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June 1990, No. 82
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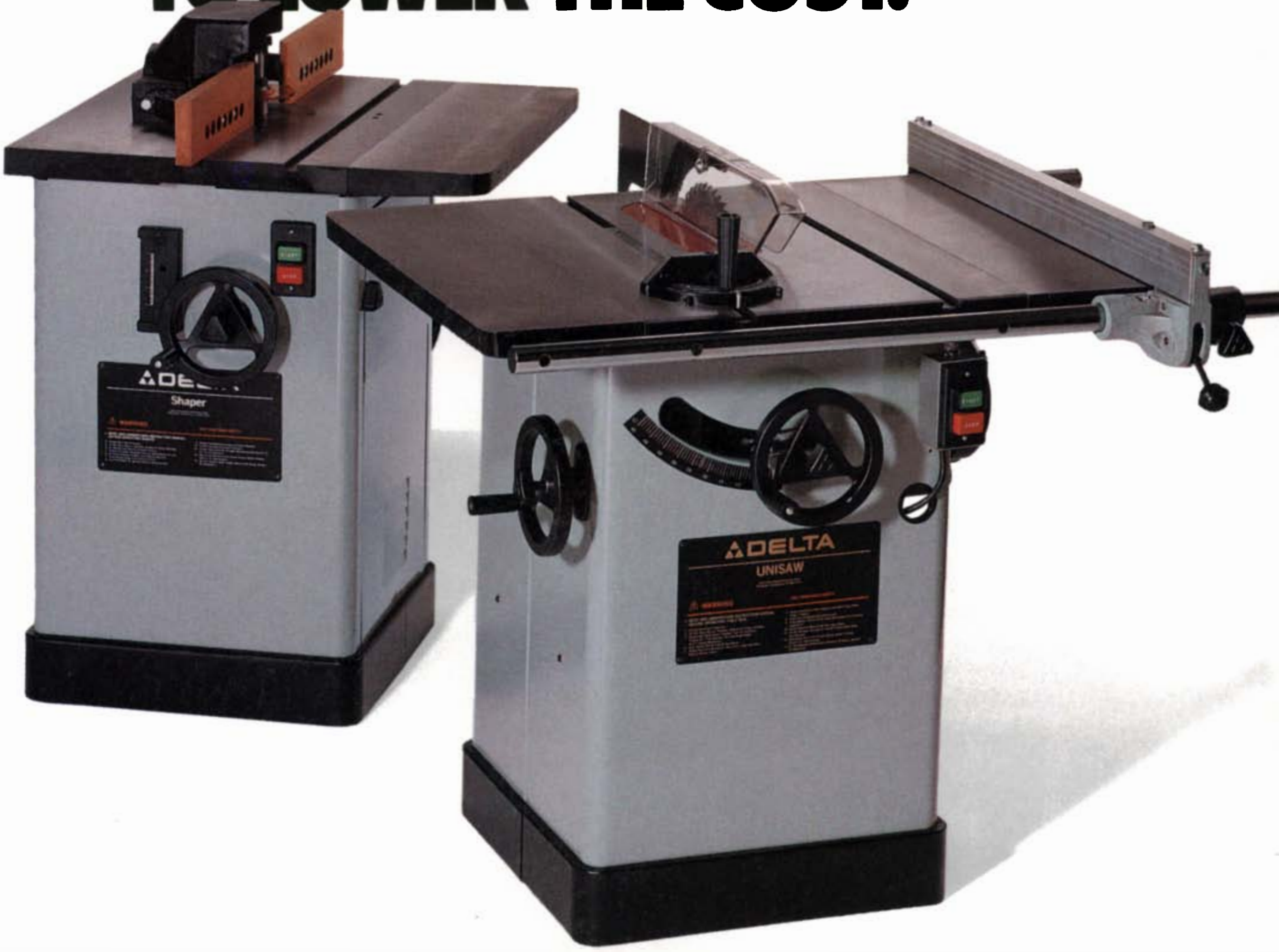

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Fine WoodWorking

May/June 1990

Conference tables are big business. On p. 86, we visit furnituremakers who tell how they handle these high-priced commissions. (Photo by Fred Lyon.) Cover: Tage Frid routs a mortise in a laminated, tapered leg for an end table. He tells how to build the table on p. 52.

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DEPARTMENTS

ARTICLES

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Antique tools should be used—As an active woodworker, I'm concerned about the repercussions of what I see as a trend toward the collecting of antique tools. The prices at shops and auctions have gone up easily five times over what they were a few years ago. The problem is simply that the majority of collectors and dealers are not purchasing these tools to use, but to polish them up and put them on the proverbial shelf or resell them at a higher price.

My complaint is that many of these tools are not made nowadays, or else modern versions are often so poorly made that the second-hand market is the only source for these items. One might also suppose that used goods that generally need tuning up would be fairly inexpensive. While I would only buy an old tool if I could use it on a project, the collectors take usable tools out of circulation, often hoarding many, and thus making them harder to find and more costly. Some not-so-antique tools such as shoulder planes now show up at sales at least as expensive or even more expensive than their currently manufactured counterparts. The situation is different when armchair woodworkers fill their little-used shops with all sorts of new machine tools; this has the effect of increasing sales volume and thus lowering prices. (You're doing us all a favor, guys.) But when the armchair woodworkers and collectors fill their unused shops and shelves with functional old tools, the active craftsmen suffer as availability decreases and prices increase. With this kind of inflation going on, I would hope that more manufacturers realize that there is a strong demand for good hand tools and I would think that many could be produced for less than what these inflated antiques sell for. The key issue is quality, and modern metalurgical and machining technology should be able to inprove on the past, not merely copy it.

—Woody Pistrich, Hadley, Mass.

Pythagoras vs. workbenches—Why have skilled craftsmen, particularly those with an obvious feel for wood, persisted in building trestle-style workbenches and ignoring basic structural principles? The essence of rigid structure is the triangle-shape diagonal bracing. Three elements pinned together make an absolutely rigid structure. (Bucky Fuller did it three dimensionally and became world famous.)

These squared-up trestle designs exert terrific leverage on the joints when stressed. Wood is guaranteed to swell and shrink, so even if the joinery is beautifully done, there eventually will be play. The answer is the diagonal brace. About 50 years ago, I added a plywood back and ends to make my bench rigid, and then added shelves and a door to utilize the space. The bench has taken a beating and it isn't very pretty anymore, but it's solid.

—Hugh Johnson, Syosset, N.Y.

Mesquite as teak substitute—I'd like to add mesquite to the teak substitutes mentioned by Jon Arno in *FWW* #80. Mesquite multiplies faster than it can be grubbed out, so it is considered a pest throughout the Southwest and is not endangered. It has a specific gravity of 0.70, which is heavier than teak. Volumetric shrinkage is 4.7%, which is 70% as great as teak. The radial shrinkage is 2.2%, and the tangential shrinkage is 2.6%. Between the two, this results in a ratio of 0.85, which is closer to unity than catalpa or any of the other woods previously listed. (The closer the ratio is to unity, the less distortion occurs with moisture changes.)

The mesquite lumber industry is also growing in the Southwest. We currently have about a dozen sawyers using small sawmills, and while we do not produce mesquite lumber in railroad-car quantities, we are producing and marketing a remarkable wood. For more information on mesquite, contact our association: Los Amigos del Mesquite, c/o Jim Lee, Reagan Wells Route, Box 122, Uvalde, Tex. 78801.

—Herb Nordmeyer, Mesquite Lumber & Crafts, Knippa, Tex.

More on teak substitutes—I have another suggestion for a replacement for teak. In my estimation, one of the finest native woods is Persimmon *(Diospyros virginiana)*. It is the same genus as ebony and has a small area of black heartwood, but the extensive sapwood is a creamy-tan color. The wood works beautifully and has natural waxes and oils. It was used in the past for weaving shuttles, because of its ability to take a fine finish, and with use it becomes even smoother. It is not easy to find as lumber, but the trees are plentiful in the Southeast. With a renewed demand, smaller mills could produce a sizable volume for the woodworking trade.

—John McClain Gray, Syracuse, N.Y.

Parts for Parks machines—We have formed a new company to stock and sell replacement parts for all Parks woodworking machines. These will be manufactured to exacting machine-tool standards, using only the original Parks drawings and material specifications. Deliveries began on March 1, 1990, and it is anticipated that all parts for Parks planers, bandsaws and jointers will either be in stock or available on a prompt delivery basis. We do not have any record of orders that may have been previously placed with Parks, but were not filled, so we request people contact us directly at (606) 581-7511 or send a fax to (606) 581-9642. No price list is available at this time, but we will quote prices upon request.

—Gregory E. Reder, Parks Repair Parts, Covington, Ky.

Gun bluing for antiquing—I thought Michael Dresdner presented a well-written and practical method for giving brass an aged look (*FWW* #80). The following is a different procedure, which I've found works very well, is easy to do, and involves materials that are safe to handle and inexpensive.

First, strip off the manufacturer's finish with lacquer thinner. Then purchase a $6 bottle of gun bluing and wipe the bluing on the brass with a clean cloth. Allow four- to six-minutes drying time/oxidizing time, and then buff the piece with 0000 steel wool until you have the desired highlight effect. Any remaining steel-wool particles can be removed with a light blast from an air nozzle. Now wrap a 2-in.-wide strip of

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masking tape to a metal clothes hanger, leaving enough sticky surface exposed to attach the brass. Lightly spray the hanging piece with a couple of vertical and horizontal passes, using clear satin or gloss lacquer and you have a ready-made piece of aged brass hardware.

—Garnet F. Dean, Ottawa, Ont., Canada

What about individual responsibility?—I must reply to L.R. Pastukiw's and Larry Hokenson's letters (*FWW* #80) concerning ivory and exotic woods. Pastukiw writes "Materials used by the trade are a small percentage of what is used by others." Just who is the trade and who are the others? Every person is individually responsible for his or her share of the problem, just as when you drive your car you contribute your share to smog, pollution and the subsequent oil spills that are all part of that system. Certainly the hobbyist or small tradesperson uses a smaller share than a plywood manufacturer, but the high demand for exotic (and beautiful) tropical hardwoods directly affects the price and thereby encourages the plundering of the rain forest.

What to do? First, the facts would be helpful. Perhaps *Fine Woodworking* could publish a list describing which species (like Cuban and Honduran mahogany and Burmese teak) are in danger of depletion, and which species (like lauan) which are being grown in managed tree farms. I understand such a list is also available from Friends of the Earth of England (write for *The Good Wood Guide*, Friends of the Earth—United Kingdom, 26-28 Underwood St., London N1 7JU, England; 01-490-1555). A good domestic source is the Rainforest Action Network, 300 Broadway, Suite 29, San Francisco, Cal. 94113.

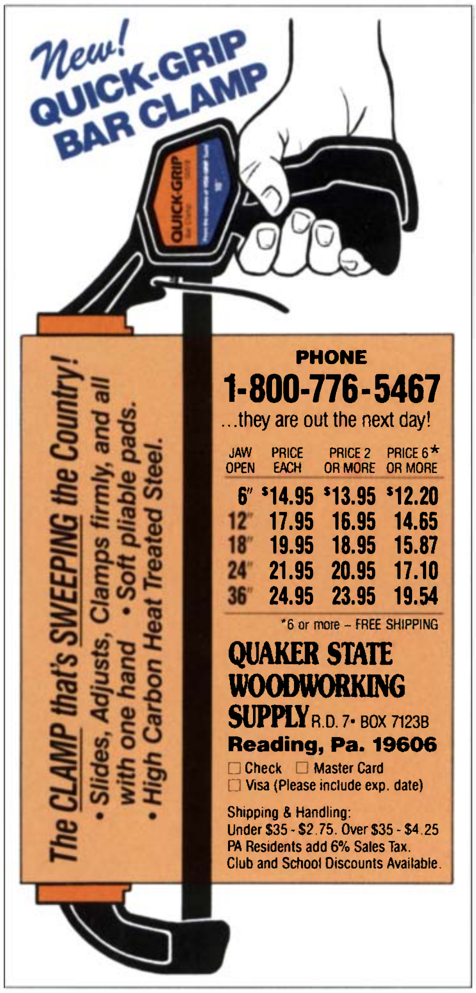
My second suggestion is to substitute a domestic or renewable wood whenever you can. I understand this is not always possible. Recently, I had to purchase some African mahogany, but I charged the client an additional premium and sent this as a donation to the Friends of the Earth in the client's name. Lastly, we must continue to discuss the problem and create a forum for thought. As much as some people may dislike it, "bans" work to control demand, legislation works to control supply, but an educated and responsible consumer works the best.

—Paul Henry, Encinitas, Cal.

Medicine and allergies—In response to Adèle A. Châtelain's letter concerning wood allergies (*FWW* #80), I would not recommend using an over-the-counter antihistamine prior to working in the shop.

Many of the over-the-counter antihistamines, while marked as "anti-drowsy" can still cause drowsiness and decrease coordination. Many of the "anti-drowsy" antihistamines are made so by the addition of decongestant medications, which tend to make people jittery. This combination in medications may cause incoordination and a nervous feeling, which can be quite dangerous in the shop.

I would recommend that persons suffering from wood-related allergies consult their family physician. There are several antihistamine medications that are truly "anti-drowsy," but they are available by prescription only. Your physician will advise you about the use of such drugs. Be wary of using any medication while working in the shop. Any drug can affect any person in any way. Prior to using machinery, take the drug on several different occasions in a harmless situation, such as watching television. Note any effects. If there are no adverse affects or alterations of judgment or coordination, then you may



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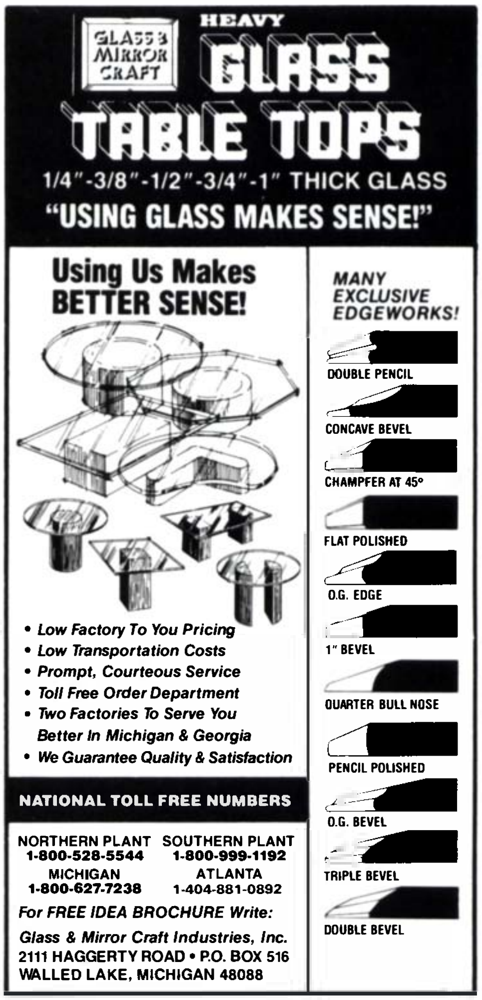

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use the drug in the shop. The other tricks mentioned in Mrs. Châtelain's letter are worth trying prior to using a medication.

—Dr. Thomas G. Phillips, State College, Pa.

Danger: oily rags—This near disaster that occurred at my home recently is a warning to all readers. I had some free time to construct a kitchen cabinet, a free-standing unit which I finished with a mixture of Varathane, tung oil and linseed oil. I left the oil on the wood for an hour and then wiped off the excess with rags, which I threw into a 30-gal. plastic trash can just outside of my garage.

Over a period of several days of applying the finish and wiping it off, about a dozen or more oily rags accumulated in the trash can. By now you have probably guessed the outcome of my error. Fire resulted from the oxidation of the oils in the rags. Fortunately, the damage was minor because the can wasn't inside the shop and it was also contained in a redwood enclosure that more or less directed the fire upward. The point of all this is to remind every finisher, especially those working with oil or oil mixtures, to dispose of oily rags in a proper manner, as described, for example, on the back of the linseed-oil can. And I now have all-metal trash cans with tight-fitting lids.

—William J. Casmaer, Goleta, Cal.

Another way to cut aluminum—I have another method for cutting aluminum (*FWW* #81). This way has proven safe with any type of blade. Use a radial-arm saw or a miter saw with crosscutting (forward extension) capacity. Pull the saw out, and then put your material behind it and cut backward. This eliminates all grab and allows you to truly be the boss of the cut. This technique is also useful for minimizing tearout on certain cuts, especially with miters and similar operations in wood, as well as for accurately lining up a blade with a mark on the front of the board.

—Paul Geiger, Gaithersburg, Md.

Dimpling effect from biscuit joinery—In the Letters column of *FWW* #81, Randall Grace mentions the dimpling effect that comes from using biscuit joinery for edge glue-ups. It is my gut feeling that what is happening is the wood at the biscuit joint has not lost all of the moisture from the glue-up before sanding begins. The surface is sanded flat and when the moisture finally leaves the joint, the wood shrinks slightly and the dimples appear. My solution has been to glue up the tabletop or panel and let it hang around the shop for a week before sanding.

—Ted Blachly, Warner, N.H.

Biscuits as the compact discs of woodworking—About 90% of the production of my woodshop is tabletops, legs, game-table tops, workbenches and counter tops, all of butcher-block design and assembly, and I have been able to use biscuit joinery to some advantage. The best part of biscuit joinery, to me, is the ease of assembly with the utmost of precision, requiring only general finish sanding. I think the inventor/developer of biscuit joinery should be knighted and retired to a villa in northern Italy, graced with his or her choice of music on compact disc. Ah yes, the compact disc—the biscuit joinery of the music world.

—Warren Foote, Olympia, Wash.

Consider the possibilities—As a math teacher, I was very interested in a problem mentioned by Chris Becksvoort in "Edge Gluing Boards" (*FWW* #79). How many possible combinations are there when you are gluing up a number of boards

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85613	1/4	1	1/4	$ 7.62
85223	9/32	7/8	1/4	$ 8.10
85224	5/16	7/8	1/4	$ 7.56
85225	3/8	7/8	1/4	$ 7.35
85276	3/8	29/32	3/8	$ 8.10
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85587M	1/16	5/16	1/2	17.40
85290M	1/8	5/16	1/4	16.74
85588M	1/8	5/16	1/2	17.94
85616M	5/32	5/32	1/4	15.60
85293M	3/16	31/64	1/4	15.54
85294M	1/4	35/64	1/4	15.60
85295M	5/16	37/64	1/4	16.74
85296M	3/8	43/64	1/4	16.83
85594M	3/8	43/64	1/2	20.97
85297M	1/2	51/64	1/4	18.39
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85495M	5/16	37/64	1/4	16.95
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85599M	3/8	43/64	1/2	21.57
85497M	1/2	51/64	1/4	19.08
85600M	1/2	51/64	1/2	25.56
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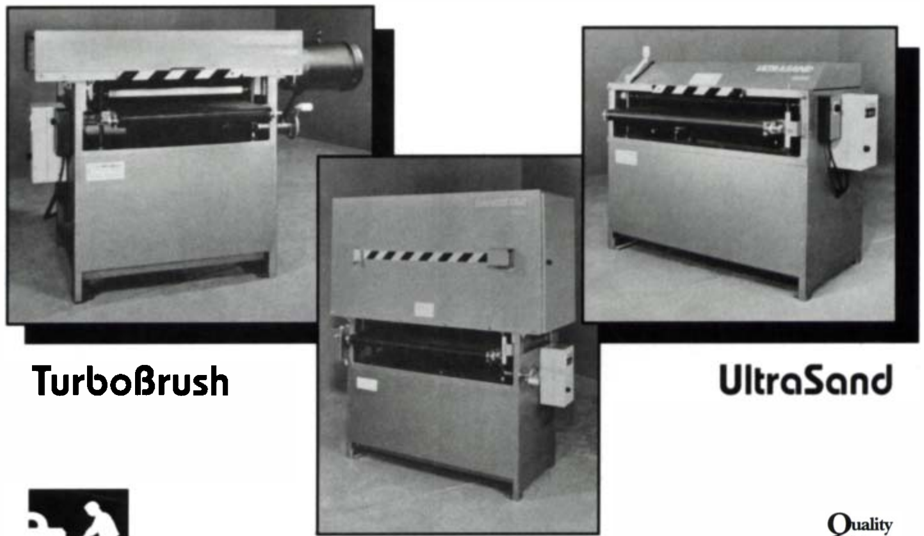

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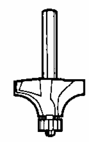

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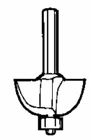

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to form a panel? After some thought, I agreed with his statement about 16 possible combinations of faces for a two-board panel. There are eight different arrangements, each producing two faces to choose from. A three-board panel has 192 possible faces. Four-board and five-board panels have more than 3,000 and 60,000 possible faces, respectively. Since each board with a serious flaw reduces the possibilities by a half, I've come to appreciate my flawed and wide lumber.

–Ken Amunrud, Atascadero, Cal.

No appreciation for woodworking–After reading *FWW* #77, I wonder if some people are beginning to lose a proper appreciation for the craft of woodworking. Peter Good's "Ode to Oak" suggests that oak is overrated because it is readily available in some areas and has some undesirable physical properties. Wood is a natural material. I believe that the skill of the true craftsman lies in the ability to produce a nice piece of furniture while working with a natural material, taking advantage of the desirable features. I work almost exclusively with red oak and have never been disappointed with the end product. If there are flaws, it is usually because I didn't take the characteristics of the wood into account. I have yet to meet the person who is not impressed with the beauty of oak furniture when it is constructed and finished properly. *–Richard W. Lehmann, Wausau, Wisc.*

Building a longbed lathe–I built the wooden longbed lathe in *FWW* #57, and found the article and design by Carlyle Lynch easy to follow and very informative. I am a sculptor, working in wood, and I built the lathe with funding received from the Emerging Artist Project grant provided by the City of Raleigh, N.C., Arts Commission with the support of the North Carolina Arts Council and the A.J. Fletcher Foundation.

My application package consisted of Lynch's design, itemized budget, resume, portfolio and letter explaining how the project could "advance my career as an artist." There are many different types of grants like this available and I would encourage craftsmen to contact their local arts council for information.

In 1986, the lathe cost less than $400 in materials. My grant was for $500 and the total cost of the lathe, built in hard maple was $750 ($280 of which went to the machinist who ground the shafts and made the hand crank for the tailstock). The rest of the money went for lumber and some tooling, such as long drill bits and a gear puller.

The only significant changes in design were to raise the drive shaft by an inch, allowing 9½-in. swing over the bed, and to use a wedge system for snugging the tailstock and tool rest. A good whack with a rubber mallet seems a lot easier than tugging on a hand crank.

The strip of wood that runs the length of the bed allowing the user to turn the power on or off from any position at the lathe is a great idea. Not only does it help efficiency by not requiring the user to run back and forth, but it is a safety feature and allows a safe distance between the user and a big turning that might need a little more careful centering.

One of the fun parts of building the lathe was the trip to the salvage yard in search of a motor. For $30 I got one that runs perfectly and retails for $135. Do not overlook salvage yards as a source of supplies.

By far the hardest part of the process was moving this huge machine around to work on it and to get it into place. It's not the sort of project you want to do solo. But, after all is said and done, the longbed lathe runs smoothly and is a joy to use.

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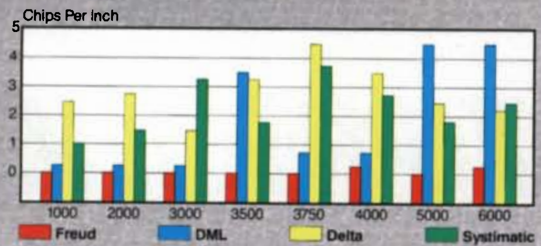

An independent test conducted by Pittsburg State University compared Freud's new HOOK Carbide blade with blades from Delta, DML (Dyanite), and Systimatic.

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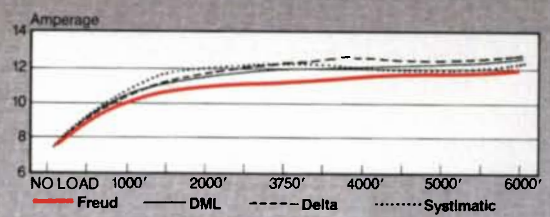

Another finding showed sharper blades required less power (amperage) to make a cut. The Freud HOOK Carbide blade used less power and therefore out performed the competition by staying sharper longer.

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The experience and the tool itself are two good reasons why you might want to invest the time and money.

—Kathryn L. Briggs, Raleigh, N.C.

Microphotograph or photomicrograph—You've probably already heard this one, given the precisionists in your readership, but the "microphotograph" on p. 56 of *FWW* #81, showing a chisel edge, although rather small, is actually a "photomicrograph."

—Stephen Hjemboe, St. Paul, Minn.

Magnetic fix for wobble—I'd like to add to the fine article by Mark Duginske on p. 24, *FWW* #79, on fixing bandsaw vibration. In stabilizing the wheels on my 14-in. bandsaw (blades removed) with small ¼-in.-wide by 1-in.-long magnets (from the local hardware store), I balanced each wheel carefully and then cemented each magnet to the wheel with two-part, five-minute epoxy. No more trouble. *—George Calderwood, Long Beach, Cal.*

A trick for mounting hinges with brass—In "Routing a Rule Joint" (*FWW* #80), Mac Campbell suggests using steel screws as a preliminary step when installing brass hardware. He used steel screws that are the same diameter as the final brass screws, but about ⅛ in. shorter, because the steel ensures that holes won't be stripped out and these tough screws can be driven in and removed with less danger of breakage. I suggest that Mac try cut brass screws available from Lee Valley Tools Ltd., 1080 Morrison Drive, Ottawa, Ont., Canada K2H 8K7 and from Garrett Wade, 161 Ave. of the Americas, New York, N.Y. 10013. The cut brass screws are almost as hard as steel screws. I've used them in all my hinges and find they work much better than other types.

—Don W. Arnold, Flushing, Mich.

Techniques for spiral-flute router bits—Some recent experiences have prompted me to share some concerns with your readers. Spiral-flute router bits do a great job for me in quickly removing extraneous wood down to the background level in roughing out relief carvings, but two concerns regarding safety and accuracy need to be addressed. The spiral flutes, as advertised, do indeed tend to keep the bit pulled down into the work, which can be a plus, but that action also tends to pull the bit down out of the collet if it is not locked in very tightly. The depth of your cut will look the same on the router settings, but a creeping bit may actually be cutting progressively deeper than the settings indicate. So, check your actual depth of cut regularly.

The other concern is that the same spiral flute that pulls the bit down into the work is also pulling up on anything it is cutting into, and if it should accidentally contact something that is not anchored down, such as the plastic clamp pegs plugged into mounting holes on the surface of small folding worktables, it will snatch such things up and into the router base and probably snap off that $20 to $30 bit. *—Dermon Sox, Jr., Columbia, S.C.*

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—John Lively, publisher

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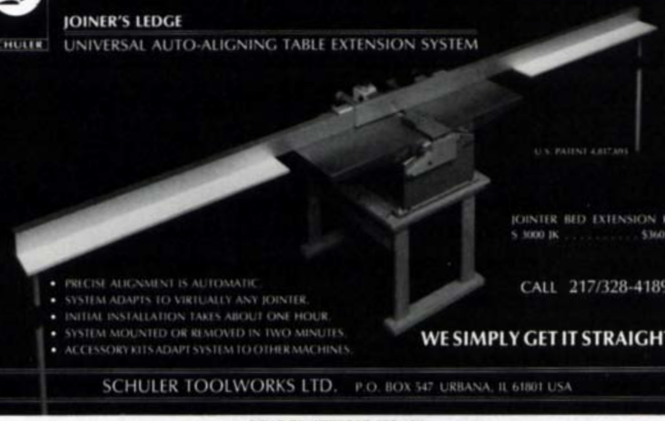

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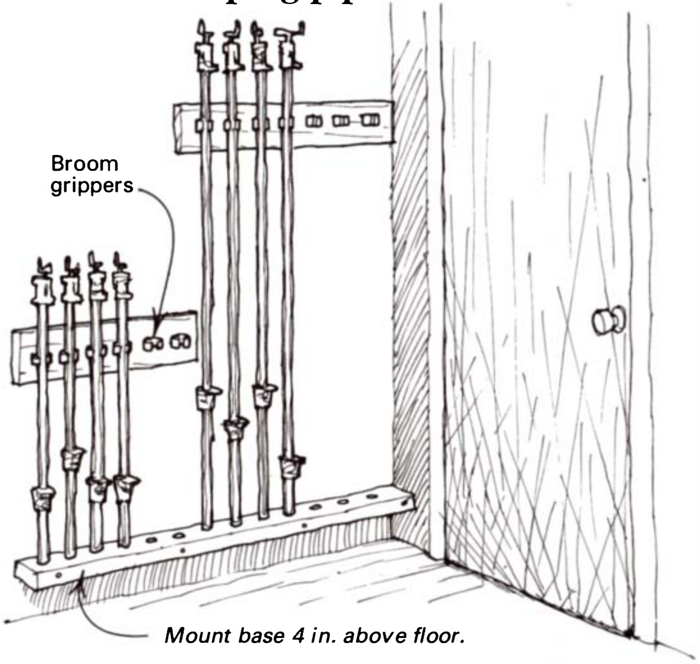
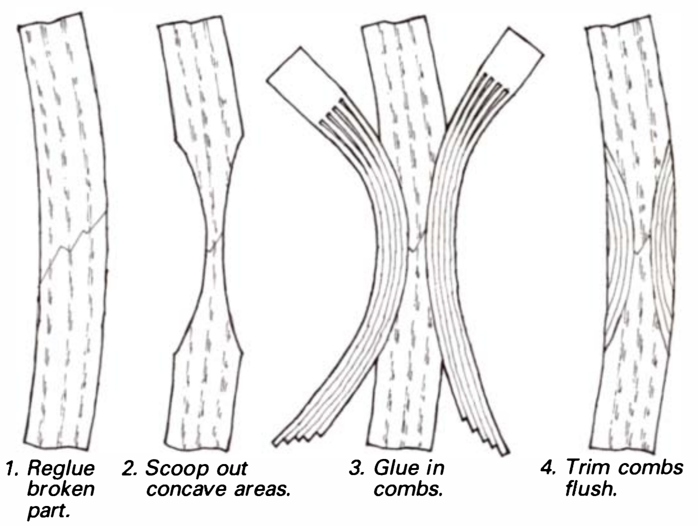


Since I normally over-complicate things, I surprised myself when I came up with this simple and effective pipe clamp rack for ¾-in. iron pipe. It uses standard spring-metal broom grippers, the kind you can find at most hardware stores, to hold the pipes. The broom grippers are screwed to plywood strips that are in turn screwed into wall studs. The base of the rack is a 2x4 with 1¼-in.-dia. holes drilled halfway through to hold the ends of the pipes. Use drywall screws to mount this base to studs 4 in. off the floor so you can sweep under it. If you have a wide range of clamp lengths, as I do, you may need two or more tiers of grippers. I installed the unit behind a door to make effective use of the narrow space. *—Kevin Stamm, San Francisco, Cal.*

Quick tip: When waxing the bed of your planer, don't skip the chipbreaker and pressure bar. It makes a difference.
—Robert Vaughan, Roanoke, Va.

Repairing chair parts with bandsawn combs

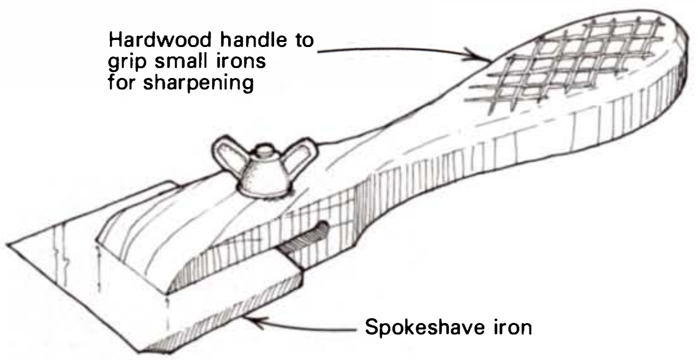


Here's a quick and easy technique I first used to repair a Windsor chair back that had broken almost straight across the grain. The key is gluing comb-like splints into scooped-out areas on each side of the break. The repair is strong and nearly invisible.

First, glue the break together to properly align the pieces and hold them together. Then, with a rasp or the nose of a belt sander, scoop out a curved section on each side of the break to hold the repair inlay. Make the comb-like inlay by kerfing a block of matching wood on the bandsaw. The result is similar to a bundle of veneer pieces held together at one end. Now, apply glue between the layers and clamp the laminated inlay into the scooped-out area. Because the layers are from a single piece of wood, the grain and color match of the laminations will be perfect.
—Walter Stanul, Malden, Mass.

Quick tip: Tongue depressors are handy for spreading glue, stirring paint, padding clamps, shimming and so on. They're available at drugstores in boxes of 750 for less than a penny each.
—Stanley Bessent, Goldthwaite, Tex.

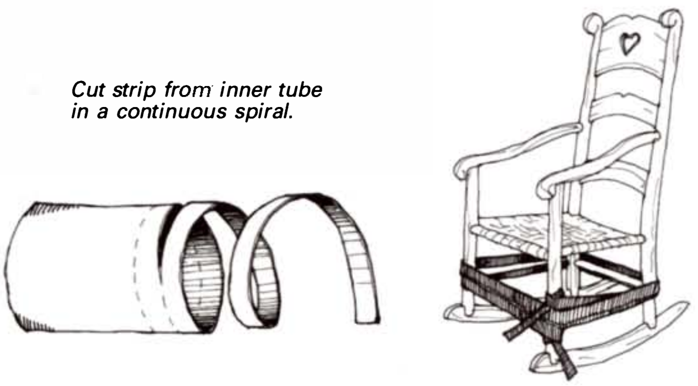
Sharpening a spokeshave blade



I use spokeshaves quite often in my work, but their narrow irons are difficult to hold onto while sharpening. To overcome this problem, I made a handle from a scrap of hardwood, a carriage bolt and a single wing nut, as shown above. It grips any size iron and provides excellent control during both grinding and honing.
—Dennis R. Mitton, Gig Harbour, Wash.

Quick tip: To avoid chipping the veneer when sawing cross-grain dadoes in plywood, make two passes. Cut through only the face veneer on the first cut, and then make a second pass to full depth. *—John Kriegshauser, Kansas City, Mo.*

Rubber-strip clamp



One of the most versatile clamps in my shop is a 1-in.-wide strip of rubber from an old inner tube that I cut in a continuous spiral. I've used the clamp for some of my trickiest jobs, like edging plywood, clamping picture frames, regluing chair legs and repairing a gusset brace on an antique chair. The strip is also handy as a supplement to conventional clamps on some jobs. But versatility is not the clamp's only advantage; it costs nothing and will never mar the work.
—Bernard Pearson, Mississauga, Ont., Canada

Quick tip: The flexible rubber bowls that art-supply stores sell for mixing casting materials are perfect containers for mix-

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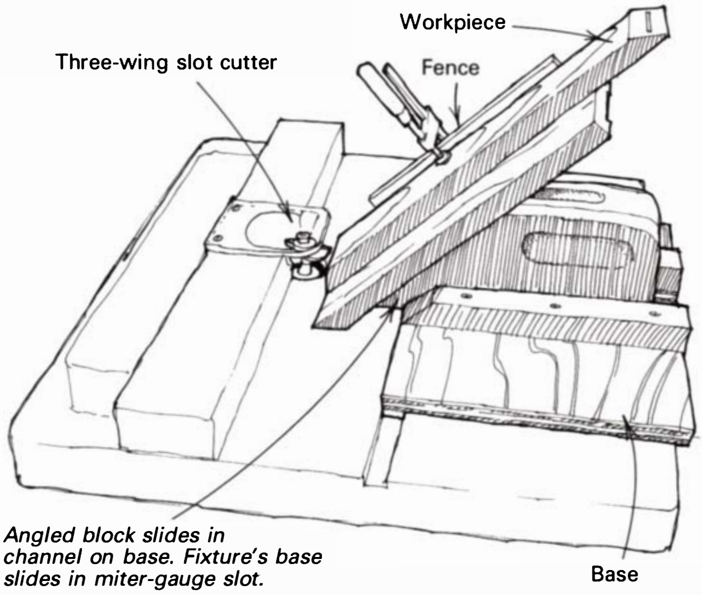
Slot-cutting jig for splined miter joints



I've found that expensive slot-cutting machines aren't really needed for plate joinery. A 5⁄32-in.-wide, three-wing slot cutter mounted in a router table works well. To use the router for edge-to-edge plate joinery, hold the right end of the work securely as you push the edge into the cutter and rout a slot slightly longer than the biscuit.

Cutting the spline slots for mitered frames, however, is not quite so easy and requires a special fixture like the one shown in the drawing. The fixture's base rides in the router table's miter-gauge slot and two pieces of 1¼-in. by 1¼-in. stock are screwed to the base to form a channel perpendicular to the miter-gauge slot. Within this channel, a block of wood with one end cut at a 45° angle slides toward or away from the three-wing cutter. Finally, a board with a fence screwed to one edge is mounted on the angled surface of the block to register the workpiece and provide a clamping perch.

To use the fixture, clamp the mitered workpiece on the 45° block and push it into the cutter. You can cut a longer slot by moving the base of the carriage in the miter-gauge slot. Make pencil marks on the face of the workpiece to designate the ends of the slot; in production situations, clamp stop blocks to the top of the router table to limit the length of the slot.

–Jim Christo, Jamestown, N.Y.

Quick tip: For those woodworkers whose eyes itch and water in a dusty environment, try a pair of swimming goggles. In addition to sealing out the dust and protecting your eyes, the goggles won't fog up when you're wearing a dust mask.

–David M. Lesko, Norwalk, Conn.

Magnetic honing handle

I have always found the job of flattening and honing the back of a small plane iron a tedious chore, primarily because the only way to hold the iron flat and simultaneously move it across the stone is to grab it by its narrow, oily edges.

Recently, I was truing up a spokeshave iron amid the debris

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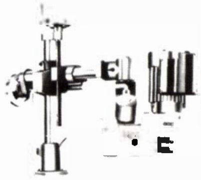

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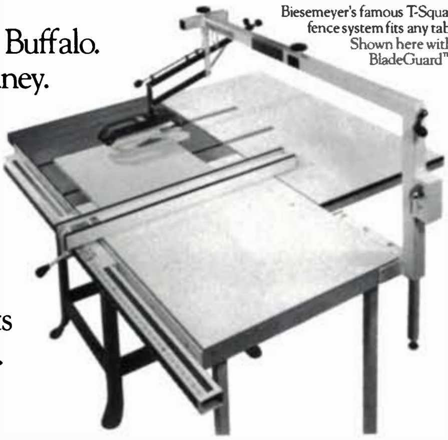

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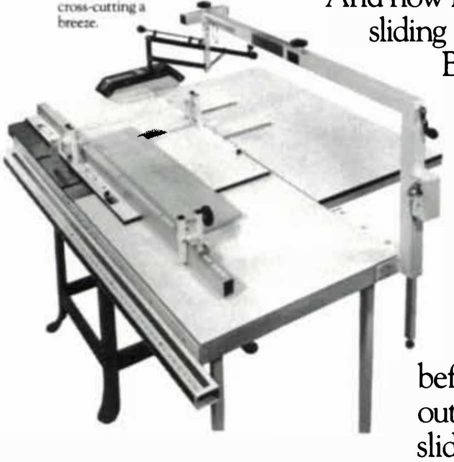

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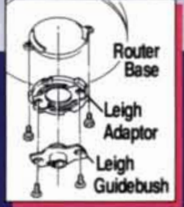

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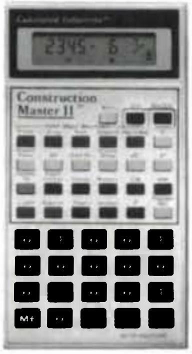

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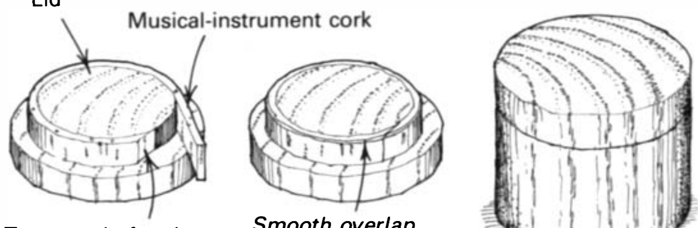
on my bench which included, by chance, an old set of hi-fi speakers. Out of frustration at trying to grip the small iron, I grabbed one of the button magnets from a speaker cone and plopped it on the reverse side of the iron. The thing gripped like a bulldog and instantly my iron had a handle on the back that allowed me to exert both downward and lateral pressure with one hand, making the whole procedure much quicker and easier. The magnets I use, which are about 1 in. in diameter, are powerful enough to work with larger bench-plane irons and are encased in metal that's conveniently shaped very much like a drawer knob. *—T. Breece Rucker, Deddington, England*

Snug fits with cork



Turning a lid for a wooden container that will fit perfectly year after year is very difficult. The lid and container usually expand and contract slightly differently and, over the years, go from round to oval in shape. The problem is even worse when you turn containers from wild-grain crotches and burls. The solution to this problem is a tried-and-true method that musical-instrument makers have used for centuries to guarantee snug fits between sections of woodwind instruments like oboes and clarinets: line the mating parts with cork.

Musical-instrument cork is available from instrument repair suppliers (Ferree's Band Instrument Tools and Supplies, Box 259, Battle Creek, Mich. 49016 is one such supplier) in 4-in. by 12-in. sheets in various thicknesses up to ¼ in. I prefer the ⅓₂ in. thickness. Musical-instrument cork is sliced from the cork oak tree much like veneer and should not be confused with the inferior pressed cork found in hardware stores. I wouldn't trust the pressed cork to stand up to the strains of removing and replacing a lid.

To install the cork, turn the lid's tenon slightly smaller than the diameter of the container's opening. I suppose the exact undersizing of the lid tenon could be carefully measured, but I just approximate. Now, cut a cork strip from the sheet that's just a bit wider than the tenon and long enough to completely wrap around the lid's tenon with some overlap. Taper one end of the strip with an emery board and glue the strip to the lid with contact cement. Don't forget to apply cement to the tapered area.

Now, trim off the excess cork and sand the overlap until it's the same thickness as the rest of the cork ring. Chamfer the leading edge of the cork with the emery board so that the tenon will enter the container mouth without tearing the cork. Finish up by applying cork grease to the joint. Cork grease, which is available in every music shop in the country, acts as a lubricant to ensure the lid will come off easily. Some people may find the smell of cork grease objectionable, but I like it; it reminds me of band rooms.

—Ken Hopps, Tacoma, Wash.

Quick tip: To make threads on the end of a wooden dowel, I buy a hex nut of the appropriate thread and size and saw it in

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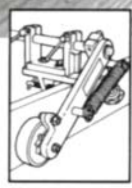

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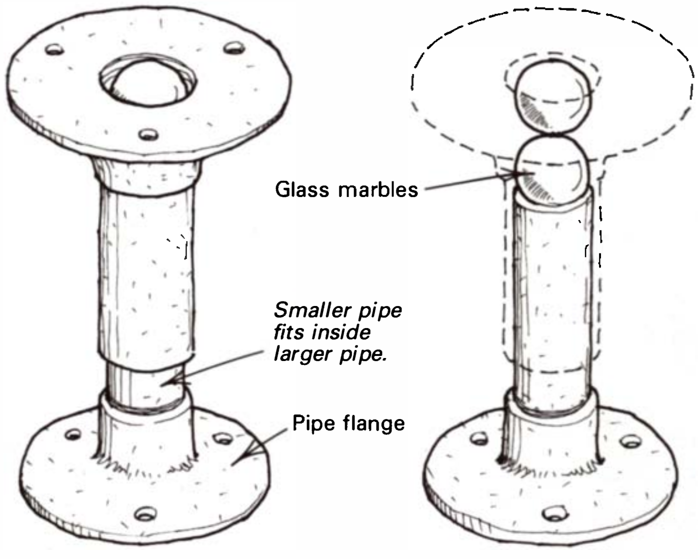
half with a hacksaw. I place the two halves around the end of the dowel and press the whole works in a vise. A 1-in. #8 hex nut is just right for mending a broken push-broom handle.

—Mark Workman, Walnut, Cal.

Pivot for weather vane



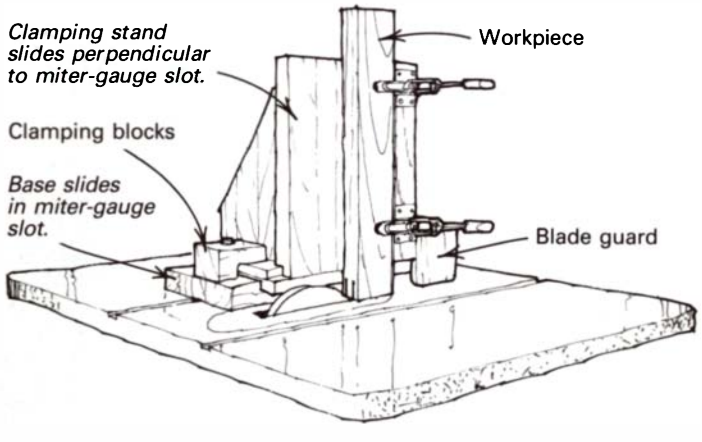
Here's a rust-proof, pivot-and-bearing surface for a weather vane, bird feeder or anything else you want to be rotated by the wind. As shown in the drawing, use two glass marbles as bearings inside of two pipe sections that fit one inside the other without too much play.

—Robert H. Schrader, Carrollton, Ohio

Quick tip: Large binder clips, available at any stationery store, make excellent small spring clamps. Other uses include fastening sliding measuring sticks and serving as a reference stop on a radial-arm saw fence.

—Stephen Agace, Herndon, Va.

Tablesaw tenoning fixture



A good tablesaw tenoning fixture must be heavy, strong, rigid and accurate. That's why I made my massive tenoning fixture from an old laminated-maple, science-lab tabletop. The fixture has two main parts: a base that slides in the miter-gauge slot on a steel key and a vertical clamping stand that slides across the base perpendicular to the miter-gauge slot. Clamping blocks are bolted into the base to hold the vertical stand in place after it's been moved into position to cut the correct-size tenon. Permanently attached lever-action clamps, like those by De-Sta-Co., screwed

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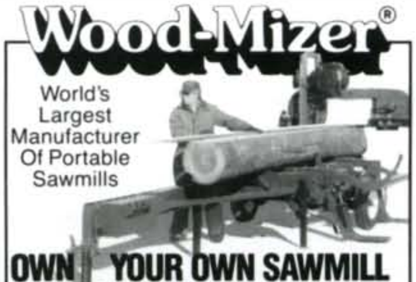

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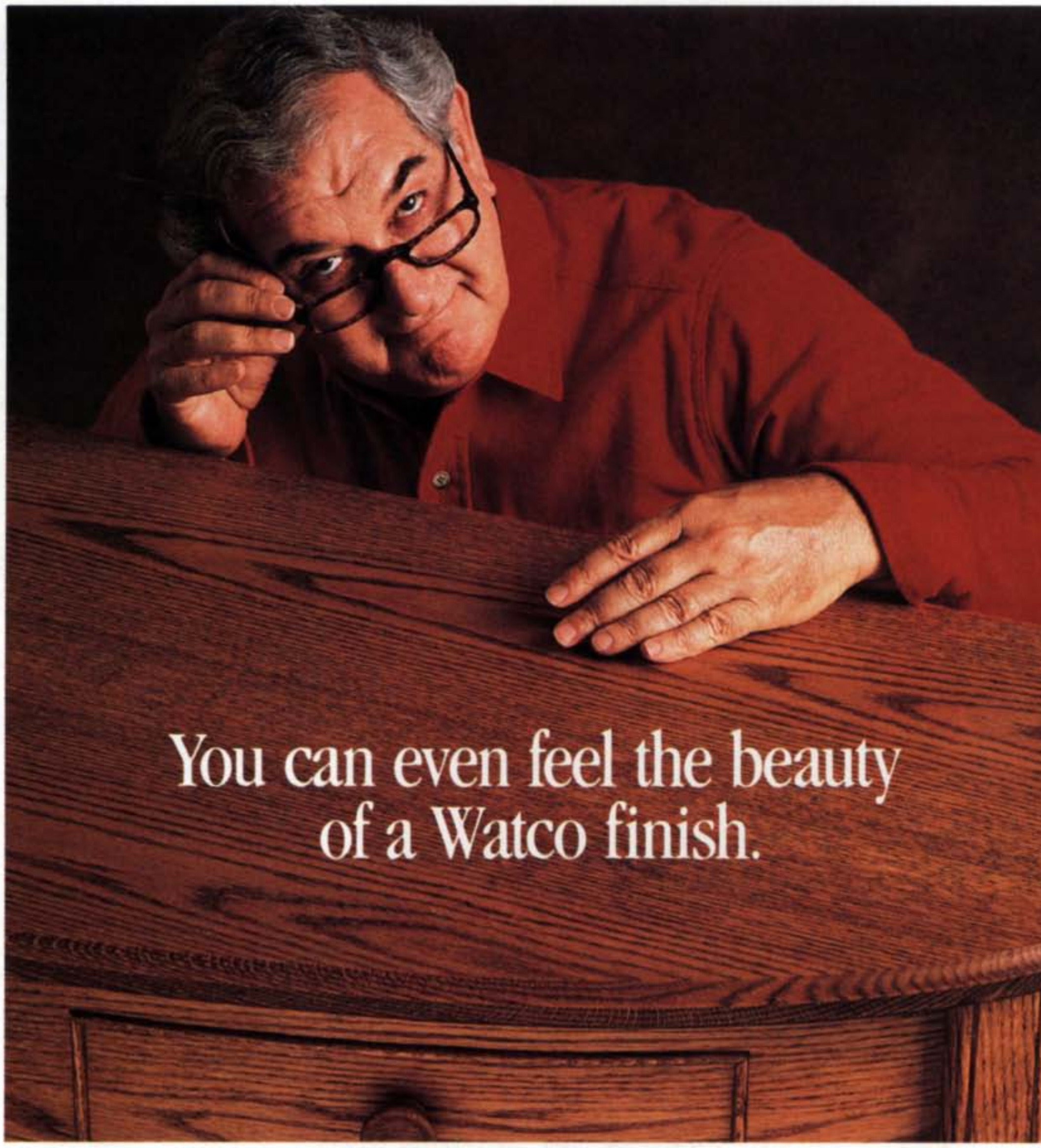

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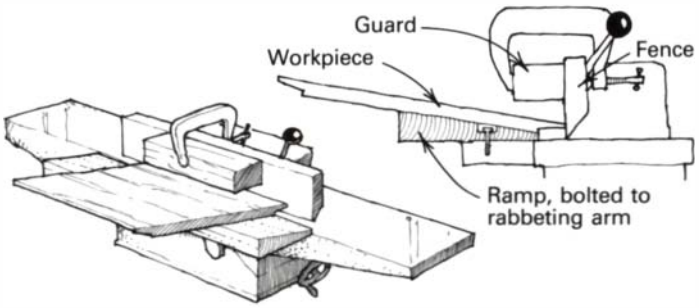
For FREE "How To" Booklet, write: Watco, P.O. Box 426W, Little Falls, NJ 07424 Dept. FW050 to the fence on the vertical stand hold the workpiece. As a safety feature, I added a blade guard on the trailing end of the fixture.

On production runs, I cut the tenon in one pass by mounting two identical blades separated by spacers, which set the final thickness of the tenon. Normally, though, when I have just one or two tenons to cut, I use a single blade and flip the workpiece for the second cut. *—Joe Moore, Brockville, Ont., Canada*

Making raised panels on the jointer



As a high-school woodworking teacher, my students and I have been cutting raised panels on the tablesaw for years. It's an altogether unsatisfactory method that at best is awkward, leaves burns on the bevel and doesn't feel safe. In addition, the slightest tilt of the stock creates a cavity that is time-consuming to sand out.

I finally purchased a monster 5-in.-dia. panel-raising cutter for our large shaper. But when I mounted it and turned on the shaper, the combination of the gaping hole in the table and the helicopter noise of the cutter winding up to 10,000 RPM was enough for me to shut down the shaper without even a trial cut. There's no way I would let students cut panels on this machine.

So, I was left with the same old alternatives: jigs for the tablesaw, radial-arm saw, router or—wait a minute, why not the jointer? After a couple of encouraging but unsatisfactory prototypes, I finally found what I was looking for—a safe, easy method that produces beautiful results.

The key to the method is a beveled ramp that's bolted to the jointer's rabbeting arm. I make the ramp by bandsawing a board at a 10° bevel and then truing up the sawn face on the jointer. Take the time to ensure that the bevel is identical at both ends. Then, drill and tap holes in the rabbeting arm so you can bolt the ramp to the arm. Make sure the inside edge of the ramp is parallel with the fence and right over the left end of the knives. You have to remove the regular cutterhead guard to use the ramp, so install a wooden guard block on the fence as shown in the drawing. The width of cut is adjusted with the fence and the depth of cut with the infeed table. I found that ¹⁄₁₆-in. cuts produce good results. Just lay the stock on the ramp with its edge up against the fence and use a push block to run it over the cutterhead. Beveling the cross-grain ends first and then following with the grain will reduce tearout at the end of the cuts.

The bevel angle may be changed by making ramps of various angles or making an adjustable ramp. Some jointers might require different mounting methods, but the important thing to remember is that the ramp is mounted to the infeed table.

—Joseph R. Robison, Freelandville, Ind.

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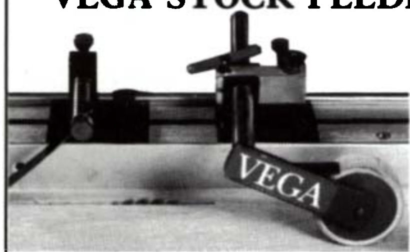

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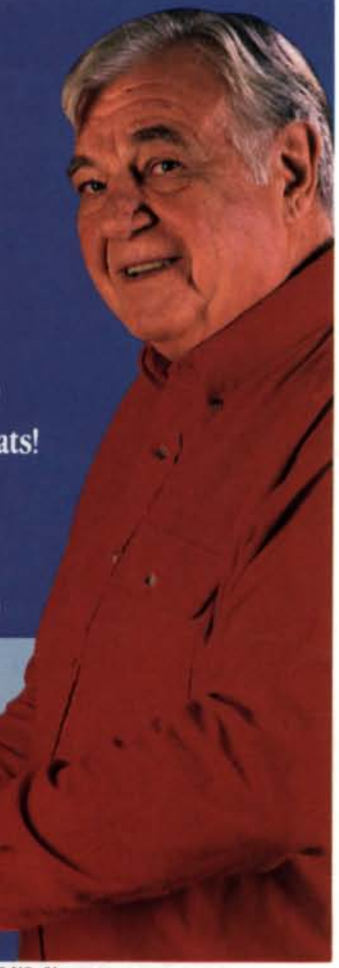

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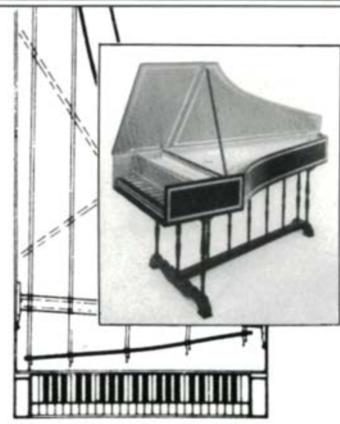

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Turning wood green again

If green turning blanks aren't available, can dry, seasoned wood be soaked or steamed to obtain turning characteristics similar to green wood? If so, what methods do you recommend?

—John Sorrells, Rockville, Md.

Drew Langsner replies: Unfortunately, neither soaking nor steaming will restore seasoned wood to the characteristics of green wood. While turning green wood is a pleasure, there are no real advantages other than ease and fast cutting. In addition, thin sections are more likely to vibrate.

Here are two ways to obtain green turning stock. If trees and/or fresh-cut logs are available, split blanks using an ax and a maul or a froe. Roughly round the pieces with an ax or drawknife. An alternative is ordering green 2x2s (or whatever dimension stock you need) from your local sawmill.

Blanks can be *kept* green in a freezer, submerged under water or wrapped in plastic. With wrapping, mold will form after a while, which may or may not stain the wood. Painting endgrain with a sealant will also retard drying, especially if the woodpile is not completely covered; two coats of latex paint work quite well.

[Drew Langsner is an author, farmer and woodworker living in Marshall, N.C.]

Cracked lacquer finishes

I have seen period-furniture reproductions with a "cracked" finish. I find this look appealing and I'd like to know the methods for achieving this type of finish.

—Ken Munsell, Litchfield, N.H.

Michael Dresdner replies: The easiest way to mimic the cracked effect of an old shellac finish is with a special lacquer known as "crackle lacquer," available from most lacquer distributors. This finish handles just like regular lacquer, and is sprayed over a smooth coat of regular gloss lacquer to allow the crackle to occur properly. The size of the cracks in the finish is controlled by the heaviness of the sprayed coat—heavier coats yield bigger areas of cracking. A fine pattern of cracks can also be obtained by coating a sealed or partially finished surface with a mixture of white glue and gilder's whiting that's thinned considerably with water. When the film has dried, exposing it to a heat gun or blow dryer will cause cracking. This method is somewhat more controllable than using crackle lacquer, but the film is milky white instead of clear, so it is only effective with white or colored finishes. The glue/whiting mix can be colored with dry-powder pigments.

[Michael Dresdner is a Contributing Editor for *FWW* and an instrumentmaker and finishing consultant in Perkasie, Pa.]

Building your own spray booth

I have a small building near my woodworking shop that I would like to turn into a finishing room with a dust-free environment. What recommendations could you make for a ventilation system to remove the spray mist and fumes?

—Dennis E. Hurley, Carlisle, Pa.

John Kriegshauser replies: The central issue in setting up an exhaust system is to protect against explosion and fire. At our professional woodworking shop, we bought a fan designed for spray booths from W.W. Grainger Inc. (5959 W. Howard St., Niles, Ill. 60648), and the company offers several sizes and models. We use the tunnel-type fan with the non-sparking aluminum blades, and the motor mounted outside the air stream.

You should pick a fan big enough to change the air in your room fast enough to prevent fumes from collecting and creating an explosive atmosphere. But selecting a fan that's too big can rob your shop of heat and cause finishes to flash-dry on the surface. A common test for exhaust-fan effectiveness is to blow a puff of cigarette smoke in the room and, if all is well, the smoke will move steadily toward the fan. But consult the manufacturers for fan-sizing information.

A good exhaust fan is, however, not enough to satisfy fire marshalls and insurance inspectors. They are more concerned with lacquer buildup on the fan and the walls of the booth. The standard booth design, which you see in most cabinet, finishing and automotive-body shops, consists of three metal walls and a ceiling to form a booth as deep as the largest objects that are sprayed. A plenum with the fan at one end, attached to the back wall of the booth, draws the spray and fumes through a filter and out of the shop. Any electrical outlets, switches or lights that could be the source of sparks must be outside the booth or they must be special (and very expensive) explosion-proof fixtures if they are inside the booth. More typically, regular fluorescent lights are installed outside the booth, shining in through wire-glass windows.

Of course, the exhaust fan sucks in dusty air as quickly as it expels the fumes. Therefore, you must install some kind of filter between your spray booth or room and the outside. The idea is to filter the incoming air without creating too much air resistance for the exhaust fan, which will work it harder and wear out faster. Common furnace filters are not restrictive, so you won't have a problem with air resistance, but they aren't effective dust removers either. A serious, cost-effective filter for your intake air is a dense-polyester type called Dicon, which is available from a local filter supplier. Allow plenty of filter surface so as not to restrict air flow.

Instead of buying the booth from a mail-order supplier or local dealer, we made ours using commercial steel studs and 22-gauge galvanized sheet metal. We put the whole thing together with self-taping screws, and ended up saving money and satisfying the inspectors. Many shops get by without having regulation booths, but then spray booth fires are all too common. Whatever you choose to do, make sure you use the proper-size exhaust fan, keep your booth free of lacquer buildup and overspray, and look out for sources of sparks. Particularly in the winter, when humidity is low, be careful of static electricity, which can also cause a fire.

As you can see, designing a spray booth involves a lot of compromises and judgment calls. Unfortunately, a well-engineered system is very expensive, but if you're a professional, it is a necessary, long-term investment.

[John Kriegshauser is a furniture designer and craftsman in Kansas City, Mo.]

The safety of garden-spread sawdust

Gardening experts often recommend sawdust as a garden-soil conditioner. But I have hesitated to use my shop sawdust in my vegetable garden because much of it comes from plywood, particleboard, and similar fabricated materials containing adhesives, binders and other chemical agents. Would this sawdust be detrimental to plant growth and would it be safe to eat vegetables grown in ground containing sawdust?

—Rhys Samuel, Hickory, N.C.

George Mustoe replies: Adhesives used in plywood and other fabricated wood products possess varying degrees of toxicity in their uncured form. But once they have solidified, the resulting plastic-like material is relatively inert and unlikely to pose any health risks to either the plants or vegetable eaters. However, painted wood and any material that has been treated with preservative compounds can release toxic heavy metals and poisonous organic compounds, and sawdust of this type should not be used in your garden. Also, while sawdust can be a useful additive for boosting the organic content of soil and increasing the permeability of clay-rich sediment, it is not a cure-all. In particular, the decomposition of large amounts of sawdust can be accompanied by a decrease in the quantity of nitrogen available to plants, requiring additional fertilizer. I confess, however, that I'm the kind of amateur gardener whose

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#232		1/4" Roman Ogee	1/4" R	1 1/2"	3/4"	1/4"	$18.00
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#460		1/4" **Bull Nose**	1/4" Dia. of Circle		1/2"	1/4"	$14.00
#461		3/8" Bull Nose	3/8" Dia. of Circle		5/8"	1/4"	$15.00
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#708		1 1/16" Dovetail	8 degree Jigs	1 1/16"	1"	1/2"	$14.00

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#470		1/4" **Straight**	plunge cutting	1/4"	3/4"	1/4"	$ 7.00
#471		5/16" Straight	plunge cutting	5/16"	1"	1/4"	$ 7.00
#472		3/8" Straight	plunge cutting	3/8"	1"	1/4"	$ 7.00
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#775		1/2" Straight	plunge cutting	1/2"	2"	1/2"	$14.00
#476		9/16" Straight	plunge cutting	9/16"	1"	1/4"	$ 7.00
#478		5/8" Straight	plunge cutting	5/8"	1"	1/4"	$ 8.00
#479		3/4" Straight	plunge cutting	3/4"	1"	1/4"	$10.00
#781		1" Straight	plunge cutting	1"	1 1/2"	1/2"	$12.00
#545		**Tongue & Groove**	Straight	1 5/8"	1"	1/4"	$29.00
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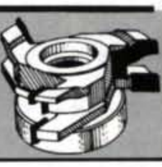

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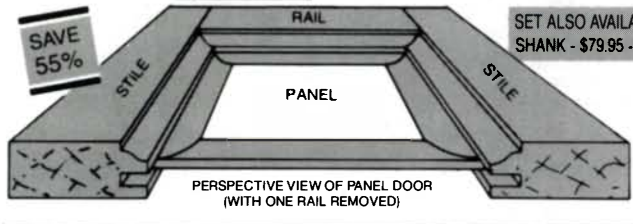

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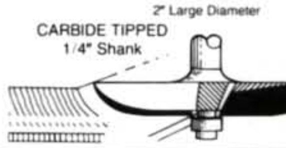

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mere glance can cause the leaves of healthy shrubs to shrivel and fall off, so before you bury your tomatoes in the leftovers from your tablesaw, you'd be well off to discuss local soil conditions with an expert, such as your nearest Department of Agriculture Cooperative Extension Office or the staff at a local nursery or garden shop.
[George Mustoe is a geochemistry research technician at Western Washington University in Bellingham, Wash.]

Ferrous sulfate mixtures for maple

I'm building an armoire out of bird's-eye maple and maple veneer and I've heard that applying a weak solution of ferrous sulfate and water will bring out maple's grain and figure. What are the exact proportions of this mixture and what is the best way to apply the solution?

–Jay Davis, Austin, Tex.

George Frank replies: There are many beautiful, deep, dramatic and vivid colors in every piece of wood, which, like the sleeping princess in the fairy tale, are just waiting to be awakened by the knight-errant of science. Many woods, such as oak, contain tannic acid that reacts when various chemicals, such as ammonia, are applied to the surface. The chemical reaction that takes place changes the wood's color. The reaction between bird's-eye maple and ferrous sulfate is similar. However, one difficulty in pinpointing the exact mixture that will bring out the desired result is that some maples react more intensely to the chemical than others. One maple species called *palazota*, found in the Balkan region of Europe, reacts much more readily to contact with ferrous sulfate than many of our domestic maple species.

In lieu of any definite formula, I suggest you carry out the following experiments on scraps of the same wood that you are using on your project. This will help you find the best mixture of sulfate and water to get the results you desire. First, put 100 grams (about 1½ oz.) of rain or distilled water in each of five clean glass containers or tumblers. Next, mix 5 grams of ferrous sulfate into the first glass, 10 grams into the second, 15 grams into the third, 20 grams into the fourth and 25 grams into the fifth (1 gram equals .035 oz., dry weight). Stir each with a clean stick until dissolved. You have now a 5%, 10%, 15%, 20% and a 25% solution of ferrous sulfate. Keep the glasses covered to prevent contamination.

Now, using a clean rubber sponge (a new one for each mixture), apply each solution to a different scrap of maple, prepared identically (sanded, scraped, etc.) as the wood for your project. With a squeezed-out sponge, wipe off the extra liquid, and let each sample dry in the shade at room temperature. Each of your samples must be numbered, and you must keep written record of every detail of your operations. I am convinced that one of these samples will meet with your approval.
[George Frank is a wood finisher living in Venice, Fla.]

Coping with bandsaw vibration

I'm wondering why my Rockwell 14-in. bandsaw fitted with a bimetal blade vibrates when I cut. The feed rate seems to have some effect; slow cutting produces a rougher cut that looks like a washboard, while fast cutting causes a smoother cut. What's happening here?

–Henry R. Linder, Jr., Roseville, Minn.

Mark Duginske replies: The samples of wood cut on your saw that I examined show the classic sign of harmonic vibration, which is produced by the blade oscillating at a uniform

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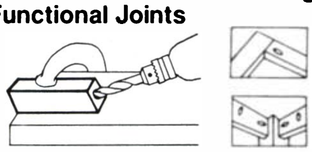

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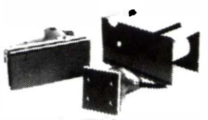

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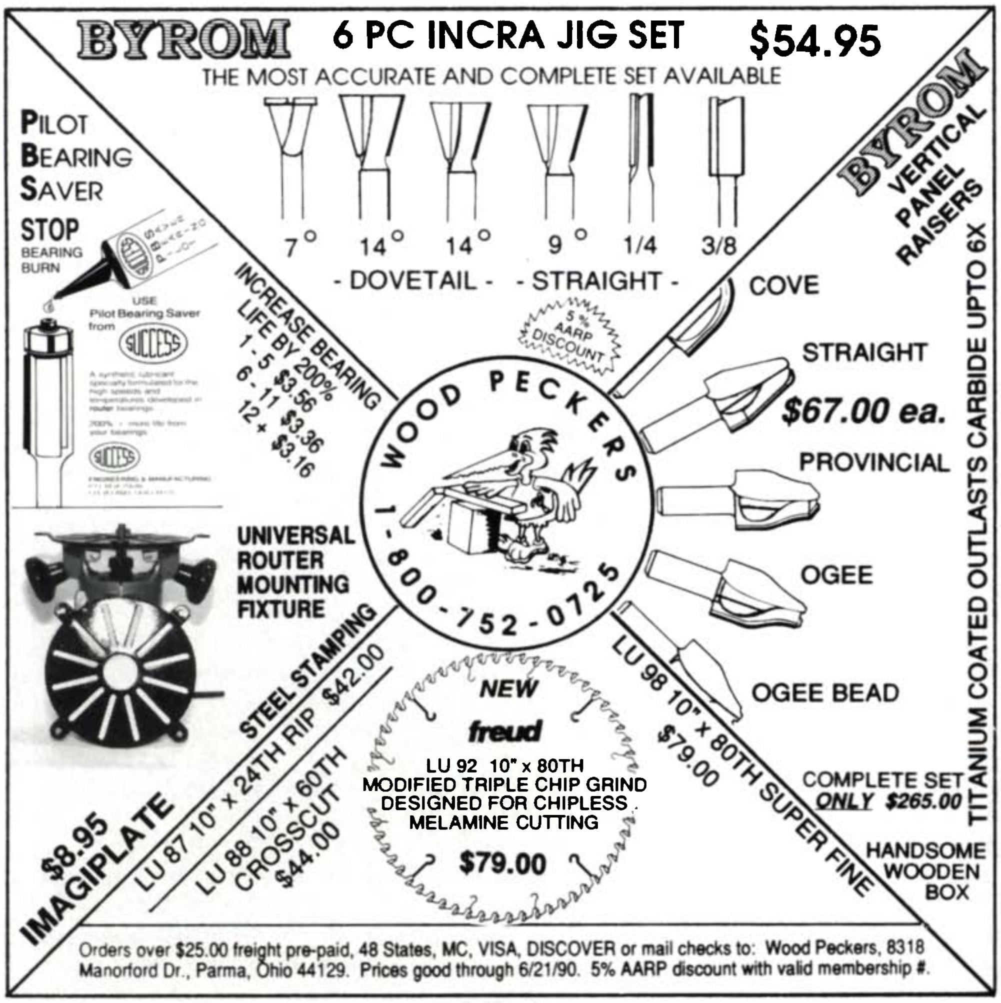

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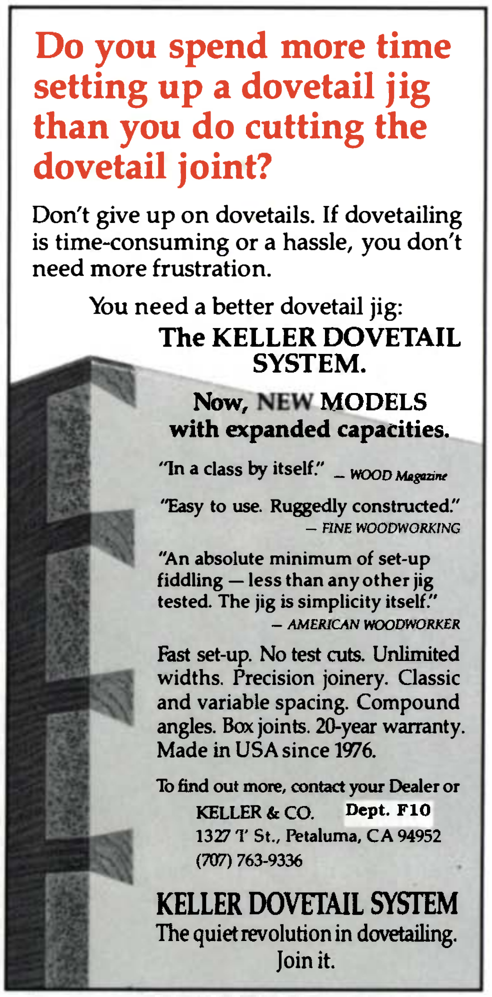

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frequency. All blades will vibrate under the right condition, which happens to be a combination of blade speed, tension, feed pressure and the hardness of the workpiece. Unfortunately, harmonic vibration seems to be a characteristic of bimetal blades when they're run at woodcutting speeds of about 2,800 feet per minute (FPM). By changing one factor, such as feed pressure, it is often easy to decrease the vibration, which explains why a faster feed rate gave you less washboard. It is easiest to change the feed speed when the saw vibrates. If the vibration happens too frequently or is too much of a bother, it may be best to use a different type of blade, as harmonic vibration tends to shorten blade life. You can also decrease the likelihood of vibration by using proper wheel alignment (see "Adjusting Bandsaw Wheels," *FWW* #75, p. 75), maintaining and cleaning the tires, and using a sharp blade.
[Mark Duginske is a woodworker, teacher and author who lives in Wausau, Wisc.]

Converting three-phase power

Although my shop has only single-phase 220v power, I recently bought a tablesaw with a 3-HP, three-phase motor rated at 7.4 amps. Is it true that I can run this motor on single-phase power by putting a capacitor in one of the three lines to the motor? ***—Ben Howze, Sr., Erwin, Tenn.***

Bruce Schneider replies: Two types of phase convertors are available for running three-phase motors: static convertors and rotary convertors. The most common type of static convertor involves the insertion of capacitors in one of the electrical legs that feed a three-phase motor. However, this approach has several severe disadvantages. Unless the capacitor's size is very carefully chosen, catastrophic overheating of the motor typically occurs. Even if the capacitor is correctly sized, overheating can occur if the motor experiences a load causing a power draw greater than 75% of the motor's maximum capacity. This effect is particularly undesirable for a machine such as a tablesaw, for which the load on the motor varies significantly as different workpieces are cut. Additionally, a static convertor can only be used on the particular motor for which it is sized—it can't be used to run several motors in the shop—and static convertors also offer low motor-starting torque. Therefore, I strongly advise that you do not use a static convertor for your situation.

Rotary-type three-phase convertors do not have as many disadvantages as static convertors, but they also must be carefully chosen. Rotary convertors employ a three-phase convertor motor with a capacitor (or capacitors) in one leg of the circuit. Typically, the convertor motor must have twice the horsepower rating as the largest single-phase motor in order to be run on the convertor. Oil-filled electrolytic capacitors are used that generally equal a value of 20 microfarads per horsepower of the convertor motor rating.

The building of a rotary phase convertor is described in *FWW* #24, p. 57 (reprinted in *Fine Woodworking on Machinery*). However, unless you are very familiar with electrical power equipment, I would suggest that you buy, rather than build, a phase convertor.
[Bruce Schneider is a patent attorney and amateur woodworker living in Sterling, N.J.]

Send queries, comments and sources of supply to Q&A, Fine Woodworking, *Box 5506, Newtown, Conn. 06470-5506. We attempt to answer all questions, but due to the great number of requests received, the process can take several months.*

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by Dick Burrows

Static electricity in the shop—Those little jolts we all receive from time to time continue to be a hot topic among woodworkers, especially those working in very dry areas.

After reading our item on static electricity in the Q&A column of *FWW* #80, Bart Balka of Fort Wayne, Ind., wrote us with a couple of additional suggestions, especially concerning the usefullness of wearing static-dissipating shoes in the shop. Bart has some experience with electrical problems since he says he is an engineer employed by a utility company and familiar with the National Electric Code, as well as an avid woodworker.

He agreed that static electricity is usually caused by two objects rubbing together. "This rubbing action actually strips electrons from one object and, in turn, they collect on the other. This accumulation of electrons, or static charge, seems to be more prevalent during the winter because of the lack of moisture or humidity in the air. Humid air actually acts as a poor conductor helping to drain the charge to ground."

But he points out that many times the static is built up by the moving components of a machine, not just by shoes rubbing against the floor or from some other piece of clothing. If the static is built up on the machine, the person touching the equipment becomes the conductor between the equipment and the floor, draining this charge to ground. "If the machine is generating this static charge, the last thing you'll want to do is buy a pair of static-dissipating shoes...this would just enhance the problem."

Under most shop conditions, he said, eliminating static electricity can be difficult and costly if major machine modifications are required. "However, if a piece of equipment is properly grounded, static charge should not be a problem. Under certain circumstances it may be necessary to modify the equipment slightly and usually inexpensively to help improve grounding for a particular application."

The first thing is to check the effectiveness of the ground by using a continuity checker (you might need the assistance of an electrician). "If you currently don't have a properly grounded system, by all means, don't ground the equipment to a water pipe. A water pipe is just that, a pipe to carry water, not electric current (violation of the National Electric Code). Don't forget, this ground is to carry the static charge away, but it will also be carrying full line current if the machine shorts out. If the electrical wiring in your shop is to code specifications, most likely the water line in the building is bonded to the electrical ground. This is done to provide a ground path in case a piece of equipment that is connected to the water line, such as a drinking fountain, electric water heater, etc., shorts out. This will provide the electric current a ground path, causing the fuse to blow instead of energizing the water line. By all means install an additional ground wire, sized properly for the circuit, instead of trying to take short cuts. Electrical safety is just as important as operational safety of your woodworking equipment."

Bart also offered advice for the static problems involving the stroke sander and shop vacuum mentioned in the Q&A item. For the stroke sander he recommended draining the charge by attaching a wire extremely close to, if not touching, the back side of the belt, and connecting it to a good grounding point on the equipment. "If you are unsure of where this might be, I would recommend that the wire be run back to the location where the ground for the power cord attaches to the machine. If this did not sufficiently drain the static charge, I would consider connecting an additional ground wire to the pressure block you are using and ground it as mentioned before."

The shop vacuum is probably double insulated, he said, and requires a slightly different grounding application. (Modern double-insulated power tools come equipped with a two-prong cord.) "I've had some success by attaching a steel hose clamp around the vacuum hose at the shop vacuum end and then grounding this clamp. Grounding is accomplished by attaching a piece of small metallic chain from this clamp, long enough to touch the floor in your shop. The floor in my shop is concrete and absorbs all of the static charge with no shocking effects. The chain provides enough flexibility to ensure constant contact with the floor. If this fails, I would consider changing the power cord to a three-wire three-prong cord and connecting the ground wire, usually green, to the clamp."

Simplify sharpening techniques—Glen Estes of Baton Rouge, La., says he thinks many of the articles we've run on hand-tool sharpening involve an unnecessary number of stones, and complicated devices and techniques. His method requires only a medium or fine diamond "stone" and honing guide; and a grinder/motor with two arbors, one for a medium or fine, rubberized abrasive wheel and one for a white- or green-rouge buffing wheel. (For more on honing guides, see *FWW* #81, pp. 55-57.)

Glen said he uses the diamond stone with a honing guide for all straight edges such as plane blades. The stone, which is available through many local suppliers and mail-order houses, stays flat forever, can be lubricated with almost any fluid (he recommends water in a squeeze bottle, or even a shot of WD-40) and cuts quickly with light pressure. "Get the biggest-size stone you can, so you can take long, smooth strokes. Light pressure means that the wire edge will be very fine and easy to remove later." He said a few strokes will flatten the backs of plane blades and straight chisels.

Curved blades, such as gouges or drawknives, and blades where you want a "softer" rounded edge are sharpened on a fine, 120-grit wheel, available from local industrial-supply shops and many mail-order houses. The motorized wheel does the work quickly, and light pressure means that there will be little heating and a fine wire edge.

Glen's final step is to polish the blade surface on a buffing wheel, which removes the wire edge and smooths the metal so the tool slides easily through wood fibers. "A hard-felt wheel is nice for straight tools, but a spiral-sewn wheel will also do a good job. Use either white-rouge ('stainless') or green-rouge buffing compounds. (Red rouge, emery and tripoli do not work as well.)"

Credit where credit is due—Due to an editing error, we failed to give proper credit for the excellent photograph of the Queen Anne dressing table in *FWW* #80. The photo was taken by Brian Gulick of York Harbor, Maine.

Roll-top measurements—A couple of sharp-eyed readers have had problems with the drawings accompanying Kenneth Baumert's article "Building a Roll-Top Desk," *FWW* #79. The horizontal raised panel in the optional knee-hole panel should measure 18½ in. across, not 17 in. A misplaced arrow also made it difficult to figure one dimension. The curved panel on the side of the roll-top is 19¾ in., not including the frame members.

Source for large cove bits—In *FWW* #80, Mac Campbell wrote about "Routing a Rule Joint," and said he was unable to find a cove bit with a radius greater than ½ in. David Freeman, vice president of sales for the Amana Tool Co., wrote to tell us that his company has the cove bits in ⅝-in., ¾-in., ⅞-in. and 1-in. diameters, in stock and ready for immediate delivery. You can contact the company at 1250 Brunswick Ave., Far Rockaway, N.Y. 11691; (718) 327-6100.

Updating the woodworking schools list—School officials at Jamestown Community College in Jamestown, N.Y., have informed us that they no longer offer a woodworking program, as listed in *FWW* #81. We apologize for any problems we may have caused the school. We also invite those who were omitted from the list to continue to write to us, so we can publish an update. □

Dick Burrows is editor of Fine Woodworking.

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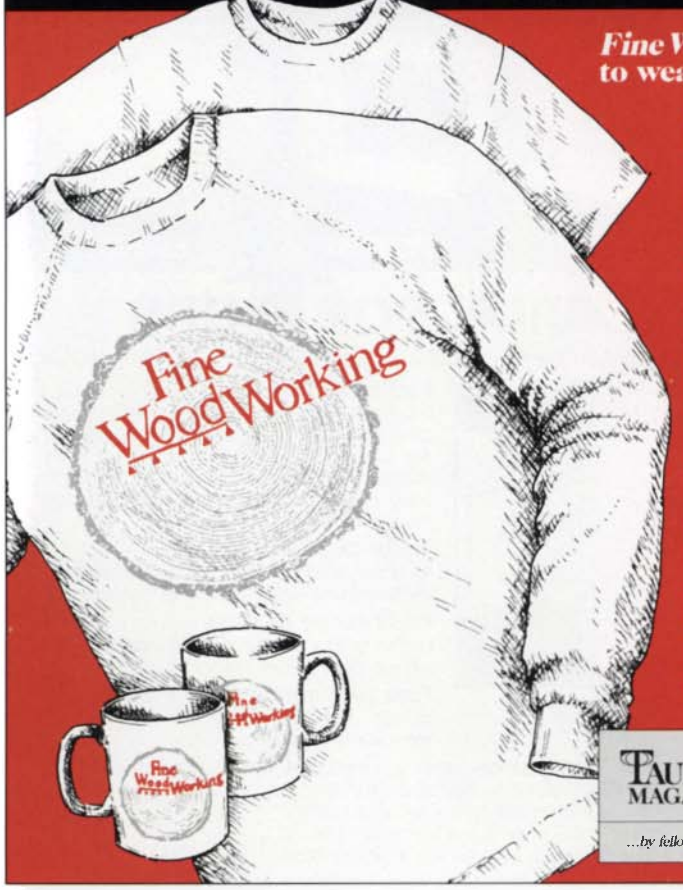

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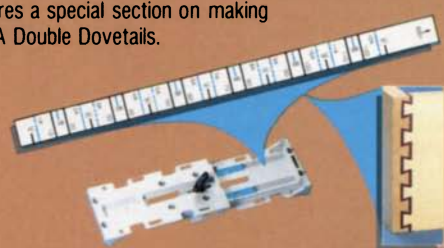

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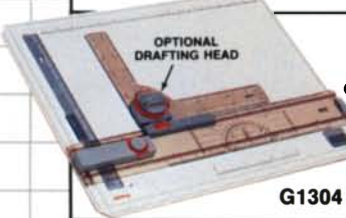

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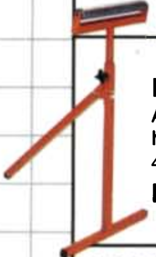

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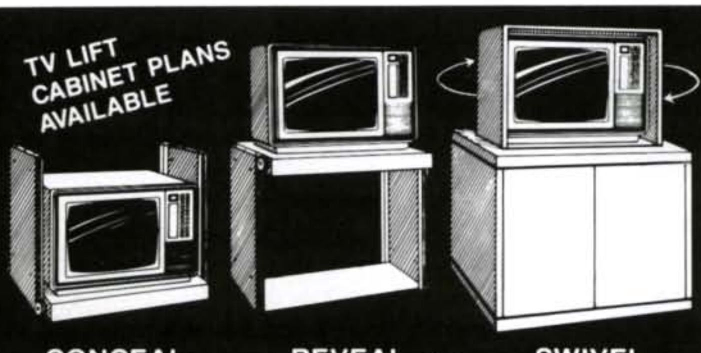

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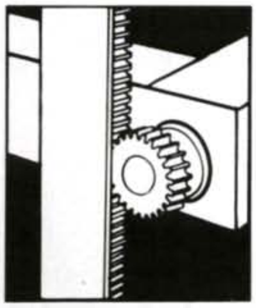

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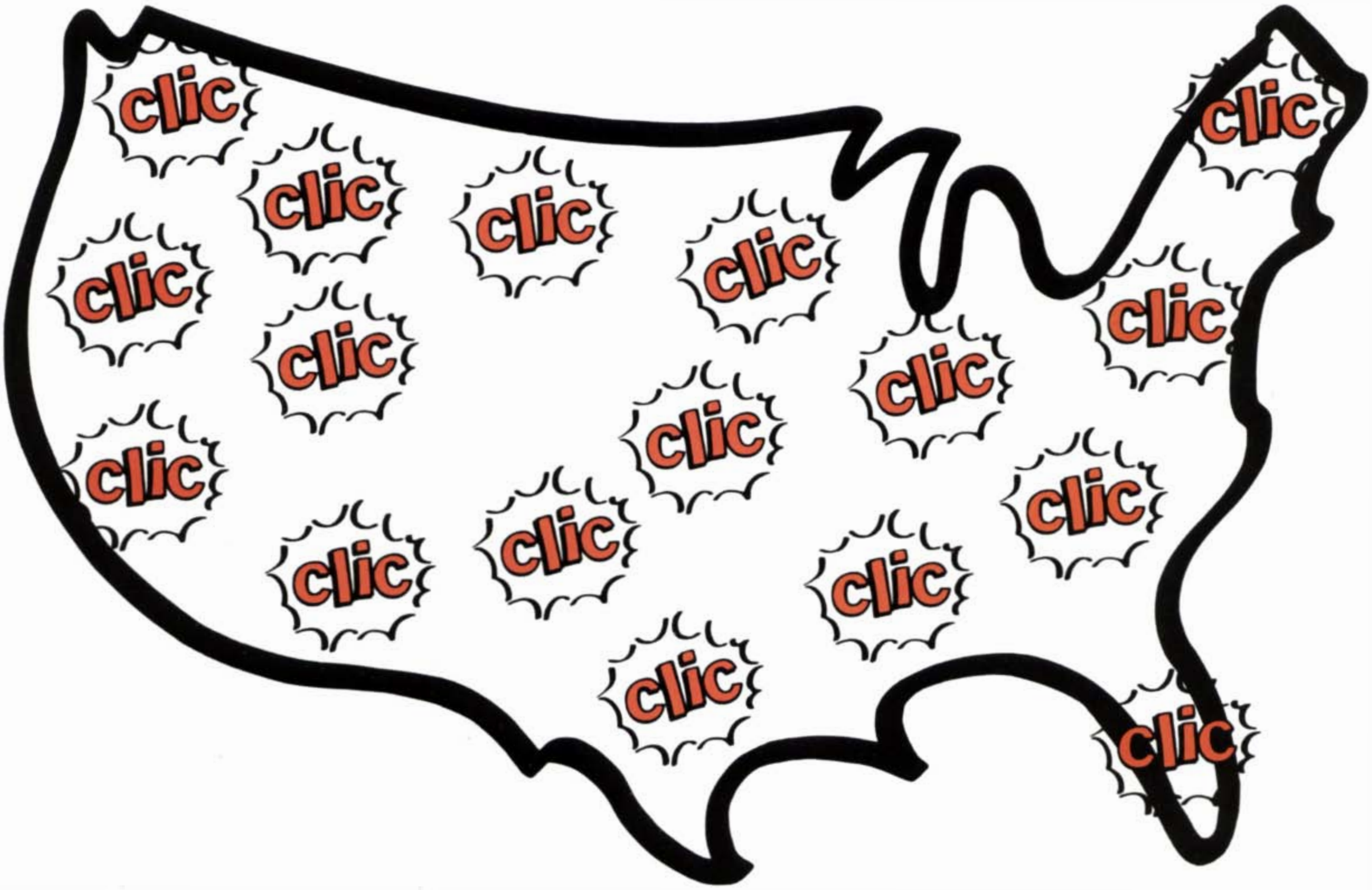

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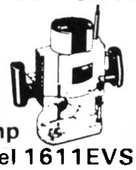

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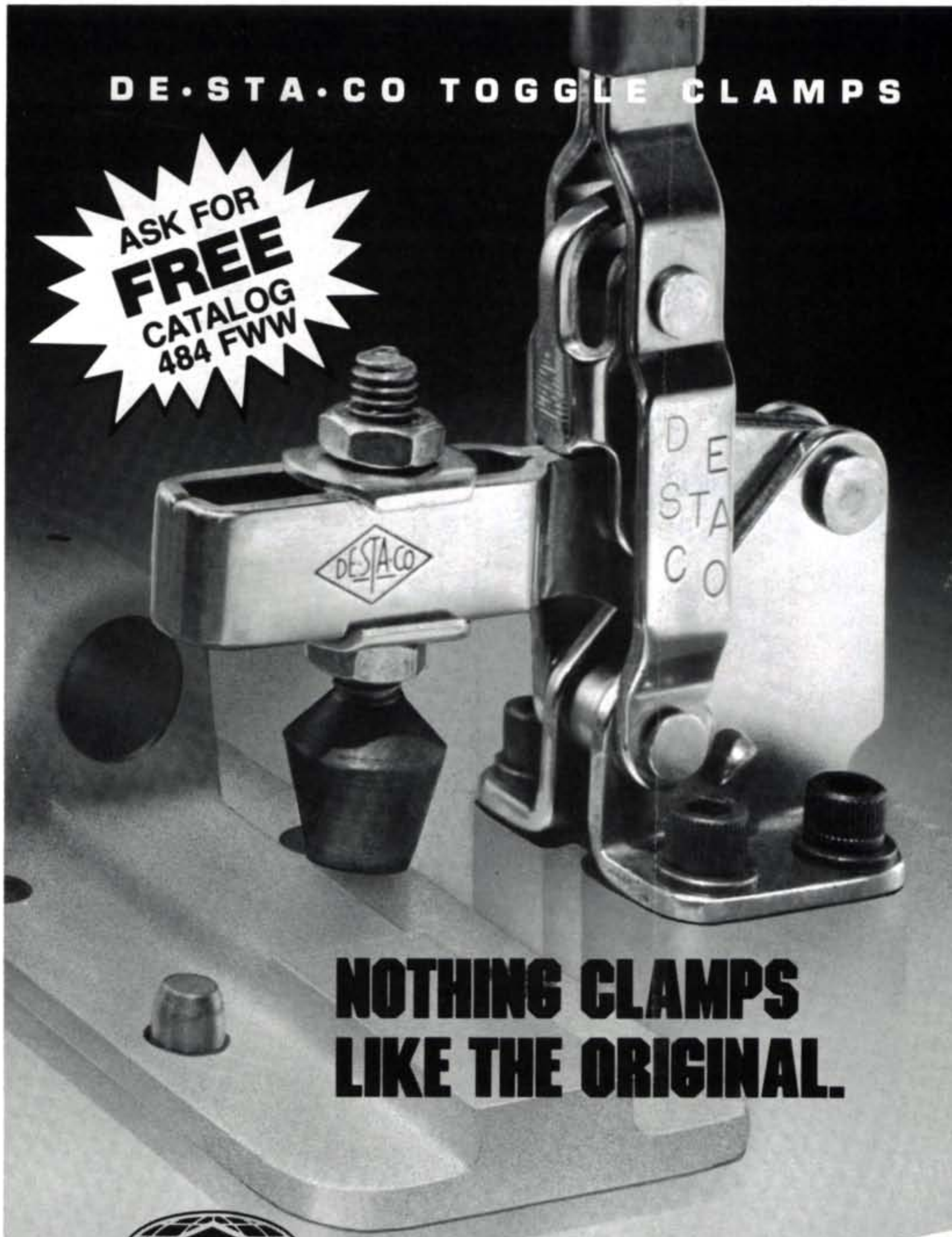

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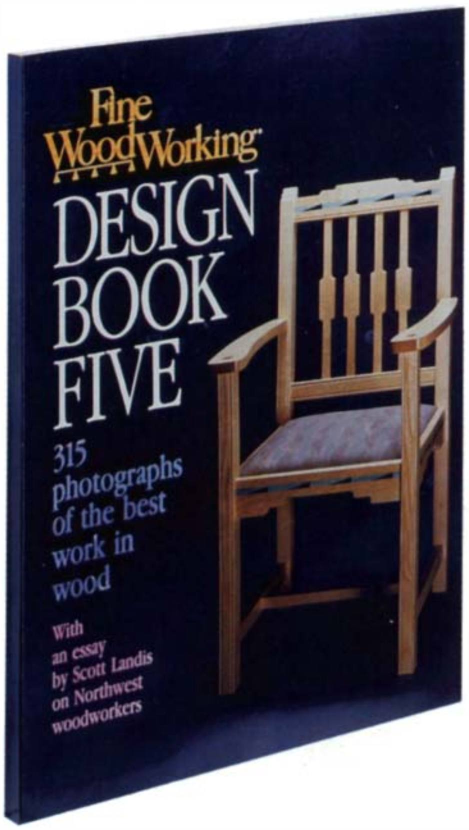

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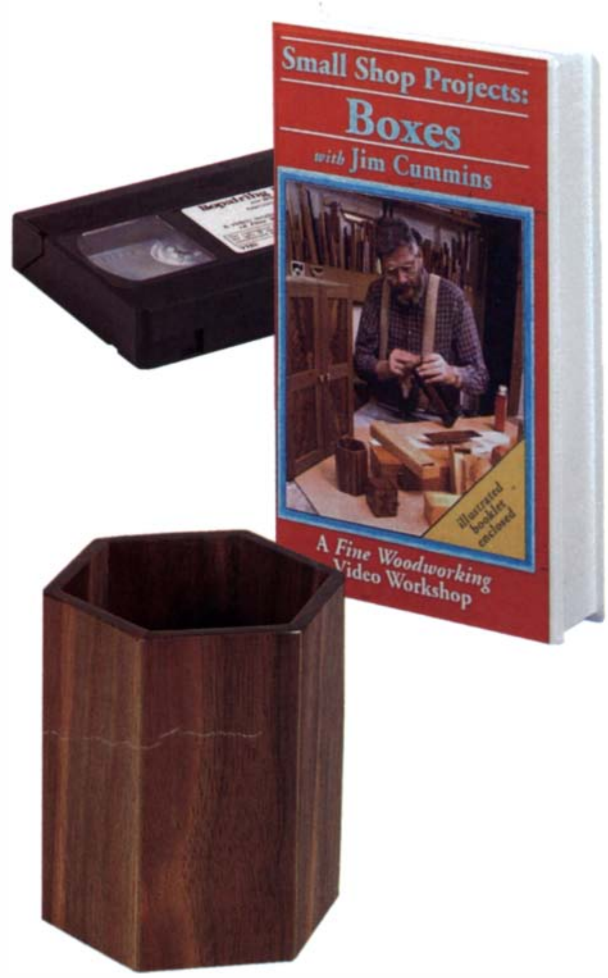

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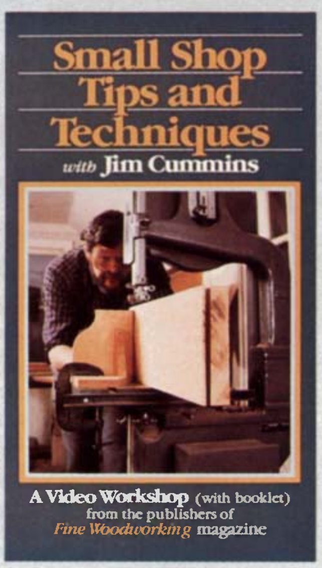

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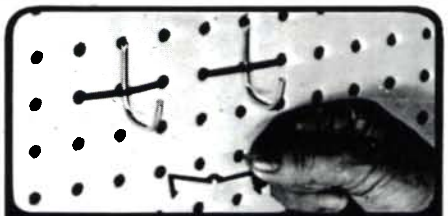

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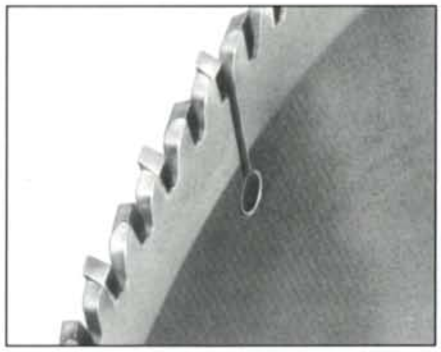

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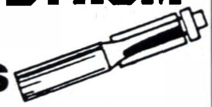

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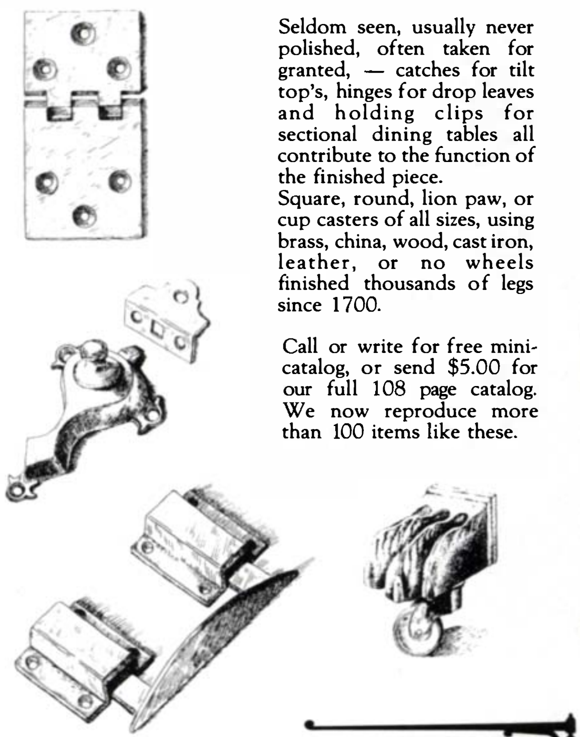

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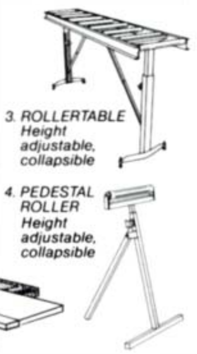

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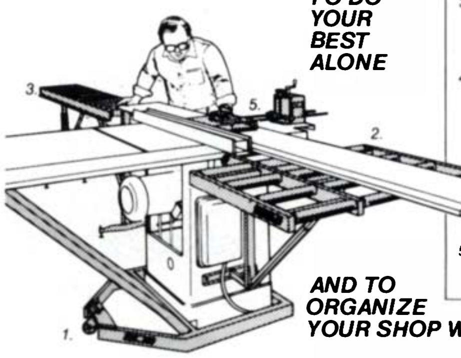

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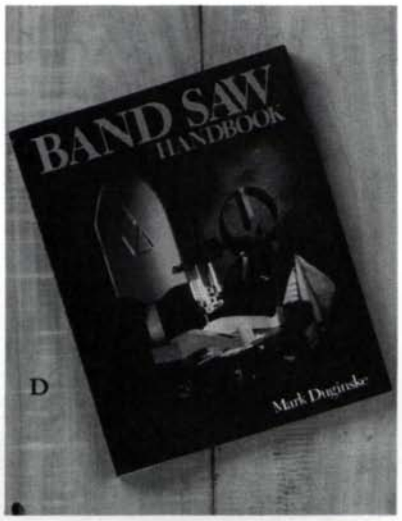

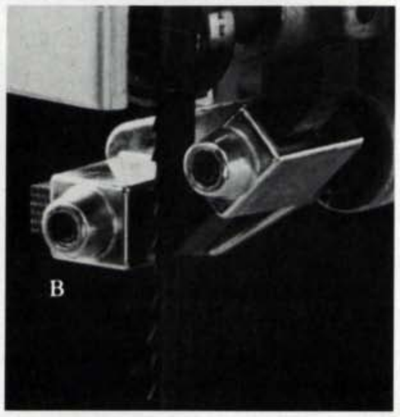

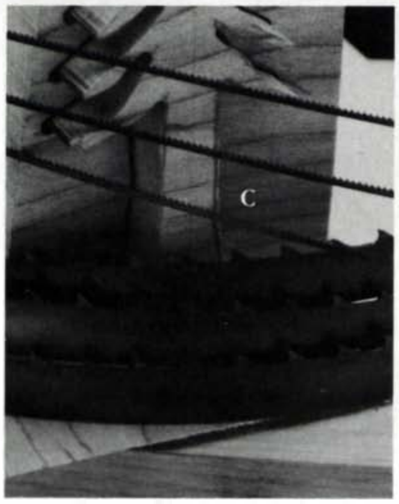

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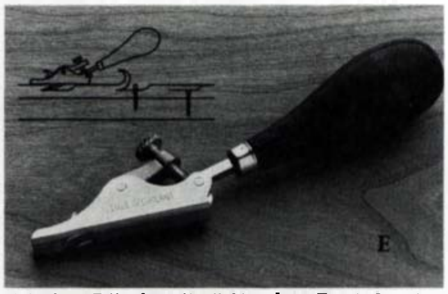

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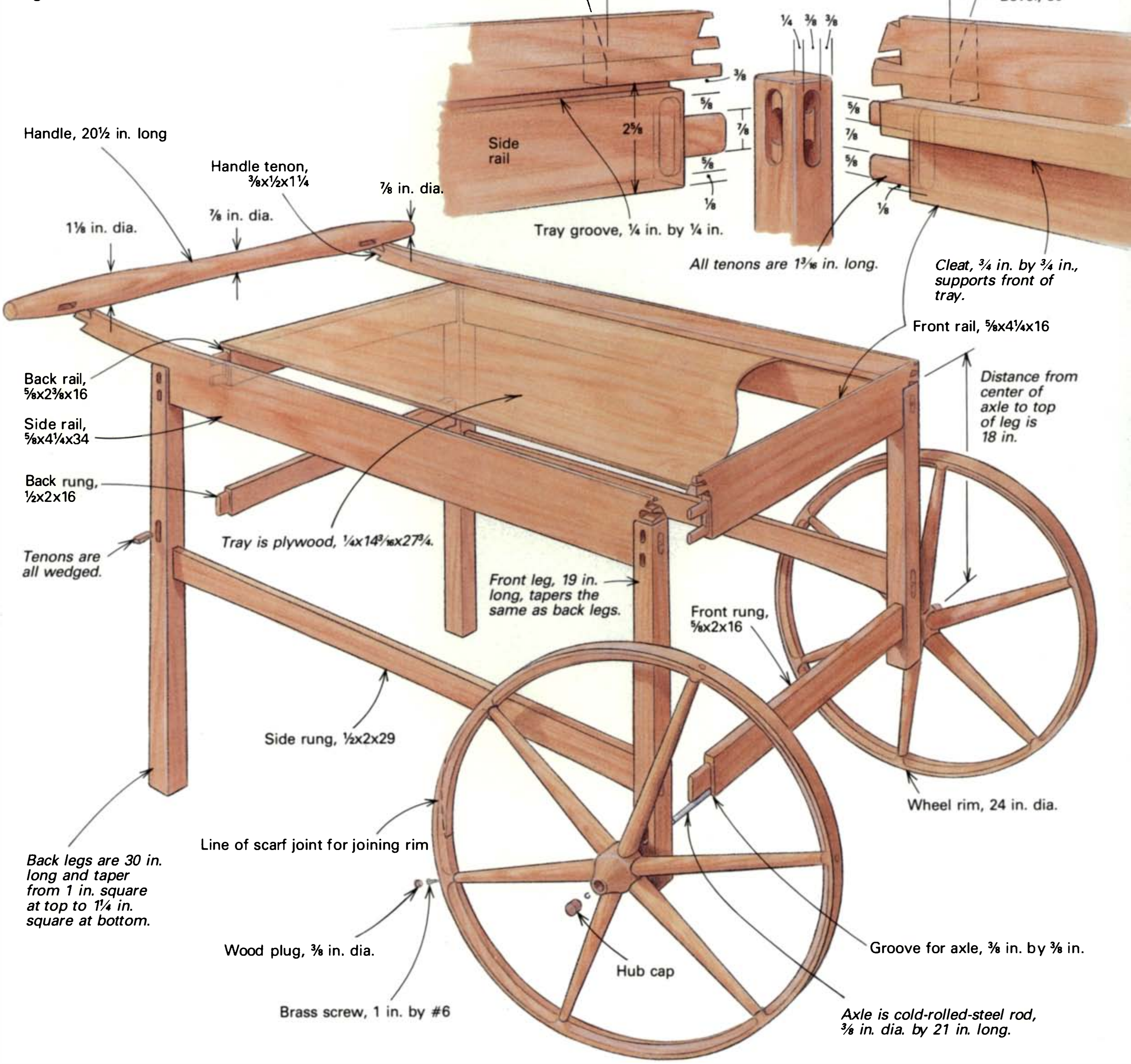
Building a Tea Cart

A simple method for making spoked wheels

by John Dunham

Fig. 1: Tea cart



A tea cart has been a regular attraction in my booth at craft fairs for the past 10 years. Even though it isn't as essential as a table and chairs in a dining room, it's always been a good seller. People are fascinated by the cart's mobility and intrigued by the possibility of simplifying the daily task of setting and clearing a table. The tea cart in the photo at right is lightweight, but strong, and the large diameter of its wheels enables it to pass easily over thresholds and carpets.

The cart itself is basically a small table with both legs at one end cut off just below the cross rung. The steel axle, which is housed within the cross rung, does not rotate. Instead, each hub is fitted with a pair of shopmade brass bushings that turn very smoothly on the axle. Although I steam-bend the wheel rims when working with woods that bend well, like oak, ash or walnut, rims can also be made by laminating thin strips together around a circular form. The bent rim stock is wrapped around the spokes, screws are run through it into the ends of the spokes and the screw holes are then plugged. The loose ends of the rim are bandsawn at an angle and glued together in a long scarf joint to close the wheel's circumference.

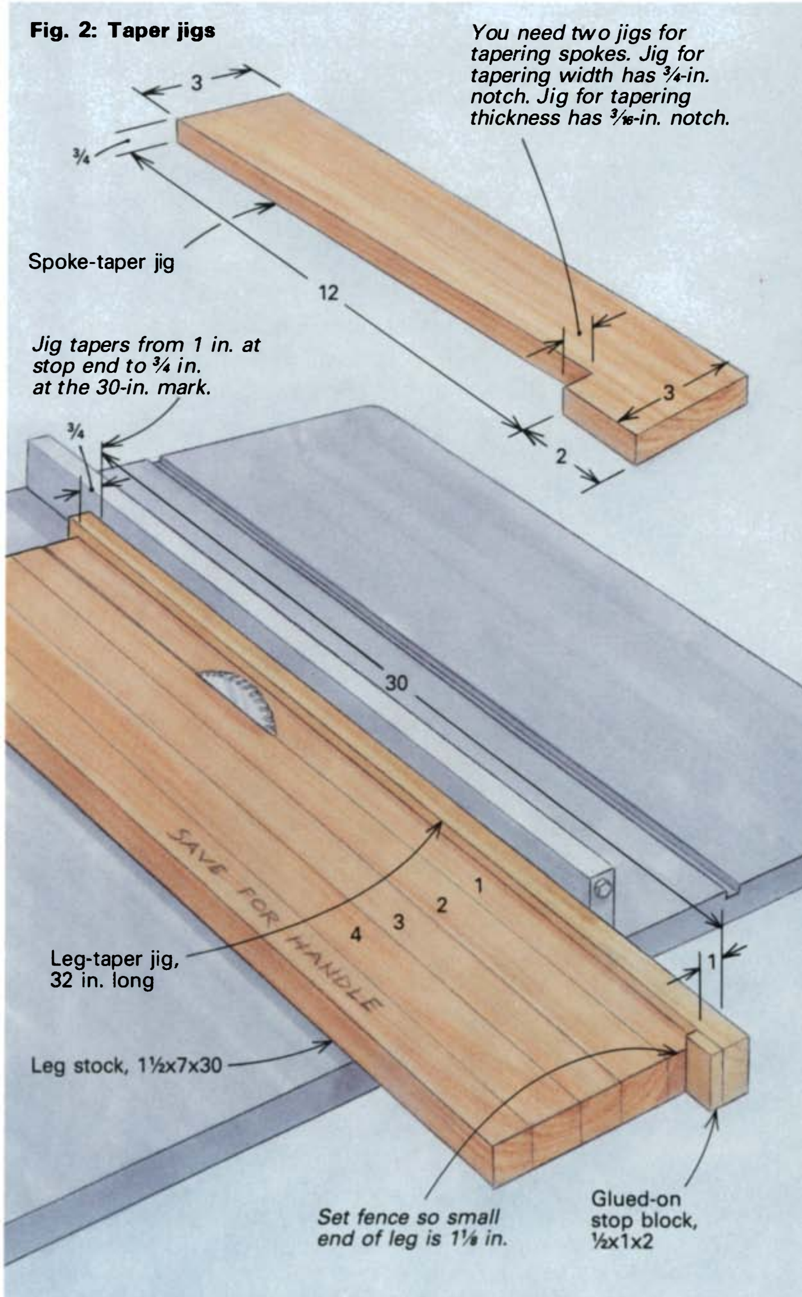
Before building the tea cart, you might want to consider a few options that can add to the utility of the basic cart shown in the photo at right. A shallow drawer can be installed below the handle by screwing guides to the side rails and reducing the width of the back rail to accommodate the drawer front. If you want more surface area than the tray provides, a lower shelf can be added by gluing cleats to the side rungs to support it. I recommend ¼-in.-thick tempered glass for this lower shelf because a wood shelf makes the cart look too heavy. Another option is lining a portion of the tray's surface with ceramic tile.

Cart joinery—The cart's frame consists of four tapered legs, four upper rails that form the tray's sides and ends, four lower rungs and the handle. For the oak cart shown in the photo above, I began with ¾-in. stock, ripping and crosscutting the rails and rungs to size and planing them to the dimensions given in figure 1 on the facing page. Notice that the front rung is slightly thicker than the other rungs to accommodate the axle. You'll need a 7-in. by 30-in. piece of 6/4 stock for the handle and legs. Even though the front legs will eventually be cut off just below the front rung, you should make four full-length legs so you can taper them all on the same tablesaw jig. If you cut the legs from a 7-in.-wide board and reverse the stock in the jig after each cut, you'll have enough stock left over for the handle.

The leg-taper jig, shown in figure 2 at right, will let you rip and plane 30-in.-long legs that taper from 1 in. square at the top to 1¼ in. square at the bottom. To make the jig, begin with a 1x2x32 board and lay out and bandsaw the taper as shown in figure 2. Fine-tune the tapered surface with a handplane or jointer and then glue a ½-in. by 1-in. stop on the flat end of the jig.

To cut the tapered legs, place the jig on edge on the saw table and up against the rip fence. The fence should be adjusted to leave about 1⅛ in. between the jig and the sawblade just in front of the jig's stop. Now, pull the jig back so there's room to lay your leg stock flat on the table in front of the blade with its end against the stop and its jointed edge firmly against the jig. Hold the jig and stock against the fence and rip the first leg. The operation is repeated with the stock reversed end for end after each pass, until you have four legs tapered on one side. Then, roll each leg 90° and taper all four legs on an adjacent side. To clean up the sawmarks and to plane the legs to their final size, place them on the jig with the sawn side up and run them through the planer, stop end first. Plane each leg on both adjacent sides until the small end is 1 in. square. The two front legs can now be crosscut to 19 in. long. Tilt

This basic oak tea cart is as much fun to build as it is to own. The large spoked wheels present a unique challenge to the builder and the finished cart adds a functional touch of class to any dining room.



Reverse stock end for end after each pass. After ripping out all four legs in this manner, use the jig to taper each leg on an adjacent side.

Photo this page: Bob Hansson; drawings: Bob La Pointe the blade used for crosscutting just a tad so that the end of the leg is cut square with the centerline and not just with the tapered side.

The rails and rungs are joined to the legs with through, wedged tenons all around. In addition, the front corners of the tray portion of the rails are also dovetailed together (see figure 1 on p. 40). On the first cart I built, the one in the photo on the previous page, I made the side and front rails wide enough to include the tray sides, and then I ripped each rail into two pieces even with the top of the legs. This made it possible to lay out and cut the tenons on the rails separately from the dovetails on the tray sides. Then I edge-glued the rails and tray sides back together before gluing up the cart frame. This simplified the joinery, but I was unhappy with the visible glueline. So now, instead of ripping the rail stock into separate rails and tray sides, I leave the rails their full 4¼ in. width. Then, I bandsaw the rail tenons, handle supports and dovetail pins on the side rails, and finish them up by hand with a chisel. Although this complicates fitting and cutting both the rail tenons and the tray dovetails, I think it's worth the trouble to preserve the smooth, unbroken surface on the side of the rails.

Whether you rip the rail/tray sides before joinery or attempt the one-piece method, the mortises for the upper rail tenons are laid out on the two adjacent sides as shown in the post detail in figure 1. The adjacent mortises are then cut on different sides of the lines so the intersecting tenons will miss each other. I originally designed haunch tenons for the side rails to resist any tendency for the rails to twist. After building the piece, I decided the haunches weren't necessary because there is enough support with the handle at one end and the dovetails at the other. However, I still use the haunch tenons on the rails because it's easier and faster to chisel a clean shoulder if the haunch remains.

I use a ⅜-in.-dia. end mill in my drill press to cut the mortises. A fence clamped to the drill-press table registers the mortises side to side and a featherboard holds the pieces firmly against the fence. I drill overlapping holes to clear out most of the mortise and then slide the piece sideways along the fence to smooth the sides. Of course a table-mounted router or a plunge router with templates can also be used for mortising.

When all the mortises are complete, the tenons are cut to fit them. As I mentioned earlier, if the rails and tray sides are left in one piece, the tenons on the side and front rails must be bandsawn and fitted by hand. The rung tenons and those on the narrow upper rail that runs beneath the tray at the handle end can be cut on the tablesaw. I use a small carving gouge that has a ⅜-in.-dia. arc to round the tenons to fit the arc of the mortise ends and then individually check the fit of each tenon to its mortise.

After fitting the rail tenons to the leg mortises, Dunham draws around the dovetail pins on the side rail to mark out the tails on the tray portion of the front rail. The depths of the pins must be adjusted along a 30° angle to fit tightly to the bevel that he'll plane on the inside edge of the front rail after marking and cutting the tails. The side rail is beveled before the pins are cut.

Joining the tray—When the rail and rung tenons are done, you can turn your attention to the upper portion of the rails that form the tray sides. Before sawing out the dovetail pins on the front ends of the side rails, I plane a 30° bevel on the inside edges, as shown in the post detail in figure 1. This bevel makes a nice detail where the tray sides meet at the front corners and lightens the tray visually, but it is yet another complication for making the dovetails. You might want to avoid the dovetails entirely and miter the tray corners instead. I wouldn't blame you. But if you continue with the dovetails, you will have to vary the pin depth on the side rails to accommodate the 30° angle that you will later plane on the front rail (see the detail in figure 1). First, cut the pins on the side rails, assemble the front rail and front legs, and mark for the tails as shown in the photo below. Then, cut the tails to fit, and bevel the inside of the front rail to match the angle for the pin.

Now you can rout the ¼-in. by ¼-in. groove on the inside of the side rails for the tray. I use ¼-in. veneered plywood for the tray, which I slide into the grooves after gluing up the cart frame. A narrow cleat is glued to the front rail to support that end of the tray and a strip of hardwood is glued on to cap the back edge.

The last step in forming the tray sides is to shape the handle extensions. First bandsaw the gentle curve along the top edges of the sides and then bandsaw the ends of the extensions to receive the handle. As shown in figure 1 on p. 40, the ends of the extensions are cut out to wrap partway around the 1⅛-in.-dia. handle, and a ⅜-in. by ½-in. tenon protrudes from the extension through the handle and is wedged like the other tenons. Turn the handle to the dimensions shown in figure 1. I recommend waiting until the cart frame is glued up before marking and drilling the mortises that join the handle to the extensions to ensure that the back of the frame pulls tightly together. These mortises are cut on the drill press like the others, except the round handle is clamped into a V-block to keep it from turning.

Because I usually make a number of carts for each show, I've devised a shaper jig for curving the tops and bottoms of the rungs. But for a single cart, the rungs can be easily shaped by hand with a spokeshave, compass plane or rasp. The bottom of the thicker front rung is left straight and a ⅜-in. by ⅜-in. slot is routed in it to house the axle. Break the edges of the rungs and legs with a ⅛-in.-radius roundover bit and sand all the parts before assembly.

The axle is a ⅜-in.-dia. by 21-in.-long cold-rolled-steel rod. It extends through the front rung mortises in the legs and is locked in place when these tightly fitting joints are assembled. The hubs are secured to the axle with snap rings, which are available at most hardware and auto-parts stores. Before the cart frame is assembled, the axle is cut to length and its ends are slightly beveled and grooved to receive the snap rings. In determining precise axle length, you must consider the distance between the snap-ring groove and the end of the axle, as well as the hub size, leg thickness and distance between the front legs. Adjust your axle's length if any of these critical dimensions vary from those in figure 1. To make the snap-ring grooves, I place one end of the axle in a Jacob's chuck mounted on the headstock of my wood lathe and the other end in the shallow cup of the tailstock center with its center point removed. The cup happens to be just the right diameter for the axle and about 3/32 in. deep. This depth seemed to be a good distance from the end for the snap-ring grooves, so I use the rim of the center cup as a guide for cutting the groove with a hacksaw. I lubricate the cup with a little grease, and with the lathe turning the axle at low speed, I hold the hacksaw blade against the cup's rim and cut about a 1/32-in.-deep groove. Test the groove to be sure the snap ring fits and then reverse the axle and groove the other end.

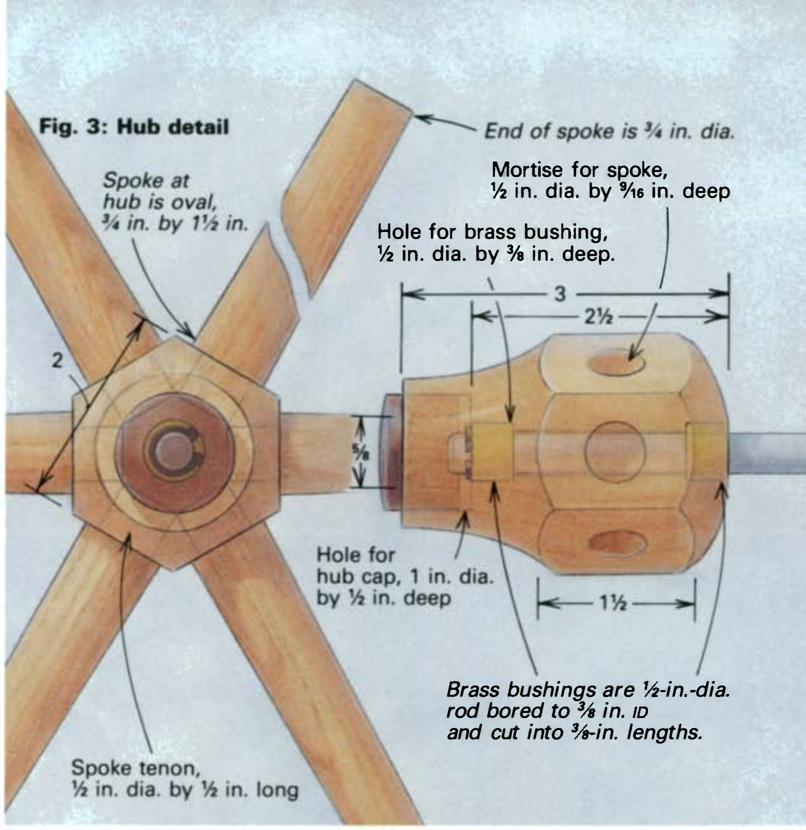
Now, you're ready to glue up the cart frame. Assemble the end frames first and then split the endgrain of the tenons with a 3/8-in. chisel and drive in a wedge dabbed with glue. Glue up the front rung with the axle in place and centered so that the snap-ring grooves are equidistant from the outside faces of both legs. Trim and sand the tenons flush with the legs on the end frames, and then glue up the sides and trim and sand those tenons. The top ends of the legs now interrupt the groove for the tray, so chisel the grooves through the legs so the plywood tray can slide all the way to the front rail. Secure the tray at the front rail by gluing it to the cleat that's also glued to the front rail.

Making the hubs and spokes—Building the wheels is not as difficult as it looks. I make the hexagonal hubs first, and then shape the spokes and glue their tenons into the hubs. The spokes are then trimmed to length on the bandsaw with a circle-cutting fixture, as shown in the top photo on the following page. Next, the narrow wheel rims are steam-bent, wrapped around the spokes and screwed into the end of each spoke.

To make the hubs, set the tablesaw blade to 30° and rip the corners off a 2x2-5/16x7 block to form a regular hexagon. Locate the centers of both ends and mount the block between centers on the lathe. Turn both hubs from the blank to the shape shown in figure 3 above, right. Remove the hub stock from the lathe and bandsaw the hubs apart. Next, a Jacobs chuck with a 1-in.-dia. Forstner bit is mounted in the headstock of the lathe. Now, mount each hub between the tailstock center and the center of the Forstner bit. With the hub suspended between centers, advance the tailstock center with the hand screw and drill a 1/2-in.-deep hole in the round end of each hub. Then, change bits and drill a 7/16-in.-dia. hole all the way through each hub. Now, remove the hub from the lathe and with a 1/2-in.-dia. bit in the drill press, enlarge both ends of the 7/16-in.-deep hole to 3/8 in. deep to accommodate the brass bushings (see figure 3).

Metal bushings ensure that the cart will roll smoothly for a long time. A steel axle with wood bushings just won't do; if the wooden hub expands, it will lock onto the axle, and if the hub shrinks, the wheel will become floppy. I make brass bushings by boring a 3/8-in.-dia. hole in the center of a 1/2-in.-dia. round brass rod. To bore out the rod, mount Jacobs chucks on both the headstock and tailstock of the lathe. Chuck a 2-in.-long piece of brass rod in the headstock chuck and a 3/8-in. bit in the tailstock chuck, and then with the rod turning at low speed, slowly advance the tailstock to drill through the rod. Then, with the rod still spinning at low speed, saw off 3/8-in.-long sections with a hacksaw: two for each hub, four for each cart. Epoxy the bushings into the hubs and when the epoxy dries, run a 3/8-in. drill bit through the bushing's center to remove any squeeze-out. Squeeze-out on the bottom of the 1-in. hole can be cleaned up with the 1-in. Forstner bit.

Although the spokes are eventually rounded over and shaped with a handplane, I start out by tapering them in both thickness and width on the tablesaw. Because the amount of taper is different in each dimension, you'll need two spoke-taper jigs (see figure 2 on p. 41). A 1x8x12 board will yield six tapered spoke blanks, so you'll need one board this size for each wheel. Begin with the jig that has the 3/4-in.-deep notch and adjust the rip fence so the blanks are tapered from 3/4 in. at one end to 1-1/2 in. at the other end. Rip the individual tapered blanks by reversing the workpiece end for end after each cut, just as you did with the legs. Next, joint one



This clamping fixture holds the spokes tightly, yet allows them to be quickly rotated, to speed up the process of handplaning the spokes so that they taper from oval at one end to round at the other.

edge of each blank and run this edge down on the saw table as you use the jig with the 3/16-in. notch to taper the blank thickness. Adjust the fence to taper the spokes from 1 in. to 13/16 in.

Find the center of both ends of each blank and, one by one, mount them between centers on the lathe and turn a 1/2-in.-dia. by 1/2-in.-long tenon on the large end of all 12 spokes. Before removing each spoke from the lathe, rough-turn the spoke just enough to be sure the tenon will be dead center after the spoke is final shaped. The wide end, with the tenon, is shaped to a nice oval that tapers smoothly to a 3/4-in.-dia. circle at the other end. The spokes can be left on the lathe and shaped with a spokeshave if the headstock can be locked so it won't turn. I made the fixture in the photo above to clamp to the bench and hold the spokes so I can handplane them to shape.

After shaping and sanding the spokes, they are glued into the hub. Locate the centers of the flat surfaces on the hub and then drill a 1/2-in.-dia. mortise, 9/16 in. deep, in each face to receive the spokes' tenons. Glue two spokes at a time, spanning across both spokes and the hub with a pipe clamp. After all six spokes are glued into the hub, I use the bandsaw circle-cutting setup

The spokes are trimmed to length after they're glued into the hub. The drill bit, which acts as the pivot point, must be aligned with the bandsaw blade and centered exactly $11\frac{3}{8}$ in. from the blade for the wheel to be 24 in. in diameter when the rim is wrapped around the spokes.

As soon as the rim stock is removed from the steam box, one end is clamped to the "spiral" form, as shown at left. Then, the rim is rolled up onto the form and its other end is clamped so that the ends overlap at least 6 in., as shown at right.

shown in the top photo above to trim them to length. Drill a $\frac{3}{8}$-in.-dia. hole in a scrap block and, for a 24-in.-dia. wheel, clamp the block to the bandsaw table so that the hole's center is $11\frac{3}{8}$ in. from the blade, measured 90° from the blade's cutting line. Place a $\frac{3}{8}$-in.-dia. drill bit in the scrap block's hole to mount the hub, and clamp a shim near the blade to support the small end of the spokes. Then, turn on the bandsaw and rotate the hub to trim the spokes.

Making the wheel rims—Oak steam-bends well, and I use steam-bent parts in other pieces of furniture that I make on a regular basis, so it was natural for me to use this technique for the wheels' rims. Of course, with woods that don't steam-bend very well, like mahogany or cherry, you could start with slightly thicker wheel stock, resaw it into three or four thin strips and laminate them back together over a form. However, steam-bending has the advantages of no messy edges to clean up and no gluelines. I've had good luck steam-bending oak, ash, beech and walnut, in that order.

No matter which bending method you use, you'll need a plywood form, the same diameter as the trimmed spokes, to bend the rim stock around. The ends of the rim stock must run past each other at least 6 in. on the form to allow for the scarf joint that closes the rim's circumference. Instead of doubling up the form to make it wide enough for the ends to run past each other, I make a kind of spiral form. I bandsaw a 2-in.-wide, $22\frac{3}{4}$-in.-OD ring from a scrap of $\frac{3}{4}$-in.-thick plywood. Then, I cut about a 4-in.-long section out of this ring and glue quarter sections of another 2-in.-wide, $22\frac{3}{4}$-in.-dia. ring on opposite sides of the original ring, so that the quarter sections overlap at the gap. This forces the original ring into a spring-like shape, as you can see in the two bottom photos.

Now you're ready to steam the rim stock. You'll need 7 ft. of clear straight-grain stock, $\frac{5}{8}$ in. thick and $\frac{3}{4}$ in. wide, for each rim. Rip an extra rim strip for each cart you're building in case one breaks when bending. My steaming box is very low tech: I screwed together a 7-ft.-long by 5-in.-square wooden box, left open at both ends, and sawed a 4-in.-square hole in the middle of the bottom. A row of dowels, inserted from side to side, creates a rack to hold the part being steamed off the bottom of the box. I place the box on top of an electric fry pan full of water so the steam will enter the box through the 4-in. hole. Scrap boards cover the portions of the frying pan that aren't covered by the steam box, making it easy to check and replenish the water level when necessary. When the water is rapidly boiling, I put the rim stock in the box, plug the ends with cloths to keep most of the steam in and wait about 45 minutes.

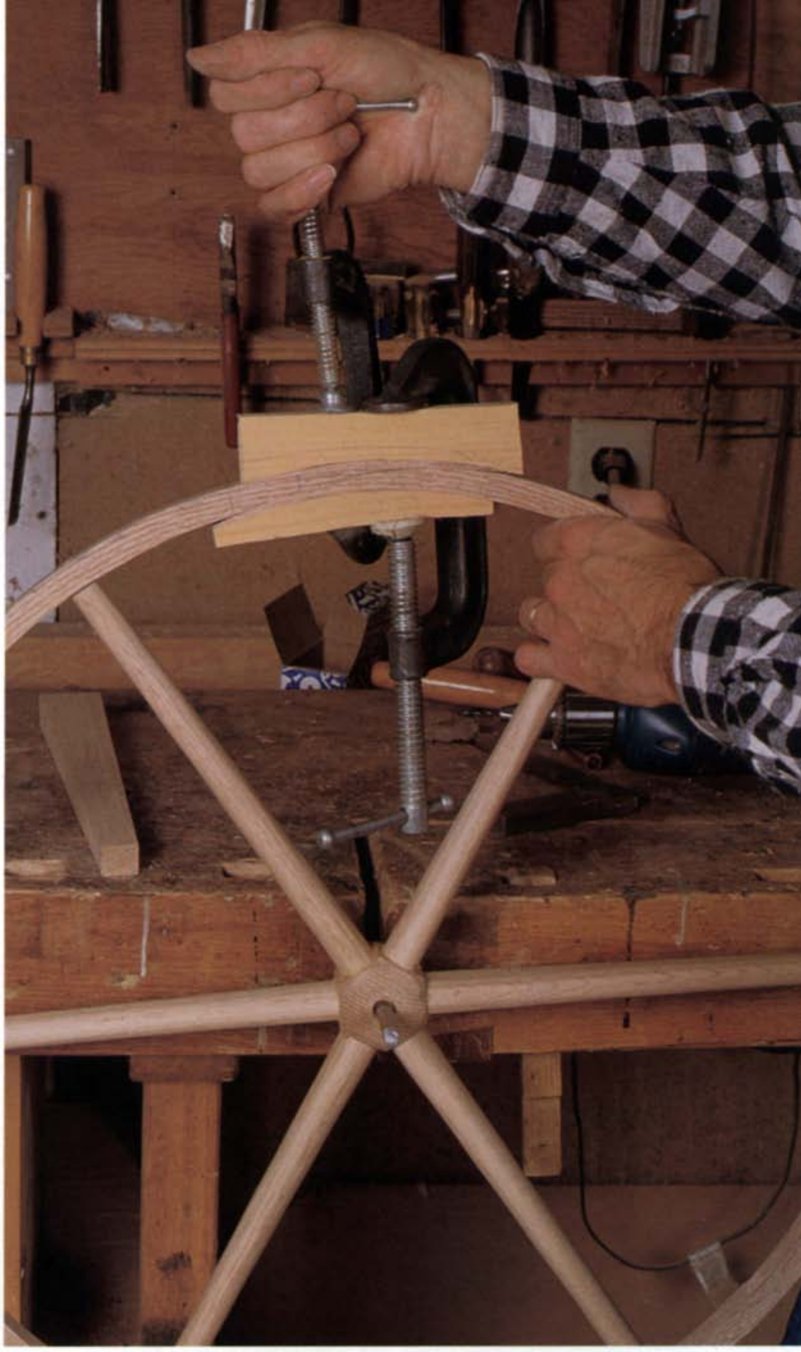
When the pieces are removed from the steam box, you must work smoothly and quickly because as the wood cools and dries out, it loses its flexibility. Have your form and a couple of C-clamps ready. Remove the rim stock from the box and clamp one end to the "beginning" of the spiral form as shown in the left, bottom photo. Quickly turn the form so the steamed wood is on the floor, and roll the rim onto the form, pressing firmly on the floor as you go. When you get around to where the clamp hits the floor, pull the free end of the rim stock up by hand and clamp it to the form so it overlaps the first end (see the right, bottom photo). Now, place another length of rim stock in the steam box, replenish the water and wait 45 minutes. When the second rim is ready to be bent, unclamp the first rim from the form and clamp its overlapping portions side by side to maintain the circle. This frees up the form for bending the second rim. Repeat the steaming and bending processes until you have all the rims you need and then let them dry overnight.

To support the hub-and-spoke assembly while attaching the rim, clamp the axle in a bench vise. Then, hold the rim so the scarf joint that closes the circle will fall between two spokes and screw the rim to one of the spokes opposite the joint. To do this, first bore a $\frac{3}{8}$-in.-dia. hole about $\frac{1}{8}$ in. deep for a wood plug, and then bore a $\frac{1}{8}$-in.-dia. hole through the rim for a 1-in.-long, #6 brass wood-screw shank; finally, while holding the rim in position against the spoke, bore a $\frac{1}{16}$-in.-dia. pilot hole into the end of the spoke. Now that the rim is located on the hub-and-spoke assembly, you can continue around the rim boring holes and screwing the rim to each of the spokes, except the one nearest the rim's joint.

With this one spoke still unattached, remove the wheel from the axle so you can lay out the rim's scarf joint. First, let the loose portion of the rim overlap alongside the attached portion and use C-clamps at both ends of the rim to clamp it into the proper arc, as shown in the top, left photo on the facing page. Next, measure 6 in. along the rim's circumference and divide this into four equal $1\frac{1}{2}$-in. sections. All five lines should now be transferred down the sides of the rims with a square. Then, still working on the rim's sides, divide the centerline in half and the lines on the right and left of the centerline in quarters. Now, begin at the inside edge of the rim and draw a diagonal across to the outside edge by con-

Before the rim is screwed to the last spoke, the rim's ends are clamped as shown above and lines are transferred down both sides as references for laying out the scarf joint.

Dunham bandsaws close to the scarf joint line: above the line on one end and below the line on the other. Then, he will smooth the scarf joint's mating surfaces with a rasp.



After the last spoke is screwed to the rim, Dunham glues and clamps the scarf joint with scrap blocks sawn to fit the inside and outside arcs. Once the dried glue is cleaned up, the wheel is ready to roll.

necting the appropriate points along the lines (see the top, left photo above). Turn the wheel over and draw a similar diagonal on the other side of the rim's overlap.

After laying out for the scarf joint, remove the clamps and bandsaw close to the diagonal lines: above the line on one overlap and below the line on the other (see the bottom, left photo above). With a rasp, clean up the mating surfaces until they clamp together without a gap and then screw the rim to the last spoke. The scarf joint is glued together and clamped with pieces of scrapwood bandsawn to the rim's inner and outer arcs to distribute the clamping pressure as shown in the right photo above. After the glue is completely dry, scrape and sand the sides of the rim so the joint can't be detected.

The wheels are now complete except for plugging the screw holes in the rim and some final detailing. I bevel the rim's inside edges on the router table with a 45° pilot-bearing router bit, taking care not to nick the spokes. Then I use carving tools and files to shape the transitions where the spokes meet the rim and hub (see figure 1 on p. 40). Before mounting the wheels on the cart, I finish them and the assembled cart with several coats of Danish oil.

When the wheels are mounted on the ends of the axle, you should be able to see the snap-ring groove. If you can't, remove the wheel and drill the 1-in. hole a little deeper. You can get a pair of snap-ring pliers at any auto-parts store, but for the convenience of my customers who usually have to assemble their tea cart after removing the parts from a shipping carton, I include a shopmade tool for putting on the snap rings. The tool is simply a ¾-in.-square length of hardwood with an axle-size, ⅜-in.-dia. hole drilled in one end. To mount the wheels, lay the cart on one side, place the wheel on the axle and balance a snap ring on the axle's slightly beveled end. Then, use the tool to press the snap ring onto the axle until it fits in the groove. Turn the cart over and mount the other wheel the same way. To cover the axle and cap the hubs, I turn tapered plugs to fit in the 1-in. holes and then drill a ⅝-in. hole, about ¼ in. deep, in one end to make room for the axle. □

John Dunham does restoration work for Sotheby's in Claverack, N.Y., and builds custom furniture out of his own shop in Glens Falls, N.Y.

Nestled into the steep mountains, and bamboo and pine forests of Taiwan is Sun Moon Lake, about an hour's drive from the city of Taichung, one of Taiwan's largest industrial complexes.

Made in Taiwan

Visiting the woodworking-machinery center of the Far East

by Sandor Nagyszalanczy

Remember when "made in Japan" meant the same thing as cheap or inferior? Now that Japanese cars and electronics are among the best in the world, that stigma has largely been lifted, but products from the Far East are still suspect. Some woodworkers assume machines made in Taiwan are as shoddy as the Japanese products of 20 years ago. But the country now produces a large percentage of the woodworking machines sold in the United States and is responsible for the affordable-machinery revolution that's affected cabinet shops and hobbyist woodworkers around the globe. Chances are, a machine or two in your shop was manufactured in Taiwan, even though the label might not say so.

To get a firsthand look at the machinery industry in Taiwan, I visited the Far East last November. I met with the owners of over a dozen large and small woodworking-machine-manufacturing companies, and toured their factories to see how the Taiwanese build machines, including how they design products and control quality. Further, I wanted to find out how their machinery industry is affected by the information and new technology imported from the West and what American tool buyers can expect from Taiwan in the future. I also attended Taiwan's biannual Taipei International Furniture and Woodworking Machinery Show '89 (TIFWMS) and talked with foreign buyers of Taiwanese machines about how these tools rate on the world market, and what to look for when buying Taiwanese machines (see the sidebar on p. 51).

The factory island—Taiwan R.O.C., the Republic of China, is a small island 80 miles off the coast of mainland China. Although the entire island is about the size of Canada's Vancouver Island—350 miles long and 125 miles wide—Taiwan's population is almost equivalent to all of Canada: about 20 million. In the western central region of the island is the industrial center of Taichung—the heart of Taiwan's woodworking machinery industry. In some neighborhoods, the factories are so close together, sometimes sharing the same outside walls, and so interdependent because of the way they share resources, that it feels as if Taichung is one big factory, rather than a city with hundreds, maybe thousands, of smaller manufacturers.

Collectively, these factories account for more than $50 million worth of machines sold in the U.S. every year, ranging from large industrial machines, like multispindle molders and panel-processing equipment; to familiar medium-size "cabinet-shop" machines, such as tablesaws, jointers and shapers; to do-it-yourself (commonly called DIY) benchtop tools, like small scroll saws and belt/disc sanders. Small- and medium-size factories often build only similar-type machines, say jointers and planers, and some produce only one type of machine, say power feeders. Although larger factories tend to produce a wider range of machines for more than one market, some specialize in DIY, which is the single largest (and growing) market. This is greatly due to the emergence of home centers and hardware-store chains across the U.S.

With so many different factories, why don't you see more nameplates from makers like Champ Fond, Jun Shiau and Shen Kung on machines in the U.S.? Because few Taiwanese dealers sell under their own brand name; instead, they sell through the dozens of U.S. dealers, including small importers, that send buyers to Taiwan to purchase a factory's standard production items. Large U.S. companies also contract Taiwanese factories to build particular machines to their design and standards. Delta, Sears and Powermatic—all well-known U.S. brands—each sell a number of machines manufactured in Taiwan. Some U.S.-based machine importers, such as Grizzly, in Bellingham, Wash., maintain full-time agents or buyers in Taiwan, to work with the factories and oversee production. Other buyers make deals with manufacturers at the TIFWMS, where the latest Taiwanese machines are displayed.

Regardless of how the orders are placed, once machines are assembled and ready, they're boxed, trucked north to Taiwan's port city of Keelung and then loaded into 40-ft.-long steel shipping containers for the long, cargo-ship trip across the Pacific to U.S. ports. Here, small- and medium-size machines are sold to American buyers through catalogs, import stores, tool dealers, hardware stores and even home centers. Now let's delve into how Taiwanese machines are made, starting with a look at the people who run the factories.

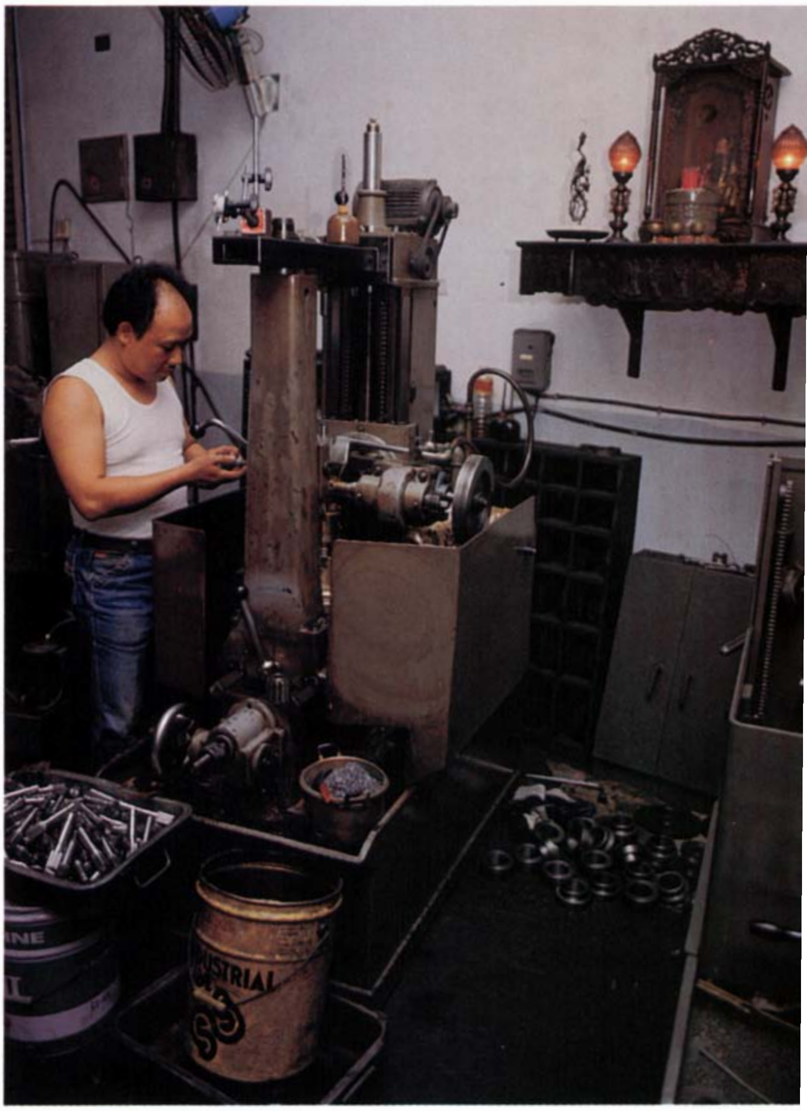
The people behind the machines—I visited more than a dozen factories, ranging in size from the smallest subcontractors—one- and two-man operations that specialize in part-making—to medium- and large-scale factories that employ anywhere from 20 to hundreds of workers. Practically all of these businesses are family owned, either run by a father and his sons, or run by the kids after the parents have retired. In some cases, the parents retire because they aren't inclined to make the transition to new technologies, such as computer-numerically controlled (CNC) milling. One manufacturer who has made the transition is Mark Chen, president of Rexon. Chen was trained as a machinist more than 25 years ago, has studied accounting and takes regular night classes to keep up with new technologies. The effort has clearly paid off: Rexon is Taiwan's single largest woodworking machine manufacturer.

Family connections are strong throughout the Taichung area, and many machinery makers are related. For instance, when I visited Chang Iron, which manufactures a line of well-known planers and shapers, I asked why motors not made at the factory carried the Chang Iron nameplate. Founder and President Ching Hsiung Chang told me it was "because my cousin who makes the motors for me is also named Chang." (Despite the number of times you see the name Chang in this article, not all of them are directly related.)

Although the people of Taiwan and mainland China share the same heritage, Taiwan split from the People's Republic of China in 1949 and is a capitalist country in the truest sense of free enterprise. Factory owners who are related may share the same sources of supply, but when it comes to business, competition rules. The entrepreneurs I met, most under age 40, are hungry to expand their businesses and gain greater personal affluence. Many drove Mercedes and Cadillacs—in a country where small motor scooters outnumber cars and back streets are wickedly narrow. In efforts to develop better relations with Western businesses, most Taiwanese factory owners and salespeople have chosen English names. While their business fervor would impress any Western capitalist, the way many smaller machinery factories get started would startle most investment bankers. For example, Co-Matic, a small factory that produces 12 different models of power feeders, was started by Oscar Lin with only a $3,500 investment—money from personal savings and loans from friends. Most owners proudly told me that they owed no money on any of their factory machinery, even though automated manufacturing equipment may cost hundreds of thousands of dollars.

Why build machines in Taiwan?—Of all the countries in the world, why has Taiwan emerged as the premier manufacturer of affordable machinery? Nevin Craig, Delta's vice president of finance, told me that the chief reasons are engineering and productivity: the country has many educated workers and qualified engineers to handle skilled jobs. As in other countries, there's a real incentive for higher vocational education: the average unskilled worker in Taiwan may earn only about $500 to $750 a month, while a skilled worker in the same factory may earn twice that amount. Although labor costs are low compared to Western countries, inflation is sure to push the cost of living in Taiwan higher, and make machines produced there more expensive. But as Craig told me, "While there are cheaper places to manufacture machines, the question is not how much labor costs per hour, but *how much work gets accomplished in that hour.*" The Taiwanese are an energetic

Right: After years of designs to improve its early wide-belt sander prototypes, Jun Shiau now produces high-quality machines with the latest pneumatic tracking technology and sophisticated digital electronics for adjusting sanding thickness. Below: There are many subcontractors in Taiwan's prolific machinery industry: small businesses that supply parts and machining services to larger factories. Although the size of a small garage, Tsai Fong Yong's company produces thousands of gears each month for thickness planers.



people that work six days a week. The workers are so diligent that they hardly looked up from their tasks when I took their photos. Further, Taiwan has a tremendous pool of machine-building resources in a very small geographical area: foundries, die casters, machine shops, plastic-parts manufacturers are all available in Taichung, an area that's about the size of Manhattan, N.Y.

Taiwan excels in engineering in part because of government aid to educational programs. The government's programs supply information to help small factories with research and development, and it provides experts to analyze factories' manufacturing methods and make recommendations for improving them through computer-aided design (CAD), computer-aided manufacturing (CAM) and other new technologies. Taiwanese manufacturers also receive some assistance from an unlikely ally: Japan, the country that governed Taiwan (then called Formosa) from 1895 until the end of World War II. The Japanese government has a special fund that pays for technical and business assistance, and regularly sends consultants to Taiwanese factories. One practice Taiwan has adopted from the Japanese is that of worker groups called the QC or "quality-control circle." These are groups of 7 to 10 employees from the same department who get together on company time to discuss problems and propose solutions. Every six months, each group presents its best ideas to a 10-judge panel of company managers that implements the best ideas, and awards the group members a prize of up to $200 each.

Machinery design and originality—Despite Taiwan's eager work force and manufacturing advantages, the reputation of Taiwanese machines has been tarnished in the past by allegations of design plagiarism. Beyond mere similarity, some Taiwanese machines were allegedly made with molds for castings taken off existing foreign machines. Some cases of copyright infringement are still in court, but Taiwan's machine manufacturers are struggling to overcome any copycat stigma. One explanation I heard for past plagiarism is that smaller factories couldn't afford marketing or research and development (R&D) of new products and often didn't know what features were desired by their foreign customers. For example, when C.C. Lin, president of Jun Shiau, started designing wide-belt sanders, he said he didn't have money to travel abroad to examine existing machines, so he based his first sander on a Japanese machine pictured in a catalog. Predictably, Lin's first machines were crude; to overcome vibration problems, on one model the base alone weighed two metric tons. After 20 years of making sanders and improving designs, the company's latest machines, shown in the top photo on the previous page, are beautiful and precise, with some models sporting sophisticated digital electronics. The copying disputes aren't limited to stealing designs from manufacturers in other countries; Taiwanese manufacturers occasionally steal each other's designs and try to undercut each other's prices.

On the positive side, Ching Hsiung Chang of Chang Iron told me that "Although Taiwan developed an early reputation for plagiarism, Taiwanese machines have improved. Because of feedback from European and American dealers, we're learning what kinds of products and features woodworkers in foreign markets desire and we're developing better machines." Rexon employs 45 people in its R&D department. These people design, draw and prototype all new machines Rexon develops, and work with its original-equipment-manufacture (OEM) customers, like Skil, Delta and Sears. They not only design new equipment, but improve the company's tooling, manufacturing and quality control. Design improvements often come directly from customer requests: C.C. Lin, for example, responded to the needs of his market by improving the design on his Sheng Shing wide-belt sanders to surface plywood accurately without cutting through the extremely thin face veneers.

Who's manufacturing what?—A tablesaw bearing an American name and sold by an American company is made in America, right? Not necessarily. While a few Taiwanese manufacturers market machines under their own brand name, most manufacturers are OEMs for dealers in the U.S. and other countries, and these companies then market the products under their own names or brand labels—a practice common with all products, from cars to coffee makers to clothing. Rexon, for instance, makes more than 100 different DIY and small-shop machines and a partial list of its customers includes Sears, Delta, Skil, Black & Decker, Grizzly, Jet and Home Depot (which sells Ohio Forge). While large manufacturers often build a diverse line of products, most of the smaller, owner-operated firms build only the machines they know best. Kuang Yung, for instance, builds 15 models of large tablesaws and radial-arm saws, the machines that its president, C.F. Chang, has been manufacturing for 26 years.

OEM marketing isn't limited to the U.S.: Taiwan is briskly trading with many countries throughout the world. Co-Matic, which makes power feeders for a half-dozen U.S. dealers, including Powermatic and Jet, also makes a brand sold in Europe called Magma, that competes with similar power feeders made in Germany and Italy. The U.S. comprises about 40% of Kuang Yung's business, while Indonesia is up to 40% and Japan is at 10%. At the time of my visit, several factories had machines crated and ready to be shipped to Indonesia. One Indonesian tool buyer I met at the TIFWMS was reportedly spending around $300,000 a month on Taiwanese woodworking machinery to fuel Indonesia's rapidly growing wood-furniture-manufacturing industry. C.F. Chang of Kuang Yung says he's very proud that the Japanese are buying from him because of their reputation for demanding high-quality tools. In contrast, Chang depicts American dealers as very price conscious: "American dealers have been known to shop for the lowest price, yet when they get low-quality machines, they complain!" However, Chang says that lately American dealers are looking for better-quality machines, because more customers are demanding quality and are willing to pay for it.

Subcontractors—Whoever said that it pays to specialize must have been thinking about Taiwan: One reason that Taiwan's woodworking machine industry is so prolific is the hundreds of subcontractors (subs) in the Taichung area. These specialized factories, sometimes only the size of a one-car garage, supply machine parts to other, usually larger, manufacturers. Many small subs don't make finished parts, but specialize in one type of machine work. For instance, a simple handwheel may involve five different machining operations, from the raw casting to the finished product, done by five different subs. One subcontractor drills the center hole for the shaft, another machines the keyway slot, another turns and polishes the rim, etc. Since precision metalworking equipment is costly, this kind of pinpoint specialization allows small subs to invest in only one costly metal lathe or milling machine. To make it pay, though, they must produce enormous quantities of parts; some subs find it necessary to run their expensive CNC milling machines 24 hours a day. One subcontractor I visited, Yeong Chang, worked in a tiny garage and performed only one operation: spindle and shaft center-boring. The setup is efficient and quite profitable for Chang, who likes being his own boss and earning as much as he can. With so many subs in one area, competition forces each to make quality products to stay in business. It seems to work: Co-Matic deals with more than 30 subs, yet the company rejects only 2% to 3% of the parts.

Production-line assembly—Because of the proliferation of subcontractors, many woodworking machinery factories are little more than assembly lines. In most cases, the factory floor is the assembly area, with rows of machine frames or bases lined up like

Above, left: Workers at the Chang Iron factory near Taichung assemble a batch of 18-in. planers destined for the U.S. market. Working six days a week, a handful of ambitious workers manage all the assembly tasks, bolting together parts that are mostly supplied by subcontractors.

Above, right: Improvements in the quality of Taiwanese machines are in part due to the increasing use of automated manufacturing and sophisticated electronics. At Chang Iron, all high-speed rotational parts, like shaper spindles and pulleys, are dynamically balanced on a special testing machine.

Bottom, left: Spurred by the lure of monetary bonuses for productivity above their quota, workers at Rexon—Taiwan's single-largest woodworking machine manufacturer—assemble small stationary belt sanders to be sold by Sears in the U.S.

chess pieces (see the top, left photo). Parts from subcontractors, held in wire-mesh bins, are grabbed as needed by workers who bolt them to the machines. Because of the abundance of good local parts subcontractors, most factories machine and test only the most crucial parts of their products, such as spindles, cutterheads, tracks, gibbs, ways and table surfaces. This way, they can control quality without investing in much expensive metalworking machinery or employing as many skilled workers. Much of the lighter-duty machine work commonly done in smaller factories is performed on drill presses: rows of them, each set up to do a single job, such as drilling, counterboring or chamfering.

Although you might expect teams of uniformed workers to build and inspect Taiwanese machines, most factories employ only a few workers as assemblers and they are often unskilled. Co-Matic employs only two skilled machinists to build its power feeders; the other employees work on the assembly line, following printed instructions posted at each workstation. Numbered bins contain the parts, so assembly becomes a sort of paint-by-number affair. In contrast, factories like Champ Fond that build larger, more complicated machines, such as spindle shapers and multiple-head boring machines, employ a higher percentage of skilled workers, needed for more demanding machining, assembly and quality-control jobs. The most impressive assembly lines I saw were at the Rexon factory. Because of the huge volume it produces—about one million machines a year—Rexon has designed special assembly lines for particular models (see the bottom photo). Workers at each station bolt on parts, check alignments and do any final tweaking before finished machines are boxed and shipped.

To motivate workers and speed up the assembly line, some factory owners offer powerful incentives. Chiu Ting, a large DIY manufacturer, employs three workers that assemble all the 15-in. planers the factory produces. If it faces a large order, this three-person team is allowed to hire outside help—usually family and friends—to meet the required deadline and receive a bonus. Rexon's assembly line has electronic signs that show workers what their production "target" is (how many machines to be completed in a work shift) and how close they are to that target at any given time. If they go over the target, each worker gets a bonus. But penalties are assessed if the quality check reveals defective work.

Quality—As you might guess, quality control varies tremendously in Taiwan's woodworking machine industry. Generally, the more ex-

Cast-iron parts are so cheap in Taiwan that they're used in large and small woodworking machines. After arriving at the CKM factory from the foundry, castings for planers and jointers are cleaned with abrasive grinders before they're machined (left). Large iron castings, such as saw tables, must be heat-treated to relieve internal stress before machining them flat, so they don't warp later. C.F. Chang, president of Kuang Yung, handles this job himself, heat-treating tables for 12-in. tablesaws in a large electric kiln (right).

pensive the machine, the better the parts and more extensive the quality checks and inspections. Factories that make cabinet-shop and industrial-size machines often have quality-checking facilities. Chang Iron uses a testing machine, shown in the top, right photo on the previous page, to check the dynamic balance of crucial rotating parts—spindles, cutterheads and pulleys—for its shapers and planers.

In contrast to the pressed-sheet-metal construction that's the hallmark of cost-cutting in most machines today, Taiwanese tools still sport lots of cast-iron parts—a feature that makes them attractive to American buyers who want heavy-duty machines at bargain prices. Taiwan excels in its use of castings, in part because pouring cast iron is an ancient technology and local sources for parts are plentiful and cheap. While the vibration-dampening properties of hefty cast parts make them desirable, cheap castings that haven't been aged properly prior to machining can warp and affect performance. Not all factories age their castings prior to machining, especially when making DIY machines. However, most factories producing cabinet-shop-quality machines, such as Kuang Yung, take extra care to heat-treat castings, like saw tables (see the top, right photo).

As you might imagine, the worst-quality machines I saw in Taiwan were the DIY types. I commonly saw machines, such as planers, tested simply by running a piece of stock through; the machine ran, but there were no real quality checks. At other factories, I saw machines coming off the assembly line put directly into cartons for shipping, without the slightest check to make sure the machine would even run. And at another factory, I saw a worker balancing the locking bars that hold the knives in planer cutterheads with a simple balance-beam scale, the kind you use to measure baking ingredients. But there are exceptions: To assure consistent quality, Rexon's DIY customers print requirements for each machine part, with specifications for things like shaft runout, motor life cycle, hardware and finish. Rexon's quality-control department has 35 people who monitor every critical part, like a drill-press spindle, and spot-check other components. Large-order customers, like Emerson and Delta, often send their own inspectors to check quality on machines before shipment.

Improvements in tools and technology—The uneven quality of Taiwanese tools of the past led to an image problem that plagues Taiwan even today. But the prevalent spirit of today's factory owners is echoed by Vincent Wang, sales manager of Shen Kung Machinery Industrial Co., maker of KUFO-brand machines and dust collectors: "Improving the product is key to a better reputation for Taiwan." Fortunately, new improvements that have raised the quality of Taiwanese machines include new, more accurate and sophisticated manufacturing machinery, computer systems and quality-control test equipment. Even the quality of cast-iron parts has improved due to better raw materials and technology. The factory manager from Chiu Ting demonstrated his confidence in the company's castings by hammering a thin section of a cast part to prove its strength. It didn't break.

In order to build better-quality machinery, most factories are replacing their older, outdated or antiquated metalworking machines with new high-tech equipment. Many of the factories I visited had old machines—lathes, milling machines, etc.—just gathering dust in a corner, eventually to be sold to stone workers, who use them to shape marble household accessories. The cost of the new tooling is high: One state-of-the-art CNC machine can cost $250,000 dollars or more. But most factory owners I spoke with viewed these machines as an essential step to improving their products and their reputations.

As with all other areas of business and manufacturing, computers have profoundly affected the Taiwanese woodworking machinery industry. High-tech electronics are now employed at every stage of a tool's conception and production, from CAD design and drafting programs, to CAM systems and CNC metalworking machines that actually make the parts, to sophisticated computerized test equipment that evaluates the product in action. In the design area, many factories have set aside their drafting boards and have installed CAD systems. Eric and Ryan Chang of Champ Fond estimate that CAD has speeded up both design of new machines as well as modification of existing models tenfold. The CKM Co., which manufactures a line of planers, installed a CAD system six months before my visit and had already used it to design a new model, as well as to draft all the shop drawings detailing parts dimensions and specifications. CAD also serves as a valuable communication tool between U.S. dealers and their Taiwanese OEMs. Many of Delta's Taiwan-made tools are conceptually designed in the U.S., and then manufacturing information is sent to Taiwan directly via computer software, for engineering, development and production.

C.L. Tu, manager of CKM, told me that besides making it easier and faster to create or modify a machine, CAD was an essential tool for checking the component fit before spending time and money on the prototype. Another bonus of CAD, several of CKM's subcontractors already had CAM systems capable of accepting software from CKM's CAD system, completing the computerized chain from computer-aided design, directly to manufacturing. Tu anticipates that in a couple of years, practically all subcontractors will have CNC machines capable of being interfaced with CAD software, just to stay competitive.

Another important use of computers is in machine testing and quality control. Champ Fond uses a special system that analyzes vibration in a running woodworking machine. The computer checks dynamic balance of the tool's spindle and also the structural integrity of the iron castings for the body of a large machine, like a multiple-head molding machine. That information is used to set the frequency of a special vibrator that relieves stress in castings prior to machining.

It's clear that all the positive changes in tooling and technology, coupled with serious concerns Taiwanese manufacturers have for improving the design and quality of their products, should mean better woodworking machines for American buyers in the years to come. However, in the same way that the prices of many Japanese cars have gone from economy buys to luxury purchases, there are rumblings that as Taiwanese tools get better, they'll probably get more expensive. All the more reason to appreciate that garage full of Taiwanese machines you bought for less than the cost of a compact car. □

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Buying Taiwanese

Shopping for quality products at a good price can be a demanding chore, regardless of whether you're buying a scroll saw or a food processor. When it comes to woodworking machinery, quality and features can be hard to evaluate, especially if you are buying a tool sight unseen, as through a mail-order catalog. There's nothing like that sinking feeling you get when you mail-order a machine, open the box and find out that the picture in the ad looked a whole lot better than the machine does.

American woodworkers who purchased Taiwanese tools because of their low cost have often pigeon holed them as universally cheap and shoddily constructed. But while its true that Taiwan's past reputation has been blemished by problems such as poor raw materials and quality control, many companies that I visited during my recent trip to Taiwan (see the main article on p. 46) are currently manufacturing cabinet-shop and industrial machines that are well made and offer good-to-great quality at competitive (sometimes bargain) prices.

Unfortunately, not all of Taiwan's machine makers share the same standards of quality. And advertising hype from U.S. dealers can make buying a Taiwanese machine an uncertain proposition. So how do you go about evaluating a tool before buying it? First of all, don't let glitzy advertisements fool you: buy a machine that's designed for the type of use you need. A DIY machine made for the occasional-use hobbyist probably won't hold up in a production cabinet shop. On the other hand, even a pro shop might be able to use a light-duty specialty machine, say an edgebander, if only used sporadically. This way, a shop can save money that can be invested in more-expensive heavy-duty machines for everyday meat-and-potatoes jobs.

Several things can make buying Taiwanese machines a confusing experience. Factories in Taiwan act as original-equipment manufacturers (OEMs) for foreign buyers, who may be established machinery companies, like Powermatic and Delta, or independent tool dealers and small import companies. What's confusing is that U.S. Customs regulations may allow the dealer to sell the machine with a "made in the U.S.A." or "assembled in the U.S.A." label, even if a significant percentage of the machine was made in Taiwan. Further, different factories in Taiwan may manufacture similar machines, in looks and features, for the same dealer, yet the factories may not share the same standards of quality. Often, similar machines are sold for vastly different prices, by factories trying to undercut each other's prices. Alternately, one factory may produce identically designed machines or tools in different grades. For instance, one factory I visited produced three grades of router bits, differentiated by their degree of final sharpening and grade of carbide. I was shown a test board with dadoes cut with three grades of the same straight bit; lower-grade bits had a lot more cross-grain tearout. Hence, a buyer may be purchasing the same tool for the same price from different dealers and get different grades of quality.

The best way to avoid pitfalls when searching for a quality machine or tool is to choose a dealer with a good reputation and customer-satisfaction record: something worth checking when making any important purchase. If the dealer has a store or a showroom, don't be afraid to go with try square and straightedge in hand, to check for the trueness or alignment of crucial parts and flatness of tables. If possible, try out the machine and put it through its paces—don't just turn it on and listen to it hum. It's hard to tell quality from just appearance, and as mentioned earlier, cosmetics can be deceptive: Never buy a machine just because it has a shiny, colorful paint job! Also, don't expect the motors on most lower-cost Taiwanese machines to actually produce the horsepower stated on the nameplate. If you can't test the machine out for yourself, call the dealer and ask for the names of people who own one of the machines you're interested in. Then, call or write to them for their opinion of the machine and dealer, as well as a brief description of how they are using it. If you're buying through mail order, make sure to get a clear idea of which accessories are included with the machine and which are optional. It's also a good idea to buy accessories you anticipate needing when you order the machine, in case the model is discontinued in the future.

Before you buy, ask dealers if they service the machines they sell. If you run into problems, you certainly won't want to send the machine back to Taiwan for repairs. Also, ask the dealers if they stock parts for your machine. If they don't, parts may be difficult or impossible to get in the future. On this score, larger dealers may have an advantage. Delta, for instance, imports parts at the same time it imports its machines, and keeps about $3 million worth of parts in stock and offers a toll-free number for customer service.

While most reputable dealers offer Taiwanese machines under their own brand names, in certain cases, it may be advantageous to buy a machine that bears the factory's own brand name. In some cases, you may get a better warranty. For instance, Rexon offers its OEM brands a one-year, 95% warranty on parts and labor, while machines sold under its own brand name are entitled to a two-year, 100% warranty.

When it comes to getting a quality woodworking machine, the bottom line isn't really too surprising: you usually get what you pay for. The advice in this article applies whether you buy Taiwanese, American or Hungarian tools. If someone offers you a "professional-quality" machine at bargain-basement prices, be suspicious: more than likely, something had to be compromised to get the price that low, and it probably wasn't the dealer's profits. *—S.N.*

Making an End Table

Multicolor laminates accent a design

by Tage Frid

I believe wood looks best in its unadorned, natural form, and the more you embellish it, the more you detract from its beauty. So when designing the end table shown below, my goal was to make a simple piece that would be strong, yet appear light, and include subtle details that entice you to look closer.

As shown in figure 1 on p. 54, the 22-in.-high table is based on straight, crisp lines and sharp corners. The sense of lightness is strengthened by the legs, which taper to half their square dimension from top to bottom. And the angled joinery required to fit the legs to the aprons isn't difficult. You can mortise the legs with a router and jig, and cut the apron's angled tenon shoulders with a tablesaw.

At first glance the table appears to be made entirely of cherry; but a narrow rabbet in each leg's outside corner reveals that the legs are actually three different woods: layers of cherry and maple laminated to a black walnut core, which appears as a thin line in the rabbet's inside corner. The various parts of the table also relate to each other well. The leg rabbets are 5⁄16 in. square, the top overhangs the frame only 1⁄4 in. and the apron is set back from the face of the leg less than 1⁄8 in., the thickness of the outer cherry laminate. Don't let the simplicity lull you into carelessness. Because of the crisp lines, an error will stick out like a sore thumb. Everything must be shaped meticulously. To achieve this precision, first make a full-size drawing to help you work out proportions and measure angles and dimensions. For this table, I drew an elevation of two legs and one apron and a plan view of two aprons and one leg.

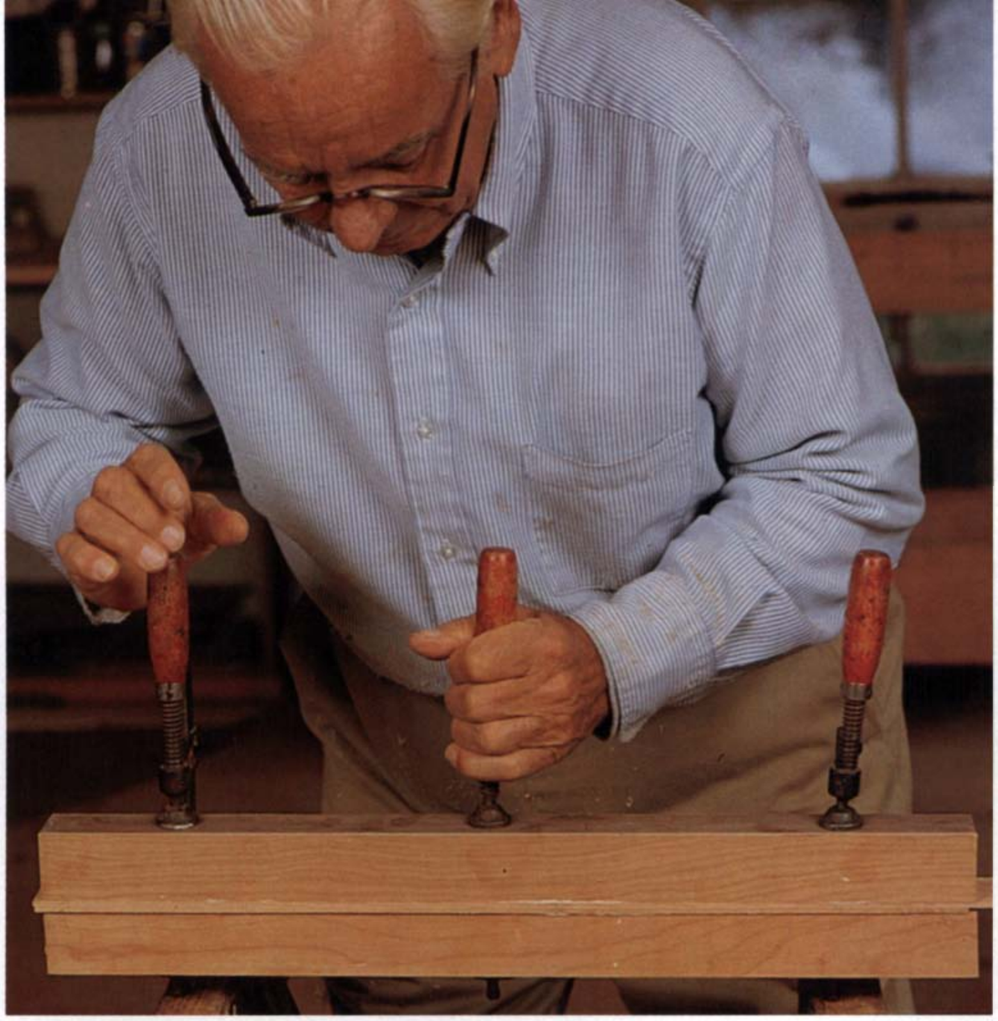
The lines of the author's end table are straight, the corners sharp and crisp, and the parts proportional to one another. The legs are thin strips of cherry and maple laminated to a walnut core, visible in the rabbet on the leg's corners.

As I made my drawings, I considered construction and assembly details. For example, notice that the tenons don't meet in a miter (see the detail in figure 1). If they did, the leg would be weak with so little wood between the tenon ends and the rabbet. Also, the apron's 3⁄8-in.-thick tenons are offset with a 5⁄16-in. shoulder on the outside and a 1⁄16-in. shoulder on the inside, to position the tenon as close as possible to the middle of the leg for strength. By using haunched tenons the full width of the apron, the top of the leg is stronger and you needn't clamp the mortise sides to the tenon cheeks when gluing. Finally, I left a 1⁄16-in. space between the end of the tenon and the bottom of the mortise for excess glue that could compress and split the top of the leg during assembly.

Preparing stock—After I made the drawings, I developed the bill of materials on p. 55 listing the necessary angles and dimensions. Initially, leave everything about 1 in. longer than called for and trim later. Also note that the bill of materials recommends some pieces be left oversize to simplify assembly; the plywood edge facing, or edgebanding, for instance, is easier to apply if it's a bit wider than the thickness of the plywood it's glued to.

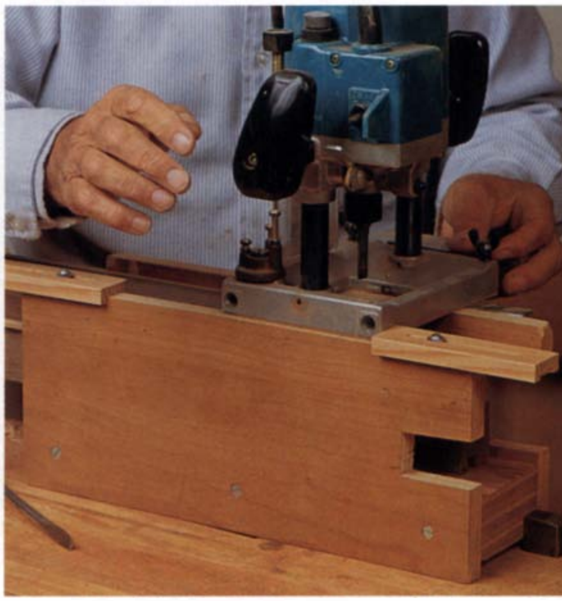
Begin building the legs by gluing, one at a time, the maple laminates and then the cherry laminates to the black walnut. Spread the glue sparingly and evenly. As shown in the left photo on the facing page, you can glue and clamp laminates on two legs at the same time if you sandwich the laminates between the walnut. If you spread the glue neatly, you won't need wax paper between the laminates to keep them from sticking to each other. By beginning with oversize, 15⁄8-in.-square walnut leg stock, you can clamp directly to the wood without pads, because clamp-dented wood will be ripped away later. Use three clamps, applying pressure from the middle clamp first and wiping away excess glue with a damp rag. If you wait until the glue is dry and then chisel it off, you can dull your tools or chip away enough wood to make the leg look as if mice gnawed it.

After the glue has cured, saw or plane and scrape the protruding laminate edges flush with the leg stock. You can remove this excess with a smoothing plane, but I rip it on the tablesaw after fitting a 3⁄4x11⁄2x18 auxiliary fence to the rip fence. Because of the low height of the auxiliary fence, the laminate doesn't interfere with the accuracy of the cut. The walnut core bears against the fence and the laminate overhangs it while you rip the excess from the leg's other side, as shown in the top, right photo on the facing page. When ripping the excess from the first maple laminate, set the auxiliary fence



Frid clamps one laminate on each of two legs at once by sandwiching the laminates between the stout walnut. Clamp pads aren't necessary because the inside of the legs will be cut away when they are tapered.

Above: Excess laminate on one side of the walnut leg extends over a 1½-in.-high auxiliary fence as the excess is ripped from the leg's other side. Below: After clamping a leg in the mortise jig, Frid guides the router fence against the jig's side and gauges the mortise's length with the jig's stops.



1⅝ in. from the blade. If you use a hollow-ground blade for these narrow rip cuts, the wood won't tear and the surface will almost be planer smooth. I finish the surface with a sharp cabinet scraper before gluing on another laminate. Remember to move the fence away from the blade as additional laminates are glued to the leg.

Cutting the leg mortises–After all the laminates are glued in place, each leg will be 1⅞ in. square and must be ripped on the inside surface and finished 1¾ in. square before mortising. I use a plunge router and the jig shown in the bottom, right photo above to mortise the legs to accept the haunched tenons. The jig is a three-sided box in which the leg is positioned against a stop, shimmed to height and clamped on one side. The router's fence bears against one side of the jig, and the length of the mortise is determined by stops set on the other side of the jig to limit router base travel. For more on the mortise jig, see *Fine Woodworking on Joinery* (The Taunton Press, 1985).

My square-base plunge router has three depth settings. I use one for a 5/16-in.-deep mortise for the haunch and one for a 13/16-in.-deep mortise for the main part of the tenon. After positioning the leg and setting the jig's stops for 2-in.-long mortises, I gradually plunge a ⅜-in. straight bit into all the legs until I've reached the haunch depth. Then, I reset the stops for the 1 9/16-in.-long tenon and gradually plunge to the tenon depth. Since the mortise is offset to one side of the leg, turn the leg end for end and reset the jig to cut the mortises on their opposite side. After routing each mortise, I square the corners with a chisel and mallet, and then slightly undercut each one to receive the angled tenon end.

Next, rip the full-length taper in the leg on the tablesaw with the plywood jig shown in figure 2 on p. 55. The jig should hold the leg snugly as you taper it from 1¾ in. square at the top to ⅞ in. square at the bottom, which is large enough not to cut into carpet or dent a wooden floor. Cut the same amount from each of the leg's two inside surfaces, but leave the dimensions slightly heavy so each surface can be trued on the jointer.

Lastly, rabbet the outside corner of each leg to reveal the laminates. I remove most of the waste by ripping the rabbet slightly smaller than shown on the drawing. Then, I finish the rabbet to 5/16 in. square with a straight bit in a table-mounted router. Since most of the waste was removed on the tablesaw, the router will leave surfaces that only need light sanding. Be careful not to round over the corners of the rabbet when sanding.

Making the aprons–The apron ends and shoulders are angled to fit the leg's full-length taper with some simple tablesaw setups. Before cutting the aprons to length, you should mark an X on their best side. Then, measure the angle between the leg and the apron and the aprons' length (including tenons) from the drawing. I measure the angle with a sliding bevel and duplicate it between the miter gauge and the blade, and then crosscut one end of each apron. By clamping a stop to the gauge, you can cut duplicate lengths of the two long aprons before resetting the stop to cut the short ones.

To cut the tenon cheeks, I use a jig made of two pieces of plywood with a piece of wood, the thickness of the saw fence, sandwiched in between (see the top photo on p. 55). The plywood edges slide on the table, and the jig is guided by the fence. To cut the cheeks, I clamp the apron to the jig so the angled end of the apron is flat on the table, set the blade height at ¾ in., square to the table, and locate the fence to leave the proper-size offset tenon. For more about this tenon jig, see my book, *Tage Frid Teaches Wood-*

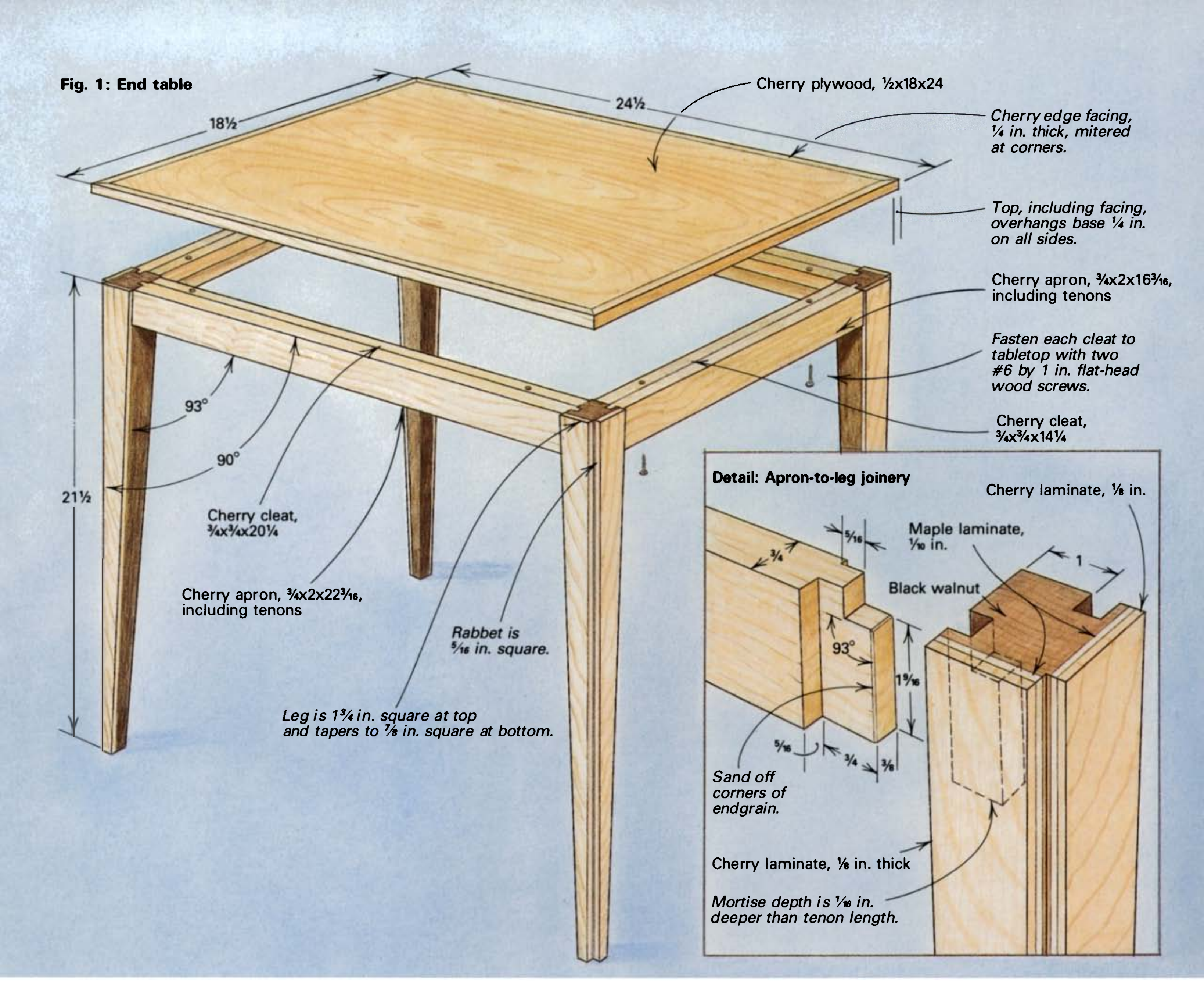


Fig. 1: End table

working, Book 1: Joinery (The Taunton Press, 1979), p. 131.

To cut the shoulders, remove the tenon jig and use the miter gauge previously set for the shoulder's angle, based on the leg's taper. Clamp a 1x2x6 block to the rip fence about 6 in. in front of the blade and position the fence for a 3/4-in.-long tenon by measuring between the blade and the block. Using the block as an end stop provides clearance between the blade and rip fence to prevent the cutoff from getting trapped and kicking back.

When cutting the tenon, butt the end of the rail against the block and then grip the rail tightly to the miter gauge fence as you make the cut. Set the blade height at 1/16 in. for the inside shoulder and test the cut on a scrap to ensure the shoulder is parallel to the rail's end. Because of the offset tenon and the opposing angles on opposite ends of the apron, you will have to cut the two right-hand, 1/16-in. shoulders, reverse the miter gauge angle and cut the left-hand, 1/16-in. shoulders. Then you can raise the blade for the 5/16-in.-deep shoulder, make the left-hand cuts and again reverse the miter gauge angle to make the right-hand cuts. I avoid having to change the miter gauge angle, which can lead to inaccuracy, by using two gauges preset to the same but opposing angles. Then I can just interchange miter gauges for either a left- or right-hand cut.

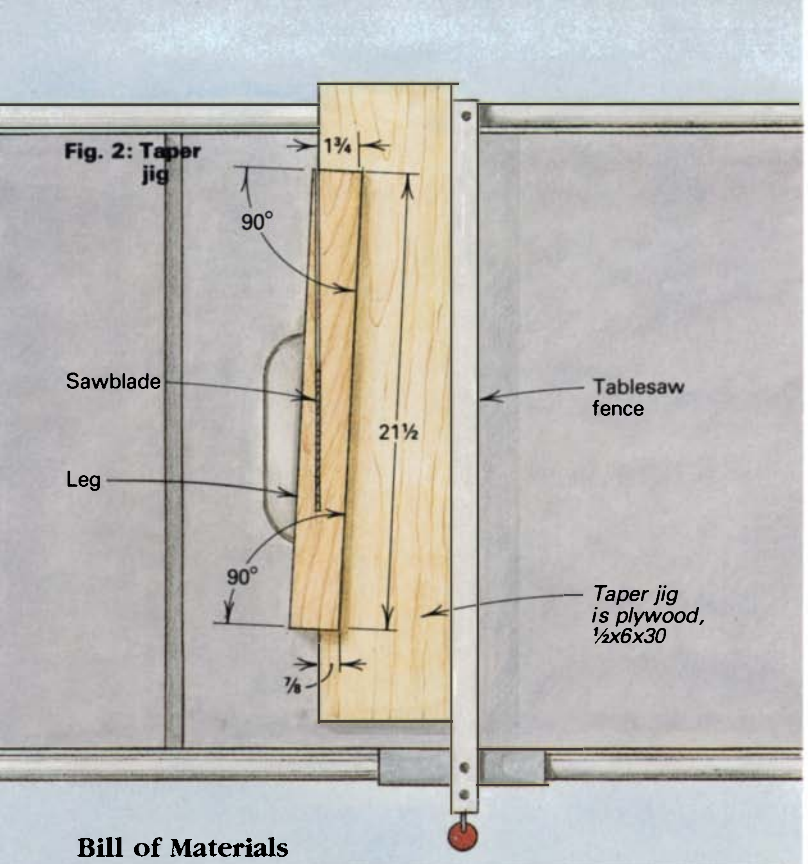
I bandsaw the tenon's haunch by clamping a fence 7/16 in. from the outside of the blade and a stop 7/16 in. behind the blade's cutting edge. Before assembly, pare a 1/16-in. bevel on the end of the tenon, so it's easier to push home in the mortise.

Sand everything before frame assembly. Since the leg stands off the face of the apron a little less than 1/8 in., the leg's line is distinct from bottom to top and presanding is possible. Lightly sand with 180-grit paper just enough to dull the edge so it won't cut your finger.

Assembling the frame—Before assembly, scrape and sand the inside of the four legs and the front and bottom of the aprons. Don't try to glue the entire frame in one operation or you'll have a difficult time squaring it. Glue the short aprons to two of the legs first, making sure each apron's thickest shoulder is on the outside of the leg. Apply glue sparingly only to the outside corners of the mortise and on the front part of the tenon cheeks; there's no need to put any on the end of the tenon. As you press the parts together by hand, the glue will spread evenly on the tenon cheeks and the sides of the mortise. If the tenons must be forced, pare off any burnished high spots. You need only one clamp (with pads), set parallel to the apron, to hold the assembly together.

The frame must be square in order for the table's four legs to be flat on the floor at the same time. I check for squareness with the bevel gauge, previously set to the inside angle between the leg and apron, and a framing square, for the 90° outside angle. If the frame

Drawings: Vince Babak



Bill of Materials

No.	Description	Wood	Angle	Dimensions (T×W×L)
2	Aprons	Cherry	3° *	¾ × 2 × 16 3/16*
2	Aprons	Cherry	3° *	¾ × 2 × 22 3/16*
4	Legs	Black walnut	90°	1⅝ × 1⅝ × 21½**
8	Laminates	Cherry	90°	⅛ × 1⅞ × 21½**
8	Laminates	Maple	90°	1/10 × 1⅞ × 21½**
2	Cleats	Cherry	90°	¾ × ¾ × 14⅜
2	Cleats	Cherry	90°	¾ × ¾ × 20⅜
1	Top	Cherry plywood	90°	½ × 18 × 24
2	Edge facings	Cherry	Mitered	¼ × 9/16 × 18½**
2	Edge facings	Cherry	Mitered	¼ × 9/16 × 24½**
8	Flat-head wood screws			#6 by 1 in.

* Angles and lengths copied from full-size drawings for accuracy.
** Ripped wider than their finish dimension for easier alignment during assembly.

Apron tenons are cut with a plywood jig that is guided by the saw fence. The jig holds the apron so that its end runs flat against the saw table.

Frid guides a modified router around the table's top and bottom surfaces to flush-trim excess facing. A piece of ¾-in. plywood is fastened to the router base and the ½-in.-dia. straight bit's flat end is nearly flush with the plywood base.

isn't square, adjust the direction of the clamp's pressure by slightly moving one or both of its ends. Before setting the glued subassemblies aside to dry, check that the legs are parallel and the outside diagonals are equal.

After the glue is set in the subassemblies, complete the frame by gluing the subassemblies to the long aprons. Again, you only need one clamp per side, but you may need one across the top to adjust the frame square as you look at it from above. Recheck that the legs are parallel and their diagonals, as well as those of the top, are equal.

Before you fasten the top in place, block-plane or belt-sand the tops of the legs, if they extend above the aprons. If you plane them, pare the inside top corners away so they don't tear out as you plane in from the outer edges of the frame. Finally, glue the cleats to the inside and the top of the aprons, as shown in figure 1.

Finishing and fastening on the top—Since the edges of the cherry plywood tabletop aren't attractive, I cover them with cherry edge facings. Dry-clamp the four facing pieces to the outside of the plywood, to ensure that the mitered ends fit well, as shown in figure 1. Remove two opposite pieces, apply glue to their joining surfaces, but not to the miters, and clamp them to the plywood's edges until the glue sets. Then, remove the other two facing pieces, apply glue to all their joining surfaces (including the miters) and glue them in place, tightly aligning the miters. If you want to avoid miters, you can butt-joint the facings as I did.

Although you could use a smoothing plane, scraper and sandpaper to dress the facings flush with the top and bottom plywood surfaces, I use a simple router modification, shown in the bottom photo above. Fasten one end of a piece of ¾-in. plywood, about 6 in. wide by 12 in. long, to the router base so that its edge is set back about ½ in. from a ½-in.-dia. straight bit. Adjust the bit's flat end flush with or slightly recessed from the plywood base. When you guide the router around the surfaces, the bit will flush-trim the excess facing. Finish-sand so the cherry facing appears as one with the cherry plywood.

All surfaces are sanded to remove machining marks and two coats of Watco Danish Oil Finish (available from Minwax Co., 102 Chestnut Ridge Plaza, Montvale, N.J. 07645) are applied.

Finally, attach the frame to the top with two #6 by 1-in. flat-head wood screws through each cleat. Since the screws penetrate only ¼ in. into the top, a small-diameter screw with more threads per inch holds best. Lay the top, finished-side down, on a soft blanket and center the frame on its underside. Be careful not to countersink the heads when boring for or driving the screws, or the screw point might penetrate the tabletop's finished surface. □

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A compressor is a versatile tool that has a place in all woodshops, regardless of size or type of woodworking done. Whether it's hooked up to an elaborate system of air pipes or used with a simple flexible hose, a compressor can drive dozens of different air-powered devices, such as spray guns, air tools, pneumatic clamps and vacuum devices. Here, a worker uses a 2-HP portable compressor to blow chips out of a mortise being chopped by hand.

Compressed-Air Systems

Taking the pressure out of choosing and using compressors

by Michael Dresdner

One valuable tool often found in woodworking shops requires no bits, cutters or blades and never needs sharpening, yet can do more jobs than the most versatile multipurpose machine. With a few adaptations, an air compressor can accomplish a surprising range of tasks. In addition to running a spray gun for applying clear finishes or paints, a compressor system provides a ready source of clean air to blow off work surfaces and parts, and clean chips from newly cut joints. And a compressor can drive specially designed sanders, drills, routers, grinders and more; power production-oriented pneumatic clamps; and create a vacuum strong enough to run a bag-type veneer press or hang on to parts in special hold-down fixtures.

I think anyone who owns a woodshop should consider buying a compressor and the accessories to use it safely and efficiently. A basic compressed-air system isn't too expensive, and you will find more than enough uses for it to justify the cost. In this article, I'll cover the basics of compressors and accessories and what you should know before buying anything, as well as how to use compressed air in a shop. I'll also talk about how to design and install a compressed-air system. First, let's look at the anatomy of a typical compressor.

The compressor—At the heart of any air system is the compressor itself. Compressors come in all sizes, usually rated by their horsepower (HP), from small ¾-HP portables to giant 25-HP and higher industrial workhorses. Regardless of the size, though, almost all compressors consist of a motor (electric or gasoline powered) connected to an air-compression pump. Both the pump and motor are usually mounted on an air storage tank. The pump drives one or more pistons, which draw air from the room through a filter, compress it and force it into an air storage tank where it's kept until needed. A single-stage pump compresses air to full pressure with one stroke of the piston (or pistons), while a two-stage pump partially compresses air with the first piston, and then compresses it to full pressure with the second. An automatic pressure switch mounted on the air tank regulates the compressor and shuts off the motor when tank pressure reaches the desired maximum, typically 100 pounds per square inch (psi). When the air is used, the pressure drops below a user-adjustable threshold and the switch turns the compressor back on to replenish the tank. Some compressors are fitted with an unloader that controls air pressure without constantly starting and stopping the unit during heavy use.

Usually the tank has a pressure gauge and a safety pressure-release valve that lets air escape if the pressure switch fails and tank pressure gets too high. When air is compressed, the moisture it carries is compressed as well, and when the air cools in the tank, the moisture condenses out. Therefore, the tank has a drain valve (also called a petcock) at the bottom (see the drawing on p. 60) to allow the water to be bled. The tank also has either feet or wheels on the bottom, depending on whether it's a stationary or portable model. Finally, the tank has an air outlet and shut-off valve where the air hose or piping is connected.

Using compressed air—A great variety of tools and devices are designed to run off a compressor—even a small-capacity model. A compressor is most commonly found in the finishing room, where it is used to drive guns that blow off sanding dust and spray guns that apply finish. Dusting guns, also known as blow guns, are available in dozens of different styles and prices; just make sure to get one that is approved by the Occupational Safety and Health Administration (OSHA). Spray guns for applying stains and finishes are available in a wide range of sizes and styles, and it is best to choose the gun with a specific use in mind (see the sidebar on p. 59).

Outside the finishing room, a compressed-air system will run sanders, routers, drills, screwdrivers, nailers—virtually any hand-held electric power tool has an air-powered equivalent. Air tools often cost two or three times more than their electric counterparts, but they tend to outlast them. One of the most common and useful air-powered tools in the woodshop is the sander (see the top photo below) because, in addition to outlasting an electric model, the air sander is stronger, faster and quieter. One indisputable advantage of an air sander is wet-sanding: Final-sanding a finish using water or solvent as a lubricant. Because of a possible explosion or fire, it's foolhardy to wet-sand with an electric tool. Air sanders use no electricity, and they are standard with most professional finishers.

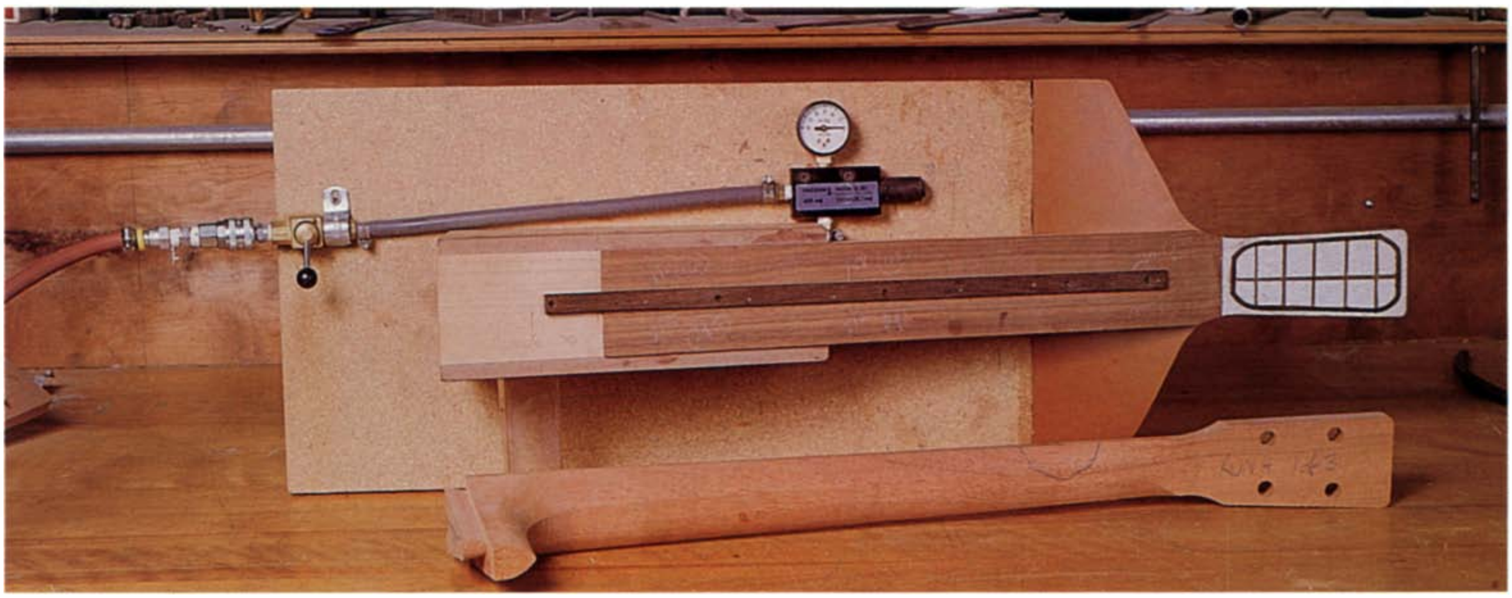
Practically every electric-powered hand tool has an air-powered equivalent that's stronger and faster. Here, the author sands an electric bass guitar with an air-powered orbital sander.

Probably the most novel use of compressed air is an ingenious device called a vacuum pump. Although it's called a pump, this device has no moving parts and it's deceptively small—about the size of a lipstick. Inside the vacuum pump's tube-like body is an accurately machined cone (a Venturi tube) with a small aperture. As compressed air is forced through the aperture, a vacuum is created just behind the tip of the cone. A vacuum line is connected via a threaded hole at 90° to the direction of air flow. Although there are several brands available, I've had good success with the JS-90 vacuum pump, which is available from Vaccon Co., Inc., Box 423, Norwood, Mass. 02062; (617) 762-2880.

A vacuum pump can revolutionize your shop. This ready source of suction transforms any jig into a reliable vacuum chuck or hold-down jig, like the one in the bottom photo below, capable of grasping complex-shaped parts during machining. Hooked up to a vinyl-bag press, the pump evacuates air, for vacuum laminating and veneering. For more on vacuum veneering, see *FWW* #56 p. 70.

Other uses for compressed air are numerous. Powerful pneumatic quick-action clamps are available for many applications, and are indispensable for production work. Many new multipurpose joinery machines offer such clamps as optional accessories. On a larger scale, compressed air is necessary for operating certain large machines. The wide-belt sander, fast becoming a cabinet shop standard, uses compressed air to tension the sanding belt and, on some models, to regulate belt tracking. Pneumatic cylinders are also used on some horizontal boring machines, on which an air-operated foot switch activates both a pneumatic clamp that holds the work down and a cylinder that thrusts the bit into the work. With a little creative effort, you can use compressed air to cool machine-tool operations, such as hollow-chisel mortisers, during pro-

A small, inexpensive vacuum pump hooked to an air compressor can turn any jig or fixture into a vacuum hold-down capable of grabbing even oddly shaped work. Here, the tiny pump is built into a jig designed to hold guitar necks as the outside of the headstock is shaped.



Compressed-air system accessories for cleaning and drying the air, as well as oiling and regulating it, are numerous. For instance, shown in the front row, left to right are a blow-off gun attached to a coiled air hose, for dusting work before finishing; a lipstick-size vacuum pump that is amazingly powerful; and a quick-change coupling system that allows air devices to be readily exchanged. Back row: This small, disposable air filter attaches directly to the gun or tool; a touch-up spray gun is handy for small finishing jobs; this regulator/gauge unit is made to attach at the device, to allow easy adjustment of the air flow; for air-powered tools, this combination device offers a filter, regulator, pressure gauge and oiler in one compact unit.

duction work or to blow chips away and prevent them from clogging a cut, such as when shaping with a pin router. For more demanding tool-cooling jobs, a T-shape device called a vortex tube can cool compressed air down to minus 40°F. This tube is available from Vortec, 10125 Carver Road, Cincinnati, Ohio 45242; (800) 441-7475.

System accessories—Regardless of the size or layout of your compressed-air system, there are a number of devices you can install on air lines to modify or control the air, including after coolers, dryers, filters, oilers and regulators. Aftercoolers chill the compressed air to condense and drain moisture. Dryers come in two types, mechanical and desiccant, and both prevent any further condensation of air in the system. These devices are essential to maintain high-quality air in the finishing room—especially in areas of high humidity. Filters remove oil mist, dust and particles, as well as moisture, all of which are contaminants that may ruin sprayed finishes and foul spray guns or air tools. There are two basic kinds of filters. Separators create a whirlpool effect to trap oil, water and particles, which collect in a chamber that has a "sneezer" or drain valve. Mechanical filters pass the air through either coalescing or absorbing filter material, usually in a cartridge. The cartridge must be periodically replaced when it becomes clogged with dirt and dust particles that bypass the primary air filter on the compressor pump or are products of deterioration in the air lines.

While filters clean the air, oilers add small amounts of air-tool oil to the air to lubricate air-powered tools. Though air tools require frequent lubrication, the use of an automatic-dispensing oiler makes these tools virtually maintenance free. A dial on the oiler allows you to control the number of drops per minute added to the air and a refillable reservoir holds a supply of the special oil (never substitute motor oil). Oilers are installed in a compressed-air system as close to the tool as possible, to prevent air lines from being contaminated with oil, which could ruin a finish if a spray gun were used with the same air line.

Because different air guns and tools have different air pressure requirements, air regulators are fitted to allow the user to control pressure. This is done by turning a hand knob that presses a diaphragm to either reduce the air pressure or leave it unchanged; regulators cannot increase the psi above line pressure. A regulator usually has an attached gauge, so you can monitor the outgoing pressure. With the exception of small, portable compressors that often have regulators mounted at the tank, air regulators are best positioned as close as possible to the end use, to allow the operator to change pressure as needed.

Average Air Consumption of Air-Powered Devices

Device	psi	Air Consumption (in CFM)
7-in. Body grinder	90	7½-30*
Dust gun	100	2.5
⅜-in. Drill	90	6-24*
Finish sander, random orbit	90	4-16*
Jigsaw	90	7-27*
Nail gun (40, 2-in. nails/min.)	100	2.2
Router (with ¼-in. collet)	90	7-28*
Stapler (40, ¼-in. by 1½-in. staples/min.)	100	1.8
Spray gun (with general-purpose nozzle)	30-50	7.8-11.5**
Touch-up spray gun (with general-purpose nozzle)	30-50	4.2-6.9**
Vacuum pump	80	1.8

* First number indicates CFM with intermittent use. Second number is CFM with constant use.

** Range of CFM varies with pressure and different nozzle selection.

Choosing a compressor—When it comes to figuring out how big your shop compressor needs to be, there are two factors to consider: pressure, measured in psi, and volume, measured in cubic feet per minute (CFM). Pressure needs for air devices used in woodworking range from less than 30 psi to around 100 psi. Even a ½-HP single-stage compressor can generate enough pressure for most small-size shop uses, although a large air system may need the higher pressure-generating potential of a two-stage compressor, which can produce pressures above 125 psi. Generally, the most important measure of a compressor's power is its CFM output. Unfortunately, a compressor's actual output isn't always reflected by the manufacturer's claims. Just as with the horsepower rating game, where power output of a motor may be rated in either "peak-developed" or "continuous" horsepower, compressor manufacturers don't all use the same rating standards. Still, standards do exist and most high-quality compressor makers rate their units in SCFM (standard cubic feet per minute). This is the actual amount of air discharged by the compressor, measured under specified atmospheric conditions of temperature, altitude and humidity. In contrast, less-expensive compressors, rated in regular CFM, may output between 10% and 20% less than those rated in SCFM—the industry standard.

To determine your compressed air needs, add up the CFM requirements of all of the tools or devices that are likely to be running at the same time, add 25% and use that as your minimum output. If your shop is at a high altitude, say above 6,000 ft., you may also want to add another 10% or more, since the air is thinner and takes more power to compress. When computing your air-tool

Selecting a spray gun

A spray gun for finishing is probably the most common device used with compressed air, yet woodworkers often give even less consideration to selecting a gun than they do a compressor. Most high-quality spray guns are capable of shooting a wide range of finishing materials, including stains and dyes, lacquers, varnishes, urethanes, epoxies, paints and even adhesives.

Most spray guns found in small shops are siphon feed, that is, the air pressure fed to the gun is used to create suction that pulls the finishing material from a cup attached to the underside of the gun. Practically all guns, save touch-up guns, have siphon-feed cups that will hold a quart—adequate for one or two coats on even a large cabinet or furniture piece. However, shops that do production cabinetry and need larger quantities often use a pressure pot. This is a special locking canister, resembling a pressure cooker, that holds several gallons or more of finish at a time and feeds the material to the gun via a separate hose coming from the pot.

When choosing a spray gun, the important thing to remember is that the brand, model or overall size of the gun is no indication of what finishing materials the gun is equipped to handle, or of how much air it will use. Instead, most guns allow the tip setup, consisting of the air nozzle and fluid nozzle and needle, to be changed, and various combinations of nozzles and needles accommodate finishing materials of different types and viscosity.

Various tip setups also use different quantities of compressed air measured in CFM (see main article on p. 56). A gun with a small air nozzle spraying a thin material, such as a stain, at low pressure might require as little as 2 CFM, while a large air nozzle spraying heavier material, such as varnish, will require both higher pressure and may pull more than 20 CFM. Both setups might fit the same spray gun, but the larger, more air-hungry tip setup will deliver a lot more finishing material than the smaller one in the same amount of time.

Choosing the right tip setup for your spray gun depends on the number of CFM available from your compressor and the viscosity of the finishing material you want to spray. Viscosity for finishes is usually stated as "#2 Zahn cup" seconds. This is the most common (for lab testing) of almost two dozen different viscosity-measuring systems (Ford #4, Centipoise and Sears being others) that determine how thick a liquid is by how many seconds it takes for a premeasured amount to flow through a special-size orifice. Most common wood-finishing materials range between 14 and 30 seconds (#2 Zahn cup seconds): stains, solvents and water: 14 to 16 seconds; sealers, lacquers and primers: 16 to 20 seconds; varnishes, shellacs and urethanes: 19 to 30 seconds. You can test other finishing materials by buying a viscosity cup and following its testing directions.

A spray-gun manufacturer's chart for selecting air and fluid nozzle and needle combinations usually lists tip choices in sections grouped by viscosity. The sections usually offer several tip setups, each using a different number of CFM. For a general-purpose spray gun, pick the tip setup that allows you to spray the widest variety of materials within the CFM capacity of your compressor. Although you don't have to pick the largest tip that your compressor will handle, larger aperture fluid and air nozzles will generally produce a wider-fan spray pattern, which means more material flow and faster spraying of large surfaces, such as tabletops or cabinet panels. A gun running off a pressure pot needs a different tip setup than a gun using a siphon-feed cup. If you need a gun that can use either a pot or a cup, make sure the spray gun you buy accommodates both and purchase two separate tip setups.

If you plan to spray "catalyzed" coatings, which often contain acids or water-base coatings, such as Hydrocote lacquer, you'll need to choose a gun that has stainless-steel fluid pathways. Also, I prefer guns with a fluid nozzle that mates to the gun body with a nylon gasket, rather than a gun with a metal-to-metal fit. On the latter type, even slight damage to either surface, which may occur when cleaning the gun or changing tips, can cause the gun to spit, spray intermittently or clog. Guns that have a replaceable nylon gasket below the fluid tip will outlive their all-metal counterparts. These gaskets are cheap and survive countless cleanings.

Although prices vary, a high-quality gun costs about $135 and comes with your choice of tip setup. Each additional setup costs about $55. If you're in the market for an all-purpose gun for your finishing room, try to pick a brand and model that gives you as many tip options as possible. My current favorite gun, the Binks model 2001, offers over 1,500 different setup combinations for a staggering range of materials. Also, 2001 tips are interchangeable with guns from many of the other models in the Binks line, making this gun extremely versatile.

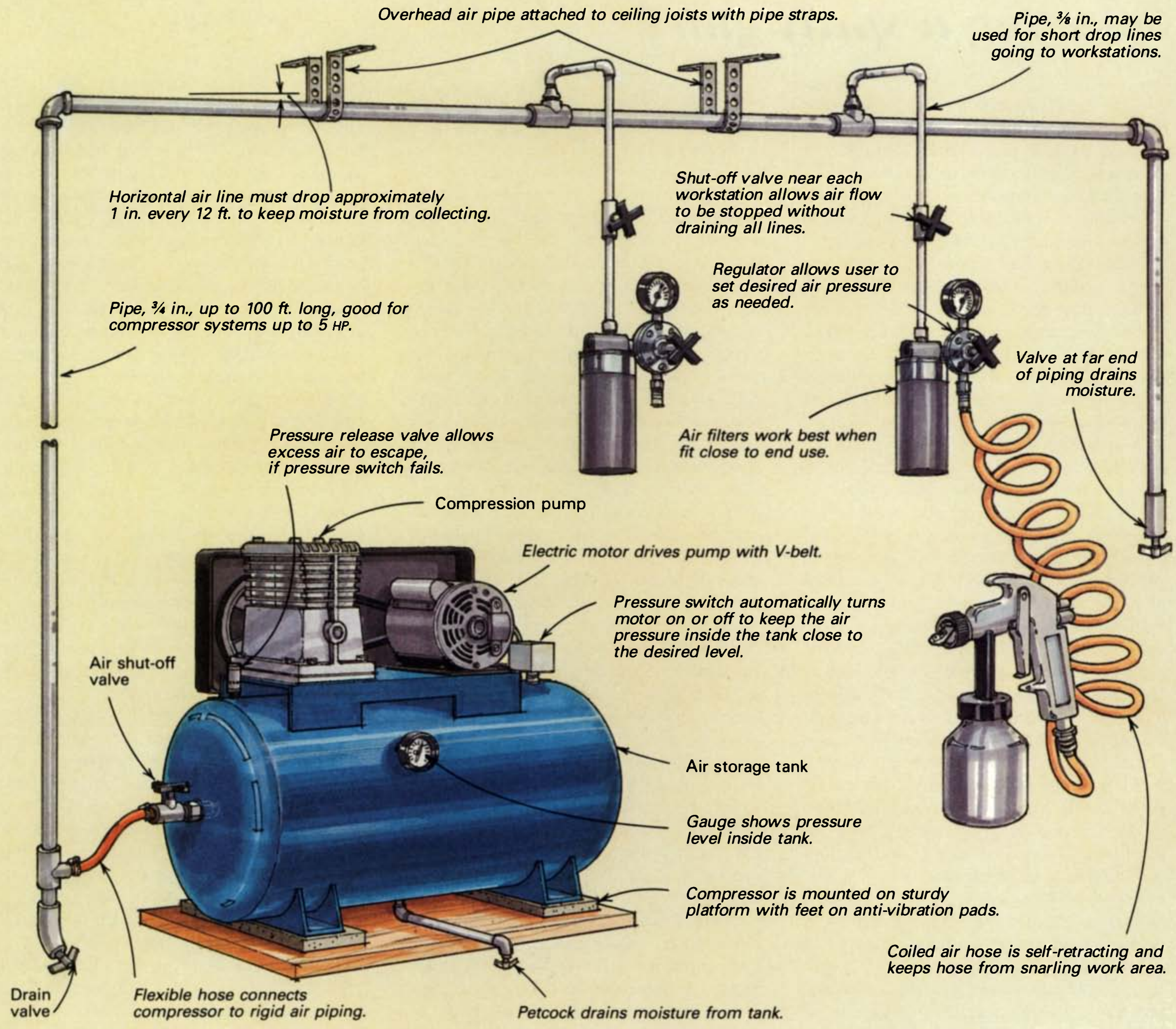
Siphon-feed cups are sold separately, and almost all cups are interchangeable with standard guns, even cheaper imports. In addition to the standard aluminum cup, there are Teflon-lined, stainless-steel and translucent polypropylene cups. All work nicely with water-base finishes and the latter two types will handle corrosive materials, such as acid-catalyzed lacquer or paint remover, as well. If you plan to spray many different materials through one gun, it is a good idea to have several siphon-feed cups. I like to keep one cup just for clear finishes and another one for solid colors. Regardless of the brand cup you buy, make sure a replacement gasket—a neoprene, nylon or leather ring between the cup and its lid—is available from your dealer, especially if you buy an off-brand or a foreign-made cup. *—M.D.*

CFM needs, take into account that certain air tools that run at a modest CFM when run intermittently, can draw tremendous amounts of air in continuous use (see the chart on the facing page). The largest range of CFM requirements is likely to be in the finishing room: A small touch-up gun, like the one in the photo on the facing page, can draw as little as 4 CFM, while a production spray gun with a large-aperture nozzle can easily draw 20 CFM or more.

To complicate compressor selection, new as well as used models are usually rated in horsepower, not CFM. This rating applies to the size of the head, or pump, and reflects the size motor that is required to run the compressor's pump at peak efficiency. The most common compressor sizes, as rated in horsepower, are: 1, 1½, 2, 3, 5, 7½, 10, 15 and from there up in 5-HP increments. Although it's not an entirely accurate rating, a common rule of thumb is to figure an output of 4 CFM per HP. Hence, a 2-HP compressor can be expected to produce about 8 CFM, which is adequate for moderate compressed-air needs in a small-size shop. While a home hobbyist with minimal air requirements may be satisfied with even a ¾-HP compressor, most professional finishers regard a 5-HP unit as the minimum size. Smaller compressors often require only 110v AC power and can be plugged into a standard wall outlet, while motors on larger units often come in both 220v single- and three-phase models. Compressors with 5-HP or larger motors should always have magnetic starter switches.

Another factor in deciding how big a compressor you need is

Compressed-air system



the size of its storage tank, with capacity rated in gallons. If your air use is intermittent rather than constant, you'll want to buy a unit with a large storage tank. This is because the larger the volume of stored air you have available, the longer it will be before the compressor's motor has to go back to work to replenish the supply. If a device in your shop needs an especially high volume of air, you may wish to install a second tank nearest the end use, to provide extra air capacity. Compressor dealers sometimes have extra tanks for sale (from defunct units). Also, make sure any used or new tank you buy bears an American Society of Mechanical Engineers (ASME) certification plaque—assurance that it's safe at maximum pressure. Air piping installed in your shop (described on the facing page), can also act as a storage system, and a manifold made from larger-diameter pipe can increase your system's short-period CFM output as well.

Designing an air system—Unless you plan to use a portable compressor with a single air hose and move the unit where it's needed, you'll want to carefully design your shop's layout of air lines and air-processing devices for best efficiency and convenience. As shown in the drawing above, a basic compressed-air system for a small- to medium-size shop consists of a compressor, air filters, regulators, accessories, air piping and hoses, and the end-use devices. The first thing to consider when designing your system is where to put the compressor. Ideally, the location should have good air circulation and lots of clean air for the compressor to draw, such as a room that's vented outdoors. Alternately, you could use flexible clothes-dryer hose to run clean air to the pump from outside. Placing the compressor near a source of sawdust will lower its efficiency and necessitate cleaning the air filter and changing the pump oil more often. Since the automatic pressure switch may start up the compressor at any time, the pulley side should be enclosed in a protective shroud or that side should face toward a wall; however, keep it at least 12 in. from the wall for unobstructed air circulation. Unless it's an explosion-proof model, the compressor shouldn't be located near the finishing area or spray booth, because a spark from

Drawing: Joel Katzowitz

its pressure switch could ignite solvent vapors. If the compressor shares the same floor as the spray room, it's a good idea to mount the compressor atop vibration-absorbing pads (cut-up pieces of old truck tires will also work nicely) to cut down on noise transmitted and/or amplified by the floor and vibration that raises dust.

When picking a spot for the compressor, try to find a location that's as close as possible to the end-use device, or, in the case of a shared shop, closest to the largest-volume air user. Because of friction inside the air lines, compressed air loses pressure (and effectively power) as it travels long distances. For example, air running through a 50-ft. length of ¼-in.-ID hose will experience a 50% drop in pressure. The same distance in a 5⁄16-in.-ID hose will cause only a 20% drop, and in a ¾-in. line (or larger) there will be virtually no loss in pressure. If you're running fairly long lengths of pipe between the compressor and the workstation, a larger-diameter pipe will not only reduce a drop in pressure, but it will act as an air-storage manifold, as described earlier. If you're at a job site and must use a small air line, say a long, ¼-in.-ID hose on a portable compressor, you can turn up the pressure at the compressor to overcome the friction losses.

Air lines—Traditionally, threaded galvanized steel pipe has been the standard for permanent air lines in the shop. It's readily available, safe and sturdy. The connections between fittings are made airtight by using pipe thread compound or Teflon tape on the joints. But because of steel pipe's cost and weight, some shops have chosen PVC plastic pipe as an alternative. It is not only lighter, but can be cut with a regular handsaw and jointed at any point without threading hassles. A word of caution though: If you're going to use plastic, make sure it's rated to withstand the highest pressure and temperature to which it will be subjected. To minimize the possibility of PVC pipe failure, compressor manufacturer Ingersoll-Rand recommends using an initial manifold of steel pipe and then connecting to your PVC branch lines. Also, use flexible hose for the initial connection between the compressor and the manifold or any air piping, lest vibration weakens the joints. You might also want the approval of your local fire marshall or insurance company before installing a plastic pipe system.

There are few restrictions as to how air lines should be run. Some shops have main lines crossing the ceiling with coiled hoses hovering above the bench areas; others have hard lines mounted to the workbench with hookups at workstations every few feet. A great configuration for a shop with many simultaneous air users is to have air pipes connect and form a loop around the shop. This reduces the drain that any single end user places on the system. Almost any configuration is possible, provided a few simple rules are followed. Due to moisture that condenses in the lines, all horizontal piping should be sloped away from the compressor. As you can see in the drawing, the slope of the horizontal line should be about 1 in. of drop per 12 ft. of run. At the end of each sloped line should be an elbow joint and a vertical drop leg, to collect the moisture. A petcock, or valve fitted on the end, allows the water to be drained. You should drain these lines, as well as the compressor tank, daily. On any lines that branch off, the T-fitting should point up, again preventing moisture from draining toward the tool, and also have a drain valve on the branch pipe or on the air-filter device. A typical network of air lines might have a ¾-in. main trunk running along the ceiling with ⅜-in., 5⁄16-in. or ¼-in. branch lines dropping down wherever needed. I also like to include a shut-off valve at the head of each branch line and one at the head of the main line so that I can cut off the air to any leg of the system for repairs or alterations without having to drain all the lines. Just make certain that the system's safety pressure-release valve is closer to the compressor than any shut-off valve; mine is on the compressor tank itself.

Dresdner uses a compressed-air workstation with an air filter and regulator where they are most efficient: near the end use, preventing moisture and debris in the air lines from contaminating a finish.

Workstation air hookups—Setting up air workstations at the workbench, where clean air can be regulated and devices hooked up quickly as they're needed, makes using compressed air convenient. If you plan to use various air-powered devices around your shop and each requires different air pressure settings, you should have a separate regulator at each workstation. Air filters should also be fitted at each workstation, located just before the regulator so that the set pressure isn't affected. For air-powered tools that use both an oiler and an air filter, the filter must come first. Some air filters are small enough to mount directly at the gun or tool and, for workstations dedicated to air-tool use, there are combination control units that contain a filter, regulator, gauge and oiler all in one device (see the photo on p. 58).

I install quick-change couplings at each workstation so any hose extension, dusting gun or tool can be quickly accommodated. These handy fittings consist of two halves; the female coupling threads onto the air source, while the male stem attaches to whatever is down line (hose extension, tool, spray gun, etc.). When the couplings are joined, the air flows freely with no leakage; but when they are separated, the female end acts as an automatic shut-off valve. Unfortunately, not all couplings are interchangeable, and one brand of stem may not fit with another brand of coupling. Although there is some brand crossover, most companies design their couplings so that you must buy only their brand for your entire system.

In the spray room of my instrumentmaking shop, quick-change couplings are especially valuable because they allow me to swap spray guns at will, for applying different finishing materials. Also, using several guns on a single hose keeps the number of hoses to a minimum to prevent the spray room from becoming a snake pit. □

Michael Dresdner is a Contributing Editor for FWW, *an instrumentmaker and finishing consultant in Perkasie, Pa. Thanks to Randy Jenkins, woodworker and retired compressor-systems specialist from Lafayette, La., for his technical assistance.*

Evaluating Wood Finishes

Shop methods for gauging durability

by Tim B. Inman

Comparing wood finishes for durability requires a few simple tools and an objective approach. The 5-in. by 12-in. samples above are prepared with each finish to be tested and then cut into four pieces and labeled 1 through 4 with the finish's name.

How do you compare the protective qualities of one wood finish to another? Do you rely on the manufacturer's literature or advice from sales clerks or company representatives? Reports from independent testing laboratories are often scarce or unavailable, so picking the right product can become a guessing game. But you can evaluate finishes in your own shop with a little knowledge of scientific techniques and simple, inexpensive supplies and equipment. If you can rate products objectively, you can match a finish to a job's requirement.

A wood finish protects by shielding itself as well as the wood from injury. To evaluate these protective qualities, you must develop a battery of tests. Generally, I determine what protective qualities are desired, identify what damages the finish, devise tests to simulate these forces and observe how well the finish stands up. I concentrate on how well a finish adheres, its distortion, abrasion and solvent resistance, and its sensitivity to temperature changes. These factors are reliably and fairly evaluated with the tests I'll describe here. Since evaluating application characteristics and aesthetic qualities often require subjective responses that are difficult or impossible to test scientifically, I won't cover those subjects here.

Begin testing by carefully preparing identical samples of wood and applying the finishes to be tested. To render objective results, apply each finish in the same environment and with identical tools and methods. Each sample panel should be about 5 in. by 12 in. and from the same area of a board. After finishing the panels with a different product, cut them into four, 3-in. by 5-in. pieces, label each with the name of the finish applied and number them 1, 2, 3 and 4.

In addition to standard shop and home equipment, you'll need a 10-power hand lens, a 1-in. steel ball and sandblasting abrasive. As you perform each of the tests, tally the ratings on a scorecard, like the one I developed on the facing page. Circle the appropriate score (1 to 5) for individual tests and then total them for a category score. If you're testing finishes for general-purpose applications, multiply each category score by one. If you're testing finishes that must perform a specific duty and a category is especially important, as heat sensitivity is for dining-table finishes, weight that category more by multiplying its score by two. After you total the results, compare one finish's total score to another's. The finish that scores the highest should perform the best. Use one scorecard per finish and be sure to compare equally weighted scorecards only.

Adhesion refers to a film's ability to stick to itself and the wood without peeling or flaking off. Good adhesion is an indication of a film's ability to withstand further damage after an injury, and you won't be able to test other protective qualities if the film won't adhere to the samples.

You can evaluate adhesion with a simple *cross-cut* test. Cut a grid on a 1-in.-square area at one end of the number 1 samples of each product, disrupting film bonding enough to allow the film to flake off of sections with poor adhesion. Using a razor knife and straightedge, cut 11 parallel lines with the grain and 11 more across the grain. Apply uniform pressure with a sharp blade to produce a grid with 100, $\frac{1}{10}$-in. squares, as shown in the top photo on the facing page. The cuts should be just deep enough to go all the way through the finish into the wood.

Now, study the finish in the grid with a hand lens and rate what you see on a 1 (failure) through 5 (successful) scale. Rate 1 if the finish has completely flaked off in many squares; 3 if there's considerable loss at the intersection of the cuts, without the loss of whole squares; and 5 if there was little or no adhesion failure due to the cuts. Next, add extra punishment by scrubbing the grid with a toothbrush, using an equal number of strokes in each direction on each sample. Repeat your observations and again rate the bonding performance on a scale of 1 through 5.

The "acid test" for adhesion is to see if the finish film can be pulled off with adhesive tape. Cover the grid with sticky tape, firmly press it down and then pull it straight up with a slow, steady motion. Again, record the results on a 1 through 5 scale.

Distortion resistance is a finish's ability to move and bend, to resist impacts and gouges that might break its adhesion. Although a harder finish might seem more durable, you'll see that it can be brittle and break apart when distorted or injured. But if the film is too soft, it offers little protection from scrapes or gouges.

You can evaluate a film's resistance to scratches as well as its hardness with the *pencil-scratch* test: attempting to scratch the finish with pencils of known hardness. Use common drafting pencils because their leads are graded by hardness on a scale from 9H, which is like nails, to 6B, which is as soft as charcoal. Only five leads—6H, 4H, HB, 2B and 5B—are needed for this test. Sharpen all the pencils uniformly and with equal pressure from each pencil, scribe a line on the end of the number 1 samples. Be sure to save the middle of these samples for another test. Use successively harder leads, holding each pencil at the same angle, and then record your observations. Rate hardness according to the hardest pencil that scratches the finish, as shown in the bottom photo. Rate 1 if the 5B scratches through, 2 if the 2B does, 3 for the HB, 4 for the 4H and 5 for the 6H.

The *mandrel-bend* test evaluates a film's ability to flex without breaking. Flexibility enables a finish to withstand normal wood movement due to temperature and humidity fluctuations. The test reveals how a film bends over five wooden dowels (mandrels): 1 in. dia., ¾ in. dia., ½ in. dia., ¼ in. dia. and ⅛ in. dia. In order to bend the film enough to cause it to break, apply the finish to aluminum foil, putting as many coats on the foil as you did on the wood. After cutting the foil into 1-in.-wide strips, begin bending them over the largest, 1-in.-dia. dowel. Continue with each successively smaller dowel, as shown in the left photo on the following page, and use the hand lens to look for cracks or flaking. Rate the sample 1 through 5 according to the smallest dowel the finish can bend around without failure: 1 for the 1-in.-dia. dowel and 5 for the ⅛-in.-dia. dowel.

The *ball-drop* test rates a film's ability to distort, or flex, under sudden shock. Did you play with Silly Putty when you were younger? If so, you may recall that if you pull slowly, you can stretch and pull it into long strings, like bubble gum. When jerked or snapped, it breaks. Finishes are like Silly Putty: they can crack or craze when suddenly hit, even though they may flex slowly without failure.

Drop a 1-in.-dia. steel ball onto the number 2 samples from a height of 36 in. Failures are most notable at the top edge of the resultant dent (shown in the center photo on the following page). Observe the dent with a hand lens and rate the performance with the 1 through 5 scale: 1 if there are several concentric bands of cracking, perhaps with some flaking off; 3 if there's some hairline cracking, but only near the top edge of the dent; and 5 if there is no cracking.

Abrasion resistance goes hand in hand with distortion resistance, and is especially related to a film's hardness. Usually, hard films

Protective Performance Finish Scorecard

Finish Type: ________________ Date: ________
Manufacturer: ________________ Wood: ________

When testing finishes for general purposes, multiply scores by one. When testing finishes that perform a specific duty and a category is especially important, as heat sensitivity is for dining tables, weight that category more by multiplying its score by two. Compare finishes by comparing their total scores.

I. Adhesion Testing
- A. *Cross-cut* test
  1 2 3 4 5
- B. *Cross-cut* test, after brushing
  1 2 3 4 5
- C. *Cross-cut* test, after pulling tape
  1 2 3 4 5

Score: ______ × ______ = ______

II. Distortion Resistance
- A. *Pencil-scratch* test
  5B: 1 2B: 2 HB: 3 4H: 4 6H: 5
- B. *Mandrel-bend* test
  1 in.: 1 ¾ in.: 2 ½ in.: 3 ¼ in.: 4 ⅛ in.: 5
- C. *Ball-drop* test
  1 2 3 4 5

Score: ______ × ______ = ______

III. Abrasion Resistance
- A. *Sand-drop* t st
  1 2 3 4 5

Score: ______ × ______ = ______

IV. Heat Sensitivity
- A. *Hot-drink* test
  - after 10 seconds: 1 2 3 4 5
  - after 1 minute: 1 2 3 4 5
  - after 5 minutes: 1 2 3 4 5
- B. *Hot-casserole* test
  - after 10 seconds: 1 2 3 4 5
  - after 1 minute: 1 2 3 4 5
  - after 5 minutes: 1 2 3 4 5
- C. *Cold-check-resistance* test
  1 2 3 4 5

Score: ______ × ______ = ______

V. Solvent Resistance
- A. *Solvent-drop* test, rate 1 - 5

	10 seconds	1 minute	5 minutes
1. Tap water	______	______	______
2. TSP + water	______	______	______
3. Vinegar	______	______	______
4. Lacquer thinner	______	______	______
5. Naphtha	______	______	______
6. Denatured alcohol	______	______	______
7. Acetone	______	______	______

- B. *Acetone-rub* test
  - fail: 1
  - pass: 5

Score: ______ × ______ = ______

Total Score: ______________

Above: Evaluate how well a film adheres to wood with the cross-cut test. Cut a grid with 100, 1/10-in. squares, and rate by counting the number of failed squares: right after making the cut, after trying to brush them off and after trying to pull them off with tape. Only the corners of eight squares have flaked off after pulling the tape on this sample; it is rated high: 4 to 5.

Below: The pencil-scratch test evaluates the film's hardness. The hardest pencil, 6H, scratched clear through the finish, a 4H just broke the surface, and the soft 5B left a mark that could be cleaned off. Rating: 3.

The mandrel-bend test evaluates a film's flexibility. Ratings are based on the smallest dowel that coated foil can be bent over without the film peeling. This film bent over a 1/8-in.-dia. dowel and rated high: 5.

Test distortion resistance after a sudden shock by dropping a 1-in. steel ball from 3 ft. onto a test sample. Base ratings on the amount of cracking at the edge of the resultant crater. This film rated low: 1.

Evaluate abrasion resistance by pouring sandblasting grit through a 3-ft. pipe onto a sample. Rate the finish based on the amount of abrasion. This finish is abraded nearly to the wood. Rating: 2 to 3.

are more susceptible to abrasion than soft films. Consider that people who sandblast letters into granite monuments sometimes mask off their work with rubber templates. Although the hard granite is abraded by the sand, the soft rubber is not. Similarly, soft films usually withstand grit attack better than hard films. But since hard finishes are usually more desirable than soft ones, the perfect finish film is a compromise.

The *sand-drop* test can prove a finish's abrasion resistance. Pour two cups of sandblasting grit through a funnel inserted into the top of a 36-in.-long, ½-in.-dia. pipe and onto the middle of the number 1 samples. Secure the pipe so its lower end is 1 in. from the surface of each sample, which should be inclined so the grit hits it at 30° to 40°, as shown in the right photo above. Use a hand lens to make your observations and rate the sample 1 if the finish is abraded away to the wood, 3 if there is superficial marking and 5 if there isn't any noticeable abrasion. Increasing the length of the pipe or using a coarser-grit abrasive will make the results more obvious, but use the same height and grit for each sample.

Heat sensitivity—Dining tables are especially subject to heat damage since they regularly support hot dishes and coffee cups. Sometimes the heat is dry and sometimes it is moist, but it's always potentially damaging. Most films are heat sensitive, so it's important to identify which are most subject to heat distress and at what temperatures they break down. Protect yourself from burns by using pot holders when performing the following tests.

The *hot-drink* test evaluates resistance to moist heat. Heat a small cup of water to about 160°F, spill some on one end of the number 3 samples, and then set the filled cup in the spill. Lift the cup and check the finish after 10 seconds, 1 minute and 5 minutes. In this test, 1 equals failure, showing wet wood beneath the finish film; 3 means there is some blush- or white-ring blemishing; and 5 indicates no obvious damage.

The *hot-casserole* test determines if the finish can stand up to much hotter dry heat. This test will probably ruin most finishes, and the real question is, how badly? Heat an oven-proof glass dish in a 400°F oven for 20 minutes. Then, carefully place the heated dish on the unused end of the number 3 samples. Again, lift the plate to observe and rate the damage, such as melting, at intervals of 10 seconds, 1 minute and 3 minutes; for total failure, such as the finish melting, burning or blistering away to the wood, rate the sample a 1; for some melting or blistering, rate it a 3; and if there is no damage, rate it a 5.

The next test is to see how well the film tolerates the cold. Temperature fluctuations from subfreezing to warm can distort the wood and finish by causing them to move due to temperature changes. *Cold-check resistance* is the American Standard Testing Materials (ASTM) term used to determine a film's ability to resist hairline cracking or checking caused by repeated exposure to cold. Put the number 2 samples in a freezer, where the temperature is minus 10°F or lower, for 30 minutes and then remove them to room temperature for 30 minutes. Continue this and count the cold-to-hot cycles before hairline cracks occur. The samples are rated as follows: 1 if cracks appear after 1 cycle, 3 if cracks appear after less than 5 cycles and 5 if there's no cracking after 10 cycles. Use a hand lens to check only the areas that weren't damaged by the steel ball.

Solvent resistance—Two final tests evaluate another common potential injury: chemical attack. Even the finest furniture comes into contact with several household chemicals and solvents that can be very destructive. Use ordinary home and industrial chemicals, which are found in many cleaners, perfumes and other products, but you should also test finishes with other chemicals you routinely use. I suggest the following: tap water (which can degrade shellac), trisodium phosphate detergent (TSP) and water, vinegar, lacquer thinner, naphtha (varnish maker's and painter's fast-drying thinner), denatured alcohol and acetone. Testing for solvent resistance is simple, but be sure to take precautions prescribed by the material safety data sheet on each of these products. (For more on this, see "Chemical Hazards of Woodworking," *FWW* #80, pp. 58-63.) If you use these chemicals as directed, avoid major spills and wear Butyl gloves, goggles and a chemical-cartridge respirator with an organic-vapor cartridge or canister, you should be reasonably protected from hazards due to absorption and inhalation.

For the *solvent-drop* test, put one or two drops of each chemical in three different places on one half of each of the number 4 samples. After 10 seconds, wipe one spot away; after 1 minute, wipe off another; and after 5 minutes, wipe away the last spot. Now rate the results for each interval: 1 if the finish was completely dissolved away to the bare wood, 3 if the finish is softened and 5 if there is no damage. An *acetone-rub* test is the acid test for chemical resistance. Dampen a 0000 steel wool pad with acetone and rub the other half of the number 4 samples with 50 strokes, using uniform pressure on each sample. Rate the finish with a 1 if there is damage and 5 if there isn't damage. □

Tim B. Inman professionally tests finishes and restores furniture in Lake Mills, Wisc.

Shopmade Sanding Discs

High-speed finishing without swirl marks

by James R. Johnson

As a turner of artistic hollow vessels, I'm faced with virtually every sanding condition imaginable—endgrain, side grain, convex and concave surfaces, spalted areas and knots; you name it, I've sanded it. Because holding sandpaper against a revolving piece can scratch the wood and be dangerous on vessels with damaged wood or voids, I've developed shopmade foam-faced sanding pads of various sizes, shapes and firmness that can be chucked in a hand-held electric drill.

Each pad is a plywood disc covered with foam, which is ¾ in. to 1 in. larger in diameter than the disc, that in turn is covered with leather, which is ¾ in. to 1 in. larger in diameter than the foam. The pads offer a couple of advantages that aren't apparent until you use them. Since sandpaper attached to the leather "floats" above the surface you're sanding, no swirl marks or scratches are created and the abrasive action is very quick. The finish also seems smoother than you'd expect; 120-grit paper cuts like 150- or 180-grit. Sandpaper also seems to last longer, partially because the foam sanding pads exert an even, light pressure against the wood and thereby generate very little heat, which can lead to clogged paper and marred surfaces. I've seen other types of shopmade discs, as well as the commercially available pads, but the ones I've tried were too firm to conform to curved surfaces and left swirl marks where the outside of the disc touched the wood. The pads I designed put so little pressure on the edge of the disc that this area really doesn't do any cutting and it almost totally eliminates swirl marks.

I've also found that you can control the effect of the pad by using foam with varying degrees of firmness. I now use three different types. The firmest is Microcell, a closed-cell foam used in swimming pool bumpers and similar accessories. My other foam is called Charester and comes in two weights: 4 lb. (medium) and 2 lb. (soft). It is commonly used as packing material for electronic components, such as computers. Many firms throw foam away, so it's not too hard to find. You can also order small quantities from Polyplastics Inc., 10201 Metropolitan Drive, Austin, Tex. 78758; (512) 339-9293.

In addition to foam, the materials needed for the pads are some ½-in.-thick plywood discs of various diameters, some assorted hardware for mounting the discs in your drill, contact cement to hold the foam to the plywood and to cover the topside of the foam with leather, and some double-sided carpet tape to hold the sandpaper to the leather. I use medium-weight tooling leather from Tandy Leather, 1400 Everman Parkway, Ft. Worth, Tex. 76140; (817) 551-9770. Don't use chrome-tanned leather; the carpet tape adheres too well and will tear the leather when you try to change sandpaper.

Making the pads—The pads are very simple. Use T-nuts to mount a ¼-in. by 2¾-in. machine bolt in the center of a plywood disc. I use discs that range from 1 in. to 5 in. in diameter. True up the disc by chucking the bolt in a power drill and running the plywood edge against a disc or belt sander. The T-nut projects above the surface of the plywood slightly, so put a 5⁄16-in. washer under the nut on the bottom of the disc. I use contact cement to attach the foam to the top of the disc, and then true up the foam the same as the plywood. The foam can be used flat, or be made slightly convex or peaked like a roof. The convex and roof-peak shapes are especially handy because the elevated center sections make the foam edges less likely to contact and scratch the turning.

After shaping the foam, attach the leather, smooth-side out. The leather can be a single sheet or two pieces butt-joined together. You can also cut sandpaper from a single sheet or split a sanding disc from the center out and lap one edge over the other. Of course, the overlapping edge should be trailing as the disc rotates; otherwise, it will fold back and peel off. The lapped edge will not affect sanding at all. After attaching the paper with the double-faced tape, trim the paper close to the leather. If you leave it projecting and bump into an edge, it will rip and the work will be scratched.

Foam pads can also be glued to old sandpaper discs and used with the Power Lock mandrel (available from Merit Abrasive Products, 201 W. Manville, Compton, Cal. 90224; 213-639-4242). Discs simply snap onto the mandrel, which makes changing them very fast and easy.

Using sanding pads—Once you have a selection of discs, chuck one in a regular or angled drill or a flexible shaft, and go to work. Generally, I start with a medium-size pad faced with 100-grit floor-sanding paper, sold by equipment rental dealers. This combination removes tool marks without excessively sanding down the softer earlywood sections, yet is flexible enough to conform to contours. Next I use a firm pad, to ensure that both the hard and soft areas of the turning will be sanded at the same rate, with 120-, 220- and 320-grit paper. Soft pads are used with 400- and finer-grit paper.

Also, don't forget to wear a dust mask. I use an army surplus gas mask to keep dust out of my lungs and eyes. Visitors are startled when they see it, but it is effective. □

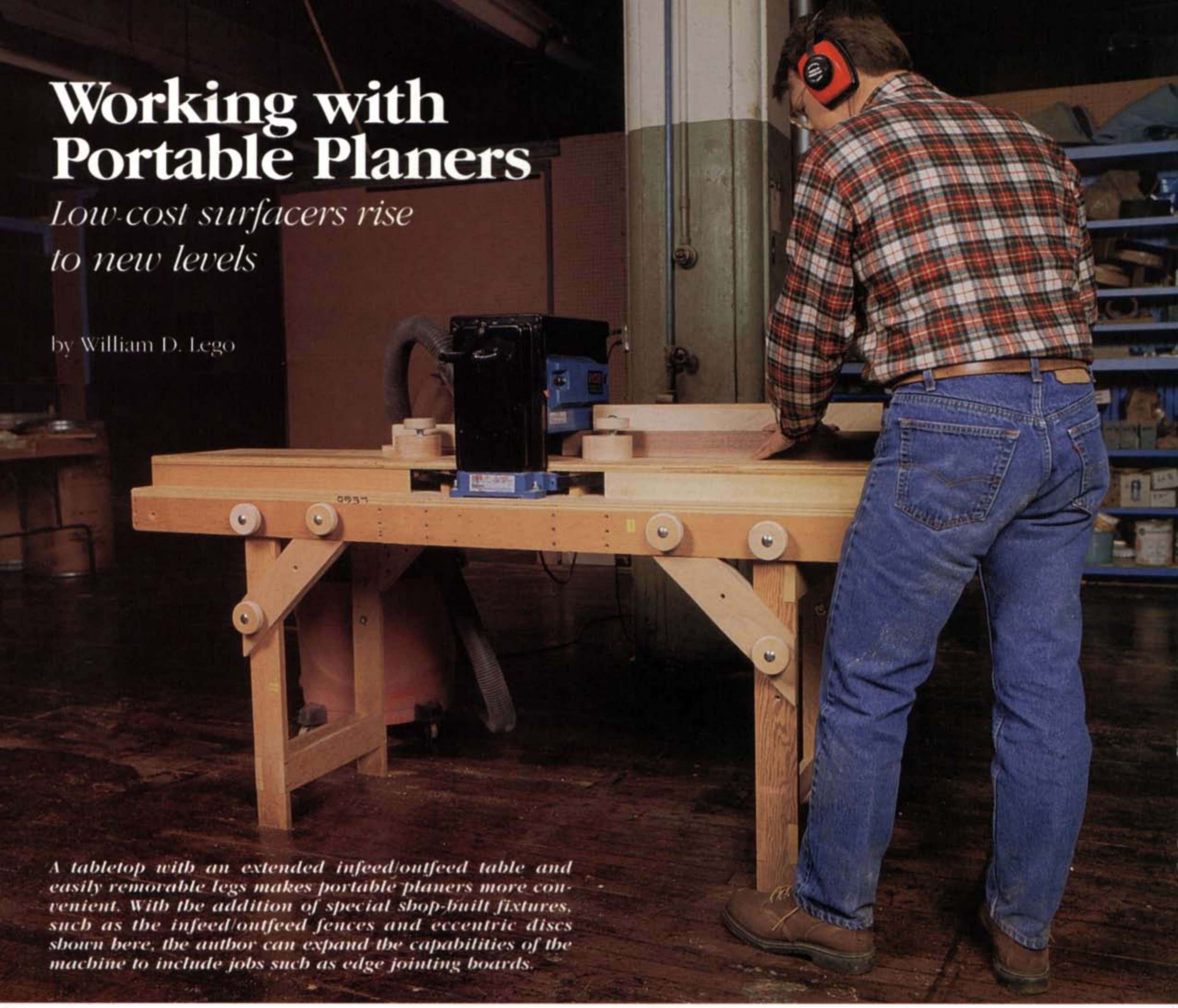
James R. Johnson is a woodturner in Bastrop, Tex.

Johnson uses a shopmade sanding pad chucked in an electric drill to finish a turned vessel without swirl marks. (Photo by author.)

Working with Portable Planers

Low-cost surfacers rise to new levels

by William D. Lego



A tabletop with an extended infeed/outfeed table and easily removable legs makes portable planers more convenient. With the addition of special shop-built fixtures, such as the infeed/outfeed fences and eccentric discs shown here, the author can expand the capabilities of the machine to include jobs such as edge jointing boards.

Several years ago, United Parcel Service brought a Ryobi AP-10 surface planer to my door, and my shop hasn't been the same since. This compact, portable machine can produce a nearly scraper-fine finish at a very affordable price. Since then, several other companies have begun marketing similar planers. They lack the stability and power of the large, stationary machines, but they can do a lot of high-quality work, especially if you build a few simple jigs. In this article, I'll describe planer setups I've developed for edge jointing boards, beveling stock and tapering table legs. These jigs evolved from one-time affairs cobbled from scraps into carefully constructed setups that can be quickly and easily installed, removed and conveniently stored.

Most of these small planers don't come with a base. After kneeling on the floor running test pieces through my new machine, I soon realized my first project would be to build a planer stand. Also, since the 19 in. of total support provided by the standard infeed and outfeed rollers was insufficient to eliminate the bounce at the end of long boards, which created a washboard surface on the stock, I decided to expand the stand into a 6-ft.-long box-beam table with support on both ends of the machine.

My first table sat atop two sawhorses and could be leaned against the wall for easy storage. Later, I added legs to the table (see the photo above). Because I did not want to eliminate the planer's portability features, I designed a table with light, yet strong legs that can be removed and stored within the framework of the tabletop, shown in the photo on p. 68. The whole stand can be made for $50 to $75.

Building the table—The basic box frame for the table is assembled with straight, clear Douglas fir 1x4 dimensional lumber and drywall screws. Even though this unit is durable enough to withstand the rigors of daily commercial use (I've been using mine for more than three years), I recommend using fir 2x4s, as shown in figure 1 on the facing page, for a table that will frequently be dragged in and out of a truck. The framework is made by fitting crossmembers into ¾-in.-deep dadoes and rabbets in the front and rear rails. The box frame is then covered with a ¾-in. birch-veneer plywood tabletop. Make sure the frame is flat and well supported on the floor or a bench before screwing on the plywood, otherwise you may build a permanent bow into the table. Next, I centered and bolted the planer to the plywood top. Poplar strips, screwed to the tabletop, support the ¾-in. birch-veneer plywood infeed/outfeed table at the exact height of the planer bed, as shown

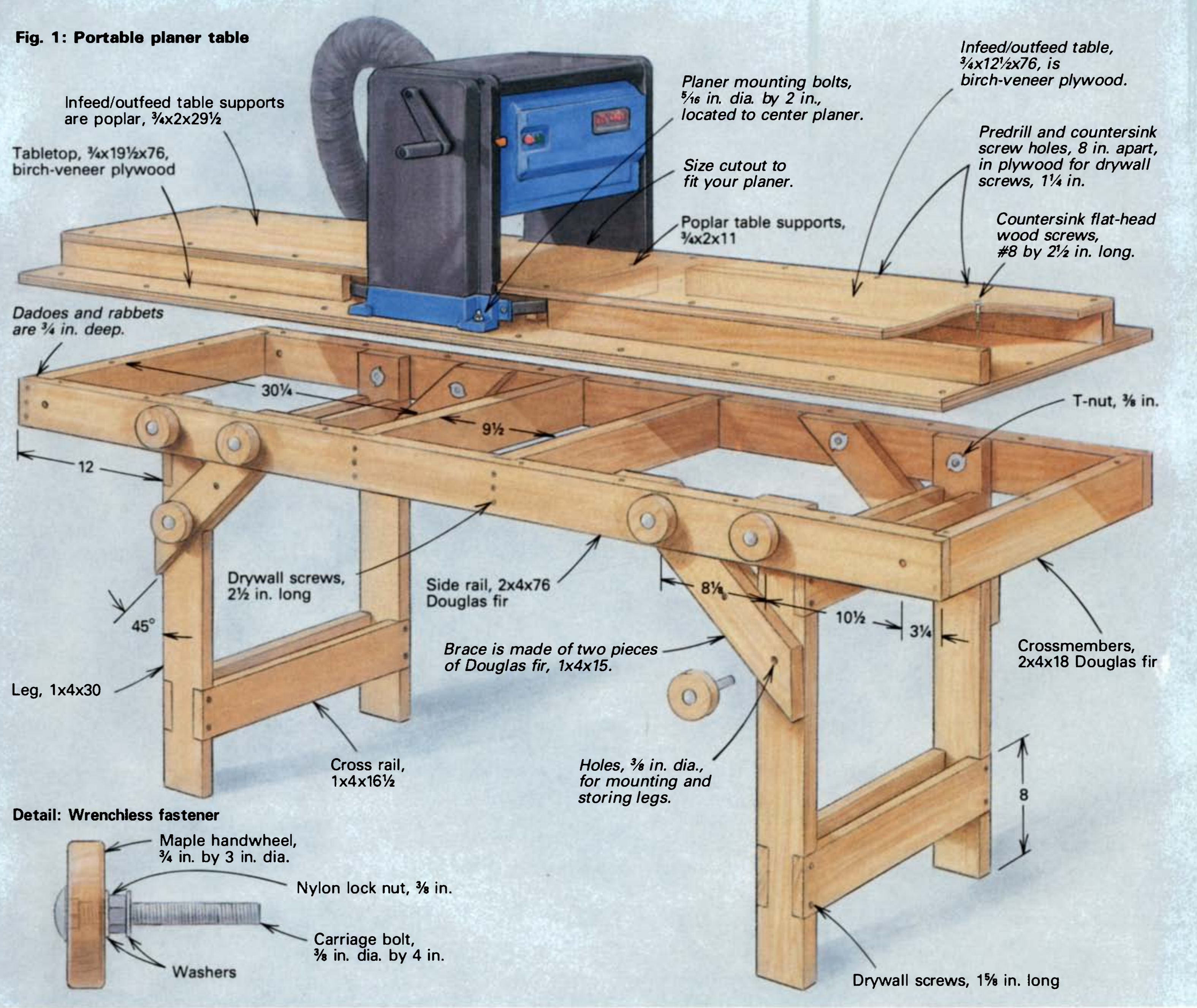


Fig. 1: Portable planer table

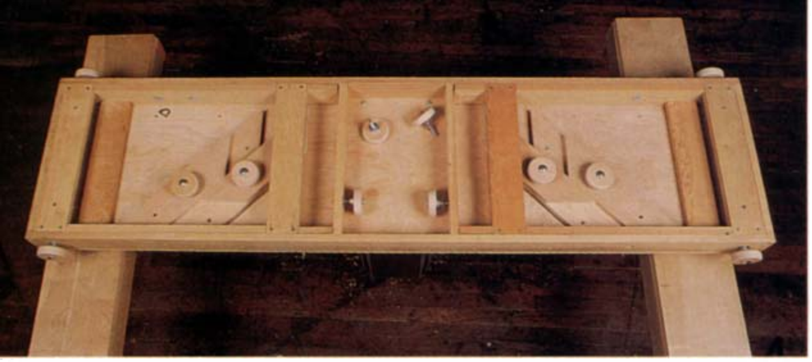
in figure 1. To install the infeed/outfeed table, set the planer to its maximum thickness of cut, and then feed the table diagonally through the planer until it can be laid flat on the bed of the planer and screwed to the support strips fastened to the main table. Although the infeed/outfeed table reduces the planer's depth of cut by ¾ in., it provides a long, smooth, sturdy support for stock being run through the machine.

The leg assemblies of 1x4 fir, shown in figure 1, are also box-beam-type construction for strength and lightness. These legs are bolted to the table frame and braced at each end by a pair of leg supports, positioned at 45° angles to virtually eliminate any wobble. When the table needs to be moved, the legs unbolt and store inside the table frame.

To make changing the legs and attaching the jigs even easier, I developed wrenchless fasteners, shown in the detail in figure 1. These fasteners are simply ¾-in. maple handwheels secured to the end of a carriage bolt. The handwheels can be turned on a lathe or cut out with a 3-in. hole saw. To sand each handwheel after cutting, mount it on its ⅜-in.-dia. carriage bolt, chuck it in the drill press and run it against a belt sander. Once the table is assembled, you're ready to go to work.

Edge jointing on the planer—Since I don't have a jointer in my shop, I tried to true the edges of the stock by running the boards on edge through the Ryobi. This resulted in strips that were less than perfectly square: they looked like little parallelograms in cross section. I first tried screwing squared blocks to the infeed/outfeed table to hold the stock vertically, but this left my table looking like a pincushion. I eventually developed the setup shown in the photo on the facing page. The jig uses round eccentric discs that adjust to hold stock between ¼ in. and 1¼ in. thick (up to 4⅜ in. wide) on edge as it is fed through the planer. These discs hold the stock against fixed fences secured to the planer's infeed/outfeed table with wrenchless fasteners. As you can see in figure 2 on the following page, the infeed fence consists of a faceplate screwed at 90° to a baseplate and reinforced with five braces. A wear plate, attached to the front of the faceplate provides a renewable working surface. I used ¾-in. lumbercore, birch-veneer plywood, although straight maple or other hardwood will do. Begin making the infeed fence by fastening the faceplate to the baseplate with 1¼-in. drywall screws. Predrilling all the holes will help prevent splitting and ensure that the screws are fully countersunk. The 90° braces are held in place with two screws through the baseplate and one

Drawings: Bob La Pointe



A view of the underside of the planer stand shows how the detached legs fit within the framework of the table and are held in place by shopmade wrenchless fasteners and leg braces.

screw through the faceplate. Finish up the fence by attaching the wear plate with 1¼-in. drywall screws through the back of the faceplate. The outfeed fence is easily made by screwing a block of maple to a piece of ¾-in. lumbercore plywood and rounding the infeed corner to prevent the stock from hanging up. The eccentric discs, which must be carefully made to hold stock perpendicular to the planer bed, can be turned on the lathe or made with a drill press and belt sander. Drill a ⅜-in. hole in each disc, ½ in. off center, to create the eccentricity. I used wrenchless fasteners, built as previously described, and ¼-in. carriage bolts to hold the fences in place. For tighter clamping with the eccentric discs, I used ⅜-in. bolts in the fasteners.

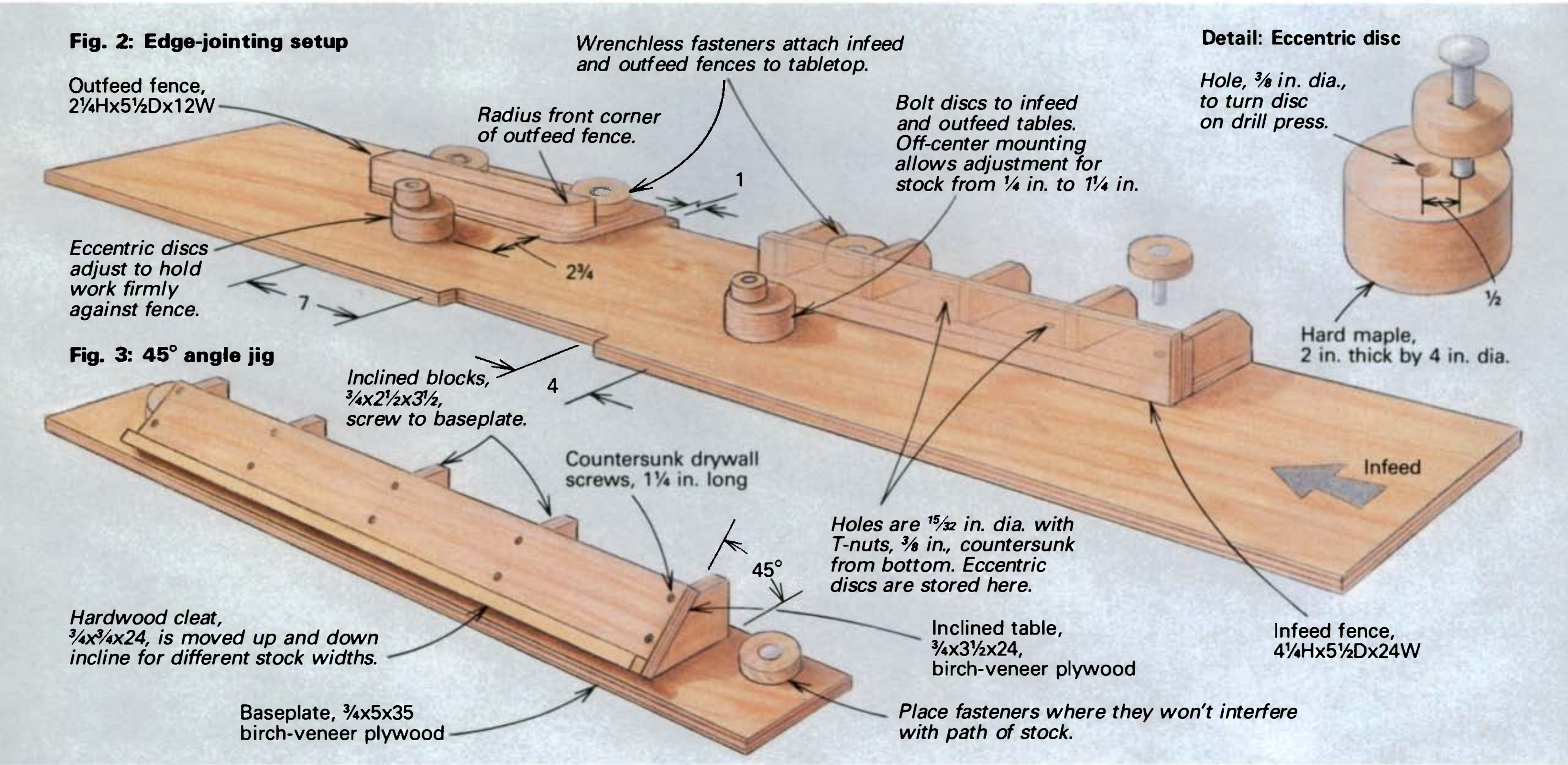
To install and operate the edge-jointing jig, mount the infeed and outfeed fences and the eccentric discs as shown in figure 2 below. Use a straightedge to align the front edges of the fences before tightening them in place on the table. To use the jig, place a piece of stock to be edge jointed against the infeed and outfeed fences. Now, rotate the eccentric discs until they just touch the stock and then back them off a few thousands of an inch until the stock just slides between the fences and the discs. If the discs are adjusted correctly and the stock has been planed to the same thickness, this setup will create a straight, square edge on your stock. Although my edge-jointing jig will only work on stock up to 4⅜ in. wide, I find it invaluable for dressing edges on face frames, door frames and drawer sides.

When not in use, the eccentric discs store on the back of the infeed fence, secured with wrenchless fasteners. I usually leave the fences in place on the infeed/outfeed table when thickness-planing stock up to 5 in. wide. However, to plane stock from 5 in. up to the full 10-in. capacity of the planer, I remove the fences.

Planing beveled edges—About the time I got my Ryobi AP-10, I was commissioned to make a walnut frame-and-panel bar with a 45° angle in the middle. To get clean, accurately cut edges, I decided to use the planer to bevel the stiles where they met at the 45° angle. This required making a jig similar to the one shown in figure 3 below, only I made this one as a temporary device with a 22½° angle. The jig consists of ¾-in. by 2½-in. hardwood cut at the desired angle to form inclined blocks that are screwed to a plywood baseplate. Another piece of plywood screwed to the blocks forms the inclined table for feeding the stock through the planer. A hardwood cleat, screwed to the inclined table, supports the bottom edge of the board being planed. The jig is held in position by fastening the baseplate to the infeed/outfeed table.

Additional jigs with inclined tables of 30°, 45° and 67½° were developed for different jobs, the only difference in each being the angle of the inclined blocks. Like the initial edge-jointing jig, the beveling jigs were screwed to the infeed/outfeed table, but they were so handy I made permanent fixtures. In addition to being sturdier, the new jigs have baseplates dimensioned the same so a uniform mounting system incorporating T-nuts and wrenchless fasteners can be used. In use, the jigs are centered, front to back, under the planer on the infeed/outfeed table and held in place with wrenchless fasteners made with ¼-in.-dia. by 2½-in.-long carriage bolts. By varying the side-to-side position of the baseplates on the table, the wear on the planer blades is more evenly distributed; but make sure the wrenchless fasteners don't interfere with stock being fed through the jig.

The degree of accuracy used in cutting the inclined blocks will determine how precise the jigs will be. A power miter box or accurately adjusted radial-arm saw will yield good results, but test



the jigs before using them on a project. To test the 45° beveling jig, for example, cut four little pieces from scrapwood run through the jig, and fit them together like pieces of a pie. If they do indeed make half a pie, then the jig is right on. If not, adjust the jig by running a strip of iron-on plywood edgebanding tape along the bottom of the baseplate. The angle of cut can be either decreased or increased by adding the tape to the front or back edge of the baseplate. When fine-tuning your jigs, it is better to err on the side of a smaller angle because this ensures the visible outside of the assembly will show a tight joint.

Shortly after completing my new set of beveling jigs, I had the opportunity to put them to use. This time the project was a three-sided frame-and-panel desk with the sides coming together at a 135° angle, as described in the sidebar on the following page.

Another angle on planing–Tapering table legs usually calls for cutting the taper on a tablesaw or bandsaw and then handplaning and sanding to the final dimension. If I were an antique restorer, replacing a damaged leg or even making legs for a table or two, I would probably make them in the traditional manner. But for limited production runs, I saw the initial taper and run the legs through the planer with the jig shown in the photo at right. This method produces uniform surfaces that are ready for finish-sanding much quicker than hand methods.

The jig is made of two leaves of ¾-in. birch-veneer plywood hinged together at one end as shown in figure 4 below. The top leaf, reinforced by two hardwood strips, is held at the desired angle by sliding supports. I made up six of these supports to accommodate a variety of angles, but normally only use three of them at a time. They are held in place by ¼-20 hex bolts that run through slots in the bottom leaf into T-nuts in the support base. My jig handles legs up to 34 in. long by 2⅝ in. square, but can be easily modified for specific applications. Cut the blank a couple of inches long so any surfacer snipes at the ends can be cut away when the leg is trimmed to its finished length. The leg blank is held in place by ¼-in.- to ¾-in.-thick cleats screwed into the top leaf on both sides and top and bottom of the blank. Be sure these cleats hold the leg firmly, and place a shim under the untapered portion of the leg to prevent any movement that would alter the taper.

Cleaning up the sawn tapers is easy. Begin by using a square to draw a reference line around the top of the leg where the taper will end; I usually leave 5 in. of untapered stock at the top of my legs. After rough-sawing the taper to shape, position the leg blank on the top leaf and secure it with cleats and the wedge, as shown in figure 4. Set the jig to the desired angle and run it and the leg through the planer until the taper reaches the reference line. Turn the blank 90° and repeat this procedure for each side you want to taper.

In developing jigs, whether for the planer or other tools, I try to expand the utility of the particular tool; but I also focus on the design and safe use of these jigs. As a general guideline when developing your own jigs, protect your hands by keeping adjustments away from moving blades and bits; be sure metal parts don't interfere with cutting edges; mark blade paths if the jig will cover the obvious path of the blade; make guards and dust pickups an integral part of the device whenever possible; and use nuts with nylon anti-loosening inserts in the threads to prevent the nuts from vibrating loose. When first using a jig, try to anticipate any problems and be extra vigilant, ready to shut the tool down at the first sign of any problem. Check for loose bolts, nuts or screws during the shake-down period and then enjoy the convenience and accuracy that jigs can add to your shop. □

William Lego builds custom cabinets and furniture in Rockford, Ill.

Sources of supply

Grizzly Imports Inc., 1821 Valencia St., Bellingham, WA 98226; (800) 541-5537, (800) 523-4777.

Jet Equipment and Tools, Box 1477, Tacoma, WA 98401; (800) 243-8538.

Makita USA, 1450 Feehanville Drive, Mt. Prospect, IL 60056; (708) 297-3100.

Penn State Industries, 2850 Comly Road, Philadelphia, PA 19154; (800) 288-7297, (215) 676-7609.

Ryobi America Corp., 1424 Pearman Dairy Road, Anderson, SC 29625; (800) 323-4615.

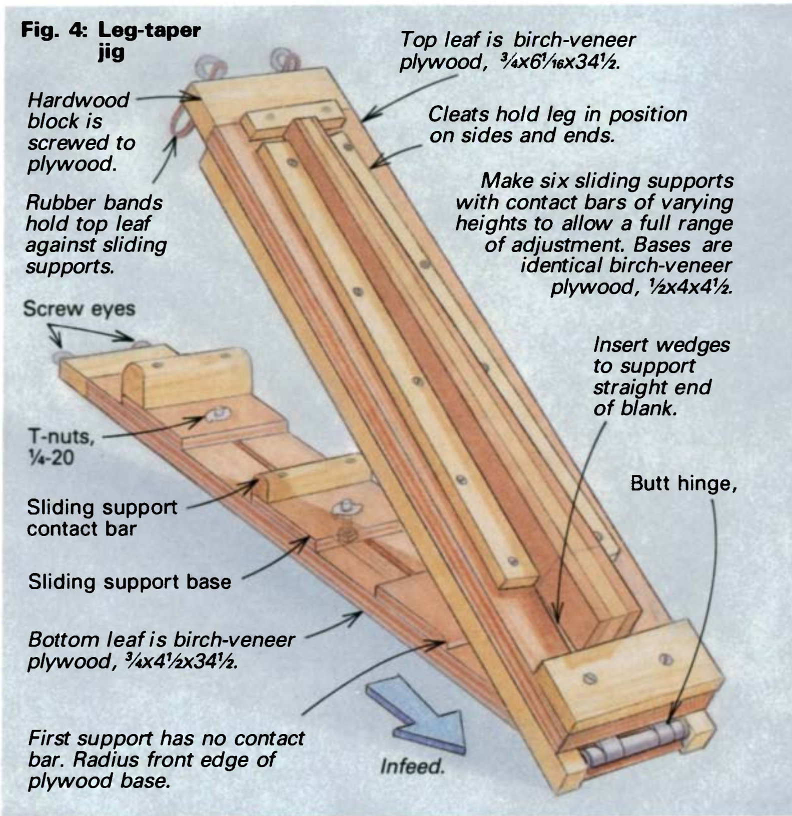
Sears Power Tools, 9390 Bunson Parkway, Louisville, KY 40220; (800) 366-3000.

Shopsmith, Inc., 3931 Image Drive, Dayton, OH 45414; (800) 543-7586.

Sunhill, 1000 Andover Park E., Seattle, WA 98188; (800) 544-1361.

Williams & Hussey, Box 1149, Wilton, NH 03086; (800) 258-1380, (603) 654-6828.

This birch-veneer plywood planer jig cleans up sawn tapers on legs more quickly and uniformly than handplaning, leaving a surface ready for final-sanding and finishing.



Custom furniture with a new angle

When working wood as a hobby, I enjoy traditional hand-crafting techniques, but to be competitive in a mass-production market, I'm quick to try new ideas and methods. When a new technique is shop proven, I blend it into our manufacturing process to produce projects like the three-sided desk, shown in the top photo at right. This system lets us execute bold designs and maintain the advantages of custom-designed furniture, while using sound construction techniques, but less labor-intensive methods, to produce an affordable product.

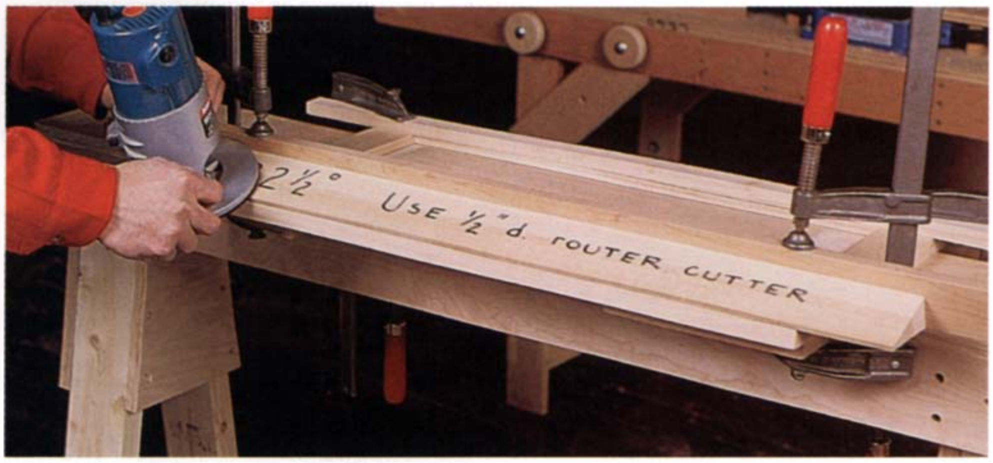
Simplified construction: By standardizing construction methods and using the jigs like those discussed on pp. 66-69, I can quickly assemble basic cabinet cases and still have time for special features like the angled joinery on the facade of the desk shown at right. My casework is all designed around a common theme: using the same basic joinery, as shown in figure 5 on the facing page. In joining these base cabinets, I've found that the gripping power of deep-threaded drywall screws into cross-grain, ¾-in. veneer-core plywood provides more than adequate stability without gluing the joints. Cabinets made this way can be assembled without worrying about clamps, curing time and the usual glue mess. I do glue and screw cabinets subjected to greater stress, such as wall-mounted cabinets or free-standing mobile base units.

Using this simplified casework method, however, doesn't give us license to be careless. Our shop follows three rules: screw through cleats into the face of plywood rather than into weaker endgrain; drill counterset shank holes for all through screws to avoid splitting the wood and for a more finished appearance; and make sure all joints and edges are cut and assembled square.

Joinery at an angle: The biggest advantage custom furniture has over its mass-produced competition is that it can be designed to fit any specific use. The wrap-around style of the desk shown above imparts a commanding feeling, provides the required storage and workspace, and yet does not overwhelm the room. The design is also consistent with a set of previously installed library bookcases over simple base cabinets with raised-panel doors.

Once conceived and designed, the desk was rather easy to build following our standard construction methods shown in figure 5. However, the angled joinery did present some challenges, especially since the desk had to be built so it could be disassembled for shipping and installation. The desk components are two base cabinets, three raised-panel facades, a keyboard drawer and the plastic laminated top.

Above: The desk and the telephone cabinet behind it were made using the same standardized construction methods for the carcase. A special router jig was used to bevel the angled joints on both units. Below: This router jig for beveling the edges of panels that are too large to be run through the planer was made using the Ryobi AP-10 portable planer and special shopmade planer jigs.

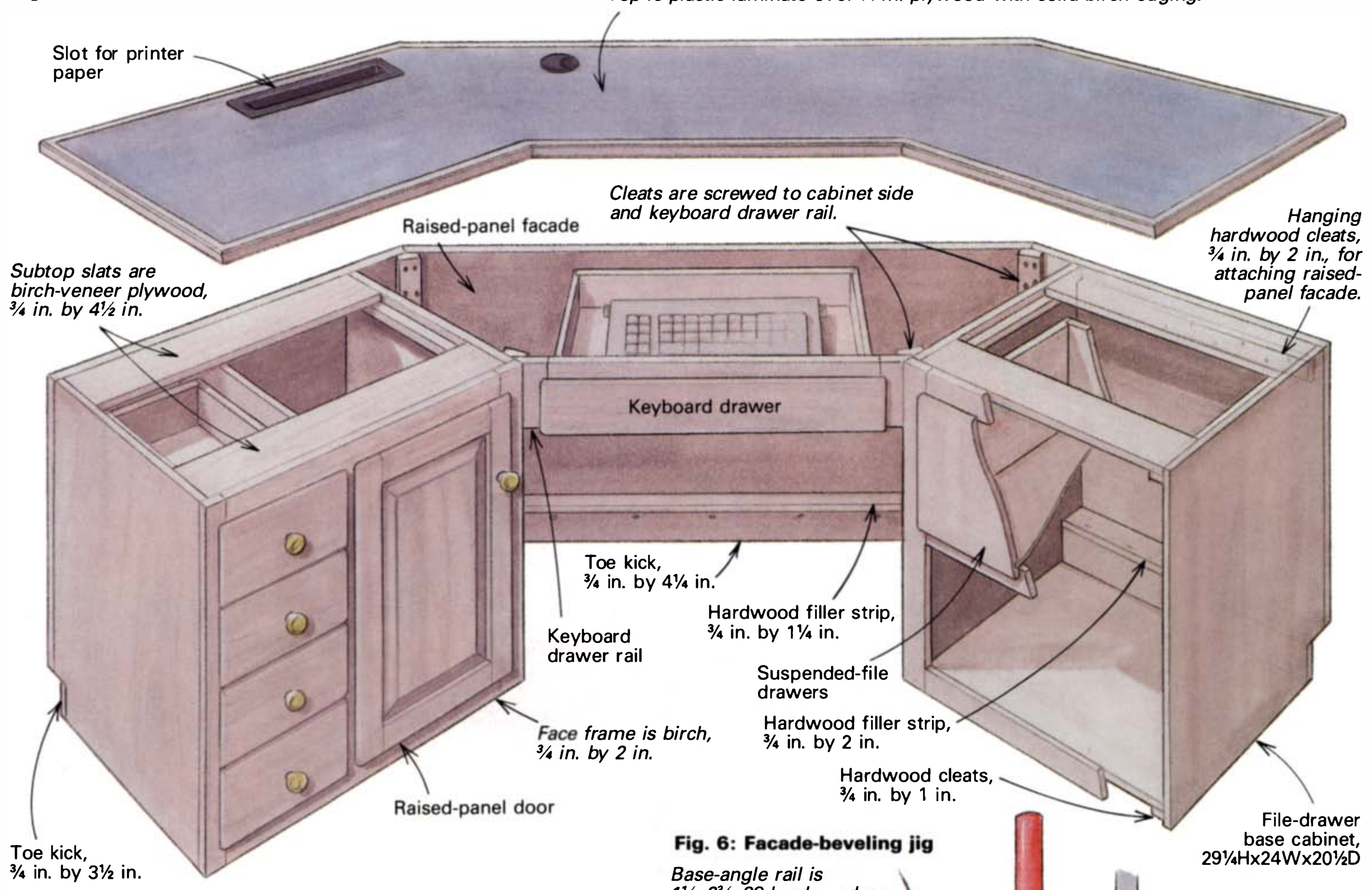


To ensure easy assembly, the three raised-panel sections of the facade had to fit together perfectly. To accomplish this, I made an angled cleat, shown in figure 5, on the planer with the 67½° beveling jig. The cleat is screwed to the back of the panel facades and forms a strong, accurate joint.

In making the angled walnut bar discussed in the main article, I found that the beveled stiles were easily damaged and required angled clamp pads when gluing up the frame-and-panel units. To minimize this complication, I opted for making my panel assemblies first and then putting the delicate bevels on the outside mating stiles. This involved an additional operation because the assembled panels were too large to run through my planer. Therefore, I used the shopmade router jig, shown in figure 6 on the facing page, to cut the bevels on the panel assemblies. Leave the base-angle rail oversize when making this jig. Then, before using the jig, run the router along the guide rail to cut an accurate alignment edge. After construction, I clamp the router jig in place on the panel assembly and run the router along the edge to accurately form the beveled edges, as shown in the bottom photo above.

The framework to which the keyboard glides are attached is suspended from the underside of the top after the top is installed. A shop-designed pivoting mount for the drawer front allows it to swing out of the way under the drawer for keyboard use. Angled cleats, similar to those for mounting the raised-panel facade, are used to install the keyboard drawer rail.

Fig. 5: Base-cabinet construction



Detail: Section view of cleat

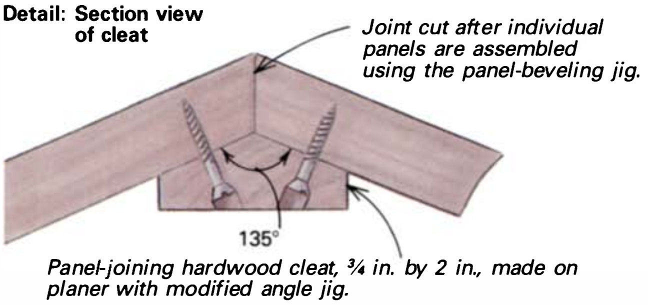
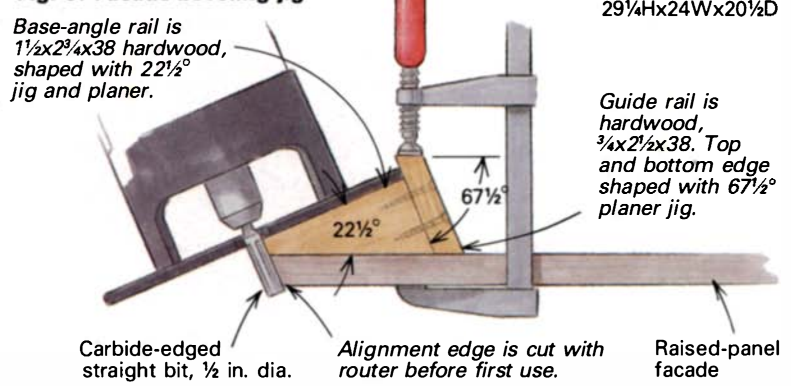


Fig. 6: Facade-beveling jig



Active features: Because my customers pay particular attention to the parts of my cabinets that move, open, swivel or glide, I always take extra effort to make sure features such as drawers and doors function properly. Mechanical drawer guides add convenience, install easily and, most importantly, operate smoothly. The Grass 6600 series drawer guides (available from Grass America, Inc., 1202 Highway 66 S., Kernersville, N.C. 27284) have a lock-when-extended stop and are epoxy coated to eliminate that metallic look. I hang all file drawers on over-extension glides rated for 150 lbs.; they work better than the lighter-duty guides and are worth the extra money.

I use lipped drawers and doors because their faces are larger than the openings and their rabbeted edges cover a little of the face frames. This makes them easier to adjust even if the cabinet, door or drawer is slightly off. Make sure the drawers stop on their mechanical guides and not on their lips against the face frame; this is particularly important for heavy file drawers. False drawer fronts are screwed on from the inside of the drawer; on larger file drawers, the top holes are elongated to allow for natural movement of the solid-wood drawer fronts.

The doors are hung with Youngdale self-closing hinges (available from The Source, 7305 Boudinot Drive, Springfield, Va. 22150; 703-644-5460) that are easily adjustable. One drawback to these hinges, however, is that they require the door stile be dadoed quite deeply to receive the hinge body. But with adequately wide stiles, 2⅛ in. wide seems to be minimum, and a dado head in the radial-arm saw, the hinge cuts can be made quite rapidly and accurately.

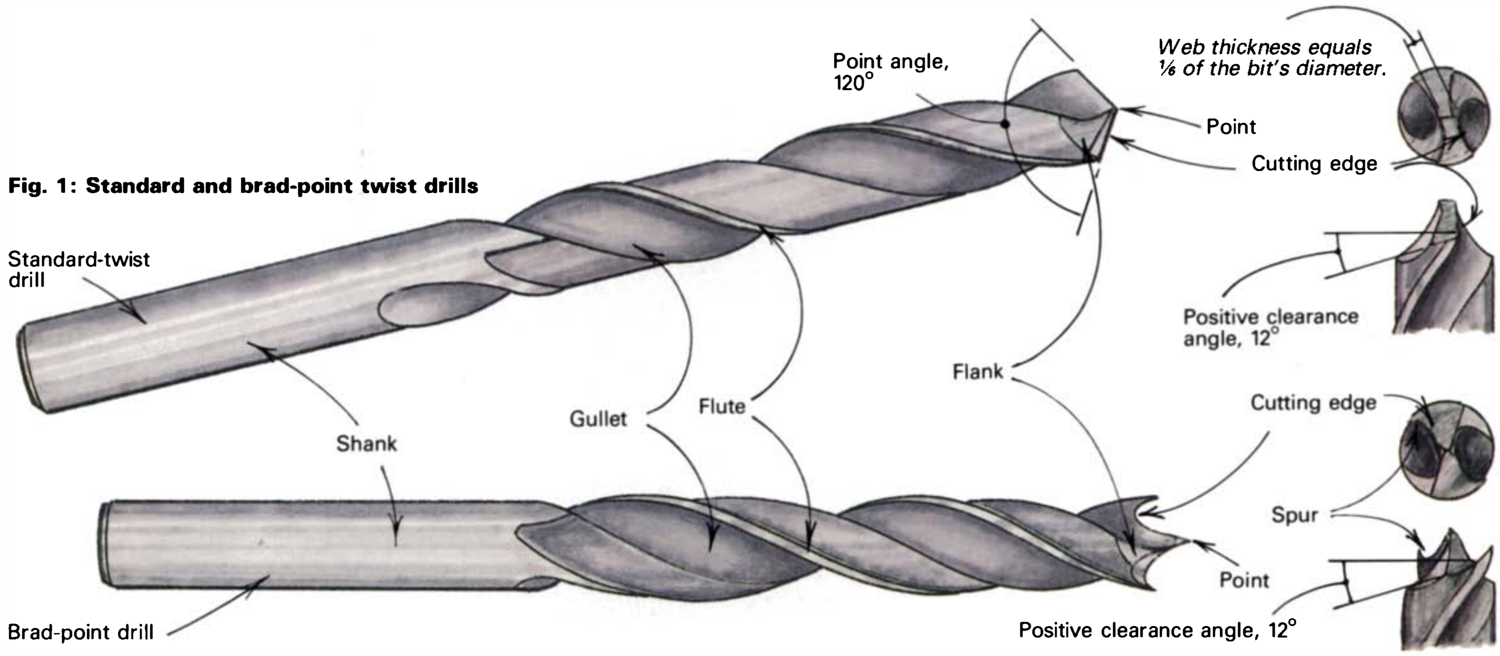
Attention to detail is especially important when making special-purpose cabinets and furniture. For example, with computer components, there must be adequate space provided for the units themselves, as well as wiring routes for power cords and component-to-component linkage. (For more on this, see *FWW* #77, pp. 32-37.) For the wiring holes and the printer's paper-feed slot, I use plastic grommets (available from The Woodworkers' Store, 21801 Industrial Blvd., Rogers, Minn. 55374-9514; 612-428-2899). They are inexpensive, come in a variety of colors and provide a finished look to the holes. —*W.L.*

Sharpening Twist Drills

Grinding standard and brad-point bits freehand

by Ken Donnell

Fig. 1: Standard and brad-point twist drills



My first lesson in woodworking came from my former scoutmaster, Merle Schelase. I've often visited his workshop and always received the same lesson: how to sharpen a scraper, handsaw, chisel and drill bit. Each visit, he showed me these same, seemingly simple procedures and I always learned new and useful information. Most of all, I learned that even the most dedicated woodworkers can spend a lifetime perfecting their tool-sharpening skills.

While most woodworkers wouldn't think of using a poorly sharpened knife or chisel, few pay equal attention to their drill bits. But a sharp bit is as valuable as a sharp paring chisel. Shaping standard twist bits is a fast and simple procedure. It's equally easy to convert twist bits to even more efficient brad-point drills by shaping them freehand on a bench grinder.

Both standard and brad-point twist drills, such as those in figure 1 above, are intended for high-speed drilling in portable electric drills or drill presses. Each bit has a center point, two cutting edges, continuous flutes that align the bit in the hole, and gullets between the flutes through which chips are cleared from the hole when drilling.

To understand the difference between standard and brad-point twist drills, let's look at how each bores a hole in wood. On any bit, the cutting edges pare with, across and against the grain as the bit is turned. On a standard bit, the outer corner of this edge cuts the hole's circumference and commonly tears the wood fibers when going against the grain, leaving a ragged edge and an oval hole. On the brad-point bit, the spurs score the circumference of the hole, eliminating fraying, and cut the hole round. The brad-point drill cuts wood more efficiently than a standard bit because its cutting angle is smaller and because its spurs shear the wood and create a smooth exit hole. And since a standard-drill-bit point is blunt, compared to a brad-point drill, it "walks" on the surface unless you punch the hole's center. Brad-point drills, because of their long, thin point, start and center easily.

My principal twist drill sharpening tools are a standard bench grinder, with a ¾-in.- to 1-in.-thick by 6-in.-dia., 60-grit Carborundum wheel, and two simple test gauges. A hand-held die grinder, such as a Dremel tool, a small cylindrical stone and a woodcarver's slip stone are useful, but not essential. Always wear safety glasses when using either the hand-held or bench grinder, and grind only on the front, outer circumference and corners of the wheel, not the side. Grinding on the side can wear the wheel, eventually causing disintegration and possible injury.

Sharpening standard twist drills—There are four fundamental criteria for sharp, efficient twist drills. First, the drill shank must be straight and the point centered. Second, both cutting edges must be at the same angle, generally 60°, so they both cut simultaneously. The two 60° edges create a 120° point angle on a standard bit. Third, there must be a positive clearance angle, about 12°, behind each cutting edge so only the cutting edges, not their flanks, contact the bottom of the hole. Finally, the web, or center of the drill between the flutes, shouldn't be thicker than one-sixth the bit's diameter, which it is at the point of a new drill. Maintaining this size web will decrease the pressure you need to apply when drilling and increase the bit's ability to clear chips from the hole.

Check for straightness by rolling each bit on a hard, flat surface, such as a drill press or saw table. Hold the shank on the flat surface and as you roll the bit, check the other end. If it wobbles and doesn't continually contact the test surface, the shank is bent. Although I've occasionally straightened bent drills by hammering them on an anvil, I usually throw them away.

Before grinding, be sure the wheel's cutting face is flat, square and free of grooves. Since drill-bit geometry is easier to see on a

Drawings: Bob Goodfellow

Grind standard twist drills by holding the cutting edge up so that it completely contacts the front of the wheel. Hold the shank down about 12° to relieve the back of the edge and create a positive clearance angle, which reduces the bit's friction when in use.

½-in. bit, practice holding a bit about that size against a stationary wheel on the bench grinder. As shown in the photo above, grip the middle of the bit between the thumb and first finger of the left hand and the shank with the thumb and first finger of the right hand. Hold the bit's cutting edge up, with the shank 60° to the left and down about 12°. This will maintain the point angle and clearance angle respectively. If you prefer, rest your hand on the grinder's tool rest, and with the grinder still turned off, practice bringing the bit against the wheel. As the cutting edge first touches the grinding wheel, use the left hand grip as a fulcrum to rock the cutting edge upward and the shank downward, keeping the bit in contact with the wheel. These hand motions first grind the cutting edge and then the flank, while simultaneously creating a positive clearance angle.

After a few practice runs with the grinder off, turn it on, and lightly bring the bit against the wheel, repeating the same motions you practiced with the grinder off. Grind each cutting edge with equal pressure and the same length of time, quenching the cutting edge with water to keep it cool. If the bit is only slightly dull, without nicks and gouges, one light pass on each edge and flank may be sufficient to sharpen it. If it's exceptionally dull, nicked and abused, several passes may be required.

To ensure the accuracy of your work, make a twist bit test gauge, such as those in figure 2 on the following page, for drills with a 120° point angle. Each cutting edge should be exactly parallel to the gauge blade when the flutes are held against the handle, as shown in the bottom, left photo. Check that the point is centered by turning the bit and observing the point in relation to the marks on the blade. If the point remains aligned with the same mark, it's centered. Now, check for sufficient clearance angle behind each cutting edge. With the bit's cutting edge against and aligned with the gauge blade, turn the bit; the flank should descend in relation to the marks on the handle so that space appears between the blade and the bit's flank. A flank with a 12° clearance angle will descend about ⅓₂ in. for each ⁵⁄₃₂-in. flank width. If you make any correc-

If the point angle on a standard twist drill is correct, both cutting edges will be parallel to the test gauge blade. The drill point is centered if it remains aligned with the same mark when the bit is turned. The marks on the handle of this gauge are missing (left). The web's thickness is maintained at one-sixth the bit's diameter to decrease the pressure necessary when drilling and increase the bit's ability to clear chips. To thin the web, hold the gullet on the wheel's right corner and angle the shank so metal is removed from the gullet, not from the cutting edge (center). A die grinder with a cone-shape stone is ideal for thinning the web. Hold the bit in one hand and use the other hand to steady the grinder as you move the stone into the gullet (right).

Left: Convert a standard bit into a brad point by holding its cutting edge level and centered on the wheel's right corner, with its shank to the right and dropped to create a clearance angle. Deeply grind each valley equally to create a pronounced center point and spurs long enough to cut an exit hole ahead of the valley's cutting edge. Right: If you don't make a right-angle gauge, use the marks on a try square blade to check that the brad point is centered. Reference marks on its handle help you to check that the spurs are recessed equally.

tions, such as point angle, recheck the other components and regrind, if necessary, until they're all correct.

Lastly, since the web tapers over the length of the flutes, from the shank to the point, it will become thicker after you've repeatedly resharpened a bit. If a bit has been excessively reground, grind equally in each gullet until web thickness is about one-sixth the bit's diameter. While grinding the web thinner, take care not to dull the cutting edges.

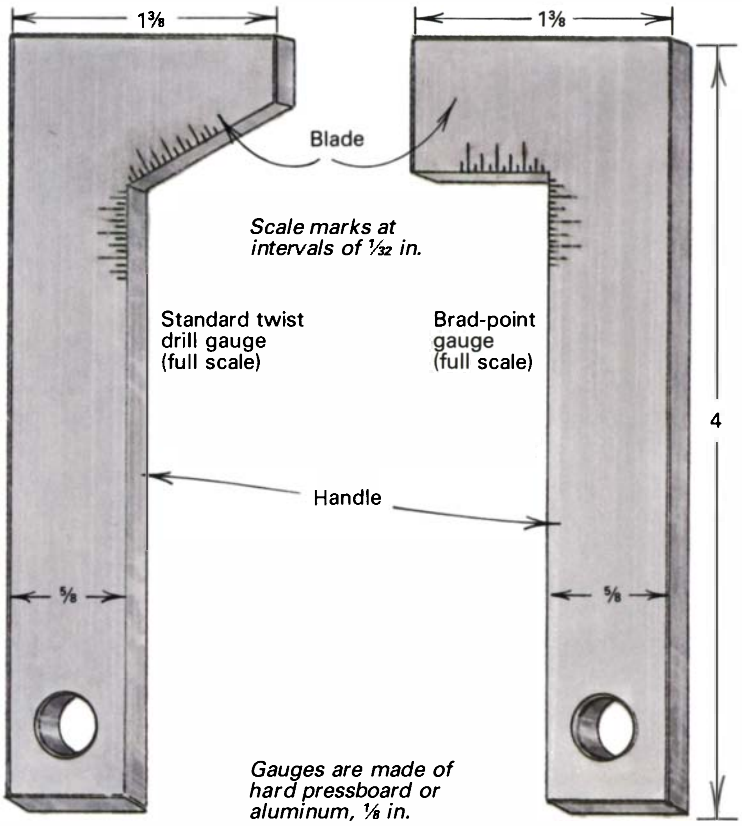
As shown in the bottom, center photo on the previous page, hold the bit with the shank downward so the gullet nestles over the right corner of the grinding wheel. Angle the shank so grinding occurs only in the gullet and not on the cutting edge. For larger-diameter bits, a die grinder with a small-diameter, cylindrical- or conical-shape cutting stone works well. While sitting, I hold the bit with one hand and the grinder with the other, as shown in the bottom, right photo on the previous page.

Converting to brad-point bits—While brad-point bits are available from most woodworking tool suppliers, you can easily convert a standard twist drill to a brad point, although the criteria for sharpness are slightly different than for standard drills. The point should be as long, thin and sharp as possible and in the exact center of the bit. The tips of the spurs should be recessed a little more than one-third the bit's diameter below the point, and located about where the outside corner of the cutting edge is in relation to the point on a standard drill. For example, when you hold the tip of a ⅜-in.-dia. brad-point bit against a try square blade, its spurs should be recessed ⅛ in. Both spurs should be recessed the same and contact the wood simultaneously when drilling perpendicular holes. Finally, as on all cutting tools, there should be a positive clearance angle so that in the valleys between the point and spurs, the actual cutting is done by the sharpened edges, rather than their flanks.

When grinding brad-point drills, most of the work is done on the corner of the grinding wheel. As shown in the left photo above, practice with a ½-in.-dia. standard twist drill, holding the cutting edge up so that it is level and centered on the right corner of the wheel. The shank should be about 60° to the right and dropped about 12° or more to create a positive clearance angle. Grind the valleys to equal depth, making them as deep as possible so the spurs will be long enough to cut an exit hole ahead of the cutting edges. Burrs on the cutting edges in the valleys are easily removed with a slip stone.

Naturally, the more rounded the corner of the wheel, the wider the valley it will grind. For smaller bits, use a crisply dressed or brand-new wheel. Likewise, when grinding a complete set of brad-point drills, start with the smallest bit and work toward the largest. Even with a new wheel, though, it's usually not possible to grind brad-point drills smaller than ⅛ in. in diameter.

Fig. 2: Test gauges



You can check the accuracy of brad-point drills with a gauge, like the one in figure 2 above, or a try square, as shown in the right photo above. First, check that the point is centered. Note its position in reference to a mark on the blade and rotate the bit against the handle to see that the point doesn't move. Then, check that the spurs are recessed equally. With the shank against the handle and the point against the blade, note the height of one spur in relation to the marks on the handle. Rotate the bit 180° and make sure the other spur is the same height. □

Ken Donnell is a professional woodworker who designs and manufactures tools in Grass Valley, Cal.

Managing a Rain Forest

A Peruvian experiment in sustained yield

by Scott Landis

Magazines and newspapers are filled with accounts of the rain forest in retreat. The cumulative effects of cattle ranching, slash-and-burn agriculture, timber mining, hydroelectric dams and overpopulation have rolled across the tropics and the media like wildfire. Notably absent in all these pages of print are any signs of progress.

Part of the problem, I think, is that people have been looking in the wrong direction, banking on grandiose schemes. In the Amazon at least, spectacular attempts almost always end in magnificent failure. Two of these examples are Henry Ford's defunct rubber-tree plantation, "Fordlandia," and shipping magnate Daniel K. Ludwig's "Jari," a billion-dollar pulpwood farm the size of Connecticut. Ludwig's and Ford's misadventures provide extravagant lessons in the futility of applying temperate-zone silvicultural practices to the tropics.

In the Palcazú Valley of central Peru, however, a small experiment in sustainable tropical-forest management is different from previous attempts. While most timber-management operations in the Amazon rely on plantations of a few non-native species, the Palcazú project is dedicated to retaining the diverse selection of regional species. And where most commercial woodcutting operations are in the hands of large companies, this project is managed by the Yanesha Forestry Cooperative, made up of a small native group of Yanesha Indians. These people account for about half of the 6,500 residents of the Palcazú Valley. The rest are mainly expatriate European coffee farmers and cattle ranchers and their descendants, along with a small population of mestizo Peruvians. The valley's 12 Yanesha communities, which occupy only 40% of the land, control more than 60% of its best production forest. The fact that the Yanesha own the land they are harvesting and rely on it to support their traditional culture gives them a stake in its survival. What's more, tropical timber is usually cut on a one-shot basis, and initial results of the Palcazú project suggest that the co-op's methods are sustainable.

When I visited Peru in March of 1989, I found the Yanesha Forestry Cooperative tenaciously clinging to life, despite a distinctly hostile climate. Unlike Jari and Fordlandia, however, which ran afoul of the ecological realities of the tropical rain forest, the Yanesha cooperative is threatened more by Peru's economic and political crises than by the natural environment. In fact, the co-op's innovative approach to forest management sheds light on what is otherwise a very dark landscape. And it may have important implications for harvesters and users of tropical hardwoods around the world.

As many as 1,000 species of trees grow in central Peru's Palcazú Valley rain forest. The area's Yanesha Indians are experimenting with a forest-management system that they hope will bring a sustained yield of valuable lumber and wood by-products.

The strip shelterbelt system—The centerpiece of the Yanesha project is the strip shelterbelt system, which involves clear-cutting and removing all trees and woody plants within a narrow strip of forest. These strips range from 20 yds. to 50 yds. wide and are designed to simulate the natural gap created when a mature tree is blown down. The artificial openings in the canopy are wide enough to permit sunlight to stimulate the regeneration of many fast-growing, light-loving native species, yet they are narrow enough for unassisted, natural reseeding from the surrounding forest on either side (shown in the left photo on the next page). The effects of erosion and the disruption of animal habitat are minimized by the small size of the strips, which are more efficiently harvested with teams of oxen than with heavy skidders. Oxen are less expensive and more easily maintained in the Palcazú Valley—where a gallon of gasoline costs $2, or about as much as a co-op bush worker makes in a day—and their impact on the soil is much more benign.

The strip shelterbelt system was promoted by ecologists Gary

Left: The strip shelterbelt system involves clear-cutting and removing all trees and woody plants from narrow lands of forest to simulate the clearing created when a mature tree falls. The three-month-old regrowth shown was possible because of sunlight penetration and natural reseeding from the nearby forest. Right: The small strips are efficiently harvested with teams of oxen, which are less expensive and more easily maintained than heavy skidders that may heavily damage the ecosystem.

Hartshorn and Joseph Tosi and their colleagues at the Tropical Science Center (TSC) in Costa Rica. Commissioned in 1981 by the United States Agency for International Development (USAID) to devise a management scheme for the project, the TSC was unwilling to accept conventional wisdom, which considered the tropical rain forest unmanageable.

Hartshorn discovered that the Yanesha are "superb woodsmen." They not only know the forest plants and trees, they intuitively "capture the underlying ecology" behind the strip shelterbelt system. What's more, their traditional communal society made them more receptive to the cooperative structure than their European counterparts. The result is the first indigenous forestry co-op in tropical America, and perhaps the only one in the world dedicated to natural forest management.

The Palcazú Valley is a true tropical environment. Rain falls year-round, but it is torrential in the summer (November to March), and regularly interrupts work and transportation. The valley is less than 150 miles from Lima and the arid Pacific coast, but has a median temperature of 77°F and receives nearly 20 ft. of rainfall a year. I visited the co-op near the end of the wet season, and witnessed the speed with which rains pass through the highly erodible, acid soil. After an intense predawn thunderstorm on the first morning, my party crossed the roiling, coffee-color Iscozacin River, which flows into the Palcazú River and eventually joins the Amazon. Guides maneuvered the motorized dugout canoe around standing waves several feet high and entire trees swept downstream in the maelstrom. When we crossed the river later that afternoon, it had dropped more than 6 ft. since the morning flood stage and was a relatively placid current.

At the landing on the other shore, we piled into the back of the co-op's battered, four-wheel-drive Toyota pickup for a 40-minute, bone-crunching ride to the project site. The truck forded a creek and wallowed above its axles through rocky mud holes. Along the way, we passed a number of small homesteads, where the Yanesha raise coffee, citrus and tropical sheep, perhaps a cow or some chickens, and more traditional crops like cassava, upland rice and yucca.

Preserving the diversity–The combination of perpetual rain and heat results in what one of our guides called a "pandemonium of growth." The mature rain forest I saw is crawling with highly adapted and predatory plant and insect life. Very little sunlight penetrates the canopy, so the understory remains relatively free of small trees. There are an estimated 1,000 species of trees in the Palcazú Valley, perhaps as many as 200 in a single hectare (roughly 2½ acres) of its wettest lowlands. Compare this diversity to that of a hectare of rich Appalachian forest in the U.S., which has no more than 25 different tree species. At least 10% of the Palcazú species are still unidentified and the working properties of many of their woods are unknown.

We began our tour by visiting two production strips. On the first strip, which was 30 yds. wide by 100 yds. long, cutting had begun in 1988, when the smallest trees were harvested as utility posts. The last of the large sawlogs were removed and the strip was cut clean only three months before my visit. Significant new growth already had sprouted from stumps and airborne seeds.

At a second strip, well away from the first one, only the smaller trees and lianas, the woody vines that wrap themselves around the trunks and tie the canopy together, had been cut. By cutting the lianas first and allowing them to decompose, they are less likely to interfere with felling the larger timber. A ganglion of lianas is capable of holding a mature tree upright after its trunk has been severed, making it necessary to drop several trees at once.

Hartshorn and other co-op advisers estimate a regeneration cycle of 30 to 40 years, which is one-half to one-third as long as in most managed temperate-zone forests. The project plan calls for cutting several strips per year, with new strips located at least 100 yds. from others recently cut. Limited thinning or selective planting may be used to augment the natural succession.

Although it will take at least one or two cycles to fully evaluate the strip shelterbelt system, the initial results are impressive. Two test strips were studied in April 1988, when one was 2½ years old and the other 2 years old. In the first strip, 20 yds. by 75 yds., 209 tree species were identified–almost three times the number originally harvested. In the second strip, 50 yds. by 100 yds., there were 285 different species. In both strips, the crown was completely closed by the second year, indicating successful regeneration.

For more information

The following organizations promote sustainable development of the tropical rain forest.

Friends of the Earth, 218 D St. S.E., Washington, DC 20003; (202) 544-2600.

Fundación Peruana para la Conservación de la Naturaleza (FPCN), Chinchón 858/A, San Isidro, Aptdo. 18-1393, Lima, Peru; 422 796.

The Nature Conservancy, 1815 N. Lynn St., Arlington, VA 22209; (703) 841-5300.

Tropical Science Center, Apartado 8-3870, San Jose 1000, Costa Rica.

Woodworkers Against Rainforest Destruction (WARD), 20 Stearns Court, Northampton, MA 01060; (413) 586-6126.

Woodworkers Alliance for Rainforest Protection (WARP), c/o Scott Landis, Hundred Acres Road, Newtown, CT 06470.

World Wildlife Fund, 1250 24th St. N.W., Washington, DC 20037; (202) 293-4800.

Besides producing lumber in its sawmill, the Yanesha Forestry Cooperative also treats posts and railroad ties in a pressurized-post-preserving facility. Small and crooked parts end up in the co-op's charcoal kiln.

High-yielding strips—Wood is processed in the co-op's facility, shown in the photo above, which includes a sawmill, a pressurized post-preservation plant and a charcoal kiln. All logs greater than 12 in. in diameter are run through the sawmill. Smaller logs, between 2 in. and 12 in. in diameter, are diverted to post production. And anything too small or gnarled to become a post or sawlog is turned into marketable charcoal.

The variety of hardwood timber is staggering. Perhaps to the valley's benefit, it is too wet to grow mahogany, rosewood or cedar, which probably would have been extracted long ago. But there are a host of other valuable, native species (see the chart on the next pages). In a small shop adjacent to the sawmill, co-op workers have begun to test wood properties and build simple furniture, which promises to bring a greater financial return out of each board.

Although I was most interested in sawlogs, lumber represents only about 40% of the co-op's total production. According to Michel Krones, the Argentinean forester who supervised the construction of the sawmill and preservation facility, "The goose with the golden egg is in posts." Without preservatives, the densest hardwoods might last four to five years in contact with the soil; in the tropics, softer hardwoods will rot in less than a year. But Krones estimates that when those same softer hardwoods are properly treated, they will last 10 to 15 years under the most extreme conditions in the valley, and much longer in the Andes or on Peru's arid coastal plain. The more valuable hardwoods will last even longer. And there is a ready market in the developing world for well-preserved fence posts, railroad ties, mining timbers and utility poles.

The key to the success of the strip shelterbelt system is using most of the wood in each strip. If demand for valuable hardwood was to cause the co-op to cut only a few of the most marketable species, the devastating slash-and-burn cycle would be inevitable. Similarly, if the understory is cleared of small timber to meet a sudden demand for posts, the diversity and natural succession of the forest will be destroyed. Properly harvested, the potential yield of the local rain forest has been estimated at 250 cu. yds. of wood per hectare. Compared with the more typical yield of 3 cu. yds. to 5 cu. yds. per hectare of average South American rain forest, the economic and environmental benefits of the strip shelterbelt management system are manifest.

Not out of the woods—So far, the co-op's success is encouraging, but many concerns must still be addressed. What are the long-term effects of removing the biomass? How many slow-growing species will be sacrificed by the proposed 30- to 40-year production cycle? Can the co-op establish markets for unknown species of hardwood lumber and guarantee a steady supply? What are the chances of duplicating the experiment in other communities? At the time of my visit, only 5 of the 12 Yanesha communities were co-op participants, with about 150 members and 27 active employees.

The fact that research and production are taking place simultaneously at the Yanesha co-op worries Howard Clark, a USAID consultant I spoke with in Lima. "That's the scary thing," Clark said. "You're supposed to do the research one day, and use the data the next." But he also acknowledged that "there is *no* appropriate technology. Everything that's been tried in the Amazon in the last two centuries has failed—so everything is research."

The co-op also faces economic and political pressure. In the towns surrounding the valley, commercial loggers hope to gain access to the timber. Peru is one of the poorest countries in Latin America and its inflation rate, which was 3,000% in 1988, makes it hard to buy and maintain co-op equipment. And just as the project was finally getting on its feet, the reported presence of Sendero Luminoso, the Shining Path guerrilla group, caused USAID to remove its advisers from the Palcazú in the fall of 1988 and reallocate remaining funds. As of this writing, the co-op is being kept afloat by the Fundación Peruana para la Conservación de la Naturaleza (FPCN), with funding from the General Service Foundation and the World Wildlife Fund.

As one observer in Lima explained, "es un periodo bastante critico"—a critical period not only for the co-op, but for all of Peru and its rain forest. And while Hartshorn admits that more information would be useful, he warns that "we don't have the time to sit around and wait 10 to 20 years for proper research to be done." If we wait that long, there may not be any rain forest left to study. □

Scott Landis is a writer in Newtown, Conn., and a founder of Woodworkers Alliance for Rainforest Protection (WARP). Photos by author.

Efforts to revalue tropical timber

Among many woodworkers, there is a growing sense of urgency and despair at the destruction of the rain forest and the dwindling supply of precious hardwoods. Some of these craftspeople are trying to become part of the solution, with proposals that range from stock-piling endangered species to boycotting tropical rain-forest timbers. Unfortunately, neither approach is likely to have more than a short-term effect, and both may hasten the destruction they seek to forestall. In fact, a successful boycott is probably the surest way to guarantee the forest's conversion to crop or ranch land. I think that unless Third-World countries can be convinced that their rain forests are worth more alive than dead, their governments will readily trade them for immediate survival needs. And who can blame them?

These issues trouble Californian John Shipstad, chairman of the Sonoma County Woodworker's Association (SCWA), who was looking for a more satisfying outlet than just donating to environmental groups. Shipstad found a receptive ear in John Curtis of The Luthier's Mercantile, a wood and tool retailer (Box 774, 412 Moore Lane, Healdsburg, Cal. 95448; 800-477-4437). After many negotiations and a trip by Curtis to Peru's Palcazú Valley, The Luthier's Mercantile organized the first export shipment of hardwoods from the Yanesha Forestry Cooperative. Wood samples and descriptions from this shipment are given in the chart on the next two pages.

It's a unique arrangement: Members of

SCWA and other interested organizations and individuals invested $1.50 per bd. ft. up front, against an estimated break-even cost of $1.91 per bd. ft. The Yanesha co-op is paid $1 per bd. ft. and the rest is absorbed by shipping, customs, container rental and travel costs. All participating woodworkers listed their first, second and third choice of woods, based on 19 samples they received. They'll pay the difference between their down payment and the actual cost when they pick up their order.

Approximately 7,300 bd. ft. of lumber was trucked across the Andes to Lima for transshipment by container to California. The co-op truck made three round-trips, each one a four-day ordeal over switchback, washed-out roads that puts years on any vehicle and takes them off the life expectancy of its driver. A 20-ft. container generally carries 10,000 bd. ft. of lumber, but the density and moisture content of the wood made a considerable dent in the weight of the first load. Curtis hopes that future loads will be dried in the valley before shipping.

Australian hardwoods: James Heusinger of Berea HardWoods (125 Jacqueline Drive, Berea, Ohio 44017; 216-243-4452) is working with Cockatoo Timbers of Australia to develop a line of exotic Australian hardwoods. Almost everything he gets is salvaged from other cutting operations and comes in several categories: readily available, regularly available (every eight months or so) and one-time only.

Heusinger rattled off an impressive list of write-offs, such as unworkably hard desert acacia, a batch of she oak that checked into pieces during shipment and some Tasmanian blackwood that was "so ugly and checked" he will be lucky to unload it. But there were pleasant surprises too. When slicing open an unspectacular log of blackheart dorrel, Heusinger struck a vein of multicolor heart stain that develops striking flame-shape fingers in the sides of a turned bowl.

The efforts of individuals: Not long ago, furnituremaker Silas Kopf organized a group called Woodworkers Against Rainforest Destruction (WARD) (see p. 76 for address) to deal with the economic and ecological issues of the rain forest. Kopf admits that custom woodworkers make a very small dent in the worldwide consumption of tropical hardwoods. But he hopes that their example will pressure the rest of the industry to conduct itself more responsibly. WARD proposes that a flexible surtax be levied on any piece of furniture that uses tropical hardwoods and the proceeds go to support sustainable timber-harvesting of the rain forest. As of this writing, Kopf and WARD have joined forces with a more broad-based organization, the Woodworkers Alliance for Rainforest Protection (WARP), which is planning a conference for this fall. *—S.L.*

Little-Known Exotics from Peru	**Description/Working Properties**
	**Almendro, *Caryocar glabrum*:** Attains height of 170 ft. with straight-bole diameters of 5 ft. to 7 ft.; free of branches for 60 ft. to 70 ft. Interlocked grain with a ribbon figure. Heartwood is honey color; sapwood is white. Resistant to rot and marine borers. Moderately abundant. Moderately difficult to saw; fair re-
	**Cachimbo, *Cariniana* sp.:** Attains height of 150 ft. with trunk up to 30 in. in diameter; free of branches to 70 ft. Grain is roey with a fine texture. Heartwood and sapwood are indistinguishable when dry and can be yellowish-, pinkish- or reddish-brown with purple tinge and dark streaks. It is easy to saw, plane, turn
	**Chontaquiro Amarillo, *Diplotropis martiusii:*** Attains height of 120 ft. with straight trunk of 30 in. or more in diameter; may be free of branches to 70 ft. Texture is coarse with yellowish sapwood and light- to dark-brown heartwood, which is very resistant to rot. Trees are relatively abundant. Works well with
	**Marupá, *Simarouba amara:*** Attains height of 140 ft. with a straight trunk up to 36 in. in diameter; may be free of branches to 90 ft. Wood is straight grained and has a uniform texture. Sapwood and heartwood are indistinguishable and become yellowish-white when exposed. Somewhat susceptible to some rots
	**Quinilla Colorada, *Manilkara bidentata:*** Reaches height of 100 ft. to 150 ft. and trunk diameters of 2 ft. to 4 ft. Boles are clear and straight to 60 ft. Wood is hard and heavy, grain is usually straight with occasional waviness; texture is fine. Heartwood is light- to dark-reddish-brown, but often not distinct from whit-
	**Requia, *Guarea* sp.:** Suggested as a mahogany substitute. Reaches height of 150 ft. with diameters to 4 ft.; free of branches to one-third its height. Its straight, interlocked grain produces a ribbon figure with a medium texture. Sapwood is yellowish and heartwood is pinkish-, brownish- to reddish-mahogany,
	**Tornillo, *Cedrelinga catenaeformis:*** Attains height of 150 ft. with straight, well-formed trunk over 4 ft. in diameter; free of branches for 80 ft. Wood is straight grained to roey with occasional wavy grain. Sapwood is off-white and heartwood is pink to golden brown. Texture is medium to coarse. It is fairly durable.
	**Turupay, *Clarisia racemosa:*** Attains height of 130 ft. with well-formed trunks to 40 in. in diameter; free of branches to 60 ft. Grain is usually interlocked, producing a ribbon figure on the radial surface. It has a medium texture. Heartwood is pale to bright yellow and remains golden on exposure. Sapwood is

Notes:

Wood samples provided by John Curtis, The Luthier's Mercantile.

Information compiled from data by Curtis and *Tropical Timbers of the World,* Martin Chudnoff, Forest Products Laboratory, USDA Forest Service, Box 5130, Madison, Wisc. 53705.

[1] Stability is the sum of percent radial and percent tangential dimensional changes. Small is less than 3.0%, medium is 3.0% to 4.5%, and large is over 4.5%.

[2] Compression parallel to the grain, in psi.

* No information available.

† Strength at 12% MC

Description/Working Properties (cont.)	Specific Gravity	Weight, lbs./cu. ft. at 12% MC	Tangential Shrinkage, % green to dry	Stability or Movement When in Use[1]	Bending Modulus of Rupture, psi†	Modulus of Elasticity, 1,000 psi†	Maximum Crushing Strength[2]
sults from planing; sands smoothly and turns well. Used in boatbuilding, furniture, flooring and applications requiring wear resistance.	.67 to .80	50 to 58	8.0	Small	17,060	2,160	8,410
and bore; it sands well and takes a smooth, glossy finish. Some species have a high silica content and will dull tools. Used for construction, furniture, shipbuilding, flooring, veneering and turnery.	.50 to .70	31 to 43	5.4	Small	13,800	1,410	7,100
saws and edge tools, and sands to a fine finish; only fair turning results are reported. Used in construction, furniture, parquetry, cabinetry and interior finish.	.74	46	*	Small	*	*	*
and stains. Trees are fast growing and abundant. Wood is reported to saw easily. Planing results are excellent; it turns fairly well and sands well. Wood stains and finishes easily and glues well. Uses include interior construction, boxes, furniture, veneering, patternmaking, millwork and particleboard. Reported to be excellent for carving.	.30 to .45	19 to 28	5.0	Small	8,350	1,290	4,900
ish or pale-brown sapwood. Trees are widely distributed and highly frequent. Reported to be moderately difficult to saw and sand, but all other sharp-edge tool working properties are rated excellent. Gluing requires special care. Steam-bending properties are rated excellent. Uses include construction, turnery, boat frames, bent work, violin bows and billiard cues.	.90 to 1.20	56 to 75	9.4	*	29,200	3,520	13,300
which is very resistant to rot, fungus and insects. Its frequency is reported to be medium and it's widely distributed. Easily worked with all tools. It has a tendency to tear when bored. Uses include furniture, cabinetry, turned pieces, musical instruments, boat planking, veneering and millwork.	.46 to .57	34 to 44	7.0	Small	12,750	1,400	6,950
Behind eucalyptus, it's the second most frequently sawn wood and accounts for more than 14% of woods produced by Peruvian sawmills. Easy to saw, but leaves woolly surfaces. Planing requires sharp edges to produce smooth surfaces in interlocking or cross-grain pieces. Turns and bores easily. Uses include interior carpentry, furniture, turnery, carvings and drawer sides.	.41 to .60	25 to 38	*	Small	7,568	1,280	4,026
white. Trees are widely distributed in scattered clumps. Easily worked. Rated fair to good in all machining operations. Requires sharp tools to produce a smooth surface. Sawing often produces woolly surfaces. Uses in construction, flooring, furniture and millwork.	.50 to .65	31 to 40	6.1	Small	16,700	2,340	9,620


Tacho negro, *Terminalia* sp.*


Pashaco, *Albizzia* sp.*


Roble negro*

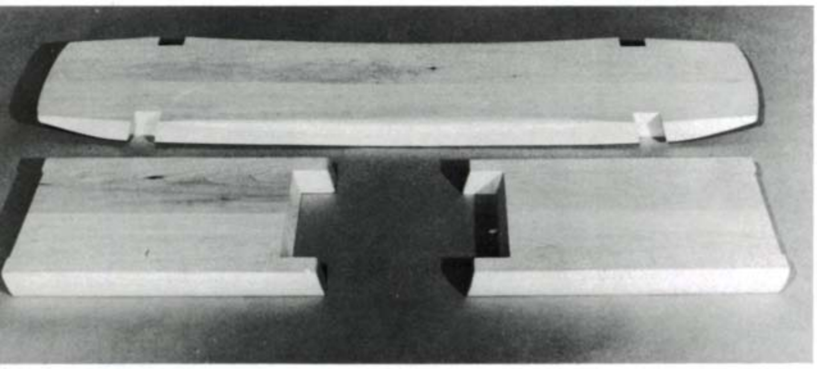
A Knock-Apart Bench

Joinery by sawing and reassembling a plank

by Stephen Sekerak

Originally designed as a simple project to help teach architecture students about woodworking, the author's knock-down bench is an attractive and simple-to-build project for any woodworker.

The knock-down bench is easy to disassemble and store flat. It's made from a single board that's sawn apart, cut into pieces that form sockets and horns that join the legs to the seat, and then glued back together.



I designed the knock-apart bench shown here as a simple project to help teach architecture students at the Technical University of Nova Scotia, Canada, about woodworking. Besides being an easy-to-build project, the bench is a practical piece of furniture: The two legs slide in and out of socket-style joints in the seat, so the bench can be knocked together or taken apart and stored flat in a closet. What's neat about the bench is that it's built entirely from a single plank, with the joints made by sawing the plank apart, cutting pieces to length and then gluing them back together (see the drawing on the facing page).

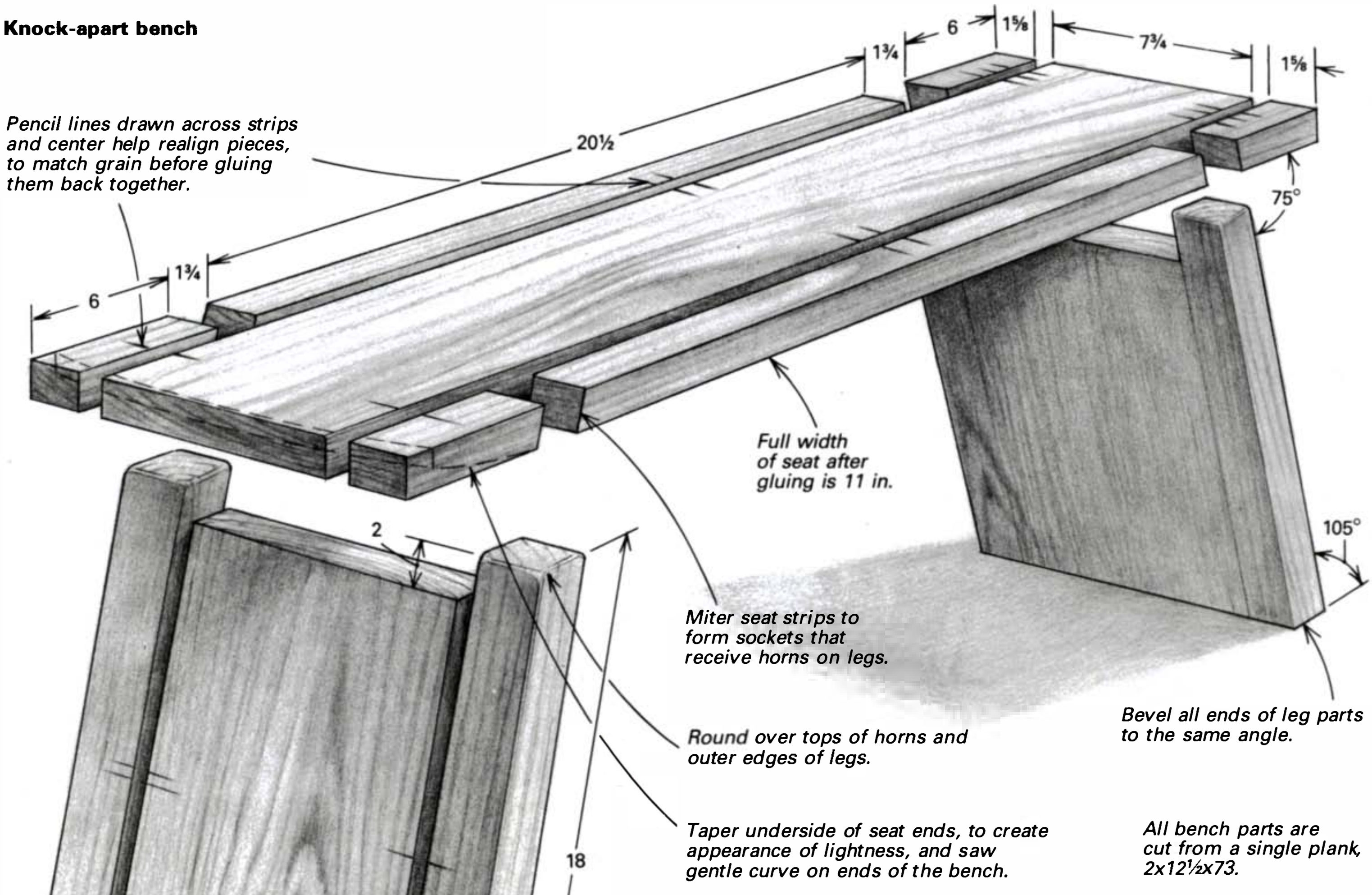
The machines I used to build the bench included a tablesaw, jointer, thickness planer and bandsaw, although you can substitute other machines, such as a scroll saw for sawing the curves. If you don't have any of these machines at your disposal, you can use hand tools. The project doesn't require much in the way of materials. I made the bench in the photo from elm, but any easily planed hardwood is suitable (most softwoods aren't strong enough for this joinery). The bench is a good project for beginning craftsmen who want to develop their machine and hand-tool skills. Even practiced furnituremakers, who need an extra seat around the house, may wish to tackle this project and brush up on some rudimentary skills.

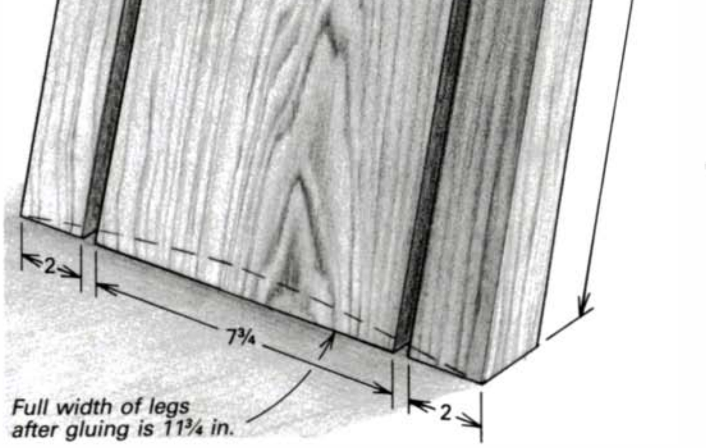
To build the 36-in.-long bench shown in the photos and drawing, start with a board that's approximately 2 in. thick by 12½ in. wide and about 73 in. long; you can make the bench longer or shorter, as you wish. By cutting all the parts from a single plank, the grain and color in the seat and legs will match. First, dress and dimension the stock by running it through the thickness planer until it's exactly 1¾ in. thick. Then, cut one edge square on the jointer and trim the plank on the tablesaw so that its edges are parallel. Clean up any resulting sawblade marks by taking a final light pass on the jointer.

Now comes the interesting part: Rip a 2-in.-wide strip off both edges of the plank. Just prior to ripping, reference these strips by marking a series of pencil lines across their faces and the center piece, so that these off-cut strips can be glued back in their original positions later. Next, temporarily reposition the pieces of plank, and then mark and crosscut the plank into three pieces: cut a section just over 18 in. long from each end for the legs, and square up the ends of the center section to make it 36 in. long.

The seat—Once again on the tablesaw, rerip the strips that belong to the center piece to 1⅝ in. wide, removing material from the outer edge of each strip. If you cut on the inner edge, you'll spoil the grain match. To create sockets on the edges of the seat, lay out a series of 75° miters and saw each strip into three pieces as shown in the drawing. These crosscuts, made with the miter gauge on the tablesaw, are angled so that the legs splay out when they're fitted

Knock-apart bench





in place. After lightly jointing the mating edges of the seat's center piece and the six strip pieces resulting from the crosscutting, glue the strip pieces back to their original positions. Take care to align them carefully, and measure the joint gaps so they are exactly 1¾ in., leaving slightly undersize slots where the legs will be fit. Check with a square to make sure that opposing pairs of strips are directly across from each other, and wax the inside faces of the slots before gluing. Take care that the strips don't shift when clamping pressure is applied; a little masking tape applied along the seams may help.

The legs—The ends of the leg strips, cut earlier, and centers can now be beveled and trimmed to length. First, tilt the tablesaw blade to 15°. Using the saw's miter gauge, trim the bottom end of all the leg pieces, making sure that the cuts across the leg center pieces and edge strips are made so the grain will match when the leg pieces are glued back together. Now, flip each piece end for end and bevel-cut the strips to 18 in. long and the centers to 16 in. long, measured along the top surface. Now you're ready to glue the leg strips and center pieces back together. Both strips will protrude 2 in. past the top of the center, forming the horns that join the legs to the seat. Wax the inner edges of the strips where they protrude beyond the tops to prevent glue from sticking and fouling the joint.

After scraping off excess glue from the surfaces of the legs and seat, plane the surfaces of the legs as needed until the horns fit snugly into their slots in the seat. You should hear a satisfying "thunk" when each leg is driven home with a mallet.

Shaping—There's no definite right or wrong way to do the final shaping of the legs and seat: It's up to your personal taste. I rounded over the tops of the leg horns, as well as the edges of the legs and seat and I sawed out shallow curves on the bottom edges of the legs, to add a look of lightness to the bench. Also, tapering and chamfering the bottom surfaces at the ends of the seat with a drawknife help achieve a feeling of lift and enhance the subtly curved seat ends. This taper doesn't have to be symmetrical across the width of the seat; I tapered the bench in the photo on the facing page to slant from one side of the piece to the other, for visual interest.

After shaping, sand the bench and, with the parts disassembled, finish it to your liking. Now you're ready to set the bench up to use as a seat or even as a narrow coffee table. Or perhaps you'll want to keep it in the closet, knocked down, until friends come over and you need an extra place to sit. □

Stephen Sekerak is a craftsman in residence at the School of Architecture at the Technical University of Nova Scotia in Canada. Photos by author.

Drawing: Kathleen Rushton/Bob La Pointe

Completing a Steel-String Guitar

Setting the neck for playability

by William "Grit" Laskin

Shown here on a finished guitar, the nut is fit into the space between the fingerboard and the headstock veneer. In addition to supporting the strings at the proper distance above the fingerboard for easy playing, sawkerfs on top of the nut keep the strings properly spaced. You can also see the white plastic fingerboard binding, which adds a clean look to the neck's edge.

The differences between a mediocre guitar and a great one are pretty subtle, but these details are an essential part of producing an instrument that plays well. Once the basic guitar has been built, as outlined in *FWW* #67 and *FWW* #69, you're ready to delve into these final steps to complete the steel-string guitar, including dovetailing and setting the neck, fretting, and making the nut, bridge and saddle. I'll also cover some of the underlying aspects of guitar construction that determine setup, action and playability. Even if you're not building a guitar but are rather an admirer or player, you should still read on, because the processes discussed here relate directly to enjoying the instrument. This article isn't meant to tell you everything about the last stages of building and fine-tuning a guitar, but to provide the last part of the overview started in *FWW* #67. For more information on details and processes that I don't cover, refer to any of the guitarmaking texts either cited later in this article or in the bibliography in *FWW* #67, p. 49.

The first step toward finishing the guitar is setting the neck. Starting with a rough-shaped neck blank with the heel block and peg-head veneer already glued on, we'll proceed with the following steps: sanding the end of the neck so it will butt to the body at the correct angle, routing the male dovetail on the neck and hand-shaping it to fit the female dovetail in the body. Then the neck can be shaped and the fingerboard prepared, fretted and glued on. After fine-tuning the neck's back bow, which is the backward angle of the neck needed to balance the tension of the strings, the neck is glued to the body.

Neck-setting begins by machining the neck's heel on a stationary belt sander to flatten the surface and create the proper angle between it and the guitar body. This angle is determined with a simple gauge cobbled together from a strip of wood and three small blocks, as shown in figure 1 on the facing page. You'll also need to draw a pencil line down the center of the neck and the body, for laterally aligning the neck.

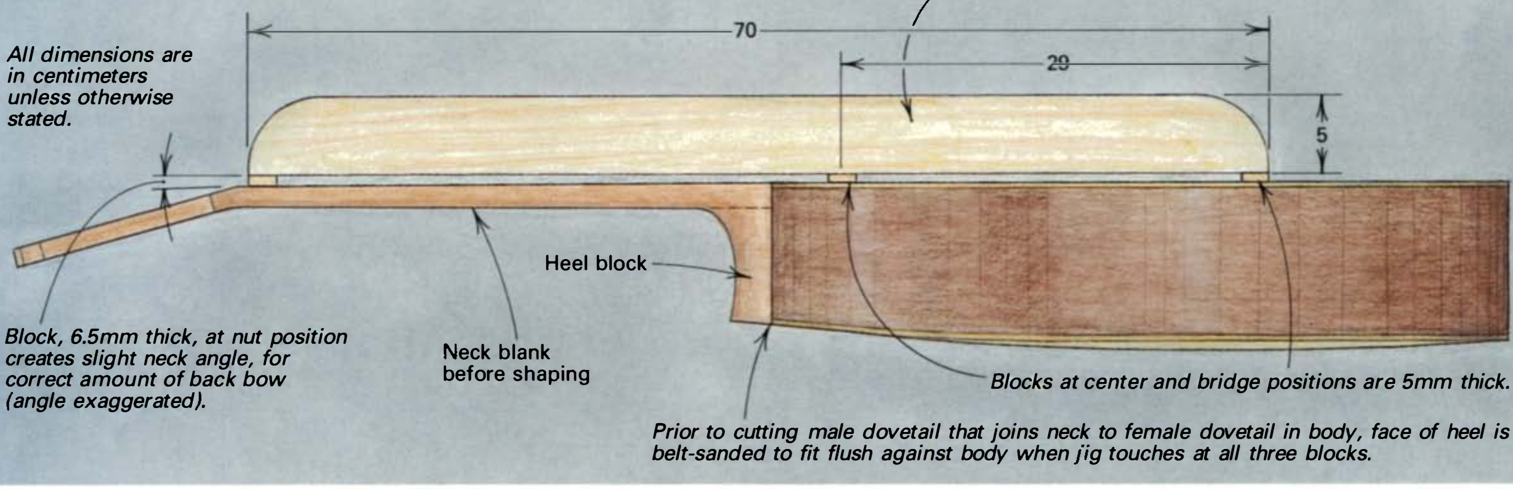
The heel face becomes the reference surface for routing the male dovetail, so sand carefully. Adjust the belt sander's fence to the desired angle (judge this by checking with the neck-angle gauge), and then sand a little and check again. The goal is to have all three gauge blocks touching the neck and top of the guitar with the neck butted up flat to the body. This positions the neck with the proper amount of back bow (more on this later). As you sand, lean the neck right or left as necessary, aligning the centerlines of both the neck and body. After sanding, use a square to mark a centerline down the face of the heel. This centerline is needed to align the template for routing the male dovetail.

In *FWW* #69, we routed the female dovetail into the guitar body using a standard ½-in. dovetail bit and a shopmade jig. We'll now use the same bit in the router table to cut the male dovetail to fit into the female dovetail. This time, a Plexiglas template rubbing against a ½-in.-OD bushing sticking up from the router table guides the cut, to ensure that the shape and taper of the male dovetail match the female exactly. Make the template by first laying a piece of Plexiglas over the female dovetail and tracing its outline. Extend the tapered outline at the top and bottom, and cut out the template. After centering it on the heel, you'll need to slide the template up to compensate for the diameter of the guide bushing (see figure 2 on the facing page). Then, screw it in place, countersinking the screw heads. In the photo at the bottom of the facing page, you can see joint-cutting in progress, with the guide bushing against the template (seen projecting beyond the heel). To steady the neck while routing, clamp it to a board that extends slightly beyond the heel to be flush with the template. With the bit set to cut slightly shallower than the female slot in the body, take several light passes on both sides of the male dovetail, until the guide bushing rubs against the template. When completed, unscrew the template and chisel off the excess end of the dovetail until the neck can be gently tapped to slide most of the way into the female dovetail.

Because of the complexity of the neck dovetail joint and the

Photos: Brian Pickell; drawings: Vince Babak

Fig. 1: Setting the neck



stress put upon it when the guitar is strung, don't expect to get a perfectly fitting joint right off the router table. Instead, aim to rout the neck's dovetail pin so that the neck will sit about 6mm proud of the body's soundboard. This extra 6mm allows you to final-trim the pin with a rasp and file. Trim carefully, and if you accidentally file off too much, glue a thin strip of veneer onto the dovetail and try again. When the neck fits tightly, yet is still 0.5mm proud of the soundboard, the joint is done.

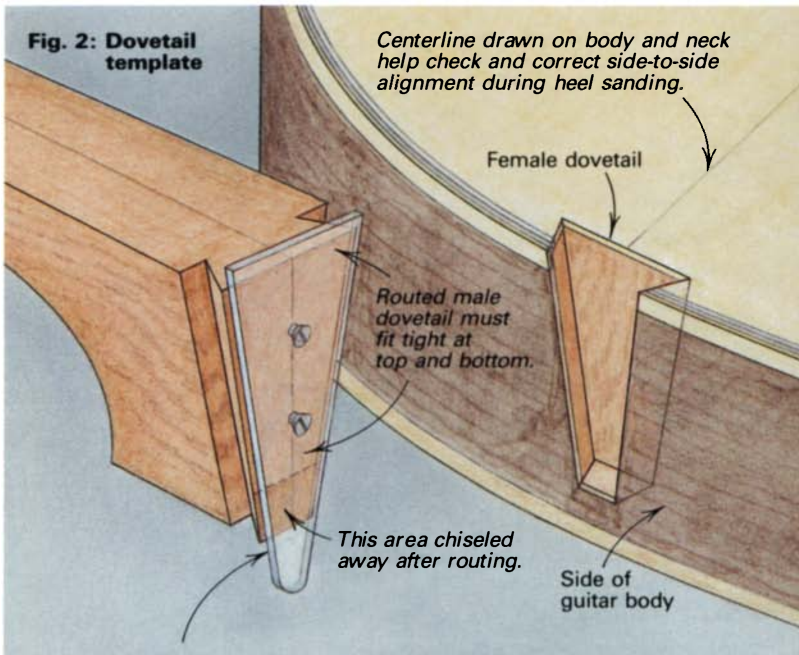
Prior to routing a slot for the truss rod (the metal bar that reinforces the neck) and gluing on the fingerboard, handplane the top of the neck, starting at the approximate location of the fifth fret and working toward the joint. Remove a gradually deepening shaving until the neck is perfectly flush with the body. The result is a neck with a very slight kink in it. This kink, or back bow, is designed so that string tension will bring the neck into the proper line for good playing response without undue finger pressure or buzzing strings. The scraping done just prior to gluing the fingerboard will remove this kink.

The fingerboard—You're now ready to handplane the roughly bandsawn fingerboard blank to the proper taper: 44mm at the nut, 55mm at the 14th fret. Then, thickness-plane it to approximately 6.5mm. The slots for the frets are sawn next, a process described in any good guitarmaking text; my favorite is *Guitar Making: Tradition and Technology* by William Cumpiano and Jon Natelson (Rosewood Press, 31 Campus Plaza Road, Hadley, Mass. 01035). Although not all guitarmakers do, I like to add a binding to the edges of the fingerboard, using either wood, white plastic or imitation ivory. While mainly decorative, I find this binding enhances the look of the neck and hides the fret slots. Before setting the fingerboard aside, sand or scrape its bottom until it's either perfectly flat or very slightly concave. This is important for the fingerboard and neck to bond well when glued.

A steel-string guitar neck needs extra reinforcement to withstand the tension of six strings. There is a vast array of adjustable and non-adjustable truss-rod systems, but I've found that the simplest is one of the most reliable: a hollow ⅜-in.-square steel tube (available from the C.F. Martin Co., 510 Sycamore St., Nazareth, Pa. 18064). Whether you choose this style of reinforcement or venture to try an adjustable rod, there is one aspect worth noting: Routing the truss-rod slot releases tension in the neck, causing the top of the neck, which should be perfectly flat, to become slightly convex. The fingerboard may crack when glued to this surface, so use a stiff scraper to flatten the neck after slot routing.

Trimming and locating the fingerboard just prior to gluing are

Fig. 2: Dovetail template



Plexiglas template, made by tracing outline of female dovetail, is screwed to heel face for routing male dovetail. Sliding tapered template up or down changes width of dovetail.

The dovetail that joins the guitar's neck to the body is shaped on the router table. A standard dovetail bit cuts the male dovetail as the neck, screwed to a Plexiglas template that rides against a stationary guide bushing, is moved over the table.

well covered in the recommended texts, especially Cumpiano. In fact, other texts do such a good job of explaining how to carve the neck, final-sand and finish the guitar, and glue on the neck that I'll also not discuss these topics. Instead, I'll review some critical aspects of a guitar's proper setup. In my shop, I glue the neck, shape and attach the bridge, set the frets, and make the nut and saddle after finishing. So let's first look at adjusting the final set of the neck.

The relationship of the neck and body—Even though most of the neck's back bow is set when the neck is glued in place (after finishing), it must now be fine-tuned for best playability. When the guitar is first strung, the tension of the strings pulling the neck upward will bring the neck to its minimum playable position—dead flat. This is where you want the neck, as it allows for reasonably low action (height of strings above the frets) and comfortable playing. However, during the first 12 to 18 months it's strung, a neck usually continues to pull up slightly. Too little back bow may eventually cause string buzzing, and too much means the strings may be too high to play. Planing the fingerboard allows you to slightly adjust the degree of back bow and make sure it has a smooth, gentle curve. I also plane the radial curve of the fingerboard at this time. To do this, I first establish the back bow of the neck with the fingerboard flat, and then I shave a small amount off the fingerboard, taking care not to remove too much.

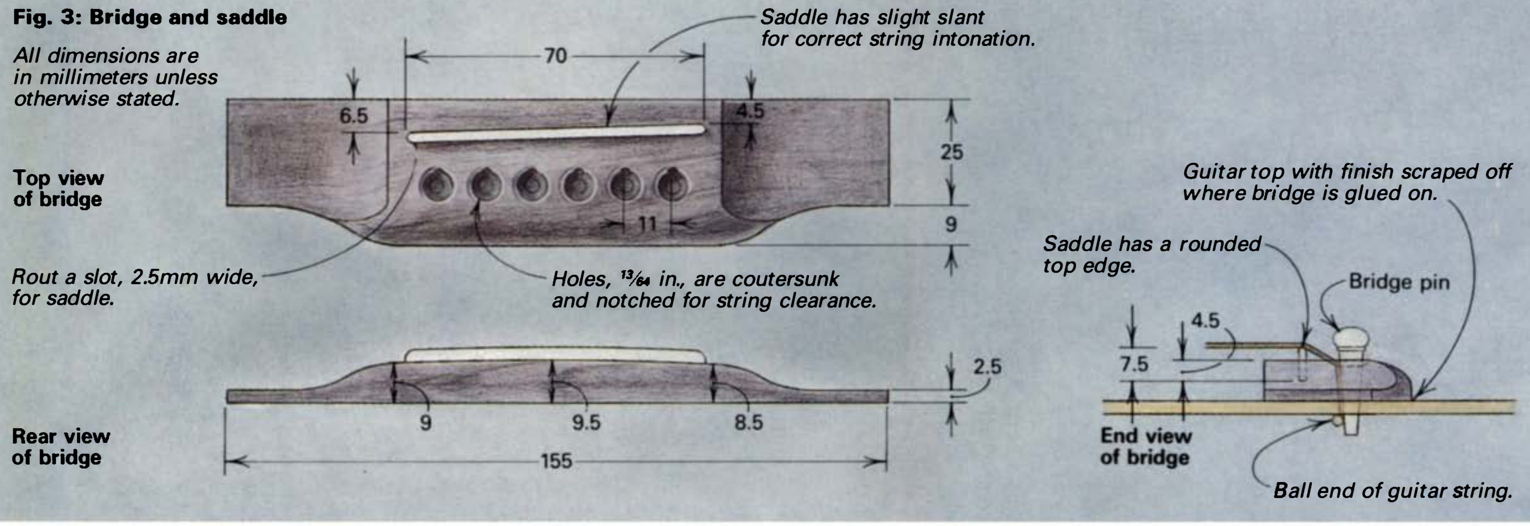
Confirming the correct degree of back bow is something I've been doing by eye and feel for more than 19 years. A neck that pulls up flat when first strung and bows up very slightly over time is the goal. I check the back bow by gripping the guitar in the heel area with one hand and pushing the neck upward, at the nut area, with my other hand. I then sight down the edge of the fingerboard to see that it lays perfectly flat under this simulation of string pull. It's not too difficult to judge when you have reached the limit of the neck's natural flexing: At that position, the fingerboard flattens out or is slightly concave. If it's not, you have some planing or sanding to do. To complicate matters, hammering the frets into the slots may increase back bow slightly. If your fret wire fits tightly, compensate by allowing a little less back bow. Also, the gauge of strings you use will effect back bow: The heavier the strings, the more they pull up the neck and require more back bow to compensate.

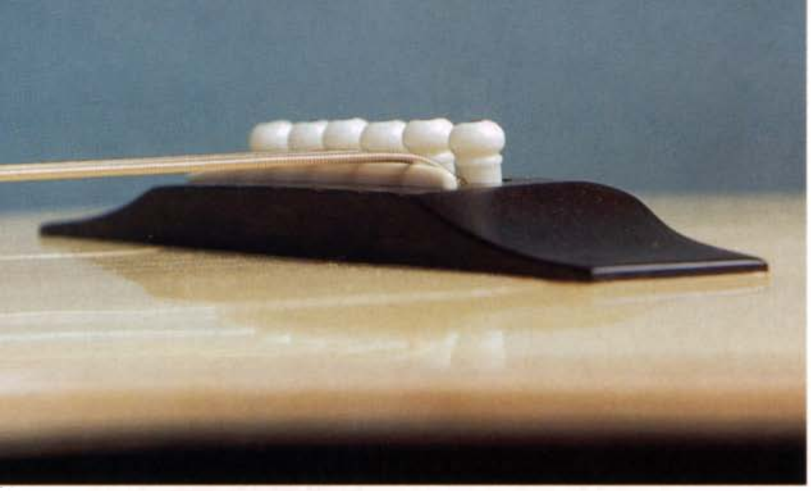
Fretting—An auto-body hammer, with its slightly convex head, is very good for fretting. I hammer in each fret by first seating one side securely, and then hammering my way across to the other side. Be sure the neck has some support directly beneath the fret you are hammering; once you reach the heel, neck support is not necessary. For the 12th through 16th frets, the heel and inner block themselves will be support enough. After that point, you must hand-hold a small metal block or some other dense object inside the guitar, beneath the fingerboard, as a support to hammer against. Check that the bottom edges of the crown of each fret sit evenly and flush against the fingerboard at all points—don't rely on final-dressing the frets (filing them flat) to smooth out irregularities in their heights. The edges of the frets are snipped off with wire cutters and filed to a shallow bevel. By filing very slightly into the edge of the fingerboard, you will recess the fret ends out of your hands' way as you play. To finish, scuff-sand the surface and edges of the frets with 400-grit paper or 0000 steel wool.

The bridge—The guitar's one-piece bridge, shown in the left photo on the top of the facing page, can be made from ebony or rosewood. Shape it to the dimensions illustrated in figure 3 below. I cut the saddle slot with a ⅛-in. two-flute straight bit fitted in the router table and guided by a template. A more simple approach would be to use a straight burr in a Dremel tool. Prior to gluing, I final-shape and sand the bridge to 240-grit and leave it unfinished. Accurate bridge location on the top is critical, so carefully check your measurements. The distance from the near edge of the saddle slot at the high E-string location is 32.7cm from the center of the 12th fret. The near edge of the slot at the low E-string location should be 32.85cm away from the same point. Once the bridge is located in relation to the scale length, mark the position of the edge with two layers of masking tape. The lateral position is located by stretching a taut thread to simulate the positions of the outer strings (both Es). Hold the thread approximately where the string would cross the nut and across its corresponding bridge pin hole. When the thread positions are equidistant from the edges of the fingerboard, mark the bridge edge with tape.

Now, cautiously scribe the outline of the bridge onto the top, gently cutting only through the finish with a surgeon's scalpel fitted with a new blade (both available from an art-supply store). If you use an X-Acto knife, hone the blade to razor sharpness to avoid chipping the finish. Remove the lacquer finish within the scribed area next by bubbling the lacquer with a hot chisel pulled backward across the area. This separates much of the lacquer from the surface and makes scraping off the remainder easy. Then, posi-

Fig. 3: Bridge and saddle





The bridge and saddle on Laskin's guitar, shown here finished, anchor the strings, via pegs in holes, and transmit string vibration to the body, which then acoustically amplifies the sound.

The distance between the strings and the 12th fret, marked by a black inlay dot, is crucial to the guitar's playability. The distance is checked with a thread and any adjustments are made at the saddle.

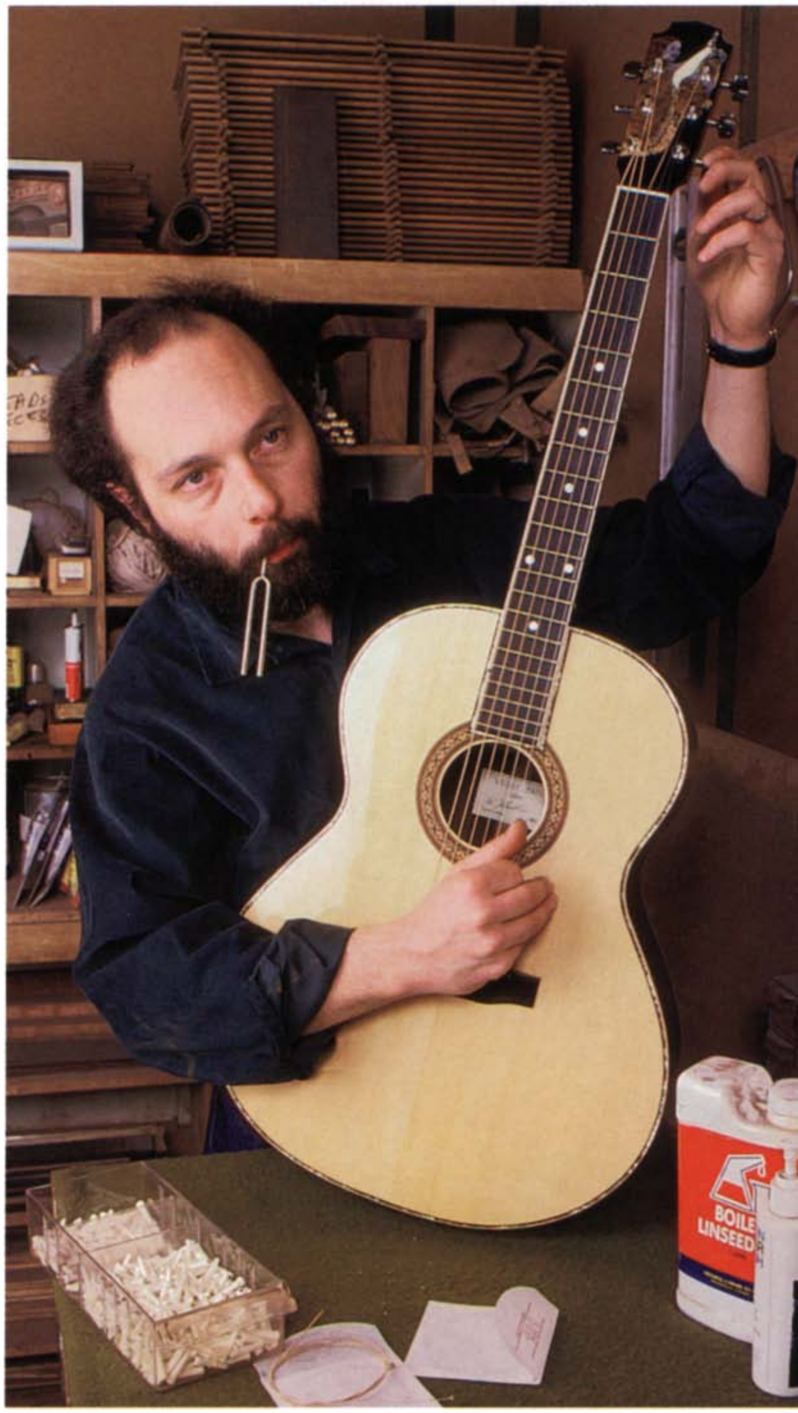
tion the bridge and accurately tape around it. This will help hold it in place when gluing, a step well covered in the recommended texts. After gluing, the pin holes in the bridge are drilled through the top itself and then countersunk, and the guide slots for the strings are filed.

Nut and saddle—The nut is made first, shaped from a 7mm-thick piece of either imitation ivory or bone. Snugly fit the piece into the gap between the peg-head veneer and the edge of the fingerboard, as shown in the photo on p. 82, either by filing or sanding the nut. Then, trim the nut's ends flush with the neck. Now, draw a line parallel to the fingerboard's curve, but 1.5mm above it. File the nut down to this point, angling and rounding it on the peghead side of the nut. For string slot positions, first mark the outer strings' locations 2.5mm from each edge and then divide the remaining distance by five, for equal string spacing. File each slot just wide enough to hold its respective string snugly, but not too tightly. To check slot depth, set a very thin straightedge into each slot and rest it on the second fret. You should be able to see a slight clearance (a few thousands of an inch) above the first fret.

The saddle, sawn and filed to the dimensions shown in figure 3 on the facing page, is fitted into the bridge next. It should fit snugly, but not so tightly that it won't seat properly or that it splits the bridge as it's pressed home. The top edge of the saddle should be shaped so its curve is equal to or slightly more exaggerated than the fingerboard's curve and so the top edge is 1mm lower on the treble side than on the bass side. Establish this height by stretching a thread from the nut to the saddle and measuring its height at the 12th fret. When the distance between the top of the fret and the thread is approximately 3mm on the bass side, mark the saddle where the thread passes it. Repeat this on the treble side when the height of its 12th fret is approximately 2.5mm. Should these measurements produce an action that is slightly high when you string the guitar, plane or scrape material from the bottom of the saddle. If the action is slightly low, place a thin ebony shim into the bottom of the saddle slot. Finally, I sand the nut and saddle down to 320-grit and then give them a quick polish on my buffing wheel using buffing compounds—the same fast-cut compounds I use to buff out the finish of a guitar.

Assuming that you have followed me and the suggested companion texts all the way through the construction of a steel-string guitar, let me now say "dig in!" String it up, play it and be proud as hell. For persevering with a uniquely difficult woodworking project, you deserve all the credit you can get. □

Grit Laskin is a guitarmaker, performer and author living in Toronto, Ont., Canada.



One of the joys after enduring the long process of building a guitar is finally being able to string and play it. Here, Laskin, tuning fork in mouth, tunes up his latest creation.

This 36-ft. by 10-ft. table was built by Charles Grant Co., Portland, Ore., for the boardroom of Santa Fe Southern Pacific in San Francisco, Cal. The little bumps in the black border are microphones so you can talk in a normal voice and be heard at the table's far end.

Conference Tables

Upscale commissions from shop to boardroom

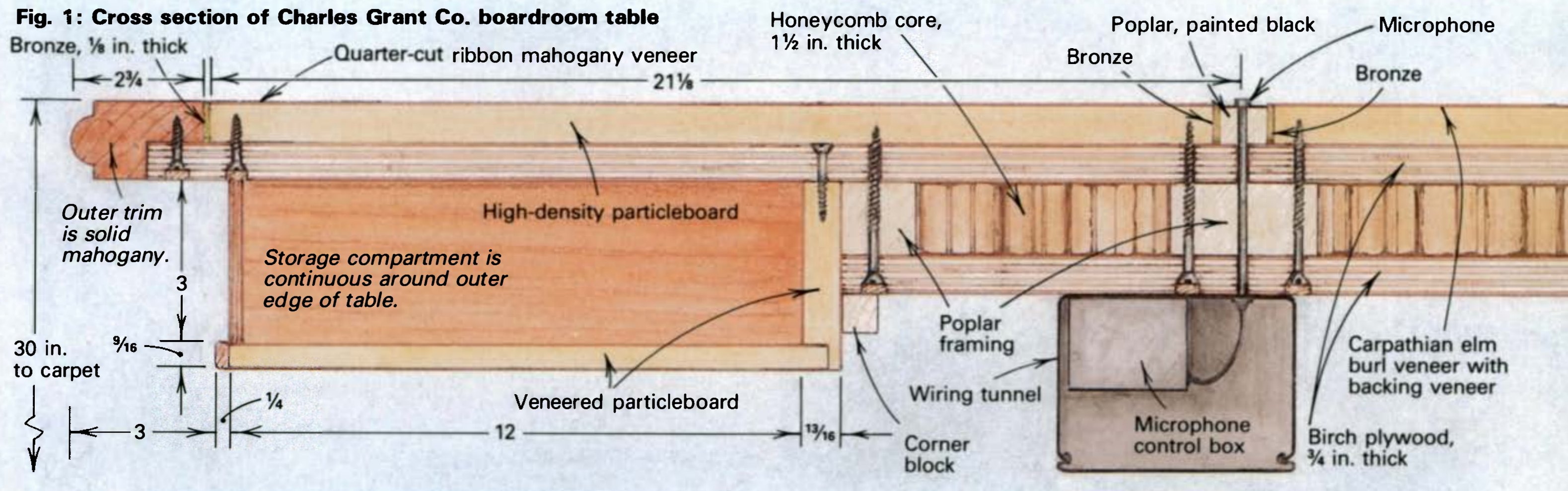
by Jim Boesel

A table is simplicity itself: four legs, four rails and a top. Or simpler yet, two pedestals, a trestle and a top. In spite of this simplicity, a large table can dominate a room, which can add to the table's perceived value. Thus, people will readily pay more for a dining-room table than any other single piece of furniture. And, if you take your basic dining-room table and increase its length, maybe its width too, to create a conference table, you have a piece of furniture that commonly sells for $10,000 to $50,000 and up.

By strict definition, a conference table can be as small as a kitchen table or as large as a yacht. But my interest in researching this article was to learn about the larger-variety tables—12 ft. and longer—that would be too large for most kitchens or even dining rooms for that matter. In addition, I narrowed my focus to concentrate on the construction of the tabletops as opposed to the bases, which ranged from simple barrel-shape pedestals to very complex, steel-reinforced structures. I visited and spoke with several makers who dedicate a good portion of their time to building conference tables. Although they all produce high-quality tables, it seemed that each shop had zeroed in on one or two of the problems shared by all, like using hollow-core construction for large tabletops; making the patterns for elliptical tops; joining and leveling multiple-part tops to achieve the look of a single board; and building large, solid-wood tabletops.

Although building large tables can be lucrative, it is definitely not for the faint of heart. These projects can be very risky. A successful table can bring prestige to the maker and attract additional work, but failure to deliver an impressive finished product on time will give designers and competing shops something to gossip about for a long time. Many of the designer-craftsmen who have found a niche in this market began in one- or two-man shops producing one-off furniture. The desire to make a decent living while building fine furniture led them into commercial work, where buyers can afford a top-notch product and want the appearance of success that finely crafted, unique furnishings bring to their offices. However, before you can win a contract for a table with a $10,000 price tag, you must first win the buyer's confidence. This means the builder must come out of the shop, get dressed up and sell the clients on

Photo above: Fred Lyon; drawings: Bob Goodfellow



the shop's ability to deliver the promised product. In fact, competing in this market requires the skills of a salesman, a planner, at least two or three good cabinetmakers and a very good finisher. And you'll need all these workers just to move the thing. I heard stories of table sections being rigged above and below elevator cars so they could be raised to the 50th floor or being hoisted up the outside of the building and in through window openings. In addition to selling, planning and managing employees in the shop, commercial furnituremakers must be willing to collaborate with designers and architects who will often have a basic design that might not be realistic in terms of construction and budget constraints. Needless to say, most of the people I visited are spending much less time in the shop and more behind the drawing board or meeting with clients. While some personal control and freedom is lost in this evolution from artisan to businessman, everybody I spoke to about the conference tables they've worked on, whether project manager, cabinetmaker or finisher, expressed the great rush of satisfaction they feel when all the parts come together on one of these truly impressive tables.

A boardroom table is just a big conference table with an attitude. Boardroom tables are concerned with status, even more than most furniture. These are not working-class tables: They have power and reside in important places, and they are expected to project an image for the company. The group of individuals who gather around this table and even the room itself take their names from this magnificent "board." The table owns the room, and in some cases, such as the 36-ft. by 10-ft. boardroom table in the photo on the facing page, it even holds the power to control the room.

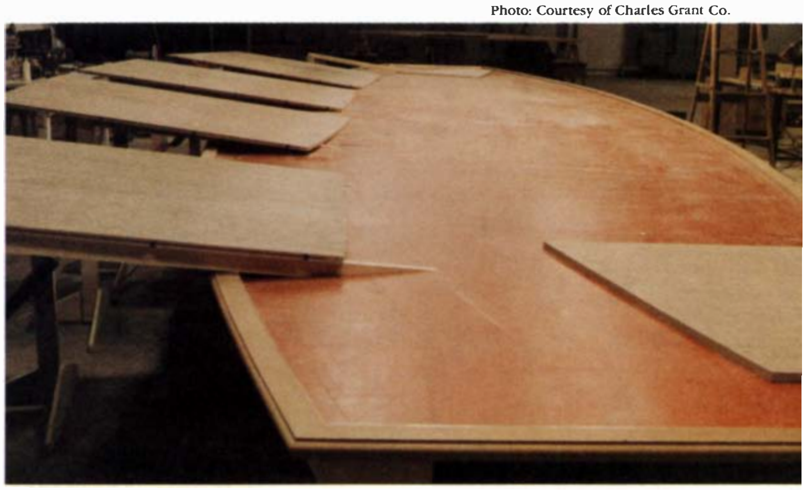
This table, designed by Raymond M. Kennedy of San Francisco, Cal., and built by Charles Grant Co. of Portland, Ore., has a Carpathian elm burl veneered center with quarter-cut ribbon mahogany book-matched in a radial pattern around the edge. The base is three large, cross-shape pedestals tied together with a substructure of steel tubing and mounting plates that supports the massive top. Wires for the room's light, sound and phone systems come up through a pedestal and run the length of the table through wire tunnels. The wires for the telephone and audio systems are connected to small microphones set 30 in. apart along the painted poplar and bronze border that divides the tabletop's two veneered portions. The microphones provide discreet amplification, which makes it possible to talk in a normal voice to someone at the other end of the table.

A mobile, nightstand-size cabinet that the table's project coordinator, Russ Craig, affectionately calls a droid, holds the control panel for all the electrical systems in the room. This little electronic valet can be rolled to either end of the table and plugged into one of the outlets on each end of one of the wire tunnels. By pushing the right buttons on the droid's built-in telephone, the table's microphones become transmitters for conference calls, transforming the table into one of the world's largest telephones. In addition, the droid has a touch-control screen that can operate various slide projectors or a videocassette player aimed at a rear projection screen built into one end of the room. The control screen can also be used to automatically adjust the lighting in the room by activating one of several preprogrammed "scenes." Each scene is a specific combination of overhead lighting and natural lighting and the options are numerous thanks to three types of window coverings: sheers, translucent drapes and blackout blinds.

According to Mike Grant, president of Charles Grant Co., the shop builds about 10, 14-ft.- to 20-ft.-long conference tables a year and in the last 10 years has built six or seven large boardroom tables similar to the one in the photo on the facing page. On tables up to 20 ft. long, the taped-up veneer pieces (known as the sketch-face) are glued directly to the 1-in.- to 1½-in.-thick high-density particleboard tabletop sections. However, to create a thick top on the larger tables, while still keeping the weight down as much as possible, a "core" tabletop is built by sandwiching a poplar frame, filled with paper honeycomb core, between sheets of birch plywood. Figure 1 above shows a cross section of this honeycomb construction (see *FWW* #76, p. 79 for more on honeycomb). In these cases, the core table is not veneered. The veneer is applied to pieces of ¾-in.-thick particleboard, which are then assembled atop the core table.

The first major hurdle with a project of this scale is to make a

Photo: Courtesy of Charles Grant Co.

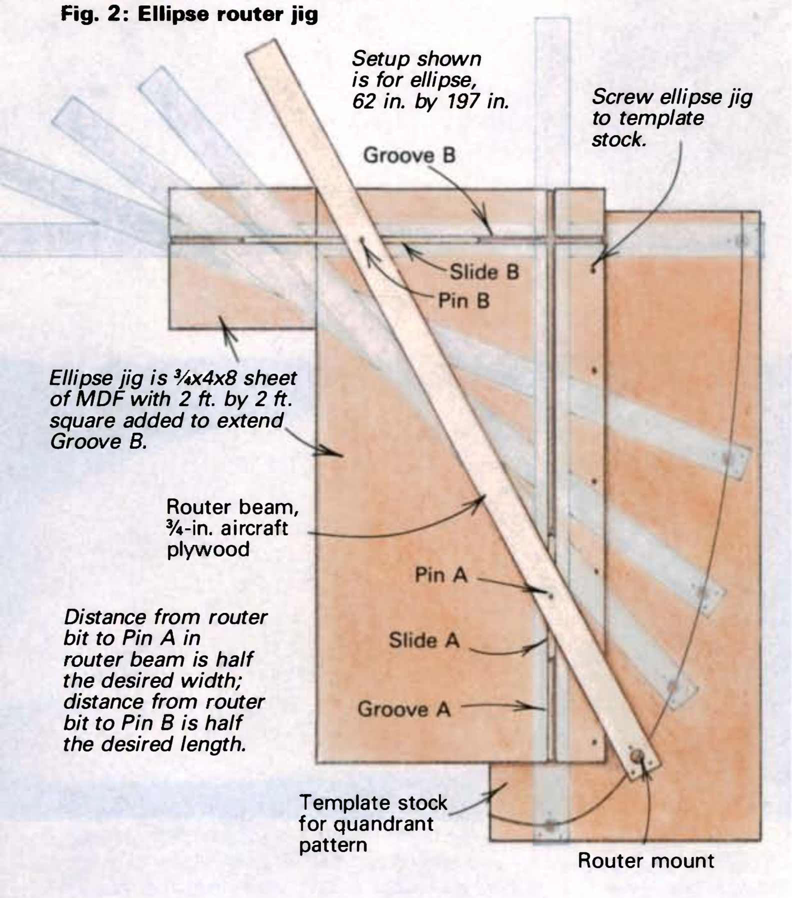


After the core table is assembled, the veneered center-section pieces are supported on stands so they can be connected from beneath with Tite Joint fasteners. The whole assembly is then slid onto the table.

Photo above: Ed La Casse

Above: This 17-ft.-long elliptical table was built by Master's Studio Ltd. of Denver, Colo. Careful alignment of the surfaces of the two-part top makes the joint between them virtually invisible, even though the joint runs cross-grain to the figured quarter-sawn cherry veneer. Left: The spring-loaded latches mortised into the mating edges of Scott Peck's tables speed up assembly and disappear, except for small wrench-access holes under the tabletop. To combat the potential for expansion and contraction caused by drastic humidity changes, Peck uses a particleboard core in all the solid-wood parts and a honeycomb core for the body of the tabletop.

Fig. 2: Ellipse router jig



particleboard pattern for a quarter section of the outer rim of the tabletop. To draw the 50-ft.-radius arc of the table's long edge on the particleboard, Craig took over an adjacent empty building and, working at floor level, used a cable for a compass. The quadrant pattern was then bandsawn out and cleaned up to the line with sanders and handwork. Additional patterns for all the table's parts that required concentric arcs were generated from the original pattern with a shopmade marking gauge. This gauge is similar to a panel gauge except that instead of a straight fence, it has two dowels to follow the pattern's arc. Once the patterns are made, the work proceeds with standard tools: shaper, bandsaw and router. After the parts are completed, they are assembled in the shop and the veneered top pieces are fine-tuned by hand until they fit snugly within the frame created by the solid-wood outer trim that's rabbeted, splined and glued to the core table. After the top is lacquered, the parts are packed and crated for shipping.

It took Craig and cabinetmaker Ted Sams a full week to uncrate and assemble the table on-site. First, the base pedestals are built in place and the steel tubing and plates that support the top are bolted to them. After leveling this framework, the core top is assembled on it using Knapp Vogt Tite Joint fasteners to bolt the sections together. Tite Joint fasteners, available from large hardware stores and builder's supply houses, are draw bolts with circular ends so they can be installed by simply drilling a hole in each of the pieces to be joined and routing a slot for the bolt's shaft. The six pieces of the veneered center section are assembled with Tite Joint fasteners that are installed in the underside of the veneered particleboard. The photo on the previous page shows the adjustable standards that Craig built to support the pieces of the veneered center sections on the core table's edge while he installed the Tite Joint fasteners. With the particleboard supported as shown, two of the four fasteners that secure one section to the next are bolted in place from underneath. Then, the assembled center section is slid down the arms of the standards onto the core table and the standards are moved around to the table's other side. The center section is slid back up onto the standards' arms and the rest of the Tite Joint fasteners are installed from below. The center section is then slid into the center of the core table and the pieces of the outer veneered section are placed on the core. The painted poplar strip that houses the microphones is then pressed in place between the veneered sections. Only then are the veneered panels anchored with screws through predrilled holes in the core table.

The shape of a conference table is often determined by the size and shape of the room, but less practical and more psychological considerations can also play a role. King Arthur commissioned a round table for conferring with his knights to preclude anyone from having the distinction of sitting at the "head" of the table. Although an elliptical conference table may not have the romantic appeal of King Arthur's round table, it is the contemporary shape of choice for seating large groups as equals because the tight curves at the ends discourage anyone from sitting there. And a true ellipse (a closed curve with a constant sum of distances from two fixed points in a plane) is a very beautiful shape, especially in the scale of a 17-ft.-long tabletop, such as the one in the top photo above built by Master's Studio Ltd. of Denver, Colo.

Scott Peck, president of Master's Studio Ltd., is a one-off furniture-maker whose shop has grown to the point where he's more likely to be meeting with clients than cutting a mortise. Much of the growth has been in commercial office furnishings, and conference tables in particular have become something of a specialty for the five-man shop. When I asked Peck about the most common shapes for conference tables, the first shape he mentioned was a true ellipse, partly because it's the basic shape upon which many of the other variations are based and partly because it's his personal favorite.

Considering this preference, it's not surprising that Peck and his cabinetmakers have developed a simple and very direct method for making the pattern for their elliptical tabletops. Figure 2 on the facing page shows how a plywood beam with two sliding pivot points, each running in one of two tracks that intersect at right angles, can be set to guide a router around any desired ellipse. Mounting a router at the end of the beam lets Peck's crew cut out the quadrant pattern for the outer edge of a large table without having to draw it out first. Any concentric curves, such as those for the tongues and grooves that secure the solid outer trim to the tabletop's substrate, are routed by using custom-made router bases and ball-bearing-piloted bits that provide the desired setbacks from the original pattern.

Equality around a table has its place, but most businesses are not democracies and there are times when a client wants a narrow elliptical table, but also wants to be able to sit at its head. Then, the ellipse is modified by trimming off the ends in a circle arc with a radius that creates a wider end: a more inviting place to sit. Although there are really no limits to the variety of shapes a conference table can take, the most common shapes besides the ellipse and modified ellipse are the boat tail: large radius arcs along the sides and straight ends (see the photo on p. 86), and the race track: straight sides with semicircular ends. Another fairly common style is a continuous narrow table that traces any shape, such as a square, circle or triangle (see the center photo on p. 91), and this usually has an opening allowing access to the area defined "inside" the shape the table traces.

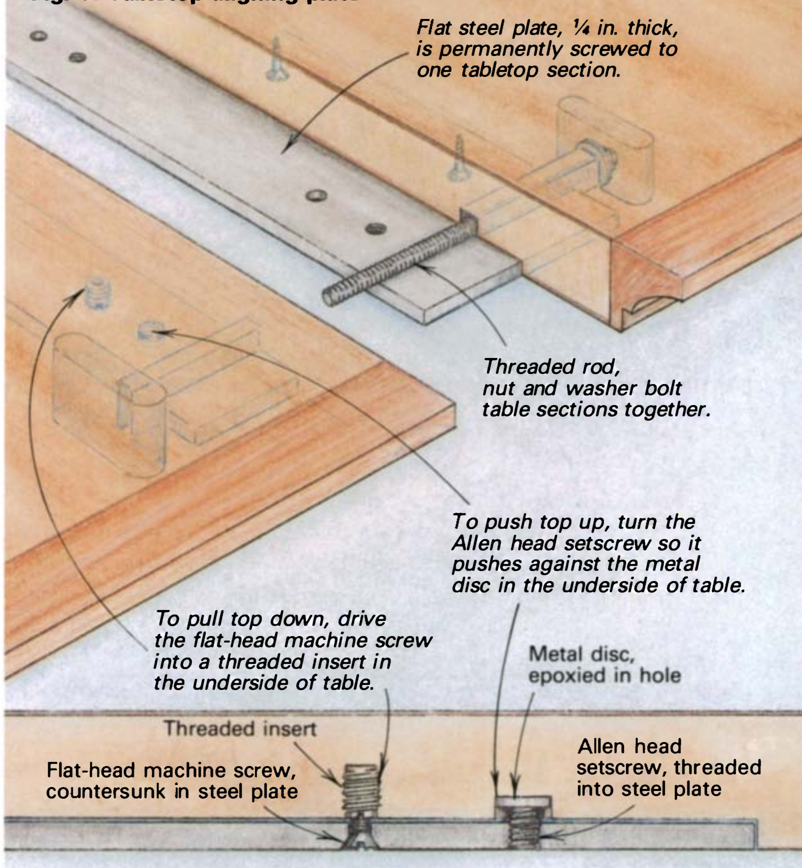
When I visited Master's Studio Ltd., there was a large modified-elliptical conference table in the finishing room that had just received its final coat of catalyzed varnish. Since the four-part table had been broken down for delivery, the connectors used to assemble the top were visible (see the bottom photo on the facing page). These spring-loaded latches from Norse Inc., 100 Franklin St., Torrington, Conn. 06790, seemed more up to the scale of the task than the Tite Joint fasteners being used by most of the other shops I visited. Besides presenting a cleaner, more professional appearance, these mortised-in latches also speed up assembly, an important factor upon final installation, but even more so in the shop, where the table might be assembled and disassembled between 6 and 10 times during fitting and finishing.

A continuous glass-like surface, is how Rick Wrigley of Holyoke, Mass., describes the obsession with the finished surface that he shares with all the conference-table builders I visited. Achieving that finish quality on a 20-ft.-plus top that's assembled from several parts can be a real challenge. Wrigley's veneered tabletops have a distinctive style. The highly figured veneers, bordered and crisscrossed with delicate inlaid strips of veneer and puncuated here and there with inlays of marble, mother of pearl and sterling silver, are his trademark (see the photo above). Often these designs can be laid out so the inlaid strips run along the joints between the tabletop sections, helping to conceal them. But this isn't always possible, as on Scott Peck's table in the photo on top of the facing page, where the two-part top breaks across the grain of the cherry veneer. In a case such as this, any minute difference in the height of the joining surfaces will catch light and frustrate a perfectionist. The obvious and most common method for aligning these surfaces is to insert splines in the joining edges. But if the splines are tight enough to provide perfect alignment, it's nearly impossible to disassemble the top without destroying the spline. And if the spline is loose enough to allow easy assembly, it will have too much play to effectively align the parts.

Photo: Michael Janeczak

This 14-ft.-long table, co-designed by Rick Wrigley and interior architects and planners KPFC Associates Inc. of New York City, is a good example of Wrigley's decorative style. The eight marble inlays are each directly above one leg of the base. The base consists of two, four-legged table bases turned 45° from the top's orientation.

Fig. 3: Tabletop aligning plate



Frustration with splines led Wrigley to devise his own method for fine-tuning table components. His solution is the steel leveling plate illustrated in figure 3 above. The plate is screwed to one of the joining tabletop sections so that it will extend beyond the edge enough to carry the mating top section. Every foot or so along the length of the overhanging steel plate he drills a pair of holes to receive what he calls "pushers and pullers." One hole of each pair is tapped to receive a hex-head setscrew that will be the pusher, and the other is countersunk for a flat-head wood screw, the puller. He then drills a hole in the underside of the tabletop that will line up with each of the holes in the plate. A metal disc, like a plug from an electrical fuse box, is epoxied into the bottom of each of the holes that line up with the leveling plate's threaded pusher

Photo: Steve Viale

By cutting and milling his own timber, Lewis Judy can find planks that will make large book-matched tables like the 14-ft. by 4-ft. walnut table (above). An unusual room shape dictated Judy's solid-mahogany table (below). He trisected the large triangle and keyed the three separate top sections together with brass splines that float in grooves in the edges of the sections. Doing this allowed him to run the grain parallel with all three of the table's outer edges.

holes, and each of the holes that line up with the plate's puller holes gets a threaded insert. To assemble the top sections, he finger-tightens the nuts on the ends of the threaded rods that he uses for draw bolts to pull the two top sections together. Then he fine-tunes the top surfaces by either pulling the top down tightly to the steel plate with a screw in the countersunk hole or pushing it up slightly by tightening the setscrew against the metal disc in the hole. When these adjustments are complete all along the joint, he tightens the puller screws next to all the pushers and wrench-tightens the nuts on the draw bolts.

Fine-tuning these surfaces is initially done in the shop prior to final-sanding and finishing the tabletop. The top must be assembled before sanding to avoid rounding over the joining edges and then left together for finishing, because even the slightly rounded corner on a couple of layers of varnish or lacquer will spoil the continuity of the surface. When taking the tabletop apart after finishing, and when assembling the table on-site, Wrigley is careful not to lift one end of the table and crush the top corner of the joining surface. These edges are always padded and wrapped before the top pieces are crated for transport.

Wrigley is a one-off furnituremaker who understands business as well as he does woodworking. Although he admits that large-scale conference tables can create a lot of logistical headaches, he adds that they can also lead to other commissions. His first boardroom table, shown on the back cover of *FWW* #60, was for the Home Box Office (HBO) headquarters in New York City. This commission helped him develop his distinctive style of inlay and it proved that he could collaborate with designers and architects on a large-scale project. When I asked him if he'd ever been approached to build a conference table from solid wood, he didn't hesitate to state that he felt it was an improper use of solid wood. Besides the obvious problem of expansion and contraction with large, solid boards, he pointed out that high-style furniture, a category that his conference tables easily fit into, has traditionally been veneered.

Solid wood, however, is Lewis Judy's specialty. Although Judy, of Jefferson, Ore., appreciates the fancy veneers and intricate designs on many conference tables, he feels that making large tabletops from solid wood may very well be the best possible use of a magnificent natural resource. The table's effect should come from the majesty of the wood itself and not from a labor-intensive process of piecing together veneer to achieve a designer's conception.

Like most furnituremakers, Judy was asked periodically to salvage the timber in an old hardwood tree that was doomed because its roots threatened a home's foundation or its limbs a roof. Finally, about five years ago, he began taking people up on these offers and found local workers who had the necessary equipment to fell and load the large walnut trees found close by on the western side of the Cascade Mountains near Salem, Ore. Although Judy already had a thriving business building a line of solid, no-nonsense oak furniture, this new resource inspired a whole new line of furniture: more formal, more geared to one-of-a-kind pieces and especially designed to show off the incredible color and figure of the 50-year- to 200-year-old walnut trees he was cutting. Because he supervises the milling, he sometimes gets several planks up to 24 in. wide from a single tree. Judy has wood that will make a 20-ft.-long, 4-ft.-wide conference table with just two book-matched boards. These two-board, walnut tables, like the 14-ft.-long table in the top photo, are certainly impressive, but there are times when a client prefers a different wood or the room itself demands an unusual shape.

The mahogany table in the bottom photo at left shows how a conference table's design can be dictated by a room's size and shape. Because the room is an irregular hexagon, a long rectangular table was not the best use of the space and although circular or square shapes were possibilities, a triangle seemed more appropriate. The triangular table, which is 13 ft. on each slightly curved side, complements the odd shape of the room, and still preserves an open area near the entry. By building the table in three separate triangular sections that are keyed together with brass splines, Judy accomplished several things: he reduced the overall potential for the wood to expand or contract, divided the table into manageable-size pieces and added a design element to break up the monotony of the large surface. The mating sides of the three table sections are grooved to receive ½-in.-thick by 3-in.-wide brass splines. A central brass hub, with "spokes" that extend about 18 in. along each joint, supports the center of the table and a single Tite Joint fastener in the center of each joint holds the tabletop sections together. The base consists of three veneered-plywood barrels, one directly under each of the joints where the top sections come together.

This triangular table resides in the center of a hospital and unlike some of the more elite conference tables pictured in this article, it receives daily hard use. In fact, after less than two years in service, it's already due for refinishing. This prompted Judy to point out that durability and repairability may be the best two arguments for using solid wood for any table. Seeing the wear and tear on this table reminded me that for every fancy, pampered conference table, there are at least a hundred others that, though smaller and humbler, serve the same purpose—to provide a place for ideas to be discussed and decisions to be made. □

Jim Boesel is an Assistant Editor at FWW.

Photo above: John Makepeace; photo below: Charles Grace

A gallery of tables

Conference tables are as varied as the clients who commission them. The boardroom table and chairs above, by John Makepeace of Dorset, England, were built from an oak tree on the client's estate. South Carolina furnituremakers Jim Lewis and Clark Ellefson used a gray wiping stain over red-oak-veneered plywood and solid-mahogany edging for the 30-ft.-long by 12-ft.-wide continuous rectangular conference table at right. Michael Fortune of Toronto, Ont., Canada, responded to the odd angles in the room at the Ontario Crafts Council when designing the 28-ft. by 8-ft. wavy bubinga-veneered table with Macassar ebony detailing (lower right). Stephen Meder and Steven Hill of Oahu, Hawaii, built the koa and travertine marble conference table, lower left, for an office in a Honolulu high rise. The 16-ft.-long table is actually two 8-ft. tables that can be pushed together end to end, as shown here, for large groups.

Photo left: David Franzen; photo right: Jeremy Jones

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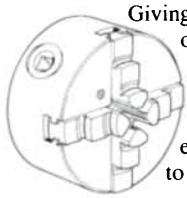

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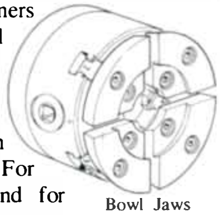

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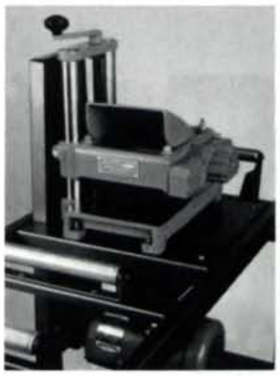

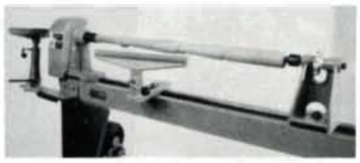

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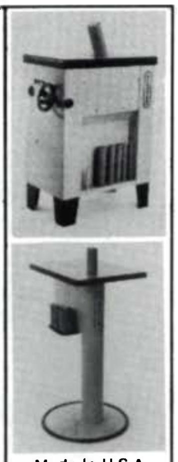

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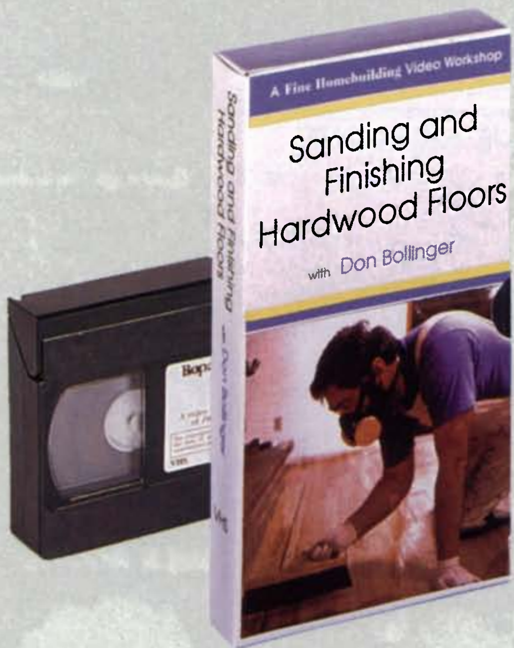

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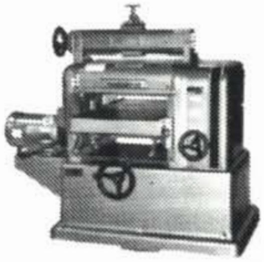

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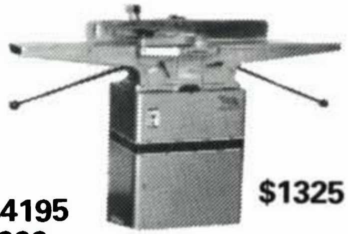

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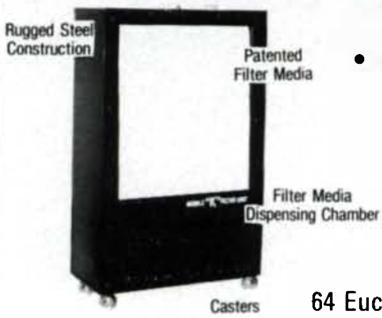

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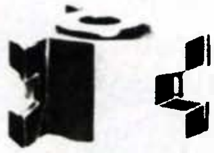

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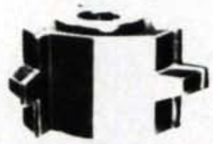

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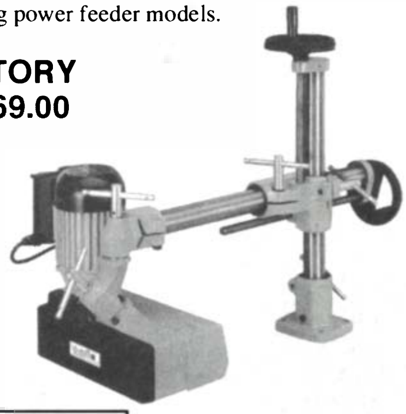

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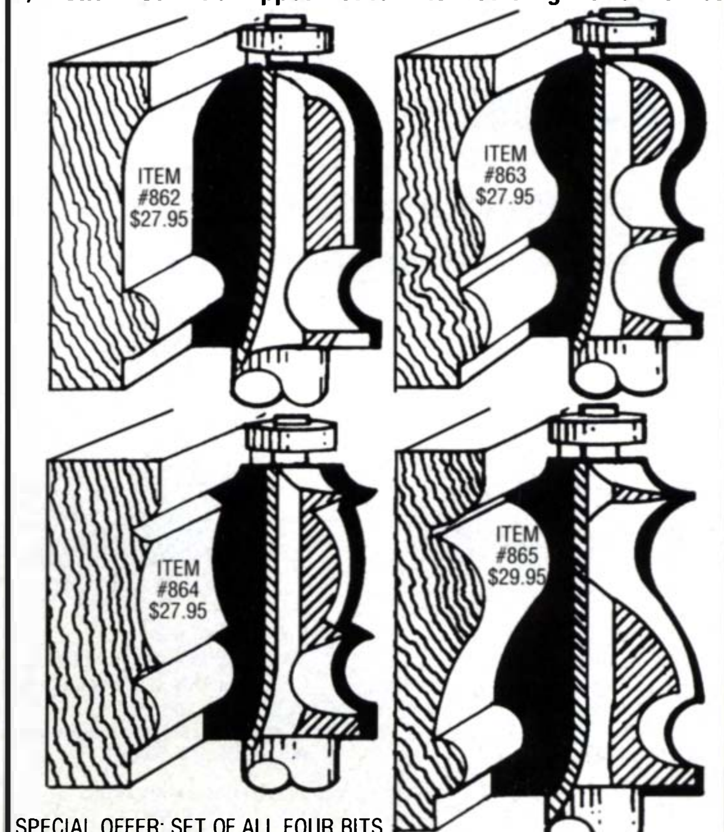

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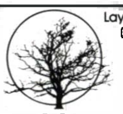

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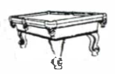

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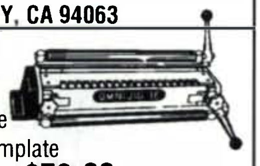

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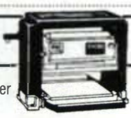

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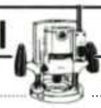

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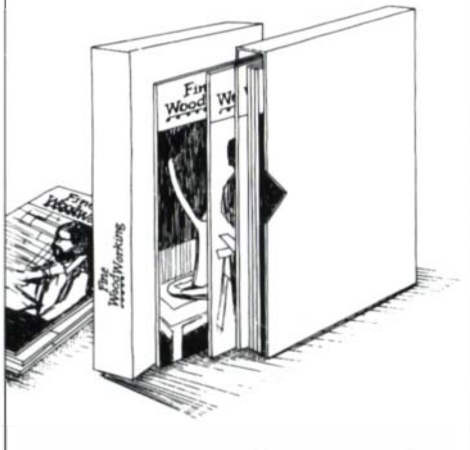

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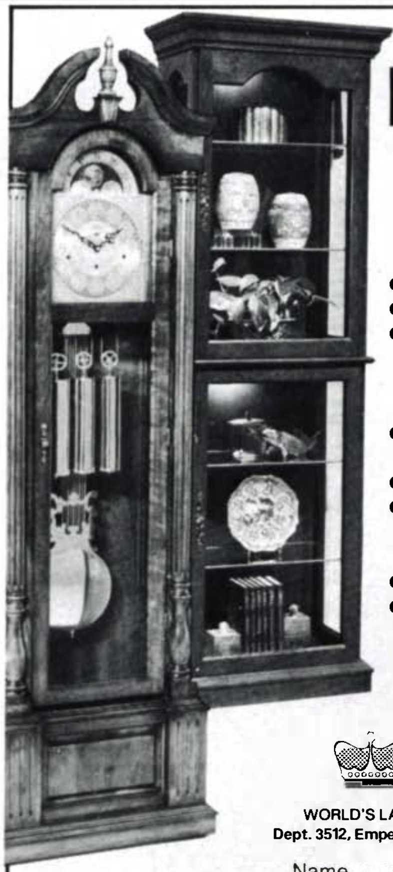

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RE600	3 hp VS elec plunge rter.	198

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JP-155	6-1/8" joint planer	318
BE321	3x21 VS elec belt sander	128

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362	4x24 sander with bag	189
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7648	VS barrel grip jig saw	139
9629	VS Tiger saw kit	139
9118	Porta-plane kit w/ct cutter	199
5116	NEW Omni-Jig	269

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7514	1/2" VSR drill	115
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4/0	5" handscrew	9
5/0	4" handscrew	8
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7236	36" I-bar clamp	18
7248	48" I-bar clamp	20
7260	60" I-bar clamp	23

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CB75F	resaw bandsaw	1629
F1000A	planer/jointer	1529
C15FB	15" miter saw	389
C10FA	10" miter saw	279
C12FA	12" miter saw NEW!	349
TR-12	3hp plunge router	179
M12V	3-1/4 hp VS router NEW!	259

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94-100	5pc router cabinet set	159
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92-100	26pc router bit set	299
90-100	15pc router bit set	159
88-100	9pc router bit set	99
FB-100	16pc Forstner bit set	149
FRT-2000	router table	169

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N80C-1	coil nailer	399
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T31-1	5/8" to 1" brad tacker	149
CWC100	1hp 4gal. compressor	329

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Listings of gallery shows, major craft fairs, lectures, workshops and exhibitions are free, but restricted to happenings of direct interest to woodworkers. We list events (including entry deadlines for future juried shows) that are current with the time period indicated on the cover of the magazine, with overlap when space permits. We go to press three months before the issue date of the magazine and must be notified well in advance. For example, the deadline for events to be held in March or April is January 1; for July and August, it's May 1, and so on.

ALABAMA: **Exhibition**–Contemporary Works in Wood Southern Style, May 6–June 17. Featuring work by Bob Trotman, Chad Voorhees, Lynn Bruce Sweet, Craig Nutt and Ron Puckett. Huntsville Museum of Art, 700 Monroe St. S.W., Huntsville, 35801. (205) 535-4350.
Juried show–Magic City Art Connection, May 11–12. Birmingham. Outdoor in the cultural and financial district, featuring all types of media including wood. For info., contact Eileen Kunzman, 1128 Glen View Rd., Birmingham, 35222. (205) 595-6306.
Juried show–Alabama Woodworkers Guild, June 4–8. South Central Bell headquarters building lobby, 600 N. 19th St., Birmingham, 35203. (205) 870-4729.

ARKANSAS: **Juried exhibit**–International Turned Objects Show, May 26–July 23. Arkansas Art Center Decorative Arts Museum, 7th and Rock Streets, Little Rock. Mon. thru Sat., 10 A.M. to 5 P.M.; Sun., 12 to 5 P.M. For info., contact Sarah Tanguy, International Sculpture Center, 1050 Potomac St. N.W., Washington, DC 20007. (202) 965-6066.
Show–Spring Festival Arts & Crafts show, June 8–10. Newton County Fairgrounds, Highway 7, Jasper. Sponsored by the Newton County Arts & Crafts Guild. For info., contact Betty Carpenter, Box 58, Jasper, 72641. (501) 294-5555.

CALIFORNIA: **Workshops**–Various workshops including Japanese woodworking, joinery and sharpening. Contact Hida Tool Co., 1333 San Pablo, Berkeley, 94702. (415) 524-3700.
Convention–Wood Machinery Manufacturers of America and Woodworking Machinery Distributors' Association joint industry convention, Apr. 21–25. Hotel Del Coronado, Coronado. For info., contact WMMA, 1900 Arch St., Philadelphia, PA 19103. (215) 564-3484.
Exhibit–"Hands On! Objects Crafted in our Time," thru May. Craft and Folk Art Museum, 5800 Wilshire Blvd., Los Angeles. (213) 937-5544.
Show–The Sacramento Woodworking Show, May 4–6. Cal Expo & State Fair, 1600 Exposition Blvd., Sacramento. Contact Judy Polo, 1516 S. Pontius Ave., Los Angeles, 90025. (213) 477-8521.
Classes–Boatbuilding classes, May 5–6, May 12–13, June 9–16. National Maritime Museum Assoc., Bldg. 275, Crissy Field, San Francisco, 94129. (415) 929-0202.
Exhibition–Cardboard Furniture by Brian Gladwell, May 5–July 1. San Francisco Craft & Folk Art Museum, San Francisco. Featuring approximately 15 pieces of cardboard furniture by the Canadian woodworker. For info., contact Mary Ann McNicholas, Landmark Building, Fort Mason, San Francisco, 94123. (415) 775-0990.
Show–The Southern California Woodworking Show, May 11–13. Pasadena Center, 300 E. Green St., Pasadena, 91101. For info., contact Michelle Troop, 1516 S. Pontius Ave., Los Angeles, 90025. (213) 477-8521.
Show–9th annual College of the Redwoods Furniture show, May 19–June 3. Highlight Gallery, 45052 Main St., Mendocino, 95460. (707) 937-3132.
Juried festival–Artists Market, June 2–3. Long Beach Museum of Art, Long Beach. For info., contact the Museum, 2300 E. Ocean Blvd., Long Beach, 90803. (213) 439-2119.
Workshops–Basic carving with Robert Fowler, June 4–15; Tools and techniques with Jim Budlong, June 25–July 13. College of the Redwoods, 440 Alger St., Fort Bragg, 95437. (707) 964-7056.
Fair–Wood Fair '90, July 13–15. College of the Redwoods, 7351 Tompkins Hill Rd., Eureka, 95501. (707) 445-6966.

COLORADO: **Workshop**–Uses and applications of Hydrocote-brand finishes, May 17 & 19. Terry Locke Distributing, 2128 S. Kalamath St., Denver, 80223-4009. (800) 783-5772. Other dates and locations available upon request.
Classes–Woodworking and related classes, year-round. Red Rocks Community College, 13300 W. 6th Ave., Lakewood, 80401. (303) 988-6160.
Workshops–One- and two-week woodworking and furniture-design workshops, June thru Aug. Registration until then. Anderson Ranch Arts Center, Box 5598, Snowmass Village, 81615. (303) 923-3181.

CONNECTICUT: **Exhibition**–Rustic furniture by David Robinson, thru Apr. 29. SoNo. Contact Brookfield/SoNo Craft Center, Brookfield Alley at 127 Washington St., South Norwalk, 06854. (203) 775-4526.
Juried show–14th annual SoNo Arts Celebration, Aug 4–5. In the waterfront district of South Norwalk. Deadline: May 31. Contact Peter Kanter, SoNo Arts Celebration, Box 569, South Norwalk, 06856. (203) 849-9366.
Workshops–Various woodworking workshops, thru June. Contact Guilford Handcrafts, Box 589, 411 Church St., Guilford, 06437. (203) 453-5947.
Juried exhibitions–The Celebration of American Crafts, Nov. 11–Dec. 23. Deadline for slides: June 15. Gilding the Lily, Mar. 24–Apr. 20, 1991. Deadline for slides: Sept. 15. Both national juried/invitational events. For info on both, contact Creative Arts Workshop, 80 Audubon St., New Haven, 06510.
Juried exhibit–33rd annual handcrafts exposition, July 19–21. Guilford Green. For info., contact Guilford Handcrafts, Box 589, 411 Church St., Guilford, 06437. (203) 453-5947.
Workshops–Various woodworking workshops, thru July. Including router techniques, finishing furniture, tool sharpening, turning wood bowls and more. Contact Brookfield Craft Center, Box 122, Route 25, Brookfield, 06804. (203) 775-4526.

DELAWARE: **Exhibit**–Furniture by Wendell Castle, thru May 13. Delaware Art Museum. For info., contact Rochester Institute of Technology, 1 Lomb Memorial Dr., Box 9887, Rochester, NY 14623. (716) 475-5064.

DISTRICT OF COLUMBIA: **Juried show**–8th annual Washington Craft Show, Apr. 19–22. The Departmental Auditorium, 1301 Constitution Ave. N.W. For info., contact Smithsonian Associates Women's Committee, Arts and Industries Bldg., Room 1465, Smithsonian Institution, 20560. (202) 357-4000.
Exhibit–Tradition and Innovation: New American Furniture, Apr. 20–Sept. 3. Renwick Gallery, 17th St. & Pennsylvania Ave. N.W. For info., call (202) 357-2247.
Seminar–20th-Century Furniture: The Spirit of Design, Apr. 30–May 4. For info., contact MaryBeth Mullen, Smithsonian National Associate Program, 1100 Jefferson Dr. S.W. (202) 357-4700.
Exhibit–Culture and Commentary: An '80s Perspective, thru May 6. Hirshhorn Museum and Sculpture Garden, Smithsonian Institution, Independence Ave. at 8th St. S.W. Featuring works of 15 artists, including wood sculptor Jeff Koons. For info., call (202) 357-2700.

GEORGIA: **Classes**–Various woodworking classes, thru May. Including making a wooden plane, building a Windsor chair, chip carving, turning and more. Highland Hardware, 1045 N. Highland Ave. N.E., Atlanta, 30306. (404) 872-4466.
Show–A Salute to American Crafts, May 4–6. Atlanta Apparel Mart, Atlanta. Contact American Craft Enterprises, Box 10, New Paltz, NY 12561. (914) 255-0039.
Juried exhibition–International Woodworking Fair Design Competition, Aug. 24–27. Challengers Award competition deadline: June 1. Contact Shirley Byron, International Woodworking Machinery and Furniture Supply Fair, 8931 Shady Grove Court, Gaithersburg, MD 20877.
Exhibit–American Wildfowl Decoys, June 10–Aug. 4. Museum of Arts and Sciences, Macon. Contact Museum of American Folk Art, Lincoln Square, Columbus Ave. and 66th St., New York, NY 10023. (212) 595-9533.
Workshops–Japanese woodworking by Toshihiro Sahara. One Saturday each month, year-round. Contact Sahara Japanese Architectural Woodworks, 1716 Defoor Place N.W., Atlanta, 30018. (404) 355-1976.

ILLINOIS: **Show**–The Chicagoland Woodworking Show, Apr. 20–22. Odeum, 1033 N. Villa Ave., Villa Park, 60181. Contact Diane Johnson, 1516 S. Pontius Ave., Los Angeles, CA 90025. (213) 477-8521.

INDIANA: **Seminars**–Work Place Efficiency in the Wood Products Industry, May 2; Wood Machining Methods to Improve Surface Quality, May 3; Lumber Grading, June 4–8; Log Lumber and Tree Grading, June 5–7; Circular Sawmill Maintenance, June 8. Elkhart. For info., contact Michigan State University at (517) 355-6544.

IOWA: **Classes**–Woodcarving classes, Apr. 28 and June thru July. Vesterheim, Norwegian-American Museum, 502 W. Water St., Decorah, 52101. (319) 382-9681.
Juried fair–20th Art in the Park, May 19–20. Main Ave., Clinton. Contact Clinton Art Assoc., Box 132, Clinton, 52732. (319) 259-8308.
Juried exhibit–The Schnitzer, June 15–17. Amana. Carving celebration sponsored by Personalized Wood Products and the Millstream Brewing Co. For info., contact Schnitzer, Box 193, Amana, 52203. (319) 622-3100.

KANSAS: **Juried show**–Dimensions, 3-dimensional art show, June 8–10. Sar-Ko-Par Trails Park, Lenexa. For info., contact William Nicks, Jr., Dimensions, 13420 Oak St., Lenexa, 66215. (913) 541-8592.
Juried show–Topeka Competition 14, thru Apr. 26. For info., contact Gallery of Fine Arts, Topeka Public Library, 1515 W. 10th, Topeka, 66604. (913) 233-2040.

KENTUCKY: **Workshop**–Green wood chairmaking, Apr. 21–22. Berea. John Alexander, Jr. and Brian Boggs instructors. New Harmony Woodworks, 128 N. Broadway, Berea. (606) 986-9393.
Juried exhibit–International Turned Objects Show, thru May 6. Civic Center, Lexington. For info., contact Kentucky Woodworkers Association, Box 22108, Lexington, 40522. (606) 252-3289.
Workshops–Woodturning and joinery instruction, thru Oct. One day to one week. Contact Jim Hall, Adventure in Woods, 415 Center St., Berea, 40403. (606) 986-8083.

LOUISIANA: **Juried show**–Craftsmen's show, thru May 4. Louisiana Crafts Council Gallery, Baton Rouge. Contact LA Crafts Council, Box 1287, Baton Rouge, 70821. (504) 383-1782.

MAINE: **Show**–Woodworking World show, Apr. 27–29. Portland Expo Building, 239 Park Ave., Portland. For info., contact WANA, Box 706, Plymouth, NH 03264. (800) 521-7623, in NH (603) 536-3768.
Classes–Design and build, May 7–29, June 18–29. Shelter Institute, 38 Centre St., Bath, 04530. (207) 442-7938.
Exhibit–Works in wood by gallery artists, thru May 10. Nancy Margolis Gallery, 367 Fore St., Portland, 04101. (207) 775-3822.
Workshops–Various woodworking workshops, June 3–Aug. 31. Haystack Mountain School of Crafts, Box 87, Deer Isle, 04627. (207) 348-2306.

MARYLAND: **Juried fairs**–Sugarloaf's 15th annual spring arts & crafts fair, Apr. 20–22. Montgomery County Fairgrounds; Sugarloaf's 13th annual spring crafts festival, May 4–6. Maryland State Fairgrounds. Contact Deann Verdier, Sugarloaf Mountain Works, 20251 Century Blvd., Germantown, 20874. (301) 540-0900.

MASSACHUSETTS: **Workshops**–Cabinetmaking, Apr. 23–27; Finish carpentry, May 7–11, June 4–8; Timber framing, June 18–22, July 23–27. Washington. Contact Will Beemer, Heartwood, Johnson Hill Rd., Washington, 01235. (413) 623-6677.
Symposium–Collecting, May 5. Boston. Lectures on how to build a collection, insure it, appraisals, donations, more. Society for the Preservation of New England Antiquities, Otis House, 141 Cambridge St., Boston, 02114. (617) 227-3956.
Juried exhibit–Handmade for the '90s, June 30–Sept. 9. Entries deadline: May 5. The Berkshire Museum, 39 South St., Pittsfield, 01201. (413) 443-7171.
Juried exhibit–Annual May craft fair, May 18–20. Contact Worcester Center for Crafts, 25 Sagamore Rd., Worcester, 01605. (508) 753-8183.
Workshops–Various three- to six-day woodworking workshops, May 19–Oct. 8. Williamsburg. Contact Horizons Craft Program, 374 Old Montague Rd., Amherst, 01002. (413) 549-4841.
Workshops–One- or two-day workshops including bandbox making and making hand tools, thru June. Old Sturbridge Village, 1 Old Sturbridge Village Rd., Sturbridge, 01566. (508) 347-3362.
Fair–ACC Craft Fair, June 19–21 (trade), June 22–24 (public). Eastern States Exposition, West Springfield. For info., contact American Craft Enterprises, Box 10, New Paltz, NY 12561. (914) 255-0039.
Classes–Woodworking classes, throughout most of the year. Boston Center for Adult Education, 5 Commonwealth Ave., Boston, 02116. (617) 267-4430.

MICHIGAN: **Seminars**–Work Place Efficiency in the Wood Products Industry, May 3; Wood Machining, May 4; Grand Rapids. Also, Work Place Efficiency in the Wood Products Industry, May 4; Ludington. For info., contact Michigan State University at (517) 355-6544.
Seminar–The Construction of Superior Furniture Panels, May 17. Holiday Inn West, Kalamazoo. Sponsored by The Forest Products Research Society Great Lakes Section. Contact Anthony Weatherspoon, Michigan Department of Natural Resources, Box 30028, Lansing, 48909. (517) 335-3332.

NEBRASKA: **Show**–Nebraska Woodworking Show, May 4–6. Aksarben Field, 63rd & Shirley Streets, Omaha, 68106. Contact: Diane Johnson, 1516 S. Pontius Ave., Los Angeles, CA 90025. (213) 477-8521.

NEW HAMPSHIRE: **Classes**–Classes in fine arts and studio arts. Manchester Institute of Arts and Sciences, 114 Concord St., Manchester, 03104.
Classes–Various craft classes, including woodworking, year-round. Contact The Hand & I, Box 264, Route 25, Moultonboro, 03254. (603) 476-5121.
Workshops–Various violin-crafting workshops, June 4–Aug. 17. UNH Violin Craftsmanship Institute, Brook House, 24 Rosemary Lane, Durham, 03824. (603) 862-1088.
Retreat–Woodworking retreat, July 22–26. Waterville Valley Resort & Conference Center, White Mountain National Forest. Contact WANA, Box 706, Plymouth, 03264. (800) 521-7623.

NEW JERSEY: **Juried show**–11th annual woodcarving show, June 2–3. Wheaton Village Glass Museum, Millville. 10 A.M. to 5 P.M. Presented by the South Jersey Wood Carvers. Contact Jack Raleigh, 716 Wood Lane, Cinnaminson, 08077. (609) 829-8731.
Workshops–Various two-day through eight-day woodworking workshops, beginning June 9–10. Contact Peters Valley Craft Center, Layton, 07851. (201) 948-5200.

NEW MEXICO: **Classes**–Building the Norwegian Pram, Apr. 20–22, 28–29. Taught by Simon Watts. Sponsored by Albuquerque Woodworkers' Association. Contact Jim Linke, 1414 Silver St., Albuquerque, 87106. (505) 243-7234.
Workshops–Seamless marquetry, Apr. 21; cabinet car-

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cases and face frames, May 12; cabinet-door construction, June 9; everything about a tablesaw, July 14; varnishing, Aug. 11. Contact Albuquerque Woodworkers' Association, Box 36133, Albuquerque, 87176-6133.

***NEW YORK:* Juried show**–Chautauqua Crafts Festival '90, July 6–8, Aug. 10–12. Bestor Plaza, Chautauqua Institution, Chautauqua. Deadline: Apr. 20. Sponsored by the Chautauqua Crafts Alliance. For info., contact Gale Svenson, Chautauqua Crafts Festival '90, Box 89, Mayville, 14757.
Exhibit–Inaugural exhibition of furniture coinciding with gallery opening, May 12. 7 to 9 P.M. Genoa Gallery, 2 Genesee St., Skaneateles. (315) 497-3000.
Classes–Various woodworking classes. Constantine, 2050 Eastchester Rd., Bronx, 10461. (212) 792-1600.
Classes–Woodworking classes at all levels. Contact The Craft Students League, 610 Lexington Ave. at 53rd St., New York, 10022. (212) 735-9732.
Workshops–Hand-tool workshops with Robert Meadows, Apr. 21–22, May 5–6, June 23–24. The Luthierie, 2449 W. Saugerties Rd., Saugerties, 12477. (914) 246-5207.
Exhibit–2nd annual open house & lecture series, featuring student exhibition, Apr. 28–29. Genoa, Box 250, Academy St., Genoa, 13071. (315) 497-3000.
Exhibition–13th annual Wood Carving Exhibition, May 5–6. Creative Arts Building, Erie County Fair Grounds, Hamburg. Contact Mark Wagner, Southtowns Wood Carvers of Western New York at (716) 681-9412.
Show–12th annual Great Neck Celebrates Crafts, May 6. Middle Neck Rd., Old Village, Great Neck. Contact Creative Faires, Box 1688, Westhampton Beach, 11978. (516) 288-2004.
Fair–American Craft at the Armory, May 11–13. 7th Regiment Armory, New York City. Contact American Craft Enterprises, Box 10, New Paltz, 12561. (914) 255-0039.
Juried show–Lilac Art Show, May 19–20. Highland Park, Rochester. Contact Arts for Greater Rochester, 335 E. Main St., Suite 200, Rochester, 14604. (716) 546-5602.
Fair–International Contemporary Furniture Fair, May 20–23 (public May 23 only). Jacob Javits Convention Center, New York City. For info., contact George Little Management, 2 Park Ave., Suite 1100, New York, 10016. (212) 686-6070.
Juried fair–Woodstock-New Paltz Art & Crafts Fair, May 26–28. Ulster County Fairgrounds, New Paltz. Contact Quail Hollow Events, Box 825, Woodstock, 12498. (914) 679-8087.
Juried exhibit–Northeast fine crafts exhibit, thru May 31. Schenectady Museum & Planetarium. Contact Marlene Scholl, Nott Terrace Heights, Schenectady, 12308. (518) 399-8381.
Conference–6th annual National Conference of the Timber Framers Guild of North America, June 14–17. Rensselaer Polytechnic Institute, Troy. Contact Julie Benson, Timber Framers Guild, Box 1046, Keene, NH 03431. (603) 835-6170.
Juried exhibition–Clearwater's Great Hudson River Revival, June 16–17. Westchester Community College, Valhalla. For info., write to 112 Market St., Poughkeepsie, 12601. (914) 454-7951.
Festival–1st Albany Wooden Boat Fest, June 23–24. Corning Preserve on the banks of the Hudson River. Sponsored by North River Boatworks and the City of Albany. Contact North River Boatworks, 6 Elm St., Albany, 12202. (518) 434-4414.
Juried show–14th annual American Crafts Festival, June 30–July 8. Lincoln Center, New York City. Contact American Concern for Artistry and Craftsmanship, Box 650, Montclair, NJ 07042. (201) 746-0091.
Competition–International Art Competition, Aug. 10–31. Marcuse Pfeifer Gallery, New York City. Slide deadline: June 30. Multimedia competition, including wood and furniture. For info., contact I.A.C., Box 1058, Lodi, NJ 07644. (201) 646-0222.
Meetings–New York Woodturners Association, first Tuesday of each month. Woodturning techniques and exhibits also. Crafts Student League, YWCA, 610 Lexington Ave., New York City.

***NORTH CAROLINA:* Exhibit**–American Wildfowl Decoys, thru May 12. Folk Art Center, Asheville. Contact Museum of American Folk Art, Lincoln Square, Columbus Ave. and 66th St., New York, NY 10023. (212) 595-9533.
Workshops–Various woodworking workshops, beginning May 14. Penland School, Penland, 28765. (704) 765-2359.
Juried show–Highland Heritage Art & Craft show, June 14–17. Asheville Mall. Contact Gail Gomez, High Country Crafters, 46 Haywood St., Asheville, 28801. (704) 254-7547.
Classes–Five- and six-day woodworking classes, beginning June 25. Including ladderback chairmaking, Scandinavian woodcraft, Windsor chairmaking, Swedish woodenware and more. Contact Country Workshops, 90 Mill Creek Rd., Marshall, 28735. (704) 656-2280.

***OHIO:* Workshop**–Spray Finishing Technology, May 7–11. Technical Training Center, DeVilbiss Co., Toledo. Sponsored by Bowling Green State University and the DeVilbiss Co. For info., contact Dr. Richard Kruppa at (419) 372-7560.

***OKLAHOMA:* Festival**–24th annual Festival of the Arts, Apr. 24–29. Festival Plaza and Myriad Gardens, Oklahoma City. For info., contact Arts Council of Oklahoma City, 400 W. California, Oklahoma City, 73102. (405) 236-1426.
Show–Oklahoma City Woodcarver Club Show and Sale, June 1–3. Penn Square Mall, Oklahoma City. For info., contact Jim Crist, 2000 N. Purdue, Oklahoma City, 73127. (405) 943-8107.

***OREGON:* Seminars**–Bird carving, May 6; stool design and construction, May 19–20. Contact the Oregon School of Arts and Crafts, 8245 S.W. Barnes Rd., Portland, 97225. (503) 297-5544.
Competition–Table, Lamp & Chair Design regional competition, Apr. 29–May 12. Design workshops in conjunction with show, May 5–6. Contact Lynda Anderson, 2701 N.W. Vaughn St., Suite 608D, Portland, 97201. (503) 224-9178.
Juried show–International Teaparty, May 13–June 16. Contemporary Crafts Gallery, 3934 S.W. Corbett Ave., Portland, 97201. (503) 223-2654.

***PENNSYLVANIA:* Workshops**–Various woodworking workshops, thru April. Including Shaker furniture and Windsor chairs. Olde Mill Cabinet Shoppe, 1660 Camp Betty Washington Rd., York, 17402. (717) 755-8884.
Juried exhibition–Contemporary Philadelphia Artists, Apr. 22–July 8. Philadelphia Museum of Art, Benjamin Franklin Pkwy., Box 7646, Philadelphia, 19101-7646. (215) 236-4465.
Juried exhibitions–Pull Up A Chair: A Contemporary Seating Exhibition, Aug. 11–Sept. 23. Deadline: Apr. 25. National competition. Also, Fish Images: A Competition, May 5–June 10. Also, national juried exhibition of contemporary crafts, Oct. 6–Nov. 4. Deadline: July 6. For info., contact Lynn Berkowitz, Luckenbach Mill Gallery, 459 Old York Rd., Bethlehem, 18018. (215) 691-0603.
Fair–Spring Pennsylvania Crafts Fair, Apr. 29. Featuring the Pennsylvania Craft Guild. Brandywine River Museum, Box 141, Chadds Ford, 19317. (215) 388-7601.
Juried show–Studio Days '90, Sept. 21–30. Open to DE, DC, MD, NJ, PA, VA, WV. Entries deadline: Apr. 30. Contact Chester Spring Studio, Chester Springs. (215) 827-7277.
Festival–Spring Craft Celebration, May 19–20. Tyler

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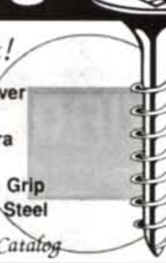

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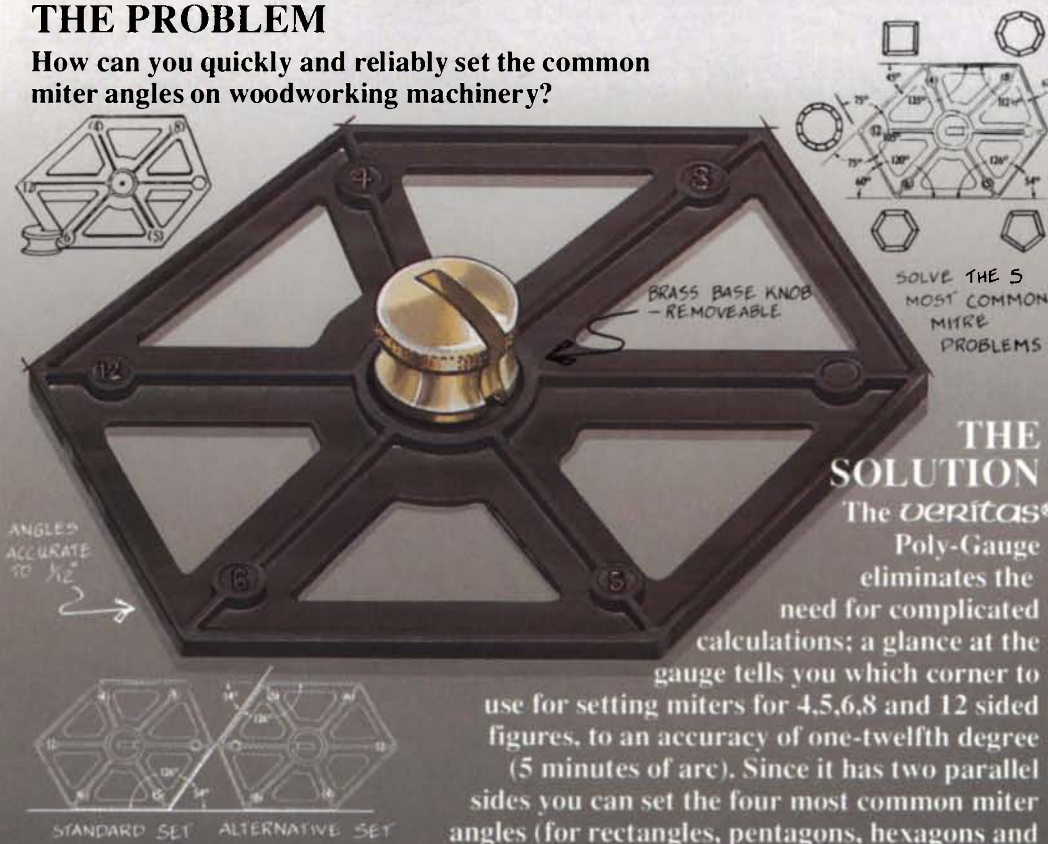

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READER SERVICE NO. 61

State Park. Contact Pennsylvania Designer-Craftsmen, Box 718, Richboro, 18954. (215) 860-0731.
Show–7th annual woodcarving and wildlife art show & sale, June 9–10. Penn State University, Route 352, Lima. Sponsored by William Rush Woodcarvers. Contact Bob Young, 736 Oak Way, Havertown, 19083. (215) 446-8945.
Workshops–Woodcarving workshops, June 11–Sept. 28. Including bird carving, relief carving, sculpting with wood, woodcarving & clay sculpture, more. Also, woodcarving show, July 7–8. Contact Sawmill Center for the Arts, Cooksburg, 16217. (814) 677-3707.
Educator symposium–The Use of the Lathe: Ideas for the Classroom, June 22–24. George School, Newtown. Instructors include Allen Androkites, Leo Doyle, Albert LeCoff, Rude Osolnik, Mark Sfirri, Palmer Sharpless, Del Stubbs. Contact The Wood Turning Center, Box 25706, Philadelphia, 19144. (215) 844-2188.
Festival–Pocono State Craft Festival '90, June 23–24. Shawnee Inn Resort. Contact Pennsylvania Designer-Craftsmen, Box 718, Richboro, 18954. (215) 860-0731.
Exhibition–Lathe-Turned Objects: Trends, Transitions, Tradition, thru July 15. Woodmere Art Museum, Chestnut Hill. Featuring objects made between 1700 and 1990. For info., call Woodmere Art Museum: (215) 247-0476.

***SOUTH CAROLINA:* Juried show**–13th annual Piccolo Spoleto Crafts Fair, June 1–3. Gaillard Auditorium, Charleston. Contact South Carolina Crafts Association, 1314 Lincoln St., Suite 308, Columbia, 29202. (803) 779-8200.

***TENNESSEE:* Exhibits**–From Here to There: Vehicles for New Forms/New Functions, thru May 19; Rude Osolnik: A Retrospective, thru May 19. Arrowmont School of Arts and Crafts, Box 567, Gatlinburg, 37738. (615) 436-5860.
Workshops–Various woodturning workshops, June 4–Aug. 10. Contact Arrowmont School of Arts and Crafts, Box 567, Gatlinburg, 37738. (615) 436-5860.
Juried exhibition–Woodturning: Vision and Concept II, Oct. 24–Dec. 8. Entries deadline: June 30. Contact Arrowmont School of Arts and Crafts, Box 567, Gatlinburg, 37738. (615) 436-5860.

***TEXAS:* Show**–Texas Arts and Crafts Fair, May 26–27, June 2–3. On the grounds of Schreiner College, Kerrville. For info., contact Texas Arts and Crafts Foundation, Box 1527, Kerrville, 78029. (512) 896-5711.

***UTAH:* Show**–Utah Woodworking show, Apr. 27–29. Salt Palace, 100 S.W. Temple St., Salt Lake City, 84101. Contact Michelle Troop, 1516 S. Pontius Ave., Los Angeles, CA 90025. (213) 477-8521.

***VIRGINIA:* Juried show**–15th annual Richmond Craft and Design show, Nov. 16–18. Richmond Centre, Richmond. Entries deadline: June 1. Sponsored by the Hand Workshop. For info., contact Barbara Hill, Hand Workshop, 1812 W. Main St., Richmond, 23220. (804) 353-0094.
Exhibit–Furniture by Wendell Castle, June 19–Aug. 19. Virginia Museum of Fine Arts, Richmond. For info., contact Rochester Institute of Technology, 1 Lomb Memorial Dr., Box 9887, Rochester, NY 14623. (716) 475-5064.

***WASHINGTON:* Classes**–Boatbuilding classes, May 5–June 30. Northwest School of Wooden Boatbuilding, 251 Otto St., Port Townsend, 98368. (206) 385-4948.
Classes–Various boatbuilding classes, April thru June. Center for Wooden Boats, 1010 Valley St., Seattle, 98109. (206) 382-2628.
Exhibitions–Dinner for Eight, thru May 31. Dining sets by Ed Steckmest. Vignette mixed-media show, thru June 30. Work by Michael Davock, June 7–July 29. Northwest Gallery, 202 First Ave. S., Seattle, 98104. (206) 625-0542.
Classes–Various woodworking classes, beginning in April. Contact Port Gamble Klallan Tribe, Box 280, Kingston, 98346. (206) 638-2794.
Exhibit–Woodworking and furniture by area artists on display, year-round. Artwood, 1000 Harris Ave., Bellingham, 98225. (206) 647-1628.

***WEST VIRGINIA:* Class**–Chip Carving, Apr. 23–29. Augusta Heritage Center, Davis & Elkins College, Elkins, 26241. (304) 636-1903.
Conference–The Hardwood Industry in the '90s, May 17–19. Charleston. For info., contact Susan Biggs, Institute for International Trade Development, 1050 4th Ave., Huntington, 25701-9958. (304) 696-6273.
Workshops–Woodturning with Del Stubbs and progressive Windsor chairmaking with Randall Fields, June 15–17. Crafts Center, Cedar Lakes, Ripley, 25271. (304) 371-7005.

***WISCONSIN:* Exhibition**–Reseated, thru May 13. Featuring works that use the chair as medium, subject matter and/or object. Contact Reseated, Exhibitions Dept., JMKAC, Box 489, Sheboygan, 53082. (414) 458-6144.

***CANADA:* Juried show**–3rd annual Quinte Wood Show, Apr. 20–22. Ben Bleecker Auditorium, Fairgrounds, Belleville, Ont. Contact The Quinte Wood Show, Box 973, Belleville, Ont., K8N 5B6. (613) 966-5564.
Exhibit–Turned vessels by Ted Hodgetts, Apr. 26–May 25. Centre de Loisirs Culturels, 7 rue Aurora, Kapuskasing, Ont. (705) 335-8461.
Seminars–Quality assurance, May 7–11; lumber manufacturing & recovery, June 4. Council of Forest Industries, Lumber Operations Services, 1200-555 Burrard St., Vancouver, B.C., V7X 1S7. (604) 684-0211.
Exhibit–Woodwork and carvings, May 22–June 2. Also, weekend workshop with Michael Fortune. Anna Leonowens Gallery, Nova Scotia College of Art and Design, 189 Granville St., Halifax, N.S. Contact the Atlantic Woodworkers' Association, Box 3501, Halifax South, N.S., B3J 3J2. (902) 827-3676.
Show–The Calgary Woodworking Show, June 1–3. Calgary Stampede, 1410 Olympic Way S.E., Calgary, Alta. For info., contact Irene Devine, 1516 S. Pontius Ave., Los Angeles, CA 90025. (213) 477-8521.
Class–Building the Nova Scotia skiff, Sea Urchin, June 23–30. Contact Wooden Boat Society, Box 787, Duncan, Vancouver Island, B.C., V9L 3Y1. (604) 746-5789.
Exhibit–Turned vessels by Ted Hodgetts, July 5–29. Art Gallery of Peterborough, 2 Crescent St., Peterborough, Ont., K9J 2G1. (705) 743-9179.
Workshops–Beginners' woodturning with Ian Waymark, July 16–18. Tools 'n Space Woodworking, 338 Catherine St., Victoria, B.C., V9A 3S8. (604) 383-9600.
Meetings–Canadian Woodturners Assoc. meetings, throughout the year. Second Tuesday of each month. Contact Bob Stone, Box 8812, Ottawa, Ont., K1G 3J1. (613) 824-2378.

***ENGLAND:* Exhibit**–Parnham at Smith's Gallery, June 26–30. Smith's Gallery, 56 Earlham St., WC2. Featuring furniture designers and makers. Also, woodworking courses, beginning July 15. Contact Laetitia Powell, Parnham, Beaminster, Dorset, DT8 3NA. (0308) 862204.

***PUERTO RICO:* Exposition**–World Expo for Woodworking Machinery and Furniture Supply, June 15–17. Roberto Clemente Coliseum, San Juan. For info., contact WEWC, Box 11228, Caparra Heights, 00922. (809) 751-6900.

***SWITZERLAND:* Tour**–Woodworking/woodcarving tour, Sept. 25–Oct. 8. For info., contact Wayne Barton, Alpine School of Woodcarving, 225 Vine Ave., Park Ridge, IL 60068. (708) 692-2822.

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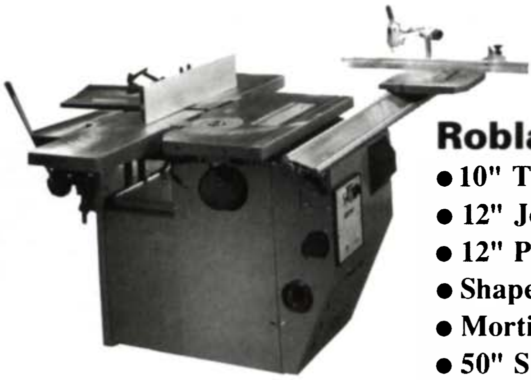

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23-880	8" bench grinder ½ H.P.	136	109
23-980	10" bench grinder 1 H.P.	246	235
11-950	8" drill press	164	135
14-040	14" drill press	313	309
40-150	15" hobby scroll saw	178	139
28-160	10" hobby band saw	189	144
31-050	1" belt sander 2.0 amp.	93	78
31-460	4" belt/6" disc sander	178	139
31-340	"NEW" 1" belt/8" disc sander	226	175

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37-280	6" motorized jointer	440	379
50-179	¾ H.P. 2 stage dust collector	435	339
50-180	1 H.P. dust collector	535	439
50-181	2 H.P. dust collector	760	599
37-154	Deluxe DJ-15 6" jointer w/¾ H.P. motor	1288	1029
22-661	13" planer w/2 H.P. motor	1750	1095
33-050	"NEW" 8¼" Sawbuck	742	545
34-330	"NEW" 8¼" Table Saw 13A	321	209
34-670	10" motorized table saw	437	379
34-985	⅙ H.P. stock feeder	698	599
32-100	"NEW" stationary plate jointer	645	459
36-040	"NEW" 8¼ compound miter saw	216	155

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0219-1	9.6V cdlss. drill w/cse	277	165
0385-1	7.2V cdlss. drill w/cse	174	105
0224-1	⅜" drill 4.5A magnum	189	114
0234-1	½" drill 4.5A mag 0-850 rpm	199	107
0244-1	½" drill 4.5A mag 0-600 rpm	199	107
0222-1	⅜" drill 3.5A 0-1000 rpm	174	99
0228-1	⅜" drill 3.5A 0-1000 rpm	164	95
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0379-1	½" close quarter drill	243	149
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6546-1	Cdlss. screwdriver 200 & 400 rpm	120	75
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3002-1	Electricians rt angle drill	320	199
5399	½" D-hdle ham drill kit	304	175
1676-1	H.D. Hole Hawg w/cs	415	224
6511	2 sp SawZall w/case	214	125
6405	8¼" circle saw	219	129
6750-1	Drywall gun 0-4000 4.5A	154	95
6507	TSC SawZall w/case	229	129
6170	14" chop saw	430	275
6012	Orbital sander 3⅝"x7⅜"	189	115
6014	Orbital sander 4½"x9¼"	199	118
6305	6¼" cordless circle saw	299	175
8977	Var. temp heat gun	114	75
5397-1	⅜" v. spd. hammer drill kit	232	139
5371-1	½" v. spd. hammer drill kit	318	185
3107-1	½" v. spd. rt angle drill kit	340	195
6754-1	Drywall gun 0-4000 4.5A	179	119
6747-1	Drywall driver-0-2500	154	99
0230-1	⅜" drill 0-1700 rpm	179	105
3300-1	½" v spd magnum rt angle kit	299	179
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5455	⅞" polisher 1750 rpm	209	129
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8975	Heat gun	89	59
6365	7¼" circular saw	195	114
6366	7¼" circ saw w/fence & bld	204	119
6368	7¼" circ saw w/fence, bld & cse	233	129
0216-1	2 spd cordless drill Hi-torque	222	129
0235-1	½" drill keyless chuck mag	209	119
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LM72M010	Ripping	10"	24	57	36
LU73M010	Cut off	10"	60	70	44
LU87M010	Thin kerf	10"	24	60	39
LU88M010	Thin kerf	10"	60	74	44
LU98M010	Ultimate	10"	80	107	69
LU89M010	Non-ferrousmetal	10"	72	87	55
PS203	Gen'l Purp.	7¼"	24	25	19
PS303	Plywood	7¼"	40	36	25
SD306	6" Dado - Carbide			184	105
SD308	8" Dado - Carbide			196	109
F0	1¾"x⅝" Biscuits 1000-Qty.			32	27
F10	2⅛"x¾" Biscuits 1000-Qty.			32	27
F20	2⅜"x1" Biscuits 1000-Qty.			34	29
FA	Assorts Biscuits 1000-Qty.			34	29
WC106	6 pce. chisel set w/cse ¼"-1"			73	52
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5090DW	3⅜" saw kit, 9.6v	256	139
6010DWK	⅜" cordless drill kit, 7.2v	164	95
6010SDW	⅜" cordless drill, 7.2v	99	65
DA3000DW	⅜" angle drill, 7.2v	251	139
8400DW	Hammer drill kit, 9.6v	272	149
4390DW	9.6 volt cdls recip saw kit	230	128
4300DW	Jig saw kit comp., 9.6v	232	129
6012HDW	2 spd. driver drill w/clutch & case, 9.6v	236	117
6092DW	V/spd. drill, kit complete	250	123
6093DW	V/spd. drill w/clutch—complete	261	127
6891DW	Drywall gun 0-1400, 9.6v	237	135
632007-4	9.6 volt battery	48	30
632002-4	7.2 volt battery	40	28
5007NBA	7¼" saw w/elec. brake	233	128
5008NBA	8¼" saw w/elec. brake	284	158
BO4510	¼ sheet pad sander	85	54
9900B	3"x21" belt sander w/bag	268	148
9924DB	3"x24" belt sander w/bag	282	149
9045N	½ sht fin. sand. w/bag	231	134
4200N	4⅜" circ saw 7.5 amp	225	127
4301BV	Orb v/sp jig saw 3.5 amp	289	155
JR3000V	Vs recip saw w/case	227	129
LS1020	New 10" miter saw	463	245
9820-2	Blade sharpener	373	209
1900BW	3¼" planer w/case	209	115
1911B	4⅜" planer 75 amp	240	139
1100	3¼" planer w/case	401	219
9207SPC	7" sander-polisher	276	155
3601B	1⅜ H.P. router	255	139
3700B	½ H.P. trimmer	190	115
9501BZ	4" grinder, 3.5 amp	126	75
BO4530	6" round sander	101	59
BO4550	¼" sheet pad sander w/bag	86	55
DA3000R	⅜" angle drill	270	148
6302	⅜" v/spd. 5.2 amp drill	209	125
HP2010N	¾" v/sp hammer drill w/cse	300	165
2708W	8¼" table saw	504	259
2711	10" table saw w/brake	841	489
2030N	12" planer/jointer	3120	1789
2040	15⅝" planer	2595	1489
1805B	6⅛" planer kit w/case	679	359
5005BA	5½" circular saw	223	135
6404	⅜" drill 0-2100 rpm, 2 amp.	104	65
6510LVR	⅜" drill rev. 0-1050 rpm	145	79
6013BR	½" drill rev. 6 amp	241	139
5402A	16" circular saw - 12 amp	636	349
3612BR	3 H.P. plunge router	377	195
9401	4"x24" belt sander w/bag	318	169
3620	1¼ H.P. plunge router w/cse	192	109
4302C	V/spd. orb. jig saw	302	159
5077B	7¼" Hypoid saw	252	138
LS1440	14" Miter saw	721	435
2414	14" cut-off saw AC/DC	351	205
5007NB	7¼" circ saw 13 amp	209	114
3612B	3 HP plunge router sq/base	377	195

SENCO AIR NAILERS

Model		List	Sale
SFN1	Finishing nailer 1" - 2"	377	269
SFN2	Finishing nailer 1½" - 2½"	571	395
SN325	Nailer 1⅞" - 3¼"	665	445
M2	General purpose 1⅜" - 2"	475	345
SN4	General purpose 2" - 3½"	685	469
LS2	Pinner ⅝" - 1"	351	255
SKS	Stapler ⅝" - 1½"	351	249
LS5	Pinner, 1"-1½"	399	285

SKIL SIZZLERS

Model		List	Sale
6850-02	"NEW" ½" EMH hammer drill w/case 4 amp	255	129
5510	(551) 5½" circ saw	112	105
5625	(552) 6½" circ saw	175	129
5656	(553) 7¼" circ saw	132	125
5750	(807) 7¼" circ - drop foot	198	145
5790	(810) 10¼" circ - drop foot	400	275
5825	(367) 6½" worm saw	229	155
5865	(825) 8¼" worm saw	250	164
4580	Vari - orbit jig saw w/cse.	144	105
3810	10" Miter saw	263	225
3810S	3810 w/60 tooth carb. blde.		239
7575	¼" palm sander	52	49
77	7¼" worm drive saw	230	145
5350	2½ HP circ. saw	80.99	77
5250	2¼ HP circ. saw	68.99	66
2735-04	12v v/spd. cordless drill complete w/cse. & 2 batt.	210	144

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MMT 500	NEW 24" multiple mortise & tenon jig	509	399
MMT	12" multiple mort. & tenon attachment for D1258-12	269	219
MMT	24" multiple mort. & tenon attachment for D1258-24	299	239

HITACHI TOOLS

Model		List	Sale
TR8	Plunge router, 1½ H.P.	219	119
M12V	NEW 3 H.P. var/spd. router	437	249
TR12	Plunge router, 3 H.P.	354	175
C10FA	10" dlxe. mitre saw	490	275
C12FA	"NEW" 12" mitre saw	586	339
C8FB	8½" slide compound saw	859	469
FREUD LU91M008	8½" c/bld 48 tooth	58	49
C15FB	15" miter saw	745	409
FREUD LU85M015	15" c/bld 108 tooth	181	115

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34-445—34-444	Table Saw complete w/30" Unifence	799.00
33-150	8¼" Saw Buck	485.00
28-283F	14" Band Saw w/enclosed stand & ¾ H.P. motor	699.00
70-200	NEW 20" Drill Press	709.00
17-900	16½" Floor Drill Press	385.00
40-601	18" Scroll Saw w/stand and blades	699.00

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PIRANHA By Black & Decker
CARBIDE TOOTH SAW BLADE

Model#	Diameter	#Teeth	List	Sale
73-716	6-1/2	18	13.70	7.35
73-756	6-1/2	36	30.45	16.85
73-717	7-1/4	18	13.90	7.99
73-737	7-1/4	24	17.20	9.29
73-757	7-1/4	40	31.30	16.79
73-758	8	40	43.80	24.85
73-759	8-1/4	40	44.65	24.99
73-719	8-1/4	22	19.65	10.95
73-739	9	30	32.35	16.79
73-769	9	60	68.35	35.99
73-715	5-1/2	16	13.70	7.49
73-704	7-1/4	18	20.20	12.85

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Model#	Diameter	#Teeth	List	Sale
73-740	10	32	33.20	15.95
73-770	10	60	61.46	29.95
73-711	10	50	65.08	29.95

JORGENSEN STEEL I-BAR CLAMPS

Model	Size	List	Sale
7224	24"	27.11	17.55
7236	36"	29.10	18.65
7248	48"	31.96	19.75
7260	60"	35.60	23.55

ADJUSTABLE HANDSCREWS BY JORGENSEN

Item No.	Jaw Length	Open Cap	List	Sale	Box of 6
#3/0	6"	3"	15.57	8.89	49.98
#2/0	7"	3½"	16.74	9.95	53.55
#0	8"	4½"	18.63	11.95	62.95
#1	10"	6"	21.30	12.99	71.49
#2	12"	8½"	24.45	15.95	81.89
#3	14"	10"	31.01	18.95	104.95
#4	16"	12"	40.30	24.89	146.85

STYLE 37 2½" Throat ¼"x¾" JORGENSEN

Item No.	Jaw Length	List	Sale	Box of 6
3706	6"	9.30	6.29	35.65
3712	12"	10.30	6.79	38.59
3718	18"	11.37	7.35	41.69
3724	24"	12.42	7.99	45.25
3730	30"	13.85	9.05	51.19
3736	36"	15.15	9.95	56.65

PONY CLAMP FIXTURES

Model		List	Sale	Lots of 12
50	¾" black pipe clamps	13.10	7.89	83.99
52	½" black pipe clamps	10.93	6.30	68.25

PANASONIC CORDLESS DRILLS

Model		List	Sale
EY6205B	NEW v/spd. 12 volt drill w/15 minute charger	390	219
EY6200B	NEW 2 spd. 12 volt drill d-hdle w/15 minute charger	350	195
EY6281B	NEW v/spd. 9.6 volt drill w/15 minute charger	350	198
EY571B	V/spd. 9.6 volt drill	239	135

BOSCH

Model		List	Sale
1581VS	Top hdle. jig saw	239	129
1582VSC	NEW "CLIC" Barrell jig saw	245	135
1582VS	Barrel grip jig saw	225	129
	Bosch metal case for above jig saws	34	30
	Bosch blade assortment for jig saws 30 of Bosch's best selling blades		25.99
1942	Heat gun 650°-900°	99	75
1272D	3"x24" belt sander w/bag	299	175
1273D	4"x24" belt sander w/bag	315	179
11-212VSR	Bulldog ¾" SDS rotary drill	339	195
1198VSR	½" v/spd hammer drill	229	135
1608	5.6 amp lam trimmer	140	89
1608L	Same as above w/trimguide	145	92
1609	5.6 amp offset base trimmer	205	122
1609K	Lam installers kit w/1609	295	169
1601	1 H.P. Router 25,500 rpm	165	105
1602	1½ H.P. Router 25,000 rpm	199	125
1603	1½ H.P. D handle router	223	137
1604	1¾ H.P. 2 hdle. router	219	119
1604K	Same as above w/cse & access.	269	169
1606	1¾ H.P. D hdle. Router	243	142
3258	3¼" planer w/blade guard	210	129
3270D	3"x21" belt sander w/bag 5A	225	135
1273DVS	V/spd. 4x24 belt sander	339	189
1611	3 H.P. plunge router	349	195
1611EVS	3 H.P. Var/spd. router	410	234
1651	7¼ circ. saw drop foot	179	109
1654	7¼ circ. saw pivot base	179	109
1632VSRK	Recip. saw 8.4A orb. v/spd.	225	135
3050 VSRK	"NEW" 9.6V v/spd. cdls. drill w/cse. & 2 batteries	235	135
3283DVS	"NEW" 5" Random orbit disc sander 2.3 amp	159	125

HEGNER SCROLL SAWS

Model		List	Sale
Multi Max II	w/stand	699	625
Multi Max 14	var./spd. w/stand	799	695
Multi Max 18	var./spd. w/stand	999	819

BOSTITCH AIR NAILERS

Model		List	Sale
N80C-1	Utility coil nailer	795	395
N80S-1	Stick nailer	795	395
T36-50	Sheathing & decking stapler	595	334
N12B-1	Coil roofing nailer	795	395
N60FN-2	Finishing nailer	625	335
T31	Brad nailer	245	149

ELU BY BLACK & DECKER

Model	Description	List	Sale
3338	2¼ H.P. var/spd plunge router	387	255
3337	2¼ H.P. plunge router	356	238
3304	1 H.P. var/spd plunge router	261	178
3375	3⅛" universal planer 72 amp	280	188
3380	Biscuit jointer/spliner w/case	485	325
4024	3x21" var/spd belt sander	289	195
3303	1 H.P. plunge router	210	159
4023	3x21" belt sander 5.2 amp	261	185
4029	4x24" belt sander 9.2 amp	469	319

BLACK & DECKER

Model		List	Sale
1166	⅜" drill 0-2500 rpm 4 amp	96	59
2600	⅜" drill 0-1200 rpm 4.5amp	125	85
1707	8½" crosscut miter saw	813	449
1703	10" miter saw w/73-770 blade	313	179
3157	Orbital var/spd jig saw	203	125
3153	Variable speed jig saw	195	120
3047-09	7¼" super saw cat w/brake	282	168
3048-09	8¼" super saw cat w/brake	297	179

BIESEMEYER FENCES

50" commercial saw fence	329	285
52" homeshop saw fence	249	225

JET TOOLS

Model	Description	List	Sale
JBS-14MW	14" band saw, 1 H.P.	482	385
JTS-10	10" table saw w/stand, 1½ H.P.	554	459
JTS-12	12" table saw w/stand, 1½ H.P.	630	509
JWS-18	½" spindle shaper w/stand, 1 H.P.	479	375
JJ-4	4" jointer, ½ H.P.	310	285
JJ-6	6" jointer, ¾ H.P.	465	379
JWP12	12½" bench planer, 2 H.P.	569	359
JWP12D	Dust chute for JWP12	45	22
JSG-6	6" x 48" belt & 12" disc sander, 1½ H.P.	634	465
DR1458	14" bench drill press, ½ H.P.	279	259
DR1758	17" bench drill press, ½ H.P.	319	279
DR1458F	14" floor drill press, ¾ H.P.	369	325
DR1758F	17" floor drill press, ¾ H.P.	395	339
DR2501F	20½" floor drill press, 1 H.P.	655	519

RYOBI SPECIALS

Model	Description	List	Sale
R500	2¼ H.P. plunge router	326	155
TS251U	10" miter saw	392	185
TS251US	10" miter w/acc. kit & B & D 73-770 carbide blade	435	225
AP10	10" surface planer 13 amp.	820	358
RA200	8¼" radial arm saw	515	249
RE600	3 H.P. plunge router	398	215
R150K	1 H.P. plunge router w/cse	206	105
BE321	3"x21" v/spd. belt sander	259	135

PORTER CABLE

690	1½ H.P. router 8 amp	225	128
691	1½ H.P. router D hdle	245	137
536	1½ H.P. speedmatic router	310	195
518	3 H.P. 5 speed router	560	338
520	3 H.P. 15 amp router	510	315
695	1½ H.P. router/shaper	310	198
696	H.D. shaper table	170	119
351	3"x21" belt sander w/o bag	225	125
352	3"x21" belt sander w/bag	235	133
360	3"x24" belt sander w/bag	310	175
361	3"x24" belt sander w/o bag	290	169
362	4"x24" belt sander w/bag	325	185
363	4"x24" belt sander w/o bag	310	179
315-1	7¼" tophdle 13 amp circ saw	195	115
9315-1	315-1 comp. w/cse. & carb. bld.	225	129
617	7¼" pushhandle 13 amp	195	115
9617	617 comp. w/cse. & carb. bld.	225	129
314	4½" trim saw 4.5 amp	215	128
9548	X HD bayonet saw w/case	290	192
9629	Recip saw v/sp 8 amp	235	137
9627	Recip saw 2 speed 8 amp	225	128
666	⅜" H.D. v.sp drill 0-1200 rpm	185	122
621	⅜" H.D. v spd. 0-1000 rpm	155	95
320	Abrasive plane 3 amp	160	109
9118	Porta plane 7 amp kit	335	185
7545	0-2500 drywall gun 5.2 A	169	104
7540	0-4000 5.2 amp gun	165	102
505	½ sheet pad sander	195	109
7511	⅜" v. spd. drill 5.2 amp	185	112
7514	½" v. spd. drill 0-750	195	119
537	1½ H.P. D hdle router	325	205
7548	Top hdl jig saw 4.8 amp	230	129
7648	Barrel grip jig saw 4.8 amp	225	139
330	Speed block sander ¼ sht	97	55
555	Plate biscuit jointer w/cse.	299	165
345	6" saw boss 9 amp	170	99
9345	345 comp. w/cse. & carb. bld.	220	129
5060	"Stair Ease" stair templet	194	129
5061	"Stair Ease" hard wood	204	135
100	⅞ H.P. router	165	105
5008	Dovetail template kit	99.50	79
5009	Mortise & Tenon jig	54.95	49
5116	omni-jig	395	265
9647	TIGER CUB recipro saw	195	119
9850	12 volt cordless drill w/cse.	230	129
8500	Extra 12v battery	48	35

NEW Tools By Porter Cable!

9637	Full v/spd recip saw 8 amp	240	135
7538	3¼ H.P. plunge router	399	249
7399	5.6 amp drywall cutout unit	120	75
7310	5.6 amp lam trimmer	145	89
7312	5.6 amp offset base lam trimmer	209	119
7319	5.6 amp tilt base lam trimmer	165	105
97310	LAM TRIM KIT W/STD. BASE, TILT BASE, OFFSET BASE, SLITTER BASE, GUIDE & CSE	330	185
7334	5" random orbit sander	205	119
693	1½ H.P. plunge router	280	165
6931	Plunge router base	120	75

7334K Kit includes: 7334 Sander 44350 case, w/1 roll of 100X & 150X discs
SUPER SPECIAL $149.95

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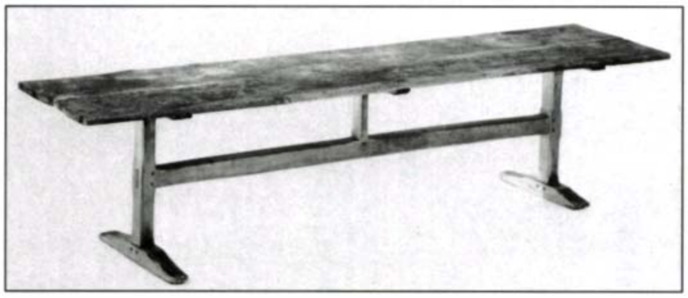
Photos this page: Courtesy of Museum of Fine Arts

Inspired by the trestle table below, right, "Mystery Robots Rip Off The Rain Forest," 31Hx30½Wx132D, is Edward Zucca's satirical piece on tropical deforestation. Zucca viewed the 11-ft. Honduran mahogany top "as a giant board from a giant tree that should not have been cut down." The evil robots seem symbolic of the furnituremakers' dilemma in using exotic woods.



Left: The ash base of Peter Dean's "Canyon Table," 30Hx27⅝Wx108D, is finished with acrylic paint and the top is book-matched curly ash with the natural edges butted along the centerline of the top. These rough edges create a canyon effect that implies "an inner energy, the bent-laminated tie beam, is breaking through to the outer world." Above: Benjamin Clark's trestle table, 26³⁄₁₆Hx24¾Wx108½D, is silver maple and white pine. The table, built between 1690 and 1720, is from the Medfield, Mass., area. Its workmanlike construction and simple lines had far different effects on Dean and Zucca.

New American Furniture makers hit the museum scene

The Boston Museum of Fine Arts recently concluded its exhibition of New American Furniture: work that 26 leading furnituremakers made specifically for this show. Realizing that current woodworkers are again taking a greater interest in historical design and furniture, the Museum invited these furnituremakers to a two-day symposium that preceded the exhibition. During this time, the participants discussed furnituremaking trends, traditions and production techniques, and they were challenged by the Museum to find inspiration in an historical piece of their choosing from the Museum's collection.

This was the first time the Museum had ever invited a group of artists to conceive and create pieces for a temporary exhibition. But the artists' overwhelming response, many producing their best work, demonstrated the diverse forms inspiration can take. Both Peter Dean's "Canyon Table," shown in the bottom, left photo above, and Edward Zucca's "Mystery Robots Rip Off The Rain Forest," shown in the top photo above, drew their inspiration from a trestle table attributed to Benjamin Clark (1644-1724), shown in the bottom, right photo above. While Dean's efforts captured the honest values and simple spirituality of the original piece, Zucca's humorous approach makes a statement on current world affairs.

The New American Furniture exhibition will be on display at the Renwick Gallery of the Smithsonian Institution, Washington, D.C., from April 20 through Sept. 3, 1990 and at the Contemporary Arts Center in Cincinnati, Ohio, from Nov. 9, 1990 through Jan. 8,

DELTA

34-782	10" 3 HP UNISAW W/ UNIFENCE
34-783	10" 5 HP 3 PH W/ UNIFENCE
43-375	3 HP 1 PH HD/Shaper
37-350	8" DJ-20 Joiner W/STAND
31-730	6" Belt 12" Disc
33-890	12" RADIAL ARM SAW
40-601	18" VS SCROLL SAW
33-990	10" RADIAL ARM SAW
22-661	DC 33 13" PLANER
50-179	3/4 HP DUST COLLECTOR
50-180	1 HP DUST COLLECTOR
50-181	2 HP DUST COLLECTOR
34-985	1 PH STOCK FEEDER 110V
34-994	1 PH STOCK FEEDER 230V
34-995	3 PH STOCK FEEDER 230V
33-150	8-1/4" SAW BUCK
34-444	10" CONTR. SAW COMPLETE
31-380	4" X 132" EDGE SANDER
34-670	10" MOTORIZED SAW
40-150	15" SCROLL SAW
31-050	1" X 30" SANDER
23-700	WET DRY GRINDER
31-460	4" BELT 6" DISC
17-900	16-1/2" DRILL PRESS
34-897	DELTA UNIFENCE

EMGLO

AM39-HC4V3/4 HP TWIN TANK	$268
AM78-HC4V1-1/2 HP TWIN TANK	298

BOSCH

1611	3 HP PLUNGE ROUTER	$193
1604	1-3/4 HP ROUTER	119
1604K	1-3/4 HP ROUTER KIT	159
1606	1-3/4 HP D-HANDLE ROUTER	135
1608	5.6 AMP. LAM. TRIMMER	79
1609K	3 IN 1 TRIMMER KIT	163
3270D	3 X 21 SANDER W/BAG	126
1272	3 X 24 SANDER	163
1272D	3 X 24 SANDER W/BAG	168
1273DVS	4 X 24 VARIABLE SPEED SANDER W/BAG	188
3050VSRK	9.6V CORDLESS W/CLUTCH	129
91066	1/2" MIGHTY MIDGET VSR	108
1347	4-1/2" MINI-GRINDER	84
1654	7-1/4" SAW W/CT BLADE	98
1581VS	TOP HANDLE JIG SAW	127
1632VSK	VS RECIP. SAW W/CASE	129

HITACHI

C-8FB	8-1/2" COMPOUND MITER SAW	$469
C-15FB	15" MITER SAW	389
TR-12	3HP PLUNGE ROUTER W/ACCES. VALUE AT $60	169

MAKITA

LS1430	14" MITER SAW	439
5402A	16-5/16" CIRC. SAW	329
5201NA	10-1/4" CIRC. SAW	299
5077B	7-1/4" HYPOID CIRC. SAW	139
5007NB	7-1/4" CIRC. SAW	114
5007NBA	7-1/4" CIRC. SAW W/ELEC. BRAKE	124
1900BW	3-1/4" PLANER W/CASE	113
1100	3-1/4" PLANER HD W/CASE	210
2708W	8-1/4" TABLE SAW	257
3612BR	3 HP PLUNGE ROUTER	199
3601B	1-3/8" HP D-HANDLE ROUTER	137
9030	1-1/8" X 21" BELT SANDER	135
9900B	3" X 21" BELT SANDER W/BAG	139
9924B	3" X 24" BELT SANDER	139
9924DB	3" X 24" BELT SANDER W/BAG	145
9401	4" X 24" BELT SANDER W/BAG	162
JR3000V	RECIPRO SAW W/CASE	121
6510LVR	3/8" VSR DRILL	85
6093DW	3/8" CORDLESS KIT 2SP VSR	129
EXTRA	9.6 VOLT BATTERY W/PURCHASE	26
B04510	4-3/8" X 4" FINISH SANDER	48

FREUD

JS-100	PLATE JOINER W/CASE	$153
EC-900	DOOR SYSTEM SHAPER SET	278
94-100	DOOR SYSTEM ROUTER SET	158
FB-107	7 PC. FORSTNER BIT SET	49
FB-100	16 PC. FORSTNER BIT SET	149
FT2000	ROUTER	185

SAW BLADES
5/8" BORE, INDUSTRIAL GRADE, CARBIDE TIPPPED

LU72M010	Gen. Purp. A.T.B.	10"	40	58	39
LU81M010	Gen. Purp.	10"	40	45	43
LU82M010	Cut-off	10"	50	77	45
LU84M011	Combination	10"	50	55	42
LU85M010	Super Cut-off	10"	80	95	57
LM72M010	Ripping	10"	24	57	38
LU73M010	Cut off	10"	60	70	44
LU87M010	Thin kerf	10"	24	68	39
LU88M010	Thin kerf	10"	60	74	44
LU98M010	Ultimate	10"	80	107	79
LU85M010	Non-ferrous metal	10"	72	87	65
PS203	Plywood	7-1/4"	40	36	25
PS303	Gen'l Purp.	7-1/4"	24	25	19

DS306	6" Dado - Carbide	184	105
DS308	8" Dado - Carbide	196	109
F0	1-3/4"x1/8" Biscuits 1000 Qty	32	27
710	2-1/8"x3/8" Biscuits 1000 Qty	32	27
F20	2-3/8"x1" Biscuits 1000 Qty	34	27
FA	Assorts Biscuits 1000 Qty	34	27
WC104	4 pc. chisel set w/cse. 1/4"-1"	54	39
WC106	6 pc. chisel set w/cse. 1/4"-1"	73	52
WC110	10 pc. chisel set w/cse. 1/4"-1-1/2"	119	79
FB100	16 pc. forstner bit set 1/4"-2-1/4"	284	149
94-100	5 pc. router bit door system	230	155
JS100	Biscuit Jointer w/cse.	300	153

ALL ROUTER BITS 35% OFF!!

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D1258-12—List 314.00—Sale 265.00
D1258-24—List 375.00—Sale 298.00
LEIGH INSTRUCTIONAL VIDEO—SALE 29.00!!

PORTER—CABLE

330	SPEED BLOC SANDER	$ 55
351	3 X 21 SANDER	118
352	3 X 21 SANDER W/BAG	124
360	3 X 24 SANDER W/BAG	175
361	3 X 24 SANDER	169
362	4 X 24 SANDER W/BAG	185
363	4 X 24 SANDER	181
617	7-1/4" SAW 13 AMP	114
315	7-1/4" SAW 13 AMP	114
314	4-1/2" TRIM SAW	124
690	1-1/2 HP ROUTER	121
9118	PORTA PLANE KIT	185
555	PLATE JOINER W/CASE	159
505	1/2 SHEET PAD SANDER	109

POWERMATIC

Model 66 Table Saw

50" Biesemeyer Rip Fence, 3HP 1PH or 5HP, 3 PH motor

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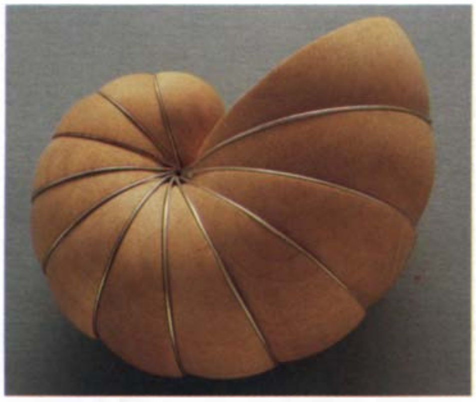
1991. Edward S. Cooke, Jr., assistant curator of American decorative arts and the driving force behind this exhibition, has put together a terrific catalog that includes a discussion of the development of the modern studio furnituremakers, beginning with the first-generation artists through to the dominance of the second-generation furnituremakers of the 1980s. The 131-page catalog features biographies of the artists along with 25 color and 79 black-and-white photos of their work, and is available for $23 from the Museum of Fine Arts, 465 Huntington Ave., Boston, Mass. 02115; (617) 267-9300.

—*Charley Robinson*

Photos below: Ted Wolff



Best of Show at the Woodturners of the Northeast 1990 exhibition went to Lottie Kwai Linn Wolff's 4-in. by 3¼-in. turned maple and sterling silver sculpture, "Spiral." She turned a series of 12 progressively smaller bowls, stacked them together and then bandsawed them in half.

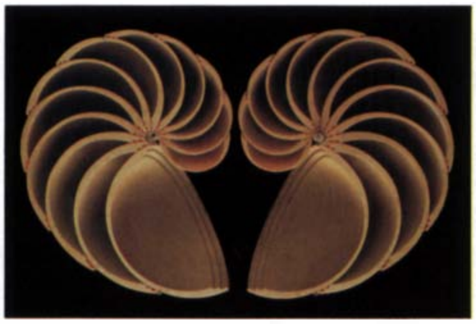


Photo: Gil Amiaga

David Ebner's 69-in.-high by 12-in.-dia. "Scallion Coat Rack" is made of bleached and painted ash.

Photo: Toby Winkler

The hand-carved surface of Toby Winkler's 6-in.-high by 9-in.-dia. red-oak bowl "Ripples on Water" is reminiscent of the windblown surface of a pond.

"Pedestal Table" by Aspy Khambatta has a 21-in.-high maple base. He made it by turning a design on the lower portion of the pedestal, quartering the spindle lengthwise, rejoining the quartered spindle with the turning inside and then turning the top portion to shape.

Photo: Courtesy of Ten Arrow Gallery

Other Boston exhibitions

This past winter, many galleries in and around Boston hosted furniture shows to coincide with the New American Furniture show at the Boston Museum of Fine Arts, reported on p. 112. Among these were the Ten Arrow Gallery, Cambridge, Mass., featuring Lathe-Turned Furniture and the Worcester Center for Crafts, cohost of Woodturners of the Northeast 1990 with the Central New England Chapter of the American Association of Woodturners.

The Ten Arrow Gallery, working with Albert LeCoff, director of the Wood Turning Center, Philadelphia, Pa., as a consultant, invited 12 nationally known craftsmen whose diverse designs in wood, metal and other materials are well represented in public and private collections. David Ebner, a full-time furnituremaker but occasional lathe-turner, exhibited his "Scallion Coat Rack," shown in the center photo. Many other pieces, as well, showed interesting applications of old techniques, like the "chatter"-turned legs on Mark Sfirri's table. Other artists combined lathe-turned pieces with further machining, such as the sectioned, spindle-turned legs of Peter Michelsen's chairs or the split-turned pedestal of Aspy Khambatta's table shown in the bottom, right photo above.

Woodturners of the Northeast 1990 is a traveling, juried exhibit that began its tour at the Worcester Center for Crafts, Worcester, Mass., and featured 26 artists from the New England states, New York, New Jersey and Pennsylvania. The pieces selected for inclusion in the exhibition have what the jurors (Michelle Holzapfel, Alan Stirt and Cyrus Lipsett) call "...the ability to draw the viewer into the piece emotionally and intellectually... and display a successful integration of what James Prestini has called 'heart and head and hand'." Lottie Kwai Linn Wolff's "Spiral," shown in the two left photos, won Best of Show. The maple and sterling silver sculpture opens to reveal its nautilus-like

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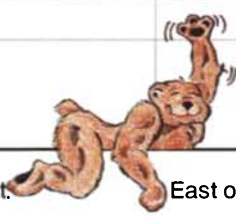

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chambers. "Ripples on Water," which is shown in the top, right photo on p. 114, is a red-oak vessel with carved textures by Toby Winkler of Grafton, Mass.

Woodturners of the Northeast 1990 has many open dates. For more information, contact Cyrus Lipsett at the Worcester Center for Crafts, 25 Sagamore Road, Worcester, Mass. 01605; (617) 753-8183.

—Carolyn Kovachik

New uses for old machinery

With the depressed price of scrap iron, the few dollars you receive for hauling an ancient woodworking machine to the salvage yard doesn't make it worthwhile. For boat owners, there are some alternatives; as moorings, the machines eliminate the need to buy a massive anchor or pour a large concrete block.

Not all machines are equally suited for this: spindle molders, for example, are hard to get a grip on; steel stands corrode rapidly and the cheaper models have too much plastic. There are some obvious considerations in selecting a machine, such as mass and a place to secure a chain. Less obvious is the necessity of having the machine lie flat on the bottom of the ocean floor so it doesn't snag fishing lines or tear the props off passing outboards.

An old bandsaw, lying on its side, works well. Jointers, 12 in. or larger, especially those with a cast-iron stand, make excellent moorings. You can slip a chain around the waist and they can usually be coaxed into lying flat. Use heavy chain, at least ¾ in. thick, with the same size shackle at the end. Tablesaws and planers will settle into mud pretty well, but I wouldn't use them on a sandy bottom. However, even a massive machine will slide around in rough weather on a rocky bottom.

The make of the machine is not crucial, but you'd do well to avoid machines of cast aluminum. Although aluminum machines might be able to moor a dinghy in a fresh-water lake, they are generally just too light to use in serious water and the aluminum castings corrode rapidly in saltwater.

As a rough guideline, you should allow at least 15 lbs. of iron for every foot of boat length. Thus, a 26-ft. boat needs a machine weighing about 400 lbs. If you can't find one this heavy, there's nothing wrong with chaining a couple of 200-lb. machines together.

If scrap prices rise or the particular machine you've chosen as a mooring comes back into favor, you can always raise it and restore it. If it has been in saltwater, rinse it off with a garden hose before using it. Marine growth is easily removed with a wire brush.

Before committing any machine to the deep, check with local ordinances or the U.S. Army Corps of Engineers. Be wary of sinking a popular machine, like an old Delta Unisaw, in clear water, as some passing woodworker might be tempted to raise it, cutting your boat loose in the process. There is a legal question of who actually owns a submerged machine. However, I have yet to have one stolen.

—Simon Watts, San Francisco, Cal.

Photo: Courtesy of David Stanley Auctions

This custom version of a Norris model A-11 miter plane recently sold for $8,200 at a London tool auction.

Miter plane: matter and myth

"Gold dust" is how a London rare-tool dealer once characterized the seldom-seen Norris-brand miter planes of prewar vintage. And he was right on the money. Last October, in one of his semiannual London tool auctions, David Stanley's gavel fell, sealing a bid of £5150—a tidy $8,200—for a custom version of the model A-11 miter plane (shown in the photo above) made half a century ago by Thomas Norris and Son of London. This bids fair to be the highest price ever paid for a single hand tool, but there's more here than meets the checkbook. Megabucks aside, the miter plane merits attention as a singular tool, significant in the evolution of the hand tools we use today, and still unrivaled in its original function.

Miter planes first appeared in the late 18th century and were probably the first metal planes to be routinely and continuously manufactured in modern times. Originally they were metallic versions of the bulky 10-in.- to 18-in.-long wooden miter-block and strike-block planes used for trimming endgrain and mitered pieces for accurate fit. This new metal tool was sometimes called simply a block plane in the United States and it is the direct ancestor of today's familiar little block plane.

The typical miter plane is a simple wood-filled rectangular metal box, 8 in. to 10 in. long, with a 2-in.- to 2½-in.-wide blade. The blade is mounted bevel up and at a considerable range of different angles: from 15° to 28°. Miter planes are sometimes used freehand on difficult face grain, but their broad-sided bodies are used to greatest advantage on shoot boards or donkey's-ear miter gauges to finish handsawn molding miters, as well as carcase miters on cabinets and keyboard instruments.

Almost all miter planes available today are antiques, priced in the medium-to-rare category, even when not well made. Modern makers, like Henley Plane Co. and Jamestown Tool Co. (both recently defunct), have supplied only one-of-a-kind custom models, priced in the multihundred-dollar range, about the same cost as a big-name-brand antique in excellent condition. A classic, late-Victorian miter plane originally cost about the same as a top-of-the-line metal smooth plane, roughly $150 to $200 in today's money. Any surviving miter planes, made by the dozen or so known historical tool makers other than Norris, today fetch between $200 and $1,000, depending on their condition and historical interest.

Norris miter planes are much scarcer than those by other makers and therefore command a higher price. Norris was late for the heyday of such tools and in its catalog around World War I, offered only the 10½-in.-long model no. 11: the "Improved Pattern." Older firms such as Spiers, Buck and Mathieson each offered as many as eight choices of miter planes.

In about 1938, a couple of years before its wartime hibernation, Norris produced a screw-adjustable cut on its miter plane; its model no. 11 was now the no. A-11 (A is for adjustable). All this was taking place about 75 years *after* American Leonard Bailey designed his adjustable-block miter, marketed by Stanley as the no. 9 "pianomaker's block plane." The new Norris adjustable model, with its sensible return to the old-fashioned oblong body pattern, somewhat resembles its American ancestor and both were World War II casualties: neither was reissued after the war. The Stanley, at least, had been available for a respectable period, from around 1868 to 1943. The Norris, on the other hand, died virtually a crib death. The wonder is that *any* made it onto the market in its brief two- to three-year period.

From an informal telephone survey I made recently, two or three Norris planes are accounted for besides the tool in question, which differs slightly because it's an adjustable version of the discontinued so-called "improved model" previously described. It is satisfying to note that this particular tool, Norris' last gasp in this genre, fittingly, was destined to be used as a pianomaker's plane: precisely the same traditional function as that described by Bailey for his Stanley no. 9, the *original* adjustable-block miter plane.

The high price of Norris miter planes is a reflection not only of the company's exceptionally low output, but of the prestige of the Norris name itself. This prestige is compounded by the fact that in the later years, public awareness of its rivals' names had dimmed. The Norris Co., almost alone among them, survived the

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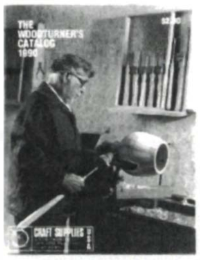

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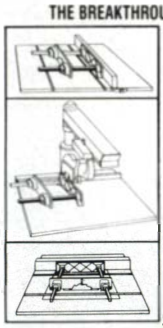

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1930s Depression and was even exhumed, briefly, after World War II. To postwar craftsmen, then, the varied Norris line of planes, even the somewhat debased, "austerity-years" versions from the late 1940s, remained the tools of choice. Norris, thus, finally advanced beyond being merely first among equals: the company became the *Last of the Mohicans.*

It's rare, with historical artifacts such as these, that we are afforded any knowledge of the person behind the tool. Usually the only thing you'll find is a cryptic set of initials stamped on a handle. I am indebted to auctioneer David Stanley for information about the original owner of the miter plane in the photo, Leslie Ward (1901-1980). Ward, who commissioned and may have specified some of this Norris miter plane's features, appears to have been an active agent in the ferment of early-20th-century high-technology woodworking. He apprenticed with no less than Thomas Sopwith, the designer of the World War I RAF aircraft, the *Sopwith "Camel."* In the early 1920s, Ward joined Arnold Dolmetsch (1858-1940), who was the most powerful force in the phenomenal 20th-century revival of historical musical-instrument manufacturing. The Dolmetsch factory in Haslemer, Surrey, England, occupies the site where those still-famous harpsichords, lutes, viols and recorders first saw light again, in this century, under the hands of such craftsmen as Ward and others who were in residence there. Ward remained head of the harpsichord and clavichord division until his retirement in 1966.

The extravagant 1989 price for Ward's Norris miter plane is an odd mix of reverence and irrationality. Today, the astronomical pricing of what is perceived as art is little questioned, even though what is art is ever more difficult to ascertain. This tool, at least, has both beauty and utility. And it is a piece of technological history—a cultural icon. How, in fact, *do* you objectively price a revered object? Especially given the dynamics of an auction, which reveals the marketplace at its most emotional; an arena of contradiction where, in heat of battle, cool reason is often overcome.

The successful bidder, Max Ott, is a longtime professional woodworker, tool collector and currently the owner and manager of a cabinet shop in London. The proud new owner, soberly, is reserving the tool for private use in his home workshop: Pleasure, not profit. But it's been that way for a long time. Commercially, the miter plane has always been a loser: it promotes quality unhurried—not quantity, requisite in the press of the late machine age.

—Maurice Fraser, New York, N.Y.

EDITOR'S NOTE: David Stanley Auctions are held twice a year in London. The next scheduled auction is Oct. 9, 1990. For information, contact David Stanley, Stordon Grange, Osgathorpe, Leicestershire LE12 9SR, England; 011 44 530 222 320.

Fish decoys on tour

Most people associate the term decoy exclusively with ducks, geese and other waterfowl. But recently there's been a resurgence of interest in fish decoys that for centuries were used in North America for ice spearfishing.

Fish decoys were usually carved white pine and painted to resemble actual species of fish, although some fishermen felt that bright colors and decoration that did not imitate nature were more effective in luring the fish they wanted. Decoys were weighted by filling a cavity in their underside with molten lead and they had a line attached through a screw eye or a hole in their back or fin. With spear in hand, the fishermen would lower the decoy into the water and move it back and forth to attract their prey. Fins fashioned from recycled metal and fragments of fish skin were sometimes added for realism and to stabilize the decoy in the water.

As evidence to the effectiveness of this fishing method, newspapers from the Lake Chautauqua region in western New York reported in January 1881, that 30,000 lbs. of pickerel (also known as northern pike) were taken by spear fishermen in a two-month period just prior to spawning. Commercial spearing in Lake Chautauqua was so extensive that by 1856, the lake district had begun regulating the sport and growing business.

These decoys, from the Lake Chautauqua area of New York, are among the oldest non-native examples in North America. The leather tails gave them "swimming" characteristics in water.

Restrictive laws were constantly revised, but greed and a total disregard for sensible game management forced the governor to abolish spearfishing on Lake Chautauqua in 1905. These legal statutes help to establish Chautauqua decoys as the earliest non-native examples in North America. Chautauqua decoys, such as those in the photo below and on the top shelf in the case on the back cover, are distinguishable by their leather tails, which could be bent to influence the decoy's "swimming" characteristics.

An exhibition of 200 fish decoys, ranging from ancient Eskimo and Indian decoys carved from bone to the carved and painted wooden decoys of the 20th century, was recently shown at the Eva and Morris Feld Gallery of the Museum of American Folk Art at Lincoln Square, New York, N.Y. Later this year, the exhibit will travel to Midland County Historical Society in Midland, Mich., for an Aug. 20 through Oct. 15 run, and then on to the Cleveland, Ohio, Museum of Natural History from Nov. 5 through Dec. 31. From there the exhibit is scheduled for shows in Milwaukee, Wisc., and Kamloops, B.C., Canada. For information and dates, call the Museum of American Folk Art at (212) 977-7298.

—Jim Boesel

Notes and Comment

Do you know something we don't about the woodworking scene in your area? Please take a moment to fill us in. Notes and Comment pays for stories, tidbits, commentary and reports on exhibits and events. Send manuscripts and color slides (or, black-and-white photos—preferably with negatives) to Notes and Comment, **Fine Woodworking,** ***Box 5506, Newtown, Conn. 06470-5506.***

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Ice fishermen have been using wooden fish decoys in the frozen freshwaters of North America since prehistoric times. The carved and painted decoys are lowered through a hole in the ice and played through the water on a line attached to each decoy's back. When a curious fish ventures too close, the fishermen impale their prey with a fork-like spear. Steven Michaan, of Pound Ridge, N.Y., became enamored with fish decoys about five years ago. Since then, he has amassed a large and impressive collection, a small portion of which is shown in the photo above in the custom-designed quilted-bubinga display case built by Michael Elkan Studios in Silverton, Ore.

Most fish decoys were tools and their value was determined by how well they attracted fish. But some makers developed distinctive styles and their work evolved into an art form. Foremost among such decoy carvers was Oscar "Pelee" Peterson (1886-1951), Cadillac, Mich., who made the fish on the middle two shelves in the photo. In addition to making more than 10,000 decoys, he carved and painted animal plaques, sculptures and other decorative objects such as the ¼-in.-thick trout in the back of the second shelf, which was once part of a mobile, and the 27-in.-long pike on the third shelf originally used as a trade sign at a store that carried his decoys. (For more on the decoys, see p. 118.)