home Co-op, Adult Education Dept., Orland, ME; Boston Center for Adult Education, Crafts Dept., 5 Commonwealth Ave., Boston, MA; YWCA, Art Dept., 1432 "N" St., Lincoln, NE; Craft Students League, 610 Lexington Ave., New York, NY; Emanuel Midtown YM-YWHA, Art & Workshop Dept., 344 E. 14 St., New York, NY; Riverbend Art Center, 142 Riverbend, Dayton, OH; Coos Art Museum, Education Dept., 515 Market Ave., Coos Bay, OR; The School of the Arts & Crafts Society of Portland, 616 N.W. 18 St., Portland, OR; Skagit Valley College, Art Dept., 2405 College Way, Mt. Vernon, WA.

CANADA

Sheridan College, Woodworking & Furniture Design Dept., Toronto, Ontario. College, 3-yr. diploma; full-time days. Furniture & cabinetmaking, carpentry, musical instruments, crafts.

MIDWEST

Indiana State University, Evansville, Art Dept., 8600 University Blvd., Evansville, IN 47712. College, $20/cr. hr.; full-time days. Furniture making, carpentry, crafts, sculpture & carving, industrial processes. "Furniture design and fabrication taught in new technology building with complete woods and metals lab."

Memorial Union Crafts Center, Iowa State Univ. Campus, Ames, IA 50010. 4-6 week short course, $18/course; full-time days, evenings, summers. Some furniture making, carving, crafts.

University of Northern Iowa, Art Dept., Cedar Falls, IA 50613. College, 4-yr. degree, $650/yr.; full-time days, evenings, summers. Furniture & cabinetmaking, carpentry, musical instruments, crafts, sculpture & carving.

Fort Hays Kansas State College, Art Dept., Hays, KS 67601. College, 4-yr. degree, $17.50/cr. hr.; summers, 2-wk. workshop or semester, short courses. Furniture making, sculpture & carving, crafts. "Courses in basic sculpture and advanced projects sculpture."

Art School of the Society of Arts & Crafts, Crafts Dept., 245 E. Kirby, Detroit, MI 48202. College, 4-yr., $150/3 clock hrs.; part-time days, evenings. Furniture & cabinetmaking, carpentry, industrial design.

Northern Michigan University, Art & Design Dept., Furniture Design Program, Marquette, MI 49855. College, 4-yr. degree, $19/cr. hr.; full-time days, evenings. Furniture & cabinetmaking, musical instruments, sculpture & carving, crafts, industrial design, wood science & technology. "Degrees in furniture design and wood crafts."

Chris Effrem's Woodcarving School, 3112 W. 28 St., Minneapolis, MN 55416. 1 or 2-week summer short course, $95/wk., full-time days; 7-week course, $55, evenings. Sculpture & carving, wood science & technology, forestry.

Minneapolis College of Art & Design, 200 E. 25 St., Minneapolis, MN 55404. Summer short courses, 2 wks., $145; full-time days. Carpentry, sculpture & carving. "Exploring wood as a medium for art."

Peru State College, Industrial Arts Dept., Peru, NE 68421. College, 4-yr. degree, $15.50/cr. hr.; full-time days, summers limited. Furniture & cabinetmaking, carpentry, industrial arts (teaching), crafts, industrial design, wood science & technology.

Agriculture Technical Institute, Wood Science Dept., Wooster, OH 44691. Junior college, 21-month degree; full-time days, some evenings, summers limited. Furniture & cabinetmaking, carpentry, musical instruments, forestry, industrial processes, wood science & technology. "Student career goals include carpentry, logging, wholesaling, cabinetmaking, and lots in between. The course builds a foundation for most careers available in forest products."

University of Wisconsin, Woodworking & Furniture Design Dept., Superior, WI 54880. College, 4 to 5-yr. degree, $232/qtr.; full-time days, evenings, summers, short course. Furniture making, crafts, sculpture & carving.

University of Wisconsin, Madison, Art Dept., 455 N. Park St., Madison, WI 53706. College, 4-yr. plus graduate; days, evenings, advanced classes. Furniture making, carving.

University of Wisconsin, Stevens Point, Art Dept., Portage/Franklin St., Stevens Point, WI 54481. College; short course; degree, $30/cr. hr.; full-time days. Furniture & cabinetmaking, carpentry, industrial arts (teaching), crafts, sculpture & carving, industrial design, industrial processes, wood science & technology.

NORTHEAST

Boston University, Program in Artisanry, 620 Commonwealth Ave., Boston, MA 02215. College, certificate of mastery program, 2-1/2 to 4 yrs., and 4-yr. degree, $3200/yr.; full-time days, evenings, 6-week summer sessions. Furniture & cabinetmaking, crafts, carving, musical instruments.

Hoosuck Design & Woodworking, Windsor Mill, 121 Union St., North Adams, MA 01247. Vocational training, 15 weeks/semester, $1000; full-time days, evenings, summers. Furniture & cabinetmaking, sculpture & carving, industrial design, industrial processes.

The New England Craftsmanship Center, P.O. Box 47, 5 Bridge St., Watertown, MA 02172. Private teaching shop, continuous courses year round, $3/hr.; full-time days, evenings. Furniture & cabinetmaking, sculpture & carving, general woodworking.

Powell & Tierney, 209 Main St., Northampton, MA 01060. Intern program, 1 to 3 yrs., $2000/yr.; full-time days. Furniture & cabinetmaking.

School of the Museum of Fine Arts, 230 The Fenway, Boston, MA 02115. College, 4-yr. degree, $2450/yr.; full-time days. Furniture and cabinetmaking, sculpture & carving, crafts. "We encourage students to take courses in diverse fields."

Truro Center for the Arts/Castle Hill Inc., Castle Rd., Truro, MA 02666. Summer course, 2 wks., half-days $85. Crafts woodworking, wood science & technology.

Worcester Craft Center, 25 Sagamore Rd., Worcester, MA 01605. Apprenticeship; short course; 2-yr. furniture design program, degree, $950/yr.; full-time days, evenings, summers. Furniture and cabinetmaking, industrial design, crafts woodworking.

Maryland Institute College of Art, Craft Dept., 1300 Mt. Royal Ave., Baltimore, MD 21217. College, 4-yr. degree, $2850/yr.; full-time days, evenings, summers. Furniture making, sculpture, crafts, woodworking, turning, carving.

Keene State College, Dept. of Industrial Education, Keene, NH 03431. College, 4-yr. degree; full-time days, summers, January short course. Furniture & cabinetmaking, carpentry, industrial arts (teaching), industrial design, industrial processes, wood science & technology.

League of New Hampshire Craftsmen, 205 N. Main St., Concord, NH 03301. Apprenticeship, short courses, one to ten weeks, $56 to $175; evenings, special seminars. Furniture & cabinetmaking, sculpture & carving.

University of New Hampshire, Art Dept., Hewitt Hall, Durham, NH 03824. College, 4-yr. degree, $1000; full-time days, evenings. Furniture & cabinetmaking, crafts, sculpture & carving, industrial processes.

Kean College of New Jersey, Fine Arts Dept., Union, NJ 07083. College, 4-yr. degree, $350/semester; full-time days. Furniture & cabinetmaking, crafts. "Wood/furniture design is part of a fine arts studio major, B.A. degree."

Peters Valley Craftsmen Inc., Peters Valley, Layton, NJ 07851. Summer short course, 1-wk., $60 tuition, $65 rm. & bd.; spring & fall weekends, $40 tuition, $25 rm. & bd., internship, 13-wk. indep. study, full-time days & evenings, $60/wk. plus work for community. Furniture and cabinetmaking, sculpture & carving, lumbering, barn building (1977).

City College of New York, Convent at 133 St., New York, NY 10031. College, 4-yr. & 1-yr. degree, $387/semester or $35/credit; full-time days, evenings, summers. Furniture and cabinetmaking, carpentry, industrial arts (teaching), industrial design, industrial processes, wood science & technology. "Basically industrial arts teacher training."

Haber School of Sculpture, 1170 Old Northern Boulevard, Roslyn, NY 11576. 12 wks., $108; days, evenings, summers. Sculpture in wood & stone.

Jiranek School, 205 Lexington Ave., New York, NY 10016. Vocational training, 2-yr. certificate, $1800/yr.; full-time days. Furniture & cabinetmaking, industrial processes, wood science & technology. "One day a week students gain actual factory experience."

John Harra Studio Inc., 39 W. 19 St., New York, NY 10010. 10-wk. short course, 5-wk. mini-courses, $165; evenings, summers. Furniture and cabinetmaking, carpentry, industrial processes, wood science & technology, crafts. "Will be V.A.-approved and credit-granting shortly."

Naples Mill School of Arts & Crafts Inc., 33 Academy St., Naples, NY 14512. Private art school, 30 weeks, $60/week; full-time days, summers, special short courses. Furniture & cabinetmaking, sculpture & carving, crafts, wood science & technology.

New York University, Vocational Education Dept., 26 Stuyvesant St., New York, NY 10003. College, 4-yr. degree, $108/point; full-time days, evenings, summers. Industrial arts (teaching), furniture and cabinetmaking, carpentry, forestry, crafts, industrial processes.

School for American Craftsmen, Rochester Institute of Technology, 1 Lomb Memorial Dr., Rochester, NY 14623. College & graduate, 2 and 4-yr. degree, $850/qtr.; full-time days, evenings, summers. Woodworking & furniture design, industrial design, cabinetmaking, sculpture & carving.

State University College at Buffalo, Design Dept., 1300 Elmwood Ave., Buffalo, NY 14222. College, 4-yr. degree, $750/yr.; full-time days, evenings, summers, continuing education short course. Furniture & cabinetmaking, crafts, industrial design, wood science & technology.

State University of New York, College at Purchase, Purchase, NY 10577. College, 4-yr. degree, $750/semester; full-time days, some evenings. Furniture & cabinetmaking, sculpture & carving, industrial design. "All wood-related courses are part of the sculpture department."

Syracuse University, College of Visual & Performing Arts, Lowe Art Center, Syracuse, NY 13210. College: short course or degree, 1 semester to 6 yrs., $1825/semester; full-time days, one evening. Furniture & cabinetmaking, carpentry, musical instruments, forestry, crafts, sculpture & carving, industrial design, wood science & technology.

Visual Arts Center, 209 Sullivan St., New York, NY 10012. Apprenticeship, short course, vocational training; $55/semester; evenings. Furniture and cabinetmaking, carpentry, crafts.

Edinboro State College, Art Dept., Art Bldg., Edinboro, PA 16412. College, 4-yr. degree, $1804/yr., full-time days, 3-wk. short course in June. Furniture & cabinetmaking, sculpture & carving, crafts.

Indiana University of Pennsylvania, Art Dept., Indiana, PA 15701. College, 4 yrs. of graduate studies, degree, $416/semester; full-time days, evenings, summers. Furniture making, carpentry, crafts, sculpture & carving.

Rhode Island School of Design, Fine Arts Dept., 2 College St., Providence, RI 02903. College and graduate program, 2-yr. degree, $3500 full-time, $260 summer. Furniture and cabinetmaking, crafts, sculpture & carving, industrial design, industrial processes, wood science & technology (limited). "No undergrad program for furniture; studio & elective courses under industrial design."

Ethan Allen Community College, 310 Bonnet St., Box 887, Manchester Center, VT 05255. Junior college, 12-week short course, $90; evenings, summers. Industrial design, sculpture & carving, crafts.

Shelburne Craft School, Harbor Rd., Shelburne, VT 05482. 10-wk. short course, $50; summers, evenings. Furniture and cabinetmaking.

Russ Zimmerman, P.O. Box 76, Underhill Center, VT 05490. 2-day course, $140 including room & board. Woodturning.

NORTHWEST

Anderson Ranch Arts Center at Snowmass, Colorado, P.O. Box 2400, W. Aspen, CO 81611. Summer workshops. Woodworking, furniture design, sculpture.

Southern Colorado State University, Dept. of Woodworking, 2200 North Bonforte Blvd., Pueblo, CO 81001. Jr. college; college; vocational training. Carpentry, cabinetmaking, industrial design, wood science & technology. "Degree in building construction."

Western Montana College, Industrial Arts Dept., Dillon, MT 59725. College, 4-yr. degree, $208/qtr., $21/credit; full-time days, some evenings, summers, 2-week short course. Furniture & cabinetmaking, carpentry, industrial arts (teaching), crafts, industrial processes.

Lane Community College, Art & Applied Design Dept., 4000 E. 30 Ave., Eugene, OR 97405. Junior college, 1 to 2-yr. certificate, $120/term, $10.50/cr. hr.; full-time days, evenings. Furniture & cabinetmaking, carpentry, forestry, crafts, sculpture & carving. Furniture design taught through Art Dept.

Linfield College, Art Dept., McMinnville, OR 97128. College, 4-yr. degree, $1200/semester; full-time days, summers, 5-week short course. Furniture & cabinetmaking, sculpture & carving, crafts.

Oregon State University, School of Forestry, Dept. of Forest Products, Corvallis, OR 97331. College, 4-yr. plus graduate, degree; full-time days, short courses. Forestry, wood science & technology, industrial processes.

University of Oregon, Dept. of Interior Architecture, Eugene, OR 97403. College, 5-yr. degree, $266/qtr.; full-time days, evenings. Furniture making.

Central Washington State College, Art Dept., Ellensburg, WA 98926. College, 2-yr. degree, $169/qtr.; full-time days. Furniture making, sculpture & carving, crafts.

SOUTH

Arkansas Arts Center, Education Dept., MacArthur Park, Little Rock, AR 72203. 12-week short course, $50; full-time days, evenings, summer workshops. Furniture making, crafts, sculpture.

Florida A & M University, Industrial Arts Dept., Tallahassee, FL 32307. College, 4-yr. degree, $225/qtr.; full-time days, summers limited. Furniture making, industrial arts (teaching), crafts.

Florida State University, Constructive Design Dept., 123 Education St., Tallahassee, FL 32306. College, 4-yr. degree; full-time days. Furniture & cabinetmaking, carpentry, crafts, sculpture & carving, industrial design.

Eastern Kentucky University, Dept. of Woodworking & Furniture Design, Richmond, KY 40475. College, 2 and 4-yr. degree; full-time days, evenings, summers. Furniture and cabinetmaking, industrial arts (teaching), crafts, wood science & technology.

Western Kentucky University, Industrial Education & Technology Dept., Bowling Green, KY 42101. College, 2 and 4-yr. degree, $211.50/semester; full-time days, evenings, summers, short courses. Furniture & cabinetmaking, carpentry, musical instruments, industrial arts (teaching), crafts, industrial design, industrial processes, wood science & technology. "General education courses required."

Northwestern State University of Louisiana, Woodworking Dept., Natchitoches, LA 71457. College, 2 or 4-yr. degree, $175/semester. Furniture & cabinetmaking, carpentry, forestry, industrial arts (teaching), industrial processes, wood science & technology.

Caldwell Community College, Highway 321, Hudson, NC 28638. Junior college, vocational training, 1 or 2-yr. degree, $35/qtr.; full-time days. Cabinetmaking, industrial design, industrial processes, wood science & technology.

Catawba Valley Technical Institute, Hickory, NC 28601. Junior college, degree, $33/qtr.; full-time days, evenings, summers, short courses. Furniture making, forestry, industrial design, industrial processes, wood science & technology.

Central Piedmont Community College, Art Dept., Box 4009, Charlotte, NC 28204. Junior college, short courses; full-time days, evenings, summers. Furniture & cabinetmaking, carpentry, musical instruments, forestry, crafts, sculpture & carving, wood science & technology. "We take all students at any stage in their development."

Guilford Technical Institute, Adult Education Dept., Box 309, Jamestown, NC 27282. Short course, technical institute, 1-yr. degree; $37.50/cr.; full-time days, evenings, summers. Furniture & cabinetmaking, carpentry, crafts, sculpture & carving. "Most courses non-credit. Carpentry/cabinetmaking program is a 1-yr. vocational certificate program."

Haywood Technical Institute, P.O. Box 457, Clyde, NC 28721. Vocational training, 7 quarters, degree, $33/qtr.; full-time days, summers. Furniture & cabinetmaking, lumbering, crafts. "We train self-supporting craftsmen."

North Carolina State University, School of Forest Resources, Dept. of Wood & Paper Science, Raleigh, NC 27607. College, 4-yr. degree, $500/yr.; full-time days. Furniture making, forestry, industrial arts (teaching), industrial design, industrial processes, wood science & technology.

Penland School of Crafts, Penland, NC 28765. Summer craft school, 2 to 3-week sessions, $60/wk. plus room and board, full-time days. Furniture making and design. "College credit available."

Austin Peay State University, Industrial Arts & Technology Dept., Clarksville, TN 37040. College, 4-yr. degree, $245/qtr.; full-time days, summers. Furniture & cabinetmaking, carpentry, industrial arts (teaching), crafts.

University of Tennessee, Dept. of Forestry, P.O. Box 1071, Knoxville, TN 37901. College, 4-yr., $136/qtr.; full-time days. Forestry, industrial processes, wood science & technology, wood uses.

Virginia Commonwealth University, Crafts Dept., Basement, 827 W. Franklin St., Richmond, VA 23220. College, 4-yr. and graduate degree, $696/yr.; full-time days, evenings, 6-wk. summers. Furniture and cabinetmaking, crafts, sculpture & carving, wood science & technology. "Emphasize one-of-a-kind, personalized direction in wood rather than carpentry."

SOUTHWEST

California State College, San Bernardino, Art Dept., 5500 State College Parkway, San Bernardino, CA 92404. College, 2 to 4-yr. degree, $100/yr.; full-time days. Furniture & cabinetmaking, crafts, musical instruments, sculpture & carving. "We prepare students to start their own businesses."

California State University at Fullerton, Art Dept., Fullerton, CA 92634. College, degree, $80/semester; full-time days. Furniture making, musical instruments, crafts.

San Diego State University, Art Dept., 5402 College Ave., San Diego, CA 92115. College, 4-yr. plus 2-yr. graduate program, degree, $100/semester; full-time days. Furniture & cabinetmaking, industrial arts (teaching), sculpture & carving, industrial processes, wood science & technology.

Eastern New Mexico University, Art Dept., Portales, NM 88130. College, 2 and 4-yr. degree, $20.50/cr. hr.; full-time days; part-time evenings; summers. Carpentry, cabinetmaking, sculpture, industrial arts (teaching), turning, woodworking machinery.

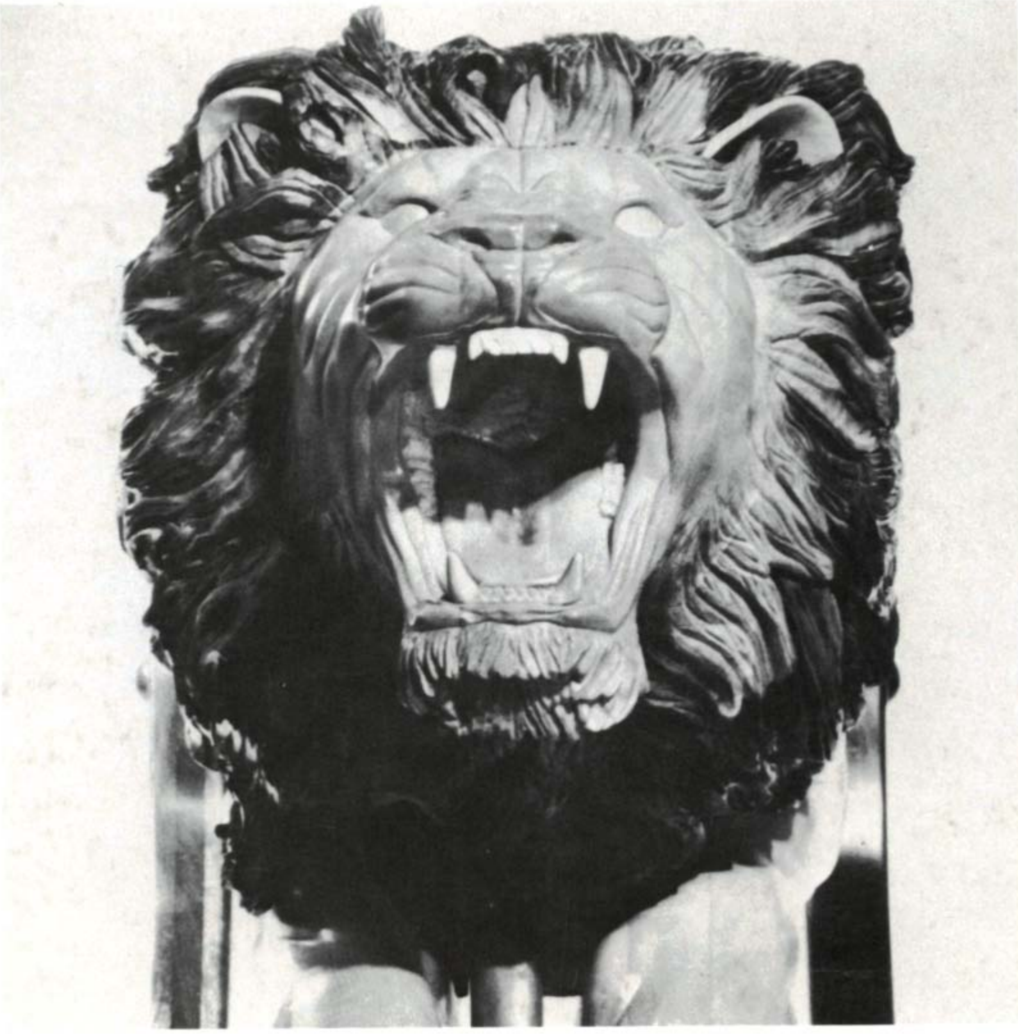
Northeastern Oklahoma State University, Industrial Ed. Dept., Tahlequah, OK 74464. College; vocational training; 2 and 4-yr. degree, $12.50/cr. hr.; full-time days, evenings, summers. Furniture & cabinetmaking, carpentry, industrial arts (teaching), wood science & technology. "An internship (16 hrs.) is required of all non-teacher majors."

Northwestern Oklahoma State University, Industrial Ed. Dept., Alva, OK 73717. College, 4-yr. degree, 2-yr. certificate, $175 to $220; full-time days, summers, short courses. Furniture & cabinetmaking, carpentry, industrial arts (teaching), crafts, industrial design, industrial processes.

Oklahoma State University, Industrial Arts Education, 104 Industrial Bulding, Stillwater, OK 74074. College, 4-yr. degree, plus graduate studies, $14.50/cr. hr.; full-time days, evenings, summers, short course. Furniture & cabinetmaking, industrial arts (teaching), crafts, sculpture & carving, industrial design, industrial processes, wood science & technology.

University of Oklahoma, Art Dept., 520 Parrington Oval, Norman, OK 73069. College, 4-yr. degree; full-time days, evenings, summers, 2 to 4-week short courses. Furniture & cabinetmaking, carpentry, crafts, sculpture & carving, industrial design, industrial processes. "Woodworking is part of the product design program."

Southwest Craft Center, Creative Art School, 300 Augusta St., San Antonio, TX 78205. Craft school, 15-week long course, $80; full-time days, evenings, summers, short course. Furniture & cabinetmaking, crafts, sculpture & carving.



King Of the Woods

This life-size and ferocious rocking lion was carved by Gary Singleton, a cabinetmaker and sculptor living in Redondo Beach, Calif. It is one of a series of six giant animals; the others are a horse, rabbit, unicorn, goat and pig. Singleton's dream is to be commissioned to carve a complete carousel.

The lion's flowing mane is carved from a mass of black walnut skillfully joined to the 300-pound laminated block of maple forming its body. The six-foot rockers are also black walnut.

The lion was shown at the recent California Craftsman '76 exhibition in Monterey (page 32), and it does indeed rock—if one has the courage to climb aboard.