A man with grey hair, wearing a dark blue zip-up jacket, is in a workshop. He is holding a large, curved wooden door panel with both hands, fitting it into a tall, narrow wooden cabinet. The cabinet has a curved, fluted design. The workshop background shows wooden cabinets, a workbench with various tools, and a window with a view of trees.

Curved, Veneered Doors

No-hassle coopering
is the core of this
low-tech method

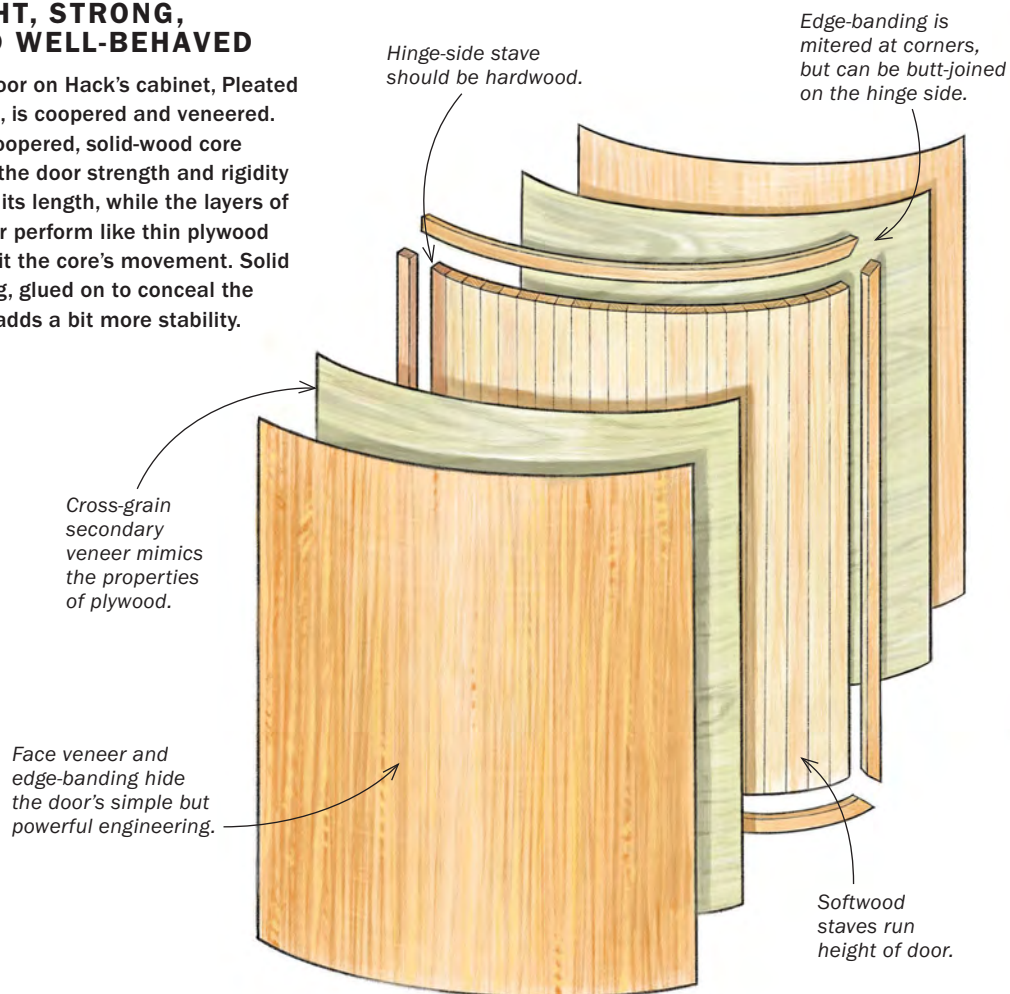
BY GARRETT HACK

A curved door, even one with a slight radius, adds a lot of pizzazz to a piece. I use a traditional technique that gives me consistent results: a coopered core of solid wood with two layers of veneer on each face, their grain at right angles to each other. The result is a curved door that's light, strong, stable, and appealing without the need for a vacuum bag. And thanks to veneer, any look is possible. I've yet to hit the limits of this method. I've made doors as large as 40 in. high and 20 in. wide, as well as ones far smaller, and from $\frac{1}{2}$ in. to 1 in. thick. The technique isn't just for doors, either. I've used it for the curved panels of frame-and-panel doors, for the curved sides of a case piece, and for interesting dividers within. Though it's more work than a flat door, it's a small price to pay for some pizzazz.

LIGHT, STRONG, AND WELL-BEHAVED

The door on Hack's cabinet, Pleated (right), is coopered and veneered.

The coopered, solid-wood core gives the door strength and rigidity along its length, while the layers of veneer perform like thin plywood to limit the core's movement. Solid edging, glued on to conceal the core, adds a bit more stability.



TEMPLATE

Get the shape of the door from a full-size drawing or, better yet, a pattern cut directly from the door opening.



Outside curve comes first. Trace the exterior shape of the opening onto a piece of paper. Use a thin piece of scrap to back up the pencil and keep the paper flat. Cut out this arc with scissors.



Inside curve next. After cutting out the paper, tape it in the opening and use a compass set to the thickness of the door to scribe the line. This gives you the radius of your bending form.



Make a hardwood template. After cutting out the paper template, glue it to a piece of hardwood and saw close to the line for the inner curve. Refine the curve with hand tools.

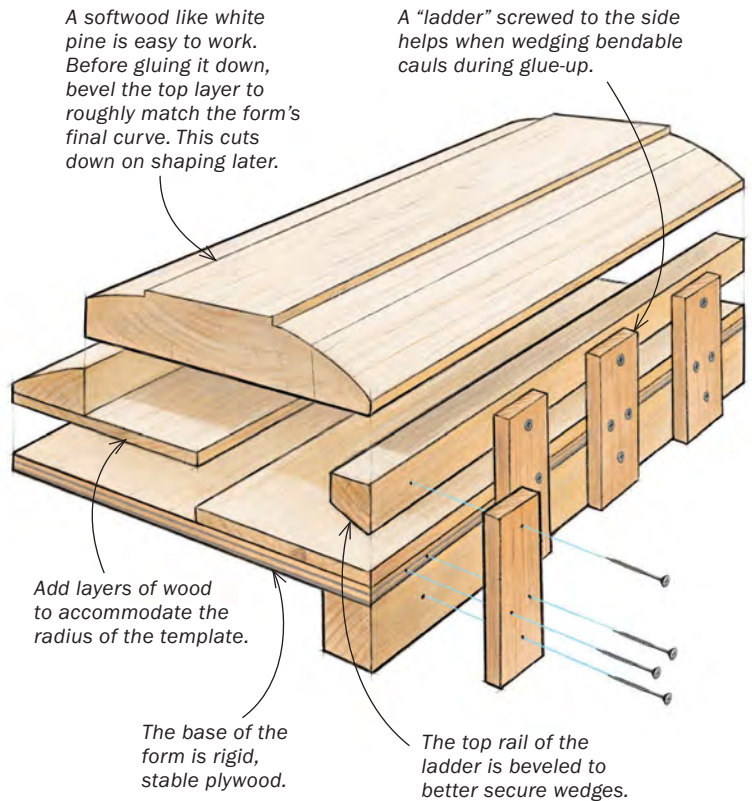
FORM

The form is the foundation of all your glue-ups, so make it accurate. Shape it to match the inside curve of the finished door exactly, since there is no springback to compensate for.



Assemble

Glue up the rough form. Hack clamps where he can, but elsewhere simply nails down the beveled parts to keep them in place while the glue dries.



Shape

Trace the door's curve to the rough form. The hardwood template gives Hack a sturdy reference to scribe against.



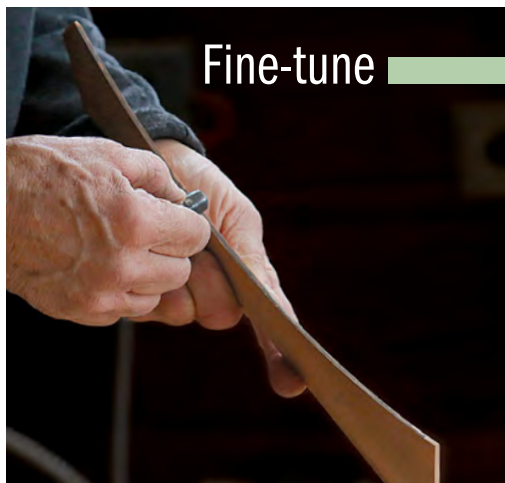
Begin shaping the form. Start with coarse cuts to bring the form nearly to shape, but don't hit your layout lines just yet.



Template and light reveal high spots early on. Regularly hold the template to the form to see where you still need to plane down. Mark these high spots. Be sure to keep the template centered.



Cross-grain cuts knock down ridges. A nimble block plane used cross-grain lets you plane down localized areas easily. Keep the template on hand and check your progress often.



Fine-tune

Crayon and template mark high spots later.

As his form nears its final shape, Hack rubs the bottom of his template with a dark crayon and drags it along the form, again keeping the template centered. The dark lines transferred to the form show where he needs to plane down. These lines should become longer as you refine the form.



Crayon and straightedge mark flatness along length. Rubbing crayon on a straightedge and sliding it back and forth lets you know when the form's flat—a crucial step to ensuring a successful glue-up.



Winding sticks check for twist. To make the winding sticks, joint one edge of a pair of boards and cut the other edge to match the curve of the form. Sight across them to make sure the form is not twisted.

Build the form

The door is built over a curved form that establishes its shape both when coopering the core and laying on the veneer. I make the form out of white pine because it's easy to work. I build it up in layers with the grain running the length of the door, and I make the form at least a couple of inches wider and longer than the finished door.

The pine boards vary in width and thickness to roughly mimic the final curve of the form to expedite shaping. After tracing the curve on an end of the form, shape it with a drawknife and planes. Regularly check that the form is flat along its length and uniform in its curve. When it's done, wax it very well or cover it with packing tape so glue won't stick to it.

Assemble the core

The door's stability starts with a coopered core of stable wood, such as basswood, red or white cedar, mahogany, or white pine.



Clamping ladder needs to be rock solid. To help secure bendable cauls, Hack attaches a ladder of sorts to the side of the form. He uses plenty of screws, as it will be under lots of stress.

CORE

The coopered joints don't need to be dead-on. The glue will bridge some gaps, and the veneer will help provide structural integrity.



Bevel



Make the staves. Hack tips the handplane (left) to form angled edges on each stave. These joints don't need to be perfect, so he finds the mating angles by trial and error, correcting each stave as he moves along. An extralong strip against the ladder will help distribute clamping pressure later.



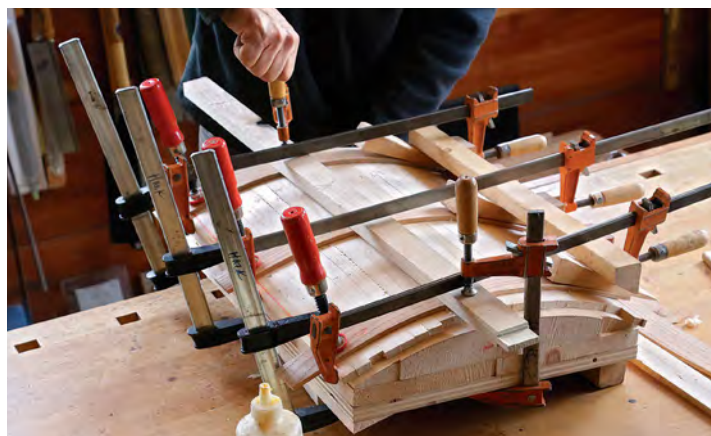
Glue up



Bendable cauls distribute pressure. To get pressure across the face of the core, Hack first wedges $\frac{1}{4}$ -in.-thick, flexible oak cauls under the ladder. He then clamps down their loose ends. A wedge-shaped clamping block under the form prevents the clamps from slipping. An extra, unglued stave, marked with red, helps with the next step.



Clamp across the door. Apply just enough pressure to keep the joints closed without buckling them. For gentler curves, like the one here, a clamp works just fine. For tighter radii, wedges may be the way to go.



Long, centered caul keeps the middle from lifting. Hack calls this his strongback, and it's used to prevent the clamping pressure across the core from pinching the staves out of shape.



Smooth



Fair the core's surfaces. To ensure a good mating surface for the cross-grain veneer, smooth both faces of the core. A plane works well for the convex face. For the concave face, Hack likes sandpaper backed with a thick piece of leather.



Add veneer

Secure the cross-grain veneer to the form. Tape down the veneer so it stays put when you glue it to the core. Keep the tape on the perimeter of the oversize sheet so it doesn't interfere with the joint.



Apply glue to core. An even, generous layer of glue across the core helps create a solid joint without voids. Don't spread glue on the veneer, as moisture from the glue could ripple the stock.

The stave on the hinge side is an exception. Since it will hold screws, I make it out of cherry or another hardwood.

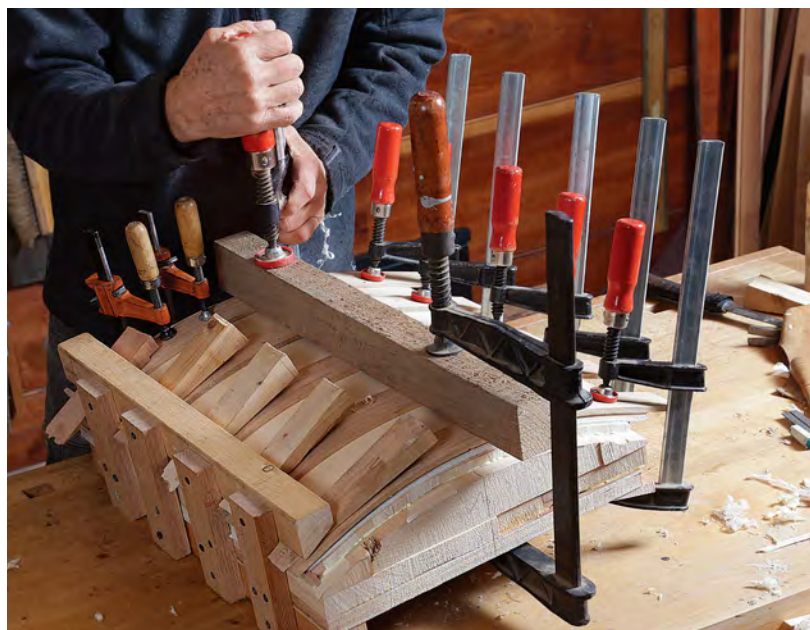
Be mindful of the staves' grain. Quartersawn and straight grain are best, but some riftsawn is OK. Just be sure to orient the pieces so that their face grain is straight. I make them 1 in. or so longer than the finished door.

The thickness of the staves should be the final thickness of the door minus the thickness of the four veneer layers. Buy or make these veneers before starting the core.

The curve of the door dictates the width of the staves. For a slight curve they could be 1 in. wide, whereas for a tighter bend they may need to be closer to $\frac{1}{2}$ in. wide. That's what I used for the door shown here. I don't fret about some randomness in their width since I fit them as I go. Keep in mind that the narrower the staves the more fair their curve will be before smoothing.

The stave joints don't need to be perfect. Glue will help fill gaps, and the two layers of veneer on each face will also hold the assembly together. I simply plane each bevel by eye, checking the fit of adjacent staves on the form. What is critical, however, is that the staves' edges are parallel along their length.

Gluing up the staves involves strategic clamping, flexible cauls, and plenty of glue. Also, if the door is very wide or very curved,



Wedges, cauls, and clamps. When clamping the cross-grain veneer, Hack uses three sheets of thin bendable plywood under the oak strips to distribute pressure. He also clamps the strips this time before wedging them so they don't shift the coopered core.

DOOR

With the cross-grain veneer in place, trim the door to size, then add edge-banding.

Sizing



Trim the core roughly to shape. Hack uses a bandsaw and cuts close to his line. When sizing the core, be careful not to saw off the hardwood hinge-side stave.

I recommend gluing it up in two stages, as I did for this one.

When the glue is set, fair the core's outside face with a block plane and its inside face with coarse sandpaper. Neither face needs to be perfect; the veneer will bridge any small variations.

Add the first veneer layer

The grain of the first layer of veneer runs perpendicular to the door's length. This layer can be made from whatever secondary wood is most convenient. For both this and the face veneer, avoid thin stock, such as most commercial veneer. My experience is that the moisture from the glue often ripples these. I prefer veneer closer to $\frac{1}{16}$ in. thick, which has no such problem. Thick veneer also gives me a little extra to plane when fitting the partially completed door later on. All four sheets should be at least 1 in. longer and wider than the core so you can easily tape them to the form.

When applying the cross-grain veneer, tape it down so it doesn't move when you apply clamping pressure. I also layer on a few cauls of bending plywood. Aside from these, the clamping arrangement is the same as when you glued up the staves, except there's no need to clamp across the door.

As for which glue to use, Titebond Original is a simple, dependable, and non-toxic option that works well for quickly gluing the veneers. For a larger door where I need more open time to position things and get clamps on, Titebond III is good. I've also had good



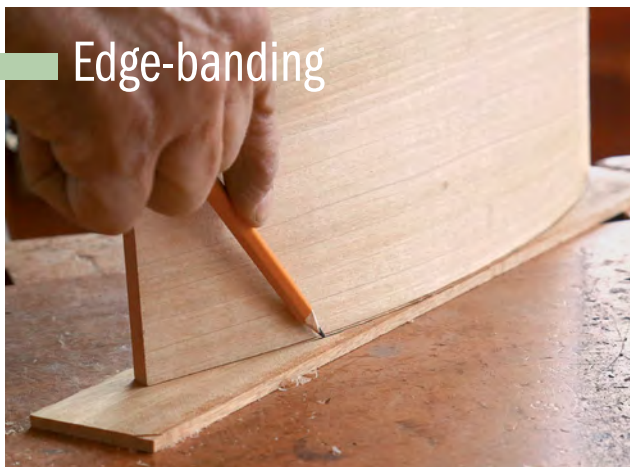
Bevel the edges of the side staves. Set a bevel gauge to the angle of the opening and plane the sides of the door to match. The hinge side should mate perfectly, but Hack slightly undercuts the other side so the door closes more easily.



Door size should account for edge-banding. When setting the door gaps, use two pieces of edge-banding as shims. Trim the door until the spacing is what you want. At this point, tight is better than loose.

Edge-banding

The edge-banding wraps around the door, giving it the look of solid wood, especially if the edging is the same species as the face veneer. Applying it before the face veneer makes the edge-banding stronger and helps it look natural.



Make the edge-banding. Use the door itself when tracing the curved pieces. Cut them out overwide at the bandsaw. Rip the straight pieces, also overwide, for the side edges.



Miters with paring block. Hack miters the edge-banding for the door's two outside corners. On the hinge side, where the joint won't be seen, he uses a simple butt joint.



Use tape and clamps for curved ends. Hack relies on green tape because it's very elastic. To protect the edge-banding, he uses the hardwood template as a caul.



Tape only for the sides. To ensure there's enough pressure, make sure the tape's pulled taut across the joint. Flush up the edge-banding before adding the final layer of veneer.

results with polyurethane glue, which I like because it imparts no moisture and won't ripple thin veneer; but it is a mess to clean up and the foaming pressure can blow glue right through the veneer.

After gluing on the cross-grain veneers, I cut the door to size and check how it fits in its opening. Fine-tune its shape by planing away a little here or adding some thin veneer there.

Add the edge-banding

The edge-banding, which wraps around the whole door, adds strength and enhances the illusion that the door is made of solid wood. You'll need curved pieces for the top and bottom of the door, and straight pieces for the sides. Cut them overwide. This extra material lets you flush up the stock later even if it slips during the glue-up. With these edge-banding pieces planed to a consistent thickness, use them as you dial in the desired gaps around the door.

When the gaps look good, glue on the edge-banding. The pieces can be mitered at all the corners, though on the hinge side they could be butted instead, since those joints are unlikely to be seen. Having them butted is helpful if you need to fit the door

DOOR

Glue on the face veneers following the same sequence you used for the cross-grain veneer.



Face veneer

Follow the same clamping steps. After gluing and clamping the face veneer, make sure there's even squeeze-out along the seams. Adjust your clamping as necessary.



After the glue-up, use a spacer when trimming the veneer. Shimming out the knife lets you clean up the joint with a plane later.



End grain may need to be cut flush without spacer. Veneer with wily grain may chip as it's cut to rough length. If this happens, forgo the spacer and take light cuts with the knife.



Finish up the edge-banding. Use a finely set plane to bring the face veneer flush with the edge-banding. Then, plane a chamfer the depth of the veneer. With a good color and grain match on the edging and face veneer, the joint disappears.

a little more, because these pieces can be planed some without much worry. You're rather limited planing mitered pieces, because changing their thickness can make the joints uneven.

Before the face veneers can go on, plane the edge-banding flush with the door. Work with the grain to avoid tearout, which would appear as gaps under the face veneer.

Now apply the face veneers

The face veneers go on using the same steps as you used for the cross-grain veneers, only their grain runs vertically. After both faces are on and the glue has set, trim and plane off the excess and add a slight chamfer to hide the joint. □

Garrett Hack makes furniture in Thetford Center, Vt.

