

Lamination Delivers Beautiful Curves

First phase of chair project is a complete lesson in bent lamination

BY MICHAEL C. FORTUNE



The Garden Chair, Part 1

This two-part series on building a comfortable, durable outdoor chair starts with the curved, bent-laminated parts: the sweeping arms and the seat and back slats. Part 2 will cover the flat parts and step-by-step assembly.

I own several classic but tired Adirondack chairs. While they are comfortable enough for reading or relaxing, they can be difficult to get in and out of. So a few years ago, I decided to redesign the classic with better ergonomics. But I didn't stop there. The graceful arc of day-lily leaves and the bloom-laden stalks in my garden inspired me to add organic curves and really make this garden chair my own.

The first version of this chair was simple (see "Three Outdoor Chairs," *FWW* #212). I designed that one with the swooping curved arms you see here, but I made the seat and back slats flat to bring the chair to a lower price point. On this version, I curved the slats for comfort. It's the same way I would do it for myself.

What makes those long curves possible, particularly in the broad

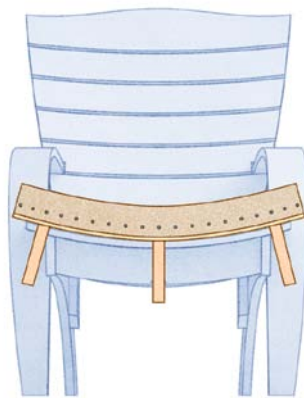
arms, is bent lamination—basically, clamping a stack of thin plies onto a curved form for glue-up. That's where the chair project begins. I'll cover the process in depth here, giving you all the secrets to success that I've learned over 40 years of making curved furniture. Bent lamination is surprisingly straightforward once you understand the basic steps. Learn them and you'll take your furniture designs to a new level.

I chose to make this chair in mahogany, but white oak, hemlock, and cedar are also good choices. All stand up to the weather well, and all bend nicely.

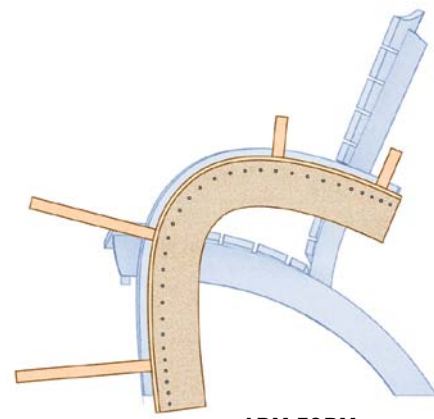
In the next issue (*FWW* #241), I'll tell you how to trim and shape these curved parts, cut out the other parts of this chair, and put everything together with screws and simple joinery.

TWO FORMS DO IT ALL

This chair project requires a number of bent laminations, but only two bending forms. The larger one is for the big, sweeping arms, and the smaller form produces all of the seat and back slats.



SLAT FORM

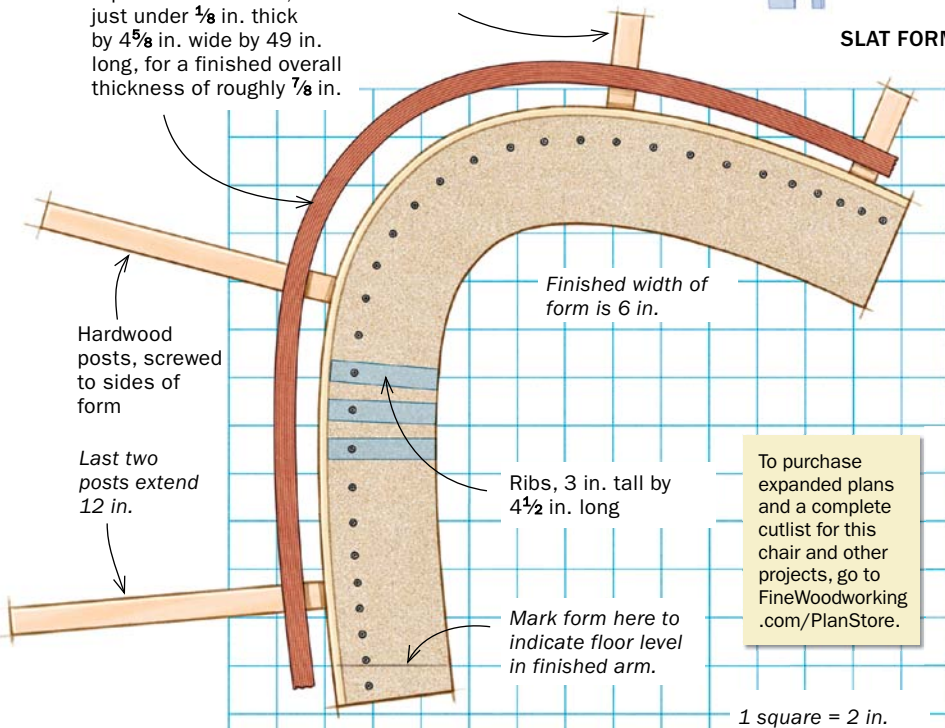


ARM FORM

ONE FOR THE ARMS

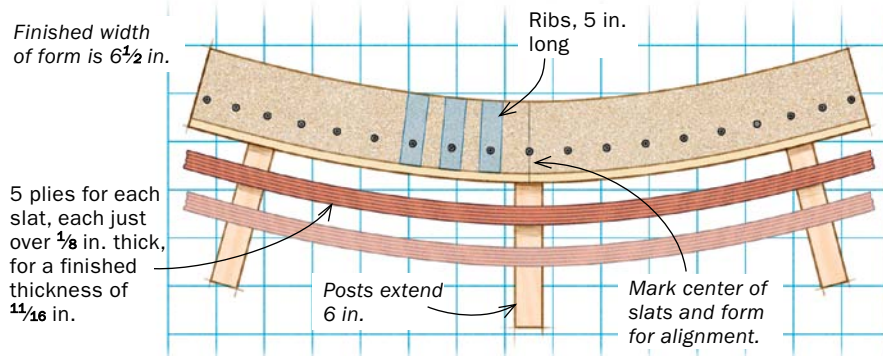
8 plies for each arm, each just under $\frac{1}{8}$ in. thick by $4\frac{5}{8}$ in. wide by 49 in. long, for a finished overall thickness of roughly $\frac{7}{8}$ in.

First two posts extend 4 in.

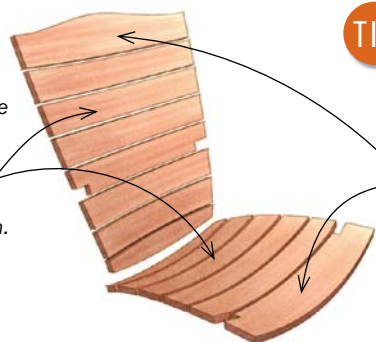


ONE FOR THE SEAT AND BACK SLATS

Finished width of form is $6\frac{1}{2}$ in.



Normal slats are made in pairs from double-wide plies, $6\frac{3}{4}$ in. wide by 26 in. long. Finished dimensions are 3 in. wide by 25 in. long after sawing in half and trimming.

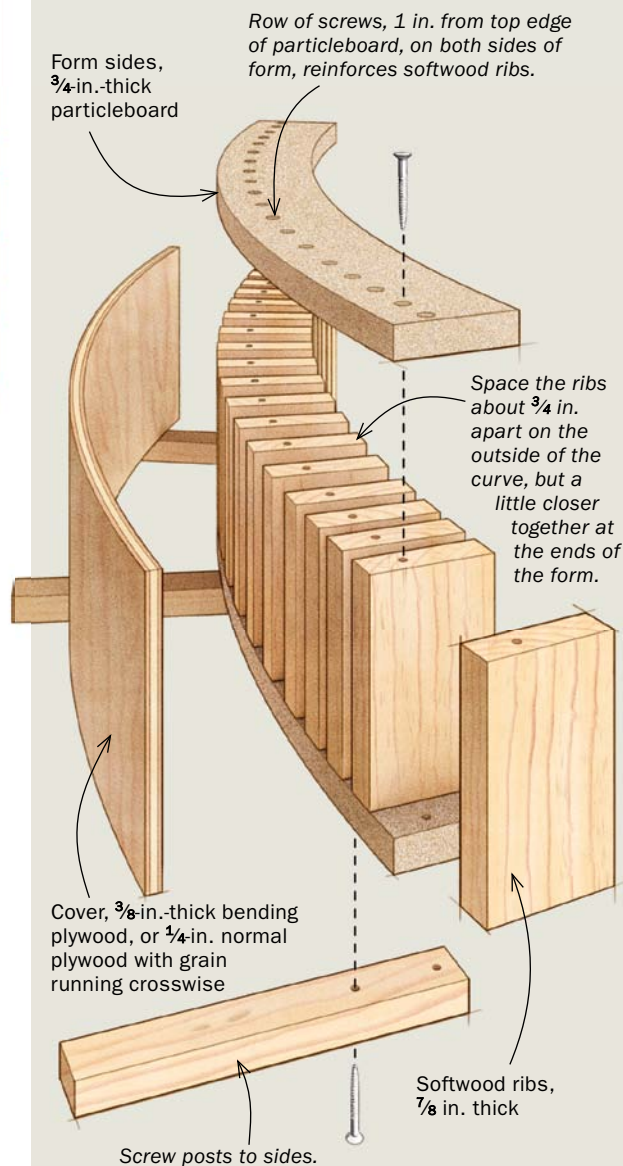


TIP You can glue two stacks of slat plies at a time to speed up the laminating process.

Front and crest slats start with $4\frac{5}{8}$ -in.-wide by 28-in.-long plies, finishing at $4\frac{1}{2}$ in. wide by 26 in. long.

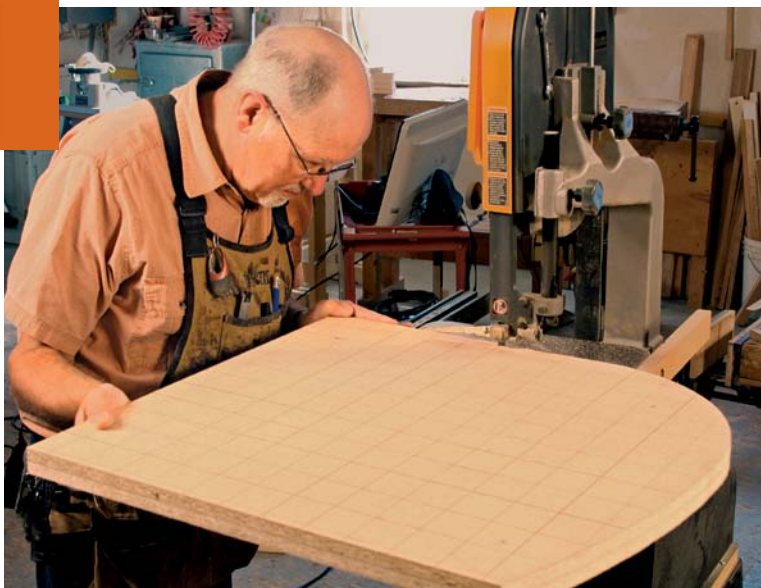
STRONG YET MANAGEABLE

Rather than make his forms from a full stack of heavy material, Fortune uses particleboard only for the sides, connecting those pieces with pine ribs and nailing a flexible cover to the front. His method creates a sturdy, lightweight form.



BUILD THE BENDING FORMS

Cut two sides at once. Nail together the two pieces of particleboard that will serve as the sides of the bending form, and saw their curves at the same time. Leave the nail heads proud so you can pull them out later.



Smooth forms make smooth curves

This chair requires two bending forms: one for the arms and one for the slats. I had to figure out all of the curves and angles using a series of full-size drawings, but things will be much easier for you. I'll include scaled patterns for all curves and parts, and templates that include all joinery.

Both forms must be fairly wide, so rather than making them by stacking particleboard into a back-breaking slab, I place softwood ribs between two outer layers of particleboard, and then cover everything with a layer of $\frac{3}{8}$ -in.-thick bending plywood. Normal $\frac{1}{4}$ -in. plywood will also work if you cut it so the grain runs across the width.

Lay out a grid on a piece of $\frac{3}{4}$ -in.-thick particleboard and transfer the shape from

ALIGN RIB BLOCKS FLUSH WITH CURVE



Corners of blocks flush with outside of curve



Add the ribs. The softwood ribs go on with white glue (for more working time) and a simple rub joint. Their corners should be just flush with the outside of the curve.



Now the cover. After you tack on the second side of the form with an air nailer and reinforce it with screws, cover the curve with a thin layer of bending plywood, attached with more glue and nails. Be sure it is flush with the sides.



Posts keep the plies aligned. Wax them to keep squeeze-out from sticking. Don't use packing tape, because it could get caught between the plies during clamping.

the grid on p. 51. You don't need to match my curves exactly, but you should try to hit the same end points. The goal is to be smooth and fair all the way around. Cut as close to the lines as you can on the bandsaw, and you shouldn't need to do much, if any, sanding.

After assembling the forms, screw on the posts that align the plies. Note that these are taller as they go along.

Tips and tricks for resawing

There is a fair amount of resawing in this project, so it's important that your bandsaw be set up well (see "Five Tips for Better Bandsawing," *FWW* #173). I recommend a sharp, $\frac{1}{2}$ -in., 3 tpi, skip-tooth blade, tracked on the middle of the upper wheel.

Photos, except where noted: Asa Christiana

Also, make sure the fence is aligned to the miter slot.

The arms are made from eight plies that end up at roughly $\frac{7}{8}$ in. thick. Resaw the plies at a little more than $\frac{1}{8}$ in. thick. Different woods bend differently, so you should cut a few test plies first and bend them around the form by hand. You want them as thick as possible, without the stack requiring very heavy clamping pressure. Too thick and the curve might spring back over time as the glue “creeps.” Too thin and you’ll have too many gluelines and too much water-based glue in the lamination, increasing the risk that the curve will contract as it dries.

You should be able to get all of the plies for each arm from a length of $\frac{8}{4}$ stock. Joint one face and one edge, and thickness-plane the other face parallel. That way you can work inward from both sides of the board.

I like to keep my plies in order using the triangle-marking method on the edge of the board. Before the board is cut, while the grain is easy to see, I also mark the grain direction there with a diagonal slash.

Joint or plane the board after each pair of resaw cuts. When you’re done, each ply will have one planed and one bandsawn face. Use the thickness planer to smooth that last face. Some planers can handle thin pieces, but on others the cutterhead won’t drop low enough or it will tend to chew up very thin stock. If yours is one of the latter, here are a few great tricks. First, put a melamine bed in your planer, with a simple cleat on the front end to keep it in place. That will raise the bed, and make it slicker. Of course, check the line you drew on the edge of each ply to be sure it enters the machine with the grain sloping downward. See the center photo at right for a few other tricks.

Smart sandwich

You now know how to make a great form for bent laminations, but to spread clamp pressure for tight, flawless gluelines, you’ll need to prepare a series of flexible bands to overlay your stack of plies.

The most important layer holds a row of hardwood blocks, one under each clamp, to act as cauls that spread pressure across the width and let you use just one row of clamps. The blocks are attached to a long piece of $\frac{1}{4}$ -in. bending ply, or normal plywood with the grain running



Resaw session. The keys to good resaw cuts are careful bandsaw setup, the right blade, and a four-square blank, so you can resaw from both faces. Joint the blank after each pair of slices, switching to the planer when the blank gets thin.



Planer tricks. Plane the bandsawn face of each ply to smooth it and bring the stack to the right overall thickness. Benchtop planers have trouble with very thin stock. The solution is a slippery melamine bed, and levering the plies downward as shown, which keeps their front edge from getting pulled upward into the cutterhead. Skewing them slightly sideways also helps.

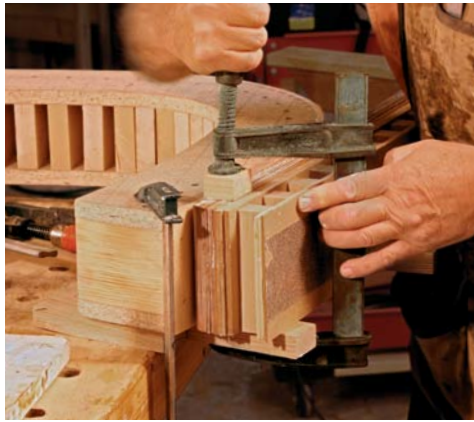
TIP

Glue a whole stack at once. Once the Titebond III goes on, the clock is ticking. You need glue on only one side of each ply, so tape down all the plies but one in a big, seamless sheet. Now you can apply glue all at once with a $\frac{1}{32}$ -in. notched spreader.



SECRETS TO A SEAMLESS BEND

Once the glue goes on, you need to move as fast as possible. That means having everything ready to go. The other keys are keeping the edges of plies aligned, and clamping in a row so squeeze-out is not trapped in the lamination.

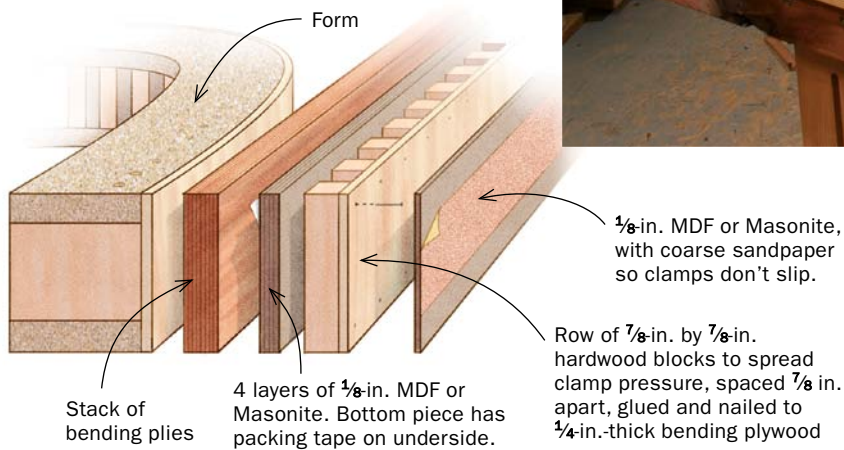


First clamp goes sideways. Using a small waxed wood block, clamp the plies against the first post.



VIDEO WORKSHOP

Watch Fortune build this chair from start to finish in a members-only video at FineWoodworking.com/extras.



All in a row. It is best to work with the form lying down. Start at one end and work clamp by clamp toward the other end, using a stand to support all the plies and parts, especially at the beginning.



Lots more clamps. It took 20 F-style clamps to complete this glue-up. Note the additional sideways clamps over the posts that keep the plies aligned.





Slat form sits upright. The seat and back slats on this outdoor chair have a shallow curve. So Fortune attaches legs to the form and stands it upright. That means it is easier to start clamping in the center in this case, and work toward both ends.

crosswise. In addition, you'll use five layers of $\frac{1}{8}$ -in. Masonite, four inside the layer with blocks and one outside. Note that the outside layer of Masonite has coarse sandpaper glued to it to prevent the clamps from slipping. Use real glue, not spray adhesive, or the sandpaper will slip. I recommend F-style bar clamps, and for this long glue-up you'll need about 20 of them.

Because this chair will live outdoors, I use Titebond III for its waterproof qualities. It also has longer working time, which allows you at least 20 minutes to apply

glue to one face of all the plies and get all the clamps on. Laminations require a surprising amount of glue, so you'll need to have a gallon or so on hand.

Be sure to leave each lamination clamped to the form for at least eight hours. After each part is removed from the form, put a clamp across the ends to keep the curve from expanding as the glue continues to cure, at least another 24 hours. You'll get a tiny amount of springback on the big arm curves, but no more than $\frac{1}{8}$ in., not enough to cause any trouble. You can fill

the time between laminating the curves by working on other parts of the chair.

A few tips for the seat and back slats

There are two sizes for the back slats, but both are the same finished thickness and are made up of five plies. The crest slat on the chair's back and the front slat on the seat are wider than the rest, so I make these one at a time. The others are narrower so I make them in pairs. With such a shallow curve, you can glue up two stacks at a time. Put paper or plastic between the two stacks so they don't get glued together.

Trim one edge square

In Part 2, we'll do a variety of things to these curved pieces, cutting the ends off cleanly, bandsawing curves along the edges, cutting small notches in a few to help carry the weight of the chair's occupant, and drilling holes for screws. But the first step with most bent laminations is jointing one edge straight and square for reference.

That sideways clamping you did on the lamination forms will pay off in a neat stack of plies with even edges. Before you head to the jointer, scrape off the squeeze-out. Hardened glue is murder on jointer knives. Now joint one edge of all the laminations, and you are ready for Part 2. □

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PREP PARTS FOR FURNITURE

Leave the parts on the form for at least eight hours. When you take them off, put a clamp across the ends for another 24 hours to prevent springback while the glue fully cures.



Scrape away squeeze-out. Fortune uses a paint scraper, sharpened on the bench grinder, to scrape all the hardened glue off the edge that will be jointed.



Joint one edge. Curved pieces are easy to joint. Just move the piece in an arc so the area being milled stays at a right angle to the cutterhead. After jointing the arms, place them back on the form and transfer the mark for the floor level. That will help you in Part 2.