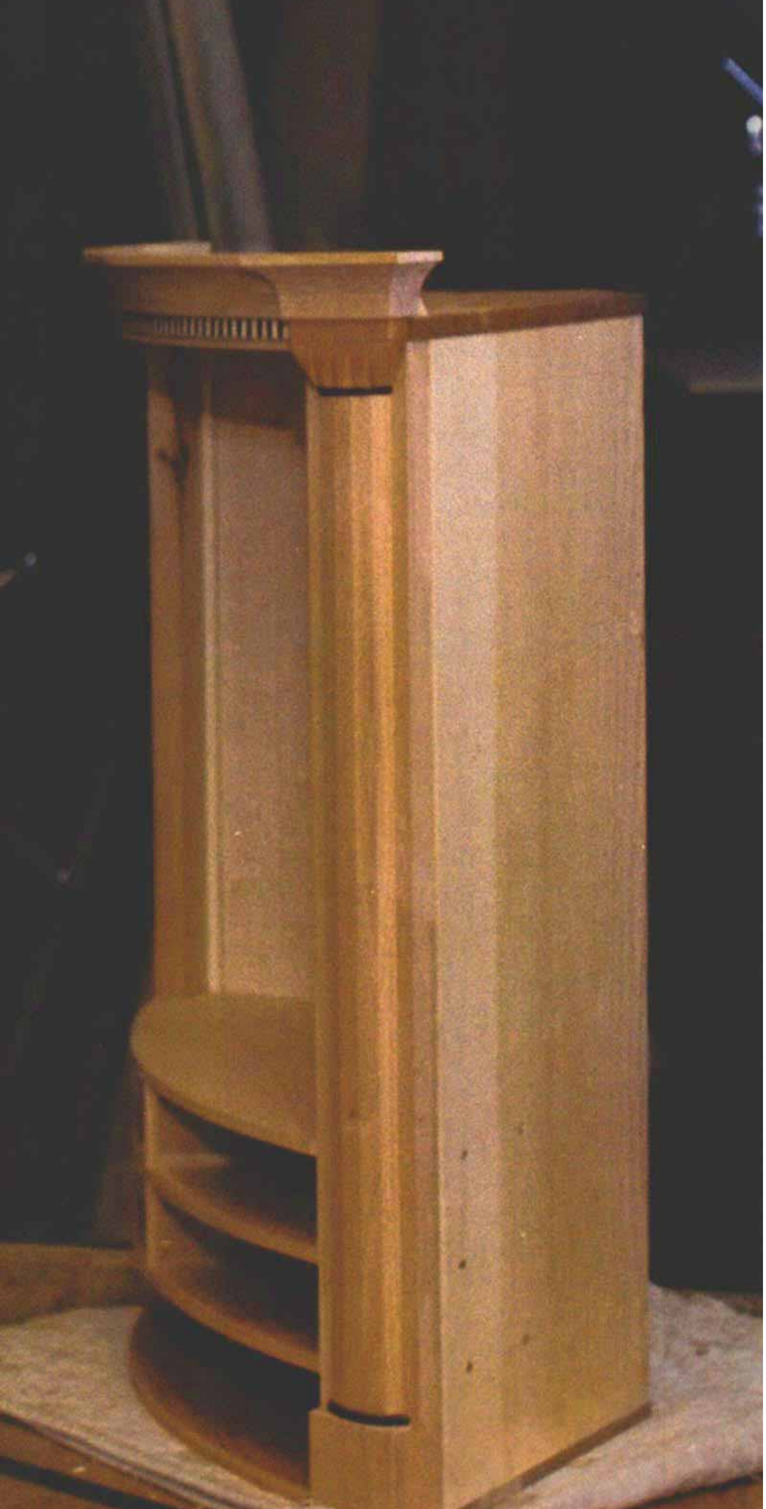
Coopering a Door

Accurately beveled staves produce a graceful curve

by Garrett Hack



Before I went to woodworking school, all of my work tended to be flat, straight and square. It wasn't intentional. Rectilinear work was all I had ever seen. When I arrived at school, everyone was designing and building curved forms, making tapered laminations—doing all kinds of curved work. It was a liberating experience to see beyond flat and square.

My first project with curves was a toolbox with a pair of coopered doors. I chose to cooper the doors—that is, to create the curves from a number of relatively narrow, bevel-edged pieces called staves—because I wanted the doors to be solid, not veneered. Coopering seemed like the simplest and best technique.

Coopering has been around since biblical days and has been most commonly used for making barrels and buckets. It appeals to me because it yields predictable results with a minimum of effort, and few tools or special fixtures are required. With careful layout and accurately cut bevels, I can make curved doors (or other furniture elements) of nearly any radius.

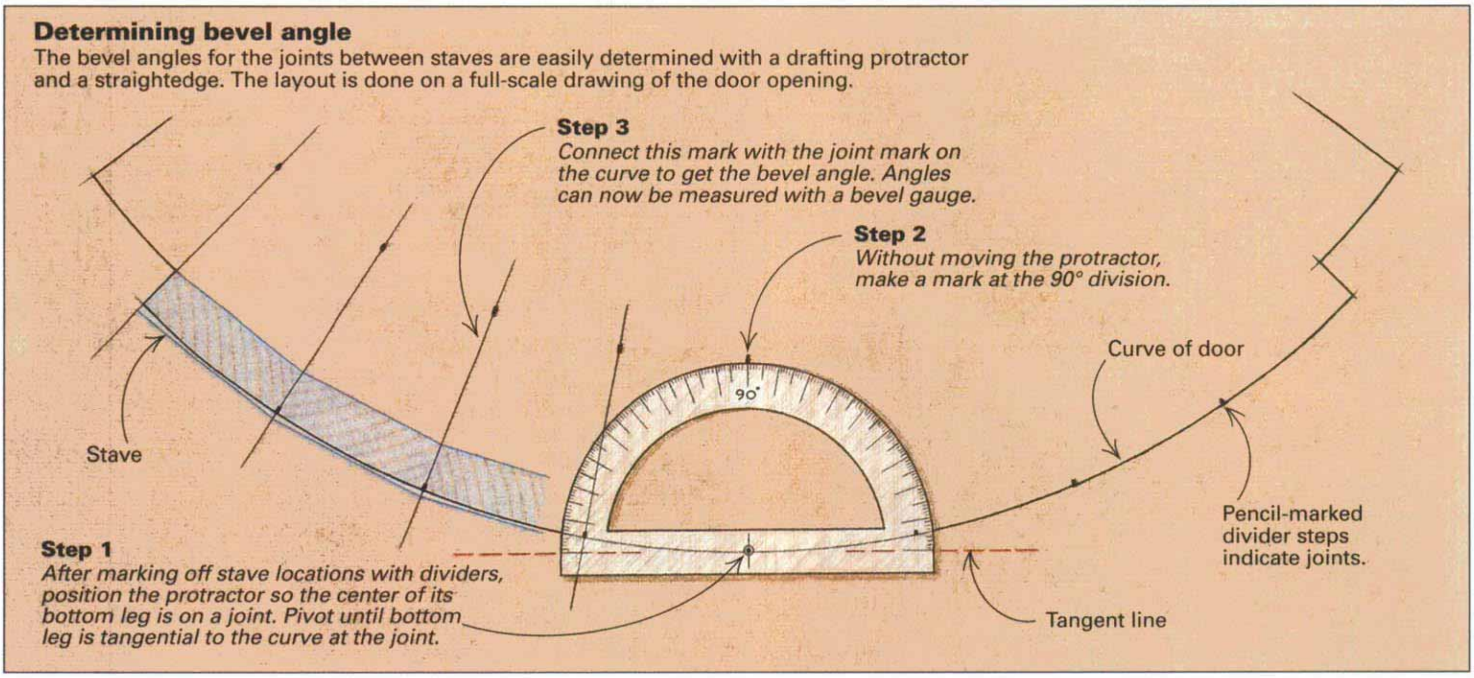
The only real alternative to coopering for making curved doors is laminating, either of solid layers or of veneer over plywood. Although laminating is somewhat stronger than coopering, it requires either carefully matched forms or a vacuum press, and results are less predictable. Laminated curves always have some degree of springback, and it's impossible to know just how much before they come out of the press. If you're willing to make a trial lamination or two to check springback and fine-tune the form, laminating will give you a very strong curved door. I've found, however, that it's not worth the effort for just a door or two.

Coopering is not without its disadvantages, but they're minor. If you want a smooth curve, rather than a faceted one, the whole door must be planed and scraped after assembly because the curve is fashioned from a number of flat pieces. The convex outer face is fairly easy to smooth. And I generally leave the inside faceted, intentionally revealing the method of construction. As for strength, as long as the glue joints are sound, a coopered door should last as long as any flat-panel construction. Also, a coopered door will shrink and swell as any solid timber will, but because of the angles at the joints, it can subtly change shape as it changes dimension. If you're concerned that a single wide door might move too much (its movement will be equal to a board as wide as the length of the curve), make two narrower doors instead.

Curve layout takes place on a pattern

The key to building any coopered door is an accurate pattern. It's on the pattern that I figure the number of staves, their width, thickness and the bevel angle at each joint. Just before assembling the case, I draw a curved pattern from the case top, bottom or even a shelf. Then I build the door to match this curve. I include the case stiles (where the door hinges and latches) on the pattern to make fitting the finished door easier. When making the coopered door for the cabinet shown in the photo at left, I started with the curved,

Laying out and beveling the staves



Record each angle. *Use a bevel gauge to measure the angles on the drawing. Then record them on scrap.*

Transfer angles to the saw. *The author uses the bevel gauge to set the tablesaw blade at the correct angle.*

With the angle set, make the cut. *Cut all the bevels of the same angle before changing the blade angle.*

laminated drawer fronts. I used the shape of the drawers to determine the curve of the case and the pattern for the door.

To establish the number and width of each stave, I used a trial block cut to what I guessed the thickness and width of the completed staves would be. By laying this out around the curve on the pattern and tracing around the block each time, I got a good idea of what the profile of the finished door would look like. This approach allows me to change a trial layout by simply trying a different-sized block.

The more staves you use, the smoother the curve, but for every stave you add, there's another joint to fit and glue. For doors with a nearly consistent curve such as this one (it's a section of an ellipse), I use staves that are all the same width. For asymmetrical curves, increasing the stave width where the curve is flatter simplifies construction. For a tighter curve, narrower staves work better.

If I am going to fair the curves (either just the outside face or both inside and outside), I allow extra thickness for each stave because some material will be planed away. The fewer the staves, the thicker they need to be because more material will have to be removed to create a smooth curve. Superimposing the trial block on the curve of the door drawn on the pattern gives me a good idea of how thick to make my staves.

I rough cut the staves about ¼ in. wider than their final dimension and at least an inch longer. I start out with this much extra because after the bevels have been ripped, I still want to have roughly ¹⁄₁₆ in. per joint to allow for the fitting between each pair of staves and for the final fitting of the door in the case. Any extra material can be trimmed equally from the two outside staves when fitting the door. Once the staves have been milled, I lay them out to get the best color and grain match. I mark each joint so I know which side is the face and which end is up.

Although the trial block tells me how many staves I need, I still have to mark off the exact location of each joint on the drawing. I do this by walking a set of dividers around the curve, marking off equal segments (for a symmetrical curve) from one end of the curve to the other. As the drawing above shows, a pair of staves

Photos: Vincent Laurence; drawing: Vince Babak

Keep checking the door against the drawing. *To avoid having to remove a large amount of material after the door has been glued up, be sure the bevel angle between staves conforms exactly to the full-scale drawing.*

will meet at each of the marks on the curve.

It's not absolutely essential that each pair of staves meet at the same bevel angle, but their surfaces will be flush inside and out if they do. This makes clamping and fairing the curves a bit easier. For a curve that is an arc of a circle, each bevel angle is the same. For any other curve, I determine the bevel angle at each joint by bisecting the angle formed by the two staves. The easiest way to do this is to draw a line perpendicular to the tangent of the curve at each joint (see the drawing). Then I take a bevel gauge and transfer the angle from the drawing to a piece of scrap I call a bevel board (see the photo at left on the facing page). All the angles are now safely recorded.

Rip bevels on the tablesaw; joint with a handplane

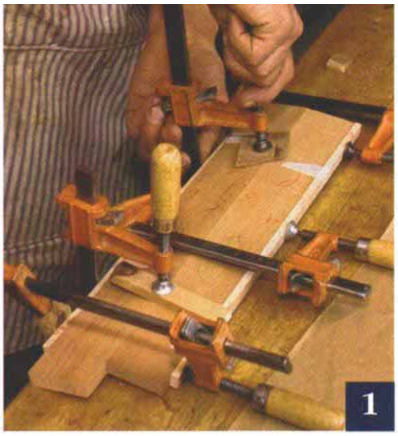
I set the blade angle on the tablesaw by referring to my bevel board (see the center photo on the facing page). To bevel the first edge, I set the fence ⅛ in. or so wider than the stave's final width and passed the stave over the saw with a jointed edge against the fence (see the photo at right on the facing page). In general, if there are any other bevels that need to be sawn at the same angle, I'll rip them all before changing the blade angle. It's easy to get a stave oriented incorrectly, so I double-check every setup.

For the second edge on a stave, I set the fence so the stave was about $1/16$ in. over its final width. Repeatedly resetting the tablesaw blade angle and fence for all the bevels results in slight differences in stave width, but it doesn't affect the result.

To get good glue joints, I jointed the tablesawn bevels with a No. 5 jack plane. (For a taller door, I would use a longer plane.) This also let me fine-tune the bevels. I started with the first stave in the curve and clamped it in a shoulder vise at a comfortable height. I took a very light cut, just enough to get a straight, polished edge. Then I did the same to the matching joint in the next stave. After shooting both bevels, I held the staves together on the pattern and checked for fit. (If need be, I can reshoot one of the bevels, taking a slightly heavier shaving toward one side of the edge or the other until the stave angles match the pattern exactly.) Before gluing

Gluing the door

Gluing up an entire door at once would be nearly impossible, so the author starts with a pair of staves and then adds one stave at a time as the glue cures. When clamping the first pair (1), downward pressure helps close the joint on its outside face. Cauls that match the faceted inside curve of the door can make clamping the joints much easier as staves are added (2). On this door, the author glued up two halves separately; then he joined the two in a final glue-up (3).



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them, I jointed the second bevel on the second stave. I wanted the back of this door faceted, so I also finish-planed the inside surfaces of both staves. If I had wanted the inside surface to be a smooth curve like the outside, I'd have skipped this step.

Glue and clamp just one joint at a time

Gluing the staves together is, without a doubt, the trickiest part of coopering, often demanding some creativity. The trick is to exert pressure evenly across the joint so that it doesn't open up either on the inside or outside. Many strategies will work: using shaped cauls, driving pinch dogs in the ends of the staves, gluing pine blocks to the faces of the staves temporarily to get a good clamping angle (with a sheet of paper in the joint so they can be broken off cleanly afterward), or just rubbing a joint together and holding it for a few minutes until the glue grabs. I always try to use the simplest clamping method that suits the scale and curvature of the door.

You can use a spline, a few biscuits or even brads (with their heads cut off) to help maintain alignment when gluing staves together. For a door this small, alignment was not very difficult. I just took the time to get it right when clamping each joint.

The bevel angles for this door were close enough to 90° that I was able to clamp them almost as I would two square-edged boards. You may find it helpful, as I did, to exert pressure both across and down onto the joint to close it up on the outside face. I used three clamps across the top side of the staves and then clamped right into the joint (using cauls to prevent marring) against the top of my bench (see the top photo at left).

For this door, I glued up two halves, one stave at a time, and then joined these two assemblies together. Because there were an odd number of staves, one-half had four staves, and one-half had only three. I glued up the first pair of staves for each half and let the glue cure before adding the next pieces. Building the doors a piece at a time makes the glue-up slower but much more manageable. Cauls can help. To glue the third stave to the first pair, I shaped two cauls with a bandsaw and block plane. I clamped the staves to these cauls and clamped across the joint with light bar clamps. Because the angle between staves can change as you work your way around the curve, the cauls may have to be reshaped (see the center photo).

When I spread glue on a joint, I kept it very thin toward the inside surface so that there would be little or no squeeze-out to clean up afterward. Nevertheless, I still used a rabbet plane and a small scraper that I ground to the angle between staves to get the inside joints sharp and distinct. I reshaped the scraper with a fine file to fit each successive joint.

Before gluing on each successive stave, I checked the joint against the pattern by holding the stave tight to the ones already glued together. I fine-tuned when necessary and finish-planed the inside surface. The final glue-up—connecting the two assemblies, one with the first four staves and the other with the last three staves—was the most complicated. It required another pair of shaped cauls and battens (see the photo at left). Even so, it wasn't that unwieldy because there was only one joint to worry about.

Fit the door to its opening

After the door was assembled, it was about an inch taller and just slightly wider than its opening. I crosscut the door on the tablesaw, leaving it slightly long to allow for a precise fitting after I'd cut it to width (see the top left photo on the facing page).

To fit to width, the hinging and closing edges need to be beveled to match their respective stiles. I could have cut these edges when I was beveling the staves initially, but I decided to keep them wide so no harm would be done by the inevitable clamping dings. Because I was very close to the width of the opening, I just took the bevel angles off the pattern and planed them by hand, checking as I went with a bevel gauge.

Once I had the door cut very nearly to width (the final fitting took place after it was hung), I planed its ends to length so that it would fit snugly, but all the way into its opening. Then, with the door in its opening, I traced a light pencil line of the curve around the top and bottom edges (see the bottom left photo). This gave me reference lines to plane to when fairing the outside to a smooth curve. For designs where the door's final shape can't be traced so easily, another possibility is to cut out the paper pattern and transfer it to the ends of the door.

I shaped the outside with a block plane, working initially across the grain and at a diagonal, paying attention to the reference lines on the top and bottom edges (see the photo below right). Most of the wood to be removed is at the joints. This is also when I fine-tune the shape of the door by checking it in its opening often. Planing the door to match the case opening precisely may leave the door slightly thinner in places, but it's hardly ever noticeable. For the final smoothing, I use a scraper and fine sandpaper.

The inside is harder to plane to a smooth shape. Coopers use a stoup plane with a doubly compassed sole. When I want a smooth inside face, I use spokeshaves and shaped scrapers.

Once you understand the basic technique, it's not that great a leap to make a tapered door with tapered staves or even one curved in three dimensions. By tapering the staves, steam-bending them to shape and then shooting the joints between them, you can cooper some dramatic curves. But you don't need to go this far to add a pair of elegant doors to your next project. □

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Fitting the door

With the glue fully cured, the door can be cut to the right height on a tablesaw (1). The author strives for a snug fit. Pencil lines drawn on the top and bottom edges of the door (2) are reference marks that guide the final shaping of the door front (3). When the door has been planed and scraped to the lines, it will be flush with the rest of the case.

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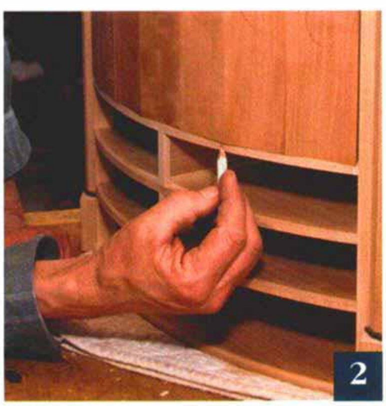

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